Simple design process.

a) Determine Design Current I_b

Design Current (Single phase)

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

$$I_b = \frac{7.4\ kW}{230V} = \mathbf{32.17A}$$

Home 7 Plus

Home Series chargers

Can I apply diversity?

When considering the additional load to be used for the EV charging equipment, the rating of the equipment is used in assessing the additional load. For a larger installation with a series of EV charging equipment connecting points, the assumed maximum load will need to be the sum of all the EV charging equipment ratings, unless there is a load curtailment arrangement limiting the load to a particular value.

722.311 Maximum demand and diversity

722.311.201 Load curtailment, including load reduction or disconnection, either automatically or manually, may be taken into account when determining maximum demand of the installation or part thereof.

Wired Energy Manager

SmartHome energy system

The home energy manager helps you source the power you need for your home and your electric vehicle with maximum possible efficiency.

Charge your car without disrupting the energy needed for home devices.
Monitor and track the energy usage of your home with daily, monthly, and yearly reports.

- Wired connection
- Supplied with pre calibrated CT clamp
- Compatible with all Home Series chargers
- See daily, monthly, and yearly reports all in your S&P app
- 1 x Wired Energy Manager supports 1 x Home Series Ev charger
- G100 compliant

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

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**)

Overcurrent protection provided by the **MCB part** - **Type B** (**OSG** Table 7.2.7 (ii) Pg 90)
(No inrush current declared by the manufacturer)

BS 7671 (2022) Pg 327

722.531.3.101 Unless supplied by a circuit using the protective measure of electrical separation, each charging point incorporating a socket-outlet or vehicle connector complying with the BS EN 62196 series shall be protected individually by an RCD of Type A, Type F or Type B and having a rated residual operating current not exceeding 30 mA.

Except where provided by the EV charging equipment, protection against DC fault currents shall be provided by:

(i) an RCD Type B, or

(ii) an RCD Type A or Type F in conjunction with a residual direct current detecting device (RDC-DD) complying with BS IEC 62955 as appropriate to the nature of the residual and superimposed currents and recommendation of the manufacturer of the charging equipment.

RCDs shall comply with one of the following standards: BS EN 61008-1, BS EN 61009-1, BS EN 60947-2 or BS EN 62423.

NOTE 1: Types of RCD are described in Regulation 531.3.3 in respect of their behaviour when exposed to DC components and frequencies.

NOTE 2: Requirements for the selection and erection of RCDs in the case of supplies using DC vehicle connectors according to the BS EN 62196 series are under consideration.

NOTE 3: An RCD Type A or Type F in conjunction with an RDC-DD can be arranged with the RDC-DD inside the EV charging equipment and the Type A or Type F RCD upstream in either the charging equipment or the installation.

SAFETY

PROTECTION SYSTEMS

Built-in RCD for residual current imbalance protection
RCD-30mA Type A
6 mA DC according to IEC 62955
Integrated overload protection according to BS EN IEC 61851-1:2019
Loss of PEN protection according to BS 7671: 2018/A1:2020
Impact resistance: IK08
Fire class: UL94
Insulation class: Class 2
Welded contact detection
Thermal protection system
Locking type 2 socket
Fail safe wireless load management*

Additional protection will need to be provided by an RCD - **Type A** upstream as the EVSE load current contains DC components and the in-built device is not recognised by BS 7671 (2022)

A **Type B** RCD would be required if the EVSE did not have an **RCD-DD** device to **BS IEC 62955** built in.

Selected a **BS EN 61009-1 Type B** (overcurrent) **40A** / **Type A RCD** (additional protection) ✓

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

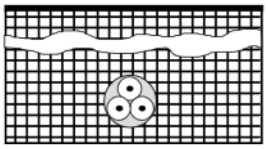
$I_n \geq I_b$ 40 ≥ 32.17 ✓

c) Determine Installation or Reference Method

Fixed direct to the masonry wall **Reference Method C**

Directly in the ground **Reference Method D**

Which method will have the **worst effect** on the current carrying capacity of the cable?
Buried directly in the ground!! **HEAT WANTS TO ESCAPE !!**

72		Sheathed, armoured or multicore cables direct in the ground: - without added mechanical protection (see note)	D

BS7671 (2022) Table 4A2 Pg 437

Reference Method **D** ✓

d) De-Rating Factors to consider.

Ambient Ground Temperature C_a of 25 °C

BS 7671 (2022) Appendix 4 Table 4B2 Pg 441

C_a = 0.96 (90°C thermoplastic cable in 25°C Ambient Ground Temperature) ✓

Buried Circuits C_c

BS 7671 (2022) Appendix 4 Section 4 **OVERLOAD PROTECTION** Pg 424

C_c = 0.90 ✓

Depth of Burial C_d

BS 7671 (2022) Appendix 4 Table 4B4 Pg 442

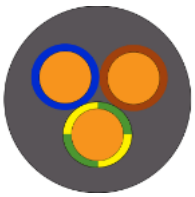
C_d = 1.03 (0.5m buried direct) ✓

Resistivity of soil C_s

BS 7671 (2022) Appendix 4 Table 4B3 Pg 442

C_s = 0.9 (Direct buried cable with soil resistivity of 3 K.m/W) ✓

e) Determine CSA of cable required.



BS 7671 (2022) Appendix 4 Pg 425

OSG Appendix F Pg 167

$$I_z = \frac{In}{Ca \; x \; Cc \; x \; Cd \; x \; Cs}$$

$$I_z = \frac{40A}{0.96 \; x \; 0.90 \; x \; 1.03 \; x \; 0.9} = \textbf{49.942 A}$$

A cable needs to be selected that can carry at least **50 Amps**.

BS 7671 (2022) Appendix 4 **Table 4D4A** Pg 454
OSG Appendix F Table F6 Pg 177

Conductor: Plain Annealed Copper Class 2 Stranded to BS EN 60228
Insulation: Thermosetting XLPE Type GP8 to BS 7655-1.3
Bedding: CarbonTek®
Steel Wire Armour: Galvanised steel wire armour (where applicable)
Sheathing: CarbonTek®
Energy Monitor Cable: Cat5e FTP—Foil Screened 4 twisted pair

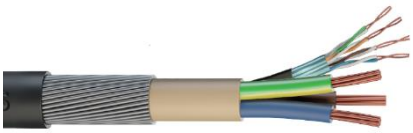


TABLE 4E4A – Multicore armoured 90 °C thermosetting insulated cables (COPPER CONDUCTORS)

NOTES:

1. Where it is intended to connect the cables in this table to equipment or accessories designed to operate at a temperature lower than the maximum operating temperature of the cable, the cables should be rated at the maximum operating temperature of the equipment or accessory (see Regulation 512.1.5).

Therefore, based on **Table 4D4A** (70 °C) a **10.0mm²** conductor which has an I_t = **60 A (Column 6)** can be selected. ✓

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

60 ≥ 50 ✓

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.

$I_z = \frac{Ib}{Ca \; x \; Cc \; x \; Cd \; x \; Cs}$

$I_z = \frac{32.17A}{0.96 \; x \; 0.90 \; x \; 1.03 \; x \; 0.9}$ = **40.165 A / 40 A**

We can now select the **6.0mm²** conductor as it has a current carrying capacity of **46 A**.

Therefore

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

46 ≥ 40 ✓

f) Calculate Volt Drop:

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

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

mV/A/m = BS 7671 (2022) **Table 4D4B** Pg 455 (column 3) = **7.3 mV/A/m**

Calculated volt drop = $\frac{7.3 \; x \; 32.17 \; x \; 26m}{1000}$ = **6.1058 V 6.1V** ✓

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**

6.1 V ≤ 11.5 V ✓

Our calculated Volt drop of 6.1 V 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**

40 A final circuit with one or more **socket outlets** TN-C-S earthing system.

Therefore, maximum disconnection time of **0.4 Seconds.** ✓
OSG Appendix B Pg 139

722.55 Other equipment

722.55.101 Socket-outlets and connectors

722.55.101.0.201.1 Each AC charging point shall incorporate:

(i) one socket-outlet complying with BS 1363-2 marked 'EV' on its rear and, except where there is no possibility of confusion, a label shall be provided on the front face or adjacent to the socket-outlet or its enclosure stating: 'suitable for electric vehicle charging', or

(ii) one socket-outlet or connector complying with BS EN 60309-2 which is interlocked and classified to clause 6.1.5 of BS EN 60309-1 to prevent the socket contacts being live when accessible, or

(iii) one socket-outlet or connector complying with BS EN 60309-2 which is part of an interlocked self-contained product complying with BS EN 60309-4 and classified to clauses 6.1.101 and 6.1.102 to prevent the socket contacts being live when accessible, or

(iv) one Type 1 vehicle connector complying with BS EN 62196-2 for use with mode 3 charging only, or

(v) one Type 2 socket-outlet or vehicle connector complying with BS EN 62196-2 for use with mode 3 charging only, or

(vi) one Type 3 socket-outlet or vehicle connector complying with BS EN 62196-2 for use with mode 3 charging only.

NOTE: Vehicle manufacturers' instructions should be taken into account when determining the type of socket-outlet to be installed.

CHARGING

Number of phases: 1 and 3 phases
Charging Current: 1.4 - 7.4 kW (6A to 32A Per Phase)
Connection: Type 2 socket
207-253v ~ 50/60Hz 32A
230v/400v 3N ~ 50/60Hz 32A
Dynamic fuse local grid management*
Multi chargepoint load management
Accuracy of built-in energy meters (+/- 2%)

Socket-outlet. A device, provided with female contacts, which is intended to be installed with the fixed wiring, and intended to receive a plug. A luminaire track system is not regarded as a socket-outlet system.

h) Determine **maximum** Earth fault loop impedance value (Zs) to achieve the **0.4 second** maximum disconnection time.

BS 7671 (2022)

OSG Appendix I Pg 217

$Z_s = Z_e + (R_1 + R_2)$

Line conductor = 6.00 mm²
CPC conductor = 6.00 mm²

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

Values for mΩ/m: **OSG** Table I1 Pg 218 = 6.16 mΩ/m
Temperature multiplier values: **OSG Table I3** Pg 220 = **1.28**
(90 °C Thermosetting cable bunched with the live conductors)

6	6	6.16

Table I3 Multipliers to be applied to Table I1 to calculate conductor resistance at maximum operating temperature (NOTE 3) for standard devices (NOTE 4)

Conductor installation	Conductor insulation		
	70 °C Thermoplastic (PVC)	90 °C Thermoplastic (PVC)	90 °C Thermosetting
Not incorporated in a cable and not bunched (NOTE 1)	1.04	1.04	1.04
Incorporated in a cable or bunched (NOTE 2)	1.20	1.28	1.28

$R_1 + R_2 = \frac{6.16 \; m\Omega/m \; x \; 1.28 \; X \; 26m}{1000}$ = 0.205 Ω **$R_1 + R_2$ = 0.21 Ω**

Z_s = 0.14 Ω + 0.21 Ω = **0.35 Ω**

i) Verify maximum earth fault loop impedance value as stated in **BS 7671 (2022)** to ensure 0.4 second disconnection time.

BS 7671 (2022) Table 41.3 Pg 68 max Zs for 40A Type B BS EN 61009 RCBO = **1.09 Ω** ✓

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

0.35 ≤ 1.09 ✓

j) **Determine the Fault current**. (I_f) (under earth fault conditions)

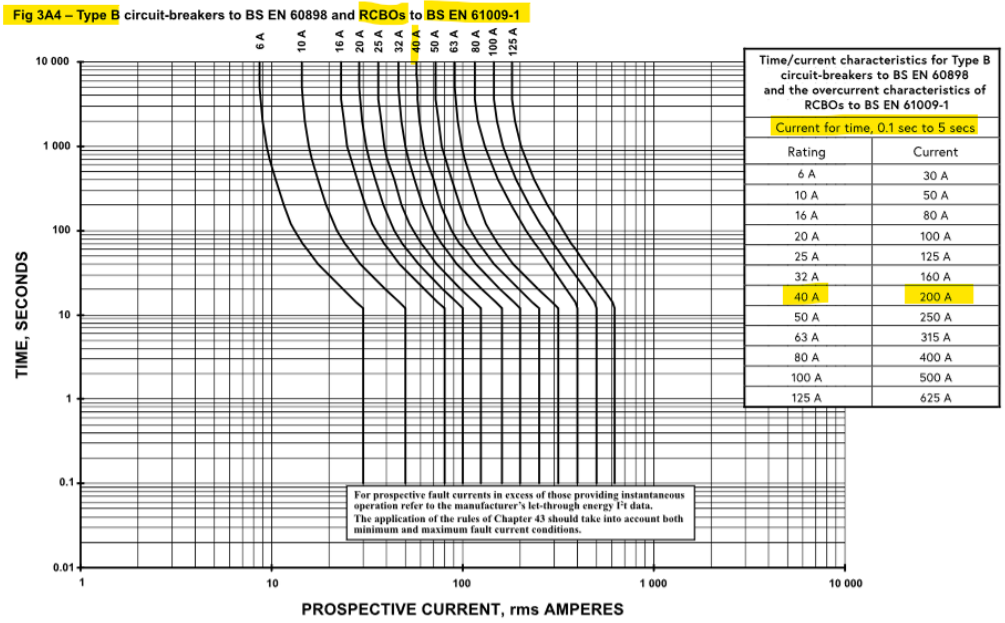
OSG Appendix I Pg 217

$I_f = \frac{Uo}{Zs} = \frac{230V}{0.35\Omega}$ = **657.14 A (PEFC)**

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

BS EN 61009-1 **40 A / Type B RCBO**

BS 7671 (2022) Appendix 3 **Fig 3A4** Pg 417



Time/current characteristics for Type B circuit-breakers to BS EN 60898 and the overcurrent characteristics of RCBOs to BS EN 61009-1

Current for time, 0.1 sec to 5 secs

Rating	Current
6 A	30 A
10 A	50 A
16 A	80 A
20 A	100 A
25 A	125 A
32 A	160 A
40 A	200 A
50 A	250 A
63 A	315 A
80 A	400 A
100 A	500 A
125 A	625 A

Time/current characteristics for Type B circuit-breakers to BS EN 60898 and the overcurrent characteristics of RCBOs to BS EN 61009-1

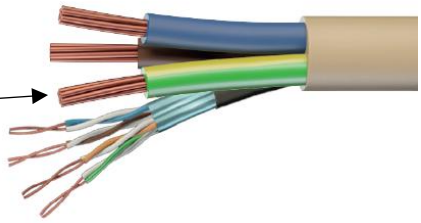
Current for time, 0.1 sec to 5 secs

Rating	Current
6 A	30 A
10 A	50 A
16 A	80 A
20 A	100 A
25 A	125 A
32 A	160 A
40 A	200 A
50 A	250 A
63 A	315 A
80 A	400 A
100 A	500 A
125 A	625 A

A minimum of 200 A is required to disconnection between **0.1s to 5seconds**.

Therefore 657.14 A will achieve our **maximum** disconnection time of **0.4 seconds**.
(0.1s actual) ✓

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



6.0mm^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 = 657.14 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) = **143**

TABLE 54.3 –
Values of k for protective conductor incorporated in a cable or bunched with cables, where the assumed initial temperature is 70 °C or greater

Material of conductor	Insulation material		
	70 °C thermoplastic	90 °C thermoplastic	90 °C thermosetting
Copper	115/103*	100/86*	143
Aluminium	76/68*	66/57*	94
Assumed initial temperature	70 °C	90 °C	90 °C
Final temperature	160 °C/140 °C*	160 °C/140 °C*	250 °C

* Above 300 mm^2

$$S = \frac{\sqrt{657.14^2 \times 0.1}}{143} = \mathbf{1.45\ mm^2}$$ ✓

6.0mm^2 CPC is within our selected cable which has a larger CSA than the minimum calculated 1.45 mm^2 and therefore an **acceptable CSA.** ✓