Re-visiting average and effective (rms) values of voltage, current and power.

Definitions:

For a purely resistive circuit, average power dissipated by a sinusoid is: P = ½(VM.IM) where VM = peak voltage and IM is peak current.

For a purely reactive circuit it is: 0!

Given a load ZL, being supplied by a source with impedance ZTH, maximum average power will be transferred when: ZL = ZTH* where ZTH* is the complex conjugate of ZL.

If the load is purely resistive then maximum average power will be transferred when: RL = sqrt(RTH^2 + XTH^2).

Average and effective values:

Average power absorbed by a resistive load is dependent on the type of source supplying the power.

If the source is DC then average power absorbed is: I^2R
If the source is sinusoidal then average power absorbed is: 1/2 (IM^2)

These are common waveforms. However most waveforms we encounter will not be so neatly presented. To compare the effectiveness of different sources delivering power to a resistive load an effective value has to be found for comparison.

Define the effective value of a periodic waveform as:

As a constant, or DC value which delivers the same average power to a resistor.

The average power delivered will be: P = $Ieff^2$*R. Ieff is also called Irms.

Ieff = sqrt(1/T(Integral of i^2(t)dt). The range of integration is from some arbitrary t0 to t0+T.
Here T is the time period.

The average power absorbed by a resistor from a periodic waveform is :
P=I^2rmsR=V^2rms/R
Note: For example: Normal 120V AC outlets have an rms value of 120V, an average value of 0V, and a maximum value of 120*1.41.

Example:

Find the rms current for a square wave with amplitude varying from -8A to +8A amps with a period of 4usec.

Do the integration:

$\{1/4e\text{-}6(\ \ 64.dt + \ \ 64.dt.)\}^{1/2}$

The range of integration for the first integral is from 0 to 4usec and the second is from 2usec to 4usec.

This gives: 8A

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