# Small unearthed portable generators

OBJECTIVE

**This article summarises the requirements and guidance related to the use of small unearthed portable generators to supply power tools and lighting in locations where other means of supply are not available.**

## Introduction

While, in general, a properly designed temporary electrical distribution system would be installed to supply site lighting, power tools and equipment, and welfare facilities on an established construction site, there will be instances where this will not be the case or indeed the scale of the work to be carried out does not warrant the installation of such an extensive supply arrangement.

There will also be occasions where electrical equipment needs to be supplied in locations where no public electrical supply is available. This would be the case, for example, at the very early stages of some construction projects and where work is being carried out on buildings or other structures in remote geographic locations.

## Earthing is not always a viable option

In many instances it is wholly impractical to expect that an electrode can be driven into the ground; reasons include, for example:

- The ground in the vicinity where the generator is to be sited is a hard surface such as a road, pavement or concrete
- Permission may not be given to install an electrode due to the damage that this would cause. Furthermore, to provide an effective connection with the general mass of Earth, the electrode would need to be either driven in to considerable depth or a significant length of electrode would need to be buried in the ground.

In either case, such actions involve the risk of danger from hitting buried services or other hidden hazards such as unexploded bombs in certain areas.

Small portable single-phase generators with ratings up to 5 kVA designed to supply low wattage power tools and the like are widely available to purchase or hire. This article considers how such generators may be used safely without an intentional connection to Earth.

## Relationship with *BS 7671*

The use of a small generator to supply portable equipment connected by plugs and socket-outlets via extension leads does not fall within the scope of *BS 7671*. The arrangement is merely a collection of products connected together temporarily. However, some of the protective measures described in *BS 7671*, which are themselves based on *BS EN 61140: 2016 Protection against electric shock – Common aspects for installation and equipment* may be used to allow for the safe use of such an arrangement. When considering safe usage it must be borne in mind that many using such supply arrangements will not be electrically competent and therefore will not understand the possible risks that electricity can pose.

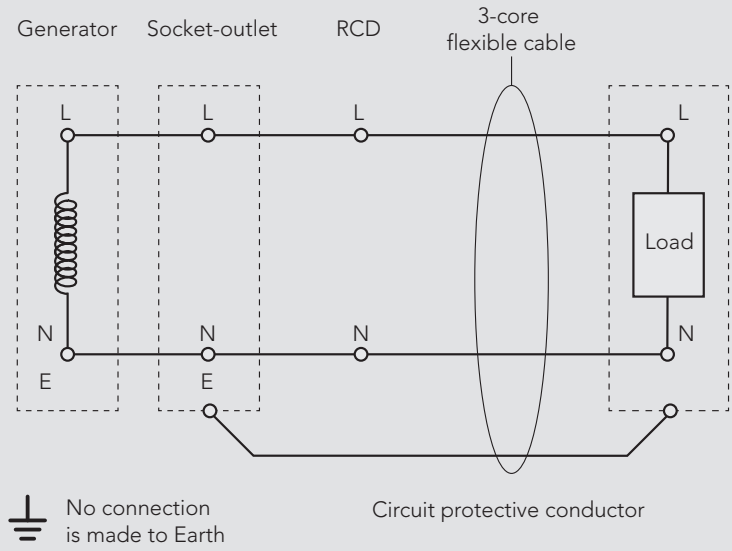
## Internal connection

Where small portable generators are used to supply portable power tools and equipment, care is needed to ensure that the generator is installed safely before use, particularly with respect to whether or not an earthing connection is necessary.

Typically the 'earth' terminal on the generator is connected internally to:

- the frame of the generator,
- the metal parts of the generator which do not

**Fig 1** Arrangement 1




carry current, and
- the protective conductor terminal of any socket-outlets on the generator.

Often there is no electrical connection between the generator windings and those parts listed above. However, in some cases, a connection is also made to one pole – typically the neutral – of the generator winding.

It is important to determine which of the above arrangements applies to any generator that is to be used, either by testing or through reference to manufacturer's product data when considering its safe use.

## Typical connection alternatives

Typically two possible connection arrangements may be employed to allow for the safe use of such generators without an intentional connection to Earth, and these are described below.

### Arrangement 1

In this arrangement, sometimes referred to as a 'floating' system', no connection is made between the neutral winding and those parts of the generator which are connected to the earthing terminal and the earthing contact of the output socket-outlet.

The arrangement provides electrical separation where:
- the insulation of the conductors and use of enclosures provides basic protection, and
- fault protection is offered by simple separation between the wiring supplied from the generator and that supplied from other sources and from Earth.

Additional protection by an RCD having a rated residual operating current ($I_{\Delta n}$) not exceeding 30 mA is not essential.

This method of supply can be used to supply one item of Class I equipment[1] or multiple items of Class II equipment but is not suitable for electrical equipment which requires a functional earth connection.

### Arrangement 2

In this arrangement, a deliberate connection is made between the neutral winding and those parts of the generator which are connected to the earthing terminal (of the generator) and the earthing terminal of the output socket-outlet.

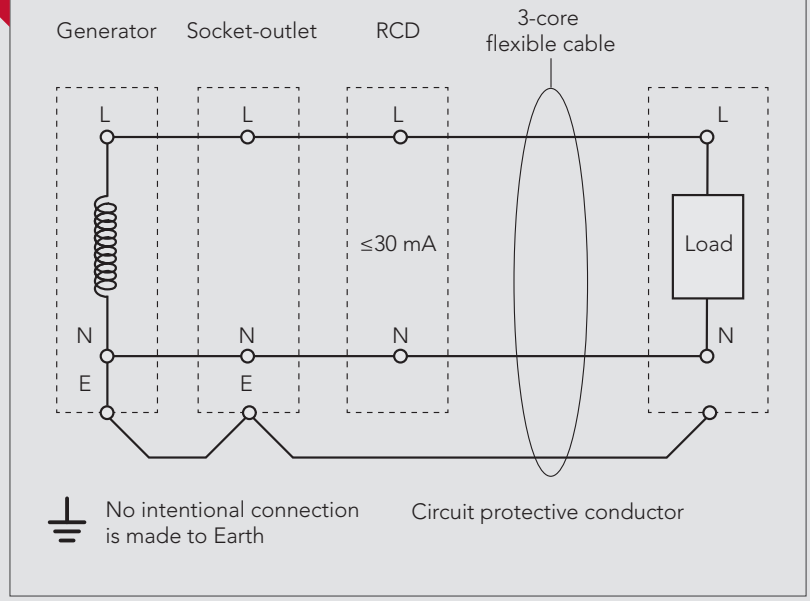
An unintended partial connection may exist between the conductive frame of the generator and the general mass of Earth. Any such unintentional connection to Earth will likely be sufficient to ensure operation of an RCD providing additional protection in the event of a fault of sufficient magnitude to present a shock risk. For this reason, the installation of an RCD having a rated residual current ($I_{\Delta n}$) not exceeding 30 mA is essential where this arrangement is employed.

Where no connection with Earth, intentional or otherwise, exists, then a fault current of sufficient magnitude to cause personal injury cannot flow to Earth.

This method of supply can also be used to supply both Class I and II equipment.

1 Regulation 413.1.3 stipulates that where more than one item of current-using equipment is supplied from an unearthed source with simple separation the requirements of Regulation 418.3 must be met.

**Fig 2** Arrangement 2



## Other factors to be taken into account

As with any other temporary electrical supply arrangement, it is essential to conduct a thorough visual inspection of all components being used prior to each use: that is, the generator, the connecting leads and the current-using equipment being supplied. Any items showing signs of significant damage should not be used.

Any specific operating instructions issued by the generator manufacturer should be taken into consideration.

As is the case for low voltage flexible cables for use on a construction site, it is recommended that flexible cable complying with H07RN-F (*BS EN 50525-2-21*[2]) type or equivalent heavy duty flexible cable should be used to minimise the likelihood of accidental damage in use.

The functionality of all installed RCDs should also be verified by use of the integral test facility prior to each use of the equipment being supplied by the generator.

## Summary

It is recognised that small portable generators can be operated unearthed without posing an electric shock risk provided that a number of basic precautions are taken, including, where necessary, the provision of protection by an RCD, the use of suitably robust flexible cables and conducting regular condition checks on all component parts of the temporary supply system.

**2** *BS EN 50525-2-21: 2011 2011 Electric cables – Low voltage energy cables of rated voltages up to and including 450/750 V (U0/U) Part 2-21: Cables for general applications – Flexible cables with crosslinked elastomeric insulation*

## Apprentice Corner answers

**1. Correct option is (b)**
It is a misunderstanding to consider the overcurrent protective device is placed at the origin of the circuit to protect the connected load such as an appliance.

**2. Correct option is (c)**
*BS 7671* contains specific requirements with regard to electromechanical forces (Regulation 521.5.201), electromagnetic effects (Regulation 521.5.1) and thermal damage likely to occur under fault conditions. Electrochemical effects, such as electrolytic corrosion, are only mentioned in relation to the selection and erection of wiring systems and earth arrangements.

**3. Correct option is (d)**
Regulation 434.5.1 refers.

**4. Correct option is (d)**
*BS 7671* allows the fault current protective device to be placed on the load side of the reduction in current-carrying capacity of a conductor, as is often necessary in short cable lengths between busbars, energy meters and such and the overcurrent protective device, providing precautions are taken such as ensuring that the cable length is no more than 3 metres (Section 434 and Regulations 434.2 and 434.2.1 refer).

**5. Correct option is (b)**

Fault current $I_{pf} = \frac{U \times Cmin}{Z}$

$= \frac{230 \times 0.95}{3} \approx 73$ A

From Table 43.1 of *BS 7671*, k = 143

Using the adiabatic equation $t = \frac{k^2S^2}{I^2}$

$= \frac{143^2 \times 2.5^2}{73^2} \approx 24$ s

**6. Correct option is (a)**
A residual current circuit-breaker only operates when the algebraic sum of the neutral and line currents is not zero; it will not react to an overload or short-circuit.