

POWER AND HEAT

How much power a part dissipates ($P = V \times I = I^2 R$), why it leaves as heat, and how to pick a part rated for it. Worked from a real regulator.

ONE THOUSAND DRONES ENGINEERING TEAM · VERIFIED 2026-07

Power is the rate a part uses energy, measured in watts. For a resistor it takes three equivalent forms, shown below. Whatever form you use, the power a resistive part burns leaves as heat, and that heat is what sets the part you buy.

$$P = V \times I = I^2 R = V^2 / R$$

CALCULATOR · RESISTOR POWER DISSIPATION CALCULATOR (WATTAGE RATING)

Find the power a resistor dissipates ($P = I^2 R$) and the smallest standard wattage rating with a 2x margin, from its current and resistance.

Interactive calculator: academy.onethousanddrones.com/tools/resistor-power

FIND A RESISTOR'S DISSIPATION AND THE WATTAGE RATING TO BUY.

WHERE THE POWER GOES

A part carrying current at a voltage is turning electrical energy into heat at a rate of $V \times I$ watts. A voltage regulator is the clearest case. On a One Thousand Drones L1.01 board the AP2112K regulator takes the USB 5 V input down to 3.3 V; the 1.7 V it drops, times the current the board draws, becomes heat in the regulator. Draw more current and it runs hotter.

HOW HOT DOES THE PART ACTUALLY GET?

The watts a part burns raise its internal temperature above the air around it. How far above is set by the part's junction-to-ambient thermal resistance, a figure in degrees C per watt from the datasheet: the die sits that many degrees hotter for every watt it dissipates. A small package like the AP2112K's SOT-23-5 has a high thermal resistance, so the copper plane it solders to is, quite literally, its heatsink. More copper pulls the number down and the part runs cooler (Diodes AP2112 datasheet).

$$T_j = T_a + P \times R(\theta_{JA})$$

- Diodes Incorporated. AP2112 600mA CMOS LDO Regulator datasheet (thermal resistance, SOT-23-5 package). [diodes.com](https://www.diodes.com)

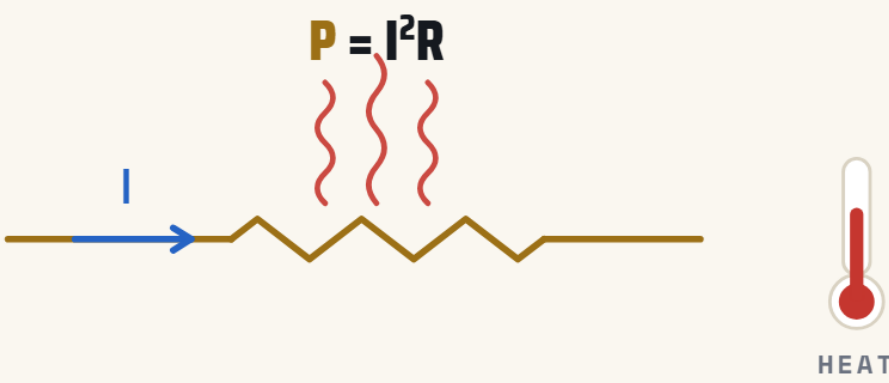
PICKING A PART RATED FOR THE HEAT

A resistor's power rating is the point where it sits near its maximum temperature in still air. A common thick-film chip resistor is rated at 70 C ambient and must not exceed a 155 C film temperature (Vishay CRCW e3 datasheet). Run one at its rating and it is hot, drifting, and short-lived, so pick a part rated above the power it dissipates, with margin, and check the datasheet's derating curve, which pulls the allowed power down as the ambient rises.

- [Vishay. D/CRCW e3 Standard Thick Film Chip Resistors datasheet \(power derating, 70 C rated, 155 C max film temperature\).](https://www.vishay.com/doc/93623/D/CRCW_e3_Standard_Thick_Film_Chip_Resistors_datasheet_(power_derating,_70_C_rated,_155_C_max_film_temperature).pdf)-
vishay.com

► FUNDAMENTALS • POWER

POWER AND HEAT



Power dissipated becomes heat ($P = I^2R$). A part's power rating is the limit on how much it can shed.

DISSIPATED POWER BECOMES HEAT; THE DATASHEET DERATING CURVE PULLS THE ALLOWED POWER DOWN AS IT GETS HOTTER.

CHECKPOINT

1. The power a resistor dissipates turns mostly into what?

- a. Light
- b. Heat**
- c. Sound

ANSWER · B

A resistor turns the power it cannot pass into heat.

2. What resistor power rating should you pick?

- a. Above the power it dissipates, with margin**
- b. Exactly the power it dissipates
- c. Below the power it dissipates

ANSWER · A

A part run at its rating sits near its maximum temperature, so leave margin.

3. A resistor's datasheet power rating assumes what?

- a. A maximum temperature it must not exceed**
- b. That it never gets warm
- c. That it runs in a vacuum

ANSWER · A

The rating holds only while the film stays under its maximum temperature; the derating curve shows the rest.

- Prerequisite: [Ohm's law](#)
- Calculate it: [the resistor power calculator](#)