Hi-Fi Amplifier Terms and Definitions

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The standards that have been promulgated by the Institute of High Fidelity for use by audio amplifier manufacturers are an important and definite guide to evaluating such equipment prior to purchase.

THE most significant transition in the design and merchandising of amplifiers for home music reproduction since the advent of stereophonic sound has at last been completed. Transistorized stereo amplifiers (more often esoterically described as "solid-state" amplifiers to dissociate them categorically from pocket radios) have all but totally supplanted their vacuum-tube predecessors.

As with all major technical revolutions, the pendulum had somewhat overshot its mark initially and is now swinging back to a more realistic approach to amplifier design. Attempts at over-miniaturization of high-powered amplifiers led to disastrous field failures for some early, hastily conceived products. Today, a measure of conservatism in design has been restored, resulting in amplifier configurations which are not significantly smaller in physical size than their tube counterparts. Attendant advantages in this seeming design retrogression have been far more reliable, trouble-free, totally stable amplifiers well worth their market price.

Almost as if to complement the new-found stability of amplifier design, the Institute of High Fidelity (IHF) has recently revised its antiquated 1958 standard on measurement of audio amplifiers. The new standard (IHF-A-201, issued in 1966) includes tests and methods of evaluation which are sufficiently sophisticated to render highly meaningful ratings and specifications for the new breed of solid-state amplifiers.

For stereophonic (dual-channel) amplifiers, the minimum specifications that must be published by a conforming manufacturer include (1) dynamic and continuous output at mid-frequency, (2) power bandwidth, (3) sensitivity, and (4) hum and noise.

Other specifications covering the familiar frequency response and less familiar criteria such as input impedance, damping factor, tracking error, separation, and crosstalk may, at the option of the conforming manufacturer, be stated in published specifications for a more complete technical description of any given stereo amplifier. *(An article discussing damping factor appears elsewhere in this issue.—Editors)* Since the four items tabulated above are deemed to be of prime importance by the Institute, an understanding of at least these basic specifications would be essential for the prospective purchaser of a stereo amplifier.

Continuous and Dynamic Output

Confusion regarding the "true" power rating of an amplifier may, at last, become a problem of the past. For one thing, the meaningless mathematical exercise known as "peak power" is absent from the new standard. Instead, two different but related means of specifying power output of an amplifier have now gained universal acceptance on the part of high-fidelity component manufacturers. Continuous output refers to the maximum amount of single-tone (sine-wave) power which may be fed to a loudspeaker for a referenced amount of distortion at 1000 Hz. Since the referenced distortion figure is still left to the discretion of the manufacturer, care must be taken by the interpreter of the rating to note just what this distortion figure is. For example, an amplifier having a published continuous power rating of 30 watts for a referenced distortion of 2% may or may not be as "powerful" as another amplifier claiming only 25 watts of continuous power at a referenced distortion of 0.5%. In general, however, most reputable manufacturers will not use a referenced distortion level higher than 2% in arriving at the power rating for an amplifier.

Recognizing that the home music enthusiast seldom listens to sine waves, the Institute now requires that a dynamic power rating be listed for all amplifiers. This rating takes cognizance of the fact that amplifier power is generally limited by the ability of the power-supply circuitry to provide constant voltage to the output section of the amplifier when high-current demands are made upon it. Particularly in the case of solid-state amplifiers, the current drawn from the power supply may vary from next to nothing during quiet passages of music to several amperes during musical crescendos. The theory underlying the "dynamic" power rating involves the fact that such crescendos (at least in music) are relatively brief—too fast to adversely affect the amplifier's power-supply voltage. Thus, a somewhat higher power rating will be derived if short, transient pulses are applied to the amplifier instead of a continuous tone. There is no fixed relationship between the two types of power ratings. Theoretically, if an amplifier were to be built having a power supply of such great capacity as to be unaffected by changes in current requirements from "soft" to "loud," the dynamic power rating would be equal to and identical with the continuous power rating. Conversely, a poorly regulated power supply which "falls apart" when high-current demands are made upon it may well result in continuous power to dynamic power ratios of 2:1 or even more.

Power Bandwidth

The price of an amplifier varies almost directly with its ability to produce not only adequate power at mid-frequencies but also sufficient power at the low end of the spectrum (bass tones) as well as at the high end (treble tones). In fact, musical structure is often constituted so that the really high power requirements involve the reproduction of low tones rather than mid-frequencies. Accordingly, the power-bandwidth specification provides a method whereby the prospective buyer can judge power capability at *all* significant frequencies. Power bandwidth is defined as the lowest and highest frequencies at which an amplifier can produce one-half its referenced output at its referenced distortion. As an example, if two amplifiers have power ratings of 20 watts but the first of these has a power bandwidth from 20 to 20,000 Hz and the second amplifier has a power bandwidth from 30 to 15,000 Hz, the first of these amplifiers is superior in this respect.

Sensitivity

The sensitivity of an amplifier (*Continued on page 30*)

is merely a means of indicating how much input signal will be required for full power output to be achieved. In terms of the user facing the problem of "matching" a tuner or tape- or record-playing equipment to a given amplifier, this specification takes on increasing importance. As an illustration, suppose a given amplifier requires 1 volt of signal (with volume control fully turned up) to produce rated power output. If an FM tuner were to be connected to this amplifier and if the tuner's maximum voltage output were only 0.5 volt, the amplifier could, at best, be driven to only *one-fourth* its potential power-output capabilities. Under such circumstances, one might just as well have bought an amplifier having a far lower power rating, since full power will never be utilized because of improper matching of the tuner to its power amplifier.

Hum and Noise

All electronic devices powered from an a.c. source (usually having a frequency of 60 Hz) will reproduce a small amount of unwanted hum (at 60 Hz, and often at multiples of this frequency as well). In addition, both tubes and transistors used in amplifying circuitry generate a small amount of random noise at all audible frequencies. These extraneous sounds detract from program enjoyment if they represent a significant percentage of the total sound output of a system. Means of stating hum and noise (as a number of decibels below rated output) have now been standardized by the Institute so as to give a meaningful indication of the audible significance of such undesired sounds. As before, the greater the number of decibels stated in connection with the signal-to-noise and hum rating, the better the amplifier in this regard.

Total Harmonic Distortion

The rich harmonies of music and the characteristic tonal quality of musical instruments are largely the result of the presence of harmonics. Hi-fi amplifiers, on the other hand, are not musical instruments and should not insert their own tone color into the sound being handled. The job of the audio equipment is to reproduce, as exactly as possible, the original quality of the sound. This task is far from simple since only absolutely perfect equipment is entirely free from all types of distortion which alter the nature of the sound signal.

Harmonic distortion occurs when the audio system being used alters the shape of the input signal the same way that it would be altered if harmonics of the input frequency were deliberately added at the input.

The distortion factor is the ratio between the total r.m.s. value of all the harmonics to the total r.m.s. value of the fundamental plus all harmonics. When this factor is expressed as a percentage, it becomes a measure of the total harmonic distortion (THD). The numerical value attached to THD usually does not specify which harmonic (or harmonics) is producing the THD.

It is common to make THD measurements throughout the entire range of the audio system under test. Such measurements impose a severe test of the system because it is far more difficult to handle the very low and very high frequencies with a minimum of distortion than it is to handle the mid-frequencies.

It is also common to make the THD measurements over a wide range of output powers, up to the full rated output. In general, as the output power is increased, so is the amount of distortion. Usually the increase is smooth and gradual up to the overload point where there is a sudden jump in distortion. Amplifiers should be rated at a power just below this overload point, while the THD is still a low figure. In the case of preamplifiers, measurement is frequently made with certain prescribed input and output voltages.

As a quality figure, then, the less the amount of THD specified (the lowest percentage figure) the better.

IM Distortion

When two different frequencies are applied to a perfectly linear device (one whose output varies directly in accordance with the input), the output of the device will contain only these two frequencies. However, if there is any non-linearity within the system, then one of the input signals will be affected (modulated) by the other. When this modulation takes place, additional frequencies will be generated. These additional frequencies are not necessarily harmonically related to either of the original frequencies. What is more, harmonics of the original two frequencies can combine with each other to produce still other frequencies. Since none of these frequencies was originally introduced into the amplifier, but exists at the output of the amplifier, then the amplifier has introduced distortion. This is called intermodulation distortion or IM.

The amount of this IM distortion is the r.m.s. sum of all the internally generated signals, expressed as a percentage of the modulated signal. Usually, the two frequencies used are 60 Hz and 7 kHz, having a relative amplitude ratio of 4:1, respectively.

In general, when an amplifier has low IM, it also has low THD, and conversely, when the IM is high, the THD is also high. However, it must be remembered that these two methods of measuring distortion are quite different, so it is logical to expect that the percentage figure for IM and THD will not be the same.

As in THD measurements, the lower the IM specified (the lowest percentage figure), the better the system.

Secondary Specifications

Many other completely defined specifications appear in the new IHF amplifier standard, and the reader having sufficient technical interest to acquaint himself with the entire standard can procure a copy of "IHF Standard Methods of Measurement for Audio Amplifiers" (IHF-A-201, price $2.00) by purchasing it directly from the Institute of High Fidelity, Inc., 516 Fifth Avenue, New York, New York 10036.

Even the non-technical music lover intent upon assembling a quality stereo music system can take comfort in the fact that an increasing measure of uniformity of published specifications has finally come to the high-fidelity component industry after nearly two decades of arbitrary and confused specification writing. Certainly, all the published specifications cannot replace the prospective buyer's aural acuity in auditioning amplifiers. Intent, patient listening tests will always be the first step in the selection of an amplifier. Also, as has already been implied, an amplifier must not be chosen out of context with the remainder of the proposed system. Sources of programs to be used in conjunction with the amplifier must be regarded in terms of their compatibility. Loudspeaker system selection, as well as room size and acoustics, still weigh heavily in determining power requirements for amplifiers. Bear in mind that ratios of as much as 10:1 in loudspeaker efficiency of the commercially available speaker systems reflect equally wide power requirements for companion amplifiers.

Fortunately, during the past couple of years, better performance loudspeaker systems have become available at a much lower cost, with the result that the mediocrities and poor performers are being driven from the market. Besides improved performance, most modern loudspeakers are designed to complement the decor of almost any home.

Careful reading of standardized specifications, however, coupled with intelligent auditioning and attention to the other details listed in this article, will result in a rewarding experience in home musical enjoyment and many years of trouble-free performance, thanks to the new generation of amplifiers. ▲