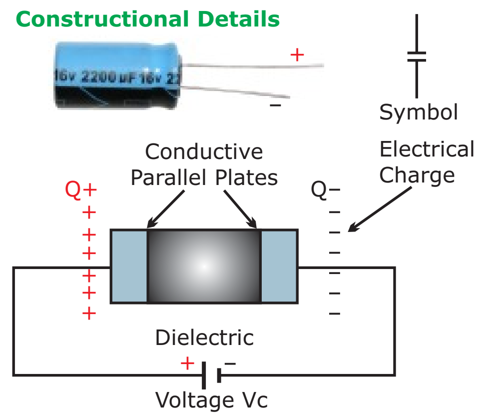
Tesca Technologies Pvt. Ltd.

Capacitors

Capacitor

Capacitor is sometimes referred to as a Condenser. It is a simple passive device which stores its energy in the form of an electrostatic charge producing a potential difference across its plates. A capacitor consists of two or more parallel conductive (metal) plates which are electrically separated wither by air or by some form of insulating material such as paper, mica, ceramic or plastic and which is called the capacitors Dielectric.

Constructional Details

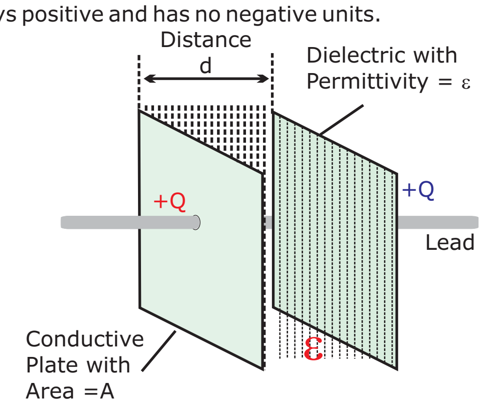


Units of Capacitance

The unit of capacitance is Farad (abbreviated to F) named after the British physicist capacitor has the capacitance of one Farad when a charge of one Coulomb is stored on the plates by a voltage of one Volt. Capacitance, C is always positive and has no negative units.

Microfarad (μF) 1μF = 10^{-6}F
Nanofarad (nF) 1nF = 10^{-9}F
Picofarad (pF) 1pF = 10^{-12}F

C = K (A / d)



Dielectric Material Used
Air, paper, polyester, polypropylene, Mylar, cermic, glass, oil.

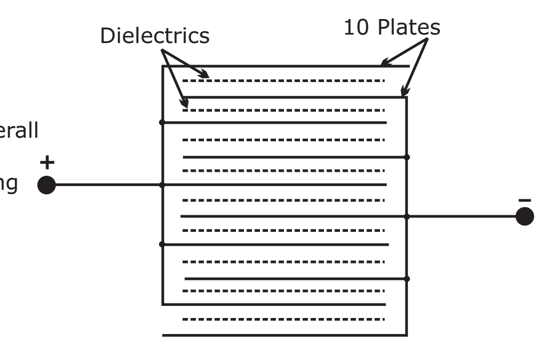
Complex Permittivity

$\varepsilon = \varepsilon_0 \times \varepsilon_r$

Permittivity is a property of a medium or a region of space. Air or vacuum has minimum value of permittivity.

Vacuum = 1.0000 Air = 1.0005 Paper = 2.5 to 3.5 Glass = 3 to 10
Mica = 5 to 7 Wood = 3 to 8 Metal Oxide Powders = 6 to 20

Capacitance, $C = \frac{\varepsilon_0 \times \varepsilon_r \times A}{d}$

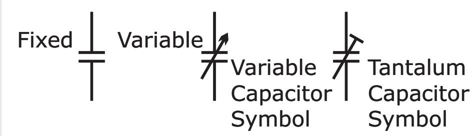


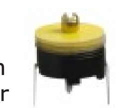
To increase the overall capacitance of a capacitor following arrangement is used.

Classification Based on Properties

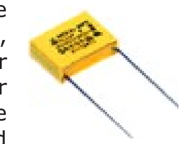
Low Loss, High Stability such as Mica, Low K Ceramic, Polystyrene.
Medium Loss, Medium Stability such as Paper, Plastic Film, High - K Ceramic,
Polarized Capacitors such as Electrolytic's Tantalum's.

Types of Capacitor





Film Capacitors: which use polystyrene, polycarbonate or Teflon as their dielectrics are sometimes called plastic Capacitors.



Ceramic Capacitors: are mad by coting two sides of a small porcelain or ceramic disc with silver and are then stacked together to make a capacitor.

Electrolytic Capacitor: are generally used when very large capacitance is required and have a value ranging between 1 to 6800 micro farad. Electrolytic provides the most capacitance in the smallest space with least cost. Electrolytic capacitors are used in circuits that have a combination of DC voltage and AC voltage.

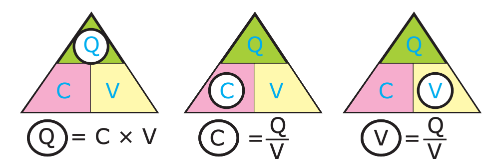
Aluminium Electrolytic Capacitors

Tantalum Electrolytic Capacitor

Charge on a Capacitor

Q = C × V

Where,
Q = Charged measured in Coulombs (C)
C= Capacitance measured in Farads (F)
V = Charge measured in Volts (V)



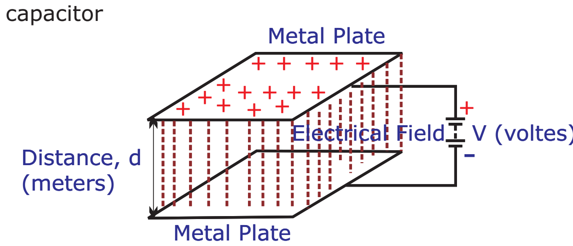
Capacitance with Air as its dielectric

$C = \frac{Q}{V} = \varepsilon \frac{A}{D}$

Capacitance with a Solid as its dielectric

$C = \frac{Q}{V} = \varepsilon_0\, \varepsilon_r \frac{A}{D}$

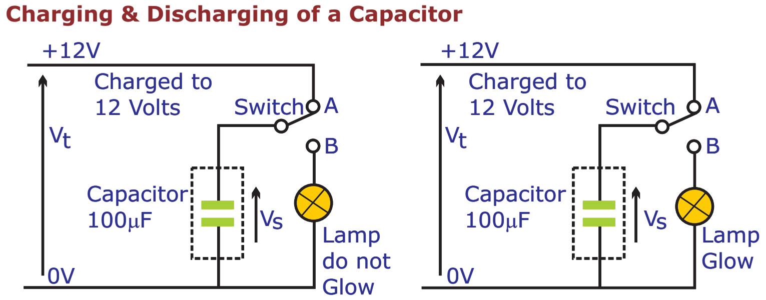
Where
A is the area of the plates in square meters m^2
d is the distance or separation between the two plates
ε_0 (epsilon) is the value of the permittivity for air which is 8.84 × 10^{-12} F/m
ε_r is the permittivity of the dielectric medium used between the two plates parallel plate capacitor

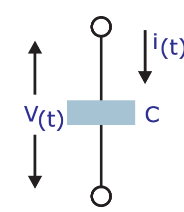


Current through a Capacitor

$i_{(t)} = C\frac{dv}{dt}$

Charging & Discharging of a Capacitor

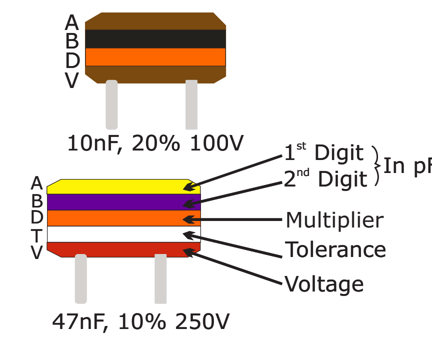




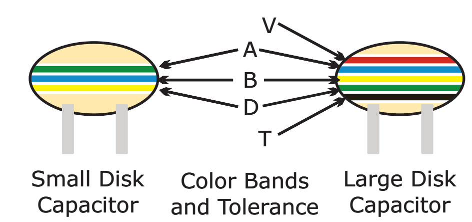
Energy in a Capacitor

Energy, $W = \frac{1}{2}CV2$ in Joules (J)

Capacitor Voltage Reference



Disc & Ceramic Capacitor

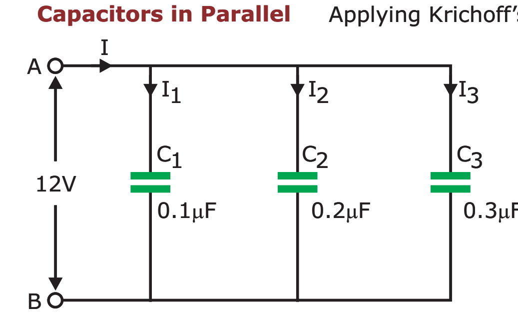


Capacitor Tolerance Letter Codes Table

Letter		B	C	D	F	G	J	K	M	Z
Tolerance	C< 10pF ±pF	0.1	.025	.5	1	2				
	C< 10pF ±pF			.5	1	2	5	10	20	+80-20

Capacitors in Parallel

Applying Krichoff's Current Law, (KCL) in the given circuit



$i_1 = C_1\frac{dv}{dt}\; i_2 = C_2\frac{dv}{dt}\; i_3 = C_3\frac{dv}{dt}$

$i_1 = i_1 + i_2 + i_3$

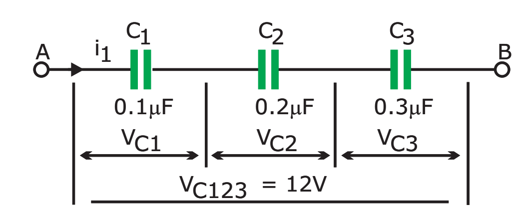
$i_1 = C_1\frac{dv}{dt} + C_2\frac{dv}{dt} + C_3\frac{dv}{dt}$

$i_1 = (C_1 + C_2 + C_3)\frac{dv}{dt}$

Capacitors in Series

Applying Krichoff's Voltage Law, (KVL) in the given circuit

$V_{AB} = V_{C1} + V_{C2} + V_{C3} = 12V$



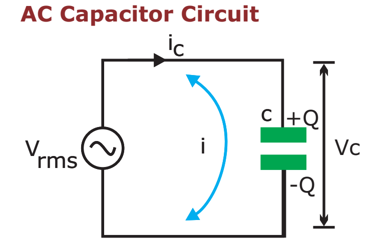
$V_{C1} = \frac{Q_T}{C_1},\; V_{C2} = \frac{Q_T}{C_2},\; V_{C3}\frac{Q_T}{C_3}$

Since Q = CV or V = Q/C

$V_{AB} = \frac{Q_T}{C_1} = \frac{Q_T}{C_1} + \frac{Q_T}{C_2} + \frac{Q_T}{C_3}$

$\frac{1}{C_1} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}$

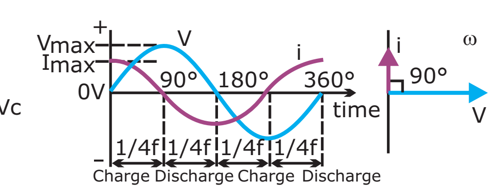
AC Capacitor Circuit



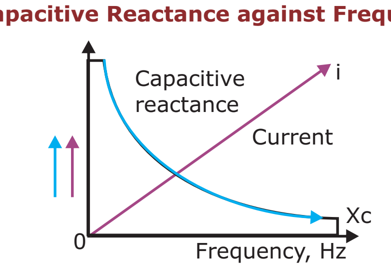
Capacitive Reactance in a purely capacitive circuit is the opposition to current flow in AC circuits only.

$X_C = \frac{1}{2\pi fC} = \frac{1}{\omega C}$

AC Capacitor Phasor Diagram



Capacitive Reactance against Frequency



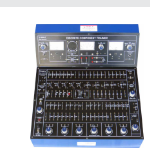
33502
Analog Lab

33503
Digital - Analog Lab

36101
Linear I.C. Trainer

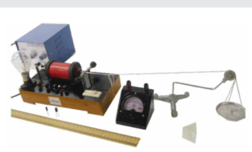
36183
Charging and Discharging of a Condenser

36184
Semi-Conductor Devices Characteristics



36185
Discrete Component Trainer

38005
Display Board Different Capacitors



55778
Frequency of AC Supply and Capacitance

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