SIZING A CPC — THE ADIABATIC, REARRANGED

HOW SMALL CAN A PROTECTIVE CONDUCTOR BE?

Earlier the adiabatic equation was used to find **t** — how long a cable survives a given fault current. Here it's rearranged to find **S** — the minimum size the protective conductor has to be. Same four letters, different unknown.

D1

Earlier

$$t = k^2S^2 \div I^2$$

How long before the cable is destroyed?

D2

Here

$$S = \sqrt{(I^2t)} \div k$$

What's the smallest CPC that survives?

S	The **nominal cross-sectional area** of the conductor, in mm^2. CSA means the **copper only** — never the copper plus its insulation.
I	The **fault current**, in amperes.
t	The **operating time** of the protective device, in seconds — from Appendix 3.
k	A factor for the conductor and its insulation. **Not** the k you used in Chapter 43 earlier — these k values come from the **Tables 54.2 onward**.

THE WORKED EXAMPLE: IS THE CPC IN 2.5 MM² TWIN & EARTH BIG ENOUGH?

The scenario, word for word:

? **2.5 mm^2 / 1.5 mm^2 flat twin & earth**, 70 °C thermoplastic, on a **BS EN 60898 type B 20 A circuit breaker**. Prove the 1.5 mm^2 CPC has been sized correctly.

1. **Find I.** Type B trips at **5 × I_n** — the worst case of the 3–5 range. 5 × 20 = **100 A**. You could look it up in Appendix 3 instead of calculating it; you get the same number.
2. **Find t.** In Appendix 3, **Figure 3A4** (type B) gives the current needed to operate the device within **0.1 s** and within **5 s**. For a 20 A type B that is 100 A, so at 100 A it operates within 0.1 s: **t = 0.1 s** — well inside the 0.4 s a TN final circuit needs.

3. **Find k.** Go to the tables from **54.2** onward and pick the right one. Twin & earth is a **multicore sheathed cable with the protective conductor incorporated in it**, at an assumed initial temperature of 70 °C or greater, copper — so **k = 115**.

PROVING THE 1.5 MM² CPC IS BIG ENOUGH

$$S = \sqrt{(100^2 \times 0.1)} \div 115$$
$$S = \sqrt{(10\,000 \times 0.1)} \div 115$$
$$S = \sqrt{1000} \div 115$$
$$S = 31.62 \div 115$$
$$\mathbf{S = 0.27\ mm^2\ minimum}$$

Actual CPC in the cable = **1.5 mm²**
1.5 mm² ≥ 0.27 mm² → **adequate**

✋ **Only I^2t goes under the square root.** It is easy to get wrong by rooting the whole fraction, k included. Do it in parts, or bracket the numerator. On a fraction-style calculator: fraction button, square root inside the top, 100 squared × 0.1, then 115 on the bottom, equals, then convert out of fraction form.

✋ **You may NOT use the adiabatic to size a bonding conductor.** Worth marking clearly in your own notes — it is a common trap. A main protective bonding conductor — your 10 mm² to the gas and water, say — is sized from **specific regulations and tables** based on the **incoming live conductors**, never from the adiabatic. Getting this backwards is a classic exam trap.

WHY THE K TABLES DON'T SAY "TWIN & EARTH"

A fair question: why isn't there a row that just says twin & earth, the way the cable tables do? Because you might be looking for the CPC inside any multicore sheathed cable — a three-core-and-earth, for instance — and the table has to cover all of them. Read the *description*, not the cable name.

Watch the sheath-or-armour row.
One row covers cables where the **sheath or armour is itself the protective conductor** — SWA, for instance. In twin & earth the CPC is a separate bare conductor, not the sheath, so that row is not yours. This is where most people pick the wrong table.

115 and 103.
Both appear, and the difference is the **final temperature** the conductor is permitted to reach before the cable is destroyed. For 70 °C thermoplastic copper under 300 mm², it's **115**.

> **Tab this.**
> Worth tabbing the k tables with their printed table number, such as "Table 54.2". Legal, because the tab only carries what's printed on that page.

- **Chapter 54** · cross-sectional area of protective conductors · the S formula ★
- **Tables 54.2 onward** · p.210 · k values · copper in a sheathed cable = **115** ★
- **Appendix 3 · Figure 3A4** · type B · currents for 0.1 s and 5 s ★
- **434.5** · the adiabatic (Part 4, Part 1)

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