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CAPACITORS AND DECOUPLING

What a capacitor does, why a decoupling cap sits beside every chip, and the difference between ceramic and electrolytic. With real board examples.

ONE THOUSAND DRONES ENGINEERING TEAM · VERIFIED 2026-07

A capacitor stores charge and releases it, which makes it the part that steadies a power rail. The decoupling capacitor beside almost every chip is the most common one you will place.

WHAT DOES A CAPACITOR DO?

A capacitor stores an amount of charge for each volt across it, which is its capacitance in farads. It resists a sudden change in voltage, and it passes a changing signal while blocking steady DC. Those two behaviors cover almost every use.

DECOUPLING: THE CAP AT EVERY CHIP

A chip's current draw jumps the instant it switches. A small capacitor placed right at its power pins supplies that sudden demand locally, so the rail does not dip and the chip stays fed. That job is decoupling, also called bypass, and a `100 nF` ceramic is the default choice.

CERAMIC AND ELECTROLYTIC

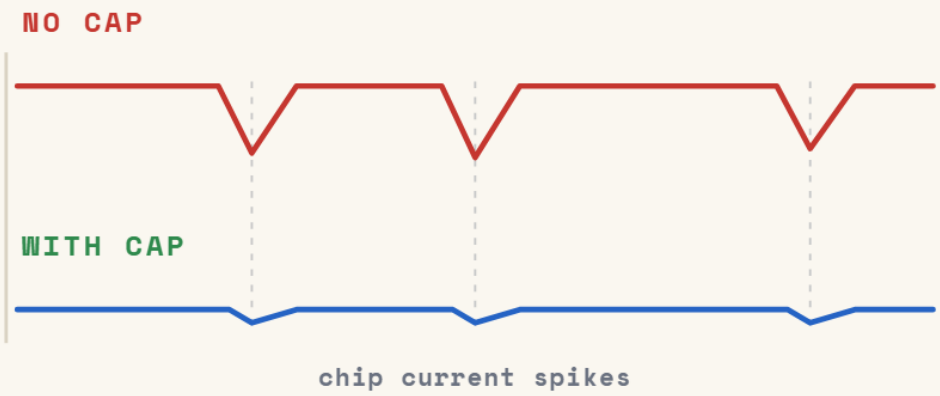
Ceramic capacitors are small and fast, and the X7R type is temperature-stable (an EIA Class II dielectric), which is why X7R is the workhorse for decoupling (Murata). Electrolytic capacitors hold far more charge for bulk energy storage where power enters the board, at the cost of size and speed.

- Murata. Ceramic Capacitor overview (X7R Class II dielectric for decoupling). murata.com

> **A CERAMIC CAP LOSES CAPACITANCE AS YOU USE ITS VOLTAGE**
>
> A Class II ceramic (X7R and its cousins) does not hold its rated value under a DC voltage. As the voltage across the part climbs toward its rating, its effective capacitance can fall by a large fraction, so a `100 nF` part rated right at the rail delivers noticeably less than `100 nF` in the circuit. The fix is free: pick a voltage rating well above the rail, a `10 V` or `16 V` part on a `3.3 V` rail, and the capacitance you designed for is the capacitance you get. (Murata)

▸ FUNDAMENTALS · CAPACITORS

CAPACITORS AND DECOUPLING



A cap stores charge and steadies the rail. Without it the supply dips on every current spike; with it, it holds.

THE DECOUPLING CAP SITS RIGHT AT THE POWER PIN AND FEEDS THE CHIP'S INSTANT DEMAND.

On a One Thousand Drones L1.01 board a `100 nF` ceramic sits right at the module's power pins, and larger bulk capacitors sit where USB power enters.

CHECKPOINT

1. What does a decoupling capacitor do?

a. Raises the supply voltage

b. Blocks the chip from drawing current

c. Supplies a chip's sudden current demand so the rail stays steady

ANSWER · C

It is a local charge reservoir right at the chip's power pins for the instant it switches.

2. Which capacitor type is the usual choice for decoupling?

a. A small X7R ceramic

b. A large electrolytic

c. A variable capacitor

ANSWER · A

X7R ceramics are small, fast, and temperature-stable, ideal for decoupling.

3. A capacitor stores charge in proportion to what?

a. The current through it

b. The voltage across it

c. The resistance beside it

ANSWER · B

Capacitance is the charge stored per volt across the part.

- Prerequisite: voltage, current, and resistance
- See it on a real board: the L1.01 build
- Next: diodes and LEDs