# RCD FAULT PROTECTION: RA × IΔN ≤ 50 V

## WHICH RCD FOR AN 87 OHM TT BARN?

The second job is **fault protection**. An RCD is used for fault protection in two situations:

1. The installation is part of a **TT** system.
2. The circuit's **disconnection time is longer than the maximum allowed**.

Both are covered in **Section 411** (automatic disconnection of supply).

**BS 7671** · **Section 411** · automatic disconnection of supply (TT systems and maximum disconnection times)

Most circuits have a maximum disconnection time. Say a circuit on a **TN-C-S** system would take **7 seconds** to disconnect. That's because of a high resistance on the R1 + R2 side, or a high Ze. Either way, if **Zs is too high**, the fault current is low and disconnection is slow. An RCD for fault protection fixes this.

**Watch out: disconnection times**A common mix-up is that maximum disconnection times range from about 0.1 to 2 seconds. For 230 V, **Table 41.1** gives **0.4 s (TN)** and **0.2 s (TT)** for final circuits up to 63 A with socket-outlets or up to 32 A supplying fixed equipment. Distribution circuits and larger final circuits are allowed **5 s (TN)** or **1 s (TT)**.

### ANY SIZE WILL DO, AS LONG AS IT PASSES

For fault protection, the RCD can be **any rating**: 30, 100, 300 or 500 mA. Each has a **maximum Zs**:

MAXIMUM ZS FOR EACH RCD RATING

| RCD RATING IΔN | IN AMPS (USE THIS IN THE SUM) | MAXIMUM ZS |
|---|---|---|
| 30 mA | 0.03 A | 1667 Ω |
| 100 mA | 0.1 A | 500 Ω |
| 300 mA | 0.3 A | 167 Ω |
| 500 mA | 0.5 A | 100 Ω |

**BS 7671** · **Table 41.5** · maximum Zs for RCDs (1667 / 500 / 167 / 100 Ω)

BS 7671 lets you pick whichever one you like, as long as it passes this check:

$$R_A \times I\Delta n \leq 50\ V$$

$R_A$ can be swapped for your **measured Zs**. IΔn is the RCD's rating **in amps**: 0.03, 0.1, 0.3 or 0.5. Don't type in 30 or 500, or you'll get the wrong answer.

IΔn is written with a triangle (the Greek letter delta), not an "A" or an "E". It's said "I delta n". The **maximum Zs** values in the table are just 50 V ÷ IΔn. For example, 50 ÷ 0.03 = 1667 Ω.

**BS 7671** · Reg **411.5.3** · $R_A \times I\Delta n \leq 50$ V for TT systems

### EXAMPLE 1: COMMERCIAL LIGHTING CIRCUIT, ZS = 10 Ω

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A lighting circuit in a commercial office on TN-C-S. Measured Zs = 10 Ω.
(10 Ω means something is seriously wrong, but go with it.)

Does it need additional protection?
  ✗ Not a socket-outlet
  ✗ Not a domestic lighting circuit
  ✗ Cables are on the surface in conduit and trunking (you can see them),
    so 522.6.202 and 522.6.203 don't apply. They're for hidden cables.
  → No 30 mA requirement. It needs FAULT protection only.

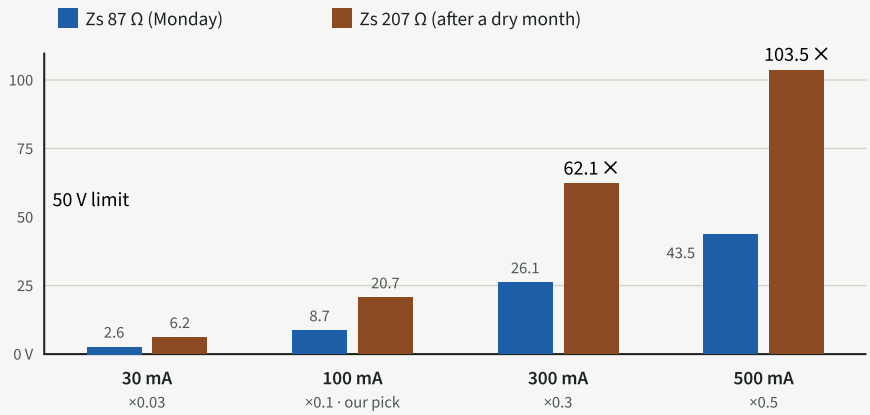
Check each size:  Zs × IΔn ≤ 50 V
  30 mA :  10 × 0.03 = 0.3 V  ✓
  100 mA:  10 × 0.1  = 1 V    ✓
  300 mA:  10 × 0.3  = 3 V    ✓
  500 mA:  10 × 0.5  = 5 V    ✓
→ Any of them is allowed.
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### EXAMPLE 2: LIGHTING IN A BARN ON TT, ZS = 87 Ω

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A lighting circuit in a barn in the middle of a field, on a TT system.
TT → it needs an RCD for fault protection. Measured Zs = 87 Ω (on a Monday).

  500 mA:  87 × 0.5  = 43.5 V  ✓ but sailing too close to the wind (max 100 Ω)
  300 mA:  87 × 0.3  = 26.1 V  ✓ still too close for comfort (max 167 Ω)
  100 mA:  87 × 0.1  = 8.7 V   ✓ our choice (max 500 Ω)
   30 mA:  87 × 0.03 = 2.61 V  ✓ but more sensitive than it needs to be

Why not the 500 or 300? Ground dries out:
  End of a hot week       Zs ≈ 107 Ω → 500 mA fails (107 × 0.5 = 53.5 V ✗)
  A month with no rain    Zs ≈ 207 Ω → 300 mA fails (207 × 0.3 = 62.1 V ✗)
                                       100 mA still fine (207 × 0.1 = 20.7 V ✓)
```




Zs × IΔn in volts for the barn example. On Monday (87 Ω) every rating passes, but the 500 mA is already close to 50 V. After a dry month (207 Ω) the 300 mA and 500 mA fail. The 100 mA still has plenty of room.

**Sparky's tip: TT fault protection**

Don't pick a rating whose maximum Zs is close to your reading. Earth electrode resistance rises as the ground dries out. The **100 mA** is a good usual choice: it's not too sensitive, and it leaves lots of headroom. Above about 200 Ω an electrode reading may not be stable, so look at improving the electrode too.

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