Does a ¼ watt resistor can safely handle **120V**?

1. Resistor Power Dissipation and Safety

Every resistor dissipates **power** as heat, which is given by:

$$P = \frac{V^2}{R}$$

where:

- P is power in **watts (W)**
- V is voltage in **volts (V)**
- R is resistance in **ohms (Ω)**

A **¼ watt (0.25W) resistor** can only **safely dissipate up to 0.25W of power**. If it exceeds this value, it will **overheat and burn out**.

2. Example: 220Ω Resistor at 120V

Let's calculate how much power a **220Ω resistor** would dissipate at **120V**:

$$P = \frac{120^2}{220} = \frac{14400}{220} \approx 65.45W$$

🔥 **This is WAY above 0.25W**, so the resistor **will burn immediately**.

3. Example: 10kΩ Resistor at 120V

Now, let’s calculate power for a **10kΩ (10,000Ω) resistor** at **120V**:

$$P = \frac{120^2}{10000} = \frac{14400}{10000} \approx 1.44W$$

🚨 **This is still too high for a ¼ watt resistor**, but it would work for a **2W resistor**.

4. Finding the Minimum Safe Resistance

To ensure that a ¼ **watt (0.25W) resistor** does not burn at **120V**, we solve for **R**:

$$P = \frac{V^2}{R} \leq 0.25$$

$$R \geq \frac{120^2}{0.25} = \frac{14400}{0.25} = 57600\Omega = 57.6k\Omega$$

5. Does Physical Size Matter?

- **Yes and No.**
- The physical **size** of a resistor is usually an **indicator of its power rating**.
- **¼ watt resistors** are small because they handle small power.
- A **10W resistor** is much larger because it needs to dissipate more heat.

Key takeaway:

- **Voltage rating itself is NOT the main concern** for a resistor (resistors often handle **200V+** easily).
- **Power dissipation is the real issue** → You must **choose a high enough resistance** so power stays below the resistor’s rated limit.

Now we are calculating the power dissipation and current in a divider.

Step 1: Calculate Current in the Divider

The total resistance of the circuit:

$$R_{total} = R_1 + R_2 = 100k\Omega + 1k\Omega = 101\text{k}\Omega$$

The total current flowing through the resistors:

$$I = \frac{V_{in}}{R_{total}} = \frac{120V}{101k\Omega}$$

$$I = \frac{120}{101{,}000} \approx 1.188mA$$

Step 2: Power Dissipation in Each Resistor

For $R_1 = 100k\Omega$:

$$P_1 = I^2 * R_1 = (1.188mA)^2 * 100k\Omega$$

$$P_1 = (1.412 * 10^{-6}) * 100,000$$

$$P_1 \approx 0.1412W$$

For $R_2 = 1k\Omega$:

$$P_2 = I^2 * R_2 = (1.188mA)^2 * 1k\Omega$$

$$P_2 = (1.412 * 10^{-6}) * 1,000$$

$$P_2 \approx 0.00141W$$

Step 3: Total Power Dissipation

$$P_{total} = P_1 + P_2 = 0.1412W + 0.00121W$$

$$P_{total} \approx 0.1426W$$

Summary:

- Power dissipated by **100kΩ resistor ≈ 0.141W**
- Power dissipated by **1kΩ resistor ≈ 0.00141W**
- **Total power dissipation ≈ 0.1426W**
- If you use a **220Ω resistor**, it **burns** (way too much power).
- If you use a **10kΩ resistor**, it **still burns** (1.44W is too high).
- If you use **57.6kΩ or higher**, a **¼ watt resistor is safe**.

So yes, higher resistance means less power dissipation, allowing the resistor to handle high voltages safely.

[Measuring SUPER HIGH VOLTAGE]()