

Capacitor Basics Cheat Sheet

Capacitance, stored energy, RC time constant and types

ENGINEERING
CHEAT SHEET

Key equations

Quantity	Equation	Notes
Capacitance	$C = Q / V$	Farads (F). Everyday parts are μF , nF or pF
Parallel-plate capacitor	$C = \epsilon_r \epsilon_0 A / d$	$\epsilon_0 \approx 8.854 \times 10^{-12} \text{ F/m}$, A = plate area, d = gap
Stored energy	$E = \frac{1}{2} C V^2$	Joules
RC time constant	$\tau = R C$	63% charged after 1τ ; about 5τ = fully charged or discharged
Charging voltage	$v(t) = V_s (1 - e^{-t/\tau})$	Discharging: $v(t) = V_0 e^{-t/\tau}$
Parallel capacitors	$C_{eq} = C_1 + C_2 + \dots$	Capacitance adds
Series capacitors	$1 / C_{eq} = 1 / C_1 + 1 / C_2 + \dots$	Less than the smallest; same charge on each

Key takeaways

- A capacitor stores energy in an **electric field** between two plates separated by a dielectric. Unlike a battery, it charges and discharges almost instantly but holds much less energy.
- Increase capacitance by **increasing plate area**, **decreasing the gap**, or using a **higher dielectric constant** material.
- Example: a 2 V source across 10 μF stores 20 μC ($Q = CV$).
- Polarized** types (electrolytic, tantalum) fail if connected backward. Ceramic and film types are non-polarized.
- Jobs in circuits: power-supply filtering, timing (with resistors), AC coupling and decoupling, and motor starting or EMI suppression.
- A capacitive accelerometer measures acceleration from the change in plate spacing of a movable mass.

Common types

Type	Polarized?	Range	Typical uses
Electrolytic	Yes	1 μF to tens of thousands of μF	Power filtering, audio
Ceramic	No	pF to low μF	Decoupling, general purpose
Tantalum	Yes	0.1 μF to hundreds of μF	Medical, automotive
Film	No	pF to tens of μF	Audio, filters