SMART WIRED

Electrical Contractor

FREE STUDY PACK FOR UK ELECTRICIANS

VISUAL STUDY CARDS

BS 7671:2018+A4:2026 · 48 cards · one topic per page

Every card: a technical drawing, five key points, the regulation numbers, a common mistake to avoid and a tip from site.

SAFETY & THE REGULATIONS
Safe isolation, GS38, the EAWR 1989, how BS 7671 is laid out, Part P and what changed in A4.

CIRCUITS, CABLES & DESIGN
Rings and radials, lighting, cable types, Ib ≤ In ≤ Iz, voltage drop, max Zs, adiabatic and safe zones.

INSPECTION, TESTING & CERTIFICATION
Test sequence, continuity, insulation resistance, polarity, Ze, Zs, RCDs, EIC, Minor Works and EICR.

BONUS: FORMULAS & PRACTICE
Key formulas on one page, and practice questions with worked answers.

SUPPLY, EARTHING & BONDING
Supply chain, TN-S, TN-C-S and TT, bonding, Ze and PFC, disconnection times and RCD protection.

SPECIAL LOCATIONS & NEW TECHNOLOGIES
Bathrooms, pools and saunas, outdoors, outbuildings, solar PV, batteries, EV charging and heat pumps.

ON-SITE PRACTICE & FAULT FINDING
Diagrams, terminations and torque, three-phase, first and second fix, and tracing common faults.

CONTENTS

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SAFETY & THE REGULATIONS

01 Safe isolation, step by step
02 GS38: test equipment
03 Electricity at Work Regulations 1989
04 How BS 7671 is laid out
05 Part P: what's notifiable
06 What's new in Amendment 4

SUPPLY, EARTHING & BONDING

07 From transformer to consumer
08 Earthing systems: TN-S, TN-C-S, TT
09 Main earthing terminal & bonding
10 Ze and prospective fault current
11 Disconnection times
12 Where 30 mA RCDs are required
13 Consumer unit layout

CIRCUITS, CABLES & DESIGN

14 Ring final circuits
15 Radial circuits
16 Lighting: one-way to intermediate
17 Cable types
18 Ib ≤ In ≤ Iz and correction factors
19 Voltage drop
20 Maximum Zs
21 The adiabatic equation
22 Safe zones in walls

SPECIAL LOCATIONS & NEW TECHNOLOGIES

23 Bathrooms: zones 0, 1 and 2
24 Swimming pools and saunas
25 Outdoor circuits & sockets
26 Supplying an outbuilding with SWA
27 Solar PV: components
28 Battery storage A4
29 EV charging: the circuit
30 Heat pumps: electrical supply

INSPECTION, TESTING & CERTIFICATION

31 The test sequence
32 Continuity: R1 + R2
33 Ring final continuity
34 Insulation resistance
35 Polarity and earth electrodes
36 Earth fault loop impedance: Zs
37 RCD testing
38 Certificates: EIC and Minor Works
39 EICR and the codes

ON-SITE PRACTICE & FAULT FINDING

40 Reading diagrams and symbols
41 Terminations and torque
42 Three-phase basics
43 First fix and second fix
44 Fault finding: an RCD that trips
45 Fault finding: low insulation resistance
46 Fault finding: broken ring or dead socket

BONUS: FORMULAS & PRACTICE

47 Formulas and key values
48 Practice questions

Read this first. These cards are a study and revision aid. They summarise and point to BS 7671:2018+A4:2026 (IET Wiring Regulations) and related guidance in our own words; they do not reproduce or replace it. Always design, install, inspect and test to the current edition, the manufacturer's instructions and your scheme's rules. Regulation numbers and values were checked at the time of writing — confirm them against your copy of the Orange Book. BS 7671 is published by the IET and BSI. SmartWired Electrical Contractor Ltd accepts no liability for work carried out using these cards.

SAFE ISOLATION, STEP BY STEP

Isolate, lock off, prove dead — the same routine on every job, every time.

1 Identify
Find the right circuit and confirm it on the circuit chart

2 Isolate
Switch off the device or the main switch for the work area

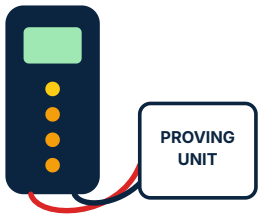
3 Lock off
Lock-off kit + padlock, key stays with you, caution notice on

4 Prove
Prove the indicator on a proving unit or known live source

5 Test dead
At the point of work: L–N, L–E, N–E

6 Re-prove
Prove the indicator again on the proving unit

7 Start work
Only now is it safe. Keep the key on you until you're done



Approved voltage indicator

Test between every combination at the point of work

Single-phase: L–N · L–E · N–E

Three-phase: L1–L2 · L2–L3 · L1–L3 · each line to N · each line to E · N–E

A functional switch is not isolation — use a device suitable for isolation and secure it open.

KEY POINTS

1. **Isolate, don't just switch off**
   A functional switch isn't isolation. Use a device suitable for isolation and secure it in the open position.
2. **Lock it off**
   Lock-off kit and a unique padlock, key kept on you, caution notice fitted (EAWR Regs 12 and 13).
3. **Prove – test – prove**
   Prove the voltage indicator on a proving unit, test dead, then prove the indicator again.
4. **Test every combination**
   Single-phase: L–N, L–E, N–E. Three-phase: each line to line, to N and to E, plus N–E.
5. **Right tester**
   A two-pole approved voltage indicator to GS38 — not a multimeter, not a non-contact 'volt stick'.

REMEMBER

Dead working is the rule. Live work is only allowed when all three EAWR Reg 14 conditions are met — and precautions are in place.

COMMON MISTAKE

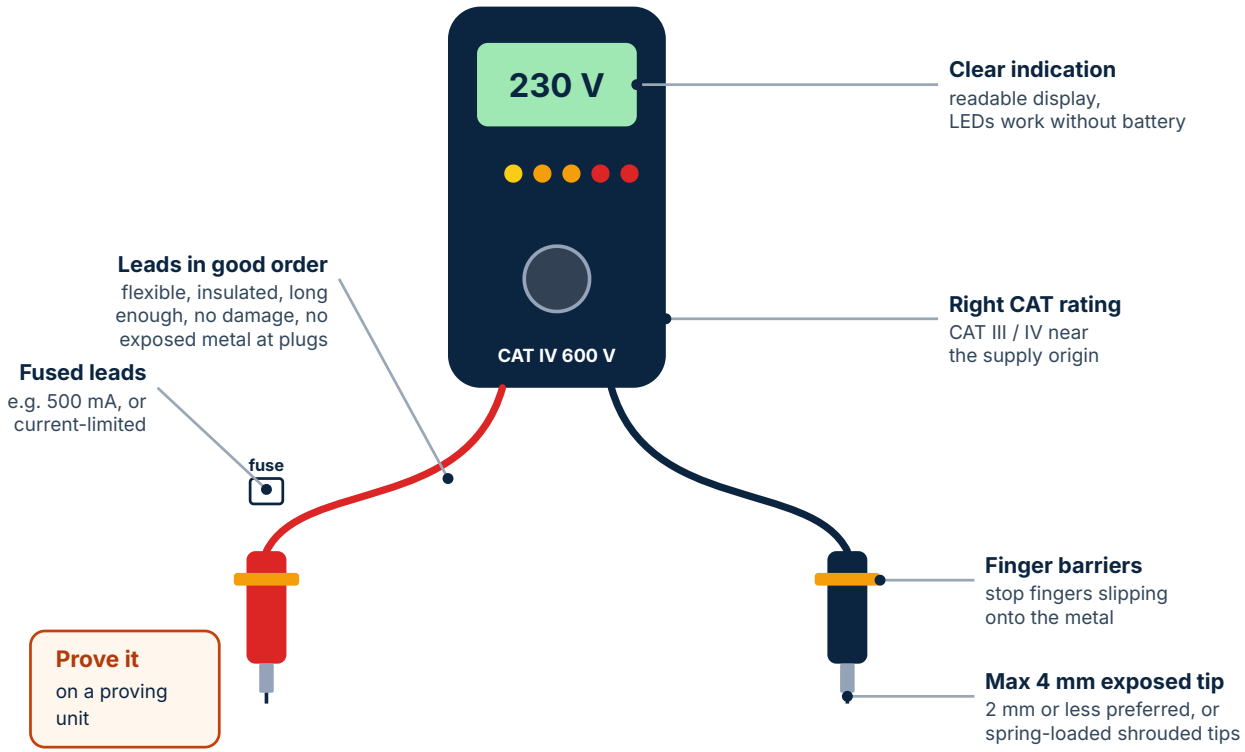
Using a non-contact voltage detector and calling it dead. It can't prove dead — only a two-pole approved voltage indicator can.

ON-SITE TIP

Carry your own proving unit. A known live socket isn't always handy, and you need to prove the tester before and after.

GS38: TEST EQUIPMENT

What safe test leads, probes and voltage indicators look like — HSE guidance GS38.



KEY POINTS

1. **Probe tips**
   No more than 4 mm of exposed metal — 2 mm or less preferred — or spring-loaded shrouded tips.
2. **Finger barriers**
   Guards on the probes stop your fingers slipping forward onto the tip or the live part.
3. **Fused or current-limited**
   Suitable fusing (e.g. 500 mA) or current-limiting in the leads cuts the energy in a fault.
4. **Leads in good order**
   Flexible, well insulated, long enough, undamaged, with no exposed metal at the connectors.
5. **Right CAT rating**
   The measurement category must suit where you test — CAT III or CAT IV near the origin.

REMEMBER

GS38 is HSE guidance, not law. Following it is how you show you've met the EAWR duty to use suitable equipment.

COMMON MISTAKE

Carrying on with a cracked lead or missing tip guards because 'it still works'. Damaged kit fails when you need it most.

ON-SITE TIP

Check leads and probes before every use, and keep your MFT's calibration certificate with your paperwork.

ELECTRICITY AT WORK REGULATIONS 1989

The law behind everything you do on site — and how BS 7671 fits under it.

Health and Safety at Work etc. Act 1974
Parent Act — general duties

↓

Electricity at Work Regulations 1989
STATUTORY — the law

↓

BS 7671 Wiring Regulations
NON-STATUTORY — how you comply

↓

Guidance: GS38, HSR25, GN3, OSG
Best practice — supports the above

Key regulations

Reg 3	**Duty holders: employers, self-** employed and employees
Reg 4	**Systems, work activities and** protective equipment kept safe
Reg 12	**Means of cutting off the supply** and of isolation
Reg 13	**Precautions so dead equipment** can't become live
Reg 14	**Work on or near live conductors** — only if all three tests met
Reg 16	**Competence to prevent danger** and injury

Some duties are ABSOLUTE (no excuse) — others apply SO FAR AS IS REASONABLY PRACTICABLE

KEY POINTS

1. **It's the law**
   EAWR 1989 is statutory, made under the Health and Safety at Work etc. Act 1974. A breach can mean prosecution.
2. **Duty holders**
   Employers, the self-employed and employees all have duties for matters within their control (Reg 3).
3. **Absolute vs practicable**
   Some duties are absolute — no excuse. Others apply so far as is reasonably practicable.
4. **Isolation & dead working**
   Reg 12: means of cutting off and isolating. Reg 13: stop dead equipment becoming live.
5. **Competence**
   Reg 16: nobody does work needing technical knowledge or experience unless competent or supervised.

REMEMBER

BS 7671 is non-statutory, but meeting it is likely to satisfy the EAWR. The HSE's guidance (HSR25) points to it.

COMMON MISTAKE

Thinking the EAWR only applies on business premises. It covers your work activity — including in a customer's home.

ON-SITE TIP

Put your safe isolation procedure in your method statement and follow it every time. It's your best defence.

HOW BS 7671 IS LAID OUT

Eight parts, plus appendices — and how to read a regulation number.

PART 1
Scope, objects & fundamental principles

PART 2
Definitions

PART 3
Assessment of general characteristics

PART 4
Protection for safety

PART 5
Selection & erection of equipment

PART 6
Inspection & testing

PART 7
Special installations or locations

PART 8
Energy efficiency & prosumer installations

Reading a regulation number

4 1 1 .3 .3

- **Part 4** — Protection for safety
- **Chapter 41** — Protection against electric shock
- **Section 411** — Automatic disconnection of supply
- **Group 411.3** — Fault protection requirements
- **Reg 411.3.3** — Additional protection: 30 mA RCD

UK-only regs are numbered from 200 up, e.g. 421.1.201

Part 7 sections start 7xx: 701 bathrooms · 712 solar 722 EV charging

KEY POINTS

1. **Parts 1–3: foundations**
   Scope and principles, definitions, and assessing the supply, use and external influences.
2. **Parts 4–5: design and install**
   Part 4 protection for safety; Part 5 selection and erection of equipment, cables and earthing.
3. **Part 6: inspect and test**
   What to inspect, which tests to do, and the certificates and reports to issue.
4. **Part 7: special locations**
   Adds to or changes Parts 1–6 for places like bathrooms (701), solar PV (712) and EV charging (722).
5. **Appendices**
   Cable ratings, max Zs, model forms and more. Some are normative (must follow), others informative.

REMEMBER

Part 7 doesn't replace the rest — it adds to it. Apply the general rules first, then the special location's extra ones.

COMMON MISTAKE

Reading one regulation on its own. Check the group and section around it — exceptions often sit right next door.

ON-SITE TIP

Know your appendices: 3 for time/current curves, 4 for cable ratings and voltage drop, 6 for the model forms.

PART P: WHAT'S NOTIFIABLE

Building Regulations for electrical work in dwellings in England — and how to notify.

NOTIFIABLE

- A new circuit — any circuit, any size
- Replacing a consumer unit
- Adding to or altering a circuit in a special location: bath/shower zones, pool, sauna

NOT NOTIFIABLE (usually)

- Replacing accessories — sockets, switches, roses
- Adding a socket or light to an existing circuit (not special loc.)
- Replacing a damaged cable for one circuit on the same route
- Installing or upgrading main or supplementary bonding

How to notify

Competent person scheme

Registered with NAPIT, NICEIC etc.? Self-certify the work. Your scheme notifies Building Control, and the customer gets a Building Regulations Compliance Certificate.

Not registered

Apply to Building Control before you start. They inspect the work and may charge a fee.

Either way: issue an EIC or MEIWC.

KEY POINTS

1. **Dwellings in England**
   Part P covers fixed electrical work in and around dwellings — houses, flats, gardens and outbuildings.
2. **Three notifiable jobs**
   A new circuit, a consumer unit replacement, or additions and alterations in a special location.
3. **Self-certify**
   Competent person scheme members notify through their scheme, which tells Building Control.
4. **Not registered?**
   Apply to Building Control before you start. They inspect the work and may charge a fee.
5. **Every job needs a cert**
   Notifiable or not, the work must meet BS 7671. Issue an EIC or Minor Works certificate.

REMEMBER

Wales has its own Part P with a longer notifiable list, and Scotland uses building warrants. Check where you're working.

COMMON MISTAKE

Treating a consumer unit swap as 'just maintenance'. It's notifiable, and it needs a full EIC with test results.

ON-SITE TIP

Notify promptly through your scheme's portal. The customer's compliance certificate depends on it — so does their house sale.

WHAT'S NEW IN AMENDMENT 4

The changes that matter on site, from batteries to RCD types and the new EICR.

Chapter 57

Batteries

New rules for stationary batteries. Dwellings: PAS 63100

Section 716

Power over Ethernet

ELV DC over data cable. Design current max 750 mA per conductor

Section 545

Functional earthing

For ICT systems. Pink replaces cream for FE conductors

Reg 531.3.3

RCD types in series

Type AC not upstream of A, F or B; Type A not upstream of F or B

Reg 421.1.7

AFDDs

Now 'high-rise domestic' over 18 m. EV circuits exempt (722.421.1.7.201)

Reg 551.7.1

Two-way energy

Bidirectional devices where needed; batteries count as generating sets

Reg 522.6

Concealed cables

Requirements restructured with a new Table 52.1 and Reg 522.6.204

Appendix 6

Model forms

Major changes to the EICR; minor changes to EIC and Minor Works

Published 15 April 2026 · previous version withdrawn 15 October 2026 · A3:2024 now built in

KEY POINTS

1. **Key dates**
   Published 15 April 2026. A2:2022+A3:2024 was withdrawn on 15 October 2026 — A4 applies now.
2. **Batteries & PoE**
   New Chapter 57 for stationary batteries, and new Section 716 for Power over Ethernet.
3. **Two-way energy**
   Protective devices must suit bidirectional flow where energy can flow both ways (Regs 530.3.201, 551.7.1).
4. **RCDs and AFDDs**
   Watch RCD types in series (531.3.3). AFDD rule now says 'high-rise domestic', over 18 m (421.1.7).
5. **Paperwork**
   Major changes to the EICR model form; minor changes to the EIC and Minor Works forms.

REMEMBER

A4 isn't retrospective. Older installations aren't unsafe just because they predate it — but new work must meet A4.

COMMON MISTAKE

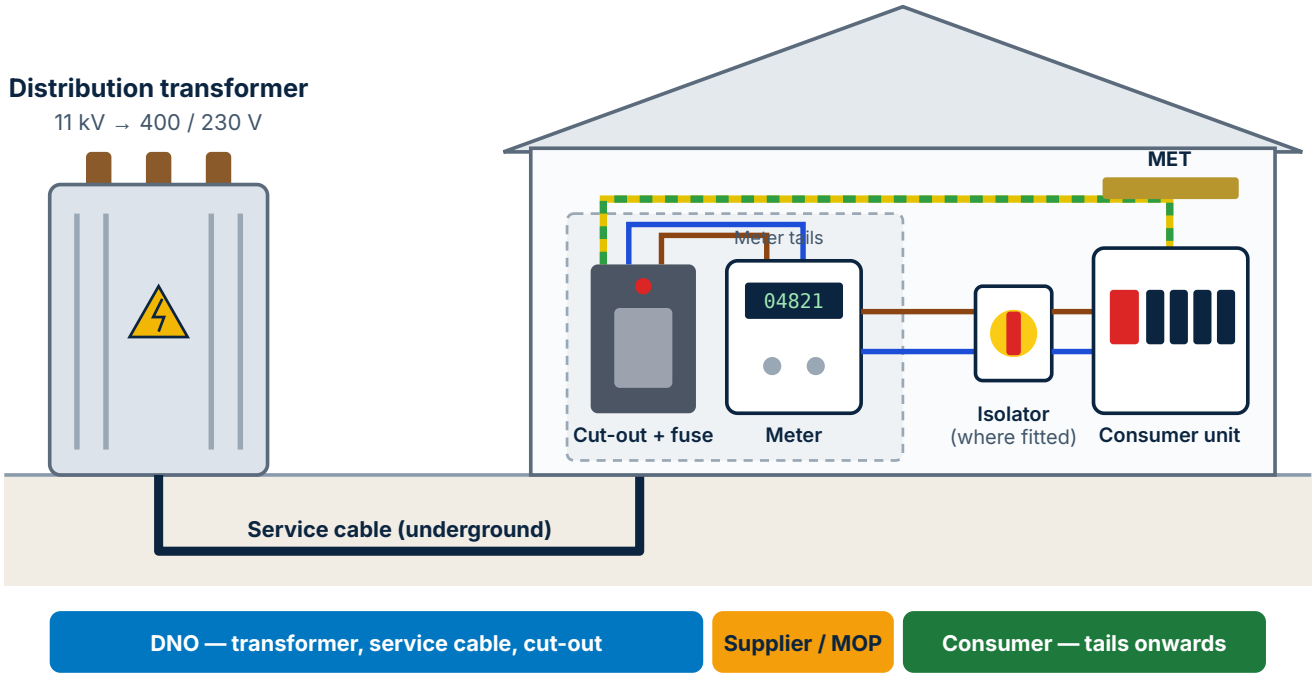
Still using old certificate templates. Update your software or pads to the A4 model forms — especially the EICR.

ON-SITE TIP

The Orange Book consolidates everything — A3:2024 is built in, so one book covers the lot.

FROM TRANSFORMER TO CONSUMER

The whole supply chain on one page — and who owns each part.



KEY POINTS

1. **DNO owns up to the cut-out**
   Transformer, service cable, cut-out and main fuse. Never break the seal or draw the fuse unless authorised.
2. **Meter, then the consumer**
   The meter belongs to the supplier / meter operator. From its outgoing terminals onwards, it is the customer's installation.
3. **Typical domestic supply**
   230 V single-phase (+10% / −6%), 50 Hz. Main fuse commonly 60, 80 or 100 A — read it, don't assume it.
4. **Know the supply before you design**
   Earthing type, Ze, PFC and fuse rating (Reg 313.1). The DNO must provide them on request (ESQCR Reg 28).
5. **Meter tails**
   Usually 25 mm² double-insulated. Keep them short and protected; long runs need a switch-fuse — check DNO rules.

REMEMBER

The earthing system — TN-S, TN-C-S (PME) or TT — drives your whole protection strategy. Identify it at the cut-out first.

COMMON MISTAKE

Quoting a charger or heat pump without checking the main fuse and existing demand. A 60 A fuse can kill the job.

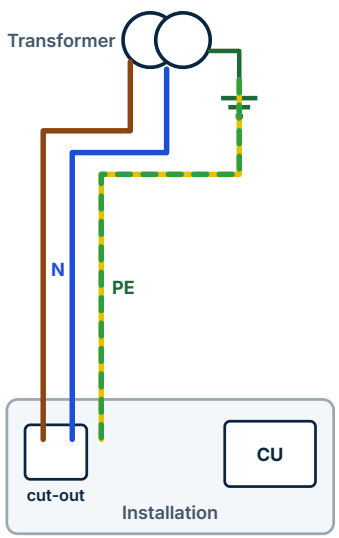
ON-SITE TIP

Photograph the cut-out, fuse rating and earthing arrangement on every survey. It saves a second visit.

EARTHING SYSTEMS: TN-S, TN-C-S, TT

Where your earth comes from — and what it means for protection.

TN-S

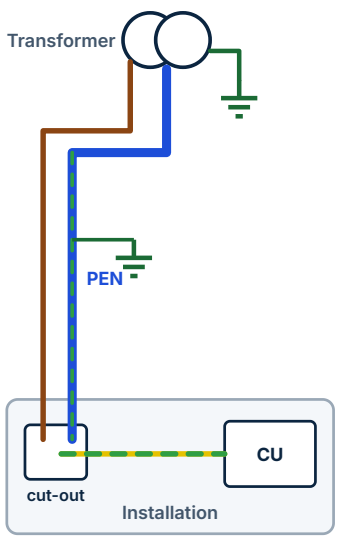


Separate N and PE all the way

Earth: supply sheath / conductor

Typical max Ze 0.8 Ω

TN-C-S (PME)

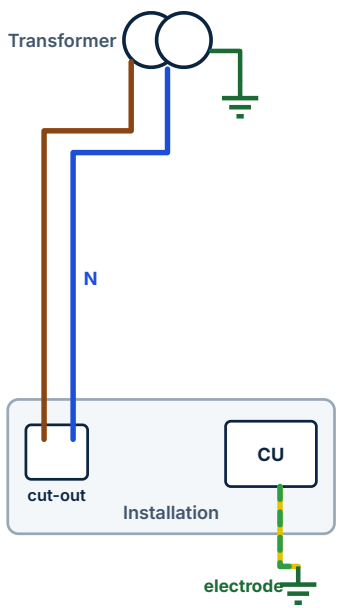


Combined PEN in the supply

Split into N + PE at the cut-out

Typical max Ze 0.35 Ω

TT



No earth from the DNO

Earth: your own electrode

RCD essential · RA ≤ 200 Ω advised

KEY POINTS

1. **Identify it first**
   Check the cut-out and earthing arrangement, and ask the DNO. Your whole design depends on it.
2. **TN-S**
   Separate neutral and earth from the transformer, often via the cable sheath. Typical max Ze 0.8 Ω.
3. **TN-C-S (PME)**
   Neutral and earth combined in the supply (PEN), split at the cut-out. Typical max Ze 0.35 Ω.
4. **TT**
   No earth from the DNO — you provide it with an electrode. Fault current is low, so rely on RCDs.
5. **PME risks**
   A broken PEN can make earthed metalwork live. Take care with outdoor equipment and outbuildings.

REMEMBER

A4 adds protective neutral bonding (PNB) as a variant of TN-C-S, shown in a new Figure 3.9B (Reg 312.2.1.1).

COMMON MISTAKE

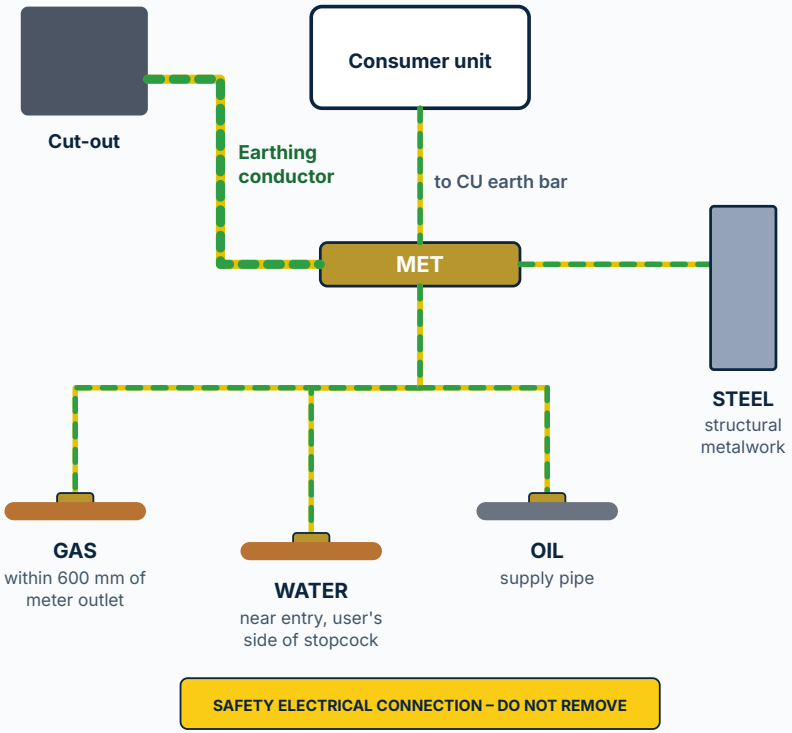
Assuming every newer house is PME. Check it — and never use a gas or water pipe as the earth electrode (Reg 542.2.6).

ON-SITE TIP

Photograph the cut-out and main earth on every survey. It settles the earthing question and backs up your Ze reading.

MAIN EARTHING TERMINAL & BONDING

What gets bonded, where the clamp goes and what size conductor to use.



Conductor sizes (copper)

PME (TN-C-S)
Main bonding sized from the supply neutral: 10 mm² where neutral ≤ 35 mm² (Table 54.8)

TN-S
Main bonding at least half the earthing conductor, min 6 mm², need not exceed 25 mm²

TT
Earthing conductor buried unprotected: 25 mm² min (Table 54.1)

Typical house
16 mm² earthing conductor
10 mm² main bonding
25 mm² meter tails

KEY POINTS

1. **One central point**
   The MET joins the earthing conductor, circuit protective conductors and main bonding together.
2. **What to bond**
   Extraneous-conductive-parts: metal water, gas and oil pipes, structural steel, other metal services.
3. **Where to connect**
   Within 600 mm of the meter outlet, or at the point of entry if the meter is outside — before any branch.
4. **Sizes on PME**
   Sized from the supply neutral: 10 mm² copper when it's up to 35 mm² (Table 54.8).
5. **Sizes on TN-S / TT**
   At least half the earthing conductor, 6 mm² minimum, never more than 25 mm² needed (Reg 544.1.1).

REMEMBER

Every earthing and bonding clamp needs a 'Safety Electrical Connection — Do Not Remove' label (Reg 514.13.1).

COMMON MISTAKE

Bonding plastic pipe, or after a plastic section. If the service enters in plastic there may be nothing to bond — check.

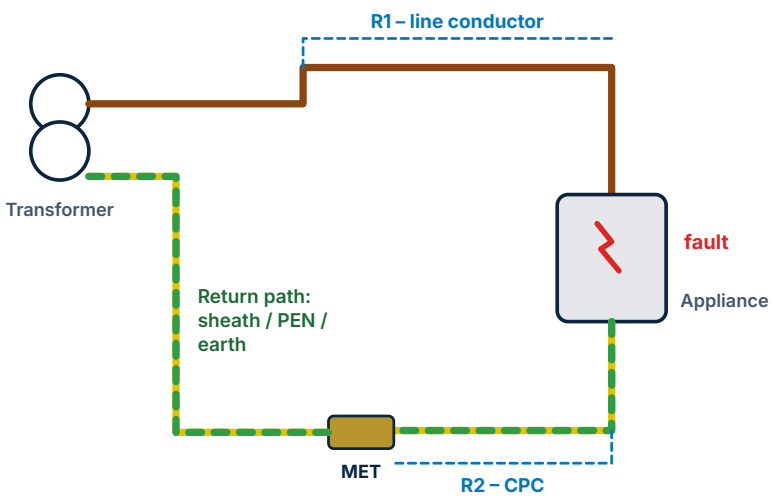
ON-SITE TIP

Missing 10 mm² bonding on a PME supply? Record it on the EICR — it's usually coded C2.

Ze AND PROSPECTIVE FAULT CURRENT

The two supply readings you need before you design anything.

The earth fault loop



Zs = Ze + (R1 + R2)

Ze: outside your installation — transformer, supply line and earth return. R1 + R2: your circuit's line conductor and CPC.

Prospective fault current

At the origin, measure:

PSCC (L – N)

PEFC (L – E)

Record the higher one

Typical max (DNO)

16 kA

single-phase domestic supply

Breaking capacity

Every device must break the PFC where it's fitted (Reg 434.5.1).

Domestic MCB: typically 6 kA. CU to BS EN 61439-3: 16 kA conditional rating when fed by a BS 88-3 fuse up to 100 A.

KEY POINTS

1. **What Ze is**
   The external loop: transformer winding, supply line conductor and the earth return path.
2. **Measuring Ze**
   At the origin, installation isolated, main earthing conductor off the MET. Reconnect it after!
3. **Zs = Ze + (R1+R2)**
   Add the circuit's R1+R2 to Ze to get Zs, then compare it with the device's max Zs.
4. **PFC**
   Measure L–N (PSCC) and L–E (PEFC) at the origin. Record the higher as the prospective fault current.
5. **Breaking capacity**
   Every device must break the PFC where it's fitted (Reg 434.5.1). Check its kA rating.

REMEMBER

Consumer units to BS EN 61439-3 are rated for 16 kA when fed by a BS 88-3 cut-out fuse of up to 100 A.

COMMON MISTAKE

Leaving the main earth off after measuring Ze. Use a 'test in progress' notice and reconnect before you re-energise.

ON-SITE TIP

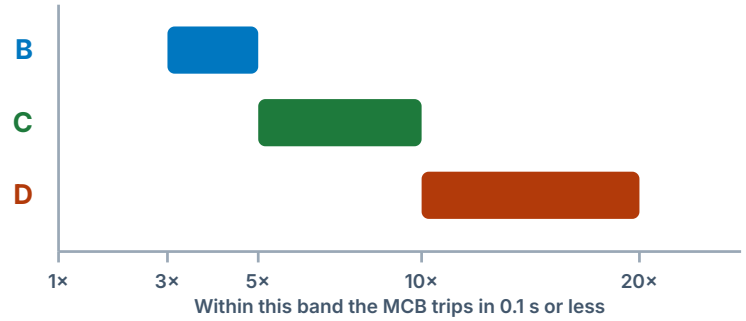
Compare Ze with the DNO's typical max (0.8 Ω TN-S, 0.35 Ω PME). Much higher? Investigate before you design.

DISCONNECTION TIMES

How fast a protective device must clear an earth fault — and why Zs decides it.

Maximum disconnection time (230 V)	TN	TT
Final circuits up to 63 A with sockets, or up to 32 A fixed equipment only	0.4 s	0.2 s
Distribution circuits and larger final circuits	5 s	1 s

MCB instant-trip range (× rated current In)



Within this band the MCB trips in 0.1 s or less

Sense check: B32

Instant trip at 5 × 32 A = 160 A

230 V ÷ 160 A ≈ 1.44 Ω

Table 41.3 max Zs: 1.37 Ω (includes the Cmin factor 0.95)

Keep Zs below the max and the fault current trips it in time.

KEY POINTS

1. **Why time matters**
   The longer a fault lasts, the longer touch voltage sits on metalwork. Fast disconnection limits it.
2. **Final circuits**
   Up to 63 A with sockets, or 32 A fixed equipment only: 0.4 s TN, 0.2 s TT at 230 V (Table 41.1).
3. **Distribution circuits**
   Larger final circuits and distribution circuits: 5 s TN, 1 s TT (Regs 411.3.2.3, 411.3.2.4).
4. **MCB types**
   Instant trip: Type B at 3–5 × In, Type C at 5–10 × In, Type D at 10–20 × In. Match it to the load.
5. **Meeting it**
   Keep Zs within the max for the device, so enough fault current flows to trip it in time.

REMEMBER

On TT the RCD usually does the disconnecting. For fault protection check RA × IΔn ≤ 50 V (Reg 411.5.3).

COMMON MISTAKE

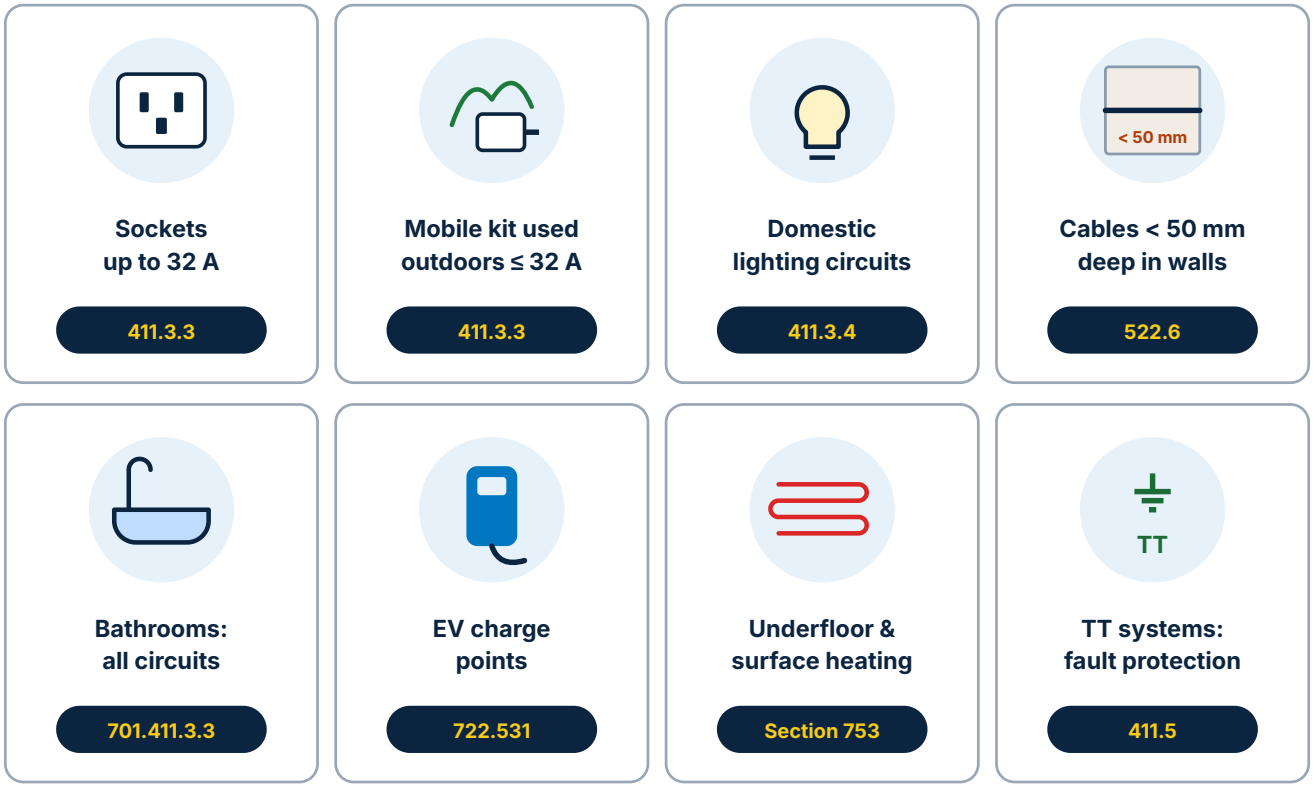
Swapping a B for a C to stop nuisance trips without re-checking Zs. A C32 needs roughly half the Zs of a B32.

ON-SITE TIP

Quick check: a B32 needs 160 A to trip instantly. 230 V ÷ 160 A ≈ 1.44 Ω — the 1.37 Ω table value adds a safety factor.

WHERE 30 mA RCDS ARE REQUIRED

Additional protection: the places BS 7671 calls for a 30 mA RCD.



KEY POINTS

1. **Sockets up to 32 A**
   30 mA RCD (Reg 411.3.3). Outside dwellings it can be left off only with a documented risk assessment.
2. **Outdoor mobile equipment**
   Mobile equipment rated up to 32 A for use outdoors needs 30 mA protection (Reg 411.3.3).
3. **Domestic lighting**
   AC final circuits supplying luminaires in domestic premises need 30 mA RCD protection (Reg 411.3.4).
4. **Concealed cables**
   Cables under 50 mm deep in walls or partitions without other protection need a 30 mA RCD (Reg 522.6).
5. **Special locations**
   Bathrooms (701), EV charging (722), heating (753) and others add their own RCD rules.

REMEMBER

Additional protection backs up basic and fault protection. An RCD is never the sole means of protection (Reg 415.1.2).

COMMON MISTAKE

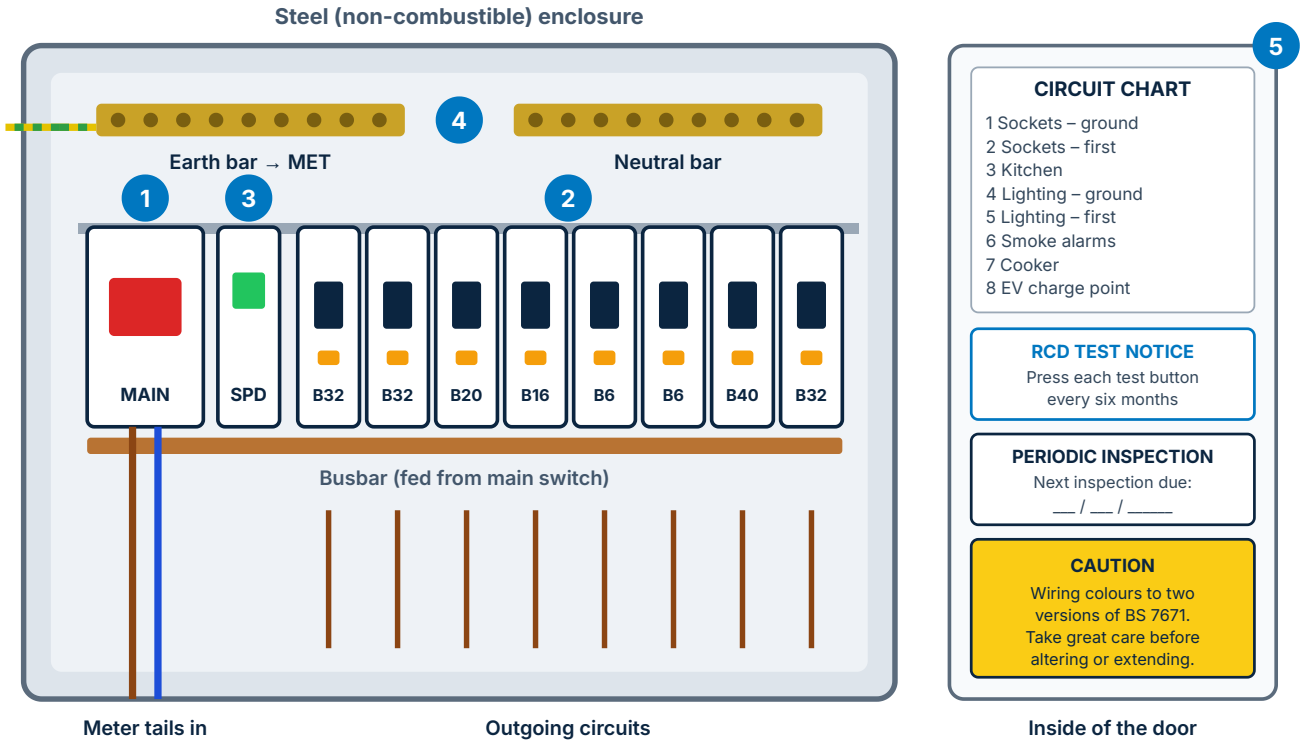
Every circuit on one RCD. One fault takes out the lot — use RCBOs or split circuits to avoid the hassle (Reg 314.1).

ON-SITE TIP

Check the RCD type as well as the rating. Loads with DC components need Type A, F or B — not Type AC (Reg 531.3.3).

CONSUMER UNIT LAYOUT

A modern all-RCBO board: where each part sits and what the labels must show.



KEY POINTS

1. **Main switch**
   Double-pole, isolates the whole installation in one action. Clearly labelled as the main switch.
2. **RCBOs**
   Overcurrent plus 30 mA RCD protection per circuit. A fault drops one circuit, not half the house (Reg 314.1).
3. **SPD**
   Fitted at the origin, with connecting leads kept as short and straight as possible (Section 534).
4. **Earth & neutral bars**
   Earth bar connected to the MET. Terminate CPCs and neutrals in the same order as their circuits.
5. **Labels**
   Circuit chart (514.9.1), RCD test notice and next-inspection notice (514.12), mixed-colours warning (514.14.1).

REMEMBER

In a dwelling the board must be non-combustible — a steel enclosure, or housed in a non-combustible cabinet (Reg 421.1.201).

COMMON MISTAKE

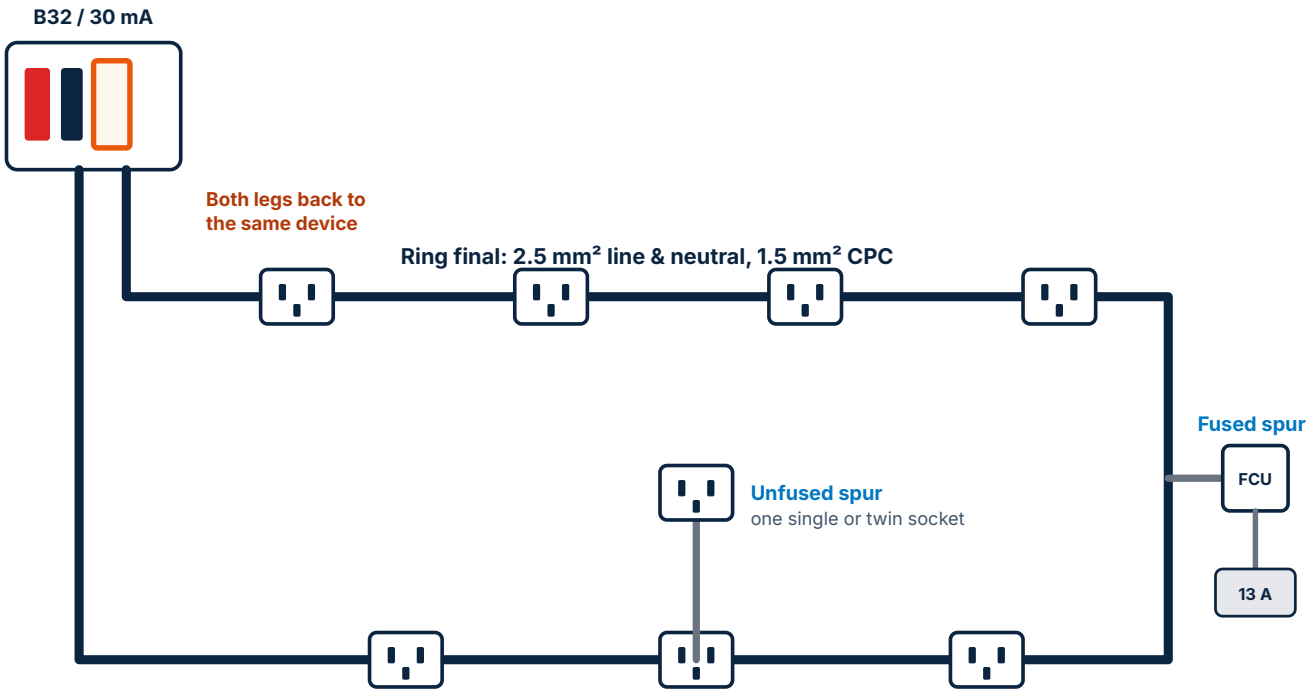
Swapping the board before testing. Borrowed neutrals and low insulation only show up once RCD protection goes on.

ON-SITE TIP

Torque every terminal to the maker's figure, then mark it with a paint pen — instant proof at handover and the next inspection.

RING FINAL CIRCUITS

The classic UK socket circuit — layout, spurs and the limits that keep it safe.



Up to 100 m² floor area · 30 or 32 A device · unfused spurs ≤ sockets on the ring

KEY POINTS

1. **The standard ring**
   2.5 mm² line and neutral, 1.5 mm² CPC, on a 30 or 32 A device. Serves up to 100 m² of floor area.
2. **Both ends home**
   Both legs go back to the same device: line to line, neutral to neutral, CPC to CPC.
3. **Unfused spurs**
   Each feeds one single or twin socket or one fixed item. No more spurs than sockets on the ring.
4. **Fused spurs**
   Via a fused connection unit (13 A max) — any number, as the fuse protects the spur cable.
5. **Kitchens**
   Ovens, hobs and showers need their own circuits. Consider a dedicated kitchen ring.

REMEMBER

A ring relies on the load sharing across both legs. Spread sockets evenly and keep heavy loads off one end.

COMMON MISTAKE

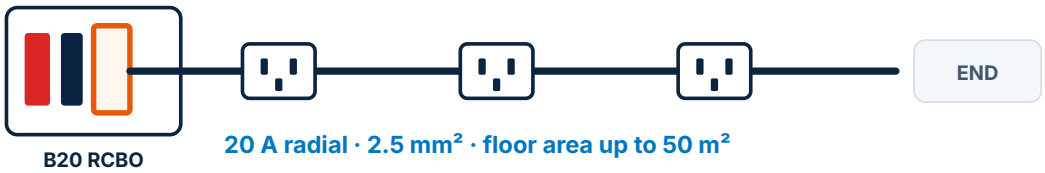
Two radials joined into a 'ring', or a hidden interconnection. The three-step ring test finds both.

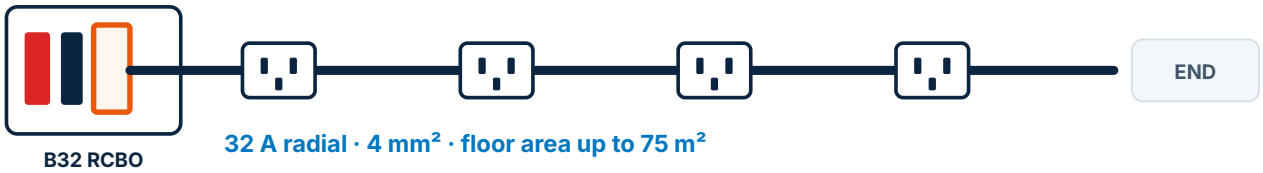
ON-SITE TIP

Label both ring legs at the board before the plasterer arrives. Second fix and testing go much quicker.

RADIAL CIRCUITS

Simple, easy to test and the go-to choice in a modern RCBO board.





Dedicated radials — sized for their own load

Electric shower	Cooker / oven	EV charger	Immersion
often 40–50 A	check rating	32 A, no diversity	16 A typical

KEY POINTS

1. **20 A radial**
   2.5 mm² cable on a 20 A device, serving a floor area up to 50 m² (Appendix 15).
2. **32 A radial**
   4 mm² cable on a 32 A device, serving a floor area up to 75 m².
3. **Simple to test**
   No ring to verify. Measure R1+R2 at the far end — the highest reading is at the last point.
4. **Dedicated circuits**
   Showers, cookers, EV chargers and immersions each get a radial sized to their own load.
5. **Check the install method**
   Appendix 15 assumes typical conditions. Insulation, grouping or heat may need a bigger cable.

REMEMBER

Appendix 15 is informative — a starting point. You still check Ib ≤ In ≤ Iz, voltage drop and max Zs.

COMMON MISTAKE

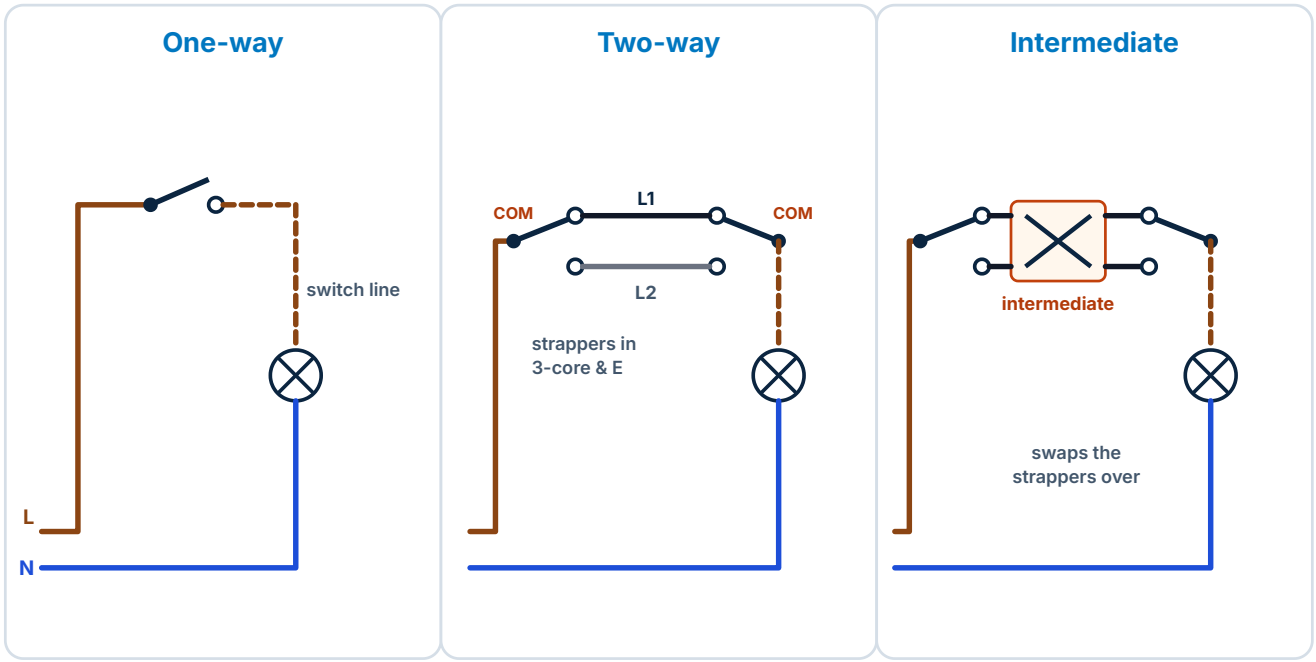
Running a 4 mm² 32 A radial through loft insulation without derating. Thermal insulation can halve its rating.

ON-SITE TIP

Radials suit RCBO boards: easy to test, easy to fault-find, and one fault doesn't take out a whole floor.

LIGHTING: ONE-WAY TO INTERMEDIATE

How the switching works — and how to identify every core.



Identify it: brown sleeving on any blue or black core used as a line or switch line.

Every point gets a CPC — terminate it at plastic fittings too. 6 A typical · 30 mA RCD in homes.

KEY POINTS

1. **One-way**
   Line goes to the switch and back to the lamp as the switch line. Neutral goes straight to the lamp.
2. **Two-way**
   Two switches with COM, L1 and L2. Strappers join L1–L1 and L2–L2, usually in 3-core and earth.
3. **Intermediate**
   Sits between two two-way switches and swaps the strappers over. Add as many as you need.
4. **Identify switch lines**
   Brown sleeving on blue or black cores used as line conductors (Reg 514.3, Table 51).
5. **Protection**
   Usually 6 A on 1.0 or 1.5 mm² cable. Domestic lighting needs 30 mA RCD protection (Reg 411.3.4).

REMEMBER

Every point needs a CPC — even with plastic switches and fittings. Terminate it, don't cut it back (Reg 411.3.1.1).

COMMON MISTAKE

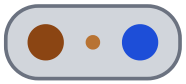
Losing track of COM and the strappers. Mark COM on both switches before you terminate — it saves a callback.

ON-SITE TIP

Leave a neutral at every switch position. Smart switches, dimmers and sensors increasingly need one.

CABLE TYPES

The common cables, what they're made to do — and where not to use them.



Twin & earth

6242Y · BS 6004

Fixed wiring indoors.
CPC smaller than live cores



3-core & earth

6243Y · BS 6004

Two-way lighting strappers, interlinked alarms



Singles

6491X · BS 6004

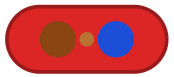
Must be enclosed in conduit or trunking



Steel wire armoured

SWA · BS 5467 / BS 6724

Buried runs, outdoors and outbuildings



Fire-resistant

e.g. BS 7629-1

Fire alarms and emergency lighting



Flexible cord

e.g. H05VV-F

Appliance tails and pendant drops — not fixed wiring

KEY POINTS

1. **Twin and earth**
   6242Y flat cable for fixed wiring indoors. The CPC is smaller than the live cores, e.g. 2.5/1.5 mm².
2. **Singles in containment**
   6491X singles must be enclosed in conduit or trunking (Reg 521.10.1).
3. **Armoured (SWA)**
   For buried runs and outdoors. Armour gives mechanical protection and can serve as the CPC.
4. **Fire-resistant**
   For fire alarms and emergency lighting — cables made to keep working during a fire.
5. **Temperature rating**
   Thermoplastic (PVC) runs at 70 °C, thermosetting (XLPE) at 90 °C — it changes the ratings.

REMEMBER

Support wiring so it can't collapse and trap people in a fire — metal fixings in escape routes and beyond (Reg 521.10.202).

COMMON MISTAKE

Standard T&E outdoors or buried. It isn't UV-resistant or armoured — use SWA or protect it properly.

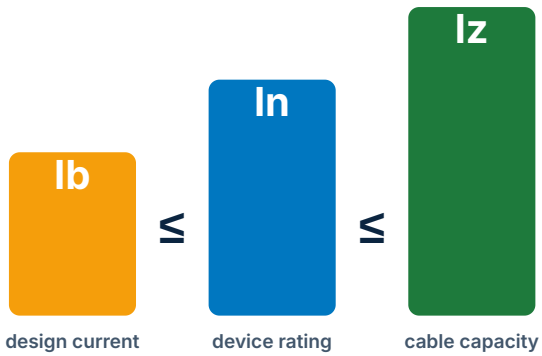
ON-SITE TIP

Specify low smoke zero halogen (LSZH) cable in escape routes and public buildings — far less toxic smoke.

Ib ≤ In ≤ Iz AND CORRECTION FACTORS

Sizing a cable properly — the golden rule, the factors and a worked example.

The golden rule



Correction factors

It ≥ In ÷ (Ca × Cg × Ci × Cc)

Ca	ambient temperature
Cg	grouping with other circuits
Ci	thermal insulation
Cc	BS 3036 fuse (0.725) or buried

Worked example — 7.4 kW EV charger

Ib = 7400 ÷ 230 ≈ 32 A

In = 32 A (B32 RCBO)

Grouped with others: Cg = 0.8 (example)

Ca = 1, Ci = 1, Cc = 1

It ≥ 32 ÷ 0.8 = 40 A

4 mm² T&E clipped direct: 37 A ×

6 mm² T&E clipped direct: 47 A ✓

Then check voltage drop and Zs

KEY POINTS

1. **Ib – design current**
   What the circuit actually draws. A 7.4 kW charger: 7400 ÷ 230 ≈ 32 A.
2. **In – device rating**
   Pick a protective device rated at or above Ib — the next standard size up.
3. **Iz – cable capacity**
   What the cable carries in its installed conditions after correction factors. Must be ≥ In.
4. **Correction factors**
   Ca ambient, Cg grouping, Ci thermal insulation, Cc for BS 3036 fuses or buried cables.
5. **Find It**
   Tabulated current It ≥ In ÷ (Ca × Cg × Ci × Cc). Then pick a cable from Appendix 4.

REMEMBER

Apply only the factors that affect the cable on its route — but use the worst point along that route.

COMMON MISTAKE

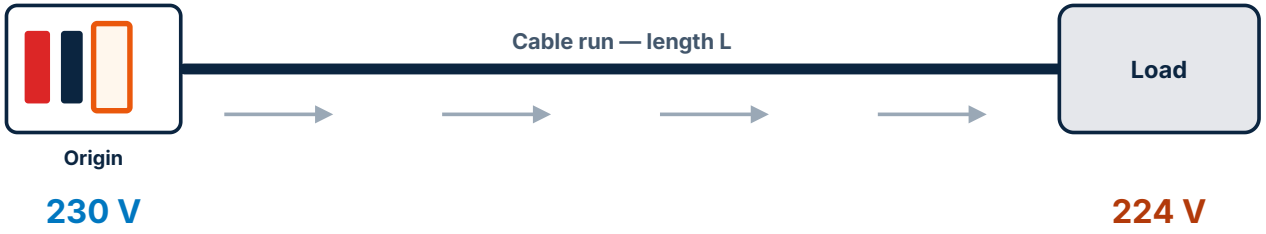
Forgetting insulation. Cable totally surrounded for over 0.5 m can lose half its rating (Ci 0.5, Reg 523.9).

ON-SITE TIP

Write your factors on the design sheet. If someone asks why 6 mm², you can show the working in seconds.

VOLTAGE DROP

The check long runs fail first — the limits, the formula and a worked example.



Limits (public supply)

Lighting

3% = 6.9 V

Other uses

5% = 11.5 V

Covers the whole installation — origin to the furthest point.

VD = mV/A/m × Ib × L ÷ 1000

Worked example — EV radial

6 mm² T&E: 7.3 mV/A/m

Ib = 32 A · L = 25 m

7.3 × 32 × 25 ÷ 1000 = 5.84 V

5.84 ÷ 230 = 2.5% ✓ (limit 5%)

Same run at 50 m: 11.7 V = 5.1% ×

→ go up to 10 mm²

KEY POINTS

1. **Why it matters**
   Too much drop and equipment runs badly — motors struggle, chargers throttle, lights dim.
2. **The limits**
   From a public supply: 3% for lighting (6.9 V), 5% for other uses (11.5 V) — Appendix 4.
3. **The formula**
   VD = (mV/A/m × Ib × length) ÷ 1000. Take mV/A/m for your cable from Appendix 4.
4. **Long runs**
   Outbuildings, EV chargers and garden circuits often fail on voltage drop before current rating.
5. **Fixes**
   Go up a cable size, shorten the route, or move the load closer to the board.

REMEMBER

The limit covers origin to load — include the drop on any distribution circuit or sub-main feeding it.

COMMON MISTAKE

Using mV/A/m for the wrong cable type or installation method. T&E, singles and SWA values all differ.

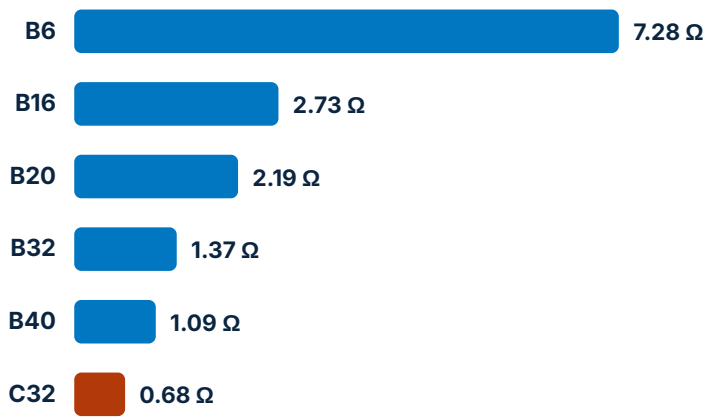
ON-SITE TIP

Borderline? The tables assume full operating temperature, so the real drop at lower load is usually less.

MAXIMUM Zs

Will the device trip in time? Reading the tables — and the 80% rule.

Max Zs examples (Table 41.3, 0.4 s)



The 80% rule

Table values are at full operating temperature. Readings taken cold should be compared with 80% of it.

B32

Table: 1.37 Ω

Measured max: 1.10 Ω

(1.37 × 0.8)

Zs = Ze + (R1 + R2)

Design: add R1+R2 from cable data to Ze. Confirm: measure Zs at the furthest point.

With an RCD: Zs × IΔn ≤ 50 V (Table 41.5) — but aim for 200 Ω or less on TT electrodes.

Too high? Bigger CPC, shorter route, Type B not C, or let an RCD provide disconnection.

KEY POINTS

1. **What max Zs means**
   The highest loop impedance at which the device still trips within the required time (Table 41.3).
2. **Measured vs table**
   Tables are at full operating temperature. Measured cold? Compare with 80% of the table value.
3. **Calculate, then measure**
   Zs = Ze + (R1+R2) at design stage, then measure at the furthest point to confirm.
4. **Too high?**
   Bigger CPC, shorter run, Type B instead of C, or an RCD providing the disconnection.
5. **With an RCD**
   Zs × IΔn ≤ 50 V. On a TT electrode aim for 200 Ω or less — higher may be unstable.

REMEMBER

Max Zs values already include Cmin (0.95) for supply voltage variation — don't apply it twice.

COMMON MISTAKE

Recording a cold Zs reading against the full table value. A pass on paper can be a fail in service.

ON-SITE TIP

Learn the B32 figures: 1.37 Ω in the table, 1.10 Ω for a cold reading. You'll use them on most jobs.

THE ADIABATIC EQUATION

Proving your CPC can survive a fault until the device clears it.

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

Reg 543.1.3 — is the CPC big enough to survive the fault until the device trips?

S	**CPC size**	mm²
I	**fault current**	U0 ÷ Zs
t	**trip time**	from curve (s)
k	**conductor factor**	115 in a PVC cable

Worked example — B32 on 2.5/1.5 T&E

Zs = 0.8 Ω → I = 230 ÷ 0.8 ≈ 288 A

288 A is in the B32 instant band → t ≤ 0.1 s

k = 115 (CPC inside PVC cable, Table 54.3)

$S = \sqrt{(288^2 \times 0.1)} \div 115 = 0.79$ mm²

1.5 mm² CPC ≥ 0.79 mm² ✓

k values (copper)

115 — CPC in a 70 °C PVC cable (Table 54.3)

143 — separate PVC-insulated CPC, not bunched (Table 54.2)

Or skip the sum and size by Table 54.7 instead.

KEY POINTS

1. **What it checks**
   That the CPC can carry the fault current for as long as the device takes to disconnect.
2. **The terms**
   S CPC size (mm²), I fault current (A), t disconnection time (s), k factor for the conductor.
3. **Finding I**
   I = U0 ÷ Zs. A Zs of 0.8 Ω on 230 V gives about 288 A of fault current.
4. **Finding t**
   From the device's time/current curve (Appendix 3), or use the maker's energy let-through (I^2t).
5. **Or use Table 54.7**
   Size the CPC from the table instead — but the adiabatic often lets you go smaller.

REMEMBER

The CPC in T&E is smaller than the line conductor, so check it — especially on long runs and Type C or D devices.

COMMON MISTAKE

Using the wrong k. A CPC inside a PVC cable is k = 115 (Table 54.3), not 143 — that's for a separate conductor.

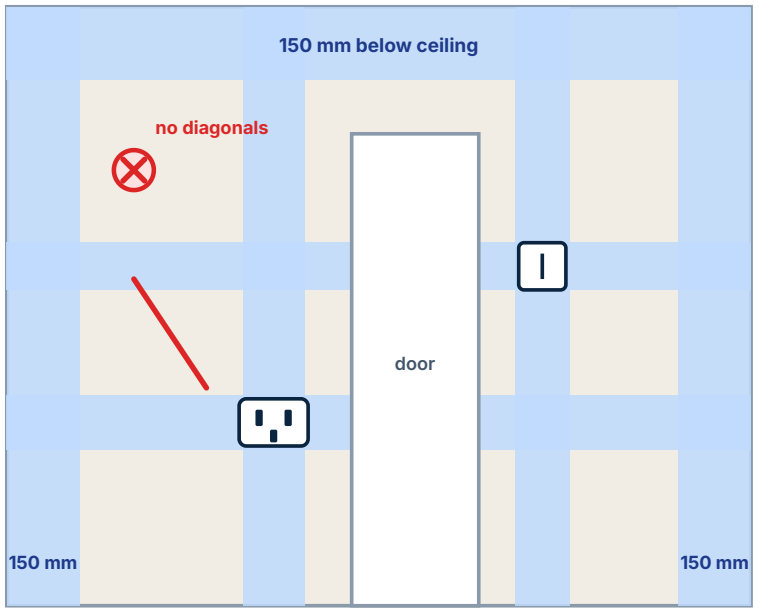
ON-SITE TIP

In the MCB's instant-trip band, t = 0.1 s gives a quick, safe answer. For borderline cases use the maker's I^2t.

SAFE ZONES IN WALLS

Where you can bury a cable without extra protection — and where you can't.

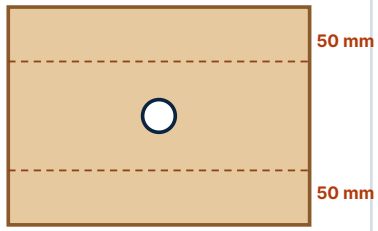
Wall elevation



Safe zone — horizontal or vertical to a point, top 150 mm, corners 150 mm

Under 50 mm deep in a home: still needs 30 mA RCD (or mechanical protection)

Joists



Hole in the middle of the depth

Cables in floors or ceilings: at least 50 mm from the top and bottom of joists, or mechanically protected.

Follow Approved Document A for hole and notch sizes and positions.

A4: rules restructured with a new Table 52.1

KEY POINTS

1. **Zones from accessories**
   Run cables horizontally or vertically in line with a point, accessory or switchgear on the wall.
2. **Top and corners**
   Within 150 mm of the ceiling, and within 150 mm of a corner where two walls meet.
3. **Thin walls**
   On walls 100 mm thick or less, a zone from an accessory on one side extends to the other side.
4. **Plus RCD in homes**
   Cables under 50 mm deep, even in safe zones, need 30 mA RCD unless mechanically protected.
5. **Metal partitions**
   Cables in partitions with metal parts need RCD or mechanical protection whatever the depth.

REMEMBER

A4 restructures these rules around a new Table 52.1 (Reg 522.6). Check the new layout in your Orange Book.

COMMON MISTAKE

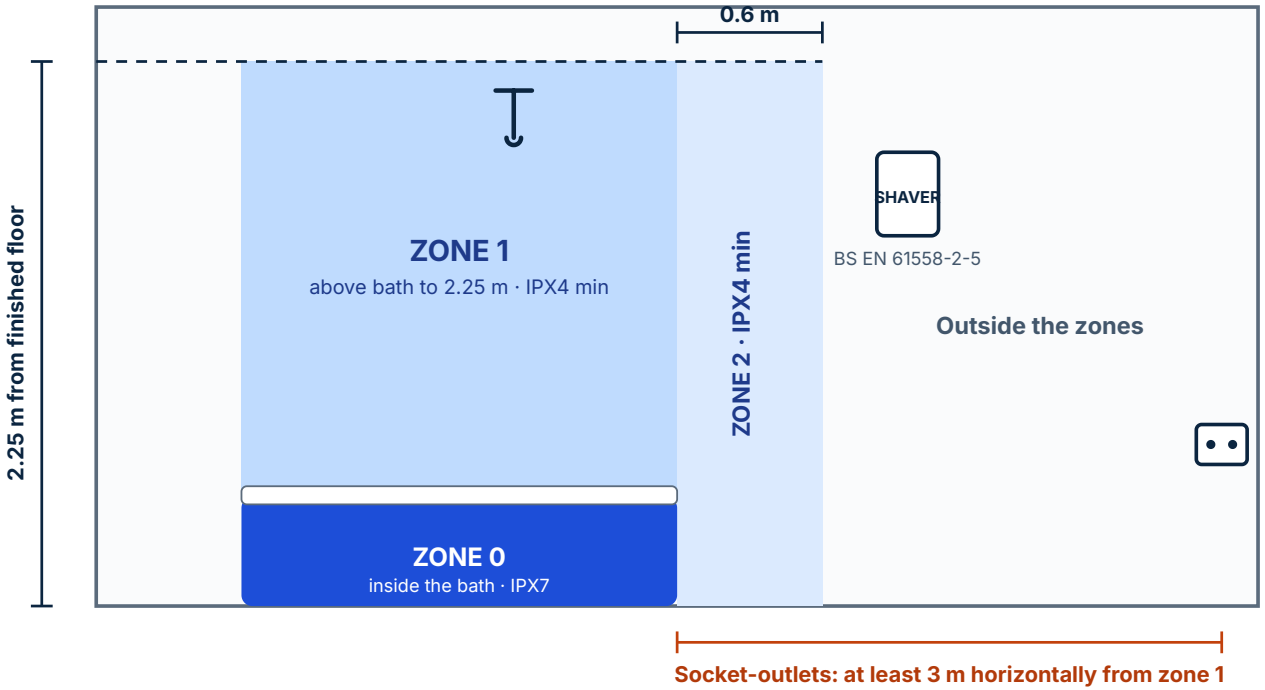
Running diagonally across a wall 'because it's shorter'. The next person drilling won't expect a cable there.

ON-SITE TIP

In joists keep cables 50 mm from top and bottom, drill in the middle of the depth, and check hole sizes.

BATHROOMS: ZONES 0, 1 AND 2

What each zone covers, the measurements that define it and the IP rating it needs — Section 701.



KEY POINTS

1. **Zone 0**
   Inside the bath or shower tray. Only fixed SELV equipment (max 12 V AC / 30 V DC), IPX7, source outside the zones.
2. **Zone 1**
   Above the bath or tray up to 2.25 m. Fixed equipment suitable for the zone only — showers, fans, towel rails. IPX4 minimum.
3. **Zone 2**
   0.6 m beyond zone 1, up to 2.25 m. IPX4 minimum (IPX5 where jets are used for cleaning). Shaver units allowed out of direct spray.
4. **30 mA RCD on everything**
   All circuits serving the location, and any passing through the zones, need 30 mA RCD protection (Reg 701.411.3.3).
5. **Socket-outlets**
   Not within 3 m horizontally of the zone 1 boundary, apart from SELV and shaver supply units (Reg 701.512.3).

REMEMBER

Supplementary bonding can be left out if every circuit has 30 mA RCD protection and main bonding is in place (Reg 701.415.2).

COMMON MISTAKE

Fitting the same downlights through the house — the ones over the bath need IPX4 minimum and the right fire rating.

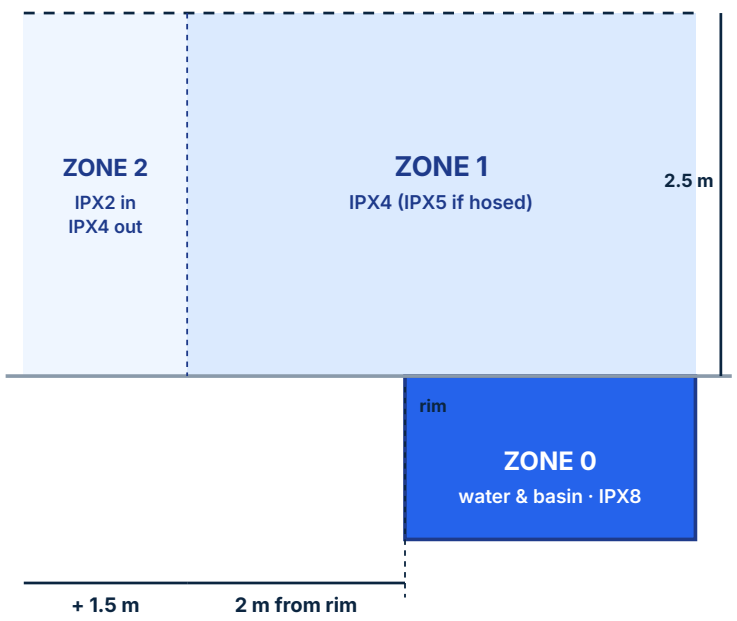
ON-SITE TIP

Measure zones from the finished floor and the actual bath edge, then sketch them on your survey photo before quoting.

SWIMMING POOLS AND SAUNAS

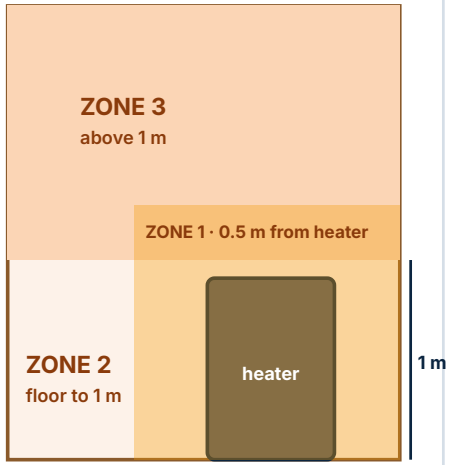
Zones, IP ratings and temperature limits for two of the harshest locations.

Swimming pool — section (Section 702)



No sockets or switchgear in zones 0 and 1 · supplementary bonding (702.415.2)

Sauna — section (Section 703)



Equipment IPX4 minimum
(IPX5 where hosed down)
Zone 3: kit to 125 °C,
cable insulation to 170 °C
Switchgear outside the cabin

A4: outdoor hot tubs now in 702

KEY POINTS

1. **Pool zones**
   Zone 0: the water and basin. Zone 1: 2 m out from the rim and 2.5 m up. Zone 2: a further 1.5 m.
2. **Pool IP ratings**
   Zone 0 IPX8, zone 1 IPX4 (IPX5 if hosed), zone 2 IPX2 indoors or IPX4 outdoors (Reg 702.512.2).
3. **Pool supplies**
   Equipment in zones 0 and 1: SELV at 12 V AC or 30 V ripple-free DC, source outside the zones.
4. **Sauna zones**
   Zone 1 within 0.5 m of the heater, zone 2 floor to 1 m, zone 3 above. Equipment IPX4 minimum.
5. **Sauna heat**
   Zone 3 equipment must withstand 125 °C, cable insulation 170 °C. Keep switchgear outside the cabin.

REMEMBER

A4 brings outdoor hot tubs into Section 702 — they must meet BS EN 60335-2-60.

COMMON MISTAKE

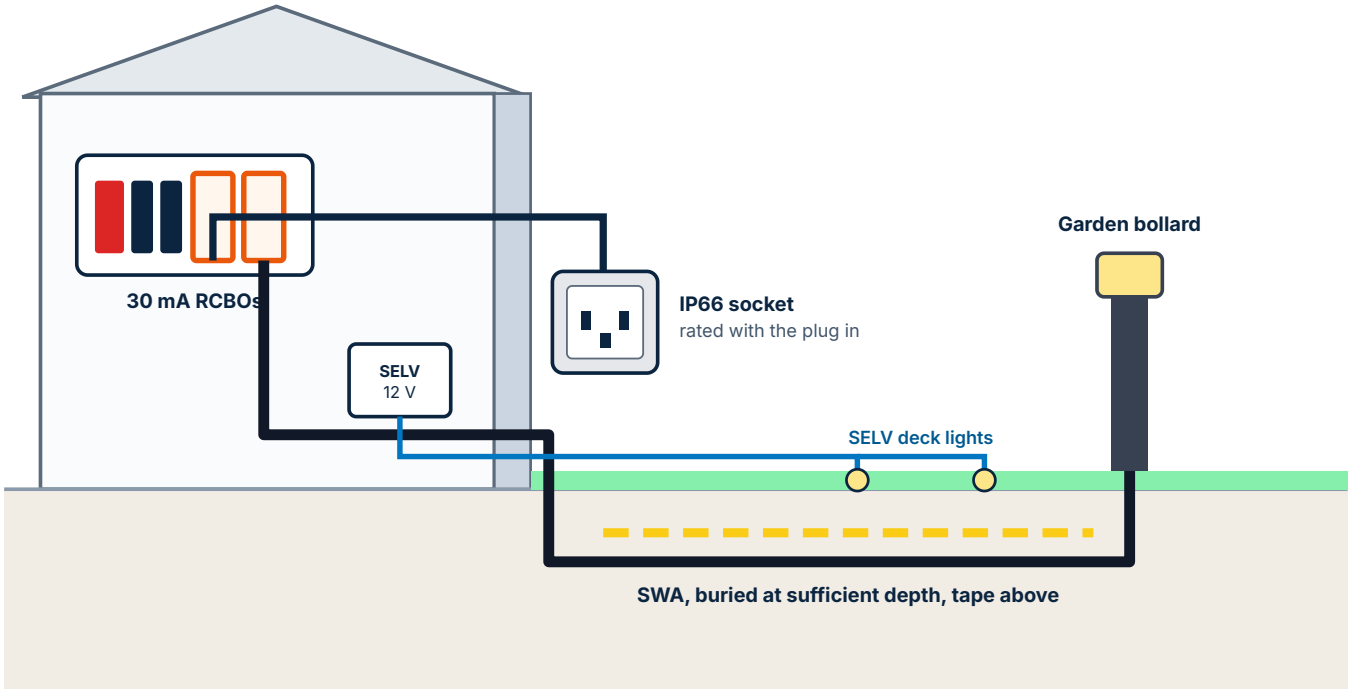
Fitting a standard socket by the pool 'for the pump'. No sockets in zones 0 or 1 — plan a plant room supply instead.

ON-SITE TIP

Sauna circuits need 30 mA RCD protection — the heater itself is exempt unless the maker recommends it.

OUTDOOR CIRCUITS & SOCKETS

RCD protection, IP ratings, cable choice and buried runs for sockets and garden lighting.



Everything outdoors: right IP rating · UV and impact protection · 30 mA RCD

KEY POINTS

1. **30 mA RCD**
   Sockets up to 32 A, and mobile equipment up to 32 A used outdoors, need 30 mA RCD protection (Reg 411.3.3).
2. **IP rating**
   Accessories suited to the external influences (Reg 512.2). Pick sockets rated for use with a plug inserted.
3. **Cable choice**
   UV-resistant and protected from impact: SWA, or suitable cable in conduit. Standard T&E isn't made for outdoors.
4. **Buried runs**
   Deep enough to avoid disturbance, marked with tape and the route recorded on the certificate (Reg 522.8.10).
5. **Garden lighting**
   Outdoor lighting falls under Section 714. Use SELV for low-level lights where you can — safer if a cable is cut.

REMEMBER

A new outdoor circuit is notifiable under Part P in England. Adding a socket to an existing circuit usually isn't.

COMMON MISTAKE

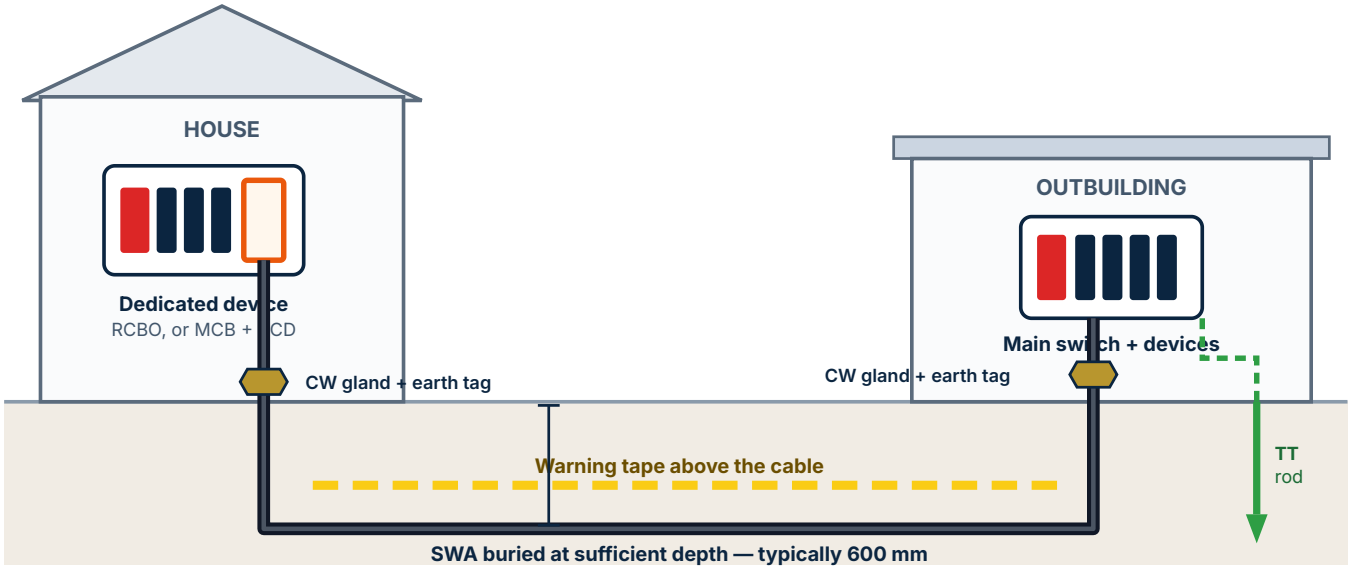
Spurring an outdoor socket off an old ring with no RCD on the board. Check the protection before you add anything outside.

ON-SITE TIP

Enter outdoor boxes from below, never the top, and fit a drain hole where the maker allows. Water follows the cable.

SUPPLYING AN OUTBUILDING WITH SWA

Dedicated device, the buried run, glands and earthing — and the PME question answered.





3-core SWA
Steel armour (CPC if large enough) + spare core as an option

PME supply? Pick one

A Export PME — only where the outbuilding can be properly bonded, or has no extraneous metalwork

B Make it TT — own electrode + RCD; armour terminated at the house end only

KEY POINTS

1. **Dedicated device**
   Its own protective device in the main board, sized for the outbuilding's load and the cable.
2. **Armour as the CPC**
   Check the armour is large enough to be the CPC (Reg 543.1.1). If not, use a spare core alongside it.
3. **Glands**
   CW glands with an earth tag, bonded to the earth bar at each end where the armour is the CPC.
4. **The buried run**
   Deep enough to avoid damage from digging, marked with warning tape and the route recorded (Reg 522.8.10).
5. **PME or TT**
   Export PME only if bonding is achievable. Otherwise TT the outbuilding with its own electrode and RCD (Reg 411.5).

REMEMBER

Going TT? Terminate the armour at the house end only, or sleeve it, so the PME earth never reaches the outbuilding.

COMMON MISTAKE

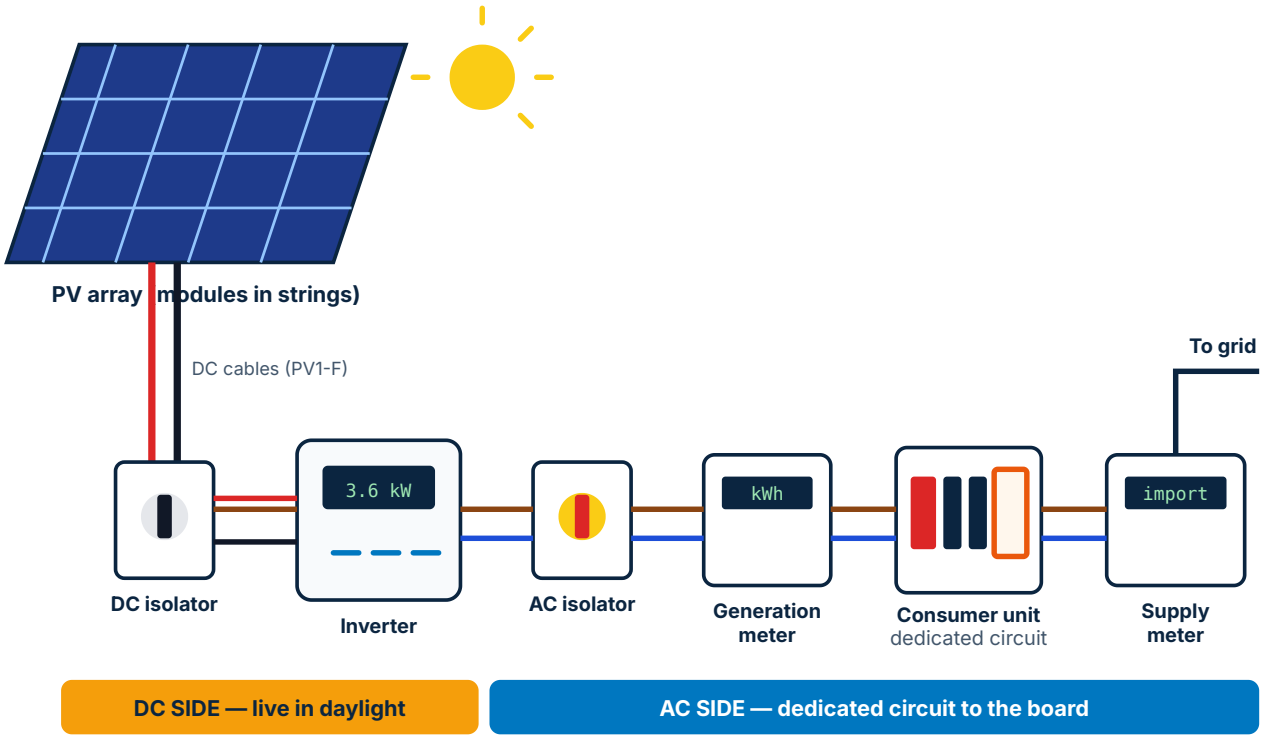
Sizing for current alone. Long garden runs usually fail on voltage drop and max Zs before they fail on current.

ON-SITE TIP

While the trench is open, lay a spare duct with a draw cord. A future EV or hot-tub supply then costs nothing to pull in.

SOLAR PV: COMPONENTS

From the modules to the consumer unit — DC side, inverter, AC side and the DNO — Section 712.



DNO: G98 — notify within 28 days (≤16 A per phase) · G99 — apply before you install

KEY POINTS

1. **DC side is always live**
   Modules generate whenever there's light. You can't switch them off at the panel — treat DC cables as live.
2. **DC isolation**
   A DC-rated switch-disconnector to isolate the inverter from the array. AC switches are not suitable on the DC side.
3. **Inverter**
   Converts DC to AC and disconnects if the grid fails (loss of mains). Use a unit type-tested to G98 / G99.
4. **AC side**
   AC isolator near the inverter, a generation meter, then a dedicated circuit back to the board (Reg 551.7).
5. **Tell the DNO**
   Up to 16 A per phase (about 3.68 kW single-phase): G98, notify within 28 days. Above that: G99, apply first.

REMEMBER

Two supplies means warning labels at the origin, the meter and the board, plus every isolation point (Reg 514.15.1).

COMMON MISTAKE

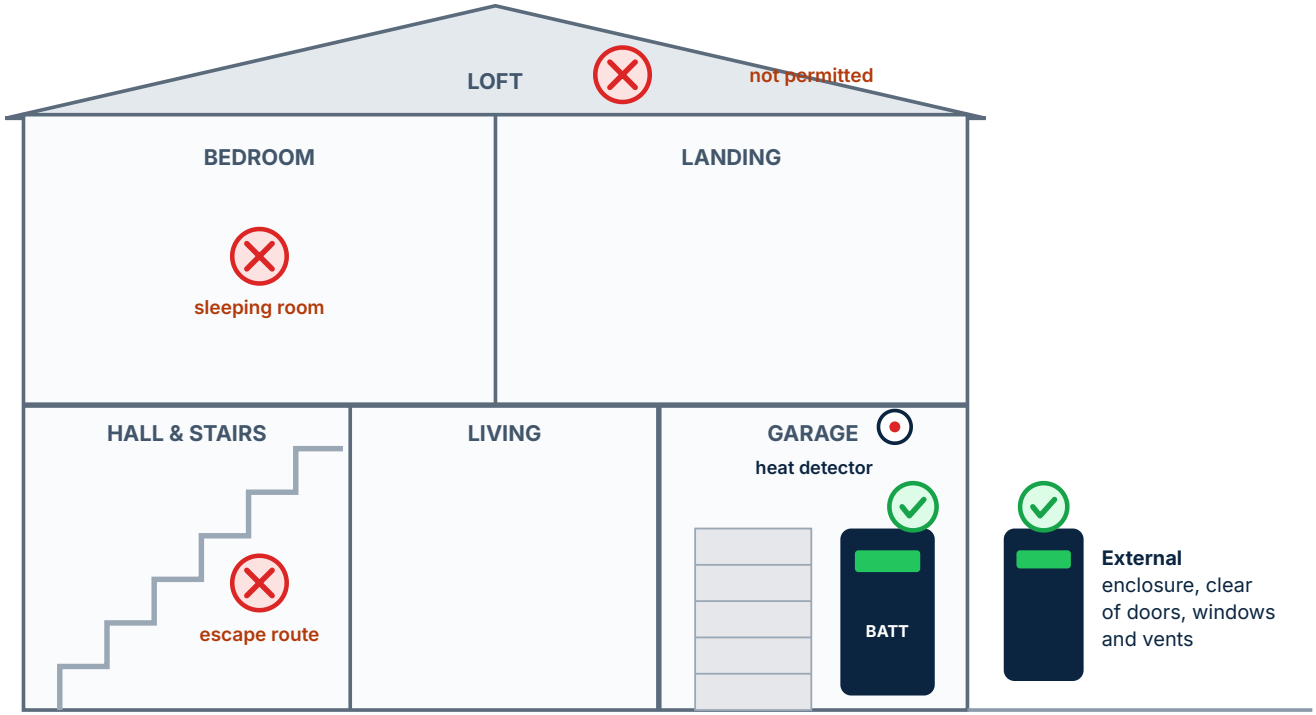
Teeing the inverter into an existing socket circuit. Run a dedicated circuit from the board.

ON-SITE TIP

Test each string's Voc and Isc before connecting the inverter, and record the readings on the certificate.

BATTERY STORAGE New in A4

Where a home battery can and can't go, fire detection, isolation and labels — Chapter 57.



Typical OK locations: garage · utility room with fire separation · plant room · external enclosure

KEY POINTS

1. **A chapter of its own**
   Stationary batteries now sit in Chapter 57. It applies to new work and alterations, not existing installs.
2. **Domestic = PAS 63100**
   Chapter 57 calls up PAS 63100 for battery installs in dwellings (Reg 570.6.7.203). Have a copy to hand.
3. **Location**
   Not in lofts, sleeping rooms or escape routes. Garages, separated utility rooms or external enclosures instead.
4. **Fire detection**
   Provide suitable detection in the space housing the battery, linked to the home's alarms where required.
5. **Isolation & labels**
   The battery stays live on DC after AC isolation. Label voltage, capacity, chemistry and every isolation point.

REMEMBER

Protective devices must suit two-way energy flow and DC where used. A standard AC device is not automatically suitable.

COMMON MISTAKE

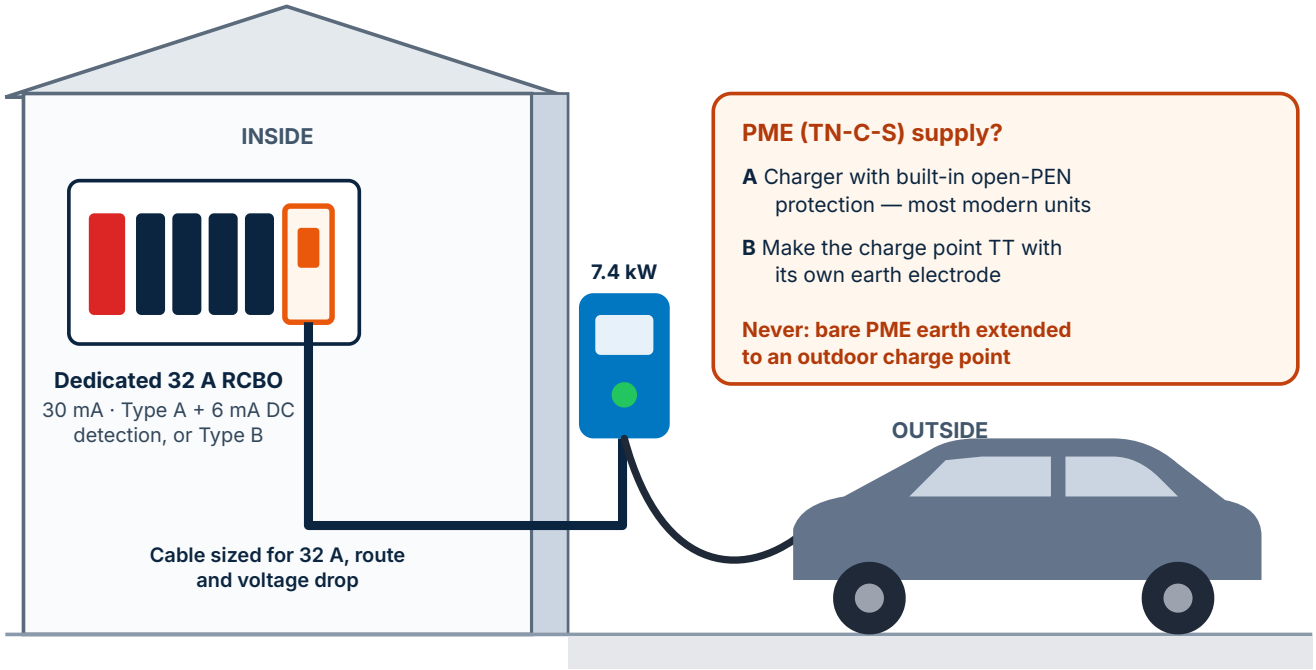
Tucking the battery in the cupboard under the stairs. Out of sight, but it's on the escape route.

ON-SITE TIP

Agree the battery location with the customer at survey, in writing. Moving it on the day means new runs and rework.

EV CHARGING: THE CIRCUIT

Dedicated circuit, no diversity, the right RCD and the PME question — Section 722.



Notify the DNO
Connect & Notify within 28 days if within limits

No diversity
Charger counts at full load in maximum demand

KEY POINTS

1. **Dedicated circuit**
   Each charge point on its own final circuit and protective device (Reg 722.533.101).
2. **No diversity**
   Charging is a long, continuous load — count it at full rating (Reg 722.311). 7.4 kW single-phase ≈ 32 A.
3. **RCD protection**
   30 mA per charge point: Type A with 6 mA DC detection (often in the charger), or Type B (Reg 722.531.3.101).
4. **PME earthing**
   Only use the PME earth outdoors with open-PEN protection; otherwise TT the charge point (Reg 722.411.4.1).
5. **Notify & certify**
   New circuit: Part P notifiable, EIC issued. DNO notified within 28 days if within limits — apply first if not.

REMEMBER

Home chargers in Great Britain must meet the Smart Charge Points Regulations 2021. Check the hardware before you fit it.

COMMON MISTAKE

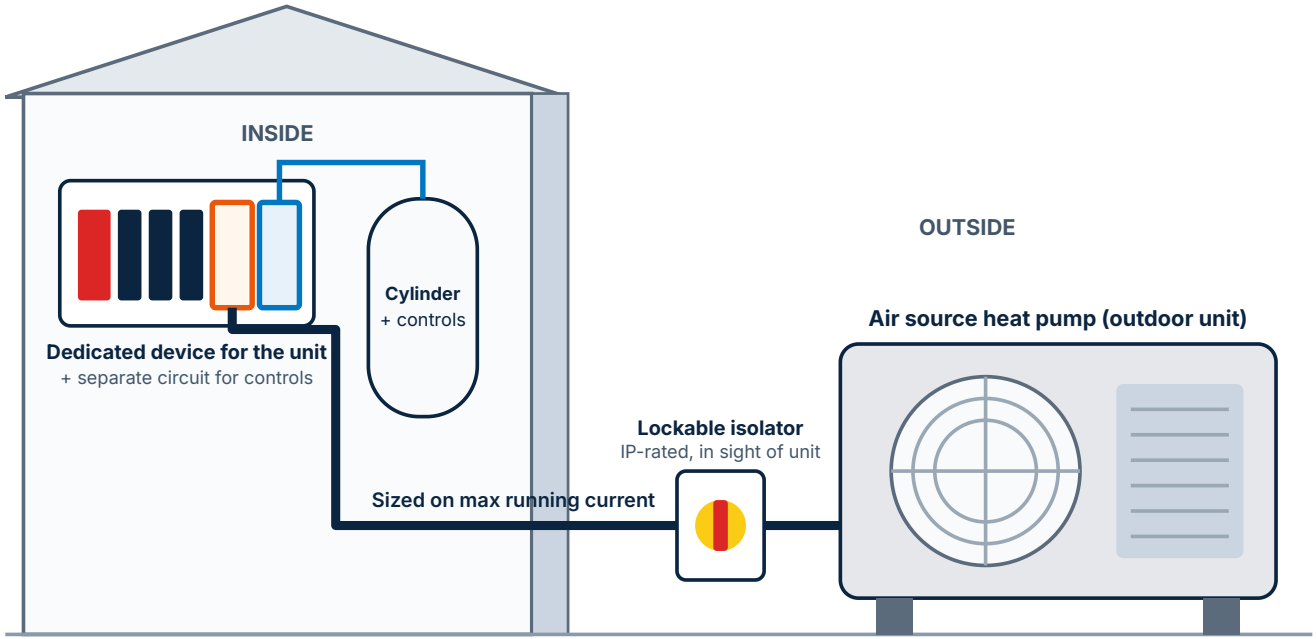
Adding 32 A to a 60 A supply that already runs a shower and oven — without checking maximum demand first.

ON-SITE TIP

Tight supply? Fit a CT clamp on the tails and set the charger's load management. It often avoids a fuse upgrade.

HEAT PUMPS: ELECTRICAL SUPPLY

Dedicated circuit, local isolator, RCD type, outdoor cable and the DNO notification.



Notify the DNO
Connect & Notify for units within limits — have the maker's electrical data ready

RCD type: check the manual
Inverter drives may need Type A, F or B. Type AC only where the maker allows it.

KEY POINTS

1. **Dedicated circuit**
   Sized on the maker's maximum running current and recommended device — not the unit's heat output in kW.
2. **Local isolator**
   Lockable, within sight of the outdoor unit, so it can be isolated for mechanical maintenance (Section 537).
3. **RCD type**
   Choose the RCD type to suit the equipment's fault currents — the manufacturer will state it (Reg 531.3.3).
4. **Outdoor cable**
   UV-resistant and protected from damage — SWA or cable in suitable conduit — with IP-rated glands (Section 522).
5. **Controls & DNO**
   Controls and immersion often need their own circuits. Notify the DNO through Connect & Notify.

REMEMBER

Read the manufacturer's wiring schedule before you quote. It sets the device, cable and RCD type — not guesswork.

COMMON MISTAKE

Sizing from the "8 kW" on the box. That's heat output — the electrical input and max current are different figures.

ON-SITE TIP

Mount the isolator to the side, not behind the unit or under its condensate drain — engineers need to reach it.

THE TEST SEQUENCE

Inspect, dead tests, energise, live tests — in that order, every time.

0 Inspect first — schedule of inspections, installation dead where needed

DEAD TESTS — supply isolated

1. **Continuity of protective** conductors & bonding
2. **Continuity of ring** final conductors
3. **Insulation** resistance
4. **SELV / PELV /** separation
5. **Polarity**
6. **Earth electrode** resistance (TT)

energise →

LIVE TESTS — supply on

7. **Earth fault loop:** Ze at origin, Zs per circuit
8. **Prospective fault** current (PFC)
9. **RCD operation** every RCD / RCBO
10. **Phase sequence** (three-phase)
11. **Functional tests** switches, AFDD test buttons
12. **Voltage drop** where needed

KEY POINTS

1. **Inspect first**
   Visual inspection before testing, with the installation dead where needed (Reg 642).
2. **Dead tests first**
   Continuity, insulation resistance and polarity are done supply-off — they prove it's safe to switch on.
3. **Then energise**
   Only switch on when dead tests pass. Then the live tests: Ze, Zs, PFC and RCDs.
4. **Fix and retest**
   If a test fails, fix it and repeat that test and any earlier test the fault could affect (Reg 643.1).
5. **Record everything**
   Results go on the schedule of test results, with the instrument used.

REMEMBER

Order matters: insulation resistance before energising, polarity before connecting the supply.

COMMON MISTAKE

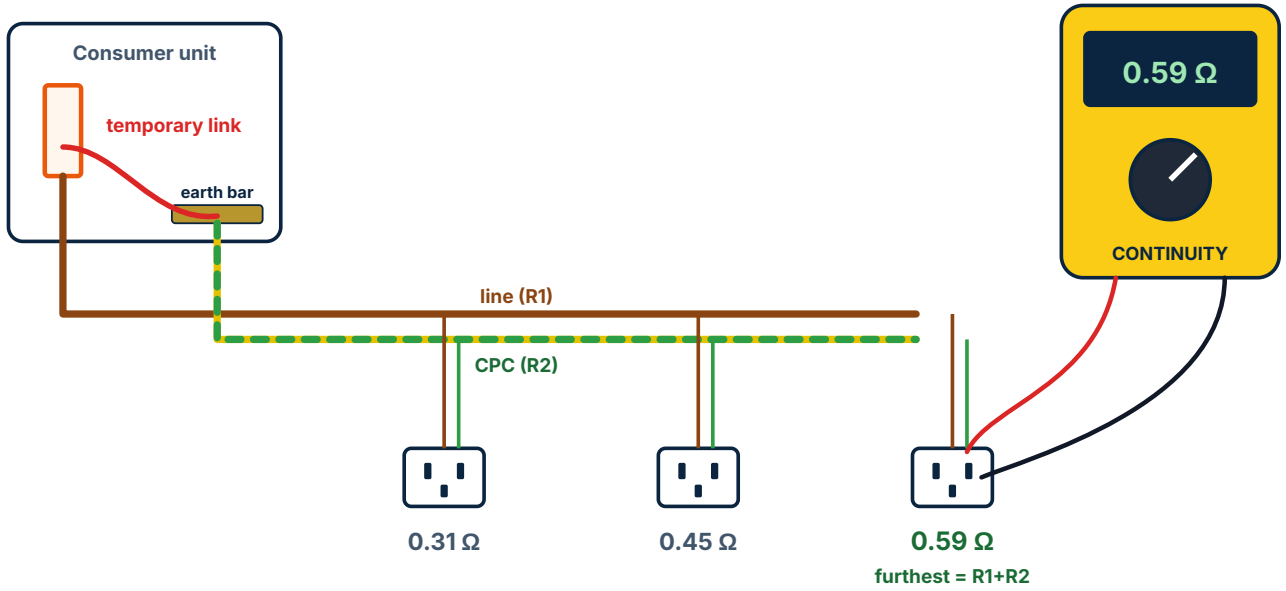
An IR test with LED drivers, SPDs or smart devices still connected. Disconnect them or you'll damage kit or get false lows.

ON-SITE TIP

Number the circuits and test them in the same order every time. The schedule fills quicker and odd results stand out.

CONTINUITY: R1 + R2

Proving every CPC is connected — and getting the figure you need for Zs.



Sense check (copper, 20 °C) · R1+R2 ≈ mΩ/m × length ÷ 1000

1.0/1.0 mm²	1.5/1.0 mm²	2.5/1.5 mm²	4/1.5 mm²	6/2.5 mm²	10/4 mm²
36.20 mΩ/m	30.20 mΩ/m	19.51 mΩ/m	16.71 mΩ/m	10.49 mΩ/m	6.44 mΩ/m

KEY POINTS

1. **What it proves**
   Every CPC is continuous and connected — and gives the R1+R2 figure you need for Zs.
2. **Method 1: link L to CPC**
   Join line and CPC at the board, then test L–E at each point. The highest reading is R1+R2.
3. **Method 2: wander lead**
   A long lead from the MET measures R2 alone at each point — handy for bonding and metalwork.
4. **Null your leads**
   Zero the test leads first, so you measure the circuit and not your leads.
5. **Sense check**
   Compare with mΩ/m × length. 2.5/1.5 T&E is about 19.5 mΩ per metre at 20 °C.

REMEMBER

Take the temporary link out when you finish. A forgotten link between line and earth is a dead short on switch-on.

COMMON MISTAKE

Recording the first reading, not the highest. R1+R2 is the highest reading — normally at the furthest point.

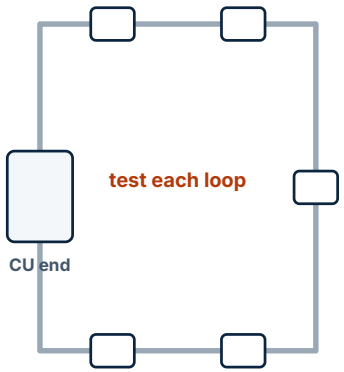
ON-SITE TIP

Polarity comes free: with the link in, operate each switch — you should only get a reading when it's in the line.

RING FINAL CONTINUITY

The three-step test that proves it's a true ring — and gives you R1+R2.

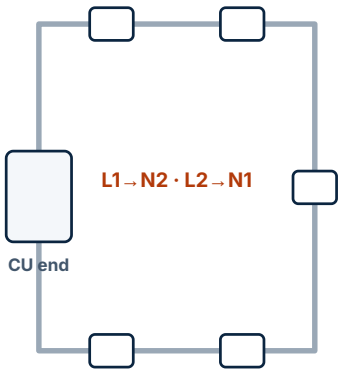
Step 1 · end to end



r1 = rn ≈ 0.50 Ω

r2 ≈ 0.83 Ω (×1.67)

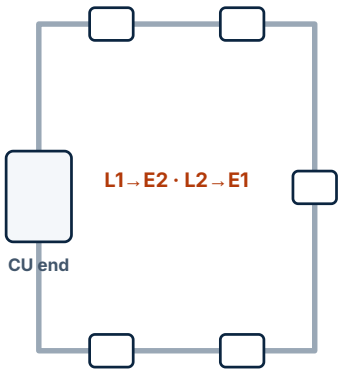
Step 2 · L–N cross



≈ 0.25 Ω at every socket

(r1 + rn) ÷ 4

Step 3 · L–CPC cross



≈ 0.33 Ω at every socket

(r1 + r2) ÷ 4 = R1+R2

Reading the results

r1 and rn should agree within 0.05 Ω. Readings that rise towards the middle of the ring mean the legs aren't cross-connected correctly. A spur reads higher than the ring sockets. Record the highest step 3 reading.

KEY POINTS

1. **Step 1: end to end**
   Measure each loop: r1 (line), rn (neutral), r2 (CPC). r1 and rn should match within 0.05 Ω.
2. **Check the ratio**
   With 2.5/1.5 cable, r2 should be about 1.67 × r1, because the CPC is smaller.
3. **Step 2: L–N cross**
   Join L of one leg to N of the other, and vice versa. Every socket reads about (r1 + rn) ÷ 4.
4. **Step 3: L–CPC cross**
   Join L to CPC across the legs. Every socket reads about (r1 + r2) ÷ 4 — that's R1+R2.
5. **Odd readings**
   Rising towards the middle: legs not crossed properly. One socket higher: a spur or a poor joint.

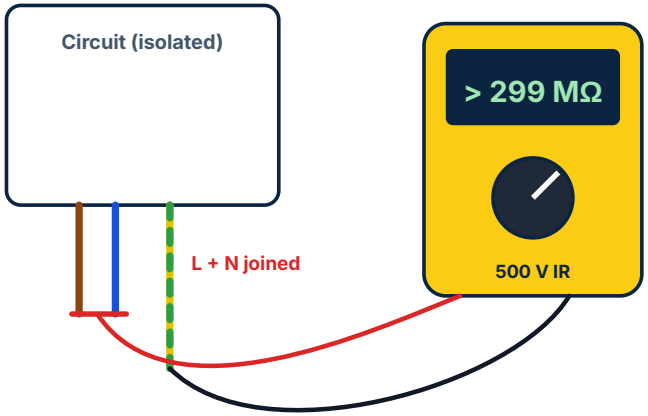
REMEMBER
Record r1, rn and r2 from step 1, and the highest step 3 reading as the circuit's R1+R2.

COMMON MISTAKE
Skipping step 1. Without end-to-end readings you can't prove it's a ring and not two radials.

ON-SITE TIP
Make up a set of cross-connection leads with 4 mm plugs. Steps 2 and 3 take minutes, not fiddling with terminals.

INSULATION RESISTANCE

Proving the insulation is sound before anything gets switched on.



test L+N to E, and L–N

Test voltage and minimum (Table 64)

SELV / PELV	250 V DC	≥ 0.5 MΩ
Up to 500 V (230/400 V)	500 V DC	≥ 1.0 MΩ
Above 500 V	1000 V DC	≥ 1.0 MΩ

New wiring typically reads

well over 100 MΩ

Before you press test — disconnect or switch out

- SPDs
- LED drivers
- Dimmers
- Smart switches
- Appliances
- Lamps out

Switches ON so every part of the wiring is tested. Under 2 MΩ on new work? Investigate.

KEY POINTS

1. **What it proves**
   No breakdown between live conductors, or between live conductors and earth.
2. **Test voltages**
   230/400 V circuits: 500 V DC, min 1 MΩ. SELV and PELV: 250 V DC, min 0.5 MΩ (Table 64).
3. **Which tests**
   L–N, and L and N to earth. Where electronics can't come out, test L and N joined, to earth.
4. **Protect equipment**
   Disconnect SPDs, LED drivers, dimmers and smart devices first — or switch them out of circuit.
5. **Low readings**
   Above the minimum but under 2 MΩ? Investigate — damp, damage or a hidden fault.

REMEMBER

Lamps out, appliances unplugged, switches on — so every part of the circuit's wiring gets tested.

COMMON MISTAKE

Calling 1.5 MΩ a pass and walking away. It meets the minimum, but new wiring should read far higher.

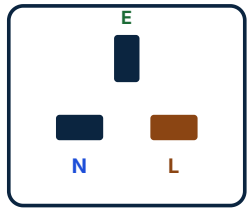
ON-SITE TIP

Test the whole board at once first. If it passes you're done; if not, split it down circuit by circuit.

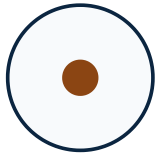
POLARITY AND EARTH ELECTRODES

Switches in the line, lampholders the right way round — and testing a TT electrode.

Polarity — what to check



Socket, front view



ES lampholder:
centre contact = line

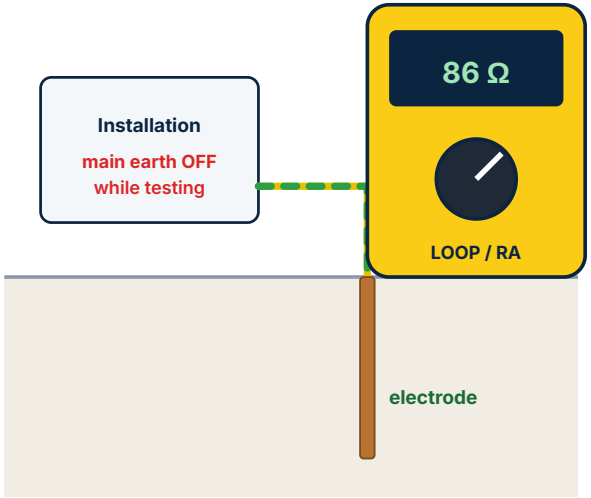


Switch in the LINE

Single-pole switches, fuses and breakers in the line conductor only. Check supply polarity at the origin — if it's reversed, stop and call the DNO.

Exempt: E14 and E27 lampholders to BS EN 60238

Earth electrode (TT) — RA



Earth electrode tester, or a loop tester with the main earth disconnected.

Aim for 200 Ω or less — higher may not be stable in dry or frozen ground.

KEY POINTS

1. **Why polarity**
   Single-pole devices must switch the line, not the neutral — or kit stays live when 'off'.
2. **What to check**
   Switches and fuses in the line only; ES lampholder centre contacts to line; sockets wired correctly.
3. **At the origin**
   Check supply polarity before you energise. If it's reversed, stop and contact the DNO.
4. **Earth electrode (TT)**
   Measure RA with an electrode tester, or a loop tester with the main earth disconnected.
5. **Electrode values**
   Above 200 Ω may not be stable — dry or frozen ground changes it. Aim well below that.

REMEMBER

E14 and E27 lampholders to BS EN 60238 are exempt from the centre-contact rule (Reg 643.6).

COMMON MISTAKE

Checking polarity only at sockets. Lighting switch lines and fused spurs are where reversed polarity hides.

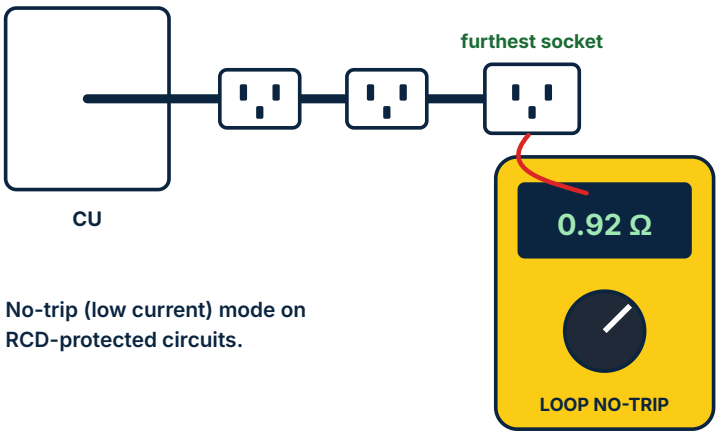
ON-SITE TIP

Test the electrode with the installation isolated and the main earth off the MET — then reconnect before anything else.

EARTH FAULT LOOP IMPEDANCE: Zs

Measuring Zs live — and checking it against what you expect.

Measure at the furthest point — live



No-trip (low current) mode on RCD-protected circuits.

Check it — B32 RCBO

Ze	0.25 Ω
R1+R2	0.59 Ω
Calculated Zs	0.84 Ω
Measured Zs	0.92 Ω
Limit (80% × 1.37)	1.10 Ω

0.92 ≤ 1.10 — pass

Watch for

Measured Zs far BELOW Ze + (R1+R2)? A parallel earth path may be hiding a broken CPC.

Measured Zs far ABOVE it? Look for a loose or high-resistance joint on the circuit.

Never disconnect the main earth or bonding for Zs — only Ze is measured that way.

KEY POINTS

1. **Where**
   At the furthest point of each circuit, live, with the main earth and bonding connected.
2. **Compare**
   Check against max Zs for the device — 80% of the Table 41.3 value for a cold reading.
3. **RCD circuits**
   Use the tester's no-trip (low current) mode, or the RCD will trip mid-test.
4. **Calculated check**
   Ze + (R1+R2) should agree with measured Zs. A big gap means a loose joint or parallel path.
5. **Record it**
   Enter the measured Zs on the schedule of test results for every circuit.

REMEMBER

Only Ze is measured with the main earth disconnected. Never take the main earth or bonding off to measure Zs.

COMMON MISTAKE

Accepting a Zs far lower than Ze + (R1+R2) without asking why. Parallel earth paths can mask a broken CPC.

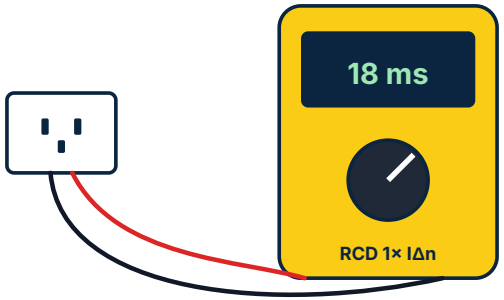
ON-SITE TIP

On TT, Zs is mostly the electrode — don't expect it to trip an MCB. The RCD does the disconnecting.

RCD TESTING

Trip times, RCD types and the A4 note on putting different types in series.

Test at the rated residual current



Test at 0° and 180° — record the slower

General type (BS EN 61008/61009)
≤ 300 ms at IΔn

S-type (time-delayed)
130–500 ms at IΔn

Then press the test button
it must trip too

RCD types — match the load

AC	sinusoidal AC only — falling out of use
A	AC + pulsating DC — most domestic kit
F	as A, plus mixed frequency (inverters)
B	as F, plus smooth DC (some EV, PV, VSDs)

A4: RCD types in series

Don't put a Type AC upstream of Type A, F or B — or a Type A upstream of Type F or B — unless the maker says it's OK (Reg 531.3.3).

Ramp test: trips well below IΔn hint at standing earth leakage.

KEY POINTS

1. **Test at IΔn**
   Apply the rated residual current (e.g. 30 mA). A general-type RCD must trip within 300 ms.
2. **Time-delayed types**
   S-type RCDs are slower by design — 130 to 500 ms at IΔn. Used upstream for selectivity.
3. **Every device**
   Test every RCD and RCBO at 0° and 180°, and record the slower time.
4. **Test button**
   After the instrument test, check the device's own test button works too.
5. **Know the type**
   Check the type (AC, A, F or B) suits the load, and how types sit in series (Reg 531.3.3).

REMEMBER

Customers should press the test button every six months — that's why the RCD test notice goes on the board.

COMMON MISTAKE

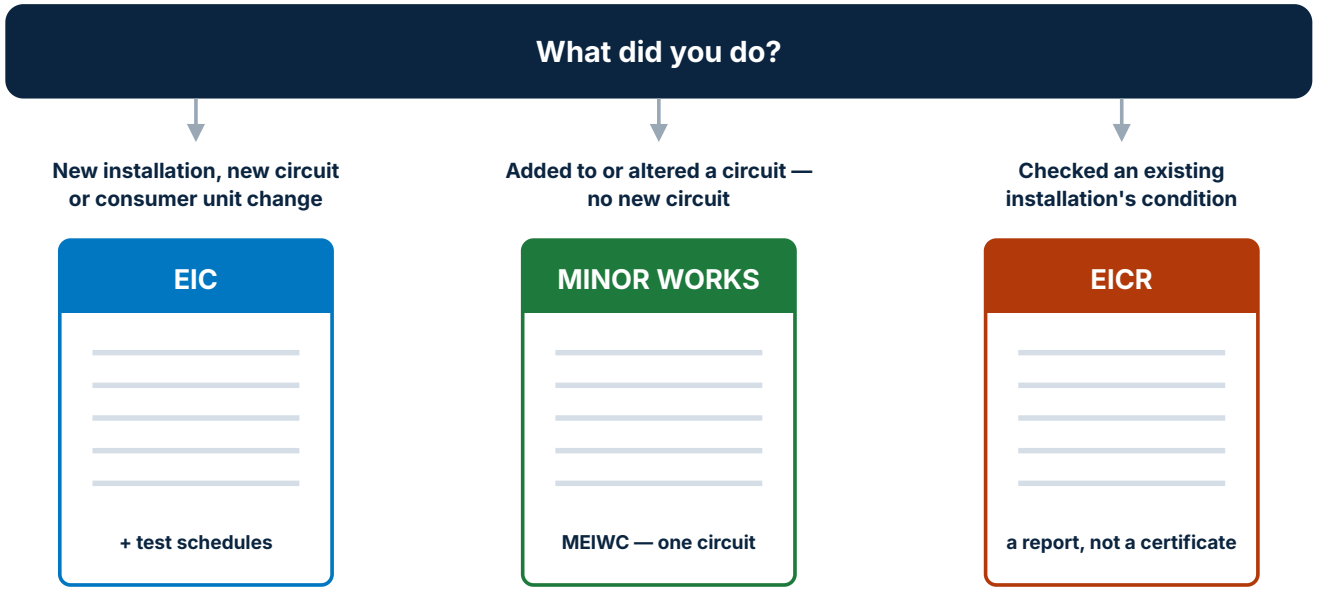
Testing RCDs before proving earth continuity. With a broken CPC the test can put a dangerous voltage on metalwork.

ON-SITE TIP

A ramp test shows the actual trip current. Trips well below IΔn suggest standing earth leakage on the circuit.

CERTIFICATES: EIC AND MINOR WORKS

Which paperwork for which job — and who signs what.



EIC signatures — design · construction · inspection & testing

Signed by whoever did each part, or one signature where one person did it all.

Record any departures from BS 7671 (Reg 120.3). Original to the person who ordered the work.

KEY POINTS

1. **EIC**
   For a new installation, a new circuit or a consumer unit change. Includes inspection and test schedules.
2. **Three signatures**
   Design, construction, and inspection & testing — by whoever did each, or one person for all three.
3. **Minor Works (MEIWC)**
   For an addition or alteration that doesn't add a new circuit — an extra socket or light.
4. **Who gets it**
   The person ordering the work gets the original. Keep a copy for your records and your scheme.
5. **Departures**
   Any intended departure from BS 7671 must be recorded on the certificate (Reg 120.3).

REMEMBER

A certificate covers the new work only. It isn't a report on the rest of the installation — that's an EICR.

COMMON MISTAKE

Issuing a Minor Works for a consumer unit change. A new board means an EIC with every circuit tested.

ON-SITE TIP

Spot defects in the existing installation? Note them in the certificate's comments and tell the customer in writing.

EICR AND THE CODES

Reporting on an existing installation: C1, C2, C3 and FI — and the overall result.

C1	C2	FI	C3
Danger present	**Potentially dangerous**	**Further investigation**	**Improvement**
Immediate remedial action	Urgent remedial action	Required without delay	recommended
e.g. accessible live parts	e.g. Zs too high to disconnect	e.g. circuit you couldn't trace	e.g. no circuit chart

Any C1, C2 or FI = UNSATISFACTORY

C3s only = satisfactory

Private rented homes in England

EICR at least every 5 years · copy to tenants within 28 days · remedial work within 28 days (or sooner if the report says so) — Electrical Safety Standards in the PRS (England) Regs 2020.

Agree the extent and limitations with the client first, and record them on the report.

KEY POINTS

1. **What an EICR is**
   A report on an existing installation's condition — not a certificate for new work.
2. **Agree the extent**
   Agree scope and limitations with the client before you start, and record them on the report.
3. **C1 and C2**
   C1: danger present, act immediately. C2: potentially dangerous, urgent remedial action.
4. **C3 and FI**
   C3: improvement recommended. FI: further investigation needed without delay.
5. **Overall result**
   Any C1, C2 or FI makes the installation unsatisfactory. C3s alone don't.

REMEMBER

A4 makes major changes to the EICR form, and photos and thermal images can now be appended (Reg 653.2).

COMMON MISTAKE

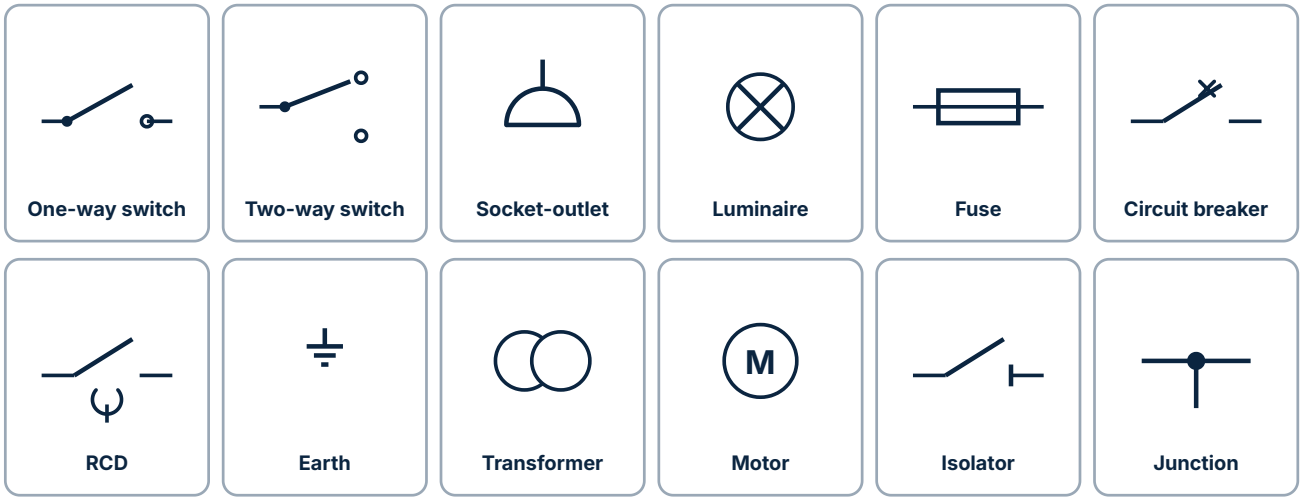
Coding C2 just because it doesn't meet the current edition. Older isn't automatically unsafe — code the real risk.

ON-SITE TIP

Make a C1 safe on the spot with the customer's agreement, record what you did, and tell them before you leave.

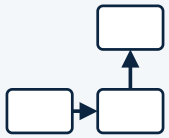
READING DIAGRAMS AND SYMBOLS

The common graphical symbols — and the three kinds of diagram you'll meet.

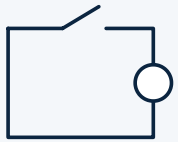


Three kinds of diagram

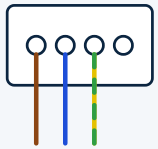
Block
how the main parts connect



Schematic
how the circuit works



Wiring
the actual terminals and cores



KEY POINTS

1. **Block diagrams**
   Show how the main parts connect — supply, board, circuits — without the wiring detail.
2. **Schematics**
   Show how a circuit works, laid out for clarity rather than as it's physically wired.
3. **Wiring diagrams**
   Show the actual terminals and cores — what you follow when you connect up.
4. **Symbols**
   Standard graphical symbols come from BS EN 60617. Learn the common ones by sight.
5. **Layout drawings**
   Floor plans show where accessories go — check the heights and positions with the client.

REMEMBER

Every installation needs a diagram or chart showing circuits, points served and protective devices (Reg 514.9.1).

COMMON MISTAKE

Wiring from a schematic as if it were a wiring diagram. The layout on paper isn't the order of the terminals.

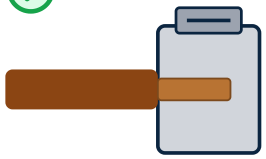
ON-SITE TIP

Mark up the drawing as you go — circuit numbers, routes, junction boxes. It's gold at testing and for the EIC.

TERMINATIONS AND TORQUE

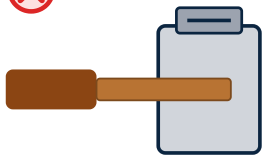
Most connection faults start at the terminal. Strip it right, torque it right.

Correct



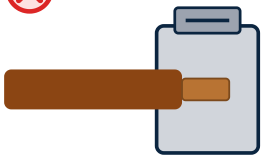
insulation to the terminal, no bare copper showing

Too much bare



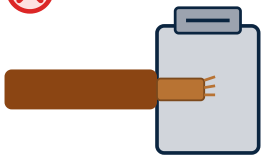
exposed copper outside the terminal

Insulation in



insulation clamped — poor contact, heat

Strands cut



cut strands reduce the conductor size

Torque it — the maker's figure



Calibrated torque screwdriver.
The figure is printed on the device or in its instructions — not 'tight enough'.

Good practice

- Ferrules on fine-stranded flex
- Green/yellow sleeve on bare CPCs
- Brown sleeve on switch-line cores
- No more conductors than allowed
- Joints accessible unless maintenance-free (BS 5733)

KEY POINTS

1. **Strip to length**
   Insulation right up to the terminal, no bare copper showing, none trapped under the screw.
2. **Torque it**
   Tighten to the maker's stated torque with a calibrated screwdriver (Reg 526.1).
3. **Fine-stranded conductors**
   Use ferrules or terminals made for them. A4 adds guidance on conductor class (Reg 526.9.1).
4. **Sleeve and identify**
   Green-and-yellow sleeving on bare CPCs, brown on switch-line cores (Reg 514.3).
5. **Accessible joints**
   Joints must be accessible for inspection unless maintenance-free, e.g. BS 5733 (Reg 526.3).

REMEMBER

Loose connections cause heat and arcing — a leading cause of consumer unit fires.

COMMON MISTAKE

Doubling two conductors into a terminal not made for it. Check the maker's limits on number and size.

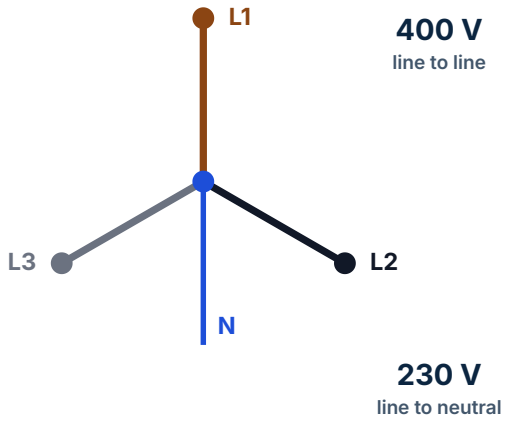
ON-SITE TIP

Mark each torqued terminal with a paint pen. Anyone checking later can see at a glance it's been done.

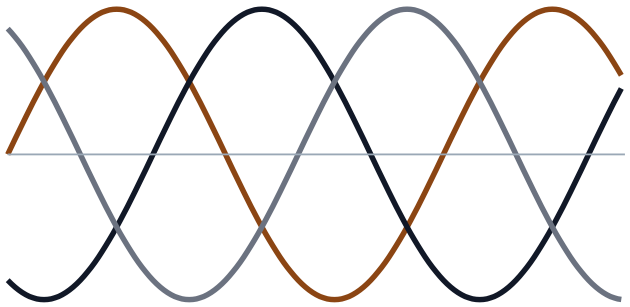
THREE-PHASE BASICS

Voltages, colours, power and phase rotation — the essentials for site.

Star (Y) supply



Three waves, 120° apart



Brown L1 · Black L2 · Grey L3 · Blue N

P = √3 × VL × IL × pf

22 kW EV charger: 22 000 ÷ (1.732 × 400) ≈ 32 A per phase.

Balanced loads → little neutral current. Unbalanced → the neutral carries the difference.

Check rotation with a phase sequence tester before connecting motors.

KEY POINTS

1. **400 / 230 V**
   400 V between any two lines, 230 V from any line to neutral. The lines are 120° apart.
2. **Colours**
   L1 brown, L2 black, L3 grey, neutral blue, protective conductor green-and-yellow (Table 51).
3. **Power**
   P = √3 × VL × IL × pf. A 22 kW charger draws about 32 A per phase.
4. **Balance the load**
   Spread single-phase circuits across the phases. Balanced loads keep neutral current low.
5. **Phase rotation**
   Motors care about sequence. Check it with a phase rotation tester (Reg 643.9).

REMEMBER

Where 400 V sits somewhere it wouldn't be expected, a warning label is required before access to live parts (Reg 514.10.1).

COMMON MISTAKE

Isolating one phase and thinking it's dead. Isolate all three, then test between every line, neutral and earth.

ON-SITE TIP

Label each phase at the board and at the far end. Swapping L2 and L3 reverses a motor's direction.

FIRST FIX AND SECOND FIX

The order of work that keeps the job neat, testable and right first time.

FIRST FIX

1. Agree positions & heights
2. Back boxes fixed and level
3. Cables in safe zones
4. Holes mid-depth in joists
5. Containment & supports
6. Label every cable end
7. Fire-stop penetrations
8. Photograph before boarding

SECOND FIX

1. Accessories fitted
2. Strip to length, torque
3. Sleeve CPCs & switch lines
4. Board connected & labelled
5. Inspect, then dead tests
6. Energise, live tests
7. Circuit chart & notices
8. Certificate & notification

KEY POINTS

1. **Plan first**
   Agree positions, heights and circuits with the client before a single cable goes in.
2. **First fix**
   Back boxes, cable runs in safe zones, holes and notches, containment — before plaster or boards.
3. **Label as you go**
   Mark every cable end with its circuit, and leave enough slack to terminate properly.
4. **Second fix**
   Accessories fitted, terminations torqued, board connected — then inspect, test and certify.
5. **Fire-stopping**
   Seal holes through fire-rated walls and floors to restore their fire resistance (Reg 527.2).

REMEMBER

Approved Document M: in new homes, switches and sockets go between 450 mm and 1200 mm above the floor.

COMMON MISTAKE

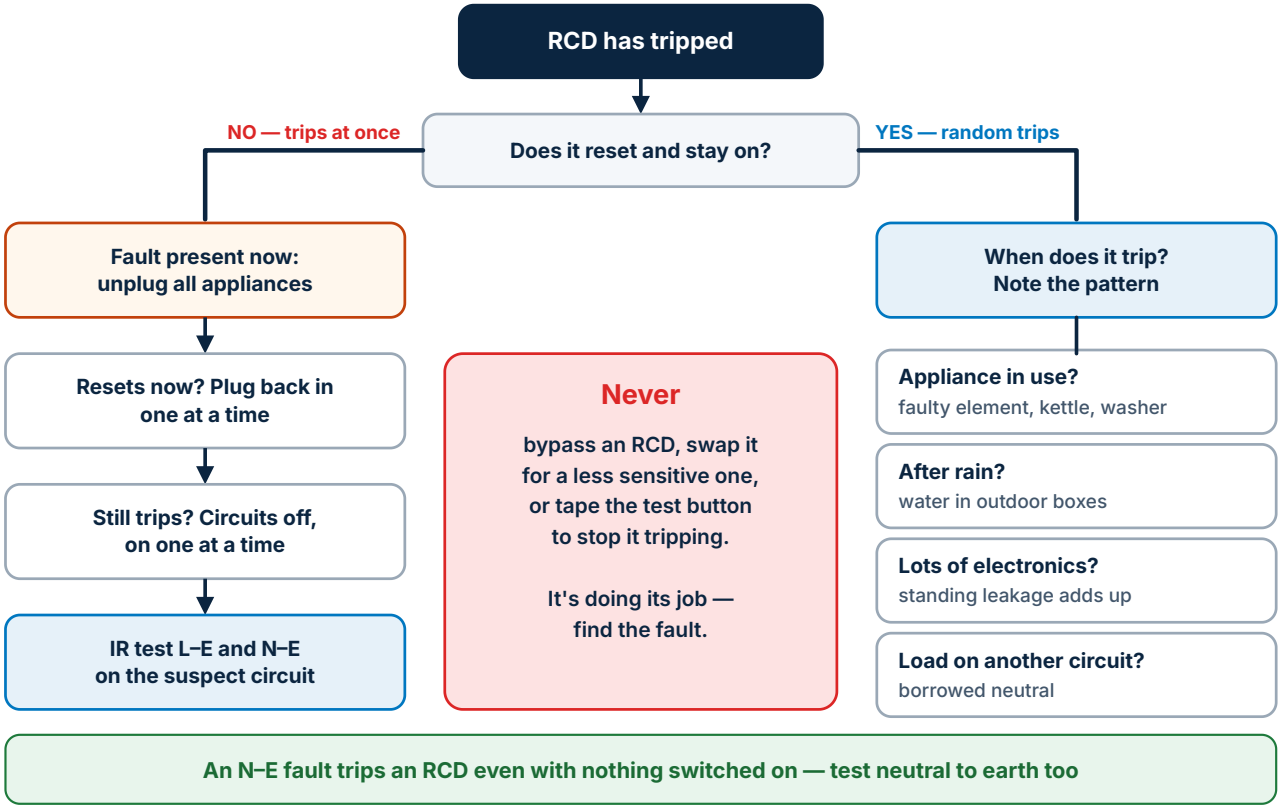
Tails too short to reach the terminals once the plaster's on. Joints in back boxes are a poor fix.

ON-SITE TIP

Photograph every wall before it's boarded. Cable routes on your phone save hours when someone asks where to drill.

FAULT FINDING: AN RCD THAT TRIPS

A logical route from 'it keeps tripping' to the actual fault.



KEY POINTS

1. **Immediate or random?**
   Trips straight away on reset: a fault is there now. Random trips: a load switching on, or damp.
2. **Unplug everything**
   If it resets with appliances unplugged, plug them back one at a time to find the culprit.
3. **Split the circuits**
   With RCBOs it's obvious. On a split-load board, MCBs off, reset, then switch on one by one.
4. **Test the suspect**
   IR test L–E and N–E on that circuit. A neutral–earth fault trips an RCD even with no load.
5. **Standing leakage**
   Electronics leak to earth and it adds up. Keep it under 30% of IΔn — split the load (Reg 531.3.2).

REMEMBER

Never bypass or swap out an RCD to stop it tripping. It's doing its job — find the fault.

COMMON MISTAKE

Missing a borrowed neutral. A neutral shared from a circuit on another RCD trips it every time that load runs.

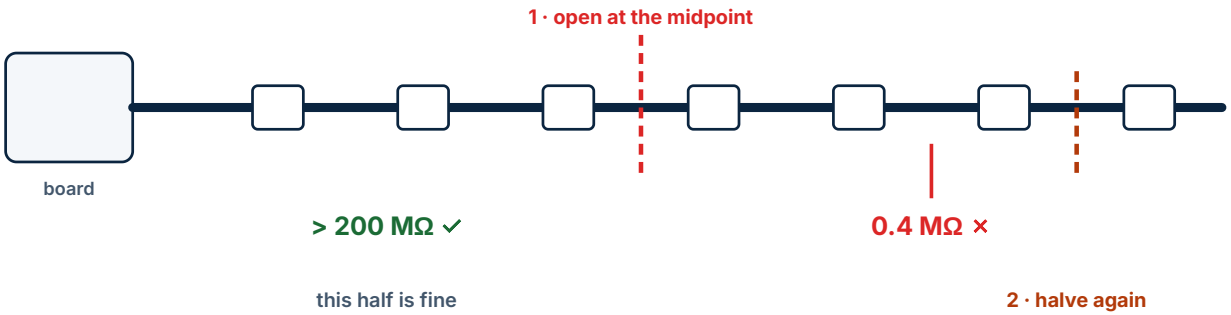
ON-SITE TIP

Check outdoor sockets, lights and junction boxes after rain — water ingress is one of the most common causes.

FAULT FINDING: LOW INSULATION RESISTANCE

Narrowing down a low IR reading quickly — and the usual suspects.

Half-split method



Usual suspects

Damp
outdoor boxes, external lights

Fixings
screw or nail through a cable

Crushed
under floors or behind units

Left on
SPDs, drivers, appliances

Back box
N or L touching the earth

Test L–E, N–E and L–N separately — it tells you which conductors the fault is between.
Below 1 MΩ on a 230 V circuit is a fail. 1–2 MΩ is a warning sign worth chasing.

KEY POINTS

1. **Confirm it**
   Retest with all equipment disconnected and lamps out. Many 'low' readings are kit left connected.
2. **Which conductors?**
   Test L–E, N–E and L–N separately — it tells you where the fault sits.
3. **Halve it**
   Open the circuit at its midpoint and test each half. Keep halving until you find the section.
4. **Usual suspects**
   Damp outdoor boxes, a screw or nail through the cable, crushed cable, damage at entry points.
5. **Fix and retest**
   Repair, then repeat the IR test and any earlier tests the fault could have affected.

REMEMBER

Below 1 MΩ on a 230 V circuit is a fail. Between 1 and 2 MΩ is a warning sign worth chasing.

COMMON MISTAKE

Testing with SPDs still connected. They can drag readings down — or be damaged by the test voltage.

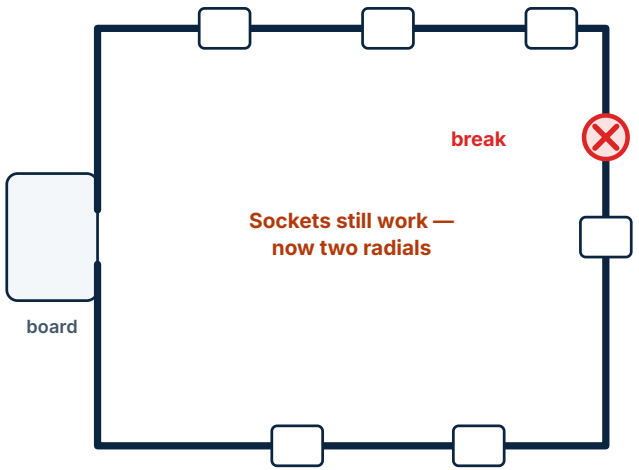
ON-SITE TIP

A thermal camera or moisture meter can find a damp joint box faster than lifting every floorboard.

FAULT FINDING: BROKEN RING OR DEAD SOCKET

Why a broken ring matters, and a quick routine for a socket that's gone dead.

Broken ring



Why it's dangerous

One leg can now carry the whole load on 2.5 mm² cable behind a 32 A device. Step 1 reads ∞ on the broken conductor. EICR: usually C2.

Dead socket — work through

1. **Device tripped?** reset — if it trips, it's a fault
2. **Voltage at the socket?** test with an approved indicator
3. **Next socket along?** live there = fault between them
4. **Terminations** loose, burnt or push-fit failed
5. **Spur or FCU** blown fuse, broken spur cable
6. **Cable damage** fresh screw or nail nearby?

KEY POINTS

1. **Spotting a break**
   Step 1 end-to-end reads open circuit (∞) on one or more conductors — the ring is broken.
2. **Why it's dangerous**
   Sockets still work as two radials, so one leg can carry more than its 2.5 mm² cable is rated for.
3. **Find it**
   Test continuity to each socket in turn from the board. The break is after the last good reading.
4. **Dead socket**
   Check the device, then the socket, then the sockets either side — it's usually a termination.
5. **Usual causes**
   Loose or burnt terminals, a failed push-fit connector, a blown FCU fuse, or a nail through the cable.

REMEMBER

A broken ring has to be put right — it's not an 'improvement'. On an EICR it's normally coded C2.

COMMON MISTAKE

Fixing a dead socket and not retesting the ring. If it was a ring joint, the whole circuit needs the 3-step test.

ON-SITE TIP

Scorch marks in a back box are a warning. Check the terminals on the neighbouring sockets too.

FORMULAS AND KEY VALUES

The sums and numbers you reach for most — on one page.

OHM'S LAW
V = I × R
volts = amps × ohms

POWER
P = V × I × pf
pf = 1 for resistive loads

THREE-PHASE POWER
P = √3 × VL × IL × pf
VL = 400 V line to line

EARTH FAULT LOOP
Zs = Ze + (R1 + R2)
compare with max Zs

FAULT CURRENT
I = U0 ÷ Zs
U0 = 230 V

ADIABATIC
S = √(I² t) ÷ k
k = 115 for a CPC in PVC cable

CABLE SIZING
It ≥ In ÷ (Ca·Cg·Ci·Cc)
then Iz ≥ In

VOLTAGE DROP
VD = mV/A/m × Ib × L ÷ 1000
3% lighting · 5% other

R1+R2 FROM CABLE
(mΩ/m × L) ÷ 1000
2.5/1.5 T&E = 19.51 mΩ/m

TEMPERATURE
R70 ≈ R20 × 1.20
PVC conductor at 70 °C

RING STEP 3
R1+R2 = (r1 + r2) ÷ 4
step 2: (r1 + rn) ÷ 4

RCD FAULT PROTECTION
RA × IΔn ≤ 50 V
TT systems (Reg 411.5.3)

KEY VALUES

Supply
230 V +10% / −6% · 400 V three-phase · 50 Hz

Typical max Ze
TN-S 0.8 Ω · TN-C-S 0.35 Ω

Max PFC
16 kA single-phase domestic

Disconnection
TN 0.4 s / 5 s · TT 0.2 s / 1 s

Insulation
500 V DC, ≥ 1 MΩ (SELV 250 V, ≥ 0.5 MΩ)

RCD
30 mA general type ≤ 300 ms at IΔn

B32 max Zs
1.37 Ω table · 1.10 Ω measured cold

Main bonding
10 mm² on PME (neutral ≤ 35 mm²)

REMEMBER
Formulas are for sense-checks. Design values still come from BS 7671 and the manufacturer's data.

COMMON MISTAKE
Mixing mΩ and Ω. Cable tables are in milliohms per metre — divide by 1000 before adding to Ze.

ON-SITE TIP
Stick a copy inside your test kit lid. It's quicker than finding the book mid-job.

PRACTICE QUESTIONS

Eight quick questions from across the pack — answers and card references alongside.

1. Max disconnection time for a 32 A socket circuit, TN system, 230 V?
A 0.2 s · B 0.4 s · C 1 s · D 5 s

2. Minimum insulation resistance for a 230 V circuit tested at 500 V DC?
A 0.5 MΩ · B 1.0 MΩ · C 2.0 MΩ · D 10 MΩ

3. PME supply with a 25 mm² neutral: main protective bonding size?
A 6 mm² · B 10 mm² · C 16 mm² · D 25 mm²

4. Ring step 1: r1 = 0.6 Ω, rn = 0.6 Ω, r2 = 1.0 Ω. Expected step 3 reading?
A 0.30 Ω · B 0.40 Ω · C 0.60 Ω · D 1.60 Ω

5. Highest acceptable cold-measured Zs on a B32 circuit?
A 0.68 Ω · B 1.10 Ω · C 1.37 Ω · D 1.44 Ω

6. Which EICR code means 'danger present — immediate action'?
A C1 · B C2 · C C3 · D FI

7. Minimum horizontal distance from zone 1 to a socket-outlet in a bathroom?
A 0.6 m · B 1.2 m · C 2.25 m · D 3 m

8. Voltage drop limit for lighting fed from a public supply?
A 3% · B 4% · C 5% · D 6%

ANSWERS

1. B — 0.4 s for TN final circuits up to 63 A with sockets. **Card 11**

2. B — 1.0 MΩ (Table 64). Under 2 MΩ — investigate. **Card 34**

3. B — 10 mm² where the supply neutral is up to 35 mm². **Card 09**

4. B — (0.6 + 1.0) ÷ 4 = 0.40 Ω at every socket. **Card 33**

5. B — 80% of 1.37 Ω = 1.10 Ω. **Card 20**

6. A — C1. Any C1, C2 or FI = unsatisfactory. **Card 39**

7. D — 3 m, except SELV and shaver supply units. **Card 23**

8. A — 3% (6.9 V). Other uses: 5%. **Card 19**

REMEMBER
Each answer shows the card number to revise from. Got it wrong? Go back to that card first.

COMMON MISTAKE
Rushing the calculation questions. Write the formula down, then the numbers — most marks go on units.

ON-SITE TIP
Cover the answers, do all eight, then mark yourself. Under six right? Revisit those cards and try again.

FOR INSTALLERS

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- **Work passed your way** — customer enquiries from riponev.co.uk go to installers who fit our chargers
- **Easy to sell** — solar-ready, PEN fault protection built in, app-controlled

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