

Re: Lumped element model limitation

Source: <http://sci.tech-archive.net/Archive/sci.electronics.basics/2004-09/1148.html>

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Date: 09/26/04

Date: Sun, 26 Sep 2004 05:20:24 GMT

"tsp" <tspjor@yahoo.com> wrote in message
news:8efbd3ef.0409232206.79cc2e2e@posting.google.com...
> *Can somebody tell me why the lumped element model breaks down when*
> *actual circuit impedances are very low, or when the length of the wire*
> *approaches the wavelength of the circuit's operating frequency?*

Lumped model circuit theory is a quasi-static approximation of field theory.

It works well when distances are considerably less than a quarter wavelength. However, where it is valid –it is a lot easier than going to more complex approaches. Below is a <list>(?) in order of complexity

Consider a 1 ft length of wire:

DC and low frequency–lumped model is a resistor.

Higher frequency– Inductance effects are measurable –lumped model OK

higher yet– both L and C lumped model works

Higher– Transmission line models as R, L and C must be considered

distributed– otherwise errors crop up

(example 100mile length of unloaded power transmission line will have about a 5% higher voltage at the receiving end than at the sending end–lumped model doesn't show this). However a lumped T or pi model can be used for a specific line and is correct at the ends but not in the middle(10V at each end of a 1/4 wavelength line and the mid–line voltage will be about 14V).

Higher yet and it is necessary to consider the line as a wave guide.

Beyond that –now you are not using lines– you are using antennae and radiating .

As for the lumped model not being valid for low impedances– not true. The breakdown may be that the model is not including all the factors which can be ignored at higher impedance levels. For example–at $Z=R=0.01$ ohms an ignored contact or meter resistance of 0.1 ohms can make measurements meaningless. If $R=100$ ohms, the effect is negligible.

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remove the urine to answer