Level Setting
By Richard Clark

Ever since I started working with audio systems I have wished that more things could be standardized. As a normal part of the quest for improvement, it is typical for competing companies to have a different way of doing things; however, sometimes it seems to be a little too much. Take the operation of a car for instance. Even though cars have giant differences in the way they are built and look -- at least they all have the gas, brake pedal, and steering wheel in the same place. Well at least half the world has them in the same place.

The fact that half the world puts everything on opposite sides of the car only strengthens my illustration that there are many way that products can differ for sometimes no better reason than somebody just wants to be different. Imagine if electrical appliances for the home were like audio gear. There would be many different kinds of plugs and every appliance would require a different operating voltage. And just think what it would be like if there were no standard for how the plugs should be wired.

That background of complaining brings us to the subject of signal matching, signal optimization, level setting or whatever you want to call it. Fact is that in virtually every audio system there are one or more places where it is necessary to "tweak" the operating parameters if maximum system performance is to be realized. An audio system is similar to a chain in that it can only perform as good as its weakest link. Unfortunately unlike a chain, an audio system will perform worse than its weakest link unless it is adjusted properly.

Proper adjustment of an audio system begins with the initial selection of components. Component interface should be considered in regard to signal level, input/output impedance, and wiring and connector types. Failure to consider that some components are just not well suited for use with certain other components can doom a system to poor performance. And just for the record -- don't assume that just because you have decided to go the "everything from one manufacturer" route that you will be spared. If we can assume that attention has been given to these issues we are faced with the basic requirements for level setting.

The real heart of the issue is that every component has a noise floor below which it cannot pass a clean signal. Every component also has a maximum level above which it cannot pass a signal without severe distortion. In operation, it is critical to make sure the signal stays as high above the noise floor as possible without exceeding the maximum undistorted level. This is important no matter what the brand, price, or design the equipment may be. It should be acknowledged that an experienced technician can probably do a quick "tune it by

Copyright © Richard Clark, All Rights Reserved. www.davidnavone.com
Do not reproduce any information without the express written consent of Richard Clark.

ear" and get most systems pretty close to optimum, but it is just as true that to achieve 100% of a system's dynamic performance, the use of test signals and at least basic test equipment is needed.

Optimal Level Setting

As we mentioned before, a system that is not set up properly will have excessive noise or distortion or more likely both. With many systems costing thousands of dollars it is really silly to consider that level matching is not worth at least a few dollars and a little time. If you have a thousand dollars invested in your system and you improve it only 5% with a little tweaking, that's a value of at least fifty dollars the way I see it. The fact is that in most cases the overall dynamic range of a system can be increased several dB with precision tweaking over what even the best "ears" can do. If you want to consider value, a mere 3dB is like doubling the value of your system.

So how do we go about this important final system tweak? First off forget all those statements such as "set it at 3/4" or "turn such and such to here." Such comments are the babblings of techno-idiots and should be ignored by anyone serious about quality audio. No doubt you have heard such poor advice, as well as the other extreme, where the process is described in detail that would rival brain surgery. Really it's not as complicated as its importance would suggest. All we really want to do is insure that when a signal starts out at the beginning of a system that it passes through the entire system as high as each component will allow without adding distortion. When a system is adjusted for absolute best S/N and lowest distortion, all the components will reach overload at the same time.

Begin With a AHB Signal

There are really only a couple things that are needed to do a professional job of level setting in an audio system. A good stable low distortion signal is the first thing required. I suggest you use a frequency of somewhere in the 500 Hz to 1 KHz range. A suitable signal would be what we call recorded at "all high bits" (AHB). This means that the signal outputs the highest voltage that would ever be encountered from an undistorted music source. There are numerous test CDs that contain suitable signals or you can burn your own from one of the numerous web sites that contain test signals.

Using An Oscilloscope

Once we have the signal we need a way to monitor it as it is passed through each stage of the system. There are several ways that work well and I will cover three of them. Naturally the best ways cost the most but either will work with patience. The best way to monitor any electrical signal is to use an oscilloscope. While this may sound rather exotic it really isn't. Considering that today a scope can be bought for as little as 100-200 dollars (even less on eBay),

Copyright © Richard Clark, All Rights Reserved. www.davidnavone.com
Do not reproduce any information without the express written consent of Richard Clark.

it is a good investment for anyone who is serious about a future in audio. Personally I would place its importance right up there with a drill or a DVM.

Without An Oscilloscope

Another way that works surprisingly well is a small piezo tweeter. At low to mid frequencies the impedance of a piezo tweeter is relatively high enough to prevent loading of the circuits being monitored, and since it cannot reproduce lower frequencies, it makes hearing distortion products (clipping) easy. Another method is to use a small self powered speaker. These units typically operate from a internal 9V battery and can be used to listen for clipping of the test signal. At any rate either of these methods will work and with patience excellent results can be obtained.

The process is really very simple. Start with the head unit and while monitoring the output with whatever device you choose to use, advance the volume control until the component just starts to exhibit clipping. Since pure sine waves can sometimes damage speakers, I prefer to turn the power amps off or at least way down just to be safe. After the head unit is set, proceed to the next component in the system and set it right to the verge of clipping. This process is to be continued all the way through the system till you reach the last component that actually feeds the power amps.

There are a couple things that have to be mentioned that can complicate the process thus far described. First is a component that has input and output gain controls. With these components, start with the output control all the way or at least almost all the way down, and adjust the input control first. Then adjust the output only after the input is adjusted.

A second complication is if a previous component seems to be over-driving a downstream component. In such a case it could be necessary to go back to the previous component and reduce its gain enough to accommodate the downstream component.

The third complication is when there are multi-way electronic crossovers in the system. If such is the case make sure that you only monitor the output that is in the pass band that contains the test signal. To set the other bands (usually feeding woofers and tweeters), it is possible to use another test signal or you can set these additional bands to the same gain as the mid-band and you will have things very close, since the maximum voltage of the device will be the same for all outputs since it shares the same internal power supply.

Adjusting the Power Amplifier

Once this simple procedure is finished, it is time to adjust the power amp gains. If we lived in a perfect world our systems would always have more power

Copyright © Richard Clark, All Rights Reserved. **www.davidnavone.com**
Do not reproduce any information without the express written consent of Richard Clark.

than we could ever use. Unfortunately it's rarely that way. If we set our gains "textbook perfect," the musical signal would never be able to produce a clipped signal. That is the good news. The bad news is that since the crest factor (peak to average power factor) of music is relatively high, the average power of most music signals is over ten to one or about ten dB. What this means is that in a perfectly gain matched system; the highest average power we can ever use from our power amps is about one tenth! This means that with a 1000 Watt power amp, the most long term average UNDISTORTED power we can listen to music is about 100 Watts or even less!

Gain Overlap

Fortunately short term music peaks don't last very long and we can cheat just a little and get away with it with little or no audible downsides. The fix for this is what is known as "gain overlap." Gain overlap is an intentional mismatch in the final gain adjustment done right at the power amp. This procedure allows for short term music peaks to be clipped and at the same time allowing the average level of signal to be increased. The net result is a large, noticeable increase in how loud the system will play.

Much testing of skilled listeners has shown that the added distortion of a 10 dB gain overlap is extremely difficult to hear. It just so happens that the real bonus of a 10 dB gain overlap is that the system will play at a level that is perceived by listeners to be fully twice as loud. Of course you can choose the amount of overlap you care to incorporate, but less overlap reduces the usable loudness, and more overlap leads to distortion audible.

Several years ago at Autosound 2000 labs we actually produced Test CD#104 "Level Setting." This disc demonstrates the actual audible effects that result from different degrees of gain overlap. The test disc also demonstrates the differences in loudness that result with each choice of overlap. Those that are new to this concept or are uncertain on just how they want to adjust their respective system might want to audition this disc. Gain settings from 0 to as high as 20 dB of overlap are demonstrated with varying steps in between.

(Note: The Autosound 2000 Test Disc CD#104 "Level Setting" is available from Automedia / Car Sound And Performance for only $15.00 at www.carsound.com)

The gain overlap is achieved by doing the very last amp gain adjustment with a test signal that is reduced in level by the amount that you want to have the gain overlapped. As such, a 10 dB overlap would be done by adjusting the amp gains with a test signal that was 10 dB less than the "O" bit signal that is used for the rest of the system components. In addition to demonstrations of the effect the actual signals necessary to make the needed adjustments are included on the CD#104.

Copyright © Richard Clark, All Rights Reserved. www.davidnavone.com
Do not reproduce any information without the express written consent of Richard Clark.

Summation:

When it comes right down to it, there is little that one can do or spend on a system that can rival the sonic improvement that comes with proper gain adjustment of the system as a whole. A system adjusted for perfect gain matching is like chain that has equal strength in every link. In such a chain every link will fail at the same instant. A properly adjusted system with gain overlap at the amplifier is like a carefully engineered electrical system that offers maximum performance but has a fusible link.

End File

Copyright © Richard Clark, All Rights Reserved. **www.davidnavone.com**
Do not reproduce any information without the express written consent of Richard Clark.