t for a simple circuit design

- the external loop impedance.

Steps to cable size selection

I shall now explain the steps to calculating the correct size of cable for a circuit.

1 Calculate the design current (Ib).

This is the normal current drawn by the load in Amps and is usually determined as follows:

$$Ib = \frac{Watts}{Volts}$$

Apply diversity where relevant from Table 1a and 1b Appendix 1 of the BS7671 On-Site Guide (OSG).

2 Select the type and current rating of the overcurrent device (In).

3 Apply the relevant installation rating factors to obtain a tabulated current (It) using Tables 6A, 6B and 6C in Appendix 6 of the OSG. See also Tables 7.2 and 7.3 of the OSG.

Note: correction factors are applied to situations which inhibit a cable from dissipating heat caused by the normal flow of current.

4 Determine the current carrying capacity of the cable (Iz) from Tables 6D1, 6E1 and 6Fof Appendix L of the OSG.

5 Calculate the voltage drop to ensure that it does not exceed the values stated in Appendix 12 of BS7671 – usually three per cent for lighting and five per cent for other uses. The voltage drop per metre can be obtained from Table 6f of the On-Site Guide.

Voltage drop can be obtained using the following formula:

$$\text{Volt drop} = \frac{mV/A/m \times Ib \times \text{length of run in metres}}{1000}$$

6 Calculate the maximum value of earth fault loop impedance for the circuit Zs.

Zs = external loop impedance, plus the resistance of the line conductor, plus the resistance of the protective conductor. This can be done with the aid of Table 9A of the On-site Guide which lists the values of resistance per metre of copper conductors.

$$Zs = Ze + \frac{(R1 + R2) \times \text{cable length in metres}}{1000}$$

Circuit design using only the On-Site Guide

I will now look at the design stages using only the On-Site Guide.

A circuit is to be installed for a 12kW electric cooker supplied from a 30mA RCD protected spare way in a consumer unit, to a cooker control unit with a 13amp socket-outlet.

The cable is pvc twin and earth and will be installed in the roof spare of a single storey barn conversion, clipped to a wooden joist above a plasterboard ceiling, where thermal insulation exceeding 100mm thickness is to be applied on one side of the cable only. The length of cable run is 40 metres, the incoming supply is TN-S. As illustrated in Fig. 1.

Step 1: determine the design current Ib

$$Ib = \frac{Watts}{Volts} = \frac{12x1000}{230} = 52.2amps$$

Now apply any diversity factors from Table 1a and 1b of the On-Site Guide.

For a cooker circuit these are:

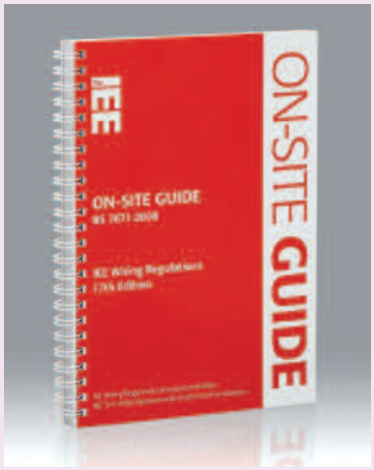
First 10 Amps + 30 per cent of remaining current +5A for the socket outlet

$$10A + \frac{(30 \times 42.2A)}{100} + 5A$$

$$= 10A + 12.66A + 5A$$

$$= 27.66 \text{ Amps}$$

Step 2: select an overcurrent protective device. In this case I have chosen a 32A BS EN 60898 Type B circuit breaker – greater than the load current.



Step 3: apply relevant installation rating factors for cable installations where the cable is installed above a plasterboard ceiling, clipped to a wooden joist with thermal insulation in excess of 100mm thickness on one side only. This factor is covered in Table 6F of the On-Site Guide, see also Table 7.2, and for this installation is 101.

Step 4: select cable size Iz using Tables 6F or 7.2 of the On-Site Guide. The cable chosen is a 10mm^2 which will carry 36 Amps. It can be seen that due to the use of thermal insulation in the roof space that a 6mm^2 cable will only carry 27Amps.

Step 5: determine the voltage drop. This has been taken into account when using Table 7.1 of the On-Site Guide.

Step 6: determine the maximum earth loop impedance of the circuit. This has also been taken into account when using Table 7.1 of the On-Site Guide.

Now use Table 7.1 to determine the maximum length of cable run.

CONTINUED OVERLEAF ➤

Fig. 2: Single domestic electrical circuit design sheet (completed)

Address			Circuit Details	
Item	**Symbol**	**Reference**	**Data/Calculation**	**Value**
Design current	Ib	Manufacturers data	$\frac{12x1000}{230}$	52.2 Amps
Apply diversity		IEE On-Site Guide Table 1A &1B	$10A + \frac{(30x42.2)+5A}{100}$ $= 10A + 12.66A + 5A$	27.66A
Protective device	In			
- rating		IEE On-Site Guide Table 7.1	32A	32A
- type			BS EN 60898 CB	
Check Ib ≤ In				Yes ↓ No
Cable installation method	A, C,100, 101, 102, 103	IEE On-Site Guide Table 6f or 7.2	101	45A
Cable size	Iz	Table 6f	10mm2	
Check Ib ≤ In ≤ Iz				Yes ↓ No
Actual length of cable run	L	Measured	40 metres	40 metres
Maximum length of cable run	L	IEE On-Site Guide Table 7.1	81 metres	
Check maximum length is greater than length required				Yes ↓ No
				Satisfactory to install

It can be seen from the table that the maximum length run which may be installed is 81 metres.

Circuit design table

In order to simplify this procedure a simple table may be used, as illustrated in Fig. 2, completed.

Using Table 7.1 of the On-Site Guide is ideal for establishing maximum cable lengths for single domestic circuits. It assumes these conditions usually satisfy installations in domestic dwellings.

The installation is supplied by one of the following supply systems:

- TN-C-S with a maximum external loop impedance Ze of 0.35Ω
- TN-S with a maximum external loop impedance Ze of 0.8Ω (using these values may lead to the selection of a larger size cable).
- TT system with RCDs.

Other conditions are:

- the final circuit is connected to a consumer unit at the origin of the circuit
- the installation method is listed in Column 4 of Table 7.1
- the ambient temperature throughout the length of the circuit does not exceed 30°c
- the characteristics of protective devices are in accordance with the relevant BS EN standards
- the cable conductors are copper
- the voltage drop for circuits other than lighting must not exceed five per cent
- the disconnection time of 0.4 seconds is applicable for all circuits up to and including 32A rating and five seconds for all other circuits.

By using such a table you are unlikely to be caught out when installing long cable runs and extending existing circuits which otherwise when tested may exceed the maximum measured loop impedance values given in Appendix 2 of the On-Site Guide and could result in replacing the cable for a larger size.