Measuring linear and nonlinear (distorted) AC waveforms with CurrentWatch

Introduction

Variable frequency drives (VFDs) improve control and conserve energy by regulating motor speed. The most common types are PWM (pulse width modulation) and Six Step. Both technologies are based on high-speed switching, which distorts the AC sine wave and can make accurate current sensing difficult.

Measuring current

The two principal methods used to measure linear and non-linear waveforms are "Average Responding" and "True RMS." Understanding these two methods can help specify the right current sensor for the application.

Most current sensors have "Average Responding" output values, meaning that they work on the assumption that the measured current is a pure sine wave (linear). Their circuitry rectifies and filters the current waveform to obtain an "average" signal. Using the peak value divided by the square root of two, this "average" signal is scaled and converted to 4–20 mA or 0–5 Vdc. This method provides fast response at a moderate cost, but only works on linear waveforms.

However, VFD outputs are simulated sine waves (nonlinear) with peaks significantly greater than the true current. The relative sizes of these peaks change as the output frequency changes. An "Average Responding" sensor that is calibrated for sinusoidal (linear) waveforms can accurately measure the VFD output at 20 Hz, but be 20 percent high at 30 Hz and 10 percent low at 40 Hz.

The True RMS solution

The best way to accurately measure non-sinusoidal (nonlinear) waveforms is to use the root-mean-square (RMS) algorithm. A True RMS measurement is obtained by first squaring the signal, then averaging the squared signal, and finally taking the square root of that average (right side of **Figure 1**).

The result is the true power (heating value) of the waveform. This allows very different waveforms to be compared to each other and to the equivalent DC (heating) value.

A True RMS sensor can be indicated by the product description. If the product is described as "True RMS on sinusoidal waveforms," the sensor is "average responding" with a clever but misleading description. A True RMS sensor will be described as "True RMS on all waveforms" and will "accurately" measure current from waveforms found with the use of VFDs or SCRs and on linear loads in "noisy" power environments.

For nonlinear load applications, choose the CurrentWatch™ EACR or EPRMR Series, as both have the capability to sense True RMS.

Other applications for True RMS

True RMS sensors can be used in any application where a device distorts the current waveform—not just VFD applications. Another common use for True RMS sensors involves applications with dimmer circuits, frequently used to control lighting. As the dimmer is adjusted, the waveform changes shape and becomes non-sinusoidal. An "Average Responding" sensor, always assuming a sinusoidal waveform, can report inaccurate current measurements.

Understanding the difference between "Average Responding" and True RMS sensing technologies will help in choosing the right current sensor for the application.

For application assistance or for help with technical issues regarding current sensors or other types of sensors in Eaton's portfolio, contact an Eaton sensor application engineer at (800) 426-9184, option 2.

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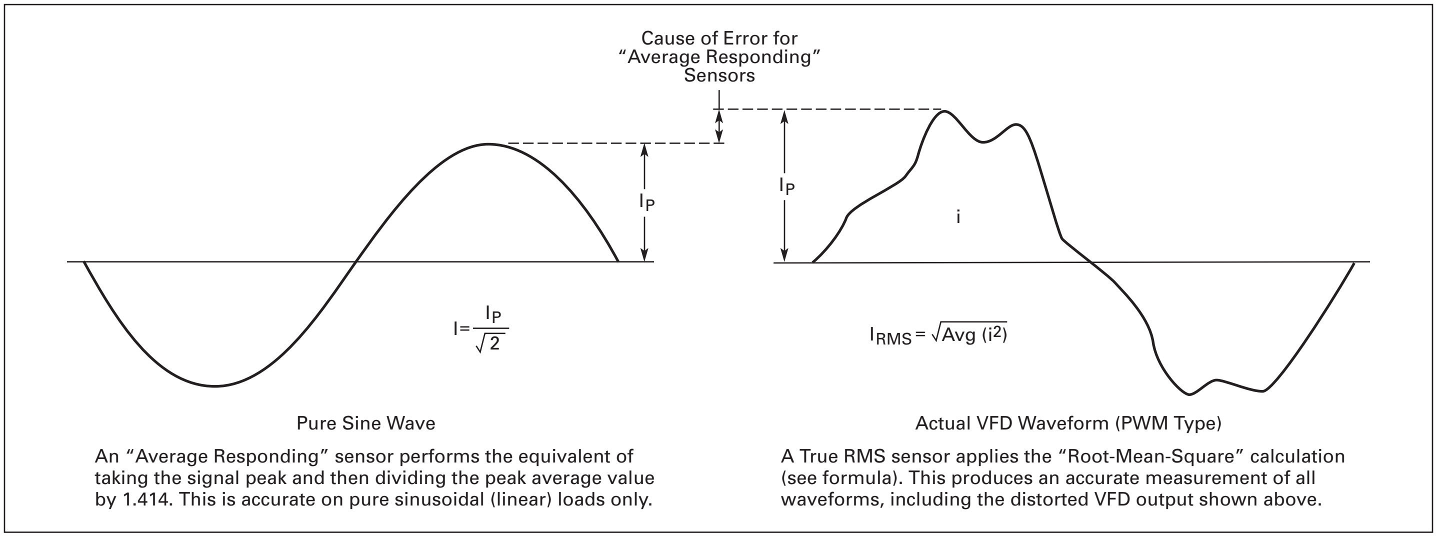

Figure 1. Measuring Waveforms of Equal Power (Heating) Value

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