Power - Real And Apparent

A Tutorial On Basic Line 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. The Power Measure Analysis (PMA2) software package simplifies these measurements and eliminates the necessity of setting up the proper math operations.

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 quan-

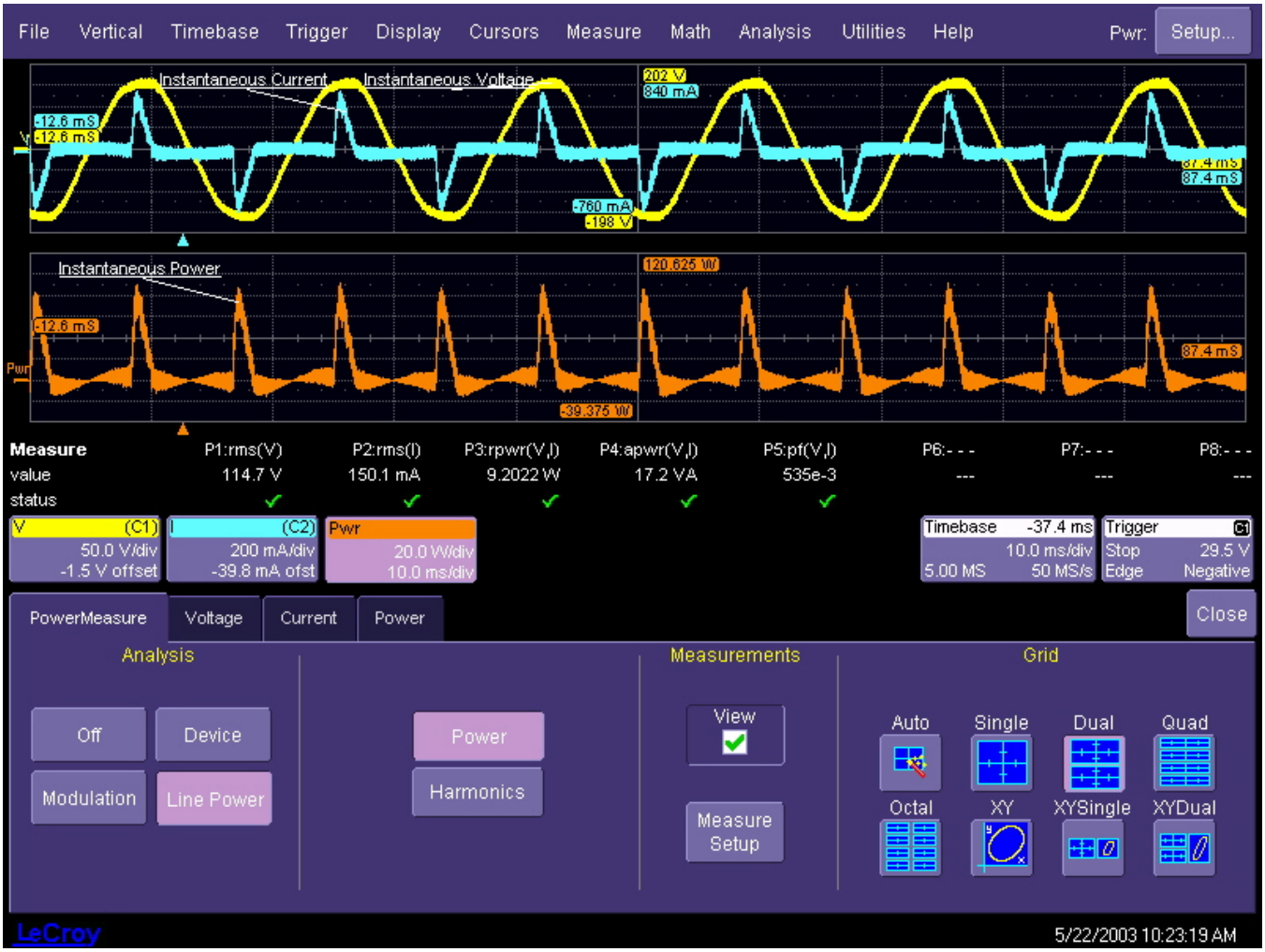

Figure 1 The elements of a power measurement (instantaneous voltage, current, and power) show on a WavePro 7300 using PMA2. Real and apparent power are automatically computed using parameters.

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tities is instantaneous power.

A basic line power measurement is shown in Figure 1. The product of the instantaneous voltage and current is the instantaneous power shown in the lower trace. 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 or real power, represented by the symbol P, is measured in units of Watts. In Figure 1 the real power is determined automatically by determining the mean or average value of the instantaneous power waveform. Real power is displayed as the parameter rpwr and has the value 9.2 W in this example.

The product of the effective (rms) current and effective (rms) 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 =114.7 * 0.1501= 17.2 VA

Apparent power is automatically computed and displayed as the parameter apwr. 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. It is more generally computed as the ratio of real to apparent power. In our example the power factor is also computed automatically and displayed using the parameter pf(V,I). The value of the power factor is 0.535.

The reactive power, N, can be derived from the real and apparent power, using the following equation:

$$N = (S^2 - P^2)^{1/2}$$

The units of reactive power are Volt Amperes Reactive or VAR. Most users have an interest in real power and power factor, so reactive power is not calculated automatically.

The PMA2 software is useful in analyzing line power. It simplifies the determination of real power, apparent power, and power factor by eliminating the need to set up math traces and parameter math. It is even more convenient to use than dedicated line power analyzers. The scope is already on your bench and the answers are only a button push away.