HOW MUCH AMPLIFIER POWER DO I NEED?

There is no exact answer to the question of how much amplifier power you should use for a particular loudspeaker. Actually, there are three separate and very distinct issues regarding selecting amplifier power for loudspeakers.

1. LOUDSPEAKER POWER HANDLING RATING

The power handling rating in EAW's specifications means that the loudspeaker has passed our standard power handling test. In this test the loudspeaker is “exercised” to a point of damage or failure. The power rating resulting from this test is intended to be used as a point of comparison with the power ratings of other loudspeakers. This rating does not necessarily correspond to the best amplifier size to use nor is it a measure of the "safe" amplifier size to use under actual operating conditions.

Discussion:

EAW’s power handling test primarily determines the limit of a loudspeaker’s thermal power handling. This limit is the point where a sustained input signal (measured as an RMS voltage) causes permanent damage to or failure of the loudspeaker due to heating. During this test, the loudspeaker is also subjected to peak input levels of up to 6 dB above the RMS level of the input signal. To a certain point, these peak levels test the loudspeaker’s peak handling capability.

The pink noise signal used for full-range loudspeaker testing is shaped to a standard EIA (Electronics Industry Association) frequency response. This response shape emulates the average frequency response of typical musical programs.

Nonetheless, this shaped pink noise signal cannot be considered representative of all real audio signals nor how a loudspeaker will react to those signals. Generally, it is a more stressful signal for a loudspeaker to reproduce than typical music or speech signals in terms of thermal limits. However, some audio signals, such as rock and dance music and even some classical music, can have content that is more stressful than the shaped pink noise signal.

Because there are no universally accepted standards, most professional loudspeaker manufacturers use different test methods to arrive at a power handling specification. In spite of this, these different tests can yield surprisingly close numbers. The ratings are known variously as the thermal, continuous, RMS, average, AES, EIA, or sustained power handling. Differences in power ratings are often simply a result of differences in testing methods or test equipment, rather than actual differences in the loudspeaker capabilities. Thus, loudspeakers within a factor of about ±1.5 of each other in power handling can usually be considered of equal capability. A factor of ±1.5 is equal to about a ±1.5 dB difference in output. For example, a loudspeaker rated for 600 watts and a similar one rated for 900 watts are likely to be equally capable in terms of power handling for real audio signals.

Note that “music”, “program”, “peak”, or similar power ratings are usually two or more times the thermal (or RMS, continuous, etc.) power rating. However, these ratings are rarely the result of actual measurements. Usually, these ratings can only be considered as an indication that the loudspeaker can handle peak inputs that are higher than the maximum rated thermal power limit.

2. SELECTING AN APPROPRIATE AMPLIFIER SIZE

The amplifier for your loudspeaker should be sized according to both the sound levels required and the type of audio signals that will be reproduced. If you are unsure of how to determine these things, consult a qualified professional or contact EAW's Application Support Group.

Discussion:

Do not confuse the specified power rating with the maximum sound level that can be achieved. This is a function of BOTH the amplifier actually used and the sensitivity of the loudspeaker. Thus, a loudspeaker used with a 100 watt amplifier with a sensitivity of 97 dB (1 watt @ 1 meter) will achieve the same maximum output as loudspeaker used with a 200 watt amplifier with a sensitivity of 94 dB (1 watt @ 1 meter).

Loudspeaker drivers, particularly compression drivers, can usually withstand momentary power peaks well in excess of those they are subjected to in EAW’s power handling testing. Some very dynamic audio signals have high momentary peak levels such as from percussion instruments. Some audio signals, such as speech, have large moment-to-moment variations in levels. To fully exploit the peak capabilities of the loudspeaker and to avoid amplifier clipping, an amplifier larger than the power rating may be needed to reproduce the peak levels in the audio signal.

For audio signals with low dynamics, such as heavy metal rock or highly compressed music, an amplifier with a rating at or below the power handling specification might be needed to avoid overstressing the loudspeaker’s thermal capabilities.

On the other hand, a loudspeaker rated at 500W continuous (or RMS, continuous, etc.) might be used to reproduce background music at low levels. In this case, perhaps only a 25 watt amplifier would be needed to reach the desired acoustic level.

Thus, the power amplifier size actually required for a given application may be considerably more or considerably less than the amplifier wattage specified as the power handling.

As a rule of thumb, where the full capability of the loudspeaker is needed to achieve appropriate acoustic output levels, EAW recommends an amplifier that is twice the loudspeaker's power handling specification. This assumes that its operation can be properly controlled (See Section 3). This allows the amplifier to reproduce peaks 6 dB above the specified power handling. This is consistent with both the test signal and the amplifier output capabilities used for EAW's power handling test. However, this recommendation does NOT guarantee trouble-free operation. That is the next issue discussed.

3. PREVENTING LOUDSPEAKER DAMAGE

Preventing damage to or failure of a loudspeaker is not a function of amplifier size nor the loudspeaker's power rating. Preventing damage is a function of operating an audio system so that a loudspeaker is not stressed beyond its limits. If an audio system is operated improperly, damage to or failure of a loudspeaker can occur even with an amplifier sized well below the loudspeaker's power rating. Contrarily, if an audio system is operated properly, damage to or failure of a loudspeaker can be avoided even with an amplifier sized well in excess of the loudspeaker's continuous (or RMS, average, etc.) power rating.

Discussion:

Proper audio system operation includes being aware of the types of audio signals being reproduced, controlling output levels accordingly, and operating all electronic equipment so that no electronic clipping occurs within the signal chain.

Examples of improper operation include:

1. Sustained microphone feedback
2. Applying equalizer boosts at frequencies beyond the operational range of the loudspeaker.
3. Applying excessive equalizer boosts within the operational range of the loudspeaker.
4. Allowing electronic clipping anywhere in the electronic chain including the mixing console, signal processing equipment, or the power amplifiers.
5. Allowing loudspeakers to be "pushed" to a point of obvious distortion.
6. Reproducing sustained tones, like synthesizer notes, at full amplifier output.

Each of the foregoing examples can easily result in damage to or failure of a loudspeaker regardless of the loudspeaker's power rating or the size of the amplifier used. ***It is the responsibility of the audio system operator to ensure that all equipment in the system is operated within its capabilities. That is the only way to ensure that loudspeakers do not get stressed beyond their limits to the point of damage or failure.***

APPENDIX: ABOUT LOUDSPEAKER "POWER"

Power tests done by EAW and, for that matter, most professional loudspeaker manufacturers, are not really power tests but voltage tests. The quantity invariably measured for such tests is the RMS or average voltage of the input signal. Power is calculated from this number using the traditional formula:

Power = voltage squared / nominal impedance

However, the result calculated from this rarely has a basis in reality because of the following reasons:

1. The nominal impedance is rarely equal to the actual impedance of the loudspeaker. In fact, a typical loudspeaker's impedance usually varies considerably over its frequency range.
2. The loudspeaker is usually a reactive load. This means it behaves, depending on the frequency, as both an inductor and capacitor. Voltage and current are not in "sync" in reactive loads, so the actual power cannot be calculated without knowing what the phase angle is between the voltage and current. This must be included this in the power equation so it becomes:

   power = (voltage squared x cosine phase angle) / impedance

Unless this formula is used to calculate the power for each frequency within the operating range, the total power calculated will not be correct. Usually only one out of the four terms in the above equation is measured, and that is the voltage. If only one term is known, you cannot solve this equation.

The bottom line is that for a given power specification at a given "nominal" impedance, the voltage is the same whether you are looking at a loudspeaker or amplifier specification. For example: for 200 watts at 8 ohms, the test voltage would be 40 volts RMS whether this refers to an amplifier or loudspeaker.

In effect the power ratings we use in audio are merely surrogate numbers for what is actually measured – voltage. However, power ratings are perfectly fine to use as a matter of accepted convention and convenience for purposes of comparing different amplifiers and different loudspeakers. Just keep in mind that, scientifically, they do not represent the actual power into a loudspeaker.