How Much Amplifier Power Do I Need?

I'm playing folk music in a coffee shop. How much amplifier power do I need?
Our rock group will be playing in a 2000-seat concert hall. How many watts will we need?
I just bought some PA speakers. I want to play them as loud as they can get without blowing them up. Which amplifier should I get?

At Crown, we often are asked similar questions, and this article will provide some answers.

First, define your goal. Do you want to power some loudspeakers so they play as loud as possible without burning out? If so, all you need to read is the section below. Do you want to achieve a certain loudness in a certain venue? If so, skip to the section called Power vs. Application.

How much power can my speakers handle?

You can determine this by looking at the speaker's data sheet. Look for the Nominal Impedance spec. Typically it will be 2, 4, 8 or 16 ohms. Next, look for the loudspeaker specification called Continuous Power Handling or Continuous Power Rating. It might be called IEC rating or Power capacity.

If you can prevent the power amp from clipping (by using a limiter), use a power amp that supplies 2 to 4 times the speakers continuous power rating per channel. This allows 3 to 6 dB of headroom for peaks in the audio signal. Speakers are built to handle those short-term peaks. If you cant keep the power amp from clipping (say, you have no limiter and the system is overdriven or goes into feedback) the amplifier power should equal the speakers continuous power rating. That way the speaker wont be damaged if the amp clips by overdriving its input. In this case there is no headroom for peaks, so youll have to drive the speaker at less than its full rated power if you want to avoid distortion.

If you are mainly doing light dance music or voice, we recommend that the amplifier power be 1.6 times the Continuous Power rating per channel. If you are doing heavy metal/grunge, try 2.5 times the Continuous Power rating per channel. The amplifier power must be rated for the impedance of the loudspeaker (2, 4, 8 or 16 ohms).

Here's an example. Suppose the impedance of your speaker is 4 ohms, and its Continuous Power Handling is 100 W. If you are playing light dance music, the amplifier's 4-ohm power should be 1.6 x 100 W or 160 W continuous per channel. To handle heavy metal/grunge, the amplifier's 4-ohm power should be 2.5 x 100 W or 250 W continuous per channel.

If you use much more power, you are likely to damage the speaker by forcing the speaker cone to its limits. If you use much less power, youll probably turn up the amp until it clips, trying to make the speaker loud enough. Clipping can damage speakers due to overheating. So stay with 1.6 to 2.5 times the speaker's continuous power rating.

Power vs. Application

This section will suggest how big a power amplifier you need to fill a venue with loud, clear sound. Basically, the louder the sound system and the bigger the room, the more power is required. Loudspeakers with high sensitivity need less power than loudspeakers with low sensitivity.

The list below recommends the total amplifier power needed for several applications. Each application has a range of power based on the desired loudness and the typical loudspeaker sensitivity.

In compiling this list, we made the following assumptions:

- Typical loudspeaker sensitivity is 85 dB SPL/W/m for home stereos, 95 dB SPL/W/m for small PA speakers, 100-105 dB for medium PA speakers, and 110 dB for large PA speakers.
- The recommended power allows for signal peaks of 10 dB for folk, jazz and pop music. Actually the peaks might be as high as 25 dB, but we're allowing for some inaudible short-term clipping.
- The recommended power allows for signal peaks of 6 dB for rock music that is highly limited or compressed.
- According to Crown's chief amplifier engineer, Gerald Stanley, amplifier continuous power and amplifier peak power are nearly the same. Typically, peak power is only 1 dB higher than continuous power, and depends on peak duration.

Total amplifier power required in various applications

- Nearfield monitoring: 25 W for 85 dB SPL average (with 15 dB peaks), 250 W for 95 dB SPL average (with 15 dB peaks)
- Home stereo: 150 W for 85 dB SPL average (with 15 dB peaks), 1,500 W for 95 dB SPL average (with 15 dB peaks)
- Folk music in a coffee shop with 50 seats: 25 to 250 W
- Folk music in a medium-size auditorium, club or house of worship with 150 to 250 seats: 95 to 250 W
- Folk music at a small outdoor festival (50 feet from speaker to audience): 250 W
- Pop or jazz music in a medium-size auditorium. club or house of worship with 150 to 250 seats: 250 to 750 W
- Pop or jazz music in a 2000-seat concert hall: 400 to 1,200 W
- Rock music in a medium-size auditorium, club or house of worship with 150 to 250 seats: At least 1,500 W
- Rock music at a small outdoor festival (50 feet from speaker to audience): At least 1,000 to 3,000 W
- Rock or heavy metal music in a stadium, arena or ampitheater (100 to 300 feet from speaker to audience): At least 4,000 to 15,000 W

Although a rock concert in an arena could be powered by 15,000 watts (allowing only 6 dB of headroom for peaks,) you'll often see large touring sound companies using 80,000 to 400,000 watts total. That much power is needed to handle 20-to-24 dB peaks without any clipping, and to power extra speakers for even coverage of a large area.

If one loudspeaker won't handle the total power required, you need to divide the total power among multiple loudspeakers and multiple amplifier channels. For example, suppose you need 1000 watts to achieve the desired average loudness, but your speakers power handling is 250 watts continuous. You could use a power amplifier of 500 watts per channel. Connect two loudspeakers in parallel on each channel. That way, each speaker will receive 250 watts (not considering the change in amplifier power at different impedances, and not considering cable losses).

Note that if you parallel two speakers, their total impedance is halved. For example, two 8-ohm speakers in parallel have an impedance of 4 ohms. In that case, each speaker would receive half of the amplifier's 4-ohm power.

Power Calculator

On the Crown website is a calculator that determines the amplifier power required to achieve the desired SPL at a certain distance. It also accounts for the number of dB of amplifier headroom needed for audio peaks. Text accompanying the calculator gives the equations used. Click on the following link to go to Crown's power calculator: Calculator

To use that calculator, you need to know the loudspeaker sensitivity, peak headroom, listener distance, and the desired SPL. Let's examine each factor.

Sensitivity

The sensitivity spec can be found in the loudspeaker's data sheet. Typical sensitivity for a PA loudspeaker is 95 to 110 dB-SPL/watt/meter. Bigger speakers generally have higher sensitivity than smaller speakers, and high-frequency drivers have higher sensitivity than low-frequency drivers.

Peak headroom

Because music has transient peaks that are 6 to 25 dB above the average level, the power amplifier needs to produce enough power to handle those peaks without distortion.

For example, if you need 100 watts continuous power to achieve the desired average SPL, you need 1,000 watts continuous to handle 10 dB peaks, 3,162 watts to handle 15 dB peaks, and 10,000 watts to handle 20 dB peaks. Clearly, the peaks require far more power than the average levels. In the calculator's Peak Headroom field, enter 6 dB for rock music that is compressed or limited, or enter 20 to 25 dB for uncompressed live music. If you can live with some short-term clipping which may be inaudible, enter 10 to 15 dB.

Listener distance from source

This is the distance from the loudspeaker to the farthest listener. If you are using several loudspeakers that extend into the audience, this distance is from the nearest loudspeaker. For example, if the audience is 100 feet deep, and you have speakers at 0 feet and 50 feet, the listener distance is 50 feet.

If you don't know this distance, you can make a rough estimate from the typical values below. Be sure to enter the distance in meters (m).

Coffee house: 16 to 32 feet (4.8 to 9.8 m)
Small club or auditorium: 32 feet (9.8 m)
Medium club, auditorium or house of worship: 45 feet (13.7 m)
2000-seat concert hall: 110 feet (33.5 m)
Small outdoor festival: 50 feet (15.2 m)
Stadium or arena: 100 to 300 feet (30.5 to 91.4 m)

Desired SPL

Listed below are typical sound pressure levels (SPLs) for various types of music. The SPL meter was set to C-weighting, slow response. You might want your system to be at least 10 dB above the background noise level to achieve a good signal-to-noise ratio.

New age: 60-70 dB
Folk: 75-90 dB
Jazz: 80-95 dB
Classical: 100 dB
Pop: 90-95 dB
Rock: 95-110 dB
Heavy metal: 110 dB.

Other Considerations

The calculations discussed here apply to anechoic or outdoor conditions. If the sound system is inside a venue, the room reverberation will increase the SPL typically by 6 dB. You can use this room gain as extra headroom.

Suppose you need to supply 1000 watts for peaks, and your speaker's continuous power handling is 250 watts. A speaker's peak power handling is typically 4 times its continuous power handling. So the speaker can probably handle 1000 watts peak. That means you can use a 1000 watt amplifier to drive that speaker -- as long as you use that power for peaks, and do not drive the speaker continuously with 1000 watts. In other words, don't turn up the amp so high that it clips.

What if your sound system uses an active crossover and a separate power-amp channel for each driver? Apply the calculator to each driver type. Say you have a 3-way system. Determine the power separately for the subs, midrange drivers and high-frequency drivers. All three types of driver should produce the same SPL at the same distance. Note that horn-loaded drivers tend to have much higher sensitivity than subwoofers, so the horns need less power to produce the same SPL as the subs.

Suppose your sound system has multiple loudspeakers that extend into the audience area. For example: an outdoor festival with speaker clusters on delays every 100 feet, or a set of ceiling-mounted speakers. Apply the calculator to each nearby speaker cluster or speaker.

Crown Amplifier Selection Guide (rated by total power)

Once you know how much power you need, you can select a Crown amplifier from this list. There is some overlap in this list because each power amplifier produces different amounts of power depending on the load impedance.

You might want to choose an amplifier that has more power than you need in case you expand your applications. Also, it's wise to specify a little more power than you need. You can always turn down a power amp if the system is too loud, but you can't turn up a power amp past maximum if the system is too quiet!

Total power (both channels combined)

25-50 W: D-45
50-100 W: 180A, 180MA, D-75A
100-200 W: 280A, 280MA, CP660
200-400 W: 1160A, 1160MA, CP660, CTs 600, XLS 202
400-800 W: CE 1000, CE 2000, CH1, CL1, CTs 600, CTs 1200, K1, MA-602, MA-1202, SR II, XLS 202, XLS 402, XLS 602
800-1,000 W: CE 1000, CE 2000, CH1, CH2, CL2, CTs 4200, K1, MA-1202, SR II, XLS 402, XLS 602, Xs500, Xs700
1,000-1,500 W: CE 1000, CE 2000TX, CE 4000, CH2, CH4, CL1, CL2, CL4, CTs 1200, CTs 2000, CTs 3000, CTs 4200, CTs 8200, K1, K2, MA-1202, MA-2402, SR II, XLS 402, XLS 602, Xs500, Xs700, Xs900, Xs1200
1,500-5,000 W: CE 4000, CH4, CL2, CL4, CTs 2000, CTs 3000, CTs 8200, I-T4000, I-T6000, K2, MA-3600VZ, MA-5002VZ, SR I, XLS 602, Xs700, Xs900, Xs1200
4,000-8,000 W: I-T6000, I-T8000, MA-5002VZ

With the tools and advice in this article, you should be able to purchase or recommend a power amplifier with the right amount of wattage for the style of music and venue.

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