

# Application Guide

QSC Cinema Subwoofers Deploying and powering



# Proper selection and powering of cinema subwoofers

IN CINEMA APPLICATIONS, the proper selection and powering of subwoofers is vital to reliably optimizing the audience experience that will keep patrons coming back and buying more tickets. Certainly a subwoofer failure is at best a significant distraction to the audience, and in many cases can be a serious letdown in the aural experience and impact of the film.

## The expense of unwise frugality

There are a number of reasons why cutting back on subwoofers and compensating with more amp power is an unwise move. To start, let's take a look at what happens in a loudspeaker when an audio signal is applied to it.

A dynamic loudspeaker—the dominant form of audio transducer over more than a century—is similar to an incandescent light bulb in that both are highly inefficient, with more than 90% of the input power turning into waste heat (Figure 1) instead of usable acoustic

Loudspeaker failures, especially repeated ones, are almost always attributable to one mistake: trying to do too much with too little. Largely because of their size and cost, cinema subwoofers are often an attractive target for misguided economizing, with cinema operators opting for fewer or less robust subwoofers than the room design actually requires and trying to make up for it with more amplifier power. This, however, is frequently a recipe for disaster and downtime.

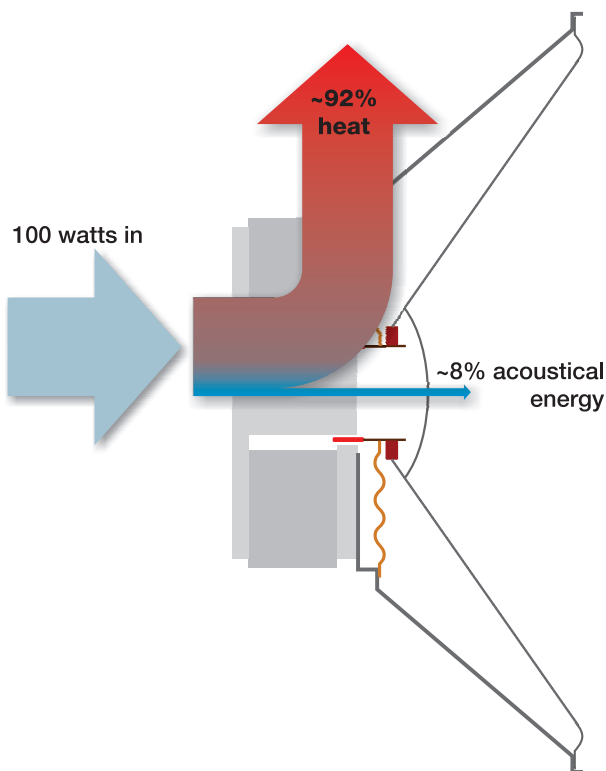
or light energy. Imagine the heat from a 100-watt light bulb. That's fairly equivalent to what the voice coil in a loudspeaker driver has to dissipate when only 100 watts of average power is put into it.

A phenomenon called power compression compounds the problem. At higher temperatures, the resistance of the voice coil wire increases, which decreases the response of its driver. The result is that the acoustical output from the driver does not respond linearly with the power put into it; for example, a 3 dB increase in power from the amplifier might produce an acoustical increase of only 2 dB or even less; this lessens the desired and palpable impact of a subwoofer. An overtaxed subwoofer simply runs hotter than it should, and this not only makes it more likely to fail but also degrades its acoustical performance.

There are two principal ways in which a loudspeaker fails: one is thermal—i.e., damage from excessive temperature. The other is mechanical, which is caused by overexcursion, or driving the loudspeaker driver beyond its physical limits; this is the more common type of failure in cinema subwoofers.

Charring, melted adhesives, or deformed formers (the cylinder around which the voice coil is wrapped, which sits inside the magnet gap) are evidence of thermal damage. Thermal damage is caused simply by excessive power, which heats the voice coil to unsafe temperatures.

Overexcursion evidence includes creases or even tears in the speaker cone or the spider (from pushing the cone beyond its mechanical constraints), or mechanical damage to the inner end of the former (from bottoming out against the magnet structure). Overexcursion is caused by excessive energy in the very low frequencies, because reproducing



**Figure 1. Typically, less than 10% of the power going into a driver gets converted to sound. The rest becomes heat.**

lower frequencies requires longer cone throws. All else being equal, a loudspeaker diaphragm's peak excursion will quadruple with each octave lower in frequency. With low enough frequencies, overexcursion damage can occur even at levels well below the

loudspeaker's thermal limits. And cinema subwoofers often must handle program material as low as 20 Hz, about an octave lower than what most pro audio subs must handle.

## The right way

We've established that using fewer subwoofers and attempting to compensate with greater amp power is a thoroughly bad idea. So what is the right approach?

**First, start with enough subwoofers, using models that are adequate to the task.** The larger the room is, the more numerous and/or substantial the subs must be. But don't assume that, say, one dual 18-inch sub system is interchangeable with another. Different models of seemingly similar composition do have different levels of performance and power handling.

So if the design calls for two SB-7218 subwoofer systems, it would be unwise to arbitrarily use only one or to substitute SB-5218 systems to save costs. If you need guidance, consult a QSC cinema product specialist or check out the QSC Cinema Products Online Application Guide at [http://appguide.qsccinema.com/\\_layouts/15/qsc/welcome.aspx](http://appguide.qsccinema.com/_layouts/15/qsc/welcome.aspx).

**Use appropriate amplifier power.** You can never make up for an inadequate deployment of subwoofers

by adding more amplifier power. It's much better to use smaller but still adequate power amplifiers with more subs. Headroom—that is, available but unused amplifier power—is good to have, but as long as you get the necessary sound pressure levels with no significant clipping in the amplifiers, you actually have enough power.

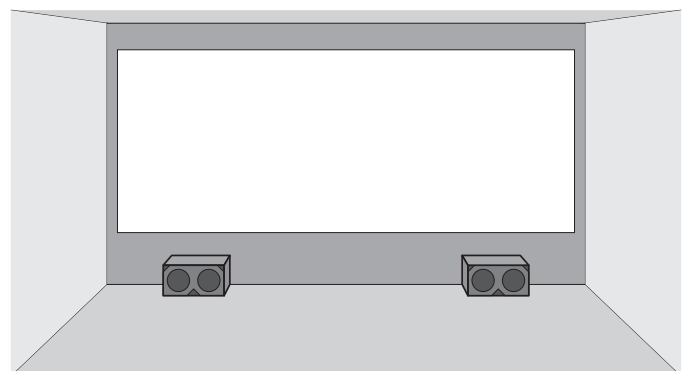
***“[Repeated] loudspeaker failures are almost always attributable to one mistake: trying to do too much with too little.”***

Note that the gain controls on the amp only determine how the amp channels multiply the input signal voltages; they do not increase or decrease how much the amp can put out. In most applications where the QSC cinema processor connects to the amplifiers through their DataPort connections, setting the controls to full gain is correct. Most applications using an amplifier's regular inputs, on the other hand, will not require full gain.

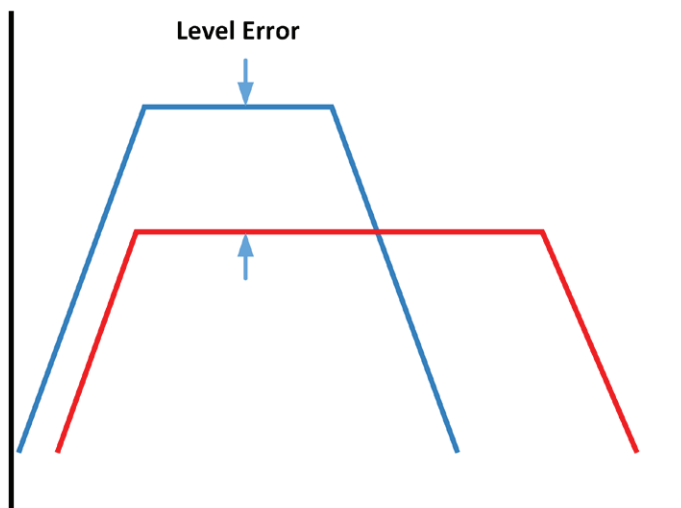
**Measure properly.** Use a real-time analyzer (RTA) to measure and verify the response as you set the sub levels (Figure 4). You need the RTA anyway to set the X curve. We do not recommend using a sound level meter because they can be inaccurate or misleading for low frequencies, particularly if they do not offer an unweighted



**Figure 2. Do this. Cluster the subwoofers together against the wall. In this arrangement they will couple acoustically and act like one very large subwoofer. This will result in the flattest, most even coverage.**



**Figure 3. Don't space the subwoofers apart. The spacing will make coverage on the sides of the room uneven.**



**Figure 4.** Using a sound level meter to set subwoofer levels could result in significant level errors, depending on the cut-off frequencies of different loudspeakers.

measurement option. Many sound level meters offer only A or C weighting, neither of which are flat in the low end.

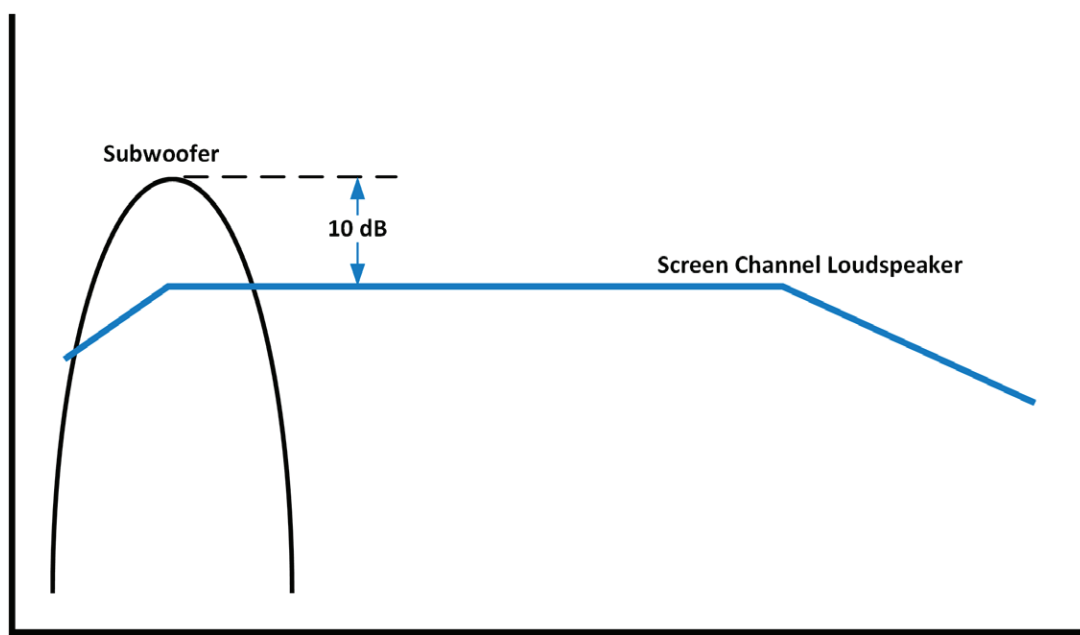
**Don't bump.** The B6 alignment on many cinema crossovers and processors exists to extend the low-frequency response of subwoofer systems that otherwise would not be able to physically reproduce the extreme low frequencies adequately. But it comes at a price: it cuts into amp headroom and drastically increases cone excursion at frequencies where

overexcursion is already a real danger in subs that are pushed to their limits. Therefore, use a B6 filter only if it is needed to flatten the subwoofer's response (Figure 5). Don't use it arbitrarily.

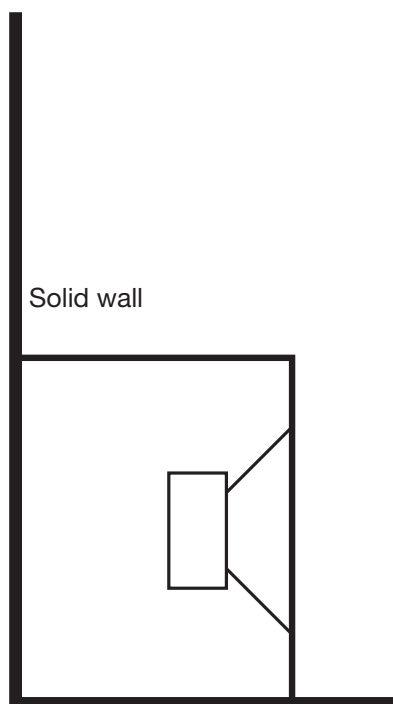
Be careful also with peaks in subwoofer frequency response that may appear on an RTA; it is better to dial in an EQ that brings peaks down than one that pulls up the other frequencies to match them.

**Cluster the subwoofers on the floor.** To take advantage of boundary effect, place subs on the floor; this increases their effective acoustic output. If you are using multiple subs, pack them tightly together so they acoustically couple (Figure 2). "Acoustic coupling" is simply having the subwoofer drivers close enough together (proportionally to the wavelengths they emit) that they behave acoustically as one large driver. This will offer the most even horizontal coverage and avoid the undesirable up-the-middle "power alley" effect that spacing the subs apart (Figure 3) would create.

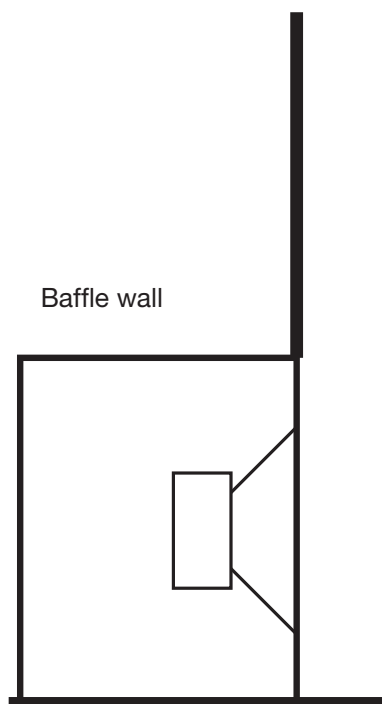
For additional boundary effect to increase the effective output of the subs, place the subs against the wall (Figure 6)—or even better—build a baffle wall behind the screen and place the subs flush with it, as in Figure 7. Don't set the subs away from the wall (Figures 8 and 9).



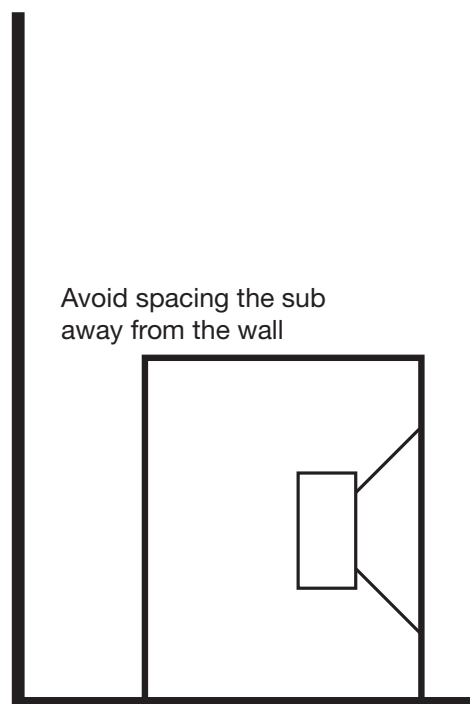
**Figure 5.** The subwoofer should show 10 dB of in-band gain compared to a screen channel loudspeaker.



**Figure 6. Do this.**



**Figure 7. Or do this.**



**Figure 8. Don't do this.**



**Figure 9. Don't place the subwoofers away from the front wall, and don't center them from the side walls.**

## Summary

Unscheduled downtime and maintenance.

Audience disappointment.

Service calls.

These are all expensive, if unintended, results of misguided attempts to economize on cinema subwoofer systems. Deploying appropriate sub models properly and in appropriate quantities has a stronger payoff in the long run.



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