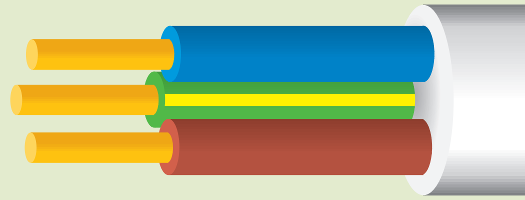
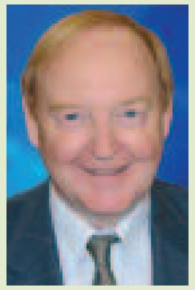
How to figure out diversity in adversity



Bill Allan turns the spotlight on diversity following inquiries about the subject on the NAPIT technical helpline



Consider the simplified consumer unit shown in Fig. 1. The current rating of the main switch is 100 amps but the combined current rating of the overcurrent protective devices is 134 amps. Is this acceptable? Yes it is if diversity has been correctly applied.

However there appears to be some confusion about the subject of diversity and this has been reflected in calls to the NAPIT technical helpline recently. It is the intention of this article to clarify what diversity is and to show how it is to be applied to installations.

What is diversity?

Regulation 311-01-01 requires the maximum demand of an installation to be assessed and, when determining the maximum demand of an installation, or part of an installation, it permits diversity to be taken into account. Diversity is not defined in BS 7671. So what is diversity anyway?

To understand what is meant by diversity, we need to understand what is meant by maximum demand. As the term, maximum demand is not defined in BS 7671 either, we need to define what we mean by these terms. But let's begin by defining another term, the connected load.

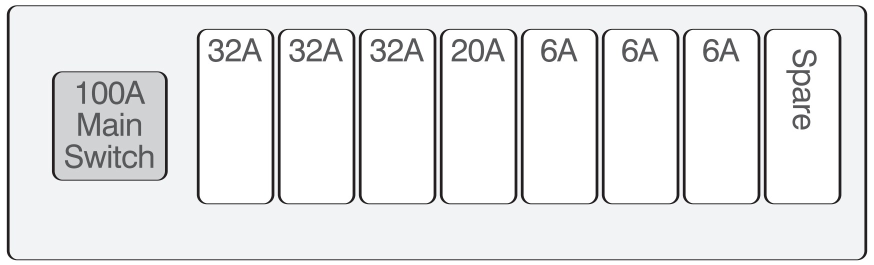
The **connected load** is the sum total of the electrical equipment without any allowance being made for diversity. It involves simply adding together the current ratings of each item of electrical equipment connected to the installation.

The **maximum demand** is the connected load including any allowance made for diversity. We could say that it is the maximum anticipated load or the actual load. The maximum demand can include allowance for future loading.

Diversity is the ratio of the maximum demand to the connected load and is expressed as a percentage. It can be expressed as follows:

$$\text{Diversity} = \frac{\text{maximum demand}}{\text{connected load}} \times 100$$

Fig 1 **Combined current rating of overcurrent devices is 134 amps**



While the connected load is fairly straightforward to determine, the assessment of the maximum demand requires considerable experience and skill on the part of the installation designer. To decide not to apply any diversity would be safe and it would be easy. But it would not be practical.

Consider for example, a 30 A or 32 A ring final circuit with 20 x 13 A socket-outlets, each capable of supplying 3 kW at 230 V. With no diversity applied, we would have to allow 60 kW (about 260 A) for this ring circuit alone!

Economic design of an electrical installation means that diversity almost always has to be applied. In the application of diversity, certain assumptions have to be made regarding the actual current drawn by items of equipment. Guidance on the current demand to be assumed for commonly used equipment and also on the application of allowance for diversity is given in Appendix 1 of the IEE On-Site Guide (OSG) and Appendix H of IEE Guidance Note 1, Selection and Erection (GN1).

Table 1A of the OSG (and Table H1 of GN1) contains guidance in determining the connected load and gives the current demand to be assumed for points of utilisation and current-using equipment. Table 1B of the OSG (and Table H2 of GN1) contains guidance in the application of diversity and gives allowances which can reasonably be made for diversity when applied to various types of final circuit. Certain items in the table have no diversity allowable.

Consumer units must be of sufficient rating to take the maximum demand of the installation which is connected to them. This means that the total current of each final circuit after allowing for diversity where diversity is allowable must be less than the current rating of the main switch.

Perhaps the best way to understand the application of diversity is by means of a worked example.

Worked example

Determine the maximum demand using diversity of an installation which has an 8-way consumer unit with a main switch rated at 100 amps. It has two spare ways and supplies six circuits as follows:

- One 10.5 kW cooker circuit with no socket-outlet on the control unit
- Two 32 A ring final circuits
- One 3 kW immersion heater
- Two lighting circuits; circuit 1 consists of six tungsten lamps and circuit 2 has six fluorescent lamps.

Solution

From Table 1B of the On-Site Guide

Cooker circuit (see item 3 of Table 1B)

$$I_b = \frac{10500}{230} = 45.6\ \text{A}$$

Allowing for diversity,
10 A + 30% of 35.6 = 20.68 A

Two socket-outlet circuits (see item 9 of Table 1B)
100 per cent of first ring circuit + 40 per cent of second ring circuit
= 32A + 12.8A
= 44.8 amps

One immersion heater circuit

$$I = \frac{W}{V} = \frac{3000}{230} = 13\ \text{A}$$ *no diversity allowable (see item 6 of Table 1B)*

Two lighting circuits

Circuit 1, 6 tungsten lamps
From Table 1A of the OSG, assume 100 W per lamp

$$I = \frac{W}{V} = \frac{6 \times 100}{230} = 2.6\ \text{A}$$

Circuit 2, 6 fluorescent lamps
From Table IA of the OSG, assume 100 W per lamp and from note 2, multiply the lamp wattage by 1.8

$$I = \frac{W \times 1.8}{V} = \frac{6 \times 100 \times 1.8}{230} = \frac{1080}{230} = 4.7\ \text{A}$$

From item 1 of Table 1B,
66 per cent of first circuit + 66 per cent of second circuit
= 1.7 A + 3.1 A
= 4.8 A

Maximum demand using diversity
= 20.68 A + 44.8 A + 13 A + 4.8 A
= 83.28 A
The 100 A rated main switch is acceptable.

Adding a shower circuit

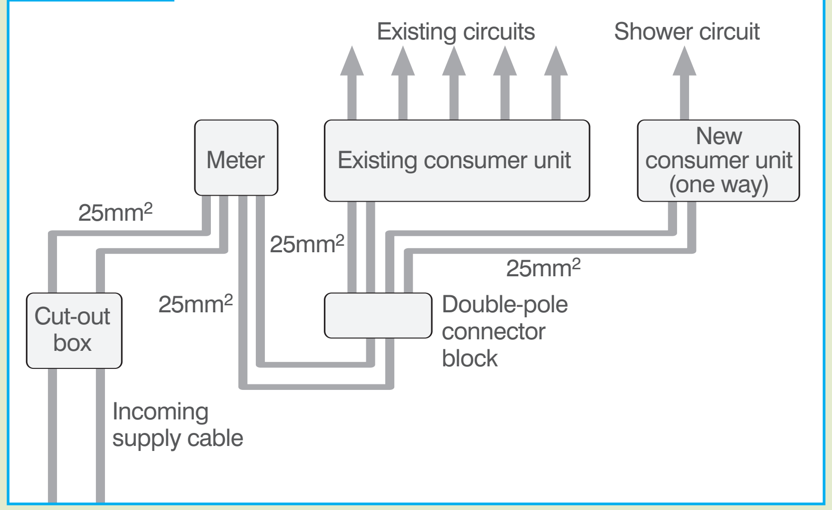
If a shower circuit of current rating say, 9 kW is to be added, the additional current load would be:

$$I_b = \frac{9000}{230} = 39.1\ \text{A}$$ *(no diversity allowable – see item 5 of Table 1B)*

The new maximum demand would be 83.28 A + 39.1 A = 122.38 A. As the new maximum demand exceeds the current rating of the consumer unit, this arrangement is unacceptable. The supplier would have to be informed of the new maximum demand as the supply arrangements may need to be altered.

The shower circuit could be supplied by means of the arrangement shown in Fig. 2.

Fig 2 **Adding a shower circuit**



Conclusion

Other methods of determining the maximum demand can be used with the values selected being the responsibility of the installation designer or a suitably qualified electrical engineer.