

Measuring and Analyzing Intermodulation

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The oscillographic method is developed to give quantitative results, based upon the experimentally found relation between total notch depth and IM percentage.

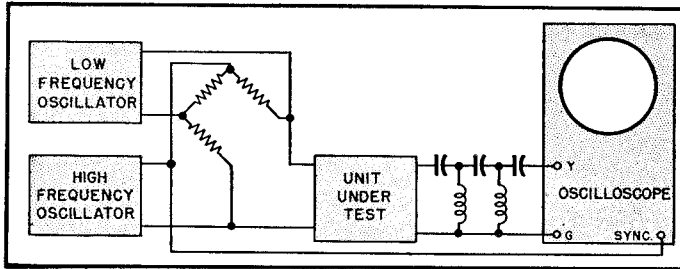


Fig. 1. Typical intermodulation analysis circuit.

THE INTERMODULATION MEASURING DEVICE to be discussed is a quantitative development of an oscillographic method hitherto considered only qualitative in nature. In the course of the research, gross inaccuracy was found in the traditionally accepted 4:1 relationship between intermodulation and harmonic distortion.

Intermodulation meters built according to Hilliard's design¹ have had provision for connecting an oscilloscope into the circuit, but the first published study of oscilloscope images in distortion measurement may be credited to McProud.²

Harmonic vs. Intermodulation Distortion—A Review

In typical audio applications, distortion measurement must yield a number which bears some relation to the offensiveness of the sound to the ear—for audio equipment is usually made to be listened to.

By this test, the harmonic method of measuring distortion may be unsatisfactory. It fails to indicate the bad effect of polishing a disc master, while the intermodulation method succeeds. The writer has found that poor tracking (of a phonograph pickup stylus in its groove) may produce hardly any effect on harmonic distortion, while the inter-

modulation and the aural effect rise greatly.

The harmonic method may be satisfactory if we measure the relative amplitude of the individual harmonics, then

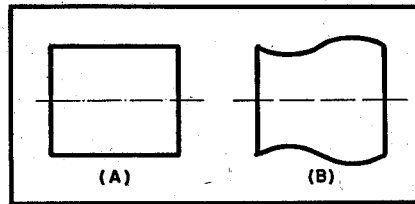


Fig. 2. Envelope of oscilloscope images without intermodulation (A), and with intermodulation (B).

multiply each by a weighting factor. This requires a wave analyzer, whose use is tedious and time consuming; and little has been published on the weighting factors which would equate the order of a harmonic and its offensiveness to the ear. An early step was the 1937 RMA proposal³ according to which

³ Radio Manufacturers Association: Specification for testing and expressing overall performance of radio broadcast receivers—Part 2—Acoustic tests;—p. 5; Dec. 1937 revision.

the amplitude of the n th harmonic would be multiplied by $n/2$, which leaves the second harmonic unchanged. A more recent proposal was made by Shorter,⁴ who proposed a weighting in which the amplitude of the n th harmonic would be multiplied by $n^2/4$, and in which harmonics weaker than .03 per cent would be neglected.

A fundamental problem of the harmonic method is that of achieving a pure waveform at the input to the equipment under test, for the harmonic measuring device cannot distinguish between an imperfection of the source waveform and one produced by the unit being tested. At any one frequency, pure waveform can be achieved by an inexpensive filter, but when testing over a wide frequency range the pure waveform source becomes more expensive than the distortion meter itself.

The intermodulation method presents no such waveform problem, for the waveform of ordinary laboratory oscillators

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⁴D. E. L. Shorter: The Influence of High Order Products in Non Linear Distortion. *Electronic Engineering*, vol. 22, no. 266, pp. 152-153, April 1950.

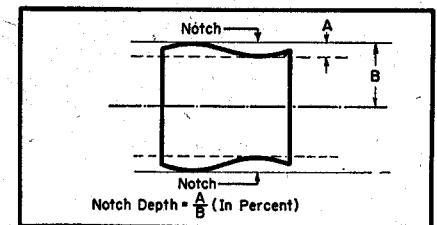


Fig. 3. Definition of notch depth.

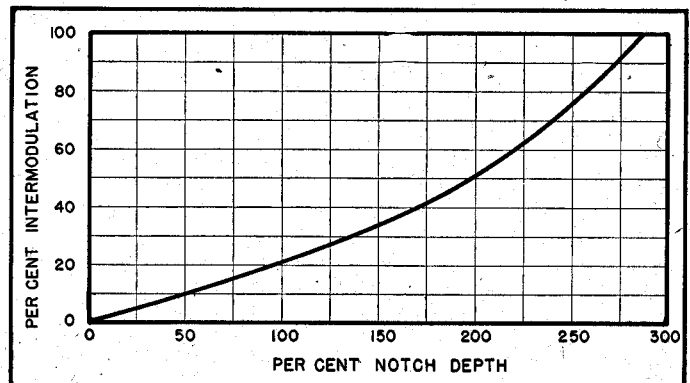


Fig. 4. Relation between notch depth and per cent intermodulation.

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¹ John K. Hilliard: Distortion tests by the intermodulation method. *Proc. I.R.E.*, vol. 29, no. 12, pp. 614-620, Dec. 1941.

² C. G. McProud: Simplified intermodulation measurement. *AUDIO ENGINEERING*, vol. 31, no. 3, pp. 21-23, May 1947.

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