SOUNDOCTOR

Using white noise to learn, aim, and adjust speakers

AIMING and "LEARNING" SPEAKERS

Here is a method for "aiming" (and learning) speakers --- for determining the splay angle AND the "lobe" of the sound coming out of [any] speaker. This method is far more accurate than ANYTHING else, even lasers. Doing it with your ears with this procedure takes *EVERYTHING* into account, including interchannel digital delays or anomalies, circuit group delay, phase shifts, if any, anywhere in the chain, including the crossovers, and it also takes into account mechanical interchannel timing issues (often somewhat incorrectly called time alignment) caused by the simple fact that the speakers or the drivers are different distances from your face. You will be able to aim and adjust your speakers to within 1/4" or better with this method.

The physically larger your speakers are, such as with 7 foot tall floorstanders or large electrostatic panels, the more sensitive and revealing this test is. However this test is still very useful with smaller speakers such as 2-way "bookshelf" speakers, and VERY useful with very large systems such as clubs, discos, line arrays, halls, etc.

The procedure is this:

☐ 1) Use the WHITE (not pink) Noise **Track #25** on the TEST CD. The track is now 4 MINUTES and "stereo" (Both channels are sample-accurate / identical) and are recorded at -20dBFS.
Please note that -20dBFS (20 decibels below Full Scale Digital) is so-called "REFERENCE LEVEL".

Please be aware that OTHER tracks on the CD are recorded 19dB HOTTER, at -1dBFS.
Set your CD player to NOT continue to the next track(s) !
However, if you play the white noise at 75dB, then even if the other tracks play they will not be louder than 95dB, so no damage will be done.

☐ 2) Use a separate CD (or DVD) player with ANALOG OUTPUTS. Connect ONE analog output (the LEFT CHANNEL) to a number of "Y" cords. You **MUST** do it this way . Do **NOT** attempt to use "mono" switches in the receiver or preamp. The setup should look like this:

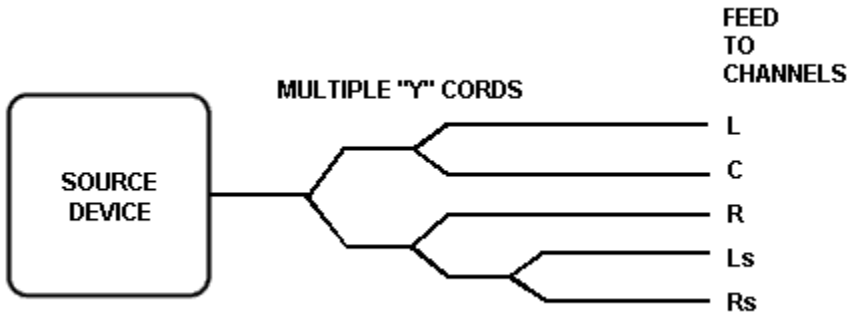


Fig 1. Method of using Y-cord adapters for multiple feeds.
This is the same thing as "daisy chaining"*
and also the same thing as "connecting all the inputs in parallel".

* "daisy chaining" is a *ridiculously* untechnical phrase. Please do not use it.

This setup, designed to feed the analog inputs of a 5.1 channel system, uses 4 "Y" cords. You may need additional lengths of RCA-RCA cables as well to make all the wires reach. You may, of course, use this procedure on a 2- channel "stereo" system., in which case you only need ONE "Y" cord. It is up to you to determine the gender requirements of your RCA cables.

☐ 3) Disconnect the sub or turn its power off.

☐ 4) Make sure the TREBLE controls for each channel are set at "0". If your receiver or preamp has level trim adjustments, make sure they are all set the same, preferably to unity gain.

☐ 5) I suggest turning all the BASS levels all the way down. If you are attempting to learn the splay pattern of speakers which are a flat panel, such as electrostatics (Quad, Sound Lab, Magnepan, Martin Logan, etc) then you might want do a separate test with the bass at "0" (or higher) in order to learn how the lower frequencies leave the dipole and bounce off the wall behind the speaker. But for now, please do the test with the bass turned down.

Since the wavelengths at high frequencies are so small, by turning the bass down you are simply removing the longer wavelengths from your auditory test. Please see my frequency-to-wavelength chart here:
http://www.soundoctor.com/freq.htm

☐ 6) If you have channel "delays" (sometimes called "distance settings" in a Home Theater receiver), MAKE SURE they are set OFF or to the minimum, and ALL THE SAME. I suggest setting these settings for the ALL the TOP speakers (**L C R Ls Rs**) at 7 feet as the entire concept and in many cases the execution (bass management pickoff spot) is flawed. However, you CAN use this concept to "fix" the inherent group delay in a powered, sealed subwoofer, by adding an equivalent delay to all the top speakers to match the sub's delay. Please see my white paper here: www.soundoctor.com/whitepapers/subs.htm .

☐ 7) Make sure that the noise floor of the room is quieter than perhaps 50 to 55 dBA Slow weighted C. Turn off fans and air conditioners. The signal you will be listening to should be perhaps 18 - 20 dB louder than the noise floor of the room. The objective is to get the test signal loud enough to understand but not so loud that you get a headache, and not so loud that you excite room modes, which is another whole topic of discussion.

☐ 8) Plug in the LEFT channel only (for example, use the AUX ins, sometimes listed as "analog 5.1 inputs".) Advance the main volume control to give a MODERATE level in the room. My suggestion is to use about 70 - 75 dB SPL (when measured Slow weighted C), not higher than 85 dB.

☐ 9) Start by sitting in your "sweet spot" chair. Now stand up. Try and discern the difference in the splay lobe from your SEATED to STANDING POSITION. You might hear a frequency change; you might hear some combing, especially if you have a tall line array. Notice that even of you DO hear a combing effect, you cannot hear it unless your body is moving! This is one reason why no one complains about multiple-driver combing in real-life use: you are not usually getting up and sitting down while listening critically.

☐ 10) Now walk around the **L** speaker in an arc and try to discern the high frequency splay or lobe pattern of the speaker. Learn the sound of the speaker from far away, to closer, until you get to the real near field, say, closer than 1 meter (3 feet). Get a feel for BOTH how the speaker is sending the waves out and *HOW THEY ARE REACTING WITH THE ROOM*. You should be able to discern the splay pattern of the speaker and get a mental picture of the sound almost as if it were a "theatrical flood" or "spotlight". Cup your ears so they are directional and face the back wall of the room and try to determine what sound, if any, is reflecting from back there.

☐ 11) Sit in the sweet spot and cup your ears and try and discern what is bouncing off the 1st reflection point on the side wall. Typically this is the most important spot to have a wideband absorber. Since the path length from each speaker to the side wall is different than the path length from the speaker to your face, the summation of these out-of-time (and therefore out-of phase) signals will often produce comb-filtering anomalies. There are also reflection areas on the floor between you and the speaker, and on the ceiling as well. You might be able to hear the localized reflection(s) by cupping your ears and directing your attention to the area in question. Another method to determine side reflections is to have a 2nd person hold a mirror flat on the wall on the sides until you can see the front of the speaker in the mirror when you are sitting in your chair. That is therefore the "main" spot to apply absorbtive treatment; specifically a wideband absorber.

☐ 12) Turn OFF the **L** and turn ON the **R**. Do the same test again with the Right channel.

☐ 13) Now turn on BOTH the **L** and **R**. Plug the Y cord into the **L** and **R** inputs. Assuming for the moment that the **L** speaker is already positioned "where it belongs" then have another person move ONE speaker (for example the **R**) while you are listening in the sweet spot. When the **R** speaker is aimed into the room correctly so it matches the **L** speaker, the high frequency signal should **SNAP TO A "DOT"** in the center. You should perceive a small "dot" of sound --- NOT a large diffused ball or indeterminate globule of noise that seems to be everywhere. If you cannot get the sound to become this "dot" then something is wrong. It could be the wiring, the receiver, and of course even the speakers, but typically it is a combination of aiming and reflections which diffuses the focus. Once this focus is achieved your imaging should be better, if not uncanny.

☐ 14) The test above has the speakers set up "normally", that is, wired correctly, IN POLARITY with each other; (often incorrectly called IN PHASE) Now we are going to try a ***MUCH*** *more critical test*. Reverse the POLARITY of **one** of the speakers. If you are calling the LEFT channel the "reference channel" as far as positioning goes, then reverse the wiring to the RIGHT speaker, in case you accidently move it a little bit. Now the speakers are **OUT OF POLARITY** with each other.

☐ 15) Since the speakers are OUT OF POLARITY with each other, when you play the white noise through BOTH you should hear a NULL, i.e. "nothing". The more accurately you perform this test, the more the 2 sources will cancel out. If you still hear a loud diffused glob of sound then something else is wrong - I have been surprised many times that in a speaker that is a line array, ONE driver might be wired incorrectly. Leaving the LEFT channel in its reference position, have the other person adjust the RIGHT speaker. As the right speaker is pivoted and tilted, you should be able to mechanically "tune" it until the null becomes the sharpest. We can only assume (or hope) that whatever the internal [passive] crossover in your main speaker is — and that entire cabinet is an electro-mechanical and physical entity — the manufacturer has correctly set it up!

Note: When you SUM 2 "exactly the same" signals IN phase (in polarity) they algebraically sum so that the net result is 6dB louder, or twice the voltage or Sound Pressure Level. When you sum 2 signals OUT OF POLARITY they cancel completely, which would literally be 50 or 60 dB (or more) weaker. That is why it is ***so much easier*** to hear a NULL rather than a PEAK.

As a further corollary, when you add 2 speakers together in a room, because of the typically de-correlated signals AND the fact that the speakers are spaced apart and have slightly differing coupling modes to the room, do NOT expect a 6dB increase in the room; expect a 4 or 5 dB increase. This is one reason why you are using y-cords; so there is absolute correlation to start with, which then passes through all the circuitry and anomalies in your system.

☐ 16) If you have electrostatic panels, this is where the tilt adjustment, both vertically and toe-in become most critical. Since the surfaces are FLAT and since the same signal is emanating from everywhere on the surface, this test becomes remarkably sensitive and you should be able to discern cancellation changes on the order of 1/4". It may take some time to learn this phenomena. IF your speakers are on a carpet then this is the ONLY time I would ever suggest using (and adjusting) spikes. In any event, you don't want the springback of the carpet to interfere with your tests. You want both speakers to be rock steady, and to stay where you put them

☐ 17) Also, with flat panel / electrostatic speakers, since they are dipoles there is an equal sound coming off the back, and hitting the wall behind the speaker, then bouncing around forward. When you turned the bass down earlier you are only listening to the higher frequencies coming off the panel. With flat panel speakers only, you might want to experiment by turning the treble all the way down, and turn the bass all the way up; this will enable you to hear and experiment with the back wave. I suggest (read my SUBS white paper again...) that you completely absorb the back wave from a flat panel dipole and only attempt to match a sub up with the front wave.

☐ 18) Put the polarity of the Right Channel back where it belongs.

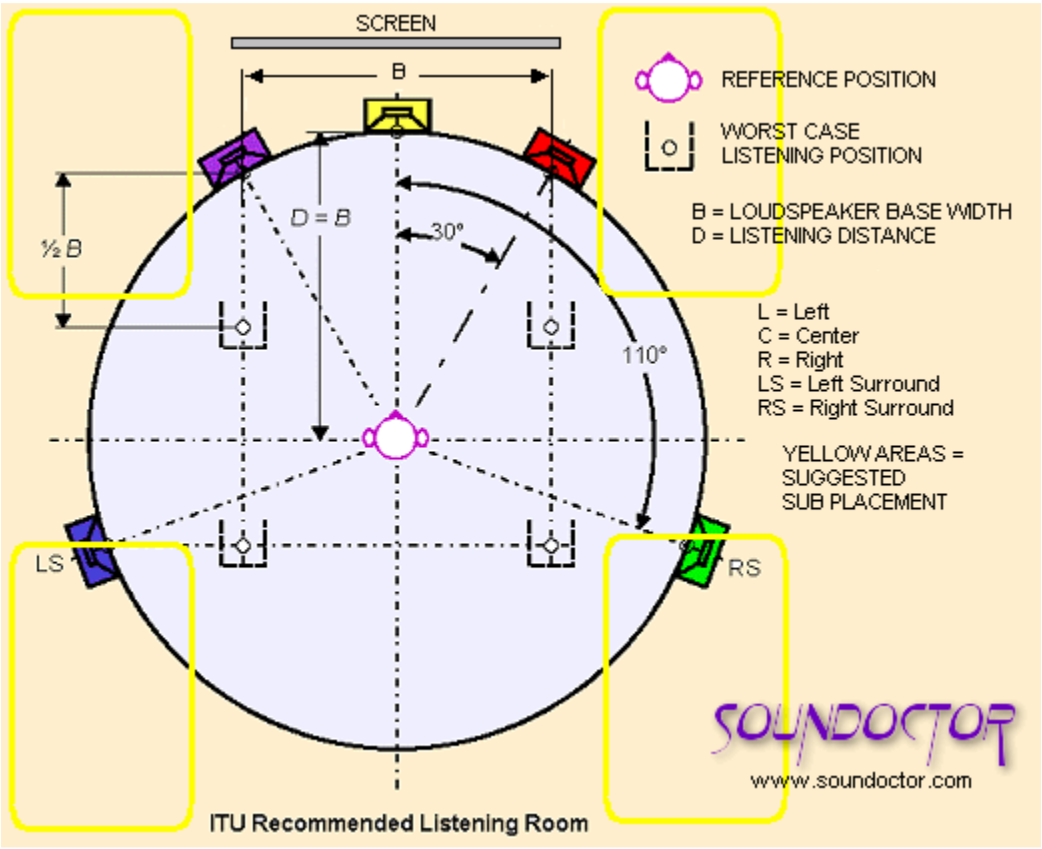
☐ 19) If you have a Home Theater 5.1 setup, after you are FINISHED determining the **L** and **R** signals, listen to the **C** channel by itself. Then have someone else change back and forth between both the **L** and **R** wires and the **C** wire only. Now you are listening to determine how the **REAL C** sounds relative to how the **PHANTOM C** sounds. This part of the test is *extremely* critical. It will immediately point out room and acoustic issues which might smear the sound such as early reflections from the side walls and other reflections. Please note that in movie DVD's, the **L** and **R** are for Music & Effects and the **C** is for dialog. There is NO panning correlation that takes place between **L C** and **R**. Music is panned **LR**. This is another reason why attempting to set the speaker distances to real-room measurements is wrong; typically the signals coming from the **LR**, and **C** and **Ls Rs** have very little to do with each other. It is only the **LR** that are phase correlated.

☐ 20) Remember that you are going to try to get a number of perceptions:
a) The direct signal from the **L**
b) The direct signal from the **R**
c) The direct signal from the **C** channel
d) The PHANTOM CENTER channel image from the acoustic summation of the **L** and **R**
e) Early reflections, such as off the side walls.
f) The reverberant field
g) The later echo field, including flutter echo and reflection(s) off the back wall.

☐ 21) Do not be surprised if you think you are getting results from this test that you may consider odd. This test is probably the MOST sensitive test you can ever do where your hearing is part of the measuring equipment.

When switching between the **C** only and **L** and **R** only, this is a VERY sensitive way to adjust the inter-channel balance.

☐ 22) If you have a Home Theater setup, when you are finished with the LCR part of the system, it is helpful and educational to learn how the **Ls Rs** are splaying into the room as well. One interesting test is to have someone hold the speaker at your ear level while you are sitting down and they then move in an arc from 90 degrees to 165 degrees when measured from the Center channel line, as in the diagram below. Note the **Rs** is shown at 110 degrees of arc from the **C**.



You will usually find that the best place for the **Ls Rs** is when they are in the psychological null of the listener which roughly corresponds to the acoustic null of the listener as well.

☐ 23) What does this mean? If and when sounds are from directly behind you, they tend to draw your attention AWAY from the movie and may be frightening to young children and elderly people, who are not prepared to expect loud noises from behind. The other extreme is sounds coming from directly to your left and right (90 degrees) which again, make you turn your head and turn your attention AWAY from the movie. But at an angle of about 110 degrees, something amazing happens: those sounds are no longer frightening and no longer divert the attention away from where it belongs, but they are integrated smoothly into the theatrical experience, and they integrate into the "surround field" smoothly.

☐ 24) Using this white noise test, you are now able to discern the splay pattern of your surrounds and how they are integrating into the room. If you have surrounds which may be switched or changed between front-firing to dipole mode to Tripole mode (such as M&K's) then you will find this part of the test to be exceptionally interesting.

These series of tests are not only very accurate but a rather inexpensive way (i.e. NO test equipment is required, other than your ears and some Y cords...) to get VERY precise results. Good luck with your acoustics tests!

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