HAA®

Home Acoustics Alliance

Acoustical Analysis Report

for

Dr. Will Smith

Quest Acoustical Interiors
(877) 900-6849

Prepared by: Your Local Calibrator, HAA Level I Certification

7/29/2004

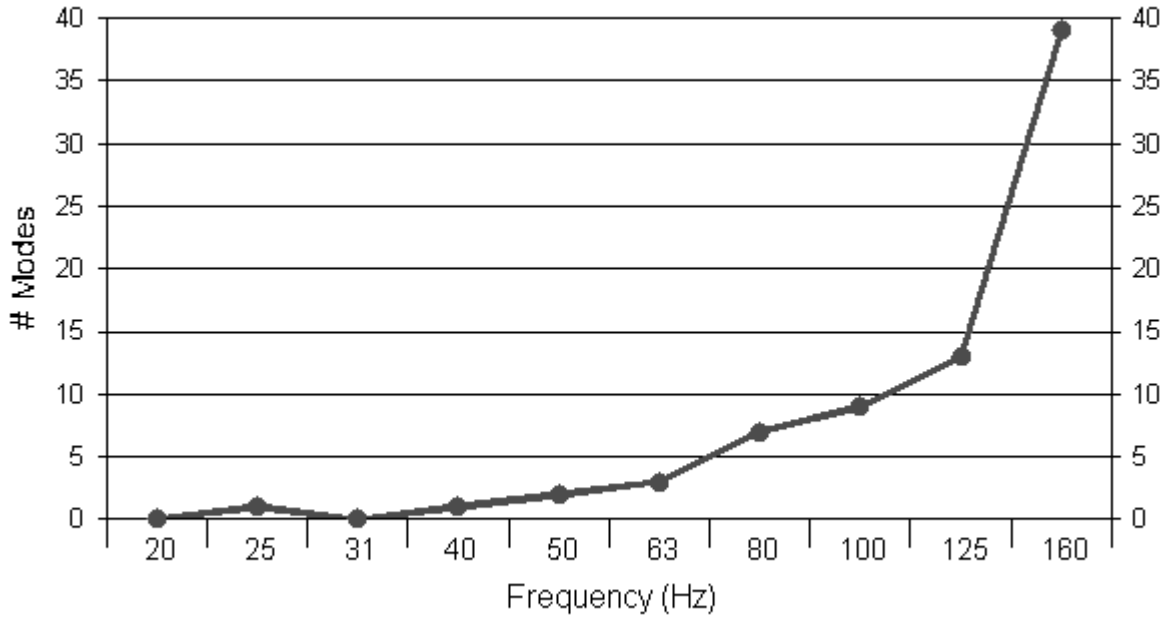
The Dimensions of Your Room

Mode Analysis Report

Understanding the acoustical nature of your listening room begins by analyzing the dimensions. While room dimensions should not be used solely to determine the suitability of a room for quality sound reproduction, room dimensions can reveal some potential problems. Good sound is possible in any room, even a room displaying poor modal distribution. Achieving good sound becomes a more challenging task though when the room dimensions do not evenly support all bass 1/3 octaves. In this analysis we focus on discovering which bass frequencies resonate in the room.

Resonant frequencies, called modes, are present in every room. Our first goal is to find out what modes are at work, we then begin learning if we can expect a neutral sounding room or a room injecting its own imprint on all of our music. Achieving uniform modal distribution means that the spacing between modes is relatively even with each 1/3 octave band occupied by a mode. Uneven modal distribution means that there are either too many or not enough modes in some of the 1/3 octave bass bands. This "mode analysis" uses the "Modes per 1/3 Octave" chart combined with a detailed modal calculation to analyse predicted bass smoothness. Use both to gain an idea of your rooms true modal character.

Modes per 1/3 Octave



Scenario: Height: 8.00 ft Width: 14.00 ft Length: 24.00 ft

Bands based upon standard spacing

Dimensional Analysis Plot: This simple looking graph reveals much about the sonic character of your room. Mathematically, it is a graphical representation of the total number of modes which occur in your room per fraction of an octave. This graph illustrates that the room uniformly creates bass modes when each successive fraction of an octave contains an equal or an increasing number of modes as the previous. Translation, a good room has modes in every 1/3 octave. A desirable dimensional analysis curve shows each band level always increasing or at least remaining constant. Any decrease in the number of modes, a retrograde sloped increment, indicates a frequency band without the proper modal support. In most cases, this causes some problems in achieving smooth bass, but depending on the scenario, it can be a significant nuisance. This is the real secret to a good room dimension ratio; Seeing how the height, width, and length effect the modal distribution by displaying this curve and by understanding modal coincidences. Modal Coincidences: A well designed room uses dimensions that do not create multiple modes at or near the same frequencies. While room modes are beneficial by enhancing low frequency energy in a room, coincident modes exagerate this enhancement at specific frequencies. Our target is to have the enhancement of bass to occur at many frequencies evenly. We therefore want to minimize the number of coincident modes, particularily at the very low frequencies below 100 Hz. Modes that are coincident are marked by an "X" on the Mode charts.

7/29/2004

The Dimensions of Your Room

Mode Analysis Report

mode analysis continued from previous page

Axial Modes

Freq (Hz)	p	q	r	Type	Wave(ft)	Spacing	Coin
23.51	1	0	0	Axial	48.07		
40.30	0	1	0	Axial	28.04	0.42	
47.02	2	0	0	Axial	24.03	0.14	
70.52	3	0	0	Axial	16.02	0.33	
70.52	0	0	1	Axial	16.02	0.00	X
80.61	0	2	0	Axial	14.02	0.13	
94.03	4	0	0	Axial	12.02	0.14	
117.54	5	0	0	Axial	9.61	0.20	
120.91	0	3	0	Axial	9.35	0.03	X
141.05	6	0	0	Axial	8.01	0.14	
141.05	0	0	2	Axial	8.01	0.00	X
161.21	0	4	0	Axial	7.01	0.13	
164.55	7	0	0	Axial	6.87	0.02	X
188.06	8	0	0	Axial	6.01	0.12	
201.52	0	5	0	Axial	5.61	0.07	
211.57	0	0	3	Axial	5.34	0.05	
211.57	9	0	0	Axial	5.34	0.00	X
235.08	10	0	0	Axial	4.81	0.10	
241.82	0	6	0	Axial	4.67	0.03	X
258.59	11	0	0	Axial	4.37	0.06	
282.09	12	0	0	Axial	4.01	0.08	
282.09	0	0	4	Axial	4.01	0.00	X
282.13	0	7	0	Axial	4.01	0.00	X

All Modes

Freq (Hz)	p	q	r	Type	Wave(ft)	Spacing	Coin
23.51	1	0	0	Axial	48.07		
40.30	0	1	0	Axial	28.04	0.42	
46.66	1	1	0	Tangential	24.22	0.14	
47.02	2	0	0	Axial	24.03	0.01	
61.93	2	1	0	Tangential	18.25	0.24	
70.52	3	0	0	Axial	16.02	0.12	
70.52	0	0	1	Axial	16.02	0.00	X
74.34	1	0	1	Tangential	15.20	0.05	
80.61	0	2	0	Axial	14.02	0.08	
81.23	0	1	1	Tangential	13.91	0.01	
81.23	3	1	0	Tangential	13.91	0.00	X
83.97	1	2	0	Tangential	13.46	0.03	
84.56	1	1	1	Oblique	13.36	0.01	
84.76	2	0	1	Tangential	13.33	0.00	X
93.32	2	2	0	Tangential	12.11	0.09	
93.85	2	1	1	Oblique	12.04	0.01	
94.03	4	0	0	Axial	12.02	0.00	X
99.74	3	0	1	Tangential	11.33	0.06	
102.30	4	1	0	Tangential	11.05	0.03	
107.10	3	2	0	Tangential	10.55	0.04	
107.10	0	2	1	Tangential	10.55	0.00	X
107.57	3	1	1	Oblique	10.50	0.00	X
109.65	1	2	1	Oblique	10.31	0.02	
116.97	2	2	1	Oblique	9.66	0.06	
117.54	5	0	0	Axial	9.61	0.00	X
117.54	4	0	1	Tangential	9.61	0.00	X
120.91	0	3	0	Axial	9.35	0.03	
123.18	1	3	0	Tangential	9.17	0.02	
123.85	4	2	0	Tangential	9.12	0.01	
124.26	5	1	0	Tangential	9.09	0.00	X
124.26	4	1	1	Oblique	9.09	0.00	X
128.24	3	2	1	Oblique	8.81	0.03	
129.73	2	3	0	Tangential	8.71	0.01	
137.07	5	0	1	Tangential	8.24	0.05	
139.98	3	3	0	Tangential	8.07	0.02	
139.98	0	3	1	Tangential	8.07	0.00	X
141.05	6	0	0	Axial	8.01	0.01	
141.05	0	0	2	Axial	8.01	0.00	X
141.94	1	3	1	Oblique	7.96	0.01	
142.52	5	2	0	Tangential	7.93	0.00	X
142.52	4	2	1	Oblique	7.93	0.00	X
142.88	5	1	1	Oblique	7.91	0.00	X
142.99	1	0	2	Tangential	7.90	0.00	X
146.69	6	1	0	Tangential	7.70	0.03	
146.69	0	1	2	Tangential	7.70	0.00	X
147.66	2	3	1	Oblique	7.65	0.01	
148.56	1	1	2	Oblique	7.61	0.01	
148.68	2	0	2	Tangential	7.60	0.00	X
153.17	4	3	0	Tangential	7.38	0.03	
154.04	2	1	2	Oblique	7.34	0.01	
156.74	3	3	1	Oblique	7.21	0.02	
157.69	6	0	1	Tangential	7.17	0.01	

Prepared by: Your Local Calibrator, HAA Level I Certification

The Dimensions of Your Room

MODE ANALYSIS REPORT

mode analysis continued from previous page

All Modes

Freq (Hz)	p	q	r	Type	Wave(ft)	Spacing	Coin
157.69	3	0	2	Tangential	7.17	0.93	
159.02	5	2	1	Oblique	7.11	0.01	
161.21	0	4	0	Axial	7.01	0.01	
162.46	0	2	2	Tangential	6.96	0.01	

System Performance Analysis

Acoustical Analysis Report

Acoustic Design Review for Home Theater

HAA definition of a System: The chain of components from source through amplification, speakers and finally including the last critical link in the chain; the listening room. All are part of the final performance picture and are integral components of the system. This analysis report focuses on the room component of the system and how well the other components are integrated into a balanced properly designed home theater.

The Home Acoustics Alliance (HAA®) has developed the Acoustics Design Review for Home Theater to be a qualitative review of the design of a home theater system. The various "Elements" that outline the framework for a properly designed system are reviewed by the acoustical calibrator and graded based upon how well they conform to the HAA® standards. The grades provide a relative scale to judge success but do not consider if the equipment has then been properly calibrated after installation. Other quantitative elements must be measured and heard to get the total picture of a systems performance. This final quantitative check called the Acoustic Performance Review factors in the actual measured performance of the system. For the total performance evaluation, the ADR establishes the required design elements and the APR orchestrates the final calibration elements. This ADR section of the report will show elements of the system that need to be changed to make high performance results possible. If both reviews are conducted the final report scoring will factor in both design and calibration elements for the final grade.

ABOUT YOUR SCORE:
The grading scale devised for this analysis is based upon a 4 point system: A score of "A" means that your system complies and high level performance will not be restricted based upon this element's influence. A score of "B" means that your system does not fully comply with the element specifications and it may begin to have some impact on sonic performance. A score of "C" is where changes to the system are strongly recommended to bring the performance up to an acceptable level. A score below "C" means that the element is a significant detriment to system performance and the current design should be changed.

Your Score Before Calibration

C

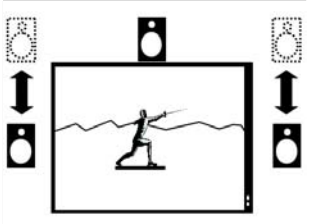
Element *4*

Your Score Before Calibration

B

Front LCR speakers are placed at similar height (+/- 2 feet between tweeter/midrange center point).

Humans hear sound differently depending on the height of the sonic source. Speakers placed a different heights will present different apparent tonal qualities and thus provide a discontinuity across the soundstage. In worst cases, the imaging is all but destroyed. One of the requirements of a well matched speaker system is tonal matching of speakers. Failure to keep the presentation height of the front channels similar defeats this important goal.



Humans hear sound differently depending on the height of the sonic source. Speakers placed a different heights will present different apparent tonal qualities and thus provide a discontinuity across the soundstage. In worst cases, the imaging is all but destroyed. I believe we can salvage the problem and solve several other issues by upgrading to the Revel satellites we discussed. This is an elegant solution since teh better speaker also is smaller allowing us to better align the front three channels.

Result: No significant change in this element

Your Score After

B

System Performance Analysis

Acoustical Analysis Report

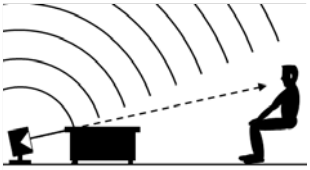
Element *6*

Front center speaker is visible from all listening locations (unobstructed direct sound), accepting any acoustically transparent coverings.

Your Score Before Calibration

C

Sound seems to easily round corners and is audible irrelevant of the speakers position. We hear the reflections of sound reverberant sound of a speaker as it scatters through objects and space. The direct sound though cannot round corners or easily seep between the legs of a beautiful coffee table. The direct sound contains the essence of focus, and clarity, two qualities one pays dearly for when purchasing high end gear. The speaker must have a clear path to all listeners' ears to relay this expensive information.



The sonic issues created by this element also relate to the position of the center channel speaker. For listeners in the front row, this is a non-issue. For listeners in the second row the low postion of the center channel means there will be little or no direct sound. A higher platform for the second row would greatly improve things here. I recommend at least a double step platform. This is not as hard as it might appear given that a seconf platfrom incorporating a step could be added on top of the existing one. I've attached a quote for the work.

Result: This performance element has been improved

Your Score After

A

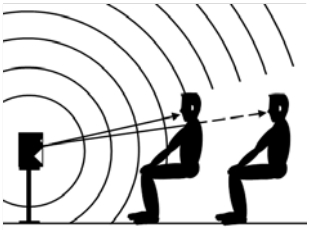
Element *9*

Front left and right speakers should have a clear line-of-sight from all listening locations (unobstructed direct sound).

Your Score Before Calibration

B

Sound seems to easily round corners and is audible irrelevant of the speakers position. We hear the reflections of sound reverberant sound of a speaker as it scatters through objects and space. The direct sound though cannot round corners or easily seep between the legs of a beautiful coffee table. The direct sound contains the essence of focus, and clarity, two qualities one pays dearly for when purchasing high end gear. The speaker must have a clear path to all listeners' ears to relay this expensive information.



The center channel is carefully placed below the large video projection screen. While the front row is in a prime position to hear the detailed stream of audio projected from the center speaker, the second row listeners appear to be blocked from it. No direct sound equals no dialogue clarity and a reduced soundstage for the folks in the second row. Suggestion: Put the second row on a two step platform vice the single. While currently, the video image may be in full view, the center channel may as well be under a bushel basket.

Result: This performance element has been improved

Your Score After

A

System Performance Analysis

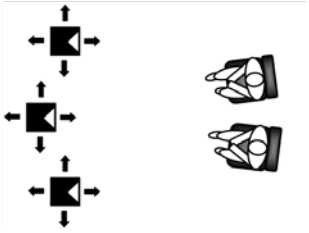
Acoustical Analysis Report

Element ***10***

Your Score Before Calibration

B

Front LCR speaker stands are movable within the room length and width wise and there is sufficient available space to allow repositioning to optimize response and soundstage presentation.



One of the hardest things a sound room designer must do is decide in advance the exact spot in a room to place a speaker to optimize performance. Expensive computer modeling aside, it is nearly impossible to account for all acoustical possibilities. The best approach is to design an area of adjustment or leeway for minor changes in speaker position. Ideally, an area at least 3 to 4 feet from the front and side walls will leave room for correction of various response problems. Otherwise, one must depend on equalization as only a partial fix or luck if you're superstitious.

This element is restricted by the layout. While some repositioning of the speakers is possible, drastic changes are not possible. Given that the general locatoin of each of the speakers is acceptable the impact of this element is minimal. As I pointed out earlier by upgrading speakers to a smaller model we can make a better arrangment of speaker position to cure many problems.

Result: No significant change in this element

Your Score After

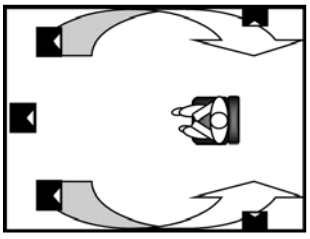
B

Element ***11***

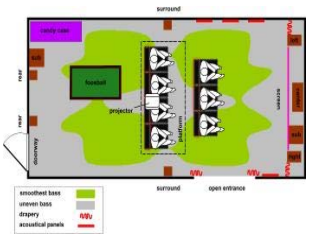
Your Score Before Calibration

D

Side surround speakers are positioned to allow seamless front to rear panning (mounted at ~110° from center axis; 90° or realign null for dipoles).



The position of side channel speakers can be critical at generating a seamless and enveloping surround field. Speakers placed behind an obstruction or too far behind the listener can cause abrupt panning from front to back and vice versa. Speakers placed too far forward do not allow proper rear sourced imaging. An exception is for dipole side speakers typically designed to be abreast the listener. Properly positioned side surround speakers will enhance the front sound stage and wrap it around the audience meanwhile providing for side channel sourcing of key effects.



In this case, the side channels are too far forward given that they are diploe speakers. The cuurent position will yield an improper timbre and be unable to create properly localized sounds behind the listeners. A better solution would be to move the speakers toward the rear, aligning them with the second row. This will yield correct results for the second row and no worse results fo the firsts row.

Result: This performance element has been improved

Your Score After

B

System Performance Analysis

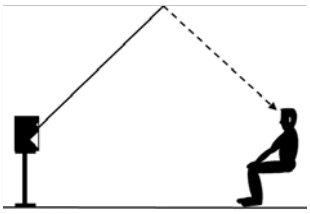
Acoustical Analysis Report

Element *23*

Your Score Before Calibration

D

Ceiling at mirror points should be substantially diffusive or at least absorptive at mirror points.



The ceiling is generally not a target of significant acoustical treatment in most sound rooms but its unobtrusive presence often offers an invisible way to add needed acoustical absorption. For low ceilings or ceiling where loudspeakers are nearby (< 6') strong reflections can be troublesome and should be dealt with by absorption. Unless a room has high ceilings and sufficient absorption elsewhere or speaker's directivity minimizes upward sound energy, the ceiling should have at least basic absorption at mirror points.

The ceiling can be easily treated with acoustical panels given that it is smooth and witout significant obstructions. A simple pattern of two by two foot panels upholstered in a fabric matching the ceiling color would be inexpensive, inocuous, and highly effective. I have attached a quote from Quest Acoustical Interiors for the necessary product and our labor to install them.

Result: This performance element has been improved

Your Score After

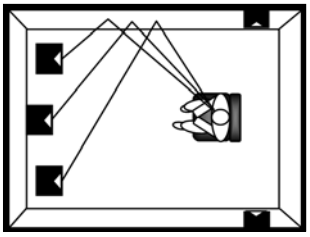
A

Element *26*

Your Score Before Calibration

B

Right side wall extends from the front wall past listeners lengthwise and lateral reflections are present yet controlled at mirror points by absorption, diffusion or realignment.



Lateral reflections allow the front soundstage to meld with the surround field creating a sense of three-dimensionality. In addition, the lateral reflections allow sounds to seamlessly pan from front to back and vice-versa. The lack of side walls as reflectors is considered a flaw in good design. In small rooms and in situations where speakers or listeners are close to the side walls, the reflections of sound can act to overwhelm the direct sound of the front speakers. For that reason, proper design dictates treatment to absorb or scatter excessively strongly reflections.

One side wall has a double wide non-doored entrance. This opening will deflate some of the lateral envelopment desired for proper imaging. A door or set of doors would be extremly helpful in solving this issue. The side walls surfaces between the front speakers and the listeners are actually critical parts of the system. These surfaces should be similar acoustically, they're not, and a gaping opening does not provide any enhancement of the enveloping soundstage.

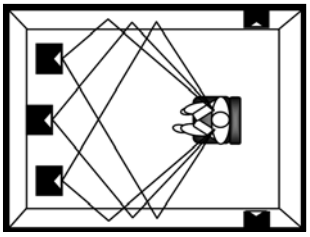
Element *27*

Your Score Before Calibration

D

Opposing horizontal wall surfaces are similar acoustically to preserve a balanced soundstage and surround field.

While it is good to have at least one side wall properly prepared acoustically, the lack of the same properties on the opposing surface is a serious flaw. These lateral surfaces are significant components in the "system". Their contribution is the foundation of performance for both home theater and two-channel stereo systems. A non-symmetrical pair of lateral walls can be a minor nuisance if only minor differences exist or create an off balance and un-involving soundstage if significantly different.



Besides the loss of envelopment as discussed in the previous element, th e lack of a balanced lateral sound field is of concern. Here again, inserting a doorway will have significant benefits. Also The QuestAcoustical plan will assist in solving remaining issues; See Acoustical quote attached

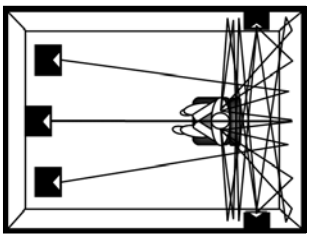
Element ***30***

Your Score Before Calibration

B

Back wall is continuous and its surface is substantially diffusive or at least not overly absorptive preserving envelopment except at front speaker mirror points.

Overly strong reflections may be present from the rear wall originating from front speakers. Such mirror points are important to control particularly in line with the three front speakers due to the possibility if flutter echoes. However, the side and rear speaker's diffusive presentation can actually be enhanced by scattered reflections from the back wall. Treatment of key mirror points should not make the back wall overly absorptive. Absence of the back wall diminishes envelopment and can be a significant flaw in the design.



See Acoustical quote attached

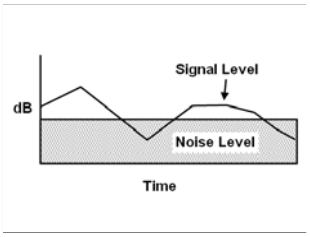
Element ***32***

Your Score Before Calibration

C

Room is sealed and all noise producing devices have been isolated or damped to reduce ambient noise.

Dynamic range is most often thought of as how loud a system can play. Equally, the dynamic range is limited by a system ability to be subtle and quiet. High resolution audio components are designed to reveal the most delicate details which can become inaudible if overwhelmed by even moderate ambient noises. Low level dialogue is turned up only to have loud special effects force us to turn the level back down. A common symptom of excessive noise is center and side channels appearing to be too quiet.



Several factors are at work here; the video projector is located immediatey overhead, the equipment rack is immediatley next to the main listening positon, and the side entrance is not doored. All are factors contributing to the potential for excessive ambient noise.

System Performance Analysis

Acoustical Analysis Report

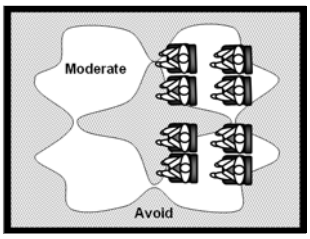
Element *33*

Your Score Before Calibration

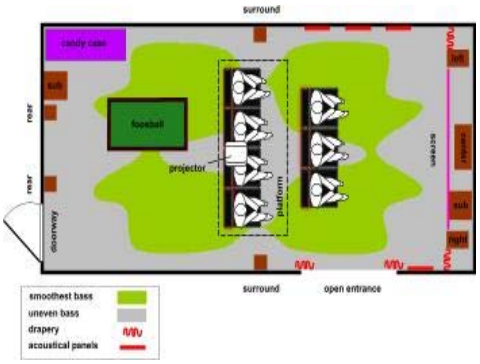
C

Listening positions are not pre-disposed to extreme bass response anomalies.

One of the problems associated with small rooms is the effect of standing waves or room modes on low frequency response smoothness. In rooms which are generally rectangular, assumptions can be made on the expected response at any given location. For less symmetrical rooms, computer modeling must be employed to understand the response. In any case, the least desirable locations are near any wall and the center of the room.



Moving both rows of listeners backward would solve more than one issue; as shown to the left the second row of listeners would move into a space for improved frequency response as would the first row. More importantly, both would be in a zone that is similar in response acoustically. This unformity would mean that any equalization would yield similar results for both rows of listeners. In additoin the large size of the chosen video screen makes "up close" viewing less than optimum and the farther viewing distance will improve the video presentation as well.



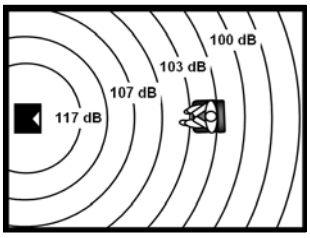
Element *34*

Your Score Before Calibration

C

System specifications show sufficient capability to achieve distortion free reference sound levels in given room volume.

Understanding how much power is necessary to achieve correct reference sound levels with out distortion is not obvious. Many well designed amplifiers seem to play louder than their wattage specifications because of a high quality design. Some speaker systems are exceptionally efficient and can greatly extend the dynamic top end of mid-size amplifiers. If the combination of power and speaker efficiency is not theoretically able to reach 105 dB at any listeners seat the system is under powered.



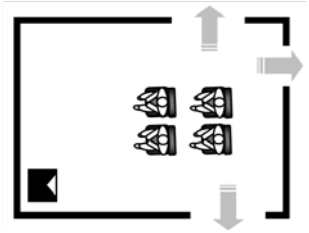
The proximity of each listener to the main speakers control much of the dynamic capability of a system. Moving the listener farther away from the speakers will reduce the top sond pressure level acheivable by the front speakers. Given the power output of the system and the large size of the room, top SPL will be difficult to acheive.

Element *35*

Your Score Before Calibration

D

Room is sealed, without windows and doors are solid core with gaskets to limit leakage of sound.



Leakage of sound, especially in the low frequencies, means more than just keeping the remainder of the house quiet. Proper reproduction of low frequency sound requires significant power and reference level sound is often is only achievable by use of multiple subwoofers in a low loss room. Proper bass levels should sound articulate, without strain and distortion. Undistorted and smooth bass at high sound levels is usually perceived as more listenable than poorly reproduced sound played at lower sound levels and with less listener fatigue.

Here again the addition of a door would have significants benefits toward the final goal of a high perfomance theater system.

System Performance Report Card

Acoustical Analysis Report

HAA Acoustic Design Review for Home Theater

HAA definition of a System: The chain of components from source through amplification, speakers and finally including the last critical link in the chain; the listening room. All are part of the final performance picture and are integral components of the system. This analysis report focuses on the room component of the system and how well the other components are integrated into balanced properly designed home theater.

The Home Acoustics Alliance (HAA®) has developed the Acoustics Design Review for Home Theater to be a qualitative review of the design of a home theater system. The various "Elements" that outline the framework for a properly designed system are reviewed by the acoustical calibrator and graded based upon how well they conform to the HAA® standards. The grades provide a relative scale to judge success but do not consider if the equipment has then been properly calibrated after installation. Other quantitative elements must be measured and heard to get the total picture of a systems performance. This final quantitative check called the Acoustic Performance Review factors in the actual measured performance of the system. For the total performance evaluation, the ADR establishes the required design elements and the APR orchestrates the final calibration elements. This ADR section of the report will show elements of the system that need to be changed to make high performance results possible. If both reviews are conducted the final report scoring will factor in both design and calibration elements for the final grade.

Clarity

Initial Score: B

Clarity is the prime acoustical quality because its perfection depends on the successful attainment of all other goals. Of paramount importance is dialogue intelligibility in movies, but one must be able to understand musical lyrics, detect quiet background details, and sense realism for acoustical sounds. Elements that affect this goal are varied including equipment quality, room reverberation levels, ambient noise levels, and listener position among others. Clarity is paramount in defining the performance of a home theater system.

Focus

Initial Score: B

The ability to precisely locate each reproduced sonic cue or image in a three-dimensional space is defined as acoustical focus. Recordings contain many such images superimposed side to side and front to back in every direction for 360 degrees around the listener. A system is said to have pin-point focus if, from the perspective of the listener, each of these images is properly sized, precisely located, and not wandering. Good focus also provides that individual images be easily distinguishable from amongst others within the limits of the recordings quality.

Envelopement

Initial Score: B

An audio system should reproduce virtual images of each recorded sound presenting the listener with its apparent source location in a three-dimensional space. Each sonic image relates a part of the recorded event and together these sounds compose a wrap-around soundstage that envelopes the listener. Proper envelopment requires that the soundstage be seamless for 360 degrees without interruption by holes or hot spots caused by speaker level imbalance or poor placement. While envelopment requires three-dimensional imaging of all sonic cues, of pivotal importance is the realistic recreation of the ambient sound field of the recorded venue. Focused sounds become more realistic as they move side to side and front to back with the backdrop of the ambient sounds of the intended venue.

Dynamics

Initial Score: C

Dynamics is simply defined as the difference between the softest and loudest sounds reproducible by a sound system. While much emphasis is placed on the loudness side, it can be shown that the audibility of the softest sounds is an equal measure of system performance. Among the acoustical requirements for proper envelopment, focus and clarity is the necessity of hearing the sonic cues relating these qualities. If they are overwhelmed by excessive ambient noise or reverberation in a room, they are not properly audible. At a minimum, a system must be capable of reproducing loud passages with ease and without excess while soft sounds remain easily audible.

System Performance Report Card

Response

Initial Score: B

The frequency response of a system is a measurement of the relative levels of all reproduced audio frequencies. The smoothness of response can be observed in a variety of ways; as improper tonal balance including boomy bass, excessive treble, improper musical timbre, or a general lack of realism. Factors of importance include selection of high quality components, and proper system set-up including (in a small room) proper listener position, speaker position, and correct use of equalization. At a minimum, the system must be non-fatiguing all sound levels, articulate and faithful to the original signal.