

# Electrical test equipment for use by electricians

Guidance Note GS 38



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**ISBN 978 0 7176 0845 4**  
**Price £3.50**

The guidance in this document is aimed at electrically competent people including electricians, electrical contractors, test supervisors, technicians, managers and/or appliance retailers.

The Electricity at Work Regulations 1989 require those in control of all or part of an electrical system to ensure it is safe to use and maintained. This document provides advice and guidance on how to achieve this.

Guidance Notes are published under five subject headings:

Medical  
Environmental Hygiene  
Chemical Safety  
Plant and Machinery  
**General**

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First published 1995

Reprinted 2002, 2004, 2005, 2007

ISBN 978 0 7176 0845 4

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# INTRODUCTION

1 This document gives guidance to electrically competent people involved in electrical testing, diagnosis and repair. Electrically competent people may include electricians, electrical contractors, test supervisors, technicians, managers or appliance repairers. It offers advice in the selection and use of:

- test probes;
- leads;
- lamps;
- voltage indicating devices;
- measuring equipment

for circuits with rated voltages not exceeding 650V.

# THE LAW

2 The Electricity at Work Regulations 1989 require those in control of part or all of an electrical system to ensure that it is safe to use and that it is maintained in a safe condition. This section does not seek to give a definitive interpretation of the law. It summarises the main issues to be borne in mind when carrying out electrical testing.

3 The most important features that are relevant for electrical test equipment for use by electrically competent people are as follows:

- (a) Equipment should be, so far as reasonably practicable:
  - (i) constructed;
  - (ii) maintained; AND
  - (iii) used in a way to prevent danger.
- (b) No live working unless:
  - (i) it is unreasonable to work dead; AND
  - (ii) it is reasonable to work live; AND
  - (iii) suitable precautions are taken to prevent injury.
- (c) Work must be carried out in a safe manner. Factors to consider when developing safe working practices include:
  - (i) control of risks while working;
  - (ii) control of test areas;
  - (iii) use of suitable tools and clothing;
  - (iv) use of suitable insulated barriers;
  - (v) adequate information;
  - (vi) adequate accompaniment;
  - (vii) adequate space, access, lighting.
- (d) People at work must:
  - (i) prevent danger and injury;
  - (ii) have adequate training, skill and experience;
  - (iii) have adequate supervision when appropriate.

## RISKS

4 Unfortunately experienced electricians have used unsatisfactory electrical test equipment, which has caused serious burns or electric shock. Arcing or 'flashover' caused by poor test probes result in more injuries than electric shocks in electrical testing. Arcs once drawn, ionise surrounding air and cause further 'flashovers'. These can rapidly engulf the working area, before anybody can escape. These accidents can be **FATAL**.

5 Systems where voltages are below 50V ac or 120V dc (extra low voltage) reduce the risk of electric shock to a low level. If system energy levels are low, then arcing is unlikely to cause burns. Where possible it is recommended that tests are carried out at reduced voltages which will usually reduce the risk of injury. Equipment should be constructed with suitably insulated and shrouded terminals to minimise the risk of short circuits, which could be dangerous. For example, batteries can cause a high energy flashover when short circuited.

6 In addition to the risk of electric shock and burn, there could be other risks to consider. For example:

- (a) chemical burns, eg from battery acid;
- (b) falls from ladders or platforms when testing.

## ACCIDENT CAUSES

7 Unsuitable test probes, leads, lamps, voltage indicators and multimeters have caused arcs due to:

- (a) inadequately insulated test probes (typically having an excessive length of bare metal at the contact end) accidentally bridging a live conductor and adjacent earthed metalwork; or
- (b) excessive current drawn through test probes, leads and measuring instruments. This happens when a multimeter is set to the wrong function, eg set on a current or resistance range when measuring voltage.

8 Other causes of accidents which could lead to electric shock are:

- (a) inadequate insulation of test leads and probes;
- (b) exposed live terminations at instruments and indicators;
- (c) a lead falling off one of the terminals of a meter and either the meter terminal or the lead terminal remaining live;
- (d) incorrect use of test equipment, eg a multimeter applied to conductors at a voltage which exceeds the maximum working voltage of the instrument;
- (e) use of poorly constructed makeshift test equipment, eg a test lamp consisting of a combination of a bayonet lamp holder, bulb and two single insulated conductors with bared ends;

- (f) the use of long intertwined leads which were not easily distinguished, resulting in one lead being connected across the instrument and the other short circuiting the live conductors under test.

## DESIGN SAFETY REQUIREMENTS

### Test probes and leads

9 The test probes and leads used in conjunction with a voltmeter, multimeter, electrician's test lamp or voltage indicator should be selected to prevent danger. Good test probes and leads will have the following:

- (a) The probes:
  - (i) have finger barriers or are shaped to guard against inadvertent hand contact with the live conductors under test;
  - (ii) are insulated to leave an exposed metal tip not exceeding 4 mm measured across any surface of the tip. Where practicable it is strongly recommended that this is reduced to 2 mm or less, or that spring loaded retractable screened probes are used;
  - (iii) should have suitable high breaking capacity (hbc), sometimes known as hrc, fuse, or fuses, with a low current rating (usually not exceeding 500 mA), or a current-limiting resistor and a fuse.
- (b) The leads:
  - (i) are adequately insulated (choice of insulating material may be influenced by the environment in which the leads are to be used);
  - (ii) are coloured so that one lead can be easily distinguished from the other;
  - (iii) are flexible and of sufficient capacity for the duty expected of them;
  - (iv) are sheathed to protect against mechanical damage;
  - (v) are long enough for the purpose, while not too long so that they are clumsy or unwieldy;
  - (vi) do not have accessible exposed conductors other than the probe tips, or have live conductors accessible to a person's finger if a lead becomes detached from a probe, indicator or instrument when in use. The test lead or leads are held captive and sealed into the body of the voltage detector.

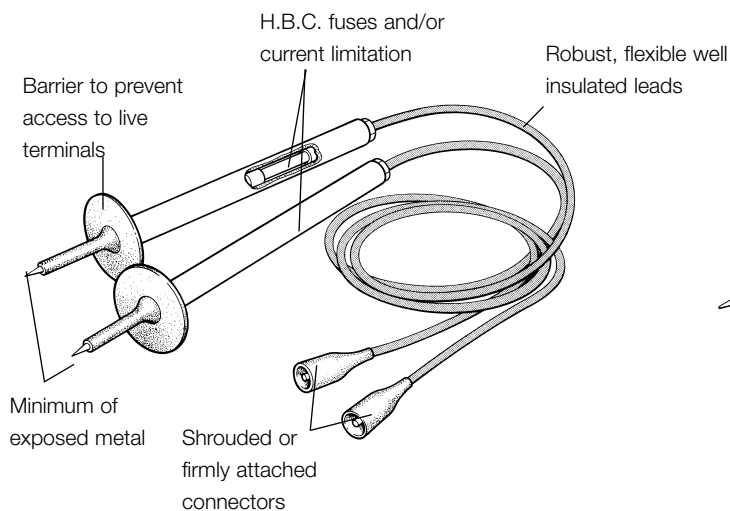


Figure 1: Test probes and leads (recommended type)

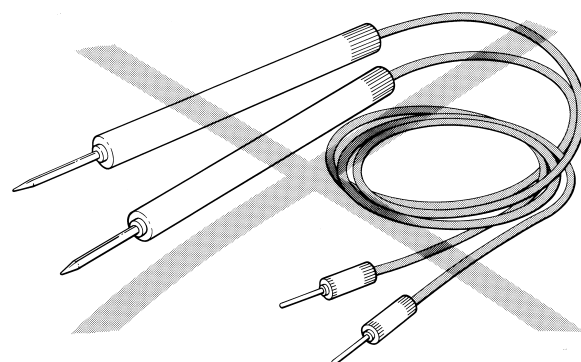


Figure 2: Test probes and leads (not recommended)

10 Probes can be provided with a variety of shapes of tip to allow access to the different types of contact.

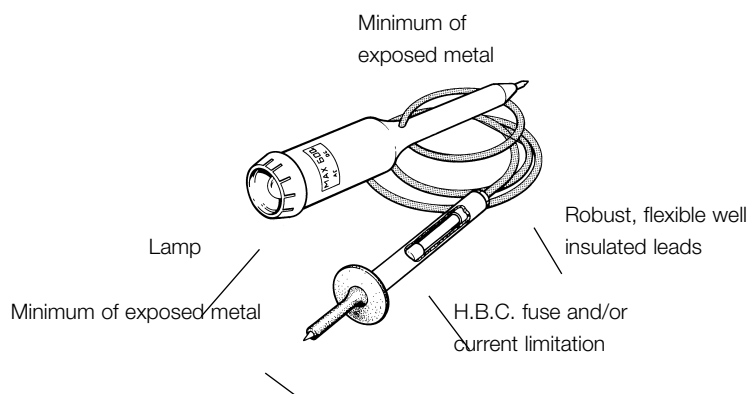
### Sockets and terminals

11 Risks of inadvertent hand or finger contact with any live test socket conductor when the equipment is live need to be reduced. The terminals and test sockets of test equipment may require shrouding.

### Voltage detection instruments

12 Instruments used solely for detecting voltage fall into two categories. These are:

- (a) detectors which rely on an illuminated bulb (test lamp) or a meter scale (test meter). Test lamps fitted with glass bulbs should not give rise to danger if the bulb is broken. It may be protected by a guard.

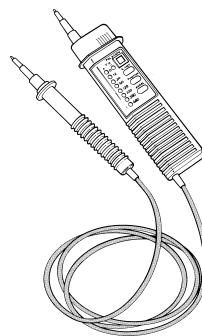


**Figure 3:** Typical test lamp

These detectors require protection against excess current. This may be provided by a suitable high breaking capacity (hbc or hrc) fuse or fuses, with a low current rating (usually not exceeding 500 mA), or by means of a current-limiting resistor and a fuse. These protective devices are housed in the probes themselves. The test lead or leads are held captive and sealed into the body of the voltage detector.

- (b) detectors which use two or more independent indicating systems (one of which may be audible) and limit energy input to the detector by the circuitry used. An example is a 2-pole voltage detector, ie a detector unit with an integral test probe, an interconnecting lead and a second test probe.

These detectors are designed and constructed to limit the current and energy which can flow into the detector. The limitation is usually provided by a combination of circuit design, using the concept of protective impedance, and current limiting resistors built into the test probes. These detectors are provided with in-built test features to check the functioning of the detector before and after use. The interconnecting lead and second test probe are not detachable components. These types of detector **do not** require additional current limiting resistors or hbc fuses to be fitted provided that they are made to an acceptable standard and the contact electrodes are shrouded as in 9(a)(ii).



**Figure 4:** A typical 2-pole voltage detector

13 Test lamps and voltage indicators are recommended to be clearly marked with:

- (a) the maximum voltage which may be tested by the device; and
- (b) any short time rating for the device if applicable. This rating is the recommended maximum current which should pass through the device for a few seconds. These devices are generally not designed to be connected for more than a few seconds.

## SYSTEMS OF WORK

14 The use of test equipment by electricians falls into three main categories:

- (a) testing for voltage (voltage detection);
- (b) measuring voltages; and
- (c) measuring current, resistance and (occasionally) inductance and capacitance.

Item (a) forms an essential part of the procedure for proving a system dead before starting work but may also be associated with simple tests to prove the presence of voltage. Items (b) and (c) are more concerned with commissioning procedures and fault finding.

### Precautions before testing

15 Before testing begins it is essential to establish that the test device including all leads, probes and connectors is suitably rated for the voltages and currents which may be present on the system under test.

16 Before any testing is carried out ensure that:

- (a) the equipment which is to be worked on is safe for the intended tests; and
- (b) the working environment does not present additional dangers. These dangers include:
  - (i) inadequate space to work safely;
  - (ii) an insecure footing;
  - (iii) insufficient light;
  - (iv) potentially flammable gases or vapours;
  - (v) explosive or conductive dusts.



17 Where a test is being made simply to establish the presence or absence of voltage, the preferred method is to use a proprietary test lamp or 2-pole voltage detector suitable for the working voltage of the system rather than a multimeter. Accident history has shown that the use of incorrectly set multimeters or makeshift devices for voltage detection has often caused accidents.

**Note:** Test lamps and some voltage indicators may fail to danger, eg a faulty lamp not indicating a live circuit. These devices should be proved before and after use on a known live source of similar voltage to the circuit under test, or alternatively on a portable test source.

### **Precautions during testing**

18 For voltage detection or measurement, test leads protected by a fuse (or fuses) are recommended when voltmeters and in particular multimeters, are used. Although some multimeters are fitted with electromechanical overload devices, these are often inadequately rated to deal with short circuit energy present on electrical power systems. It is usually necessary to use leads which incorporate high breaking capacity (hbc) fuses even if the multimeter has an overload trip. If terminal clips are provided for connection to test points, they should be adequately insulated and arranged to be suitable for use with the test leads, as a safe alternative to the use of test probes. It is important that a multifunction or multirange meter is set to the correct function and/or range before the connections are made. Where there is doubt about the value of voltage to be detected or measured, the highest range should be selected at first, provided that the maximum voltage possible is known to fall within the range of the instrument.

19 Progressive voltage detection or measurement is often used to prove circuit continuity. The dangers from exposed live conductors should be borne in mind when using this method. In many cases, continuity testing can be carried out safely with the apparatus dead, using a self-contained low voltage dc source and indicator.

20 If tong-test instruments are to be used, it is necessary to check first that there is adequate working space free from danger (ie from bare live conductors at dangerous voltages) at the place where the instrument will be held. The tong insulation should always be examined visually before the instrument is used; if defects are present the instrument should not be used.

**Note:** Special precautions and provisions may be necessary for current measurement in CT secondary circuits and such measurement techniques are outside the scope of the guidance in this document.

21 Where current measurements are to be made using instruments other than insulated tong-test type instruments, the connections should be made with the apparatus dead, and should be made secure before the power is switched on. Any such temporary connections need to be adequately rated both for current and voltage.

22 If regular testing needs to be done, for example on complex control panels, nearby bare live conductors should not be accessible (eg screened) where access is not required. Alternatively, purpose-made screened test points or instrumentation may be provided.

## **Examination of equipment**

23 All items of test equipment, including those items issued on a personal basis, should receive a regular inspection and, where necessary, a test by a competent person. Records are recommended to be kept of inspection and testing of the equipment, particularly where faults are found. These records will help decide how often visual inspection or testing will need to be carried out. It is important that electricians are aware of the kinds of defect which may occur in test equipment. Examples of common faults are:

- (a) cracked meter cases;
- (b) damaged insulation (abrasion, cuts or perishing of flexible insulation);
- (c) loose terminals.

## **Further information**

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