Simple design process.

a) Determine Design Current I_b

Triton T80 Pro Fit Electric Shower - 10.5kW SP8001PF

TRITON

Design Current (Single phase)

$$I_b = \frac{P}{V \times \cos\emptyset}$$

$$I_b = \frac{10.5\,kW}{230V} = \mathbf{45.65A}$$

Can I apply diversity?

OSG Table A2 Pg 137

6 Water heaters (thermostatically controlled)	No diversity allowable†

For an individual household installation **not allowed**.

b) Determine rating and type of overcurrent protective consider additional protection if required.


ADB150

Nominal Rating of Device **In**

$I_n \geq I_b \geq I_z$ (This gives compliance with **BS7671 (2022)** Regulation 433.1.1 **OVERLOAD PROTECTION**)

Manufacturer's Instructions require a 30mA RCD.
BS 7671 (2022) Pg 243 **OSG** Pg 87 7.2.5 (d)
Regulation 701.411.3.3 requires additional protection via a **30mA RCD**.

Hager VM144 consumer unit with 100 A Main Switch

Hager RCBO available and compatible with existing consumer unit. ✓ **RCBO Electronic 1M 1P 10kA B-50A 30mA AC Class**

Fault protection provided by the MCB part - **Type B** (no inrush current to consider)
OSG Table 7.2.7 (ii) Pg 90
Additional protection provided by the RCD - **Type AC** ~ is suitable as the shower load current has no DC components. **BS 7671 (2022**) Pg 157

Selected a BS EN 61009-1 Type B 50A.

BS 7671 (2022) Table 41.3 Pg 68 / OSG Table B6 Pg 145

$I_n \geq I_b$ $50 \geq 45.65$ ✓

c) Determine Installation or Reference Method

Under floors Reference Method **C**

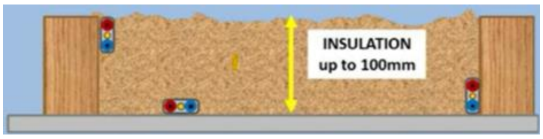
Inside trunking Reference Method **B**

Inside loft under **<100mm** of insulation touching on one side Reference Method **100**

Which method will have the worst effect on the current carrying capacity of the cable?
Inside the loft!!

BS7671 (2022) Table 4A2 Pg 437
OSG Table 7.1(iv) Pg 85

Reference Method **100** ✓



d) De-Rating Factors to consider.

Ambient Temperature C_a

BS 7671 (2022) Appendix 4 Table 4B1 Pg 441

OSG Appendix F Table F1 Pg 168

C_a = 1 (70°C thermoplastic cable in 30°C Ambient temp)

Grouping C_g

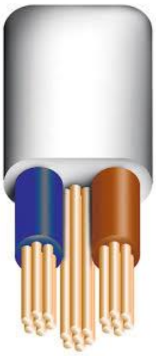
BS 7671 (2022) Appendix 4 Table 4C1 Pg 443

OSG Appendix F Table F3 Pg 170

C_g = 0.80 (Circuit enclosed with 1 other circuit so 2 circuit total)

C_i: N/A
C_f: N/A
C_c: N/A

e) Determine CSA of cable required.



BS 7671 (2022) Appendix 4 Pg 425

OSG Appendix F Pg 167

$I_z = \frac{In}{Ca \ x \ Cg}$

$I_z = \frac{50A}{0.80 \ x \ 1}$ = **62.5 A**

A cable needs to be selected that can carry at least **62.5 Amps**.

BS 7671 (2022) Appendix 4 Table 4D5 Pg 456
OSG Appendix F Table F6 Pg 177

16.0mm² conductor which has an I_t = 57 A ✗

This is the largest CSA available but does not comply with **Regulation 433.1.1 BS 7671 (2022)**

$I_t \geq I_z$ (This gives compliance with **BS7671 (2022) Regulation 433.1.1**)

57 ≥ 62.5 ✗

Possible solution
Change cable type and increase CSA?

Or have we overlooked something?

BS 7671 (2022) Appendix 4 Pg 425

Alternatively, it may be obtained from the following formulae, provided the circuits of the group are not liable to simultaneous overload.

$I_z = \frac{Ib}{Ca \ x \ Cg}$

$I_z = \frac{45.65A}{1 \ x \ 0.8}$ = **57 A**

We can now select the **16.0mm²** conductor as it has a current carrying capacity of 57 A.

Therefore

$I_t \geq I_z$ (This gives compliance with **BS7671 (2022) Regulation 433.1.1**)

57 ≥ 57 ✓

f) Calculate Volt Drop:

BS 7671 (2022) Appendix 4 (6) Pg 428 Table 4AB Pg 430

OSG Appendix F Pg 168

Volt drop = $\frac{mV/A/m \ x \ Ib \ x \ Length}{1000}$

mV/A/m = BS 7671 (2022) Table 4D5 Pg 456 (column 9) = 2.8 mV/A/m

mV/A/m = OSG Table F6 Pg 177 (column 8) 2.8 mV/A/m

Calculated volt drop = $\frac{2.8 \ x \ 45..65 \ x \ 78m}{1000}$ = **3.3 V** ✓

Max Volt drop is stated **BS 7671 (2022)** Table 4AB.

For Power circuits **max volt drop** = 5% of U_o (230V) Max volt drop = $\frac{230 \ x \ 5}{100}$ = **11.5 V**

3.3 V $\leq$ 11.5 V ✓

Our calculated Volt drop is less than maximum allowed so is **acceptable.** ✓

g) Determine Max Disconnection time for this circuit. (Shock Protection)
ADS chosen protective measure from **Chapter 41 BS 7671 (2022)**

BS 7671 (2022) Pg 64 / 65

Regulation 411.3.2.3

Maximum disconnections time stated in Table 41.1 shall be applied to final circuits with a rated current not exceeding:

(i) 63 A with one or more socket-outlets
(ii) 32 A supplying fixed connected current-using equipment.

In a TN-C-S system, a disconnection time **not exceeding 5 s** is permitted for a distribution circuit and for a **circuit not covered** by **Regulation 411.3.2.2**

50A final circuit TN-C-S earthing system.

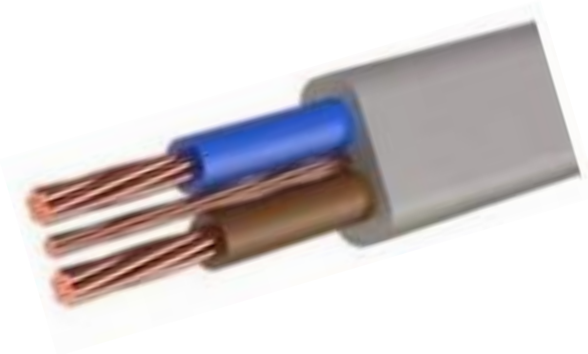
Therefore, maximum disconnection time of **5 Seconds.** ✓

OSG Appendix B Pg 139

h) Determine maximum Earth fault loop impedance value (Zs) to achieve the 5 second maximum disconnection time.

BS 7671 (2022)

OSG Appendix I Pg 217



$Z_s = Z_e + (R_1 + R_2)$

Line conductor = 16.00 mm²
CPC conductor = 6.00 mm²

$R_1 + R_2 = \frac{m\Omega/m \times Multiplier \times Length}{1000}$

Values for mΩ/m: **OSG** Table I1 Pg 218 = 4.23 mΩ/m
Temperature multiplier values: **OSG** Table I3 Pg 220 = 1.20
(70°C Thermoplastic cable bunched with the live conductors)

16	6	4.23

Incorporated in a cable or bunched (NOTE 2)	1.20

$R_1 + R_2 = \frac{4.23\ m\Omega/m \times 1.2 \times 78\ m}{1000}$ = 0.3959 Ω $R_1 + R_2$ = 0.40 Ω

Z_s = 0.14 Ω + 0.40 Ω = **0.54 Ω**

i) Verify maximum earth fault loop impedance value as stated in **BS 7671 (2022)** to ensure 5 second disconnection time.

BS 7671 (2022) Table 41.3 Pg 68 max Zs for 50A Type B BS EN 61009 RCBO = **0.87 Ω** ✓

Our calculated Zs value is less than the maximum allowed and therefore acceptable.

j) **Determine the Fault current**. (I_f)

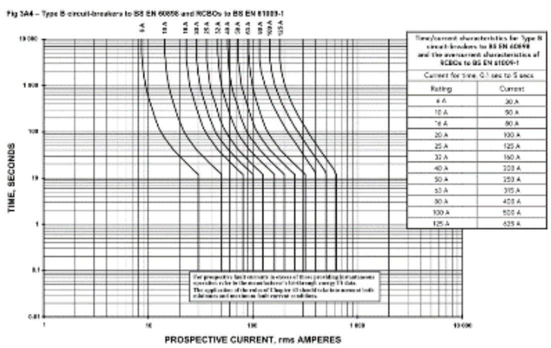
OSG Appendix I Pg 217

$I_f = \frac{Uo}{Zs} = \frac{230V}{0.54\Omega}$ = **425.92 A**

k) **Confirm the disconnection time of device selected.**

BS EN 61009-1 Type B RCBO
BS 7671 (2022) Appendix 3 Fig 3A4 Pg 417

50 A	250 A



A minimum of 250 A is required to disconnection between 0.1s to 5seconds.
Therefore 425.92 A will achieve our maximum disconnection time of 5 seconds. (0.1s actual) ✓

l) Is the CSA of the CPC acceptable within our selected cable?

$16.0mm^2$ Line and Neutral conductors + $6.0mm^2$ CPC

BS 7671 (2022) Pg 199

Regulation 543.1.3 states to calculate minimum CSA of the CPC required:

$$S = \frac{\sqrt{I^2 t}}{k}$$

I = 425.92 A
t = Table 3A4 Appendix 3 **BS 7671 (2022)** Pg 417 = 0.1s
k= Table 54.3 Pg 200 **BS 7671 (2022)** (70°C Thermoplastic Copper conductor) = 115

$$S = \frac{\sqrt{425.92A^2 \; x \; 0.1s}}{115} = 1.17 \text{ mm}^2$$ ✓

$6.0mm^2$ CPC is within our selected cable which has a larger CSA than the minimum calculated 1.17 mm^2 and therefore an **acceptable CSA.** ✓

Summary

Our chosen cable CSA of $16.0mm^2$ will comply fully with the relevant parts of BS 7671 (2022).

Could this circuit be designed and installed differently?