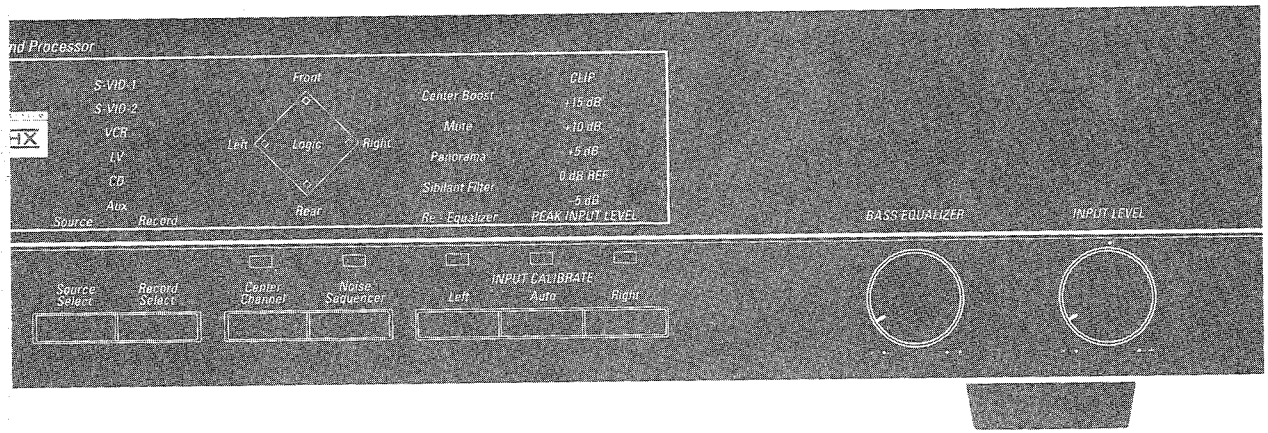
AVP1



harman/kardon

Audio/Video Surround Processor with Preamplifier

SYSTEMS PLANNING MANUAL

PLANNING YOUR HOME AUDIO SURROUND AUDIO SYSTEM

Home surround systems are primarily intended for use with video. The AVP1, however, has been especially designed to work equally well with both non-encoded sources (CD's, cassettes, broadcast television and records) as well as surround-encoded video sources (motion pictures and broadcast television).

A complete Home THX* Audio System further enhances the performance of various music and video sources. It is designed for use in rooms as large as 5,000 cubic feet and with the use of additional THX speaker subwoofers the Harman Kardon group of THX audio components can deliver certified performance in rooms up to 10,000 cubic feet.

You can use existing equipment to begin building a complete Home THX Audio System. Although it will not be a full-fledged THX Audio System until it is complete, the incremental improvements will be clearly heard as each step is taken toward the goal.

You should start with the AVP1 THX controller and upgrade the system a step at a time by adding either the THX dipolar surround speakers or the main front speakers with a subwoofer.

PLEASE NOTE: The THX specification includes an electronic crossover for the front speaker system. If you are using THX speakers without the AVP1, or other THX controller, some provision must be made for an appropriate crossover between the subwoofer(s) and the front speakers.

*THX is a registered trademark of LUCUSARTS ENTERTAINMENT COMPANY.

The list of equipment needed for a complete Harman Kardon Home THX Audio System Installation is fairly straightforward:

- An AVP1 THX controller.
- At least seven channels of amplification for left, center, right front channels plus two surround speakers and one or more subwoofers.
- Identical THX left, center and right front speakers with appropriate stands or mounting brackets to facilitate aiming them directly at the primary listening area.
- One or more THX subwoofers (depending on room sized) designed for use with the THX front speakers.
- A pair of THX dipolar surround speakers with appropriate stands, or attached mounting brackets to position them at least two feet above ear level when seated.
- Assorted interconnecting cables and speaker wires.

Position of components: Electronics

- **Keep noisy components away**
- **Hide distracting (LEDs)**
- **Consider IR receiver by the screen**
- **Provide cooling for power amps**
- **Aim for short speaker cables (unless in high RF fields where low levels might pick up noise)**

A home theater also requires a large screen television and the best possible video sources. The best A/V sources are laser disc or home satellite followed by off-the-air television, cable or VHS HiFi.

A 31"-35" direct view television may be appropriate in smaller rooms but cannot impart the theatrical experience of having your field of vision dominated by the size of the image on the screen. Attaining this effect with a 35" television requires sitting uncomfortably close to the screen.

ELECTRONICS PLACEMENT

- Cabinets should be used to conceal equipment which must be placed near the screen. The lights and visual displays on the equipment should not distract the viewer.
- Ample ventilation must be provided, preferably through convection, to avoid fan noise.

VIDEO VIEWING REQUIREMENTS

- The primary seating areas should be centered in front of the picture.
- NTSC video looks best at a seating distance from 3-5 times the width of the screen for maximum perceived clarity. However, you may choose to sit as little as 2.5 times the screen width to achieve maximum visual impact and involvement.
- Ambient light should be minimized to maximize video contrast performance particularly with projection video display systems.
- The main front speakers should flank the screen and be placed with reasonable symmetry with respect to adjacent walls.
- The screen should be well away from side walls. The front speakers have broad horizontal dispersion and it is best to minimize side wall reflections.

SPEAKER PLACEMENT

The AVP1 may be used with conventional, high quality speaker systems or with Home THX-certified loudspeaker systems. There are some general installation guidelines that apply to both types of systems in terms of achieving optimum performance.

Select speakers designed to meet your system requirements. Don't, for example, flush-mount a book shelf speaker designed for different mounting applications. If the room is quite large, you may require two or more subwoofers to achieve optimum performance. Acoustically dead rooms may require higher efficiency speakers to achieve louder sound levels.

If you have questions regarding the proper installation of your speakers consult your dealer or the manufacturer.

MAIN LEFT, CENTER, RIGHT SPEAKERS (LCR)

The Left and Right front (L/R) speakers should be placed close to the edges of the screen to eliminate the disorientation which results when sounds appear to occur well away from their visual on-screen location. Some allowance must be made for those installations involving screens smaller than five or six feet measured diagonally. Placing the

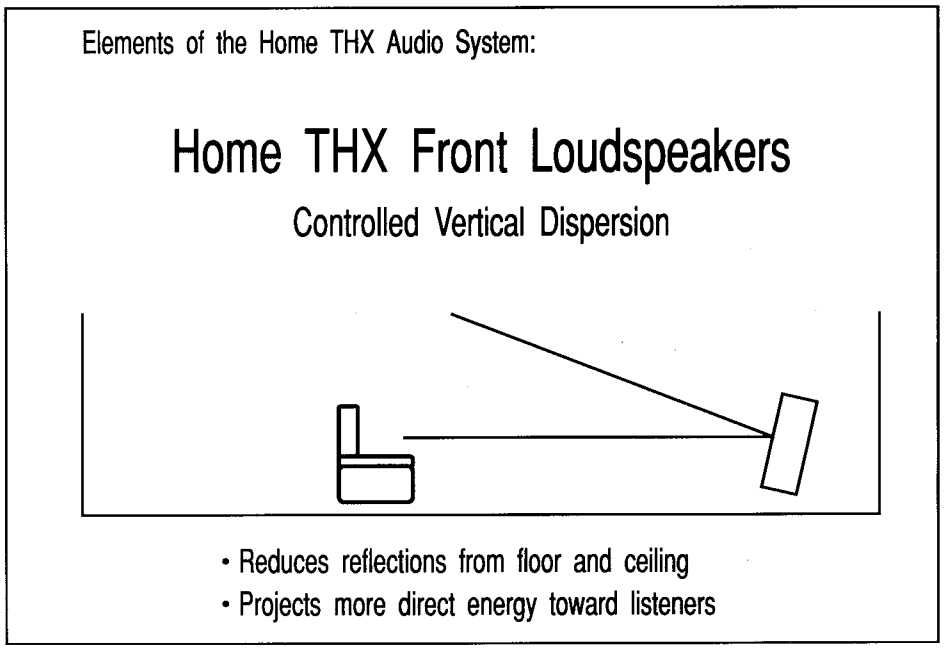


figure 1

speakers immediately beside a small screen usually reduces stereo separation to unacceptable levels. Some experimentation may be in order, but as a rule of thumb, try to place the L/R front speakers no more than 18" to 24" from the sides of the screen.

Try to avoid placing the L/R front speakers to close to side walls or room corners. They should usually be placed no closer than 18" to 24" from corners and side walls. Conventional speakers should be toed in slightly towards the seating areas. THX-certified speakers will usually require no toe-in, however some toe-in will assure even lateral coverage of the seating area and reduced side-wall reflections.

THX LCR speakers are designed to be used vertically only. If they must be either above or below the screen they must be properly aimed towards the listener. Proper aiming is critical because THX speakers are intentionally quite directional in the vertical plane to focus sound energy to improve dialogue intelligibility and image localization.

The Center speaker should be directly above or below the screen. When possible, try to keep the center speaker tweeters as close to the level of the tweeters in the L/R speakers (no more than a two foot difference), so that lateral audio pans do not create noticeable changes in vertical localization.

Placing the LCR speakers below the screen is preferable since aiming them upward maximizes the usable listening area. Placing the Center speaker directly in front of a television is fine as long as it does not obscure any portion of the screen, provided it is magnetically shielded. All THX LCR speakers are magnetically shielded.

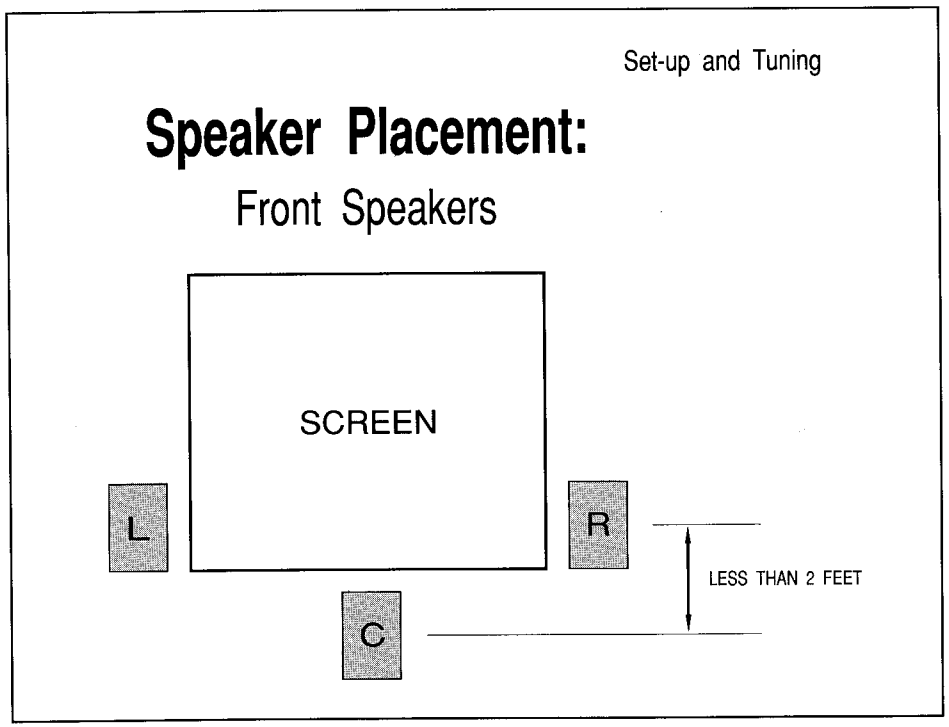


figure 2

SUBWOOFER PLACEMENT

Subwoofers do not have to be placed extremely close to the front channel speakers but placement will affect the low bass.

Leave yourself some leeway during final installation for minor movements to minimize room modes. corner placement will yield the most deep bass, but this excites the maximum number of standing waves resulting in uneven frequency response. Use of multiple subwoofers will increase bass output and allows one subwoofer to smooth irregularities created by room modes. Placement near a video projector is acceptable since all THX subwoofers are magnetically shielded.

FINE TUNING YOUR AUDIO SYSTEM

The procedures outlined in the previous sections should allow proper performance of your system. There are several things you can do to "tweak" the installation even further.

In many cases, the concepts contained in this section are not necessary to achieve the kind of impact the AVP1 and a Home THX Audio System can provide. The following ideas and suggestions are for the most demanding installations or when the room itself presents a special challenge.

ACOUSTICAL PROBLEMS IN LISTENING ROOMS

The Home THX Audio System addresses many of the problems common to high quality reproduction of music or soundtracks in a home environment. For example, the dispersion pattern of the front LCR speakers minimizes the effects of floor and ceiling reflections. Still there are many variables which are beyond the control of a manufacturer. Room reflections create spurious false images and "comb filter" interference effects which alter the tonality of the system while degrading the localization of specific sounds. Larger rooms sustain echoes which degrade dialogue intelligibility and detail. All rooms have standing waves which emphasize certain frequencies at the expense of others, based on the dimensions of the room.

Other concerns include environmental noise, which is often greater than people realize. Although they might become accustomed to its presence and "tune it out," it still reduces the perceived low-level resolution of the system. In addition, the profound bass capabilities of a Home THX Audio System can create distracting rattles which lesser systems might never evoke.

It can be tempting to try to solve all of these problems with the indiscriminate use of sound-absorbing products, but even this technique has its pitfalls.

All of these common acoustical problems will be addressed in this section. Once again, these techniques are not necessary for a successful Home THX Audio System installation. Rather, they are provided to solve occasional problems and to provide further enhancement possibilities.

ROOM REFLECTIONS

The most troublesome room reflections are usually the early reflections of the LCR speakers off the floor, ceiling and side walls. These reflections reach the listener's ears delayed with respect to direct sounds and blur the perceived image. They can also degrade dialogue intelligibility, through the same mechanisms.

The design of the THX LCR speakers minimizes the floor and ceiling reflections. As an extra enhancement, it is often a good idea to place a thick, absorptive carpet between the front speakers and the listening position, just to further reduce this primary reflection from floors with hard surfaces. A rug made from wool will have more uniform absorption characteristics than one made from synthetic fibers.

The THX LCR speakers have a broad dispersion in the horizontal plane in order to ensure a wide usable listening area. This design choice can induce reflections off of the side walls, especially in installations where they are relatively close to the front speakers. These reflections can be reduced simply by angling the left and right speakers inward somewhat.

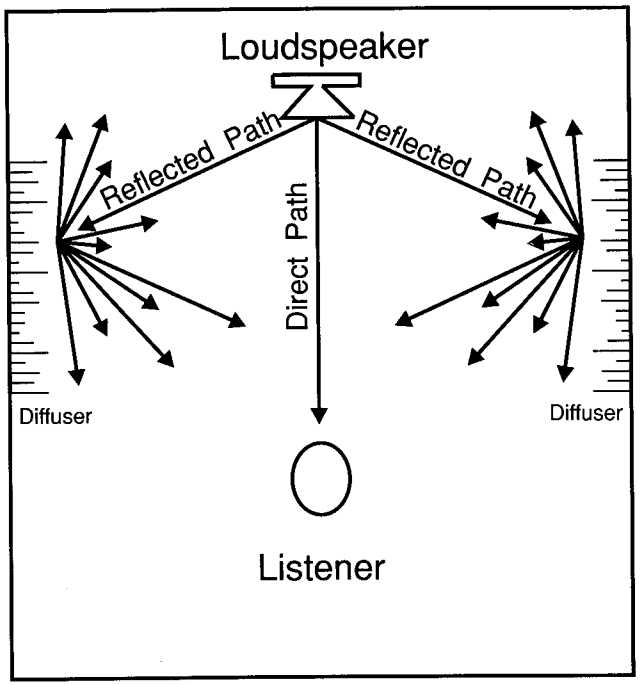
If giving the speakers some "toe-in" is not enough, the next step is the strategic placement of absorptive materials on the side walls. These range from commercially available fiberglass and dense foam to heavy draperies and even large overstuffed furniture. The optimal position for these materials can be found with a small hand mirror and an assistant. Sit at the primary listening position and have the assistant slowly slide the mirror along the wall. When you can see any of the front speakers reflected in the mirror, mark the wall at the mirror for later placement of absorptive material.

A variation of this method is especially helpful in rooms which are already fairly "dead" acoustically. Rather than using absorptive material in rooms like these, try using diffusion instead. Commercially built diffusers are available but large bookcases and irregularly shaped furniture will also serve the same purpose. They reflect sounds in a highly randomized way which effectively "scatters" the sound in all directions. Place the diffuser where you would otherwise place the absorptive material (using the "mirror trick"), to break up the first early reflections and scatter them randomly throughout the room.

Commercially available fiberglass, foam and diffusion panels may not be aesthetically acceptable in many installations, particularly when the home theater room serves multiple purposes. all of these materials can be covered with acoustically-transparent cloth for design considerations. It is important that the cloth be acoustically transparent, however, or else the effectiveness of the absorptive material will be greatly reduced. The simplest test for this is to hold a large sample of the cloth in front of a speaker playing the pink noise found in Chapter 6 of the

SOLUTIONS TO ROOM REFLECTIONS:

Diffusion

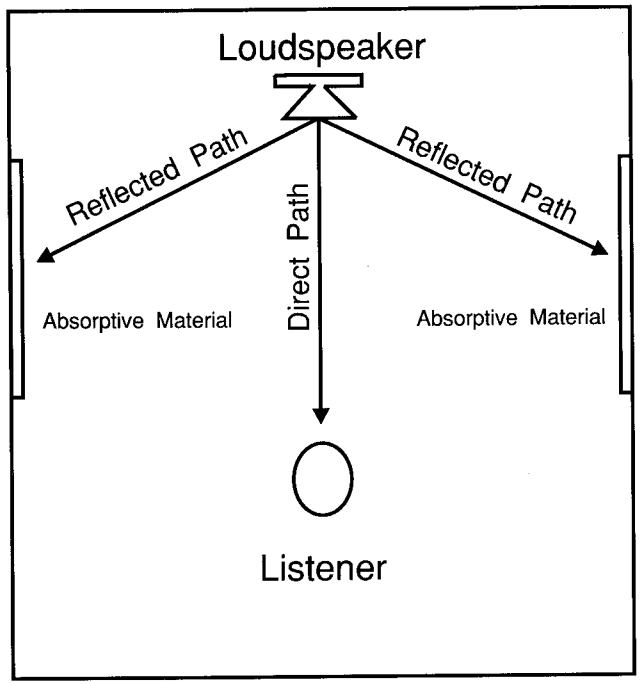


Diffusive Materials:

- "RPG" Brand Panels
- Bookcase
- Furniture

figure 3A

Absorption



Absorptive Materials:

- fiberglass
- dense foam
- draperies
- stuffed chairs

Find position for absorption by the "mirror" trick

figure 3B

WOW! laser disc. If you can move the cloth in front of the speaker without hearing a difference, you are all set.

Large expanses of glass can be challenging. They reflect mids and highs but often pass bass through almost as though they didn't exist. The result is a characteristically bright, rough sound which can be difficult to correct electronically. The best treatment is generally the heaviest insulated drapes which can be found (incidentally, these serve double duty, controlling light which might otherwise fall on the screen).

The materials just discussed here are ineffective at lower frequencies. See the discussion on Standing Waves for more information about treating environments with low frequency response problems.

EXCESSIVE USE OF ABSORPTIVE MATERIALS

People are sometimes tempted to go overboard with absorptive material once they discover how powerful its use can be. While the ideal home theater should be considerably "deader" acoustically than a typical living room, it still needs some reflectivity and diffusion. In particular, the surround speakers depend on non-absorptive surfaces for the operation, since they radiate virtually no sound directly at the listeners.

The best arrangement of the absorptive and non-absorptive surfaces in the room can be seen in the diagram below. Most of the room surfaces are relatively absorptive, with the notable exception of the rear wall and the highest portions of the other walls which should be diffusive.

"SLAP" ECHOES

"Slap" echoes are common in rooms which have parallel walls with little or no absorption or diffusion. Sounds tend to bounce back and forth between the parallel wall many times before they die out, causing a characteristic bright, "zingy" sound and interfering with the intended tonal balance and acoustic nature of the soundtrack.

Walk slowly through the room, clapping your hands. No clear reflections should be heard at any point in the room - especially not near the primary seating area. Listen for a "flutter echo" of the hand clap (a rapidly-repeating percussive sound, indicative of the sound bouncing between two parallel walls). Again, the best home theaters are fairly "dead" acoustically. This allows the program material and the playback system to create the environment, rather than having the room's native acoustic signature color everything. You can also use the hand claps in chapters 17 and 18 of WOW!

The solution for slap echoes is usually a combination of absorption and diffusion. Specifically, placing absorptive material behind the front speakers (heavy drapes, fiberglass, dense foam) and diffusion in the rear of the room (bookcases irregularly-shaped furniture, etc.) will deliver the greatest benefits. This will effectively suppress the slap echoes while at the same time providing a diffusive surface in the rear

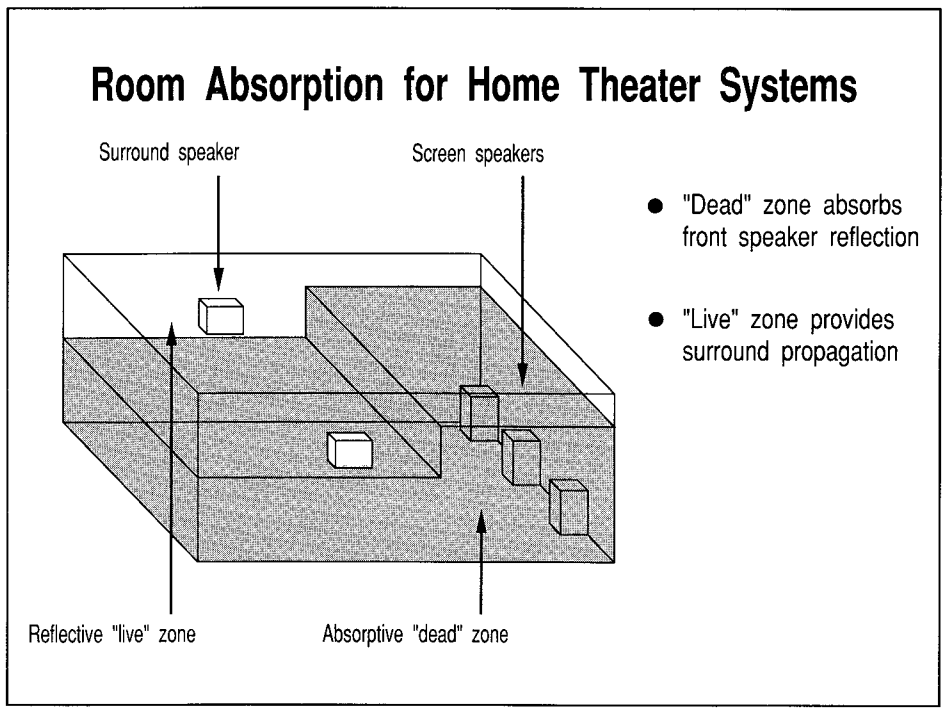


figure 4

for the surround speakers. This enhances the enveloping characteristic of the surrounds even further.

In those relatively rare cases where you have the luxury of building the home theater room from scratch, consider using non-parallel surfaces in the construction of the room. A difference of as little as 6 degrees will break up the slap echoes very effectively. For example, "flaring" the side walls out from the front by approximately 6 degrees and having the ceiling rise toward the rear of the room at a comparable rate will do wonders for the room's acoustics, if the wall design is solid and the angles are clearly intentional from the outset.

RATTLES

Rattles in the room are structural resonances (as opposed to standing waves, which are airborne resonances) which the system may stimulate due to its broad frequency response and wide dynamic range. They are particularly prominent for sounds in the lower frequencies, and can sound like distortion. Sources of rattles include: furniture, loose window frames, walls, lighting fixtures, ventilation systems, and even knick-knacks on various shelves around the room. the simplest way of identifying these rattles is by using the Rattle Test found on WOW! (Chapter 16). This is an extremely slow low frequency sweep from 20 Hz to 500 Hz, recorded at reference level. 10 dB of output level increase over standard level might be necessary to allow hearing all the room rattles. Be careful with this test, as it is also a severe test of associated amplifiers and speakers.

As the sweep makes its way up the frequency range, you will probably find a surprising number of rattles in your room. All of these rattles will occur at one time or another during music or movies, but are usually perceived as background noise or distortion in the system.

Once identified, eliminating the rattle is usually straightforward. As an example, small pieces of felt can be affixed to the back of a painting (in the bottom corners) to prevent audible rattle against the wall. Likewise, strips of felt can be wedged into a loose window rattling in its frame. Recessed lighting fixtures can be tightened up. A piece of cloth can be placed under offending knick-knacks.

Every Home THX Audio System should be subject to the rattle test at least once - the difference in low level resolution and in freedom from pseudo-distortion is sometimes large and the effort involved is quite small.

BACKGROUND NOISE

The effect of background noise on system performance is dramatic, yet often overlooked. Most people might think of it as merely a minor inconvenience, yet it has a profound effect on the way we perceive sound.

The presence of more-or-less constant background noise alters the way we perceive volume, since subjective loudness is a relative measure. In a quiet room, even a 70 dB SPL sound can seem fairly loud. In a noisy convention center the same volume would be barely audible. Since there is a practical upper limit to both the volume to which we should expose ourselves and to the volume a given system can reproduce, having a relatively noisy environment effectively limits the perceived dynamic range of the program material. This, in turn, limits the dramatic effect which might have been intended by the director (or the performer, if listening to music).

Constant background noise also obscures, or masks, low-level signals which are frequently important in films. Many scenes use subtle ambient noises to set the mood prior to an important event - without the full perception of the whispered secret or the barely-heard creaking of a door, the impact of the following scene is diminished.

It has been demonstrated that even a relatively narrow-bandwidth noise can effectively reduce our hearing acuity over a broad range of frequencies, far greater than the noise itself. When you add up all the various sources of noise from electric motors, noisy heating/cooling systems, outside noises, plus noises that even audio and video components can introduce such as noisy transformers, motors in laser players, or projector fan noise, our ability to discern the low-level information in the soundtrack is greatly compromised - and the director's intention along with it.

BACKGROUND NOISE SOLUTIONS

Many sources of noise in a home environment can be addressed simply. Locating the home theater in the basement often removes it from many household noises as well as isolating it from the other family members. Taking care to completely seal windows and doors can also make a significant difference in reducing outside noise.

Heating and cooling systems are more challenging. Sometimes, the answer may be as simple as using a "whistle-free" diffusion grille rather than one which creates undue noise from turbulence. In cases of new construction, using larger- diameter air ducts for lower air velocity is very beneficial. You can go further by using ductwork which is lined with acoustically absorptive material. Where possible, longer ducts which have several turns further reduce the sound of the airflow, by eliminating the straight path from the heating/cooling system to the room.

Some of the construction techniques used to minimize the transmission of external sounds into the listening environment include:

- Double or triple layers of sheet rock (gypsum board)
- Double wall construction, meaning two complete sets of studs (preferably stuffed with fiberglass insulation)
- Double wall construction with staggered studs (minimizes transmission of vibrations from one set of studs to the next)
- Floating floor construction (again, preferably stuffed with fiberglass; this also can enhance the perceived bass, since the subwoofers may cause structural vibrations through the false floor which then get transmitted through the furniture)
- Seal all windows, doors, vents
- Seal and caulk all apertures in the wall (electrical outlets, through-wall plumbing, etc.)

Finally, transient noises (traffic on the street, dripping faucets, etc.) distract your attention away from the program material, and remind you that you are in your home theater/living room rather than a participant in the action of a movie.

STANDING WAVES

A "standing wave" is what causes a pipe of a particular length in a large pipe organ to have its characteristic pitch. The pipe literally amplifies certain frequencies, based on its length and the wavelength of the frequency.

A typical rectangular room has three characteristic "lengths," and thus three fundamental standing wave frequencies. In addition, multiples of these frequencies are also amplified. These frequencies are often referred to as "room resonances" or "room modes" - that is, the frequencies at which the room tends to vibrate of its own accord. These resonances lead to uneven frequency response, the greatest problems being in the 60-150 Hz range for a typical domestic living room (at lower frequencies in larger rooms).

Unfortunately, there is no way to eliminate the effects of standing waves completely. The best that can be done is to minimize their effect through a variety of strategies.

STANDING WAVE SOLUTIONS: ROOM RATIOS

In new construction, the best way to minimize the audibility of standing waves is to plan for an even distribution of them, so that their effects do not "pile up" on top of each other. In this regard, the ratios of room dimensions are the critical factor. Rooms having equal dimensions are the worst, since the standing waves in all directions reinforce one another. Room dimensions which are even multiples of one another are also to be avoided where possible.

STANDING WAVE SOLUTIONS: SPEAKER PLACEMENT

Speaker placement also has an effect on standing waves and their audibility. In particular, placement of any speaker (including subwoofers)

where two walls and the floor meet will tend to stimulate all of the available standing waves, causing the most irregular response. The displacement required to minimize a particular standing wave depends on its frequency, with lower frequencies requiring more movement owing to their longer wavelengths. As a result, minimizing colorations due to standing waves often requires significant adjustment of subwoofer placement. Leave yourself some latitude with regard to subwoofer placement when planning your system - the final adjustment will probably have to be done on something of a trial-and-error basis.

STANDING WAVE SOLUTIONS: ABSORPTION

In theory, it is possible to damp standing waves with absorptive material. The difficulty is that the thickness of the absorptive material would have to be approximately one-half the wavelength of the lowest frequency requiring damping. This means a five-foot thickness of fiberglass would be required in order to damp everything down to 100 Hz - not very practical.

Standing wave energy tends to be concentrated in the corners of rooms which is why these are the worst places for subwoofers. Because of this fact, it may be possible to break them up somewhat by "breaking up" the corner. This can be accomplished by placing a column of thick, absorptive materials in the corners (covered by acoustically transparent cloth, of course). The column ought to be at least a foot on a side, and run from floor to ceiling. A variation on this theme is to run an absorptive panel diagonally across the corner, leaving open air space behind it. Neither of these techniques is more than a partial solution, at best, but they are easily tried and sometimes quite effective.

STANDING WAVE SOLUTIONS: ROOM EQUALIZATION

If a room exhibits severe standing wave problems, the best solution is to know your limitations: hire a trained acoustician. These professionals have the necessary background to analyze the various room modes and recommend appropriate action. This will sometimes take the form of a custom-designed bass trap, which may be easily constructed, but it takes specific skills to determine its optimal design.

On other occasions, careful third-octave analysis and equalization may be appropriate. Optimize everything else that you can, then use EQ, if necessary, to "touch up" the room. This is its best use. If everyone used EQ this way, it wouldn't have the bad reputation that it has in some consumer electronics circles. Professionals use it all the time, with excellent results - because they know its limitations and how to apply it.

Never equalize a room by ear. Room analysis is not as straightforward as it may seem. The analysis should be done using equipment with at least one-third octave resolution, using both spatial and temporal averaging. The final electronic equalization should be applied by means of a one-third octave graphic equalizer at a minimum.

In any event, rooms requiring this level of treatment are relatively rare and the skills necessary to handle them properly are highly specialized. Do not hesitate to use the professional services of an acoustician when you need them.

SUGGESTED DEMONSTRATION TITLES

The THX disc, *WOW!,* features a number of sections with exciting and entertaining demonstrations of the various aspects of motion picture sound tracks including low frequency response, dynamics, and surround effects. There are also many other discs which will provide outstanding demostrations of surround for both music and movies.

A large number of compact discs have been released encoded with Dolby Surround recently. These encoded titles, along with the tens of thousands of well-recorded stereo recordings available, provide a vast library of recorded music material for use with your AVP1 processor.

A short list of film titles is provided below which provide exceptional audio mixes.

ALL STAR WARS

ALL STAR TREK

ALL INDIANA JONES

THE ABYSS

AIR AMERICA

ALIENS

AMADEUS

APOCALYPSE NOW*
(REISSUE WIDESCREEN)

BACKDRAFT

BACK TO THE FUTURE

BACK TO THE FUTURE II

BATMAN

BEETLEJUICE

BLACK RAIN

BLADERUNNER
(REISSUE WIDESCREEN)

BRAINSTORM

DANCES WITH WOLVES

DICK TRACY*

GHOST

HAMBURGER HILL

HOME ALONE

THE HUNT FOR RED OCTOBER

IMAX: THE DREAM IS ALIVE*

JACOB'S LADDER

LADYHAWKE

THE MISSION

MEMPHIS BELLE

OUT OF AFRICA

PREDATOR

PREDATOR II

ROBIN HOOD

RUSTLER'S RHAPSODY

THE ROCKETEER

THE RIGHT STUFF

TEENAGE MUTANT NINJA TURTLES

TOTAL RECALL

WITCHES OF EASTWICK

*** EXERCISE CAUTION! The bass energy and recorded levels on this disc can damage or destroy ordinary speakers and subwoofers.**