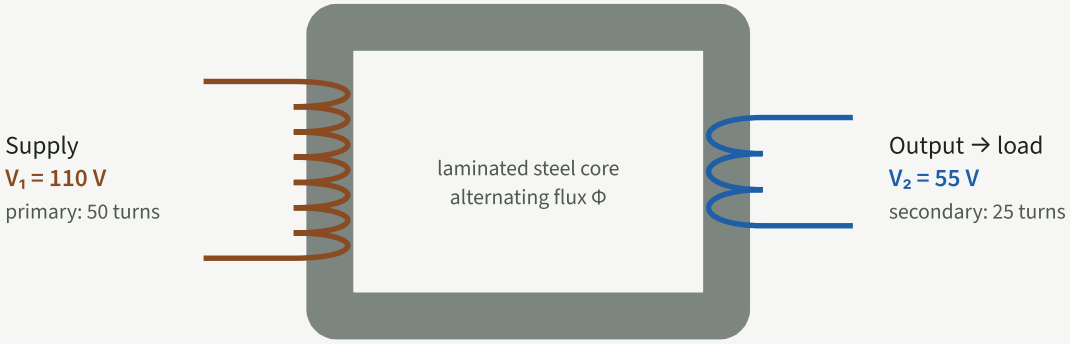
TRANSFORMERS AND IMPEDANCE

HOW DO YOU TURN 110 VOLTS INTO 55?

A transformer converts an **alternating voltage at one level to an alternating voltage at a higher or lower level** (step up or step down). It uses **mutual induction**. A continually changing flux in the primary winding induces a voltage in the secondary winding. That's why a transformer **only works on AC**: DC doesn't produce a changing flux.



An example: 50 windings on the primary at 110 V and 25 windings on the secondary gives 55 V. Half the turns means half the voltage, which is a step-down transformer.

TURNS RATIO

$$V_1 / V_2 = N_1 / N_2$$

$$110 / V_2 = 50 / 25 \quad \rightarrow \quad V_2 = 55 \text{ V}$$

- **Fewer turns on the secondary means step down, and more turns means step up.** You can tell which one a transformer is by comparing the windings.
- On drawings, the **primary** is usually on the **left** and the **secondary** on the **right**.
- The two coils **never touch**. The voltage is induced across through the magnetic field in the core.
- The core is **laminated** (thin lacquered layers) to reduce losses.

Types you'll see: step-up, step-down and **isolating** transformers. An isolating transformer separates you from earth, so there's no path through your body to earth. A bathroom **shaver socket** has one inside. You'll also see pole-mounted three-phase transformers, current transformers (CTs), potential transformers, and the big fenced-off "Danger, high voltage" substations near housing estates.

Impedance (Z) is resistance in an **AC** circuit (in DC it's just called resistance). It's still opposition to current and still measured in ohms. It comes from the resistance of the conductors *plus* the effect of inductance in the supply transformers. You can swap Z in for R in Ohm's law.

`Ze` = **external** impedance: the transformer and supply cable up to your property.

`Zs` = **total** earth fault loop impedance: Ze *plus* the resistance of the circuit you installed. You'll test it in the inspection and testing modules.

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