A capacitor works on the principal of having two conductive plates which are very close and are parallel to each other. When a charge is applied to one plate of the capacitor, the electrons will generate an approximately equal, but opposite charge on the other plate of the capacitor. Capacitors will pass AC current, but will block DC current. A capacitor can also be used to smooth out voltage ripple, as in DC power supplies. Capacitance is measured in Farads (F).

### Capacitor Parameters
Capacitors have five parameters. Capacitance (Farads), Tolerance (%), Maximum Working Voltage (Volts), Surge Voltage (Volts) and leakage. Because a Farad is a very large unit, most capacitors are normally measured in the ranges of pico, nano and micro farads.

**Working Voltage**
This refers to the maximum voltage that should be placed across the capacitor under normal operating conditions.

**Surge Voltages**
The maximum instantaneous voltage a capacitor can withstand. If the surge voltage is exceeded over too long a period there is a very good chance that the capacitor will be destroyed by the voltage ‘punching’ through the insulating material inside the casing of the capacitor. If a circuit has a surging characteristic, choose a capacitor with a high rated surge voltage.

**Leakage**
Refers to the amount of charge that is lost when the capacitor has a voltage across its terminals. If a capacitor has a low leakage it means that very little power is lost. Generally leakage is very small and is not normally a consideration for general purpose circuits.

**Tolerance**
As with resistors, tolerance indicates how close the capacitor is to its noted value. These are normally written on the larger capacitors and encoded on the small ones.

<table>
<thead>
<tr>
<th>Code</th>
<th>Tolerance</th>
<th>Code</th>
<th>Tolerance</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>±0.25pF</td>
<td>D</td>
<td>±0.5pF</td>
</tr>
<tr>
<td>E</td>
<td>±1pF</td>
<td>G</td>
<td>±2%</td>
</tr>
<tr>
<td>J</td>
<td>±5%</td>
<td>K</td>
<td>±10%</td>
</tr>
<tr>
<td>L</td>
<td>±15%</td>
<td>M</td>
<td>±20%</td>
</tr>
<tr>
<td>N</td>
<td>±30%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Capacitor Markings
There are two methods for marking capacitor values. One is to write the information numerically directly onto the capacitor itself. The second is to use the EIA coding system.

**EIA Coding**
The EIA code works on a very similar principle to the resistor colour code. The first two digits refer to the value with the third being the multiplier. The fourth character represents the tolerance.

When the EIA code is used, the value will always be in Pico-Farads (see Decimal Multipliers ).

**Example 1:** 103K
This expands to:
1 = 1
0 = 0
3 = x 1,000
K = 10% (see Capacitor Tolerance for listings)

Then we combine these numbers together:
1 0 x1,000 = 10,000pF = 0.01µF,
103K = ±10% tolerance.

**Example 2:** 335K
This expands to:
3 = 3; 3 = 3; 5 = x 100,000; K = ±10%

Then we combine these numbers together:
3 3 x100,000 = 3,300,000pF = 3,300nF = 3.3µF, at 10% tolerance.

### Capacitors in Series
Capacitors in series can be calculated by: Note:- The new capacitance value will always be lower.

\[
C_{\text{Total}} = C_1 + C_2 + C_3 + \text{etc}...
\]

### Capacitors in Parallel
When capacitors are placed in parallel they can be simply added together.

\[
C_{\text{Total}} = \frac{1}{\frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} + \text{etc}...}
\]

### Reading & Converting Capacitor Values
<table>
<thead>
<tr>
<th>µF</th>
<th>nF</th>
<th>pF</th>
<th>EIA Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.001µF</td>
<td>1.0nF</td>
<td>1000pF</td>
<td>102</td>
</tr>
<tr>
<td>0.002µF</td>
<td>2.0nF</td>
<td>2000pF</td>
<td>103</td>
</tr>
<tr>
<td>0.003µF</td>
<td>3.0nF</td>
<td>3000pF</td>
<td>104</td>
</tr>
<tr>
<td>0.004µF</td>
<td>4.0nF</td>
<td>4000pF</td>
<td>105</td>
</tr>
<tr>
<td>0.005µF</td>
<td>5.0nF</td>
<td>5000pF</td>
<td>106</td>
</tr>
<tr>
<td>0.006µF</td>
<td>6.0nF</td>
<td>6000pF</td>
<td>107</td>
</tr>
<tr>
<td>0.007µF</td>
<td>7.0nF</td>
<td>7000pF</td>
<td>108</td>
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<tr>
<td>0.008µF</td>
<td>8.0nF</td>
<td>8000pF</td>
<td>109</td>
</tr>
<tr>
<td>0.009µF</td>
<td>9.0nF</td>
<td>9000pF</td>
<td>110</td>
</tr>
</tbody>
</table>

**OR...**

### Example

\[
\begin{align*}
\text{CTotal} &= C_1 + C_2 + C_3 + \text{etc}... \\
C_1 &= 335K \\
C_2 &= 335K \\
C_3 &= 335K \\
\text{CTotal} &= \frac{1}{\frac{1}{335K} + \frac{1}{335K} + \frac{1}{335K}} \\
\end{align*}
\]