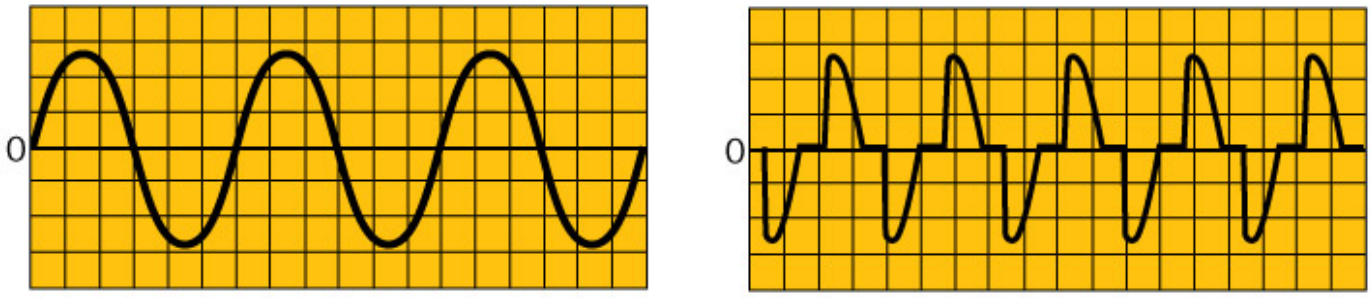

Left: Sinusoidal (sine) alternating current waves. Right: nonsinusoidal waves.

What is true-rms?

A **true-rms** device (rms = root mean square) is one of three tools that can measure alternating current (ac) or ac voltage:

1. True-rms digital multimeters (or clamp meter)
2. Average-responding digital multimeter (or clamp meter)
3. Oscilloscope

Only the first two are commonly used, and both can accurately measure standard (pure ac) sinusoidal waveforms.

Yet a true-rms meter is widely preferred because only it can accurately measure both sinusoidal *and* nonsinusoidal ac waveforms. See illustrations at the top of the page.

- **Sinusoidal (sine) waves**: Pure, without distortion, with symmetrical transitions between peaks and valleys.
- **Nonsinusoidal waves:** Waves with distorted, irregular patterns—spikes, pulse trains, squares, triangles, sawtooths and any other ragged or angular waves.

As mentioned previously, **rms = root mean square.** Though its formula can be challenging to grasp, rms essentially **calculates the equivalent direct current (dc) value of an ac waveform**. More technically, it determines the “effective,” or dc heating value, of any ac wave shape.

An **average-responding meter** uses averaging mathematical formulas to accurately measure pure sinusoidal waves. It *can* measure nonsinusoidal waves, but with uncertain accuracy.

A more sophisticated **true-rms meter** can accurately measure both pure waves and the more complex nonsinusoidal waves. Waveforms can be distorted by nonlinear loads such as variable speed drives or computers. An averaging meter attempting to measure distorted waves can be up to 40% low or 10% high in its calculations.

Multimeter type	Response to sine wave	Response to square wave	Response to single phase diode rectifier	Response to 3 ∅ diode rectifier
Average responding	Correct	10 % high	40 % low	5 % to 30 % low
True-rms	Correct	Correct	Correct	Correct

The need for true-rms meters has grown as the possibility of nonsinusoidal waves in circuits has greatly increased in recent years. Some examples:

- Variable-speed motor drives
- Electronic ballasts
- Computers
- HVAC
- Solid-state environments

In these environments, current occurs in short pulses rather than the smooth sine wave drawn by a standard induction motor. The current wave shape can have a dramatic effect on a current clamp reading.

In addition, a true-rms meter is the better choice for taking measurements on power lines where ac characteristics are unknown.

Reference: Digital Multimeter Principles by Glen A. Mazur, American Technical Publishers.