

RLC Circuit Maximum Voltage Drops.

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Consider the RLC circuit shown in Figure 1. We seek the *maximum* voltage difference or *drop* across each circuit element using the least amount of calculation. This is easy if we remember how voltage drops are calculated for DC circuits with just resistors. We also need to know the impedances of the individual circuit elements. Finally, we need to know how impedances add in series and in parallel. Again, these rules are all easy.

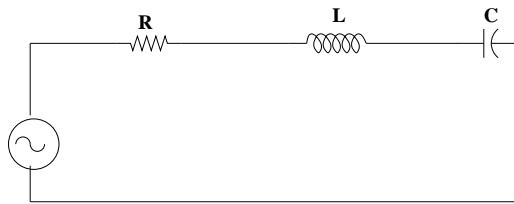


Figure 1: Series *RLC* circuit.

Circuit element	Impedance Z
R	R
C	$1/j\omega C$
L	$j\omega L$

For impedances in **series**, regardless of their “flavor,” add them like pure resistors in series: $Z = Z_1 + Z_2 + Z_3 + \dots$. This is also called “adding them like dollar bills.”

For impedances in **parallel**, regardless of their “flavor,” add them like pure resistors in parallel: $1/Z = 1/Z_1 + 1/Z_2 + 1/Z_3 + \dots$. That is, you add the

reciprocals of the individual impedances like dollar bills and then invert your final answer to find Z .

So far, so easy. To get the maximum voltage drop across an individual circuit element, first find the total impedance of the circuit Z_T . This is often a complex number and most certainly is for the circuit above. Find the magnitude $|Z_T|$ of Z_T . For example, if $L = 0$, then $|Z_T| = (R^2 + (1/\omega C)^2)^{1/2}$. Next, to find the maximum voltage drop across a circuit element, divide the magnitude of that circuit element's impedance by $|Z_T|$, and then finally multiply that ratio by the maximum voltage produced by your source and applied to you circuit. For our case with $L = 0$,

$$V_C^{max} = \frac{(1/\omega C)}{[R^2 + (1/\omega C)^2]^{1/2}} V_0,$$

where $V = V_0 \sin(\omega t)$ is the time varying voltage impressed on our circuit by, say, our signal generator, and $\omega = 2\pi f$, with f the frequency (measured in Hz) of the impressed voltage.