How Do Resistors Drop Voltage in a Circuit?

Resistors **drop voltage** by converting electrical energy into heat. This happens due to **Ohm's Law**, which states:

$$V = I * R$$

where:

- **V** = Voltage drop across the resistor
- **I** = Current flowing through the resistor
- **R** = Resistance in ohms (Ω)

When **current flows through a resistor, it encounters resistance, causing a voltage drop**. The total voltage of a circuit is distributed across all resistors, depending on their values and how they are arranged.

Voltage Drop in Series Circuits

In a **series circuit**, resistors share the total supply voltage. The sum of all voltage drops across each resistor equals the total voltage:

$$V_{total} = V_1 + V_2 + V_3 + ...$$

Example: Two Resistors in Series

If you have **a 10V source** and two resistors:

- **R_1 = 2kΩ**
- **R_2 = 3kΩ**

First, find the total resistance:

$$R_{total} = R_1 + R_2 = 2k\Omega + 3k\Omega = 5k\Omega$$

Find the current using **Ohm's Law**:

$$I = \frac{V}{R_{total}} = \frac{10V}{5k\Omega} = 2mA$$

Now, find the voltage drop across each resistor:

$$V_1 = I * R_1 = (2mA) * (2k\Omega) = 4V$$

$$V_1 = I * R_2 = (2mA) * (3k\Omega) = 6V$$

Total voltage drop: **4V + 6V = 10V**, matching the source voltage.

In a series circuit, bigger resistors drop more voltage because they resist more current flow.

Voltage Drop in Parallel Circuits

In a **parallel circuit**, **all resistors get the same voltage** as the supply, but the current splits among them. Each branch's voltage drop is the same as the total voltage:

$$V_{total} = V_1 = V_2 = V_3$$

Example: Two Resistors in Parallel

If you have **a 10V source** and two resistors in parallel:

- **R_1 = 2kΩ**
- **R_2 = 3kΩ**

Each resistor **gets 10V across it**. The **current through each resistor** is:

$$I_1 = \frac{V}{R_1} = \frac{10V}{2k\Omega} = 5mA$$

$$I_2 = \frac{V}{R_2} = \frac{10V}{3k\Omega} = 3.33mA$$

Total current:

$$I_{total} = I_1 + I_2 = 5mA + 3.33mA = 8.33mA$$

In a parallel circuit, each resistor drops the same voltage, but the current through each depends on its resistance.

Ground Voltage

- The bottom ends of both resistors are connected to the ground (0V).
- Since the voltage is measured relative to the ground, the potential difference is:
    - **Top of the resistors = +10V**
    - **Bottom of the resistors = 0V (ground)**
    - **Voltage drop across each resistor = 10V - 0V = 10V**

Each resistor drops 10V.
The total voltage across the entire parallel network is 10V.
The current through each resistor is different because of their different resistances.
At ground, the voltage is always 0V.

Summary

- **In series circuits:** Resistors split the total voltage based on their resistance values. **Larger resistors drop more voltage**.
- **In parallel circuits:** Each resistor **gets the same voltage**, but **the current splits according to resistance**.
- **!!! Total voltage is always fully "used up" by the circuit**, so the sum of all voltage drops equals the supply voltage.

Understanding Voltage Drop: Calculating Dropped Volts With Easy Math/Numbers ⚡ Cars Simplified

What is Voltage Drop? How to Measure Voltage Drop with a Multimeter