

BASIC SYSTEM GAIN STRUCTURE

Note: This does not cover how to set the gain in a mixing console but is concerned with overall system gain structure.

Although this is not a rigorous treatment of the subject, the following are general guidelines that may be helpful in setting the gain structure for an audio system and making final adjustments to it for best results.

A Basic Procedure

1. As a minimum, you need to use at least a voltmeter along with the maximum output voltage specification for each piece of electronics. The preferable tool is an oscilloscope that can be used to observe the signal directly. If neither of these are available, you can use the level or clipping indicators on each piece of equipment in the signal chain. Without some method of determining the clipping point for each piece of equipment, you cannot expect to optimize the gain structure.
2. Before setting gain structure disconnect the loudspeaker(s) from the amplifiers. If controllers are used that sense the amplifier outputs do not disconnect the sense lines.
3. The basic procedure is to use a test signal (a sine wave signal is ideal) and set the first piece of equipment in the signal chain (usually the mixer) so it is just below maximum voltage output as read on the voltmeter or on equipment's output meter or just below clipping as observed on the oscilloscope. Without changing this signal level adjust the level controls on each piece of equipment following, including the power amplifiers, so it is just below its maximum output. You will find that the input level controls on the power amplifier will end up being set anywhere from 10 dB to over 20 dB of attenuation

NOTES:

- a. Due to differences in the capabilities of devices in the signal chain, it may not be possible to achieve the results exactly as stated.
 - b. Gain structure should be set after any equalization is set for the system so that any boosts (which reduce headroom in the equalizer) are taken into account.
 - c. For each device, make sure it is the output and not the input that is clipping.
 - d. Always make sure that the any limiters in the system go into limiting prior to anything else in the system going into clipping. In this way the limiter, rather than a clipped signal somewhere else in the signal chain, will control the system's maximum output
4. Remove the test signal, turn off all equipment and reconnect the loudspeaker(s) and the system is ready for level balancing, assuming you have more than one loudspeaker. If you have only one loudspeaker the system should be ready for use.

B Residual Noise

Horn loaded loudspeakers and drivers have high sensitivities which means that they produce a relatively high output for a given electrical input. This includes the residual electronic noise of an audio system. By setting gain structure properly and using high quality professional electronics, this noise should be at or near inaudibility. Among the noisier electronic devices are 16 bit digital devices such as some signal delays. They have signal to noise ratios that are only 90 dB. However, if the gain structure is set correctly this means that, for example, if the system can produce 120 dB SPL at maximum output, the residual noise should be about 30 dB SPL. This would be acceptable for a quiet recording studio. If residual noise is a problem, gain structure is usually the culprit – it is never the loudspeakers.

C Level Balancing

Once the system gain structure is set, the level balances can be adjusted. This may mean the levels between HF and LF sections of a biamplified loudspeaker, a full-range loudspeaker to subwoofer level, levels between multiple loudspeakers, or between main and delayed loudspeaker array. The idea is to make the system sound the best it can without using any equalization. This may be done using acoustic test equipment such as an RTA (real-time analyzer), TEF™ analyzer or similar. You must always determine the final level balance by listening to a variety of known program material. Level balancing can also be done entirely by ear if acoustic test equipment is not available. In any case, the preferred method of adjusting levels for balancing is to use the amplifier input level controls.

IMPORTANT: In order to maintain the system's dynamic range that was maximized by setting the proper gain structure, **DO NOT TURN UP THE INPUT LEVEL CONTROLS OF ANY OF THE AMPLIFIERS.** For example, if you decide that a subwoofer is not loud enough, do not turn up the input level control of its amplifier. Instead, turn down the input level of the full-range loudspeaker's amplifier.

D Equalization

Once level balances are set, you can then equalize the loudspeaker(s), if necessary. Community loudspeakers are optimized for highly accurate and well balanced reproduction "out-of-the-box". Generally, equalization should only be needed to eliminate difficult feedback frequencies or to adapt the system to a difficult acoustic environment. You should not need more than a few dB of boost or cut equalization for any particular range of frequencies. The best equalization techniques involve cutting rather than boosting frequencies.

E Final Results

Once the above procedures are followed, your loudspeaker should reproduce audio cleanly, clearly and with all frequencies in good balance. Noise should not be audible and you should be able to drive the amplifier(s) in the system to maximum output on normal program

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material with no significant distortion or other undesirable sound. If limiters are used, the onset of limiting should occur just before any amplifier clipping.

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Sep 99