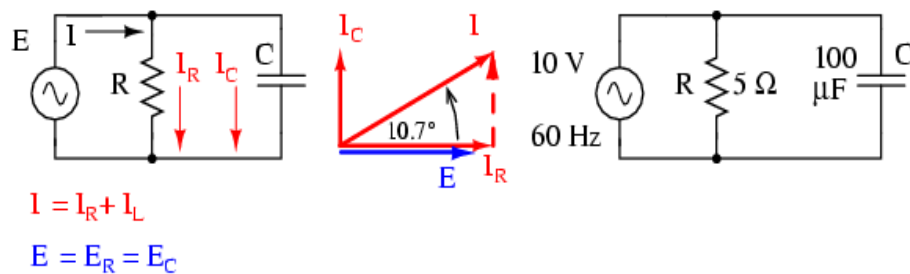


PARALLEL RESISTOR-CAPACITOR CIRCUITS

Using the same value components in our series example circuit, we will connect them in parallel and see what happens: (Figure below)



Parallel R-C circuit.

Because the power source has the same frequency as the series example circuit, and the resistor and capacitor both have the same values of resistance and capacitance, respectively, they must also have the same values of impedance. So, we can begin our analysis table with the same “given” values:

	R	C	Total	
E			$10 + j0$ $10 \angle 0^\circ$	Volts
I				Amps
Z	$5 + j0$ $5 \angle 0^\circ$	$0 - j26.5258$ $26.5258 \angle -90^\circ$		Ohms

This being a parallel circuit now, we know that voltage is shared equally by all components, so we can place the figure for total voltage (10 volts $\angle 0^\circ$) in all the columns:

	R	C	Total	
E	10 + j0 10 $\angle 0^\circ$	10 + j0 10 $\angle 0^\circ$	10 + j0 10 $\angle 0^\circ$	Volts
I				Amps
Z	5 + j0 5 $\angle 0^\circ$	0 - j26.5258 26.5258 $\angle -90^\circ$		Ohms

Rule of parallel circuits:
 $E_{\text{total}} = E_R = E_C$

Now we can apply Ohm's Law ($I=E/Z$) vertically to two columns in the table, calculating current through the resistor and current through the capacitor:

	R	C	Total	
E	10 + j0 10 $\angle 0^\circ$	10 + j0 10 $\angle 0^\circ$	10 + j0 10 $\angle 0^\circ$	Volts
I	2 + j0 2 $\angle 0^\circ$	0 + j376.99m 376.99m $\angle 90^\circ$		Amps
Z	5 + j0 5 $\angle 0^\circ$	0 - j26.5258 26.5258 $\angle -90^\circ$		Ohms

\uparrow
Ohm's Law
 $I = \frac{E}{Z}$

\uparrow
Ohm's Law
 $I = \frac{E}{Z}$

Just as with DC circuits, branch currents in a parallel AC circuit add up to form the total current (Kirchhoff's Current Law again):

	R	C	Total	
E	10 + j0 10 ∠ 0°	10 + j0 10 ∠ 0°	10 + j0 10 ∠ 0°	Volts
I	2 + j0 2 ∠ 0°	0 + j376.99m 376.99m ∠ 90°	2 + j376.99m 2.0352 ∠ 10.675°	Amps
Z	5 + j0 5 ∠ 0°	0 - j26.5258 26.5258 ∠ -90°		Ohms

Rule of parallel circuits:

$$I_{\text{total}} = I_R + I_C$$

Finally, total impedance can be calculated by using Ohm's Law ($Z=E/I$) vertically in the "Total" column. As we saw in the AC inductance chapter, parallel impedance can also be calculated by using a reciprocal formula identical to that used in calculating parallel resistances. It is noteworthy to mention that this parallel impedance rule holds true regardless of the kind of impedances placed in parallel. In other words, it doesn't matter if we're calculating a circuit composed of parallel resistors, parallel inductors, parallel capacitors, or some combination thereof: in the form of impedances (Z), all the terms are common and can be applied uniformly to the same formula. Once again, the parallel impedance formula looks like this:

$$Z_{\text{parallel}} = \frac{1}{\frac{1}{Z_1} + \frac{1}{Z_2} + \dots + \frac{1}{Z_n}}$$

The only drawback to using this equation is the significant amount of work required to work it out, especially without the assistance of a calculator capable of manipulating complex quantities. Regardless of how we calculate total impedance for our parallel circuit (either Ohm's Law or the reciprocal formula), we will arrive at the same figure:

	R	C	Total	
E	10 + j0 10 ∠ 0°	10 + j0 10 ∠ 0°	10 + j0 10 ∠ 0°	Volts
I	2 + j0 2 ∠ 0°	0 + j376.99m 376.99m ∠ 90°	2 + j376.99m 2.0352 ∠ 10.675°	Amps
Z	5 + j0 5 ∠ 0°	0 - j26.5258 26.5258 ∠ -90°	4.8284 - j910.14m 4.9135 ∠ -10.675°	Ohms

↑

Ohm's Law or *Rule of parallel circuits:*

$$Z = \frac{E}{I}$$

$$Z_{\text{total}} = \frac{1}{\frac{1}{Z_R} + \frac{1}{Z_C}}$$