



PERMITTED FORMS OF SUPPLY FOR PORTABLE AND HANDHELD EQUIPMENT

By Jon Elliott

MOST PORTABLE equipment being used outdoors is supplied via a flexible cord fed from either a socket-outlet or a flexible cable/cord outlet plate. This cable/cord may have a high susceptibility to damage for the following reasons:

- the lead is trailed whilst the equipment is in use giving rise to abrasion, twisting and straining influences
- connected items such as lawnmowers, hedge-cutters

and power tools have moving parts capable of causing damage that may expose live parts

- equipment and the supply cables/cords in exterior installations are prone to exposure to moisture as a result of precipitation

The presence of moisture as a result of rain or even heavy dew can result in users of portable equipment outdoors having damp feet. This will inevitably result in a lowered contact resistance of the person with the general mass of earth, further increasing shock risk, particularly in the case of handheld equipment.

BS 7671 requirements for portable equipment

These increased risk factors mentioned above are reflected in the specific requirements of 471-16 which relates to supplies to portable equipment outdoors supplied via a socket-outlet and is reproduced below:

471-16-01 *A socket-outlet rated at 32 A or less which may reasonably be expected to supply portable equipment for use outdoors shall be provided with supplementary protection to reduce the risk associated with direct contact by means of a residual current device having the characteristics specified in Regulation 412-06-02(ii).*

This regulation does not apply to a socket-outlet supplied by a circuit incorporating one or more of the protective measures specified in items (i) to (iii) below and complying with the Regulations indicated:

- (i) *protection by SELV (see Regulations 411-02 and 471-02)*
- (ii) *protection by electrical separation (see Regulations*

413-06 and 471-12)

(iii) protection by automatic disconnection and reduced low voltage systems (see Regulation 471-15).

Regulation 471-16-02 relates to supplies to portable equipment outdoors supplied by means other than a socket and is reproduced below:

471-16-02 Except where one or more of the protective measures specified in items (i) to (iii) of Regulation 471-16-01 are applied in compliance with the corresponding regulations stated therein, a circuit supplying portable equipment for use outdoors, connected other than through a socket-outlet by means of flexible cable or cord having a current-carrying capacity of 32 A or less, shall be provided with supplementary protection to reduce the risk associated with direct contact, by means of a residual current device having the characteristics specified in Regulation 412-06-02(ii).

Both of the above Regulations make reference to the use of RCDs that meet the requirements of Regulation 412-06-02 (ii) to provide supplementary protection against direct contact. That is, the RCD should have a rated residual current ($I_{\Delta n}$) not exceeding 30 mA and an operating time not exceeding 40 mS at 5 $I_{\Delta n}$.

The use of such RCDs to provide supplementary protection against direct contact is commonly employed. However, as can be seen from reference to the two Regulations reproduced above, the use of such RCDs is not the sole method of protection suitable for supplies to portable equipment outdoors.

The use of a 30 mA RCD is not required where the source of supply originates from a circuit that is protected by

- SELV
- electrical separation
- automatic disconnection and reduced low voltage systems

SELV

SELV is defined in BS 7671 as “An extra-low voltage system which is electrically separated from Earth and from other systems in such away that a single fault cannot give rise to the risk of electric shock”.

The supply for a SELV system may be derived from the following sources:

- a safety isolating transformer in which there is no connection between the output winding and the body or to earth
- a motor-generator set in which the windings

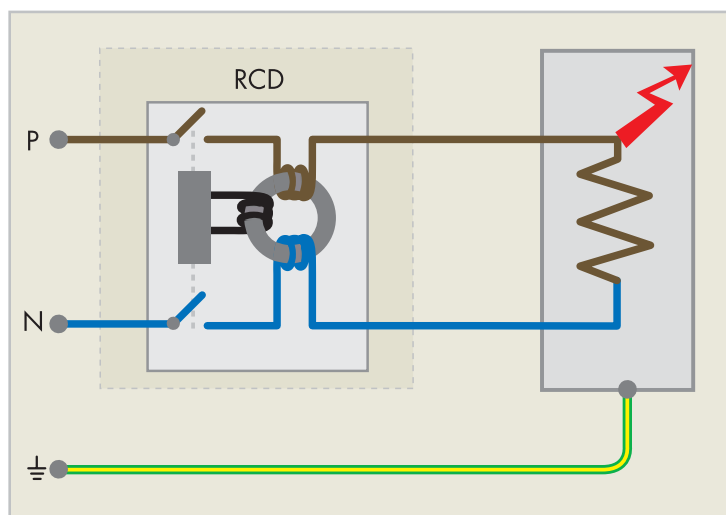


Figure 1: RCD under fault conditions

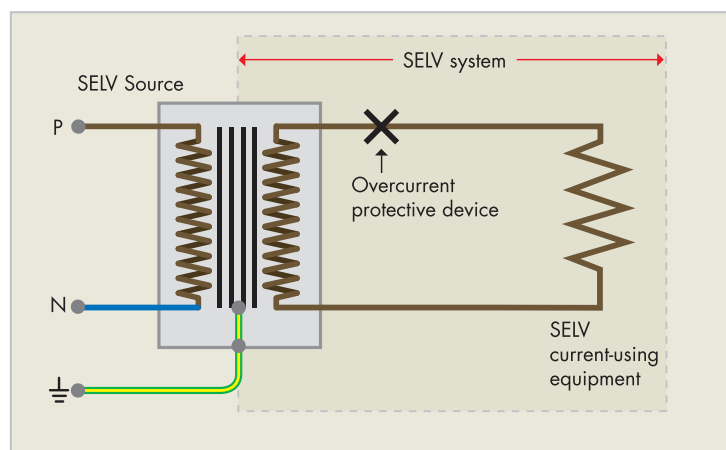


Figure 2: Separated extra-low voltage supply derived from a transformer

provide isolation equivalent to that provided by the windings of an isolating transformer

- a battery

The maximum permitted voltages of 50 V a.c. or 120 V ripple-free d.c. limit the employment of SELV as a source of supply for portable tools and equipment. However, there are a number of instances where the use of SELV is the only means of supply permitted for handheld or portable items of electrical equipment. These are summarised later within this article.

Electrical separation

In the case of using electrical separation it is necessary to make reference to Regulation 471-12-01 which is reproduced below:

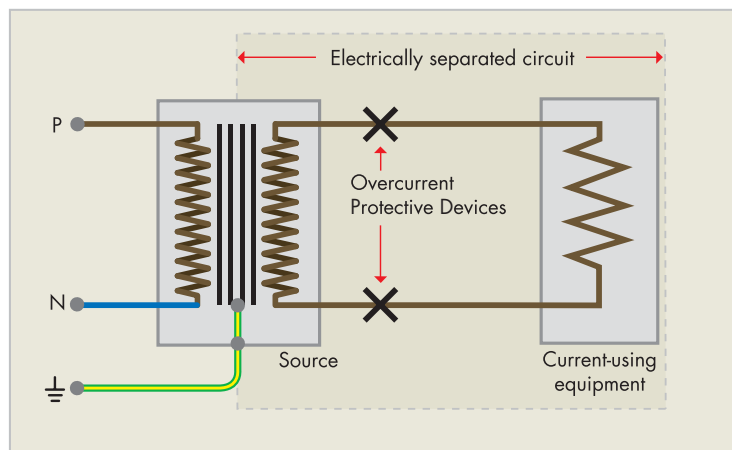


Figure 3: Electrically separated supply derived from a transformer

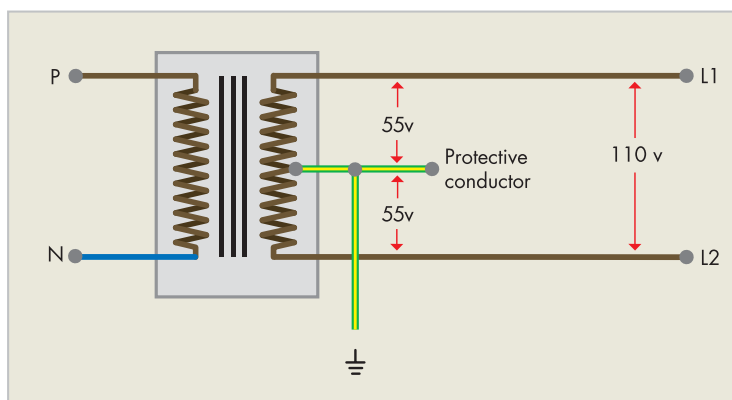


Figure 4: Reduced low voltage supply derived from a transformer centre tapped to earth

471-12-01 This measure is intended, in an individual circuit, to prevent shock current through contact with exposed-conductive-parts which might be energised by a fault in the basic insulation of that circuit. It may be applied to the supply of any individual item of equipment by means of a transformer complying with BS 3535 the secondary of which is not earthed, or a source affording equivalent safety. Its use to supply several items of equipment from a single separated source is recognised in the Regulations only for special situations under effective supervision, where specified by a suitably qualified electrical engineer. Where the measure is used to supply several items of equipment from a single source, a warning notice complying with Regulation 514-13-02 shall be fixed in a prominent position adjacent to every point of access to the location concerned.

The actual requirements placed upon the designer of the installation vary depending upon the number of items of equipment that is intended to supply.

Where only a single item of equipment is supplied by an isolating transformer to BS 3535 requirements, the following measures are required by 413-06-03

- There should be no connection between the separated circuit and any other circuit, or to Earth
- A flexible cable/cord liable to mechanical damage should be visible throughout its length
- It is preferred that a separate wiring system should be used for the separated circuit (although multicore cables without magnetic sheath or insulated conductors in an insulated enclosure are permitted if the rated voltage of the cables is not less than the highest voltage likely to occur and each circuit is protected against overcurrent)
- Every live part of each separate circuit shall be electrically separated from all other circuits to a standard not less than that provided between input and output windings of an isolating transformer to BS 3535

Regulation 413-06-04 requires that no exposed-conductive-part of the separated circuit shall be connected to either the protective conductor of the source circuit, or to any exposed-conductive-parts of any other circuit.

Where it is intended to use a single separated source to supply a number of items of equipment, where this protective measure is permitted by BS 7671, it will be necessary to meet the relevant requirements of 413-06 (Protection by electrical separation).

Reduced low voltage

Regulation 471-15 states the requirements for automatic disconnection and reduced low voltage systems, which are summarised below:

In situations where it is impracticable to employ extra-low voltage and there is no requirement for the use of SELV, a reduced low voltage system may be used (471-15-01).

The nominal voltage of reduced low voltage circuits shall not exceed 110 V a.c. rms between phases (either three-phase 63.5 V to earthed neutral or single-phase 55 V to earthed midpoint) (471-15-02).

The supply for a reduced low-voltage system may be derived from:

- a double wound isolating transformer
- a motor-generator set in which the windings provide isolation equivalent to that provided by the windings of an isolating transformer
- an engine driven generator (471-15-03)

The neutral (star) point on secondary windings of three-phase transformers or generators, or the mid-point of the secondary windings of single-phase transformers or generators shall be connected to earth (471-15-04).

Protection against direct contact should be provided by insulation or by a barrier/enclosure (471-15-05)

Protection against indirect contact shall be provided by an overcurrent protective device such as a fuse or MCB, or by an RCD placed in each phase conductor such that the earth fault loop impedance at any point of utilisation permits a disconnection time not exceeding 5 seconds. Where an RCD is used, the product of rated residual current ($I_{\Delta n}$) and the earth fault loop impedance shall not exceed 50 (471-15-06).

All plugs, socket-outlets and cable couplers used in a reduced low voltage system shall have a protective conductor contact and not be dimensionally interchangeable with plugs, socket-outlets and cable couplers within the same installation for use at other voltages or frequencies (471-15-07).

Summary of BS 7671 requirements for supplies to portable and handheld equipment

There are a number of instances where BS 7671 makes specific reference to the type of protection that is suitable for supplies to portable and handheld equipment. These are summarised below:

Supplies for portable equipment outdoors (471-16-01 & 471-16-02)

- RCD having a rated residual operating current ($I_{\Delta n}$) not exceeding 30 mA and an operating time not exceeding 40 mS at 5 $I_{\Delta n}$ (412-06-02)
- SELV (411-02 & 471-02)
- Electrical separation (413-06 & 471-12)
- Automatic disconnection and reduced low voltage systems (471-15)

Swimming pools (Section 602)

Note: Socket-outlets provided in a swimming pool location are provided for the intention of cleaning/maintenance purposes carried out when the pool is not in use.

- Zone A – None permitted
- Zone B – BS EN 60309-2 socket-outlets may only be installed if it is not possible to position them outside zone B if they are:
 - More than 1.25 m beyond the border of zone A, and
 - At least 0.3 m above the floor level, and
 - Protected by either:

– 30 mA RCD

– Electrical separation, where the safety isolating transformer is placed outside zones A, B and C

- Zone C – BS EN 60309-2 socket-outlets

Construction sites (section 604)

Note: All plugs and sockets used should comply with BS EN 60309-2 regardless of voltage being supplied (604-12-02)

- Supplies for portable hand lamps for use in confined or damp locations – SELV
- Portable hand lamps for general use; portable hand-held tools and local lighting up to 2 kW – 1-phase reduced low voltage
- Portable hand-held tools and local lighting up to 2 kW; small mobile plant up to 3.75 kW – 3-phase reduced low voltage

The use of 230 V to supply portable equipment supplied via a 30 mA RCD, although not stated in BS 7671 is permitted (HSE Guidance Note HSG 141 refers). However, the use of automatic disconnection and reduced low voltage supply as prescribed in BS 7671 is the preferred system for use on construction sites in the United Kingdom.

There is a possibility of damage occurring to the sensitive operating mechanism of the RCD as a result of the harshness of the environment inherent on a construction site. Any such damage may render the RCD inoperative, removing any protection that it was intended to provide. As such, attention must be given to correct positioning of RCDs and to the choice of enclosures employed. Where an RCD is provided on a construction site, for reasons of safety, its correct operation should be confirmed prior to each use.

Agricultural and horticultural premises (section 605)

- SELV
- Socket-outlets protected by 30 mA RCD (605-03-01)

Restrictive conductive locations (section 606)

- Socket-outlets or other supplies for hand lamps
- SELV (606-04-02)
- Socket-outlets or other supplies for hand-held tools (606-04-04)
 - SELV
 - Electrical separation where only one socket-outlet or piece of equipment is connected to each secondary winding of a transformer (606-04-01(iv)) ■