

DIODES AND LEDES

How a diode passes current one way, why an LED needs a current-limiting resistor, and the forward voltage by color. With a live calculator.

ONE THOUSAND DRONES ENGINEERING TEAM · VERIFIED 2026-07

A diode lets current flow one way and blocks it the other. An LED is a diode that emits light, and like any diode it drops a roughly fixed forward voltage, so it needs a resistor to set its current.

A ONE-WAY VALVE

In the forward direction a diode conducts with a small voltage drop; in reverse it blocks. A common use is reverse-polarity protection: a diode in the power path passes current only when the supply is connected the right way round, so a reversed battery cannot damage the board.

DEEP DIVE · WHY GOOD DESIGNS REPLACE THE PROTECTION DIODE

A series diode is the simplest reverse-polarity guard, but it is not free: its forward voltage drop is always there, so it burns its drop times the load current as heat every second the board runs, and it steals that slice from a battery. That is why more advanced designs swap the diode for a P-channel MOSFET wired as an ideal diode. Its on-resistance is milliohms, so it wastes almost nothing and stays cool, at the cost of a couple more parts. Same job, far less loss. (TI, Basics of Ideal Diodes)

- [Texas Instruments. Basics of Ideal Diodes application note \(SLVAE57B\): P-channel MOSFET reverse-polarity protection.](#) ti.com

THE LED FORWARD VOLTAGE

An LED drops a forward voltage that depends on its color, roughly **1.8 V** for red and **3.0 V** to **3.4 V** for blue and white at a typical 20 mA (see the forward-voltage reference below, and always read the specific LED's datasheet at your current). Because that drop is roughly fixed, you set the current with a series resistor sized from the supply, the forward voltage, and your target current.

$$R = (V_{\text{supply}} - V_f) / I$$

CALCULATOR · LED SERIES RESISTOR CALCULATOR (Ω FROM SUPPLY, V_f, CURRENT)

Size an LED's current-limiting resistor from supply voltage, forward voltage, and target current. Gives the nearest E24 standard value and the power it burns.

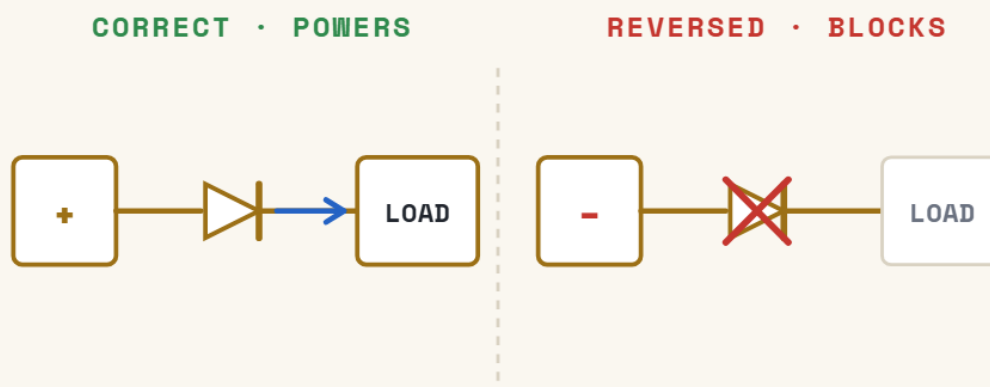
Interactive calculator: academy.onethousanddrones.com/tools/led-series-resistor

SIZE AN LED'S CURRENT-LIMITING RESISTOR.

- [CircuitBread. The forward voltages of different LEDs \(typical V_f by color at 20 mA\).](#) circuitbread.com

► FUNDAMENTALS · DIODES

REVERSE-POLARITY PROTECTION



A diode passes current one way. In series on the power input it passes the correct supply and blocks a reversed one.

A DIODE CONDUCTS ONE WAY; AN LED NEEDS A SERIES RESISTOR TO SET ITS CURRENT.

On a One Thousand Drones board a diode in the power input path is reverse-polarity protection: it only conducts when the supply is the right way round, and its direction and its forward drop are the whole point.

CHECKPOINT

1. A diode does what?

- a. Passes current one way and blocks the other
- b. Passes current in both directions equally
- c. Stores charge like a capacitor

ANSWER · A

A diode is a one-way valve: forward it conducts, reverse it blocks.

2. Why does an LED need a series resistor?

- a. To raise its brightness above the supply
- b. To set its current, since its forward voltage is roughly fixed
- c. To store energy between blinks

ANSWER · B

The LED drop is roughly fixed, so the resistor sets the current.

3. A red LED's forward voltage is closest to which value?

- a. 0.2 V
- b. 12 V
- c. 1.8 V

ANSWER · C

Red is about 1.8 V; blue and white are nearer 3.0 to 3.4 V, at 20 mA.

- Prerequisite: Ohm's law
- Calculate it: the LED series resistor calculator
- Next: reactive parts and filtering