Consumer Unit Guide

Specification and Installation Recommendations to the Wiring Regulations BS 7671

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changing times

In an increasingly safety conscious society the safety critical elements of a home's electrical installation; the consumer unit and its protective devices, are becoming more important to the specifier.

After all it is often an electrically unqualified person, the homeowner or tenant, who has access for operation and is therefore potentially most at risk from a non compliant product or installation.

In addition we are living in an increasingly electronic age where electricity consumption is on the increase, so the consumer unit has to function at more demanding levels than ever before and this trend for more power is likely to continue.

As a result the modern consumer unit typically contains many advanced circuit protection devices such as overcurrent and earth fault devices. New levels of functionality in the domestic installation are also being realised through the addition of more control products such as time clocks, bell transformers and even surge protection devices.

Clearly the role of the specifier and contractor in selecting consumer units and their protective devices to comply with the changing requirements of the wiring regulations is becoming increasingly difficult.

About this guide

This guide helps you consider the necessary criteria needed to select the most appropriate consumer unit for your application, while taking the requirements of the wiring regulations into account.

You may well specify or install such products regularly, and no doubt you will already know much of the content, but equally there may be some areas that you feel are worth revisiting – perhaps TT installations for instance.

Contents:

independent approval

511-01-01 Every item of equipment shall comply with the relevant requirements of the applicable British Standards, or Harmonised Standard appropriate to the intended use of the equipment.

Most consumer unit manufacturers have no independent verification that their products comply fully with British and European standards.

So in the face of cheap imports and stiff price competition, how can you be confident that the consumer units you are selecting do not compromise on safety?

Remember product standards are there to provide a defined level of performance and safety, see regulation 511-01-01 above.

Hager is one of only two manufacturers who have taken the safety orientated stance of getting full independant approval for their consumer units. As proof look for the ASTA diamond mark on the product.

About ASTA

As the industry's accredited independent testing and certification organisation, ASTA test and certify electrical products to British, European and International standards. There is, however, more than one level of testing and certification, see below:

Type testing

One or more elements of the British Standard are tested for e.g. short circuit testing.

Complete compliance testing

The product is tested for full compliance against the product standard.

Full ASTA approval

This is an ongoing guarantee from ASTA that the product meets and continues to meet the specified British and International standards.

This is achieved by:

- complete compliance testing of all product variants to be marked
- verification of consistent manufacturing methods to ISO 9001/9002
- verification of quality procedures

For the ongoing assurance that the Diamond Mark gives ASTA will then:

- complete an annual retest of a randomly selected sample off the production line.
- ratify proposed changes in production or design and retest if appropriate.
- repeat full compliance testing after 7 years.

"Remember only the ASTA Diamond Mark gives you the ongoing confidence to specify an independently endorsed safe product."

what is a consumer unit?

Annex ZA of BSEN439-3 'Customer Distribution Board: An integrated assembly, for the control and distribution of electrical energy, principally in household or similar premises, incorporating manual means of double pole isolation on the incoming circuit(s), with polarity observed thoughout. They are designed for the use exclusively with specific protective devices on the outgoing circuits, and type-tested for use when energised through the specified 100A fuse. NOTE: Generally known as a Consumer unit.'

The purpose of which is to safely control and distribute electricity in domestic (household) applications or in other places where unskilled persons have access to their use.

A consumer unit should be designed, manufactured and tested to the European harmonized standard BS EN 60439-3 titled Low-voltage switchgear and control gear assemblies.

Part 3 details the particular requirements for assemblies intended to be installed where unskilled persons have access to their use – Distribution boards.

Annex ZA to BS EN 60439-3 is where we get specific mention of what we typically call a consumer unit.

This annex states that the co-ordinated assembly that is a consumer unit must pass a stringent short circuit test, see right.

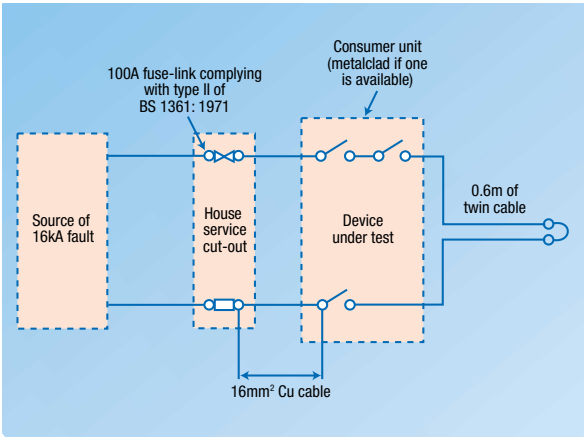
As it is designed to be a co-ordinated assembly product testing will always be completed using the manufacturer's own protective devices within the consumer unit.

Don't mix and match

Fitting a consumer unit made by one manufacturer with MCBs and RCCBs from another would make any certification null and void and difficult to prove compliance with the wiring regulations. Responsibility for compliance with the regulations would then rest with the specifier and the installer.

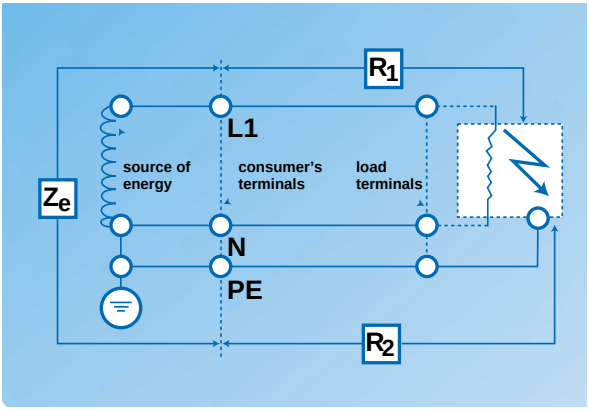
A consumer unit made from loose, non co-ordinated components, generally assembled on site, would be called a Partially Type Tested Assembly (PTTA) and is not likely to be subjected to the same rigorous testing.

As consumer units and the associated protective devices are familiar to us, their selection tends to be based on historic parameters. However, the increasing use of more sophisticated boards in the form of split-load configurations, in all its guises, and the ever changing wiring regulations gives us reason to revisit the selection process.



The earthing arrangement provided by the Public Electricity Supplier is one of the primary factors affecting consumer unit selection. Here we review the most common systems used in the UK, before looking at the affect they may have on product selection.

Before doing so it is worth reminding ourselves of the basic formulae used to ensure disconnection times are met for circuits feeding both fixed and portable equipment.



From the equation $Z_s = Z_e + (R_1 + R_2)$ we can see that Z_e has a big impact on the phase-earth fault loop impedance.

To achieve the required disconnection times sufficient current must flow through the protective device.

$$\text{Fault current} = \frac{\text{Open Circuit Voltage (240V)}}{\text{Earth Fault Loop Impedance}}$$

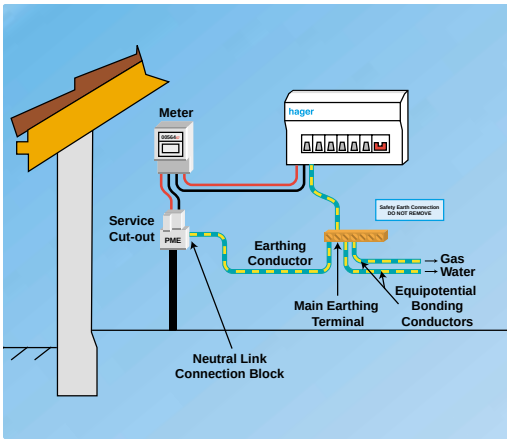
Therefore a low value of Z_e will contribute to an overall low Z_s value. This gives a relatively high fault current. This can then be used to determine the disconnection time of the protection device.

TN-C-S (PME) – see figure 1
This is probably the most common form of supplier earthing. It combines the neutral and earth fault path from the supply transformer to the installation in one conductor – called the Protective Earth and Neutral conductor, or PEN for short.

However, loss of the PEN conductor could lead to 230V appearing on earthed metal work in the installation under fault conditions. To minimise this risk, the PEN conductor is staked to the ground at regular intervals, hence the term Protective Multiple Earth (PME). This means that if the PEN conductor goes open circuit along its length, there is still a fault current path back to the supply transformer via a short run of ground.

Generally the maximum external earth fault loop impedance of the TN-C-S system is quoted as 0.35Ω.

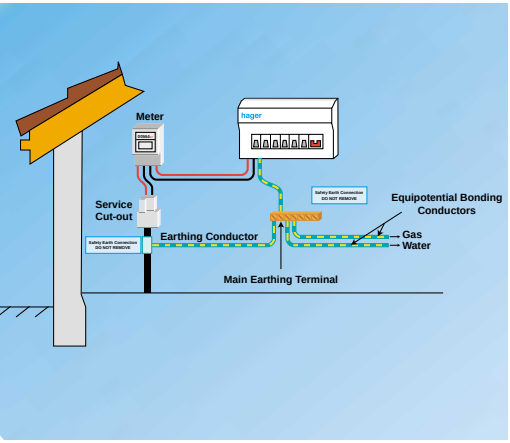
Figure 1



supply earthing systems *continued*

TN-S – see figure 2
The supply transformer arrangement is the same as in the TN-C-S system. However, the neutral and earth are separate conductors both to and in the installation. Public Electricity Suppliers (PES's formerly the REC's) typically give the maximum Z_e for a TN-S system as 0.8Ω.

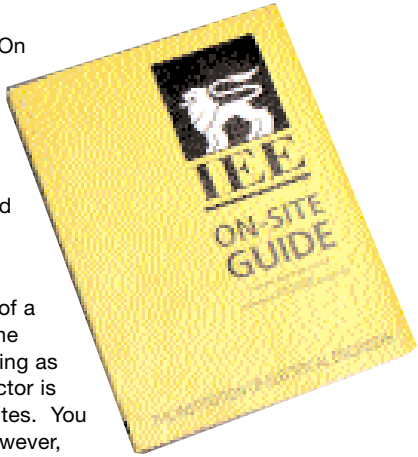
Figure 2



TT – see figure 3
Generally used in rural areas, the TT system uses the ground as the earth fault return path rather than a dedicated conductor. The supply transformer neutral is yet again earthed, however in this system the installation's exposed metal work is connected to earth via an earthing electrode.

Due to the soils varying mineral and water content and its affect on resistivity, the earth fault loop impedance for such systems varies widely from a few Ohms to several hundred Ohms. As such this arrangement normally needs special consideration when selecting distribution and protection products.

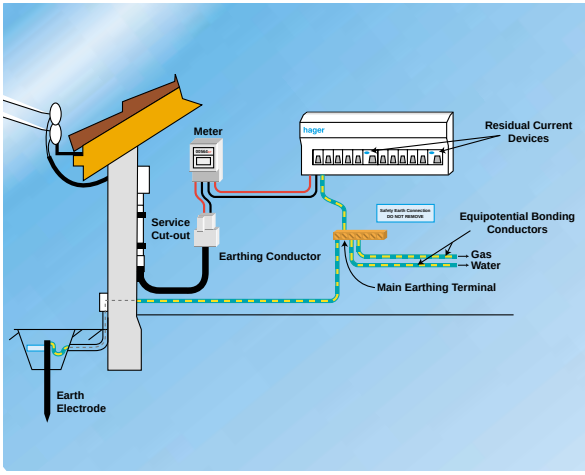
Note: "The IEE On Site Guide", states that anything over 200Ω for R_A in a TT system is too unstable and not recommended.



The advantage of a TT system for the PES is cost saving as no earth conductor is run to remote sites. You should note, however, that some PES's have had an on-going project to PME their overhead supplies. As such PME is available in some remote areas.

As stated earlier the type of supply earthing used has a big influence in determining the configuration of consumer unit selected – see pages 7-9 for guidance.

Figure 3



For installations with TN-C-S and TN-S earthing systems the Z_s is generally of a low enough value that the required disconnection times of 5s and 0.4s are achievable using an overcurrent protective device.

Consumer Units in TT installation

A TT installation, however, can be a different matter therefore we will consider this first. With a typical external earth fault loop impedance of 40Ω, a maximum earth fault current of 240/40 = 6A will flow. This means that even a 6A MCB will not operate within the stated disconnection times. A common solution is to use an RCCB as an incomer.

So it is likely that, on a TT installation, you will need an RCCB controlled consumer unit. But how do you decide which sensitivity? Please remember that an RCCB as an incomer in this instance is being used to achieve disconnection time, not to offer protection against direct contact.

Reg. **413-02-20** gives the equation to calculate maximum sensitivity.

413-02-20 The following condition shall be fulfilled for each circuit:

$$R_A I_a \leq 50\ V$$

This equation states that the sum of the resistance of the earth electrode and all protective conductors connecting it to exposed conductive parts, multiplied by the current causing effective operation of the device (sensitivity of RCD) is not allowed to exceed 50V. The requirement is intended to limit the touch voltage to 50V or for higher fault currents to values within the touch voltage curve. For normal installations 50V is considered a safe touch voltage.

Reg. 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)

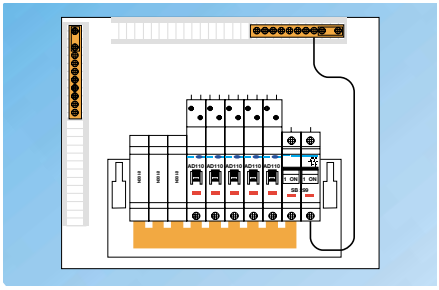
Reading regulation **471-16-01** (above) it is tempting to specify a 30mA incoming RCCB to offer blanket earth fault protection to the installation, while also satisfying the need for compliant disconnection times. Resist this temptation. Avoidance of danger and minimising inconvenience as in Reg. 314-01-01 (see page 10), is not best served by an incoming earth fault device since a fault on any circuit will cause the loss of power to all circuits.

Three solutions

This is why the On Site Guide (OSG) states that an RCCB incomer should not be less than 100mA. There are 3 main solutions to the above dilemma each with its own merits. Two of these are shown in the On Site Guide.

a) Switch disconnector incomer and RCBOs on all circuits (figure 4).

Figure 4

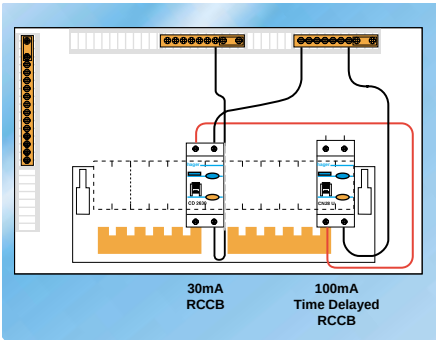


selecting a consumer unit *continued*

This is the best solution since under fault conditions only the affected RCBO will trip. However, for many applications this may prove too expensive.

b) Split-load time delayed board. A 100mA time delayed RCCB (selective-S type) feeds both a number of low risk circuits (lights etc) and also feeds a 30mA non-time delayed RCCB feeding the high risk circuits. (Fig. 5 and 6)

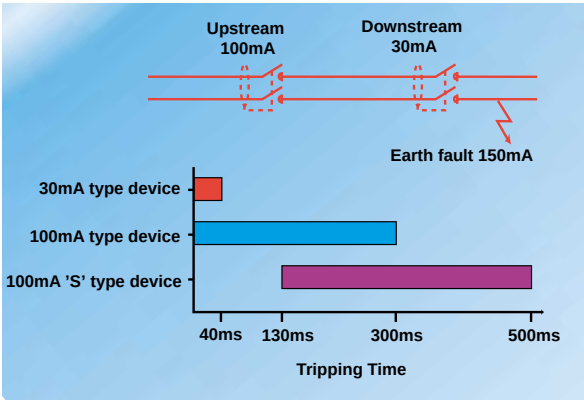
Figure 5



This solution helps provide continuity of supply by ensuring that for the most common faults i.e. those on the high risk circuits, only the 30mA RCD trips. The time delayed RCD does not trip with the 30 mA device ensuring compliance with reg 531-02-09 (see below).

531-02-09 Where, for compliance with the requirements of the Regulations for protection against indirect contact or otherwise to prevent danger, two or more residual current devices are in series, and where discrimination in their operation is necessary to prevent danger, the characteristics of the devices shall be such that the intended discrimination is achieved.

Figure 6

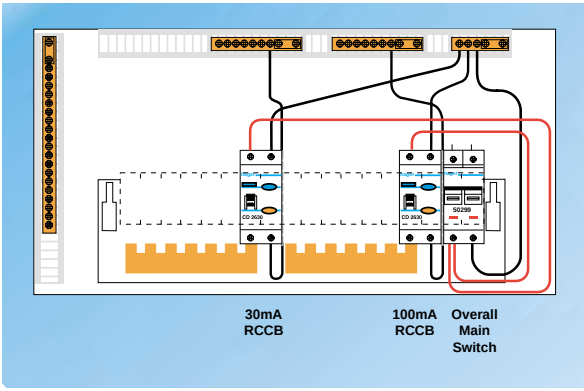


Note: Faults on the 100mA protected circuits will cause loss of supply to the whole board.

Twin RCCB Board

c) Switch disconnector with parallel fed 30mA and 100mA RCCBs (Fig. 7)

Figure 7



This is perhaps the best cost effective solution, as irrespective of fault location only the affected RCCB will operate.

In TT installations the construction of the enclosure is also important and should preferably be of an all insulated or Class ii construction. If a metallic enclosure is necessary then precautions in the form of insulated bushes and additional support for the incoming tails is required. This minimises the chance of an earth fault occurring on the supply side of the RCCB, which won't be detected and cleared by that device.

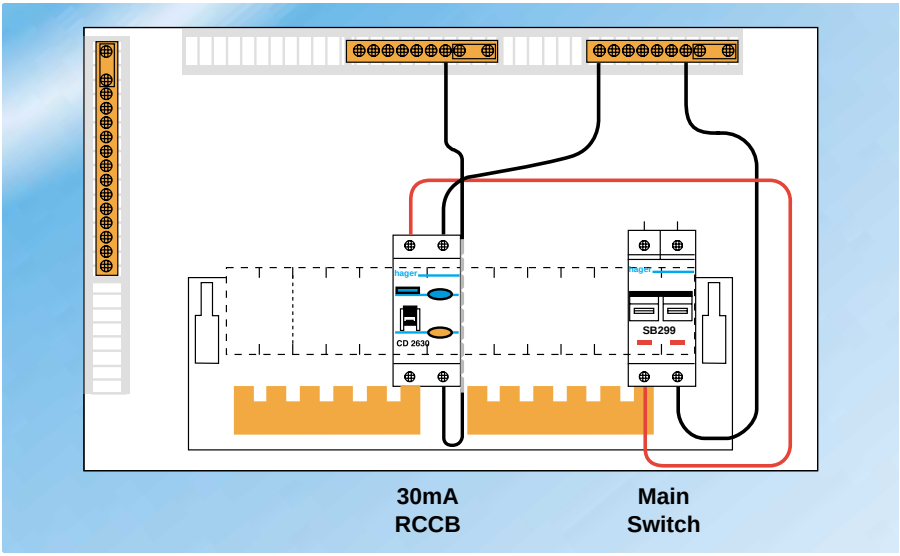
Consumer units in TN-C-S and TN-S installations – see figure 8

With these earthing systems offering low external earth fault loop impedance, the majority of installations will not need an RCCB as an incomer. This helps minimise inconvenience, a key objective of the Wiring Regulations. Generally the use of split load consumer units is a good solution for TN-C-S and TN-S installations.

Refer to page 10 for details of which circuit should be fed from the switch disconnector and which from the RCCB.

An alternative to a standard split load would be the same as Fig. 5 (split load time delayed), with the 100mA device offering excellent general and fire protection (well worth considering on properties with increased fire risk such as thatched properties).

Figure 8



division of circuits

314-01-01 Every installation shall be divided into circuits as necessary to:

i) avoid danger and minimize inconvenience in the event of a fault, and

ii) facilitate safe operation, inspection, testing and maintenance.

It is impossible to give a hard and fast rule to meet the regulations since each installation and its use will be different. In practice the engineer's experience and consultation with the end user will determine the outcome.

The number of final circuits plus an allowance for future expansion will determine the number of outgoing ways chosen.

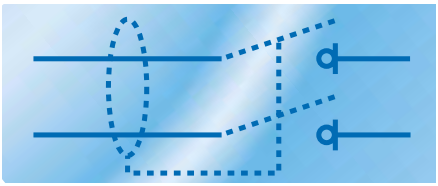
So, first let's list down the typical circuits that might exist in a domestic property and indicate whether or not they should be RCD protected on a split load board. While not exhaustive, the list does give us a sound base to work from:-

Probable circuits	**RCD protection?**
Downstairs ring final circuit	Yes
Upstairs ring final circuit	Not required to regulations
Kitchen ring final circuit	Dependant on consideration of accessible outlets
Utility ring final circuit	Dependant on consideration of accessible outlets
Downstairs lighting circuit	No
Upstairs lighting circuit	No
Smoke detector circuit	No
Immersion heater	Not required to regulations
Cooker	Not required to regulations
Fridge or fridge/freezer	No - if dedicated circuit
Garage sub distribution circuit	Yes
Shed sub distribution circuit	Yes
Workshop sub distribution circuit	Yes
Alarm circuits	No (if unavoidable an RCD should be dedicated to this circuit and be no more sensitive than 100mA)
External lighting	Dependant on whether Class I or II
Electric shower circuit	Yes (manufacturer's recommendations)
Ring final circuit for home office	**(depends on location within property)**

Obviously not all of these have to be separate circuits. A burglar alarm can be fed off the ring final circuits for sockets via a fused connection unit with exterior lighting commonly fed from an interior lighting circuit, for example. Thought must, however, be given to the number and type of circuits.

In a typical installation there might be seven to eight separate circuits with provision for four future additions.

TO RCD OR NOT TO RCD?



Exactly which circuits should be given earth fault protection and which shouldn't is always open to debate. The table on page 10 opposite summarises our recommendations. Here we deal with just the socket outlet circuits.

Reg. 471-16-01 (see page 7) requires any socket outlet rated at 32A or less that can reasonably be expected to feed portable equipment outdoors is protected with an RCD that has a sensitivity of not more than 30mA.

In a typical two-storey house this could include all downstairs socket outlets, including accessible outlets in kitchens, outbuildings and garages. Earth fault protection for upstairs sockets is debatable and generally would not be needed.

Ground floor flats, on the other hand, should have all their sockets protected, but think hard before providing RCD protection for flats on the first floor and above.

Avoiding nuisance tripping

Selecting the current carrying capacity for an RCCB is simple enough based on circuit design current; but choosing the right sensitivity is more difficult. Feeding inappropriate equipment can often cause nuisance tripping.

Regulation 607-02-03 states that any RCD must not have standing earth leakage of more than 25% of its sensitivity placed on it. This regulation applies to one item of stationary equipment, but it makes good sense to apply it to other circuits in order to avoid nuisance tripping. For a 30mA RCD this means any standing earth leakage current (not earth fault) greater than 7.5mA is unacceptable.

With a typical house having personal computers, DVD players, TVs, Hi-Fis, microwaves, electric showers and fridge freezers, (which can all have earth leakage) care must be taken to avoid this common pitfall. Division of ring final circuits is a good way of avoiding this problem, particularly if the property has a home office set up with a corresponding increase in electronic equipment.

607-02-03 Where more than one item of stationary equipment having an earth leakage current exceeding 3.5 mA in normal service is to be supplied from an installation incorporating a residual current device, it shall be verified that the total leakage current does not exceed 25% of the nominal tripping current of the residual current device (see also Regulation 531-02-04)

circuit protective devices

So far we have looked at the most appropriate consumer unit for a particular installation.

Here we briefly consider the outgoing protective devices. These could be BS1361 fuse carriers, miniature circuit breakers (MCBs), or residual current circuit breakers with integral overcurrent protection (RCBOs).

Whilst it is beyond the scope of this booklet to detail the full criteria for selecting a device, it is still worth making a few points.

Historically, B-curve breakers are used in domestic environments.

For lighting circuits, however, it is wise to consider a C curve MCB not just for the inrush on Extra Low Voltage lighting but also to minimise the chance of the MCB tripping when a single lamp blows (increasingly common).

Compliance with the BS7671: 1992 with regard to cable protection and disconnection times etc must still be obtained if using C Curve MCBs

The modern home has a huge amount of expensive electronic equipment. However little consideration is given to how increasingly frequent overvoltages can affect this equipment. It is likely that the next rewrite of the regulations will address this issue.

Consider surge protection

A surge protection device (SPD) protects equipment from such transient overvoltages and is easily incorporated into standard consumer unit configurations. This ensures that the whole installation is protected at source, i.e. at the consumer unit (see figure 9), as opposed to the common use of protective trailing leads, which only protect a couple of loads.

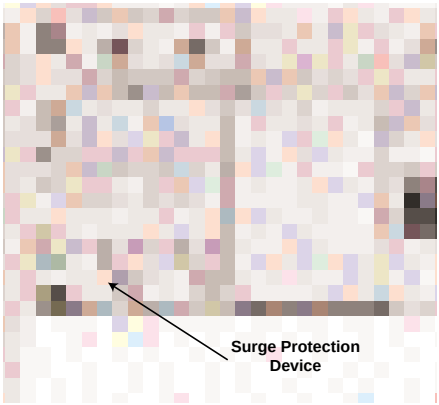


Figure 9

Typically these short time disturbances on the supply will be generated either by atmospheric discharges (lightning) or more likely by inductive equipment being switched on and off. These overvoltages can be several thousands of volts and can cause anything from data loss in a PC to complete destruction of equipment.

Most domestic installations would only need a single SPD to provide a high level of protection from these transients and ensure the integrity of the increasing array of domestic appliances. This is particularly true with the growing predominance of home working (Small Office Home Office, or SOHO applications)

For advice about SPD selection telephone our technical hotline on 0870 607 6677.

single pole and switched neutral (SPSN) consumer units

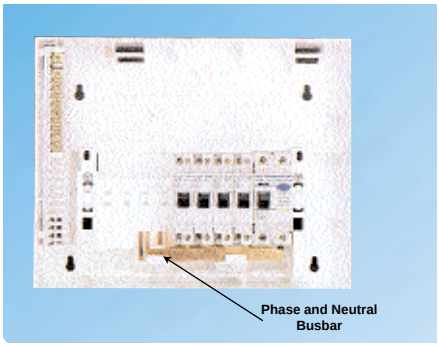


Figure 10

These consumer units have particular benefits for local authorities and housing associations. Unlike conventional consumer units, where only the phase is switched on outgoing circuits, SPSN MCBs allow both the phase and neutral to be switched (yet the MCB width is maintained in one module) figure 11. This offers higher levels of safety due to the double pole (total) isolation.

They have several distinct advantages

1. They disconnect neutral to earth faults as well as phase to earth faults. Typically neutral to earth faults have low levels of fault current flowing and do not trip the circuit overcurrent protective device i.e. the MCB or fuse. However it will trip the main RCD (if fitted), which detects and reacts to these small faults – leaving several circuits unnecessarily without electricity.

   By turning off all the SPSN MCBs the tenant or homeowner can usually switch the main RCD back on. Then by turning on the MCBs one at a time, until the RCD trips, they can identify which circuit the fault is on and just leave that one off.

   By talking the homeowner or tenant through the above procedure an emergency call out can often be turned into a planned call the next day, thus saving money and inconvenience for the tenant.

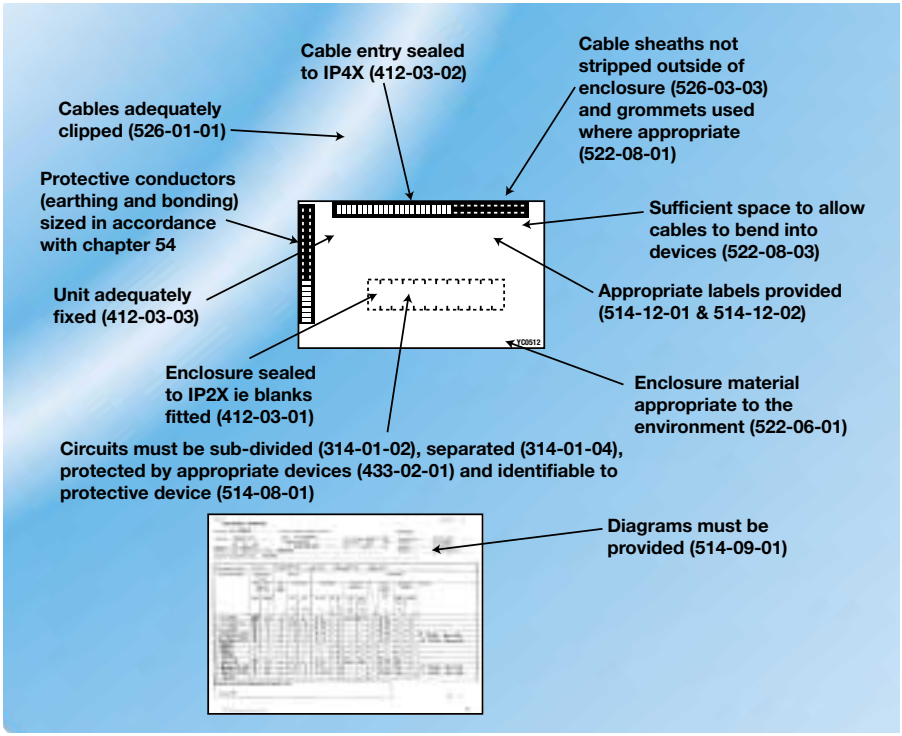
2. By identifying which circuit the fault occurred on, it makes subsequent fault finding easier.

3. Easier, quicker and neater wiring simplifies circuit identification.

Note: All of the above should be viewed in conjunction with the earthing system selection criteria (see pages 5-6).

Figure 11

regulations for installing a consumer unit



General requirements	Regulation
• Complies with the relevant requirements of the applicable British Standard or harmonised Standard	511-01-01
• Manufacturer's instructions are followed, or the unit would have to be classified as Partially Type Tested Assembly (PTTA)	713-05
• The protective devices in the Consumer Unit are adequate for the prospective fault level (conditional rating?)	313-01-01 512-02-01 (ii)
• The rating of the main switch or circuit breaker is sufficient for the likely electrical load	512-02-01 (i)
• The tails between the Consumer Unit and the meter, or REC's isolating switch, are adequately sized and protected against mechanical damage	523-01-01 522-06-01 522-08-01 (433-02-01)
• Minimum bending radius for cables not exceeded	522-05-03
• Installation divided into circuits to avoid danger and minimise inconvenience in the event of a fault	314-01-01
• Supplementary protection of socket-outlets which may reasonably be expected to supply portable equipment for use outdoors (30mA RCD)	471-16-01

• Where an rcd is installed at the main switch position, and the installation is part of a TT system, the tails are adequately protected against the possibility of earth fault where they enter a metal-clad Consumer Unit	531-04-01
• The Consumer Unit is installed in a readily accessible position	513-01-01
• The earthing conductor is of adequate cross-sectional area	543-01-01
• The polarity of the connections to the main switch is correct	530-01-02 713-09-01
• The phase and neutral conductors are taken into the Consumer unit through a common entry in a metal-clad Consumer Unit	521-02-01
• Final circuit cables adjacent to the Unit are adequately protected against the risk of mechanical damage in use	522-06-01 522-08-01
• Circuit cables entering the Consumer Unit are not at risk from abrasion, etc	522-08-01
• The Consumer Unit is adequately secured in position	130-01-01
• Conductor terminations are properly secure (tight) within their terminals	526-01-01
• The unsheathed cores of conductors are fully contained within the consumer unit	526-03-03
• 2-core 'bell wire' segregated from the cables of low voltage (240V) circuits. Bell wire should not be run in the same conduit, ducting, trunking or even holes drilled though joists as cables of other circuits	528-01-02
• Where the sheath of twin and cpc cable has been removed the bare circuit protective conductor is sleeved in green/yellow insulating material	543-03-02
• Neutral and protective conductors are connected in the same sequence as the phase conductors	314-01-04
• Circuits are correctly and easily identified	514-08-01
• Terminations and joints of cables are enclosed in a suitable enclosure	422-01-04 526-03-0
• Unused holes (ways) on the Consumer Unit are blanked off	522-04-01 (412-03-01)
• Rating of the protective device is not greater than the current carrying capacity of the installed circuit conductor	433-02-01
• Live parts shall be inside enclosures or behind barriers providing at least the degree of protection IP2X or IPXXB	412-03-01
• The horizontal top surface of a barrier or an enclosure which is readily accessible shall provide a degree of protection of at least IP4X	412-03-02
• Correct Labels, Periodic inspection, RCD, Isolation, Equipment vulnerable to testing, Main switch	514-12-01 514-12-02 461-01-05 514-11-01 514-09-01 514-09-01 514-01-01 (514-08-01)
• A legible diagram, chart or table or equivalent form of information shall be provided	514-09-01
• Earthing Requirements For The Installation Of Equipment Having High Earth Leakage Currents, individual items of equipment where the earth leakage current exceeds 3.5mA/final circuits where the accumulated earth leakage is expected to exceed 10mA	607-01
• Electrical Connections, Durable electrical continuity, Adequate mechanical strength and connection, Suitable for the conductor csa and shape and the number of conductor strands, capable of accepting all conductors without modification of the conductors (no cutting out strands)	526-01-01 526-01-01 526-02-01

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