Understanding Loudspeaker Power Handling
a n d
Selecting the Proper Power Amplifier

EAW
EASTERN ACOUSTIC WORKS

Obtaining maximum performance from a loudspeaker system requires, among other things, selecting a power amplifier with proper output characteristics. The amplifier must be capable of driving the loudspeaker system to maximum acoustic output without damaging the drivers.

This Application Note will explain some of the concepts associated with loudspeaker power handling including definitions of commonly used specifications and how these relate to amplifier selection.

BACKGROUND AND COMMONLY USED TERMS
To understand loudspeaker power handling, one must first understand how loudspeaker drivers typically fail. The two most common failure modes are *thermal* and *excursion*.

Thermal failure occurs when the heating capacity of the electrical signal is beyond the capability of the loudspeaker voice coil. The result is overheating and burning of the voice coil.

Excursion failure occurs when the loudspeaker cone or diaphragm is forced to physically move beyond its limits. The result is physical destruction of the loudspeaker cone, diaphragm and/or surround. This usually occurs when the electrical signal contains more low frequency content than the loudspeaker was intended to handle.

Three terms that relate to the energy content of a signal are *RMS*, *Peak* and *Crest Factor*. These terms are defined as follows:

RMS, or root-mean-square, is a measure of the average power level of a signal. The RMS level is representative of the heating capacity of the signal.

Peak is a measure of the maximum level that a signal attains. For a sine wave, the peak level is 3 dB above the RMS level (see diagram below). For music, the peak level can easily be in the range of 10 to 15 dB above the RMS level. Peak level is important in assessing the excursion capability of a loudspeaker.
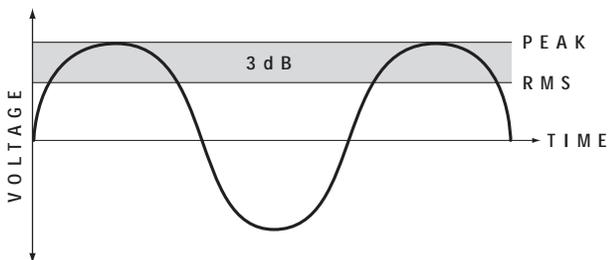
Crest Factor is generally used to describe the ratio of the peak level to the RMS level for a pink-noise signal. For a Crest Factor of 6 dB, the peak voltage is twice the RMS voltage.

THE AES POWER HANDLING SPECIFICATION
AES2-1984 (ANSI S4.26-1984) describes a method for testing the power handling capacity of a loudspeaker driver. Some of the key conditions for the test are as follows (paraphrased):

High Frequency Loudspeaker Mounting: The driver is mounted on a device which reasonably simulates the acoustical loading of a horn.

Low Frequency Loudspeaker Mounting: The driver is mounted in free air, oriented so that the motion of the driver is in the horizontal plane.

Test Signal: The loudspeaker is energized with pink noise, having a crest factor of 6 dB. The pink noise is restricted to one octave, starting at the low frequency limit of the device under test.

Power Calculation: The RMS voltage at the loudspeaker is measured. The power is then calculated based on the RMS voltage and the minimum impedance of the driver ($P = V^2_{RMS}/Z_{MIN}$).

Duration of Test: The loudspeaker is subjected to successively higher power levels, with time allowed for the loudspeaker to stabilize at each increment. The recommended stabilization time is 2 hours.

Rated Power: The loudspeaker is rated for the power that it can withstand for 2 hours without permanent change in acoustical, mechanical or electrical characteristics greater than 10%.

EAW'S POWER HANDLING TEST
EAW has devised a power handling test procedure based on the AES standard described above, but with a number of important differences:

Loudspeaker Mounting: Loudspeaker drivers are mounted in the exact horn/enclosure under consideration. The acoustic loading on the drivers is therefore identical to the users' conditions.

Test Signal: Rather than restricting the test signal to one octave, EAW uses pink noise subjected to the EIA-426 weighting curve. This produces a full-range test signal with frequency content closely resembling that of music. The pink noise crest factor is 6 dB. Naturally, the test signal is

subjected to the appropriate high-pass, low pass or band pass filters to restrict the noise spectrum to the operating range of the device under test.

Power Calculation: RMS voltage is measured at the loudspeaker. However, the power calculation is based on the average impedance over the important range of the loudspeaker (not the minimum impedance). This produces a more conservative indication of the actual power delivered to the loudspeaker ($P=V^2_{RMS}/Z_{NOMINAL}$).

Duration of Test: The loudspeaker is "broken in" for approximately 30 minutes at a low power level prior to the progressive power rating process. The loudspeaker is then subjected to successively higher power levels with time allowed for the loudspeaker to stabilize at each increment with 30 minutes between increments for cooling. Power is increased in approximately 20 watt increments. The loudspeaker driver(s) along with all passive components (such as crossovers, etc.) are tested for signs of fatigue or failure between each power increment. This "power cycling" is intended to simulate real world applications, where loudspeaker components may repeatedly heat up and cool down during use, rather than operate at constant thermal/electrical conditions.

Rated Power: The loudspeaker is rated for 40 to 60 watts less than the final power level that caused destruction of the loudspeaker driver or related (crossover) components.

AMPLIFIER SELECTION

The power handling listed for a given EAW loudspeaker system is a good indicator of the size of the amplifier which will safely drive the loudspeaker system to full output under most conditions. Users should select an amplifier with a "20 Hz - 20 kHz" power output rating which matches the EAW-specified power handling capacity of the loudspeaker under consideration.

Selecting a smaller amplifier might seem to provide an additional measure of safety against loudspeaker failure. However, an under-powered loudspeaker can actually fail sooner than a properly powered loudspeaker with the same electrical input signal. This happens as follows:

Amplifier Clipping: When a typical power amplifier exceeds its maximum voltage output capability, it "clips" the peaks off of the electrical signal. Under severe clipping, the shape of a sine wave approaches that of a square wave (see diagram in next column).

Increased Heating: Once clipping begins, the RMS level of the sine wave rises and can actually reach its peak level. This is accompanied by a corresponding rise in heating capacity which can cause thermal failure of the loudspeaker driver at a lower signal level than expected. Clipping also results in additional high frequencies sent to the loudspeaker. It is therefore extremely important to select amplifiers that are large enough to avoid clipping of the output signal.

LOUDSPEAKER MAXIMUM OUTPUT

Each EAW Technical Specifications sheet contains a section called "Calculated Maximum Output (dB SPL @ 1m)". This is the acoustic output (at 1 meter) expected from the loudspeaker system based on the measured power handling and sensitivity. Note that the "Peak" rating is always 6 dB higher than the "Long Term" rating. This reflects the 6 dB pink noise crest factor from the power handling test described above.
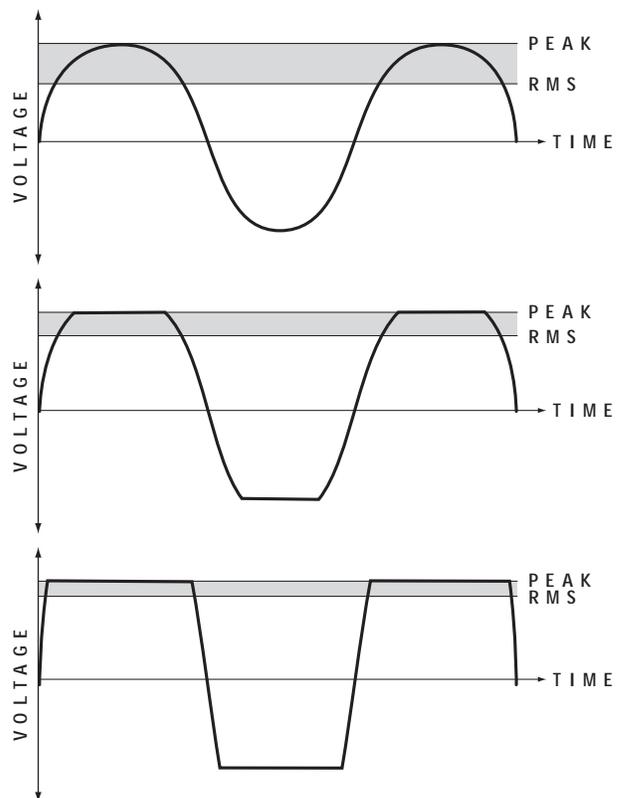
SUMMARY

EAW has devised a power handling testing regimen which accurately simulates "real world" uses. We believe that this testing process is more rigorous than the AES standard, and results in a rating which more accurately reflects the power handling capability of the various loudspeakers and loudspeaker systems.

More technical details can be found in AES2-1984: AES RECOMMENDED PRACTICE, SPECIFICATION OF LOUDSPEAKER COMPONENTS USED IN PROFESSIONAL AUDIO AND SOUND REINFORCEMENT.

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