

Speaker Power Requirements

Answers To Some Often Asked Questions

1. What do terms like "peak," "instantaneous power," "music power," and "program power" mean?

Basically, these terms describe, in one way or another, the time-varying nature of music and the electrical power required to reproduce it. A 150-watt light bulb presents a constant 150-watt load to an electrical power source when it is on. By contrast, a 150-watt audio amplifier will only *rarely* be called upon to deliver its full output to a loudspeaker. Figure 1 illustrates the time-varying nature of music and the power which may be required to reproduce it.

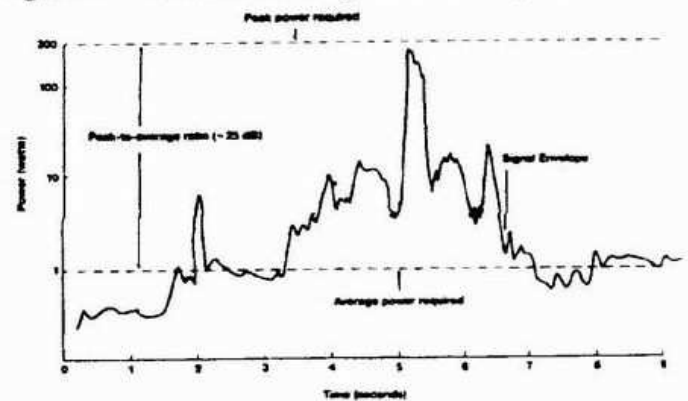
In the illustration, the term *peak power* is clearly defined as the maximum power required over the time interval shown. Average power represents the overall average power requirement for the time interval in question.

There are two points to be noted here: both peak and average power requirements are very dependent on the nature of the program signal, and the peak-to-average ratio can vary considerably from one kind of program to another.

Strictly speaking, the term *instantaneous power* refers to any very short-term power requirement, and normally it is associated with the maximum power which the program signal may require. Such terms as *music power* and *program power* are not rigorously defined, but may be thought of essentially as variations of average power.

In the figure, the program envelope is plotted against time along the horizontal axis for a typical loudspeaker system rated for use with a 300-watt amplifier. Note that most of the time the power requirements are quite low; only occasional momentary peaks will require full system output. The ratio in decibels calculated from the two dashed lines is known as the peak factor of the signal. In this case, the ratio is about 25 dB, and that would be typical for classical music. For rock music, we would expect to see signal peak factors in the range of 8 to 10 dB.

Figure 1. Peak and Average Power Requirements



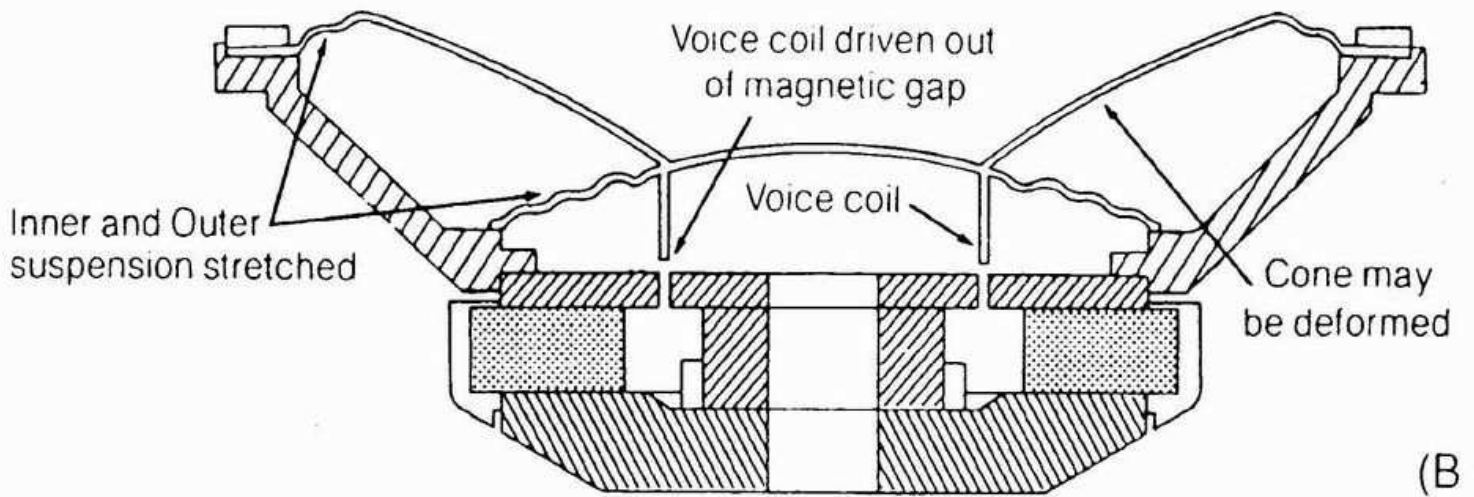
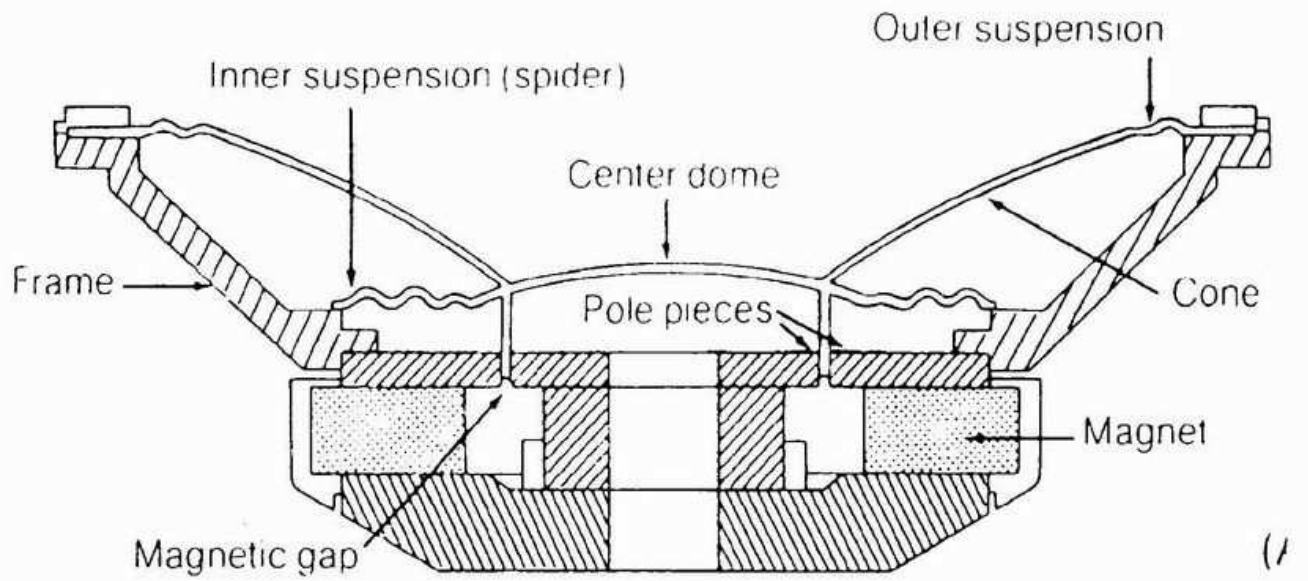
All loudspeakers are capable of sustaining short peaks of power *much higher than they can sustain on a steady, continuous basis*, and the proper choice of amplifier is quite dependent on the loudspeaker's ability to do this.

2. How does the nature of program material affect a loudspeaker's power handling capability?

Loudspeakers can sustain two kinds of damage, thermal and mechanical. Let us assume that a 100-watt amplifier becomes defective and goes into oscillation at some high frequency outside the range of normal hearing. In short order, the light tweeter voice coil may be burnt out through overheating. On the other hand, suppose that a woofer is repeatedly stressed by excessive excursions due to turntable rumble, excessive bass boost, low-frequency feedback, or any combination of these. After a while, the moving parts of the woofer will be so strained that possible misalignment of the voice coil and consequent rubbing could occur. In especially severe cases, the voice coil may be forced out of the gap and hang up on the pole piece, as shown in Figure 2.

The amounts of power required for this kind of damage may not be great at all, perhaps no more than 20 or 30 watts, if the signal is in the subsonic range. Good engineering practice requires some degree of high-pass filtering in professional systems to attenuate signals below the pass-band of the system.

Figure 2. Loudspeakers in Normal (A) and Overdriven (B) States



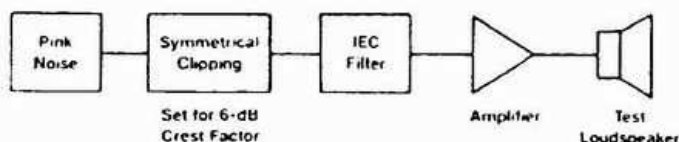
3. How are JBL Professional loudspeaker systems rated?

As we have seen, a loudspeaker can be damaged by both excessive voice coil heating and by over-excursion at low frequencies. Ideally, we would like to use a standard test signal which took both of these failure modes into account and which, at the same time, related sensibly to real-world application. Such a signal is described by the International Electrotechnical Commission (IEC) Standard number 268-5; it is a pink noise signal with a crest factor of 6 dB, filtered at 12 dB/octave below 40 Hz and above 5 kHz.

In establishing a meaningful power rating for a loudspeaker, a sufficiently large sample size of the model is subjected to the signal at power increments, and the rating is defined as that power which the sample can sustain for a period of 8 hours. Details of the testing method are shown in Figure 3.

Figure 3. IEC Power Measurement

A. Signal Flow Diagram



B. IEC Test Spectrum Filter Response



We stated that the crest factor of the noise signal was 6 dB. We now explain this in more detail. Crest factor is related to peak factor and is a precise measure of the peak noise value as related to the average "heating capability" of the signal in the voice coil. A crest factor of 6 dB means that a given loudspeaker or transducer is being stressed by signals with four-times the power of the average signal. For instance, a loudspeaker rated at 150 watts by this testing method would have been stressed during its 8-hour test period by instantaneous power input of 600 watts. The test method relates so well to real-world conditions that JBL has adopted it for loudspeaker systems to the exclusion of all previous power ratings.

4. What about loudspeaker abuse in normal operation? Should there be any de-rating of systems to allow for this?

Yes. JBL defines the following three categories of loudspeaker application, each requiring an adjustment of the system's IEC rating:

A. For carefully monitored applications where peak transient capability must be maintained, a system should be powered with an amplifier capable of delivering twice its IEC rating. For example, a studio monitor system rated at 300 watts can be safely driven by an amplifier capable of 600 watts output.

Discussion: Careful monitoring is the key here. High quality music production today demands high peak factors in the recorded signal. Such peak signals are normally of such short duration that they hardly stress the system's components. Thus, the extra 3-dB margin (times two) of power will result in cleaner overall operation of the system, with less listening fatigue.

B. For routine application where high continuous, but non-distorted, output is likely to be encountered, a system should be powered with an amplifier capable of delivering the IEC rating of the system.

Discussion: This case describes the bulk of sound reinforcement activities. Such systems can often be inadvertently overdriven, or can go into feedback. When powered with an amplifier equal to their IEC rating, the user is guaranteed of safe operation.

C. For musical instrument application, where distorted (overdriven) output may be a musical requirement, the system should be powered with an amplifier capable of delivering only one-half of the IEC rating for the system.

Discussion: Much rock music is produced at full output with the amplifier well into clipping, and this is a matter of musical choice. When an amplifier capable of, say, 300 watts of undistorted sinewave output is driven well into clipping, its output power can approach 600 watts! So, Berating the system to one-half its IEC power will result in safe operation of the loudspeaker.

For a more detailed discussion of these topics, see JBL Technical Notes, Volume 1, Number 16.

