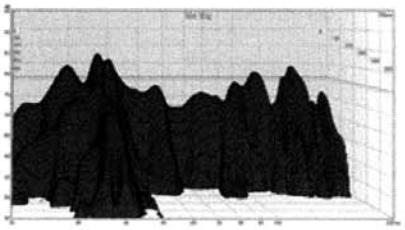
Automated Room Correction Explained

By: Dennis Burger, *November 18, 2013*

If you've purchased a new **AV receiver** or **surround sound processor** in the past seven or eight years, chances are good that it included some form of auto setup and/or automatic EQ (also known as room correction.) On the surface, all of the different auto-calibration systems - from **Audyssey** to ARC to MCACC to YPAO - seem similar in implementation. Each requires you to place a microphone in your room (either in your main listening position or at several points in the room, depending on the sophistication of the system), which measures test tones played through each of your speakers, then uses those measurements for two different purposes. Firstly, the software will automatically adjust the relative levels of all your speakers, so that the center, mains, surrounds, and subwoofer are all playing at the same loudness. It sets the crossover point between your satellite speakers and **subwoofer**, and it makes an educated guess as to how far each of your speakers is from your main listening position and adjusts the delay settings in your receiver or processor accordingly. Secondly, it looks at those measurements to determine what sort of deleterious effects your room's acoustics are having on the performance of your speakers, and then applies some mixture of equalization and/or filtering to compensate.

It's worth noting, though, that no amount of digital room correction can compensate for all of the acoustic problems in a room. To understand why, we need to break the audio spectrum into two different chunks

and look at them separately (with apologies in advance to any acoustic experts in the audience for the oversimplification that follows). From 20 Hz to somewhere around 200 or 300 Hz, standing waves are your biggest enemy. Standing waves are an unavoidable byproduct of placing loudspeakers in an enclosed space. The reflected sound waves from your walls interfere with the sound waves coming directly from your subwoofer or speakers, resulting in an increase in volume at some spots in the room and a decrease in volume at other spots, with different dips and spikes at different spots depending on the frequency. In other words, even if your subwoofer is creating low-frequency sounds at the same loudness level across the entire bass spectrum, a 50Hz tone may be twice as loud in your listening position as it's supposed to be, whereas an 80Hz tone may be practically nonexistent. Switch to another seat in the room, and the opposite may be true (probably not exactly, but you get the point). And all of this is determined primarily by the size and shape of your room, as well as where the speakers are placed.

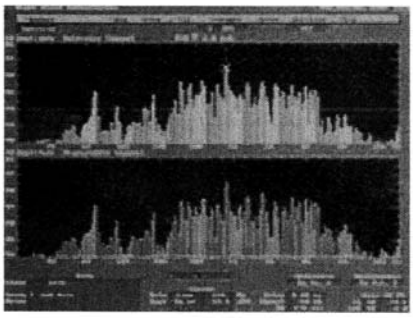


Standing waves are also really tough (if not impossible) to combat with physical acoustic treatments alone, which makes digital room correction an ideal solution. Well, it's an ideal solution to at least half of that problem. While equalization can handily deal with nasty boosts in bass caused by standing waves, most room correction systems cannot effectively deal with dips in bass caused by interference. In other words, if the size and shape of your room are causing, say, 80Hz tones to fall into a black hole at your favorite seat in the room, digital room correction isn't really your best bet for solving the problem. You're much better off moving your **subwoofer**, rearranging your furniture, or adding another subwoofer to your system - not to generate more bass, but to give you more even bass coverage, with one sub filling the nulls caused by the placement of the other. But, when it comes to combating the boomy, bloated bass caused by the reinforcement of standing waves, most room correction systems can work wonders.

Above 200 or 300 Hz or so, though, your room's effects on the sound that reaches your ear have less to do with the size and shape of the space and more to do with the qualities of the surfaces within it. Here, we're dipping into controversial territory, because not everyone agrees that a digital room correction system based on microphone measurements and calculated target equalization curves can successfully deal with problems in these frequencies. As acoustic engineer and president of Performance Media Industries Anthony Grimani once explained to me, "An omnidirectional microphone does not listen the way a human being does. The main difference is that a human being hears high-frequency sounds as mainly directional, directly from the speaker, and low-frequency sounds as integrated from the speaker plus the room. And then between low-frequency and high-frequency, there's a splice where those different ways of hearing gradually shift from one to the other." Needless to say, a microphone doesn't hear things that way.

Acoustic experts ranging from acoustic consultant **Floyd Toole** to Pro Audio Technology founder Paul Hales agree that room correction shouldn't be applied above this switchover point, primarily because our

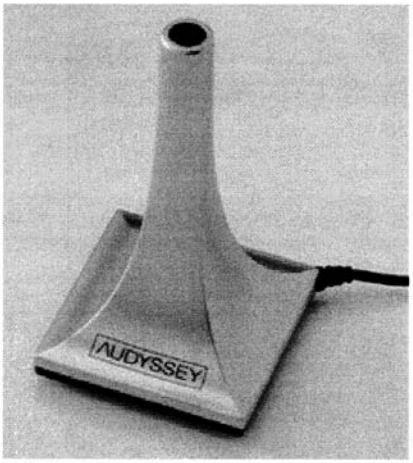
brains are perfectly capable of compensating for things like the difference between direct and reflected sound above 200 or 300 Hz. The way Hales explains it is that a great concert grand piano sounds like a great concert grand piano no matter where you put it; you don't EQ it differently for different rooms. Likewise, whether you and I are talking in an anechoic chamber or a tiled public bathroom, you recognize my voice as being my voice. That's why many of us who aren't overly enthusiastic about many digital room correction systems describe the results as deadening or dull.



That said, I'll be the first to admit that better digital room correction systems - those with a higher filter resolution and those that measure not only the relative loudness of different frequencies, but also when those frequencies arrive at the microphone - can do a good job of combating some acoustic problems in the higher frequencies. They can't effectively deal with things like long reverberation decay, at least not in my experience with setting up home theater systems for friends with very reverberant rooms. If you play guitar, you're probably well aware of the effect that a long decay can have on sound. If not, sit in your room and sing a few notes. If your voice sort of hangs in the air for a bit, what you're hearing is long decay. Or you can stand in the middle of your room and clap your hands. If it sounds like you're in a cathedral or parking deck, no amount of digital room correction can effectively compensate for that. You're going to need to invest in some absorptive acoustic treatments for your room, whether they be professional products or just some strategically placed draperies.

Good digital room correction can, though, combat ringing artifacts (a bit of pre-echo or post-echo accompanying high-frequency sounds). Of course, not all digital room correction systems are the same, and not all of them deal with different acoustic artifacts in the same way. So it's worth discussing a few of the more popular (as well as a few of the more advanced) room correction systems individually. This isn't a comprehensive list by any means; the intent is merely to give you a selective overview of the different room correction systems you're likely to come across when shopping for a new receiver or AV processor.

Audyssey



The big daddy. The Godfather of mass-market room correction systems. The first name you think of when you think "auto-EQ." **Audyssey's** room equalization platform appears in everything from Denon's $400 AV receivers to **Wisdom Audio's $6,000 SC-1 System Controller**. Of course, both ends of that spectrum aren't covered by exactly the same Audyssey technology. The company's auto-equalization is available in five different flavors, starting with its basic 2EQ solution. You may recall from my review of **Cambridge Audio's Azur 751R AV Receiver** that I'm not overly fond of 2EQ, which completely ignores the bass frequencies that most benefit from digital room correction and features a limited number of filters for high frequencies.

The standard MultEQ solution improves things a bit, with twice the number of high-frequency filters and some much-needed correction for bass frequencies. But with all due respect to Audyssey, in my experience, I still find that MultEQ does more harm than good to the mid and high frequencies in anything approaching an acoustically acceptable room.

Move up to MultEQ XT, though, and now we're talking. With eight times the high-frequency filter resolution of vanilla MultEQ, XT allows for more precise equalization and, as such, sounds less processed, less lifeless, more spacious. It also allows for eight measuring positions (compared with MultEQ's six and 2EQ's three). More measuring positions means that the system has a more comprehensive view of your entire listening space, allowing it to make more intelligent decisions about which problems it should and shouldn't try to correct. When reviewing a receiver with MultEQ XT, I tend to turn it off when listening to multi-channel music, but I quite enjoy the effect it has on movies.

For most consumers, the step-up MultEQ XT 32 - usually only included with top-of-the-line receivers - is as good as it gets, with 256 times the high-frequency filter resolution of MultEQ and four times the bass filter resolution. Like MultEQ XT, it also benefits from eight measuring positions and, also like MultEQ XT, it gives professional installers access to **MultEQ Pro**, a kit that includes a professional-grade microphone and preamp, and allows for as many as 32 measurements in the room. MultEQ Pro also allows your installer to dial in customized target EQ curves better suited to your listening environment and preferences, rather than the one-size-fits-all target EQ curves of 2EQ, MultEQ, XT, and XT 32.

MCACC

Chances are good that, if you buy a mass-market receiver above the entry level that doesn't feature Audyssey, it will instead include one of two proprietary alternatives. MCACC (or Advanced MCACC) is Pioneer's room correction system, and it has improved dramatically in the past few years. MCACC is nice, in my opinion, in that it gives you a lot of visual feedback for things like the amount of reverberation in your room. Depending on the model of Pioneer receiver you opt for, you'll have either five or nine bands of parametric equalization at your disposal and, from my experience - with a bit of tweaking - overall performance is on par with Audyssey MultEQ XT (despite the fact that the systems operate quite differently).

YPAO (Yamaha Parametric Room Acoustic Optimizer)

YPAO, as you may have guessed from its name, is Yamaha's proprietary room setup system. Unlike other manufacturers, the company doesn't give different names to its different levels of implementation, but YPAO on high-end Yamaha receivers doesn't sound like YPAO on its budget offerings. I will say this, though: I like YPAO a bit better than Audyssey's MultEQ (and especially 2EQ), mostly because it doesn't do much. That may sound like a backhanded compliment, but I appreciate the fact that YAPO doesn't color the high end nearly as much. Unfortunately, as an auto-setup program, Yamaha's offering can be rather lacking. The system has never set crossover points, speaker size, or subwoofer levels correctly for me. So, if you're running YPAO, prepare to tweak pretty much every one of its default settings by hand after the fact. That's true to some degree of many auto-setup routines, but it's universally true with YPAO.

Anthem Room Correction

Anthem's proprietary room correction system is, in my opinion, the best of the bunch, although it is limited to Anthem's pre/pros and receivers. Unlike most room correction systems, it does require the use of a Windows computer, and the microphone that comes with ARC is a beast compared with the little hat-wearing hockey-puck mics packed in with most room correction systems. The use of a computer provides ARC with much more processing power to take its measurements and create its filters. Perhaps due to that fact, ARC has never failed to perfectly nail crossover points and speaker levels in the dozens of times I've run it on both my **D2v 3D processor** and **MRX 700 receiver**. *[Editor's note, 11/20/13: A previous version of this story suggested that ARC does speaker distance measurements, but it does not.]*

What I really love about ARC, though, is that by default it doesn't apply correction to any frequencies above 5,000 Hz, and it allows you to set the max EQ frequency yourself, at anywhere between 200 and 5,000 Hz. In my main home theater, with the Anthem D2v 3D, I tend to find that a max EQ setting of roughly 400 Hz is ideal. In my secondary home theater in the back of the house, I set the MRX 700's max EQ to 600 Hz so that the system can smoothly deal with a spike in that room at right around 500 Hz.

It should also be noted that, until now, Anthem hasn't given ARC different names for different levels. If you ran ARC on the D2v, it ran at its full capabilities; running ARC on the MRX 500 or 700 gave you the same measurements, but applied fewer filters. ARC also required that the connection between your PC and pre/pro or receiver come in the form of an **RS-232 connection**, which required the use of a USB-to-serial adapter for most users. With the introduction of the new MRX 510 and 710 receivers, Anthem also debuted ARC M1, which benefits from more filters for the receivers (not as many as the D2v is capable of, but still more), along with speedier calibration and network capabilities. So now you'll be able to run ARC on a new Anthem receiver as long as it and your computer are both connected to the same home network.

PBK

Paradigm/Anthem also has another proprietary room correction system called the **Perfect Bass Kit**, which as you may have gathered only works on Paradigm subs. Think of it as a simplified version of ARC (with simplified connections, too; it includes the same USB microphone as ARC and only requires a USB connection from your computer to the subwoofer). The great thing about PBK is that it applies room correction where your room needs it the most - in the bass frequencies. The downside, of course, is that this only applies to the subwoofer channel, which is probably crossed over at 80 Hz by your processor. So it won't catch problems in the main channels, which also generate bass between the crossover frequency and that critical 200-to-300 Hz point where standing waves can plague

upper bass performance.

Sunfire Room EQ

Sunfire doesn't have a fancy name for the room EQ system included with many of its subwoofers (I've run it with excellent results on both the AtmosXT in my bedroom and the SubRosa Flat Panel Subwoofer in my home theater). It's quick. It's simple. It gets the job done and deals with most of the acoustic problems in both of my rooms. But of course, as with PBK, it can only apply correction up to the crossover point between your subs and satellites.

TacT

Before the advent of Audyssey Dynamic EQ, TacT was the only digital room correction system I had any experience with that adjusted its filters based on your listening level. Until recently, TacT room correction was also limited to the company's own preamps and room correction processors, but it will soon be available in Emotiva's new XMC-1 pre/pro.

Trinnov

Trinnov calls its room correction system **Acoustic Correction**, and by all rights I should hate it. Uniquely, Trinnov works not only in the frequency and time domains, but in the spatial domain as well. The microphone included with Trinnov is actually a microphone array that includes an arrow that must be pointed directly at your screen. During its measurements, the system maps your speakers' locations in three dimensions and can actually move the perceived location of one or more of your speakers to compensate for less-than-ideal speaker placement. It can take front left and right speakers that are spaced too closely together - or too far apart - and virtually relocate them to a pitch perfect 22.5 or 30 degrees out from your center channel. It can even bring the image of your center speaker up to the level of your main left and right speakers if it's placed too far below (or, heaven forbid, above) your TV. The effect is downright spooky, and again - on paper - I absolutely hate the idea of it. But in practice, it's fantastic. I reviewed a Sherwood Newcastle receiver a few years back that included the Trinnov Optimizer and absolutely fell in love with the effect. If the realities of your room prevent you from placing your surround channels symmetrically, or if your room itself is oddly shaped, I highly recommend giving Trinnov Acoustic Correction a try.

Of course, as I said, this list overlooks many other notable room correction systems, from **Harman's ARCOS** to **Lyngdorf's RoomPerfect** to **Meridian's excellent MRC**, along with other bass-only solutions like **Velodyne's SMS-1**. So, if I've left out your favorite, let us know in the Comments below.

Do you love what room correction does for your sound system, or do you absolutely loathe it? Or does your relationship with room correction, like mine, fall under the fabled Facebook category of "It's Complicated"?