CORE ELECTRICS · MODULE 2 · DAY 1 · 16/09/2026

Earthing, Bonding & Circuit Design

Study notes from the Module 2 Day 1 webinars. The morning covers earthing and bonding: exposed vs extraneous conductive parts, main and supplementary bonding, conductor sizes, touch voltage and cable colours. The afternoon covers design: cable types, installation reference methods, safe zones, socket circuits and the step-by-step cable selection method with a worked example.

Book reference page numbers appear in highlighted tags like this.

"New" = current orange / green-orange editions. "Old" = previous brown / green-brown editions. Page numbers are as the tutor gave them on screen. Tab them in your books, but remember you **can't write** in them.

AM Earthing & bonding

01 Recap: earthing systems and Ze

SYSTEM	KEY POINT	MAX ZE
TN-C-S (PME)	Neutral and earth combined in the supply (the **PEN** conductor, protective earth neutral), separated at the cut-out	0.35 Ω
TN-S	Earth and neutral separate the whole way, with the earth via the cable sheath	0.8 Ω
TT	Earth electrode, **provided and paid for by the client**. Ze is high because of ground conditions: a metal rod in the general mass of earth. Above 200 Ω the earth connection becomes unstable.	21–200 Ω

Ze only measures the external earth path, from the transformer to the incoming MET or consumer unit. Under a fault the circuit breaker should trip in **0.4 s** and a 30 mA RCD in **300 ms**.

The tutor said about 40 minutes at the start of yesterday's (Day 2) afternoon recording was missed, which matches the note on that page. Older recordings of the mains position are available on the portal.

02 Exposed vs extraneous conductive parts

Exposed conductive part
A **metal** part of the electrical installation that **you installed** and that someone can touch. It isn't normally live, but could become live under a fault.
Examples: metal conduit, a metal-clad socket or switch, a metal consumer unit, a metal shower case, a metal light fitting.

Extraneous conductive part
Metalwork that is **not part of the electrical installation** (you didn't install it) and that comes **into the building from the ground**, so it can introduce earth potential.
Examples: metal water and gas pipes, oil pipes, central heating and air-conditioning pipework, exposed metal structural parts (beams, steel studs), lightning protection.

Rule of thumb from the tutor: metal and *you* installed it means exposed. Metal and you *didn't* install it (it comes in from outside) means extraneous. If it's plastic it isn't conductive, so it's neither.

BS 7671 · Part 2 Definitions · "Extraneous-conductive-part" and "Exposed-conductive-part"

HIGHLIGHT BOTH DEFINITIONS. THEY'RE ALSO IN THE ELECTRICIAN'S GUIDE AND THE ON-SITE GUIDE.

Myth: radiators don't automatically need bonding. They aren't something you install, and they don't come in from the ground. An **electric** towel rail is different: it's part of the installation, so it's an exposed conductive part.

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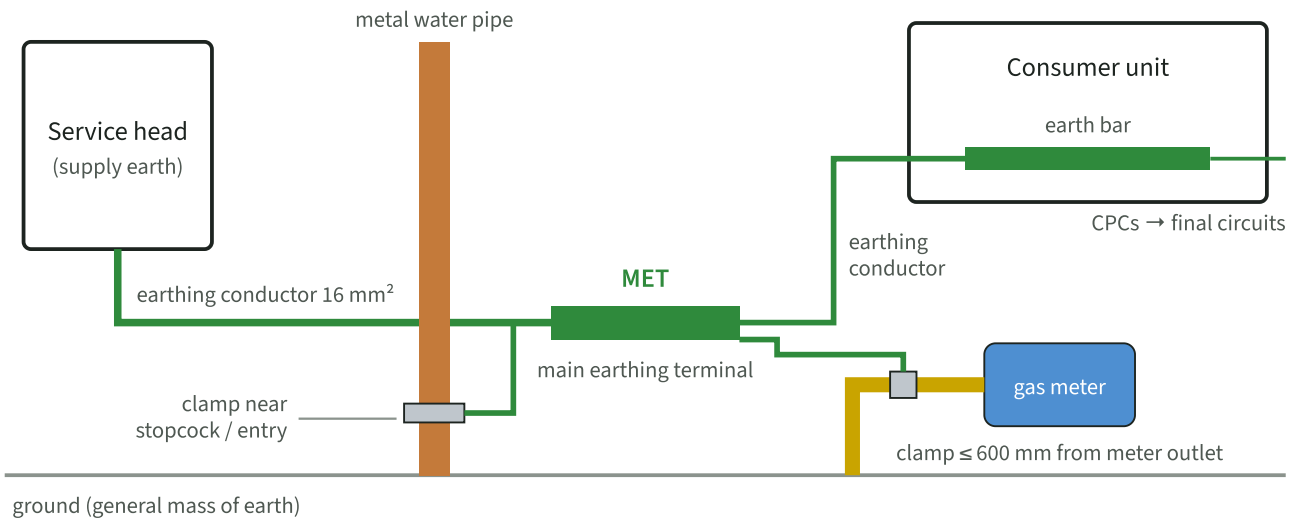
03 Main protective bonding



main protective bonding conductors (10 mm²), each with a BS 951 clamp and label

Main protective bonding connects every **extraneous conductive part** to the **MET**. If there's no separate external MET, the earth bar in the consumer unit acts as the MET, and all the bonding, the earthing conductor and the CPCs go there.

- Make the bond on the **consumer's side** of the meter or stopcock, **within 600 mm** of the gas meter outlet union or the water point of entry, before any branch.
- **Plastic incoming service pipe? No main bonding needed**, e.g. yellow plastic gas pipe or blue plastic water pipe. If even a short length of the incoming pipe is **metal** where it leaves the ground, you **must** bond it.
- **CPCs** (the green/yellow in your final circuits) go to the earth bar in the **consumer unit**, not to an external MET.
- Bonding clamps are **BS 951**. The conductor goes under the plate (lugged, crimped or wrapped round the screw). They carry a **"Safety electrical connection – do not remove"** label, and a label also goes at the MET. Labels are required by the regulations.

BS 951 CLAMP COLOUR (AS TAUGHT)	ENVIRONMENT
Red / silver	Internal, dry areas
Blue	External or slightly damp areas
Green	Corrosive or hazardous areas

Electrician's Guide to the Building Regs · 3.3.2 Earthing conductor and main protective bonding conductors: list of services to bond · **p.58** new · p.52 old

Electrician's Guide to the Building Regs · Plastic supply pipes: no bonding needed. Bonding within 600 mm of meter or entry · **p.59** new · p.52–53 old

Electrician's Guide to the Building Regs · BS 951 earth clamp label image · **p.63** new · p.57 old

On-Site Guide · Section 4 Bonding and earthing: earthing and main bonding figure · **p.61**

READ THE NOTES UNDER TABLES

The tutor said a lot of exam questions come from the small **notes** under tables and figures. Don't skip them.

04 Sizing earthing and bonding conductors

CSA (cross-sectional area) is the size of the **copper only**, not including the insulation. A 10 mm² bonding conductor has 7 strands.

Quick rule for TN-S / TN-C-S (as taught): the earthing conductor is at least **half** the size of the supply tails, rounded **up** to the next available size. Main bonding is at least **half** the earthing conductor, rounded up with a **minimum of 10 mm²**.

Example: `25 mm² tails` → 25 ÷ 2 = 12.5 → `16 mm² earthing conductor` → 16 ÷ 2 = 8 → `10 mm² main bonding`

TN-C-S (PME) AND TN-S

SUPPLY LINE/NEUTRAL (MM²)	EARTHING CONDUCTOR (MM²)	MAIN BONDING (MM²)
4	10	10
6	10	10
10	10	10
16	16	10
25	16	10
35	16	10
50	25	16
70	35	25

TT

LINE CONDUCTOR (MM²)	EARTHING CONDUCTOR, NOT BURIED (MM²)	MAIN BONDING (MM²)
4	4	6
6	6	6
10	10	6
16	16	10
25	16	10
35	16	10
50	25	16
70	35	25

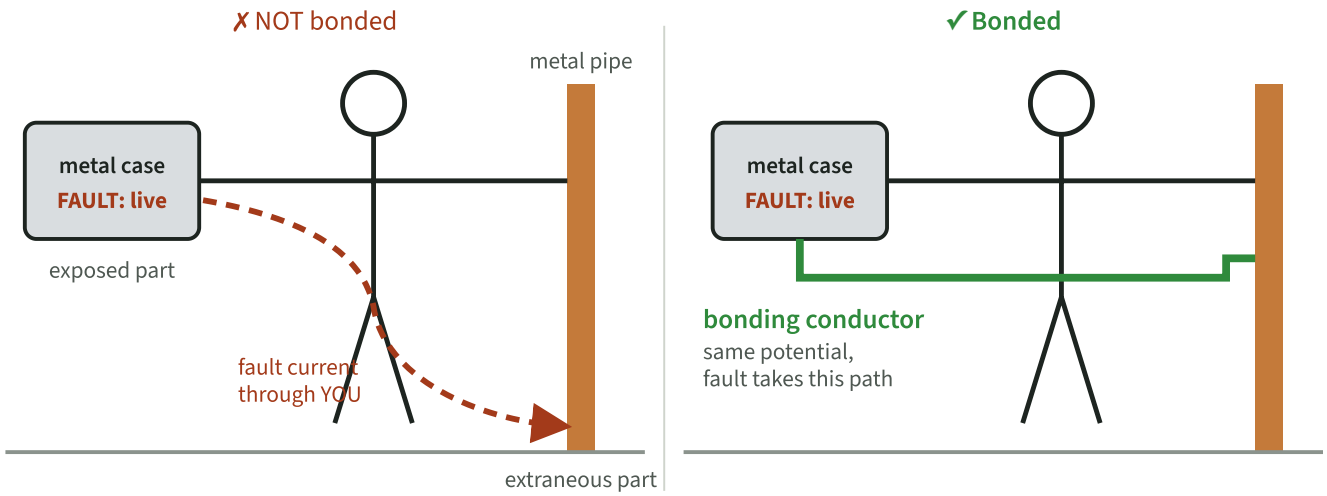
Values as shown on the session slides (highlighted rows = typical domestic).

Always check the tables in your own book: **Tables 3.3.2a and 3.3.2b**. For TT, BS 7671 has extra conditions for buried earthing conductors.

Electrician's Guide to the Building Regs · Tables 3.3.2a and 3.3.2b: earthing and main protective bonding conductor sizes · **p.59** new · p.53 old

05 Why bond? Touch voltage and 1667 Ω

Write this down: the purpose of main protective bonding is to **reduce the potential difference between exposed and extraneous conductive parts**, so that **no more than 50 V** can pass from one to the other when an **earth fault** occurs.



CURRENT THROUGH A BODY

Body resistance ≈ 1000 Ω (less when wet)
I = V ÷ R = 230 ÷ 1000 = 0.23 A = 230 mA

About 50 mA (0.05 A) can stop your heart
(cardiac arrest). 230 mA is far more.
→ it's the CURRENT that kills.

WHERE 50 V TOUCH VOLTAGE COMES FROM

30 mA RCD → max 1667 Ω (BS 7671 Table 41.5)
V = I × R = 0.03 × 1667 = 50.01 V

So with a 30 mA RCD, keeping the resistance
of extraneous parts to earth ≤ 1667 Ω keeps
touch voltage at about 50 V.

A **30 mA RCD** is set below the ~50 mA that can cause cardiac arrest. It gives **additional protection** by cutting off before serious harm.

BS 7671 · Table 41.5: max earth fault loop impedance for RCDs (30 mA → 1667 Ω) · **p.77** new · p.70 old

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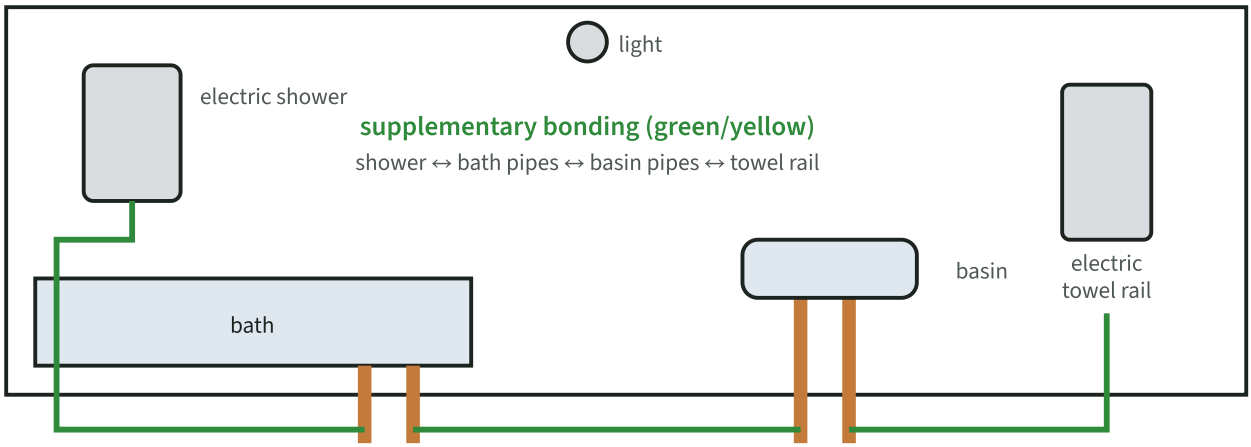
06 Supplementary bonding in bathrooms

Supplementary bonding links exposed and extraneous conductive parts **locally**, e.g. the metal pipes under a bath to a metal shower, so they stay at the **same potential**. You'll often see it as a loop of green/yellow between copper pipes, such as at a boiler. Somewhere along those pipes, a main bonding conductor goes back to the MET.



The tutor called supplementary bonding a real pain to install, because every metal pipe connection needs linking. It's rarely installed now, because it can be **left out** when the three conditions below are met.

Supplementary bonding may be omitted in a room with a bath or shower (BS 7671 **701.415.2**) if **all three** are met:

1. All final circuits in the location meet **automatic disconnection of supply (ADS)**: a CB within 0.4 s, a 30 mA RCD within 300 ms.
2. All final circuits in the location have **additional protection by a 30 mA RCD**.
3. All extraneous conductive parts are **effectively connected to the main protective bonding** (back to the MET).

BS 7671 · Section 701: locations containing a bath or shower · Reg 701.415.2 supplementary bonding · **p.257** new · p.242 old

Supplementary bonding conductor sizes

This depends on what you're linking and whether the conductor is **mechanically protected**, e.g. in conduit. A single-core green/yellow conductor has only one layer of insulation. The grey sheath on twin and earth *is* mechanical protection, and an RCD is **additional** protection, not mechanical.

EXAMPLE FROM THE SESSION

Main protective bonding = 10 mm²
Link: electric shower (exposed part) → pipes under the bath (extraneous part)
Not mechanically protected → 6 mm² (still 6 mm² if protected)
Exposed part → exposed part, both mechanically protected with 10 mm² → 10 mm²

Electrician's Guide to the Building Regs · 3.3.3 Supplementary bonding conductors · Table 3.3.3 sizes · **p.62** new · p.56 old

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07 Protective conductors and cable colours

Green/yellow = protective conductor. It's used **only** for:

- the earthing conductor
- main protective bonding conductors
- supplementary bonding conductors
- circuit protective conductors (CPCs)

The mix is **70% / 30%** green and yellow, either way round. **Never** put green/yellow sleeving on a line or neutral.

COLOUR	USE
Green/yellow	Protective conductor
Blue	Neutral
Brown	Line (L1 on three-phase)
Black	Line 2 (three-phase)
Grey	Line 3 (three-phase)

- **On single-phase**, a blue, black or grey conductor used as a line **must be sleeved brown** at the terminations. For example, the blue of twin and earth used as a **switch line** gets brown sleeving. It's cheaper than buying twin brown cable.
- A neutral used as a mid-point or supply neutral must stay blue.
- Sleeve and terminate correctly as you go. Inspecting while you work saves problems when you test.
- UK colours changed in **2004** (from red/black). You'll still find old installations.

BS 7671 · Reg 514: identification of conductors · **p.141** new · p.132 old

Electrician's Guide to the Building Regs · Chapter 11: identification of conductors, old and new colours

THE TUTOR WAS ASKED ABOUT CONDUCTOR ID IN HER OWN EXAM

PM Electrical design

08 What design means

Design isn't just picking any cable. It's based on the client's needs and on what's already there. Before adding or altering a circuit, check that the existing installation can:

- **carry the additional load**
- **provide adequate shock protection**
- has **satisfactory earthing and bonding**

Think of design as a **chain**. The **load** gives the design current, which decides the **protective device**, which with the **installation method** and conditions decides the **cable size**, which must then pass **voltage drop**. Example: if a client upgrades a shower from 5 kW to 8 kW, the existing cable may no longer be suitable.

BS 7671 · Appendix 1: British Standards and other standards referred to (about 22 pages) · **p.411** new · p.385 old

09 Cable types and marks of conformity

CABLE	WHAT IT IS / WHERE IT'S USED
Single core	One insulated conductor, e.g. a 10 mm² green/yellow bonding conductor or a 16 mm² earthing conductor. "Single core" means one cable, not one strand.
Twin and earth (T&E) flat, multicore, PVC/PVC, 70 °C	The standard domestic cable. **6242Y** has a **grey** sheath. **6242B** has a **white** sheath and is **low smoke zero halogen (LSZH / LSF)**: less, lighter smoke in a fire, but harder to strip. Grey has a chalky powder inside so it strips easily, which is why most sparks prefer it.
Flex	Flexible cable with many fine strands (e.g. 19), for appliances and pendants
MICC	**Mineral insulated copper clad**: copper sheath with magnesium oxide powder inside. Very tough and expensive, but moisture from sweaty hands or breath on the ends ruins it. **White sheath** = emergency lighting (e.g. listed buildings, schools, churches). **Red sheath** = fire alarms.
SWA	**Steel wire armoured**, with 3, 4 or 5 cores. Used commercially and industrially, and for outside sockets, lights and outbuildings. The armour can be used as the CPC. It's not the same as the DNO supply cable.

Marks of conformity show a product meets the required standards:

- **CE** is the EU mark.

- After Brexit, **UKCA** is used in Great Britain and **UKNI** in Northern Ireland.
- You'll also see **BASEC** (cables), **ENEC**, **BEAB** and the **Kitemark**.

Electrician's Guide to the Building Regs · 2.2.2 Conformance to equipment standards: UKCA / UKNI marks · **p.35** new · p.33 old

MESSY DOESN'T MEAN NON-COMPLIANT

One slide showed T&E draped loosely across loft joists with a single clip. It's ugly and poor workmanship, but it isn't against the rules, because it's clipped direct. A better job would drill through the joists (following Part A) or clip at every joist.

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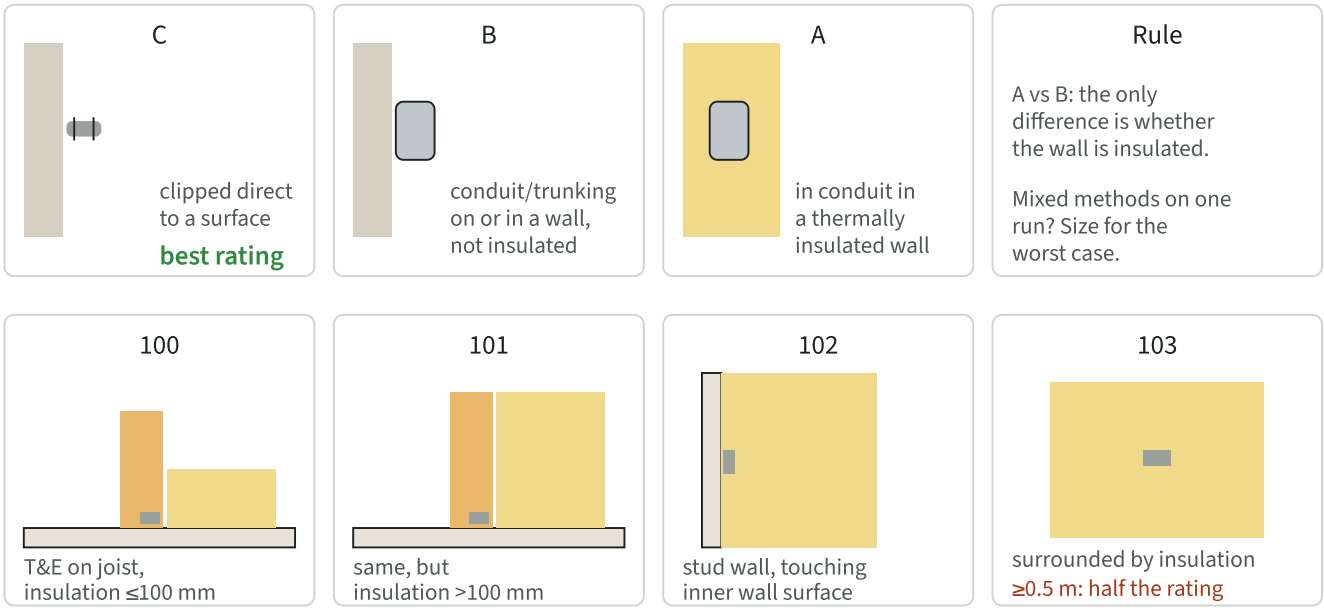
10 Installation reference methods

The **reference method** describes how and where a cable is installed. This affects how much current it can carry, because heat has to escape. **More insulation around a cable means more heat trapped**, which means more resistance and a lower current rating. You may then need a bigger cable.



Simplified sketches. Methods 100–103 apply to **flat twin and earth** (thermoplastic, PVC/PVC, 70 °C). "Multicore flat cable" is another name for T&E. **Method C** (clipped direct) gives the highest current rating.

- **103:** less than **5 cm** surrounded by insulation means **no derating**. Totally enclosed for **0.5 m or more** means the rating is **half** that of clipped direct.
- Examples from the table: **1.0 mm² T&E clipped direct = 16 A** (enclosed in insulation, about half), and **2.5 mm² clipped direct = 27 A**. The rating drops for method B and the 100-series methods.

- PVC-sheathed cable **must not touch polystyrene**, which degrades it over time.
- Twin and earth *can* go in conduit or mini-trunking for extra protection. Councils often run mini-trunking along skirting and ceilings instead of chasing. But more cables bunched together means more heat.

Electrician's Guide to the Building Regs · 2.3.1 Cable installation methods A, B, C · **pp.38–39** new · pp.34–35 old

Electrician's Guide to the Building Regs · Reference methods 100, 101, 102, 103 · Table 2.3.1 T&E current ratings · **p.40** new · p.36 old

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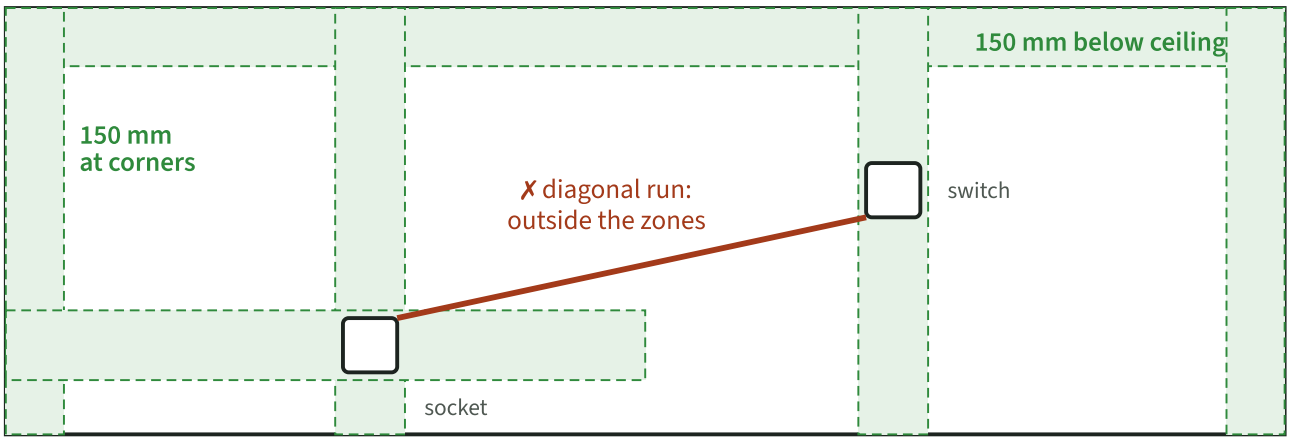
11 Safe zones, depth and metal stud walls



Green = permitted zones: in line (vertically or horizontally) with an accessory, within 150 mm of the ceiling, or within 150 mm of a corner.

Cables concealed in a wall less than 50 mm deep must be protected in one of these ways:

1. Enclosed in **earthed metal** conduit, trunking or ducting (or similar).
2. Run **in the permitted zones**. This also needs **30 mA RCD** additional protection.
3. Part of a **SELV/PELV** circuit (extra-low voltage, covered later).

- **Why the zones?** Nobody is likely to hang a picture 150 mm from the ceiling or right in a corner. Cables in line with an accessory are where people expect them.
- Running across into a different room through a partition isn't "in line with an accessory", so it needs extra protection.
- **Metal or plastic capping** over cables in a chase is good practice, because it stops nails and screws. Capping doesn't count as conduit or trunking.

- **Under floors and in ceilings:** unarmoured cables through joists must be at least **50 mm from the top or bottom** of the joist, or be protected (earthed steel conduit, etc.).

Electrician's Guide to the Building Regs · Permitted cable routes / safe zones figure and <50 mm depth rules · 2.3.2 Floors and ceilings · **p.43** new

Metal stud walls: Reg 522.6.203
If a circuit is installed in a **stud wall made mainly of metal**, a **30 mA RCD is required**, **unless Reg 522.6.204** is followed. That means the cable has an earthed metallic covering, is in earthed conduit or trunking, has mechanical protection against penetration, or is part of SELV/PELV.
The RCD **doesn't stop the cable being damaged**. It protects **the person** from a shock if a screw or nail goes through it.

BS 7671 · Regs 522.6.202, 522.6.203, 522.6.204: cables in walls and metal stud partitions · **p.152** new

IN THE 18TH EDITION EXAM YOU FIND REGS BY NUMBER, NOT PAGE. PRACTISE.

RESISTANCE, LENGTH AND SIZE
Resistance is **directly proportional to length**: double the length, double the resistance. It's **inversely proportional to CSA**: a bigger cable has lower resistance. Going from 4 mm^2 to 10 mm^2 (2.5× bigger) cuts resistance by 2.5×. Adding cable to a circuit raises its resistance, so test readings change.

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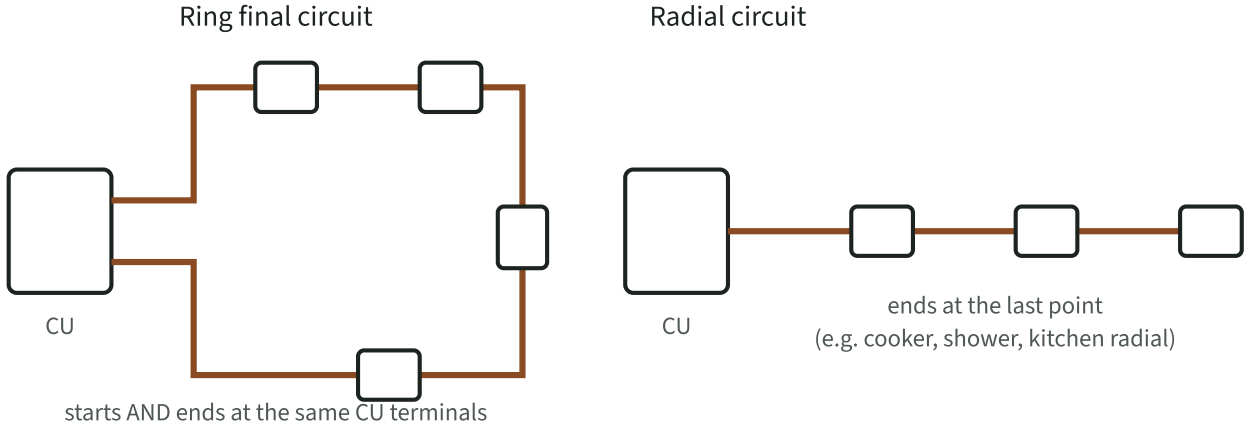
12 Socket circuits: rings and radials



At each socket on a ring, the two lines share one terminal, as do the two neutrals and the two CPCs. It's **parallel** wiring, never series. Say "ring **final** circuit", not "ring main". A ring main is a distribution or supply circuit *before* the property. A **spur** is a branch off a ring or radial.

CIRCUIT	PROTECTIVE DEVICE	MIN. COPPER CSA (T&E)	MAX. FLOOR AREA
Ring final	30 or 32 A	2.5 mm²	100 m²
Radial	20 A	2.5 mm²	50 m²
Radial	30 or 32 A	4.0 mm²	75 m²

- This table is for normal **socket-outlet circuits**. Lighting (usually 6 A), cookers, showers and immersion heaters go through the full design process instead.
- Floor area means the **room area served**, not metres of cable. On a 20 A radial, 50.02 m² is already too much.
- Many kitchens now use a **32 A radial in 4 mm²** instead of a ring. Rings go on a 32 A device. If you need smaller breakers, use two 20 A radials instead.

Electrician's Guide to the Building Regs · 4.2 Final circuits using 13 A socket-outlets · Table 4.2.1 · **p.77** new · p.72 old

On-Site Guide · Appendix H · Table H2.1: final circuits using socket-outlets · **p.218** new · p.210 old "WORTH HIGHLIGHTING"

On-Site Guide · Appendix A: maximum demand

13 Cable selection: the 7 steps

1. **Work out the design current, Ib.** `Ib = P ÷ V`. Also note the **installation reference method** now, from the question.
2. **Select the protective device rating, In** (e.g. B40), so that In ≥ Ib.
3. **Identify the installation method** (C, B, A, 100–103…).
4. **Apply any correction factors**, e.g. ambient temperature, grouping or thermal insulation.
5. **Calculate the tabulated current, It**, that the cable must be able to carry.
6. **Select the cable size** from the tables (BS 7671 or the On-Site Guide).
7. **Check the voltage drop.**

Ib	**Design current** of the circuit: the load. "Ib", not "ID".
In	**Nominal rating of the protective device** in amps, e.g. the "6" on a B6.
Iz	**Current-carrying capacity** of the cable under normal conditions **once correction factors have been applied**. The Z here has nothing to do with impedance.
It	**Tabulated current-carrying capacity**: the value straight from the tables.

$$Ib \leq In \leq Iz$$

With no correction factors, Iz = It, so you pick a cable whose tabulated rating It ≥ In.

VOLTAGE DROP: RADIAL CIRCUITS

```
VD = (mV/A/m × Ib × L) ÷ 1000

÷1000 because mV/A/m is in
millivolts
```

VOLTAGE DROP: RING FINAL CIRCUITS

```
VD = (mV/A/m × Ib × L) ÷ 4000

÷4000: the ring has 4 legs
(2 lines + 2 neutrals)
```

MAX VOLTAGE DROP	SINGLE-PHASE 230 V	THREE-PHASE 400 V
Lighting: **3%**	6.9 V	12 V
All other circuits (sockets, showers, cookers): **5%**	11.5 V	20 V

If the voltage drop is too high, **upsize** the cable. You never downsize.

On-Site Guide · Appendix F: voltage drop explanation, radial formula (and ring formula, new edition only) · **p.184** new · p.168 old

HIGHLIGHT THE FORMULA AND THE 3% / 5% PARAGRAPH

IN REAL LIFE

On most jobs a designer, your boss or the company has already done these calculations, and you install to the design. You still need to know the method for the exams and homework. The Level 4 design course takes it much further.

14 Worked example: 8.5 kW shower

THE QUESTION

An 8.5 kW electric shower is to be installed in a domestic property.

- Wired in PVC/PVC flat twin and earth
- Reference method 102
- Cable run 20 m
- Protective device: BS EN 60898 circuit breaker
- No rating factors

Select a suitable cable and protective device. Show all working.

WORKING

```
1) Design current
   Ib = P ÷ V = 8500 ÷ 230 = 36.96 A      (37 A is fine)

2) Protective device (domestic, so Type B)
   Next standard size ≥ 36.96 A → In = 40 A, Type B, BS EN 60898
   Check: Ib ≤ In → 36.96 ≤ 40 ✓

3-4) Method 102, no correction factors → Iz = It, and it must be ≥ In = 40 A

5-6) On-Site Guide Table F6 (70 °C flat T&E), method 102 column:
   6 mm²  → 35 A  ✗ (less than 40)
   10 mm² → 47 A  ✓  → select 10 mm² twin and earth

7) Voltage drop (not lighting, so max 5% = 11.5 V)
   Table F6, 10 mm² → 4.4 mV/A/m
   VD = (4.4 × 36.96 × 20) ÷ 1000 = 3.25 V
   3.25 V ≤ 11.5 V ✓

Answer: 10 mm² T&E on a 40 A Type B circuit breaker
```

On-Site Guide · Appendix B · Table B6: circuit-breaker ratings (BS EN 60898 / RCBOs) · **p.159** new · p.145 old

On-Site Guide · Appendix F · Tables F4–F6: current-carrying capacity and voltage drop · from **p.187** new · p.171 old

On-Site Guide · **Table F6**: 70 °C thermoplastic flat twin and earth (It and mV/A/m) · **p.193** new · p.177 old

PICK THE RIGHT TABLE

Table F4 is **single-core** cable and Table F5 is multicore **round** cable. Neither is T&E. **Table F6** says *flat* thermoplastic sheathed cable, and that's the twin and earth table. It gives you both **It** and **mV/A/m**. The tutor said the design work is continued tomorrow morning.

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15 Calculator tips

- **Milli = ×10⁻³**, so dividing by 1000 is the same as using `×10^ -3`.
- **Newer Casio (fx-991CW, black with round keys):** it has an **EXE** key instead of "=" and a **FORMAT** key. To get decimals instead of fractions every time, go to **Settings → Calc Settings → Input/Output → MathI/DecimalO**.

- **Older fx-85GT / fx-83GT:** use `S⇔D` to switch fraction ↔ decimal.
- You may need **brackets** round the top line of the voltage drop formula.
- Bring your **own non-programmable scientific calculator** to the exam. The ones provided are basic, and phones aren't allowed. Practise with a scientific calculator app at home until yours arrives.

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16 All book references from this day

Tab these pages. "New" = orange / green-orange editions, "old" = brown / green-brown.

BOOK	WHAT	NEW	OLD
Electrician's Guide to the Building Regs	2.2.2 Marks of conformity (UKCA/UKNI)	35	33
Electrician's Guide to the Building Regs	2.3.1 Installation methods A, B, C	38–39	34–35
Electrician's Guide to the Building Regs	Methods 100–103, Table 2.3.1 T&E ratings	40	36
Electrician's Guide to the Building Regs	Safe zones, <50 mm depth, 2.3.2 floors and ceilings	43	–
Electrician's Guide to the Building Regs	3.3.2 Main protective bonding: what to bond ★	58	52
Electrician's Guide to the Building Regs	Tables 3.3.2a/b earthing and bonding sizes; plastic pipes ★	59	53
Electrician's Guide to the Building Regs	Table 3.3.3 supplementary bonding sizes ★	62	56
Electrician's Guide to the Building Regs	BS 951 clamp label	63	57
Electrician's Guide to the Building Regs	Table 4.2.1 socket circuits (ring/radial) ★	77	72
Electrician's Guide to the Building Regs	Chapter 11 identification of conductors	–	–
BS 7671	Part 2 definitions: exposed and extraneous conductive parts ★	–	–
BS 7671	Table 41.5: RCD max Zs (30 mA → 1667 Ω) ★	77	70
BS 7671	Reg 514: identification of conductors ★	141	132
BS 7671	Regs 522.6.202–204: cables in walls, metal stud walls	152	–
BS 7671	Section 701 bath/shower, Reg 701.415.2 supplementary bonding ★	257	242
BS 7671	Appendix 1: British Standards list	411	385
On-Site Guide	Section 4 bonding and earthing figure	61	–
On-Site Guide	Appendix B Table B6: circuit-breaker ratings	159	145

BOOK	WHAT	NEW	OLD
On-Site Guide	Appendix F voltage drop formula (ring formula new only) ★	184	168
On-Site Guide	Appendix F Tables F4–F6 start	187	171
On-Site Guide	Table F6: flat T&E (It and mV/A/m) ★	193	177
On-Site Guide	Appendix H Table H2.1: socket-outlet final circuits ★	218	210
On-Site Guide	Appendix A: maximum demand	–	–

★ = the tutor specifically said to highlight it, or went through it in detail. Page numbers are as given in the session. Check them against your own copy.

17 Self-test

Test yourself. Answers are under each question.

▼ **A metal back box and metal socket front you installed: exposed or extraneous? A copper water pipe coming in from the ground?**

Socket: exposed conductive part · water pipe: extraneous conductive part

▼ **What's the purpose of main protective bonding?**

To reduce the potential difference between exposed and extraneous conductive parts, so no more than 50 V can pass from one to the other during an earth fault.

▼ **TN-C-S supply with 25 mm² tails. Earthing conductor and main bonding sizes?**

16 mm² earthing conductor · 10 mm² main protective bonding

▼ **The incoming water service pipe is blue plastic all the way into the stopcock. Does it need main bonding?**

No. There's no requirement to bond a plastic incoming service pipe.

▼ **Show where the 50 V touch voltage comes from for a 30 mA RCD.**

$V = I \times R = 0.03 \times 1667 = 50.01\ V$

▼ **Name the three conditions that let you leave out supplementary bonding in a bathroom.**

All circuits meet ADS · all circuits have 30 mA RCD additional protection · all extraneous parts are connected to main protective bonding

▼ **Which four conductors may be green/yellow?**

Earthing conductor · main protective bonding · supplementary bonding · CPC

▼ **What's the maximum floor area for a 20 A radial in 2.5 mm²? And a 32 A ring?**

50 m² · 100 m²

▼ **A 7.2 kW shower on 230 V: Ib, and which Type B breaker?**

Ib = 7200 ÷ 230 = 31.30 A → 32 A Type B

▼ **A 20 m radial carries 25 A in cable rated 7.3 mV/A/m. Voltage drop? OK for sockets? For lighting?**

(7.3 × 25 × 20) ÷ 1000 = 3.65 V · sockets (≤11.5 V) ✓ · lighting (≤6.9 V) ✓

▼ **A ring final is 40 m long, Ib = 30 A, cable 18 mV/A/m. Voltage drop?**

(18 × 30 × 40) ÷ 4000 = 5.4 V

▼ **What does Reg 522.6.203 require in a metal stud wall, and what does that RCD protect?**

A 30 mA RCD (unless 522.6.204 is met). It protects the person from shock, not the cable from damage.