Re: AC sine wave: What does increasing the frequency do?

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From: John Fields (*jfields_at_austininstruments.com*)
Date: 11/27/04

Date: Sat, 27 Nov 2004 12:48:37 −0600

On Fri, 26 Nov 2004 18:02:46 −0800, John Larkin
<jjlarkin@highlandSNIPtechTHISnologyPLEASE.com> wrote:

>On Fri, 26 Nov 2004 19:42:05 −0600, John Fields
><jfields@austininstruments.com> wrote:
>
>>On Fri, 26 Nov 2004 17:23:14 −0800, John Larkin
>><jjlarkin@highlandSNIPtechTHISnologyPLEASE.com> wrote:

>>>Which brings up the concept that an incandescent lamp appears to have
>>>a capacitive component of impedance, which is itself a function of
>>>frequency.
>>
>>−−−
>>It may seem that it does if you're referring to the inrush current,
>>but put a resistor in series with the lamp and the voltage and current
>>will be in phase across and through them both, I believe, since all
>>that changes is the resistance of the lamp filament.
>
>
>The filament has a substantial 120 Hz temperature cycle (you can hear
>it with a photocell) and the tungsten has a positive TC. So the
>resistance varies with time. The thermal lag results in the filament
>resistance peaking later than the voltage peak. So the current leads
>the voltage, which looks like a capacitive component.

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Since there's no energy storage in the form of anything other than the
incidental capacitance and inductance of the filament, I don't see how
that can happen. That is, whether the resistance is parametric or
not, it's still just resistance and the current which will be forced
through the filament will remain in phase with the voltage forcing it
through.
Seems to me it would be akin to a simple resistive divider where one
of the resistors is variable, like this:

```
          E1
          |
        [RV1]
          |
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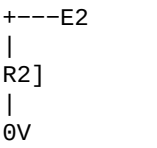
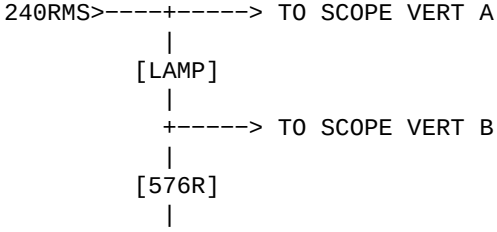


Since there's no reactive term in there, then the total impedance of the string is simply the resistance, R1+R2, and E2 will always be equal to

$$E2 = \frac{E1R2}{RV1+R2}$$

for any instantaneous value of E1 and RV1 and any value of R2.
To check, I did this:



The lamp was a 120V 25W incandescent, the resistor was 576 ohms worth of wirewounds in a Clarostat power decade resistor box, and the scope was an HP 54602B. I found a phase shift of about +/− 1.1° max which, since it varied randomly about zero seemed to me like it might be quantization noise.
But, there was the inductance of the decade box to consider, so in order to rule it out I measured it and it came out to about 6mH, which comes out to an Xl of 2.2 ohms at 60Hz, so the angle due to the reactance of the box comes out to 0.109° which, being an order of magnitude smaller than what the scope measured, puts it way down in the noise.
−−−
>There are also harmonics in the current, for the same reasons. GR once
>made a line−voltage regulator that used a motorized variac; the
>voltage sensor was an incandescent bulb, and they sensed the second
>harmonic current (somehow) to servo on.
−−−
Since I don't have a schematic in front of me... ;)
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John Fields