

Kris Audio & Digital Technologies

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White Paper

Home Theater Systems – Audio, Video and Controls

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Many audiophile purists insist that movies and music require different systems. However if the aim of high fidelity in home theater is to get the most natural reproduction value for money, even fairly basic audio and video can be easily adjusted to near perfection once the major pitfalls are known and adjusted for.

What is the difference between a loud stereo and a good stereo?

Just as the sound in the bathroom is clearly different to the sound in your living room, different living rooms impart their own colour to the sound of your expensive audio system. But if all rooms are different, how does one get around this issue? Well, an expensive sound engineer can help you tailor the sound like they do in professional auditoriums – with bass traps and treble reflectors in strategic locations, but quite frankly – these things look hideous in all but specially-built listening rooms. Yes, some of us have partners that might let you get away with painted egg-cartons stuck all over the ceiling and walls, but such a person is most probably going to be harder to find than winning the lottery.

All rooms colour the sound of even the most expensive sound systems

However computers and microchip technology are now available to save the day if need be. Yes, they can add their own colour and imperfections to the sound, and thus purists shun them, but for the average audiophile the benefits they bring far outweigh the minor changes they may add – if any. With the right technology you can make an expensive system – which sounds bad due to poor room acoustics – change and present a very pleasant experience indeed.

So what can one do if the expensive sound system purchased ends up being shrill, boomy, or both in the listening room? With audio systems more than anything else, the law of diminishing returns holds. Change your house to one that has (or build one that has) the perfect room dimensions? No, simply tweak the sound output of your system to get the tonal balance right!

Most modern AV receivers include a simple calibration system to match the loudness of your 5 speakers to one another. But slightly more sophisticated (AMRT) systems will also compensate for when room resonances are too high, and when sounds are being absorbed. The most sophisticated systems even repair the minute time-delays which occur between the low- and high-frequency drivers of a loudspeaker system.

But electronic wizardry can only do so much. A common error is to try and get 'real' sound from tiny "invisible" systems, when the laws of physics say No. For example, drums are large. Trying to get a 100cm loudspeaker to accurately reproduce the satisfying thump of a 600cm kick drum is really pushing things a little bit. Yes, small speakers *might* sound okay during the initial listen, but not once your ear has a chance to re-calibrate itself (the brain is a mighty device and will compensate for poor sound when needed – so you can hear the sound of your baby crying outdoors, even with a waterfall in full blast) – it knows when something is not true. Does that mean we need to have loudspeakers that are 600cm in size? Not so, but clearly the larger the speakers are, the more accurate the reproduction of key mid-bass frequencies – 80% of all sound are in the mid-bass range.

Is big always better?

Yes larger is better for the low end, but size and mass do different things. A large loudspeaker (or truck) could have low mass (when empty) or be very heavy (when filled).

Because sounds and music are a constant series of starts and stops, it is easy to understand that a large heavy and slow-acting loudspeaker is not going to reproduce music as well as a large light and fast-acting loudspeaker would.

Think of it this way, when you hit a drum, how long does it wait before it starts moving, and when you put your hand on it, how quickly does it stop moving? Different drums have different start-stop characteristics, and that is what makes them sound different. But since loudspeakers are supposed to be neutral and reproduce different drum sounds with all their subtle differences, it requires the loudspeaker itself to start instantly and stop instantly (or it will change and colour the sound of the drum slightly).

These slight changes and colorations are what cause listener fatigue. Yes, there is no perfect room or system, but if key laws of physics are followed, the chances of selecting a more perfect and less-fatiguing sound system is possible.

Neutralize the room. And the speakers....

There are 10 octaves of sounds that an average human can hear

Octave	1	2	3	4	5	6	7	8	9	10
Center Frequency Hz	30	60	125	250	500	1000	2000	4000	8000	16000

Of these, the first two and the last two octaves are actually seldom reproduced in most sound systems! Or they are drowned out by having too much of the other octaves.

So how does one get the balance right?

It's hard. It takes years and years of listening practice, but “automated room management technology” – used correctly – can come to the rescue. AV receivers that incorporate AMRTs are available.

- Automated Room Management Technology – 1

The MCACC¹ firmware available in Pioneer's AV receivers is a basic system that measures the system's loudness **and frequency response** at the listening position, and changes them so the listener is presented a balanced sound stage. Sound too bright (because of hard walls, floor and furnishings)? Easily corrected. Is the sound too dull and/or boomy? Same thing!

This technology is even advertised as being available in Pioneer's lowest price (\$600 RRP) receiver which sometimes sells for as little as \$400, and it has the power to change any basic system into one that is clearly in the hi-fi category – will little user effort.

- Automated Room Management Technology – 2

The manufacturer-independent Audyssey² system also measures the system's loudness **and frequency response** at various listening positions, and changes them so listeners are presented a balanced sound stage, but also fine-tunes the time signatures of the various woofer, midrange and tweeter drivers across the frequency range. This firmware is available on slightly higher priced (than Pioneer) but 'budget' Onkyo AV receivers, and also on receivers from Denon and NAD.

Some powered speaker systems also exist that incorporate Audyssey smarts, so one could use an existing receiver and gain the benefits of Audyssey.

If your budget allows, Audyssey is the best consumer ARMT currently available, but the audible difference to a new audiophile will be minimal when compared with – for example – the Pioneer MCACC solution.

Since modern ARMT changes are affected in the digital domain, issues – caused when such changes are made in the analogue domain – are avoided. Note that there are some brands of systems that remove the key frequency-balance adjustments from ARMT offerings with their lower priced models, so check carefully; get your store to agree to offer you a full refund if so, as this is usually not apparent until well into system setup.

Of course, if ARMT is never set up correctly or never set up at all (it happens!), it is no better than having a system without the technology.

Bi-amping theory you need to understand

Sound studios and ICE (in-car entertainment) fans use bi- and multi-amping regularly. It is not so 'common' with home hi-fi, but the theory is sound: if you had a single bass note played by an organ pedal and also a high note, the amount of power would be reduced in the ratios 25:10:2 if each were sent to a different amplifier (through an “active crossover” device), than if a single amplifier was used³.

What it means is that in place of a single 25 watt amplifier, you could get the same loudness with a 10 watt amp for the bass and a 2 watt amp on the treble! How can we use this for home theater? With correct sub-woofer settings.

Sub-woofer adjustments

Full-range speakers can reproduce bass. A better option is to remove the deepest bass from the main amplifier and have a dedicated active (self-amplified) “sub” woofer. While subs can be set to only reproduce LFE (low frequency effects) from movies, they should be set to output both effects- and normal-low frequency sounds, freeing the main amplifier to reproduce the loudest frequencies in Octaves 3 to 5.

Once you set your receiver to send everything under 80Hz to the sub-woofer, the receiver suddenly has massive amounts of spare power available for the other octaves! Don't forget that with the 25:10:2 rule, a dedicated 100 watts sub-woofer has 2.5 times more power available than a 100 watts full-range system.

Loudness and Power

Loudspeakers are rated by their output in decibels with a 1 watt input. Since most loudspeaker sensitivities are advertised as being around 90db do we really need 100s of watts of power? The answer lies in how the measurement is made and how we hear.

The 90db measured is at a 1 meter distance from the driver. Since sound drops off with distance, by 4 meters we are down by 12db. To bring that back up to 90db requires 15x the power, or 15 watts.

But we do not listen at 90db.

Normal home background noise levels are 60db. To listen at 75db requires a lot less power again. Just 0.5 watts. Yes you read correctly, one-half of a watt, most times!

But music is not all at a consistent level. It varies between soft and loud. And very loud. This very loud is the 'reserve' power an amplifier needs to have available. (Many DVD players default to a compressed dynamic range setting, so the loudest sounds are simply never played louder, and thus an amplifier is never called to work at it's maximum. For proper playback, make sure you select full-range 'realistic' mode – one reason why unthinking audiophiles claim CD players are needed to play CDs properly!)

Hi-fi amplifier ratings are given as RMS power and peak power. The RMS rating is like your average power. So one that is 30 watts is actually very loud for the average speaker system.

How loud?

So how much power is enough? Look at it another way. If – and it's a big if – you get highly inefficient loudspeakers and they are putting out 83 db average (at 4 meters distance) with your amplifier running at it's maximum of – say – 150 watts RMS, trying to get to 86 db loudness at the

listening position needs an amplifier of 300watts RMS, and for 92 db you would need 1,200watts. Per channel! RMS!! At these scales, 10s of watts and even 100s of watts really don't mean much.

So unless you are trying to fill an auditorium, the average 50 to 100 watts RMS per channel receiver is more than adequate for the average home – especially when it is running at ½ of a watt most times!

You can do a simple test yourself to prove high power is over-rated – connect the headphones output of your 1watt MP3 player to a set of “large” loudspeakers and you'll be amazed just how 'loud' they can play!

How many speakers?

Recent advertisements are promoting more and more 2.1 systems! People are getting fed up with the mess of cables needed for surround sound that don't have much benefit – even with movies. Perhaps some real action type movies might give you more 'rear' audio, but in general a well tuned (note – ARMTs required) 2.1 system will offer a lot more pleasure than an un-tuned shrill and boomy 5.1 system (5 speakers and a sub). Even 3.1 – a center channel speaker – is overkill; they were really meant for very large theaters. Yes, a center-channel speaker would be a requirement if you are watching movies on a large 300cm projection screen, but not if you have the average 100cm flat panel display. And if you decided to use more than 2 speakers for music listening, ensure they are matched as you would otherwise get listener fatigue very quickly.

Okay, we have an adequate power, some decent speakers, and room correction, so what else do we need?

The seldom considered but major bugbear with home theater users (other than the person who purchased the system) is the confusing array of remote controls and buttons to press. One recent talk-back radio announcer was swamped with calls when he raised the issue of *Who Turns On The TV In Your House*, with callers complaining that with the new systems, they have to wait till “the chief operator” comes home before they could watch even basic TV.

The reason is simple. Every device in the chain wants to be “in charge”. Some DVD remote controls control the TV too, but not the digital recorders. Recorders don't record because they have been accidentally turned Off. Electronic Program Guides are anything but. And oftentimes users get a picture but not sound, or the other way around. And does the sound come out of the expensive AV receiver and speakers, or out of the TV speakers?

The solution is a simple device – a “smart” remote control. No, not just a “learning” or multi-device remote. It's got to be smart. So it knows that if you are listening to a music CD in the DVD player, the TV display does not have to be switched On. Or if you press Watch TV, the digital recorder should come on, the DVD player turn Off, and the TV turned On too, of course! There are several brands of which the Logitech Harmony series is the most cost effective. All Logitech remotes use the same software; but they require IT knowledge in configuring them.

Signals and cables

The last hurdle is knowing which audio and digital cables and signals should be used, and which are overkill. Everyone talks about HDMI, but what if you need to connect up an old VCR and it does not have HDMI? Does that mean you need to have 2 cables going between the VCR and the amp and another two sets going to the display (one as HDMI for the Blu-Ray player another for the VCR and so on)?

The better AV receivers not just signal-switch but also up/downscale the video and audio signals for you. Is there anything wrong with the composite, s-video, RGB signals available on some systems? Not at all. The important thing to be aware of is to know and understand what your prime quality audio and video feeds are and which are secondary, then connect up accordingly.

Cable costs

Overpriced cables are the bane of the AV industry. Not knowing any better, consumers sometimes pay as much for their cables as they do the electronics – and gain no benefit.

Digital signals are simply that, digital. Signals either get to the other side or not. If they do (however weak) there is perfect sound and vision. Take for example a scratched computer disc with a document. If the scratches are very bad, it won't be readable. Full stop. If it is readable (ie.

above the minimum threshold), error correction ensures that the data is reproduced 100%. There is no 99% with digital.

Analogue signals are different. If the tape was perfect but the cable between a cassette player and the amplifier was poor, the sound quality would be affected. But unless you have an extensive, irreplaceable and priceless analogue collection (which you are converting to digital – since analogue degrades with each playing!) there is little or no reason to part with expensive cable, even with analogue.

Speaker cables are different. Once cable runs exceed 3 meters it is important to get a thick cable. But in this particular sector of the market snake-oil salesmen have come in and you can spend a lot of money for very little gain. Be warned. Just get run of the mill cable (AWG-20 rated; the lower the number the thicker the cable is) from Jaycar Electronics or Dick Smith. Then *after* the system is functional for a few months, feel free to purchase – with a money-back guarantee! – expensive cables and give them a try. If you do think you hear an improvement, quantify that as a percentage gain against the cost. Very few will accept a 10% gain against cables that cost 10x more (it happens!)

To prove the point, KAADTEK have a deliberately set up a system with a with a 5 meter run of super-thin (AWG-27) phone-cable and a basic 50W (RMS/ch) AV receiver, and many are amazed at it's great sound quality – due to room matching electronics mainly, and a truly fantastic pair of loudspeakers. One day the cable might melt, but it hasn't happened yet!

Display errors

It is also important to calibrate your display correctly. All too many displays are set too white, too black, and too vivid. The most common fault is to have a single black when there are hundreds of shades of black! And skin tones that are Orange all the time – humans have thousands of variations. (Note: DVDs with 'THX' usually have calibration images, check out the Special Options menu.)

Reference sounds

As for sound, start listening to (not just hearing) natural musical instruments. An un-amplified nylon-string guitar, an un-amplified steel-string guitar, a saxophone, drums and a piano. These will help calibrate your hearing to appreciate accurate sound.

Summary

The key to the pudding is in the eating, as they say. How does your final system perform? Here is an example. In the 2006 movie *Children Of Men*, I had my attention diverted during a “quiet” moment as the hero buys his cup of morning coffee, and there is an explosion. It literally made me jump out of my seat – not because it was loud, but because it was real – the sound was not from “the TV” but appeared real! Or when during a Sunday-evening period drama on ABC TV where a teacup was dropped and broke, I thought for a moment someone had done so in my kitchen! Such a response is the measure of an excellent integration of room acoustics, great transient (start/stop) response, adequate amplification, and a truly balanced loudspeaker system.

It is not hard to purchase a good home theater system; it takes a just little bit more work to obtain a **great** home theater system! The pinnacle of hi-fi systems? Well, that's just a endless run with ever-diminishing returns. If you did have a spare \$100,000 to spend, yes you can get better sound. But is it really **that** much better?

Key strategies

- obtain large but light transducers in 'non-existent' loudspeaker cabinets
- compensate for room acoustics
- leave the lowest (or lowest two) octaves to the powered sub-woofer
- use an all-in-one smart remote control

References:

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