



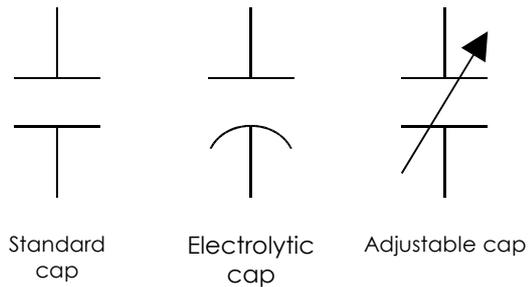
Capacitors

Functionality

A capacitor is a component that holds or releases electrical charge. It is like a reservoir, in the same way that a reservoir holds rainwater that can be emptied later, the capacitor can be filled with electricity and emptied gradually over time.

Schematic symbol

The basic symbol for a capacitor is two parallel lines. This can be changed slightly to indicate different types of capacitor. Some capacitors will only work if they are used the correct way around. These are called electrolytic capacitors. The symbol for an electrolytic has to indicate the polarisation of the capacitor. This is done by making one of the lines on the basic capacitor curved. Capacitors that can be adjusted have a line running through them with an arrow on one end.



Values

The value of a capacitor is measured in Farads, though a 1 Farad capacitor would be very big. Therefore we tend to use milli Farads (mF), micro Farads (μF), nano Farads (nF) and pico Farads (pF). A μF is a millionth of a farad, $1\mu\text{F} = 1000\text{ nF}$ and $1\text{ nF} = 1000\text{ pF}$.

1F	= 1,000mF
1F	= 1,000,000 μF
1F	= 1,000,000,000nF
1F	= 1,000,000,000,000pF

The larger electrolytic capacitors tend to have the value printed on the side of them along with a black band showing the negative lead of the capacitor.

Other capacitors (as shown on the right), which are often smaller, may not have enough space to print the value in full and can use a 3-digit code. The first 2 digits are the first part of the number and the third digit give the number of zeros to give it's value in pF.



Examples: $104 = 10 + 0000$ (4 zero's) = **100,000 pF** (which is also $0.1\ \mu\text{F}$)

Printing on capacitor	Two digit start	Number of zero's	Value in pF
222			
103			
333			
473			



RC constant

The amount of time taken to charge (fill) or discharge (empty) the capacitor to a given voltage depends upon how quickly charge is allowed to flow into the capacitor. If a capacitor is connected across a battery without a resistor it will charge to the same voltage as the battery almost instantly as the flow of charge is not opposed. If however a current limiting resistor is placed in series with the capacitor the charge is opposed and the capacitor charges at a slower rate. When a resistor and capacitor are used together an RC timing circuit is produced. The RC timing circuit can be used to produce delays, the amount of time taken to get to 70% of the final voltage is given by the resistance times the capacitance.

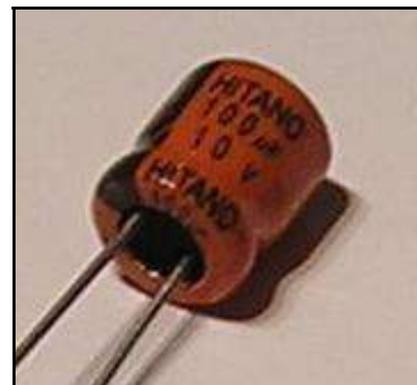
Example of calculating RC constants For a 1M Ω resistor and a 100 μ F capacitor
 $T = R \times C$
 $T = 1,000,000 (1M) \times 0.000,1 (100\mu F)$
 $T = 100 \text{ Seconds}$

So an RC of 1 second could be produced with a 10K resistor and 100 μ F capacitor.

Resistor Value	Capacitor Value	RC Time Constant
2,000,000 (2MΩ)	0.000,1 (100μF)	
100,000 (100KΩ)	0.000,1 (100μF)	
100,000 (100KΩ)	0.000,047 (47μF)	

Maximum Working Voltage

Capacitors also have a maximum working voltage that should not be exceeded. This will be printed on the capacitors or can be found in the catalogue the parts came from. You can see that the capacitor on the right is printed with a 10V maximum working voltage.





Answers

Capacitor Ceramic Disk Values

Printing on capacitor	Two digit start	Number of zero's	Value in pF
222	22	00	2200pF (2.2nF)
103	10	000	10000pF (10nF)
333	33	000	33000pF (33nF)
473	47	000	47000pF (47nF)

RC Time Constants

Resistor Value	Capacitor Value	RC Time Constant
2,000,000 (2M Ω)	0.000,1 (100 μ F)	200 Seconds
100,000 (100K Ω)	0.000,1 (100 μ F)	10 Seconds
100,000 (100K Ω)	0.000,047 (47 μ F)	4.7 Seconds