

Can you trust your meter reading ?

Why True RMS?

Measuring current accurately is a difficult job in today's industrial plants and offices. More and more personal computers, adjustable speed drives and other types of equipment that draw current in short pulses rather than at a steady level come on line every day. Equipment like this can cause the readings of conventional average-responding meters to be at least inaccurate. If you have ever experienced blown fuses without any clear cause, then maybe your meter is to blame.

Average-responding
When people talk about values of AC currents, they normally mean the effective heating or RMS (Root Mean Square) value of the current. This value is equivalent to a DC current with the

However, if the waveform is not a perfect sinewave, this relationship no longer applies. This is why average responding meters often give incorrect readings when measuring currents in today's power systems.

Linear and non-linear loads

Linear loads - consisting purely of resistors, coils and capacitors - always draw a sinewave current, so there is no measurement problem (see fig.1). But non-linear loads like adjustable frequency drives and office equipment power supplies, draw distorted current waveforms (see fig 2). Measuring the RMS value of these distorted currents with an average-responding meter could give you readings which are up to 50% too low (see fig. 3), leaving you wondering why your 14A fuse blows continuously while the current according to your meter is only 10A.

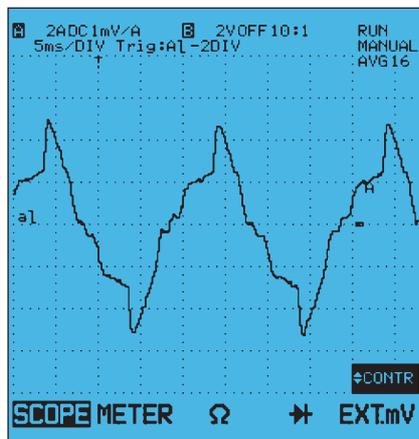
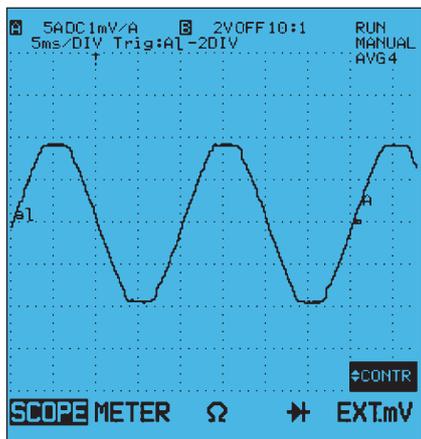


Fig 1. Current waveform of a linear load.

Fig 2. Current waveform of a non-linear load.

Type Of Meter	Measuring Circuit	Response To Sine Wave	Response To Square Wave	Response To Distorted Wave
Average-responding	Multiplies rectified average by 1.1	Correct	10% high	Up to 50% low
True-rms-responding	RMS-calculating converter calculates heating value	Correct	Correct	Correct

Fig 3. Comparing the Performance of Average-Responding and True-rms Responding Meters.

same heating value as the AC current which is being measured. The most common way to measure this RMS value with a meter is to rectify the AC current, determine the average value of this rectified signal and then multiply the result by a factor 1.1. This factor represents the constant relationship between the average and RMS values of a perfect sinewave.

True RMS

To measure such distorted current waveforms, you could first check the waveform with a waveform capturing device, and only use an average responding meter if the waveform is a perfect sine-wave. Or alternatively you could take no chances by always using a true RMS meter. A modern true RMS meter uses an electronic measurement technique to provide you with the real effective value of an AC current, no matter if the waveform of the current is a perfect sinewave or a distorted waveform.

Crest factor

One of the specifications that you should take into account when choos-

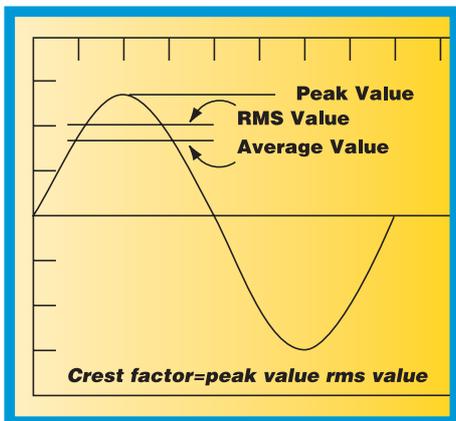


Fig.4. Meters that use the average responding method of measuring ac measure the average value of the rectified signal and then multiply that by a factor to give "rms".

ing a true RMS meter is the Crest factor. This tells you how badly the waveform is distorted, and can be calculated by dividing the peak value of the current by the effective true RMS value (see fig. 4). For a perfect sine-wave the Crest factor is 1.414, and the more the signal is distorted, the higher the factor gets because of the ever-sharper peaks, as shown by fig. 5. This means that a true RMS meter with a maximum Crest factor of 1.5 will still give you incorrect readings on distorted waveforms, and is only capable of measuring close-to-perfect sinewaves. Normally, a Crest factor of up to 3 is more than adequate for most power distribution measurements.

Bandwidth

Another important specification that is closely related to the Crest factor is the bandwidth of the meter. The bandwidth refers to the range of frequencies of the current within which the meter is capable of making accurate measurements. You might think that you only need to measure the 50 Hz frequency of the power system, but if you were to examine a distorted waveform with a frequency analyzer you would see that it is actually built up of the fundamental sinewave of 50 Hz plus several other smaller

sinewaves with frequencies which are multiples of the 50 Hz fundamental. For example, the waveform of the PC current in fig. 4 also contains 150 Hz, 250 Hz and 350 Hz components. Measuring this distorted signal with a true RMS meter with a bandwidth of only 50 Hz would result in the same wrong reading as an average-responding meter, because the meter is not capable of measuring the signals with higher frequencies. A meter with a bandwidth of at least 1 kHz is normally adequate for accurate measurement of distorted waveforms in most commercial and industrial power systems.

Safety

If you are working on a power system, all meters should be capable of taking at least the maximum expected voltage of 600V at the input. However, for your own safety you want to be sure there are no problems if an unexpected high voltage occurs due to a transient or other problem. If you choose a meter rated to EN-61010-1 Category III, you can be sure that you will be able to make safe measurements on the power system under all circumstances.

Fluke, as a leader in all kinds of compact electronic test tools, offers a wide

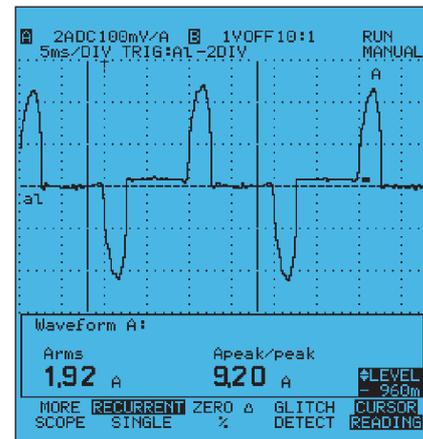


Fig 6. Current waveform of a PC.

range of true RMS instruments, including both clamp meters and multimeters for general-purpose use. All these instruments meet the most stringent safety standards, offering a high degree of protection both to the user and to the meter itself.

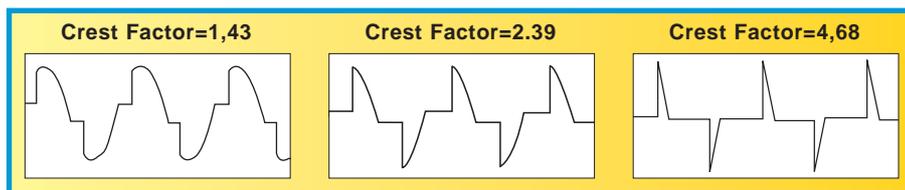


Fig 5. Crest Factors of different current waveforms.