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# POWERING SURROUND SPEAKERS

BY

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**It's a common practice in this industry to under power the surround channel. Several "rules of thumb" have evolved. One approach has been to use a single amplifier of the type used for the screen speakers. Sometimes two amplifiers are thrown in. Another practice uses a certain number of amplifiers or watts per a certain number of seats. These approaches completely ignore the actual size of the theatre, the sound pressure level required and the speakers used. There is a simpler answer.**

**In order to determine the needed power for the surrounds, one should not consider the power employed for the screen speakers at all. These larger units are as much as 10 to 40 times more efficient as typical surround speakers. In addition, the screen speakers must cover a greater distance. Aside from being in the same theatre, the requirements of the two speakers really have no relationship whatsoever and should therefore be considered separately.**

**Quite simply, the factors determining the power required are: speaker sensitivity and the sound pressure level desired at some chosen distance from the speaker. Some argue that the reverberation time of the room should be considered. I have always disagreed with this for two reasons: First, the amount of level added by sustained reverberation is not the same for every theatre, it varies with frequency and isn't very much anyway. Second, in the final analysis, the sustained reverberation isn't even relevant. The peak power required is for peaks, or transients. It is the first arrival of these peaks, which we must deliver to the listener's ears, at the desired level. First arrivals are just that; first, without reverberation.**

**With this in mind, it makes more sense to use the classic, simple and straightforward inverse square law. This law basically states that as you double the distance from a speaker, the power drops by a factor of four. In other words, if you have a level of 100 dB Sound Pressure Level (SPL), ten feet from a speaker, you will have 94 dB SPL, at 20 feet. To obtain a level of 100 dB SPL at 20 feet, you will need four times the amplifier power, or 6 dB more.**

## HOW MUCH LEVEL DO YOU REALLY NEED?

**The level required from the surround channel is one of the most often misunderstood and**

**misstated concepts in theatre sound. Some have suggested that one needs only 85 dB SPL from the surrounds. I believe this confusion comes from the standard practice of balancing theatre systems, with pink noise, at 85 dB. This is only a calibration level, however, and has nothing to do with the actual operating peaks and levels.**

**Since the surrounds can be recorded at the same peak modulation as any screen channel, they must be able to deliver the same sound pressure level as any screen channel. For conventional 35 MM Dolby "A" type systems, this is about 100 dB SPL for the most dynamic films which I have measured. For Digital Stereo, 70 MM and Dolby "SR" films (optical or magnetic), the peak level is in the 105 dB SPL range. Adding a small safety margin of 6 dB, for the amplifiers, brings the level requirement to about 111 dB SPL. This will be the point where the amplifiers run out of power.**

**For obvious reasons, all new systems should be Digital or Dolby "SR" ready when they are installed. Digital and SR are here. The requirements for each are essentially the same. Many current theatres will need to be updated with a more hefty surround system.**

## THE DISTANCE FACTOR:

**Once the required level is known, the next item to consider is the distance from the source. Should we calculate using the distance from the speaker to the center of the room, or to the farthest wall? I use the center because the level increase one encounters near walls is not only helpful, but it also makes actual measurements difficult. I would suggest that when determining power requirements for surround speakers, the distance figure used should be 1/2 the theatre's width, or 1/2 the length of the seating area, whichever is less.**

**Since there are typically 10 to 12 surrounds in a surround array, we need to investigate a phenomenon known as mutual coupling. When two speakers are placed close to one another and given the same signal, at the same level, from different amplifiers, their total output can go up not by a factor of two, but a factor of four. When using full size speaker systems, this happens mostly in the bass frequencies. If there was mutual coupling between surround speakers, we could get by with less amplifier power. Unfortunately, as I have personally verified, the surround speakers are too far apart to gain any coupling advantage.**

**This actually simplifies things. The total power required for the entire group of surround speakers is now the same as it would be if there were only one surround speaker.**

## SPEAKERS MAKE A DIFFERENCE

**There is a considerable difference in the sensitivity among the speakers most often chosen for surround use. Some are as much as ten times more sensitive than others. Those with the higher sensitivities need a lot less power. For instance, a speaker which is 10 dB less sensitive than another, will need ten times more power to play at the same level.**

**All to often, I have visited theatres equipped with surround speakers having a sensitivity of about 90 dB (1 watt / 1 meter) all driven by a 100 watt amplifier. In a 45 foot wide theatre, the maximum level such a system can deliver is 93 dB SPL. This is a far cry from the 100 dB SPL peak program level needed for the more dynamic stereo films. Using the inverse square law, what those speakers really require in a 45 foot wide room is 6,313 watts for digital, 70 MM or Dolby SR.**

**Now, consider what happens if you select a 98 dB sensitive surround speaker. In the same theatre, digital, 70 MM and Dolby SR would need only 631 watts. This is a lot more reasonable.**

**Incidentally, if you used the reverberation time of the theatre in your calculations, you might be able to reduce these requirements by 1 dB, or so, SPL. Not much really. Since all you're really giving up is your safety margin, it's best to be a little conservative and stay with the simpler inverse square law.**

**Here is the inverse square law formula to use for determining the power needed for your surround speakers. This assumes a Dolby SR or digital installation. A scientific calculator will prove handy. You may also use these formulas for screen speakers.**

**For surround speakers: Let "D" equal in feet 1/2 the theatre's width, or 1/2 the length of the seating area, whichever is less.**

**For screen speakers: Let "D" equal in feet the distance from the screen speaker to the center of the theatre.**

**Watts required = $10^{X}$**

**Where X = (111-(speaker's 1 meter sensitivity-2)+20log10)/(D/4)**

**If you would like to know the peak SPL available from your current surround system, use**

**this formula:**

**Peak SPL = (speaker's 1 meter sensitivity -2) +l0log amplifier power -20log(D/4)**

**Note: If your speaker sensitivity is given at 4 feet, add 2 dB to convert it to a 1 meter equivalent.**



***John F. Allen is the founder and president of High Performance Stereo in Newton, Mass. He is also the inventor of the HPS-4000® cinema sound system and in 1984 was the first to bring digital sound to the cinema. John Allen can be reached by E-mail at JohnFAllen@aol.com.***