

Theater Systems: A Quick Guide to Specifying Cinema Loudspeakers

by John Eargle and Mark Gander

Specifying Screen Channels:

1. Screen channel assumptions:

- 15" LF drivers in the 95 to 97 dB sensitivity range (1 W at 1 m).
- LF power handling in the 300-watt range.
- HF systems with matching sensitivity and output capability.
- House sizes based on survey of the range of typical installations.

2. Low frequency driver count (per channel):

- For houses with 200 seats or less, specify systems with one LF driver per channel.
- For houses with 200 to 500 seats, specify systems with two LF drivers per channel.
- For houses with more than 500 seats, specify systems with four LF drivers per channel.

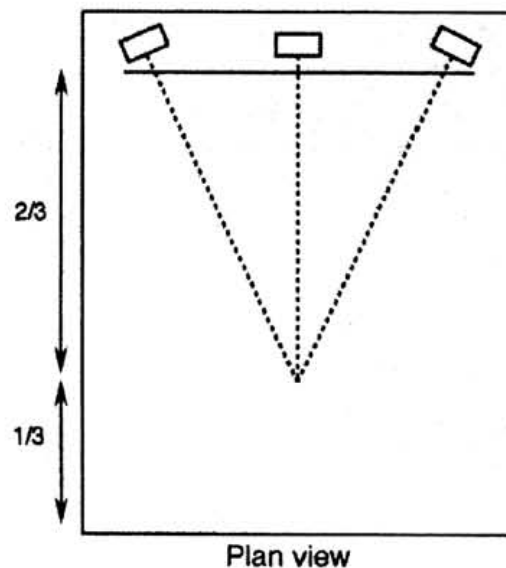
REMEMBER: You can always specify a larger system for a smaller house, but not vice versa.

3. Placement of screen channels:

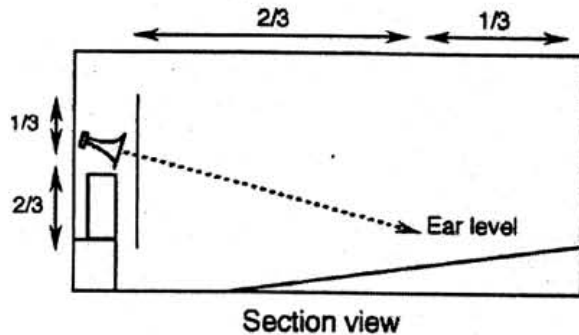
- Space horizontally to match the widest picture format.
- Elevate systems so that HF sections are about $\frac{2}{3}$ the screen height.
- Place the systems so the HF sections are as close as possible to the screen.
- Paint matte black any reflecting surfaces.

4. Toe-in of screen loudspeakers:

Whether the screen is curved or not, toe the outside loudspeakers in so that their on-axis extensions intersect at a point about $\frac{2}{3}$ the distance to the back wall.



5. Downward tilt of HF elements:
Tilt the HF elements downward so they point at ear level at a distance $2/3$ toward the back of the house.



(Note: this will not be necessary for systems that use asymmetrical horns which already incorporate the downward angle in their design.)

Specifying Surround Channels:

1. Surround channel assumptions:

- Moderate power surrounds (cone/dome): Sensitivity: 91 dB SPL, 1 W at 1 m.
Power rating: 100 watts continuous.
- High power surrounds (HF horn): Sensitivity: 96 dB SPL, 1 W at 1 m.
Power rating: 250 watts continuous.

Note: Maximum output difference 9 dB.

2. When to use which surround model:

- For houses with seating no greater than 200 patrons, use either moderate or high power surrounds.
- For houses with seating greater than 200 patrons, always use high power surrounds.

3. How many surrounds?

- In most houses the ideal number will be 12 to 16.
- Normally, specify at least 4 surrounds on the back wall.
- An exception here is in very small houses, where there may be 2 on

the back wall. In this case a total of 8 (3 on each side; 2 on back wall) will be sufficient.

4. Surround wiring:

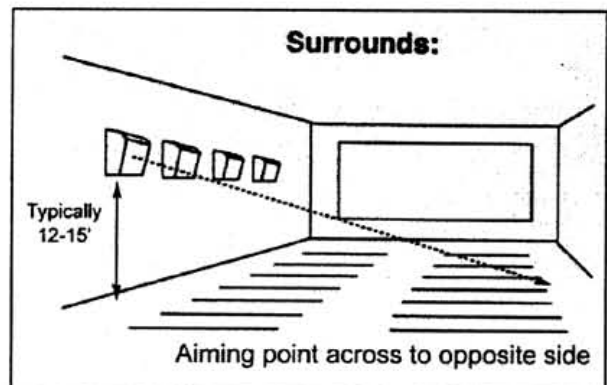
- Always use a "home run" from the booth to each surround loudspeaker.
- Do all of the loudspeaker paralleling in the booth.
- Select wire gauges that will ensure no more insertion loss than 0.5 dB.

5. How to position the surrounds:

- The front-most surrounds are normally $2/3$ the distance from the back wall to the screen.
- The back-most side wall surrounds should be about 9 to 12 feet from the back wall.
- Surround density should be about one unit for each 9 to 12 feet along the walls.

6. Surround height and aiming:

- Height should normally be 12 to 15 feet above the floor.
- The high frequency axis should be aimed at seats on the opposite wall.
- When possible, follow the rake of the main floor.



(Note: Architects may have other ideas, and they usually win.)

7. Be prepared for **Surround EX**:

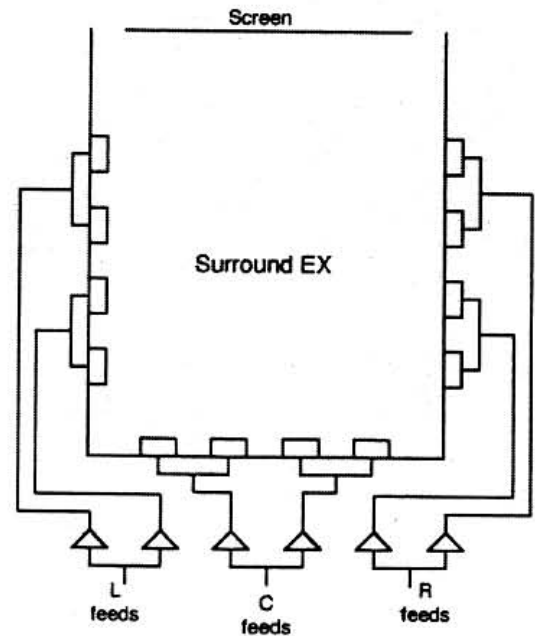
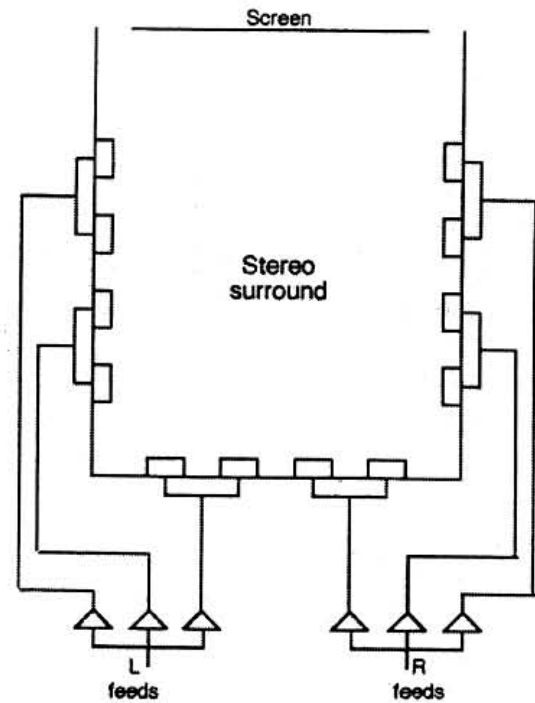
- Ideally, the three surround channels should have the same output capability. This calls for an equal number of loudspeakers per channel.
- When possible, specify surrounds in a quantity divisible by 6 (12, 18 or 24) to ensure optimum paralleling.

8. Selecting surround amplifiers:

- Choose stereo amplifiers with a generous 4-ohm power rating that equals twice the individual surround loudspeaker power rating.
- For example, using high power surrounds, select a stereo amplifier that can deliver 500 watts into 4 ohms.

9. If you have followed all of these rules:

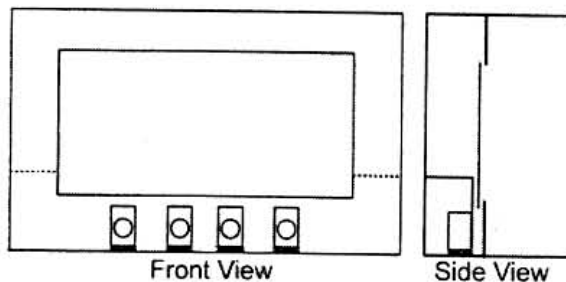
- Surround coverage in the back 2/3 of the house will be uniform ± 2 dB.
- Fine tuning drive levels may further improve uniformity.
- In deep houses, be prepared to zone surrounds with delay to maintain proper front/back perspectives.



(Note: Paralleling should take place at the amplifier output, not at the speakers.)

Specifying Subwoofers:

1. Subwoofer channel assumptions:
 - Use 18-inch diameter drivers.
 - Sensitivity: no less than about 97 dB, 1 W at 1 m.
 - Power rating per-driver should be no less than about 400 watts continuous.
2. How many subwoofer drivers are necessary?
 - A safe rule is to specify one sub driver for each 25,000 cubic feet of house volume.
 - Always round up; if your calculations indicate 5½ subs, use 6.
 - You can always specify more subs for greater impact.
3. Subwoofer powering:
 - We recommend powering each subwoofer driver with its own amplifier section.
 - Choose amplifiers with an output rating commensurate with each driver at its rated impedance.



4. Subwoofer mounting:
 - Mount the subwoofers at the base of the screen as close as possible to the wall/floor intersection.
 - Cluster the individual units together as tightly as possible in order to take maximum advantage of mutual coupling.
 - Watch out for rattles; use plenty of Neoprene padding for isolation.

Good Wiring Practice:

1. Do not waste the money that you have spent on power amplifiers by specifying inadequate wiring. The table below will tell you what wire gauge to use to maintain cable losses at 5% or less (approximately 0.5 dB).
2. When determining the gauge of wiring for the surrounds, use a load value of 8 ohms, which is the impedance of each home run to each surround loudspeaker.

American Wire Gauge (AWG)

	25 ft	50 ft	100 ft	250 ft	500 ft
16 ohms	21	18	15	11	8
8 ohms	18	15	12	8	5
4 ohms	15	12	9	6	3



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