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SINE-WAVE INPUT (A) COMPARED WITH DISTORTED OUTPUT (B)

FIGURE 1

as a measurable filter-output voltage. This voltage then may be construed to indicate that the tested device has distorted the originally pure test signal. (4) This distortion voltage is measured, and the harmonic distortion percentage determined from the ratio of harmonic voltage to the total fundamental and harmonic voltage. For this purpose, the two voltages might be measured before and after the filter. The measurement is made with an oscilloscope or a.c. vacuum-tube voltmeter. Several test frequencies through the audio spectrum are employed. This system is the basis of all commercial harmonic distortion meters which indicate total distortion.

Several difficulties confront the technician in the actual practical application of this method. First, and very important, a pure sine-wave test-signal source is an absolute requirement. An oscillator or audio signal generator meeting this specification seldom is found outside of the advanced laboratory and is an exceedingly expensive instrument. Indeed, many high-priced audio oscillators are not completely satisfactory for the purpose. Attempts to correct for the inherent distortion of the average oscillator often give rise to a number of inaccuracies, because of involved mathematical relationships. Furthermore, the distortion tests are complicated and delayed when corrections must be made. The second important difficulty concerns the filters. Ideally, a distortion filter must attenuate the fundamental frequency completely, while transmitting all of the harmonics with no distortion. The farther you fall from this goal, the greater will be the error due to residual fundamental or attenuated harmonic voltages. A filter having sufficiently sharp cutoff and low enough attenuation of the harmonic frequencies to permit distortion measurements lower than a few percent must be designed, and this filter must be constructed with expensive high-Q components. The third difficulty has to do with the indicating instrument. For best results, this should be a full-wave, high-gain, a.c. vacuum-tube voltmeter, not a common type.

Aside from harmonic distortion checking, the measurement of intermodulation distortion has received...
considerable attention during recent years. This is a measurement of the interaction between signals of two different frequencies passing simultaneously through an amplifier or other nonlinear device. The majority of distortion tests are favored in many quarters because tests of this type are more closely with actual listening tests. In one system of intermodulation testing (the one credited to the Society of Motion Picture and Television Engineers, SMPTE), a low-frequency high-frequency signal are applied simultaneously to a tested device. If the latter has none of the nonlinearities which give rise to distortions and dissonances in the output, the two signals will be delivered with no interaction between the two.

The required high- and low-pass filters must have sharp results obtained.

tion method and in interpreting the filter and its amplitude measured with reference level by means of a gain control.

The peak amplitude of the distortion components measured by the oscilloscope should be recorded as E(8). Determine the distortion percentage (D) by means of the formula: \[ D(\%) = \frac{100 \times E_s}{E_0} \]

The setup shown in Figure 3 illustrates the basic essentials of any circuit for checking distortion by the phase-shift method. Many variations are possible, and the reader may introduce obvious refinements which might appeal to him. An entire distortion meter might be constructed, for example, with a self-contained power supply and built-in v. t. voltmeter or miniature oscilloscope. It is possible also to build the distortion meter into the same case with an audio oscillator, so that patch connections can be made only from the oscillator output to the amplifier and from the amplifier output back to the instrument.

We believe that the phase-shift method of distortion checking does a creditable job in a reasonably foolproof manner and recommended this method, or some variation of it, to the serious audio experimenter unable to afford expensive fidelity testing equipment. Components, such as a high-quality transformer, should be checked, as well as amplifiers.