Electrical Safety First

The UK's electrical safety experts

Best Practice Guide 8

Selection and use of plug-in socket-outlet test devices

HSE

BestPracticeGuide

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ELECSA
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(Electrical Contractors' Association of Scotland)
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In electronic format, this Guide is intended to be made available free of charge to all interested parties. Further copies may be downloaded from the websites of some of the contributing organisations.

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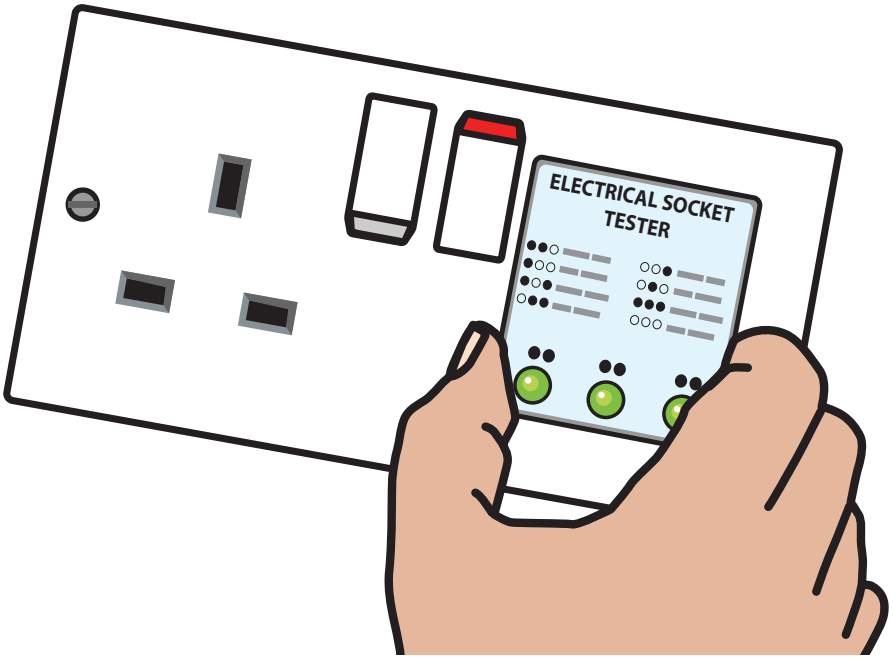
Selection and use of **plug-in socket-outlet** test devices



Aim

The Health and Safety Executive (HSE) has expressed concerns about instances where simple* socket-outlet test devices have been relied on to demonstrate that socket-outlets are 'safe', either as part of the initial verification of newly-installed socket-outlets, or for the periodic testing of existing socket-outlets. This guidance is intended to address those concerns.

No socket-outlet test device (however sophisticated) can be relied on alone to provide full assurance that a socket-outlet is safe to use. This guidance therefore covers not only simple socket-outlet test devices but also those of more advanced designs.

The guidance is intended to supplement the information provided with socket-outlet test devices, which must always be read and followed in order to ensure that the device is used safely and correctly.

The guidance is intended for electrically competent and skilled persons only.

**It is important to distinguish between simple socket-outlet test devices that have been available for many years and are in widespread use, and certain more advanced designs. Most simple socket-outlet test devices indicate basic wiring faults. There are other, more sophisticated, socket-outlet test devices available which will, in addition, display either the range of numerical values into which the earth fault loop impedance falls, or the numerical value of the loop impedance. Such devices are considered to be either 'advanced' or 'professional', rather than 'simple', socket-outlet test devices for the purposes of this Best Practice Guide.*

Introduction

There are a number of proprietary plug-in devices on the market that are designed to give a quick and easy indication of the electrical condition of socket-outlet circuits.

Although all these devices will indicate some of the basic electrical faults that may be found in socket-outlet circuits, the simpler versions cannot be relied on to indicate certain other faults, some of which can be dangerous.

Furthermore, no socket-outlet test device, including an advanced or professional device, can alone provide full assurance that a socket-outlet is safe to use. For example, none can detect an open ring final circuit, a loose electrical connection, a case of unsatisfactory insulation resistance of circuit conductors, or a reversal of the neutral and protective conductors.

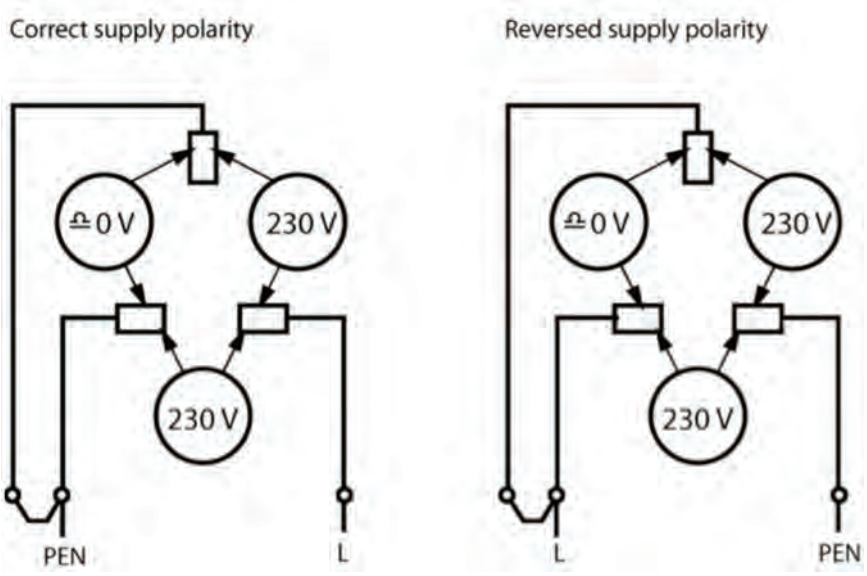
Similar advice applies if a socket-outlet test device is used to test an extension lead.

A further fault that most types of socket-outlet test device cannot detect is a reversal of the line and PEN conductors within the incoming electricity supply to the premises, if the installation forms part of a TN-C-S system. The reason why this potentially dangerous fault cannot be detected by the test device is that the voltages 'seen' by the device between the various contacts of the socket-outlet are unaffected by a reversal in the polarity of the supply, as shown in Fig 1.

Socket-outlet test devices are commonly seen in tool bags but, unfortunately, due to a lack of knowledge of their limitations amongst some users, such devices are often used, inappropriately, as the sole means of checking whether a socket-outlet is safe to put into, or continue in, service.

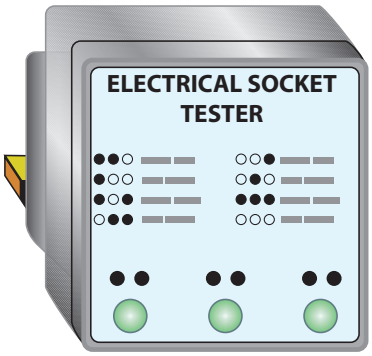
This can only be checked by following the inspection and testing procedures set out in Part 6 of BS 7671, Requirements for Electrical Installations (IEE Wiring Regulations).

Fig 1.
Reversal of polarity in the supply in a TN-C-S system

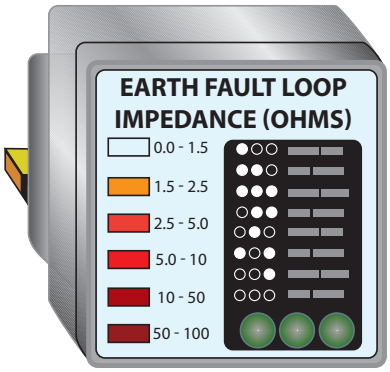


Types of socket-outlet test device

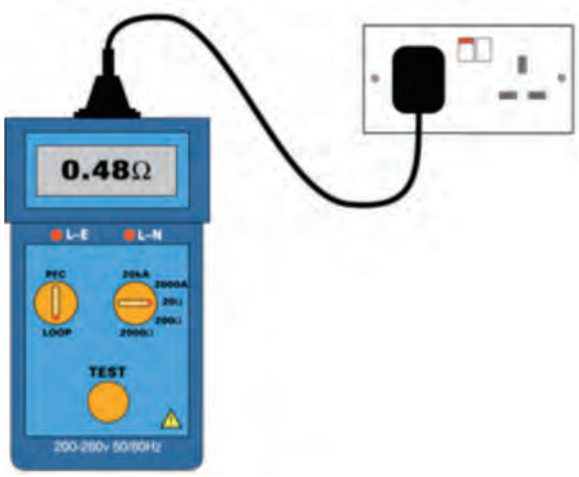
There are three types of socket-outlet test device: simple, advanced and professional. Examples are depicted below.



Simple device



Advanced device



Professional device

Simple devices are designed to detect various faults. However, they cannot indicate or make any measurement of the effectiveness of the protective earthing (the earth fault loop impedance), or identify some other dangerous faults.

Advanced and professional devices are designed to detect a wider range of faults, and can indicate or measure the effectiveness of the protective earthing.

These advanced and professional devices display either the range of numerical values into which the earth fault loop impedance falls or the numerical value of the loop impedance. This information must be interpreted by the user of the socket-outlet test device to determine whether or not the socket-outlet is adequately earthed for safety.

The interpretation process requires knowledge of the maximum value of earth fault loop impedance allowed for the protective device that is relied on to provide automatic disconnection in the event of an earth fault. The maximum value depends on the type and rating of the protective device.

Simple socket-outlet test devices

Simple socket-outlet test devices are usually similar in size and appearance to a 13 A plug and typically cost less than £20 each.

They are useful devices because they will generally indicate whether a socket-outlet is functional and are able to detect certain faults, including, in most cases, reversed live and earth connections or the absence of an earth, which can be very dangerous faults.

However, although simple test devices are able to detect the absence of an earth, they are unable to measure the earth fault loop impedance at the socket-outlet and might therefore imply that it is safe to use even where the earthing is dangerously defective.

This very important fact might not be stated on simple test devices or the associated packaging or instructions, and is also not known by many users of such devices.

Simple socket-outlet test devices can therefore very easily mislead the user into believing a socket-outlet is acceptably safe when it is not.

If the test device does not display either the numerical value of earth fault loop impedance or the range of numerical values into which the loop impedance falls, then it is a simple socket-outlet test device and must not be relied upon to indicate whether a socket-outlet is safe to use.

This is because the test device cannot verify that certain critical safety requirements of BS 7671 are being met, including the adequacy of the protective earthing.

HSE investigations into simple socket-outlet test devices

The HSE tested a sample of simple socket-outlet test devices after an HSE electrical inspector observed various instances where such devices were being used inappropriately.

In two instances where simple socket-outlet test devices had been used to demonstrate to an inspector that socket-outlets in installations forming part of a TN-C-S system were adequately earthed, the inspector found with a professional socket-outlet test device that the earth fault loop impedances at the socket-outlets were 22 Ω and 218 Ω respectively.

Such impedances are far in excess of the maximum values providing automatic disconnection of supply by means of the circuit overcurrent protective device in the event of an earth fault.

Tests undertaken by HSE showed that simple socket-outlet test devices would not indicate a problem unless the earth fault loop impedance exceeded very high values, which could be in excess of 20,000 Ω.

Advanced socket-outlet test devices

Advanced socket-outlet test devices typically cost between £50 and £100.

These devices are more complex than simple ones because they use additional components and technology to determine and indicate earth fault loop impedance. The ease of using advanced devices is intended to encourage more frequent checking of this very important parameter.

They have all the normal check functions of simple test devices, including reversed line and earth or reversed line and neutral.

An advanced device displays the range of numerical values into which the earth fault loop impedance falls. However, there can be cases where this information is not sufficiently precise to indicate whether a socket-outlet is adequately earthed for safety. This depends on the particular range of values and the type and rating of the protective device that is relied on to provide automatic disconnection of supply in the event of an earth fault.

Professional socket-outlet test devices

Professional socket-outlet test devices typically cost several hundreds of pounds.

These devices meet the requirements of BS EN 61557-3. They usually take the form of an earth fault loop impedance test instrument used in conjunction with a lead equipped with plug to suit the socket-outlet that is to be tested.

These devices display the numerical value of the earth fault loop impedance rather than a range of numerical values into which the measurement falls.

Comparison of capabilities of the different socket-outlet test device types

Table 1 summarises the capabilities of the three different types of socket-outlet test device covered in this guide.

Table 1 – Capabilities of simple, advanced and professional socket-outlet test devices

Intended use	Simple	Advanced	Professional	Remarks
Indicate whether socket-outlet is functional	✓	✓	✓	Cannot, alone, indicate whether socket-outlet is safe to use
Detect reversed line and neutral	✓	✓	✓	Does not detect a line and neutral reversal within the supply network of a TN-C-S system (see Note 3)
Detect reversed line and earth	✓	✓	✓	Does not detect a line and neutral reversal within the supply network of a TN-C-S system (see Note 3)
Detect reversed neutral and earth	✘	✘	✘	Requires use of other test instruments (e.g. continuity test instrument)
Detect presence of earth	✓	✓	✓	Does not indicate whether socket-outlet is adequately earthed for safety. **Simple socket-outlet test devices can easily mislead by showing 'Earth OK' (or similar indication) even when earth fault loop impedance is in excess of 20,000 Ohms**
Display the range of numerical values into which earth fault loop impedance falls	✘	✓	✘	Displayed range may not be sufficiently precise in some cases to indicate whether a socket-outlet is adequately earthed for safety
Display numerical value of earth fault loop impedance	✘	✘	✓	Value must be checked to establish that it is not greater than the maximum value for the relevant protective device
May be used to measure values of earth fault loop impedance to certify or report on the installation	✘	✘	✓	Value must be checked to establish that it is not greater than the maximum value for the relevant protective device
Detect open ring final circuit	✘	✘	✘	Requires use of continuity test instrument
Detect loose electrical connection	✘	✘	✘	Requires inspection
Detect unsatisfactory insulation resistance	✘	✘	✘	Requires use of insulation resistance test instrument
Indicate whether RCD will operate effectively	✘	Note 2	✘	Requires use of RCD test instrument
Check whether voltage drop is within required limits	✘	✘	✘	Requires use of voltmeter and load, or ohmmeter and calculation
Check for exposed live parts	✘	✘	✘	Requires inspection

Notes.

1) ✓ Denotes device is capable. ✘ Denotes device is not capable.

2) Some types of advanced test device can carry out a **functional** test of an RCD protecting the socket-outlet.

3) Some socket-outlet test devices do have the ability to detect reversed line and neutral polarity in the supply network. Alternatively, this dangerous condition may be detected by use of an appropriate voltage detection device.

Training for users of socket-outlet test devices

Users of socket-outlet test devices should be trained to:

- use the socket-outlet test device correctly and safely
- know the capabilities **and limitations** of the different types of socket-outlet test device
- understand the types of fault that can be present at a socket-outlet
- identify the means by which the electrical installation is earthed (for example, through an earth terminal provided by the electricity distributor (TN system) or through earth rods (TT system)
- know what earth fault loop impedance means, and what values of earth fault loop impedance are acceptable
- determine whether or not RCD protection is present or should be provided
- know when to take further action.

Initial verification or testing after maintenance

New, repositioned or replaced socket-outlets should not be put into service until the required verification procedures have been completed and it has been established that the requirements of BS 7671 have been met. (Regulation 134.2 refers.)

In particular, for new work, it is unsafe and therefore unacceptable to energise a socket-outlet final circuit and then to plug in a socket-outlet test device to check for basic wiring faults.

Condition Reporting (Periodic Inspection Reporting)

For condition reporting, inspection comprising careful scrutiny and the appropriate tests of Chapter 61 of BS 7671 should be performed.

The appropriate tests on a socket-outlet would normally consist of protective conductor continuity or ring final circuit continuity, insulation resistance, polarity, earth fault loop impedance and functionality, including the correct operation of any RCD protecting the socket-outlet.

Summary

Socket-outlet test devices are useful because they will generally indicate whether a socket-outlet is functional. They are able to detect certain faults, including, in most cases, reversed live and earth connections, which can be very dangerous.

There are three types of socket-outlet test device: simple, advanced and professional.

Although all three types will indicate some of the basic electrical faults that may be found in socket-outlet circuits, the simpler versions cannot make any measurement of the effectiveness of the protective earthing or indicate certain other faults, some of which can be dangerous.

Simple socket-outlet test devices can also very easily mislead the user into believing that a socket-outlet is adequately earthed by showing *'Earth OK'* or similar indication even when the earth fault loop impedance is in excess of 20,000 Ohms.

If a socket-outlet test device cannot display the earth fault loop impedance, it should not be used to check whether a socket-outlet is adequately earthed for safety.

If a socket-outlet test device can display the range of numerical values into which the earth fault loop impedance falls, it may still be necessary in some instances to obtain the numeric value (using a professional socket-outlet test device) to confirm that a socket-outlet is adequately earthed for safety.

No socket-outlet test device (however sophisticated) can be relied on alone to provide full assurance that a socket-outlet is safe to use.

The only means of checking whether a newly installed socket-outlet is safe to put into service, or of determining whether an existing socket-outlet is safe to continue in service as part of a formal electrical installation condition report (periodic inspection report) on the installation, is to follow the inspection and testing procedures set out in Part 6 of BS 7671, using a full set of test instruments complying with the relevant parts of BS EN 61557.

Your Notes

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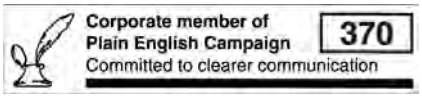

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Electrical Safety First is the UK charity dedicated to reducing deaths and injuries caused by electrical accidents. Our aim is to ensure everyone in the UK can use electricity safely

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