Power - Real And Apparent
A Tutorial On Basic Power Measurements

Oscilloscopes measure current and voltage and through the magic of mathematics calculate power. Unfortunately, power comes in a large number of guises: instantaneous, real, apparent, and reactive. This plethora of power terms often leads to confusion. This application brief is intended to help clarify the confusion about the measurement of power.

Oscilloscopes, whether analog or digital, are voltage responding instruments. Current is measured using a suitable transducer, usually a current probe or resistive shunt. The oscilloscope display is the instantaneous function of voltage or current vs. time. The product of these quantities is instantaneous power. A basic power measurement using sinusoidal sources is shown in figure 1.

The product of the instantaneous voltage and current is the instantaneous power shown if trace A of figure 1. Note that the power waveform consists of a waveform at twice the frequency of the current or voltage and a DC offset. This DC offset represents the average power being delivered to the load.   The average power, represented by the symbol P, is measured in units of Watts. In figure 1 the average power is determined using the
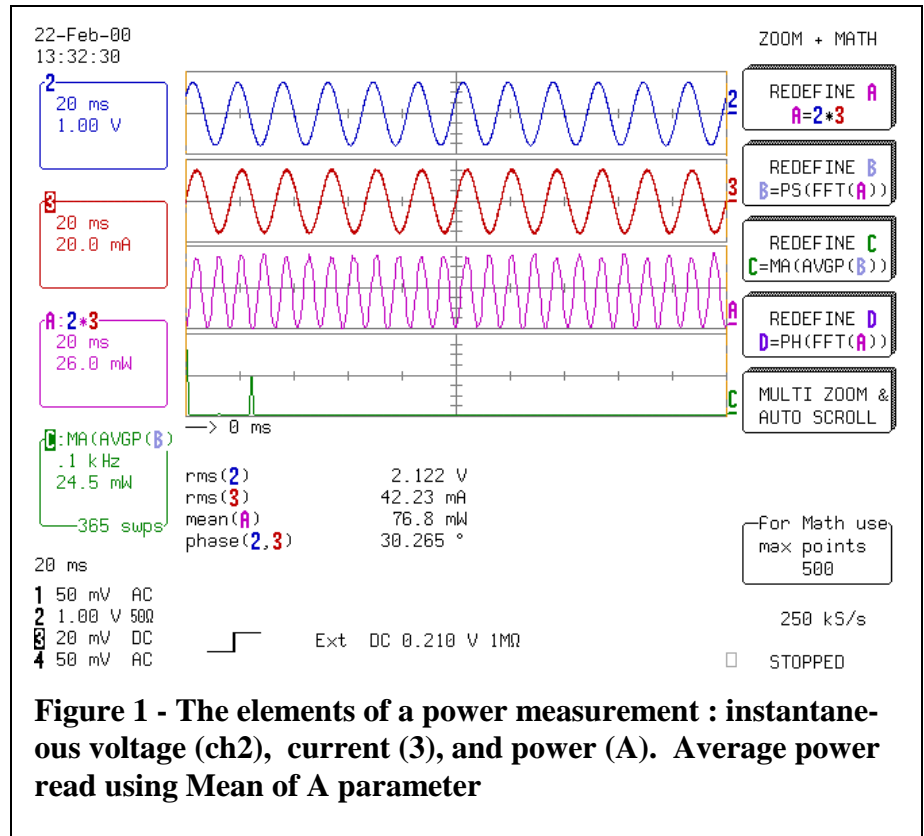

Figure 1 - The elements of a power measurement : instantaneous voltage (ch2), current (3), and power (A). Average power read using Mean of A parameter

mean parameter to extract the average value of the power waveform (76.8 mW in the example).

The product of the effective (rms) current and effective voltage is called the apparent power. Apparent power is represented by the symbol S and is measured in units of Volt-Amps (VA). In our example above the apparent power is:

S =2.122 * 0.04223 = 0.896 VA.

For resistive loads the apparent and average power are equal.

The ratio of average to apparent power is the power factor. In the sinusoidal case the power factor is equal to the cosine of the phase angle between the current and voltage waveforms.

The third part of electrical power is reactive power, represented by the symbol N and measured in units of Volt-Amps reactive or VAR. The reactive power represents the difference between the average and apparent power:

$$S^2 = P^2 + N^2$$