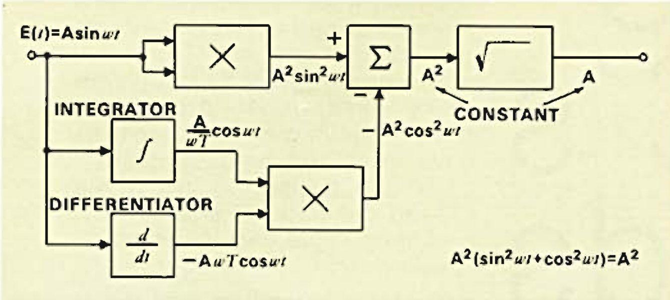
Amplitudes Without Delay

MEASURING SINE-WAVE AMPLITUDES WITHOUT FILTERING



Here is an ideal† (that actually works) for making use of trigonometric identities to compute the amplitude of a sinusoid without the usual rectifying and filtering. The advantage is, in concept, that the peak value is computed directly, without one's having to wait for a rectifier-filter to settle down.

What makes it practical, these days, is the availability of low-cost operational amplifiers (such as AD741C) and MDSSR's* (such as AD530–see pages 8 and 16).

For the experimenter who is interested in assembling this system, here are a few practical suggestions:

1. It will work best for a single-frequency input. As frequency varies, the dynamic range depends on the square of the ratio of maximum to minimum frequency.
2. The input amplitude should be scaled to ±10V for the largest signal, to make fullest use of the available dynamic range. For variable frequency, the amplitude should be scaled down by the square-root of the ratio of maximum to minimum frequency.
3. The integrator and the differentiator should be scaled to the input frequency. For variable frequency, they should be scaled to the geometric mean between the highest and lowest frequencies of interest.
4. Both integrator and differentiator should become "non-ideal" at low and high frequencies respectively. The scheme is shown in Figure 1.
5. The assumptions that lead to the indicated results are valid only for clean sine waves. Note that if the amplitude varies rapidly, especially at a frequency comparable to (or approaching) the signal frequency, the sidebands will introduce a ripple component.

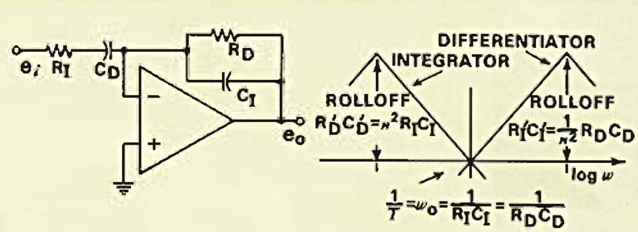


Figure 1. "Nonideal" Integrator/Differentiator circuit. For integrator, use R_IC_I, with $R_D'C_D'$ for rolloff; For differentiator, use R_DC_D, with $R_I'C_I'$ for rolloff; For n=100, magnitude error is negligible, phase error is 1.15° at ω_0.

†Contributed by Douglas Jolley, McDonnell Douglas Aircraft Company

Worth Reading

"On the Differential Operational Amplifier, a Device that Simulates Almost Anything." From "The Amateur Scientist," *Scientific American,* January, 1971. Here is a practical and introductory treatment of the operational amplifier from the standpoint of the amateur experimenter. The reader is shown how to construct a breadboard/instrument into which an op amp will be plugged, then introduced to basic circuits (inverter, follower, subtractor, current-to-voltage converter). Then, for more practical uses, he is introduced to amplifier, constant-current circuit, constant-temperature circuit, tuning fork circuit, low-frequency oscillator, and power amplifier. Mainly for the amateur, but it can help broaden the outlook of the occasional or routine user.

Applications of dc Constant Current Source, Hewlett-Packard Application Note No. 128. Here is an excellent discussion of the applications of current sources to resistance measurement, semiconductor device measurements, component testing, cryogenics and electrochemicals. A general section discusses desirable characteristics and approximations. This booklet should be of especial interest to op amp users, because of the ready applicability of the op amp–at very low cost–to current generation, and voltage-to-current transconduction, and hence to the banquet of testing suggestions outlined in the Note.

"Extraction of Square Roots . . . A Useful Analog Instrumentation Technique" by Tom Cate, *Electronic Instrument Digest,* January, 1971, page 7. Since square rooting is a ready application of MDSSR's* (AD530, Model 426, etc.), such applications as linearizing square-law signals, two-component vector computation, and rms computing may be of especial interest. The article is interesting when it talks about applications, but it bogs down in the particularities of design of a special purpose module.

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*MDSSR: Multiplier-Divider-Squarer-Square Rooter