AVERAGE, PEAK, AND RMS VALUES

What is meant by the various ways of specifying ac potentials and currents.

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WHEN dealing with dc potentials, there is no ambiguity about what *kind* of voltage is meant. A dc volt is a dc volt. When it comes to ac voltage, however, the picture is very different and often confusing. For example, a potential specified as 100 volts ac has little or no meaning unless it is followed by an identifier like "peak," "rms," "average," or "effective," each of which has a different meaning from the others.

To illustrate what we mean, consider your common 117-volt ac power-line potential. This figure specifies the rms voltage of the power line. The peak potential is actually 164.66 volts, which is 39.8% greater than the rms potential. The average potential, at 11% lower than the rms potential, is 104.52 volts.

The peak voltage is the maximum potential of the entire waveform. This volt-

and capacitor are simply reversed.)

The average voltage is important for two different reasons. First, it is easy to find with simple circuits. Second, it is reliably close to the rms voltage with sine waves. The basic circuit for finding the average ac voltage is illustrated in Fig. 2.

In this case the output is a series of half-waves of the same polarity. (Again, to change the output voltage polarity, simply reverse the diodes.) A meter placed between the output point and ground provides the reading and is usually calibrated with a scale that is compressed just the right amount to give a relatively accurate rms reading with sine-wave signals. This is the type of circuit used in most ac voltmeters ranging from inexpensive portable to expensive laboratory instruments.

put in terms of rms with sine waves. What about nonsinusoidal waveforms? If we take a 117-volt sine wave and allow only one alternation in 10 to come through, the peak potential is still 164.66 volts. Since only a half wave out of every 10 cycles comes through, our average potential would be divided by 10 (104.52/10 = 10.452 volts).

If we allow only one alternation in 10 cycles to come through for a 117-volt ac rms waveform, we cannot simply divide by 10 to find the new rms potential. First, we must square 117, which yields 13,689. Then, we find the average by dividing 13,689 by 10, yielding 1368.9. Finally, we must find the square root of 1368.9, which results in 37 volts rms. This last figure is a long way from the average reading of this one-in-10 waveform, even when the average scale is
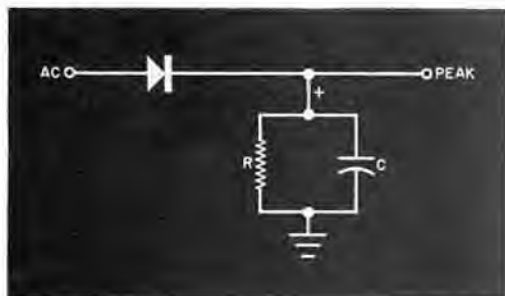

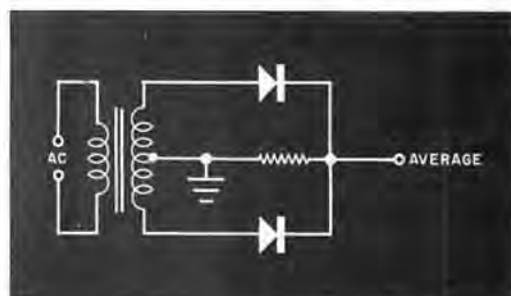Fig. 1. Simple RC and diode circuit is used to find peak potential.

age is extremely important for designing the insulation of high-voltage ac circuits. An 11,500-volt (rms) line, for example, has a peak potential of 11,500 + 4577 = 16,077 volts. That difference of more than 4500 volts must be considered when specifying components.

The peak potential is easy to find with the circuit shown in Fig. 1.

The capacitor charges up to the peak voltage during the first positive alternation of the ac input. The charge then slowly drains off through the resistor until the next positive alternation comes along. (For a negative output, the diode

Fig. 2. Series of half waves is measured to find average value.

At this point, you are probably wondering where rms voltage comes into the picture. Well, the purpose of the rms measurement is to specify the dc voltage that has the same power capacity as the ac voltage it represents. "Rms" stands for "root mean squared," which is shorthand for saying that to find the rms voltage, you must square the ac waveform, find the average of the squared waveform, and find the square root of that average. About the only simple way of showing an rms detector system is as in Fig. 3.

The average-law circuit gives an out-

compressed to indicate in make-believe rms. Using the compressed scale, the indicated reading would be almost 70% low!

As you can see from the foregoing, when dealing with pure sinusoidal waveforms, you can use a peak-, average-, or rms-indicating circuit to convert from one type of ac voltage to another without introducing errors. But when you are dealing with nonsinusoidal waveforms, watch out. All your readings might be so grossly inaccurate as to be useless for anything other than to indicate the presence or absence of a potential. ◊
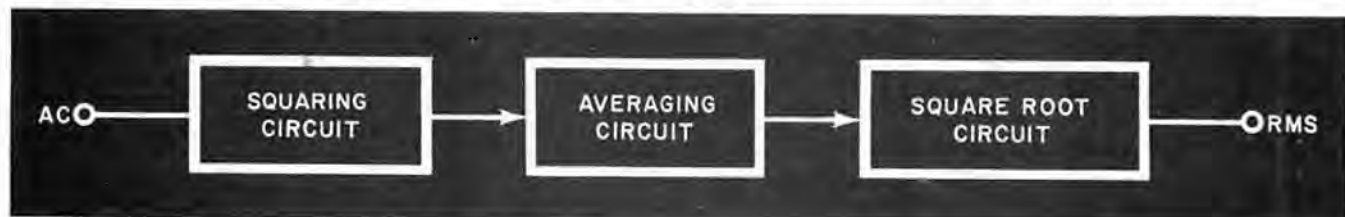

Fig. 3. Simple block diagram of an rms detector circuit.