Does a Copper Wire Have Resistance?

Yes, **copper wire** does have resistance. Although copper is an excellent conductor, it is not perfect. The resistance of a copper wire depends on:

1. **Length**: Longer wires have more resistance.
2. **Cross-sectional area (thickness)**: Thicker wires have less resistance.
3. **Temperature**: Higher temperatures increase resistance.

The resistance RRR of a copper wire can be calculated using the formula:

$$R = \rho * L / A$$

Where:

- ρ is the resistivity of copper (1.68 × 10^−8 Ω m at 20°C),
- L is the length of the wire in meters,
- A is the cross-sectional area in square meters.

For most household wiring, this resistance is very small but not zero.

Imaginary Wire with Zero Resistance

If you have an **ideal wire with zero resistance**, then the current (I) in the wire depends only on the **voltage** (V) and the **load resistance** connected to it (if any). Ohm's Law applies:

$$I = V / R$$

Where:

- V is the voltage (120V in this case),
- R is the total resistance in the circuit.

What Happens with R=0R?

If the resistance is **0 ohms**, the formula becomes:

$$I = 120 / 0$$

This results in a **mathematical infinity**. In practical terms:

- If there is no resistance to limit the current, the current can theoretically become infinite.
- In reality, this would cause the wire to draw as much current as the power source can supply.

Real-World Constraints

In practice:

1. Power sources (like a household outlet or power plant) have **maximum current limits** based on their design.
    - A typical household outlet is limited to **15-20 amps** due to circuit breakers.
    - Even power plants cannot supply infinite current; they have physical and engineering constraints.
2. If an ideal zero-resistance wire were connected to a power source, it would result in a **short circuit**, likely tripping the circuit breaker or damaging the source.

Summary

1. Copper wires have a small but nonzero resistance.
2. For a wire with **0 resistance**:
    - Theoretically, it could carry an infinite current at a fixed voltage.
    - In practice, the current would be limited by the power source's maximum capacity, and a short circuit would occur.
3. Zero-resistance wires don't exist in reality, but **superconductors** (materials with no resistance at very low temperatures) are the closest equivalent. Even then, practical current limits depend on the power supply and other factors.

Resistance

How to Test for Resistance? What is Continuity?