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Mixing Console Gain Structure:

The Target Gain Method

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What is Mixing Console Gain Structure?

Console gain structure is the interaction of amplification stages within the mixing console: from the channel inputs to the output busses. When set properly, the mixing console will exhibit good signal-to-noise performance, have sufficient headroom, and will give the best "transparent" sound possible. However, with improper gain structure, the mixing console has poor signal-to-noise performance, a "muddy" sound quality, and is prone to premature distortion and clipping.

It is understood that proper gain structure technique begins here - with the mixing console. This approach is followed through all the way to the loudspeakers. In a properly optimized system, the loudspeakers would be the weak link of the entire system. For this session, we will be focusing on gain structure in a mixing console.

Different Approaches to Gain Structure

In times past, many sound operators were taught to set mixing console input levels by adjusting the channel-input trim to clipping; then, lower the level slightly back again to a clean signal. A few of the drawbacks with this method are:

- The main buss rail voltage of the console has reached maximum capacity with just a few input channels in operation
- The main buss clips prematurely
- Everything "downstream" of the input trim control is being over-driven, resulting in distortion

Another very common approach is to set the channel input trim control to around 0dB. Although this provides cleaner results than the fore-mentioned method; it still presents some challenges:

- The main buss rail voltage is close to maximum capacity with all input channels in operation; exhibiting levels as high as +18dB or greater.

NOTE: *Although most mixing consoles can safely manage these levels, most everything else "downstream" in the sound system's audio path cannot. This results in the need for in-line attenuators (i.e. "pads") in various locations of the signal path; which, if improperly built or used, could possibly degrade the overall quality of the sound system.*

- The main buss could clip prematurely from the transient peaks of the program material - everything "downstream" of the input trim control is subject to being over-driven, resulting in distortion

Why is Gain Structure so Important?

Reason #1: ***Signal-to-Noise:*** Good Signal-to-Noise (SNR) performance ensures that the average voltage of the audio signal is high enough above the noise floor that the softest portions can be heard. Inversely, with poor SNR performance, the audio signal appears noisy during soft portions – usually resulting in "hiss" (*see Fig. 1 below*). This is because now the softer portions of the audio signal are buried within the thermal noise floor of the audio circuit.

Reason #2: ***Headroom:*** Good headroom (HR) performance ensures that the dynamic transient peaks of the audio signal will pass transparently through the circuit; retaining the "punch" and clarity of the audio signal. Inversely, poor HR performance results in clipping and distortion of the "hot" portions of the audio signal (*see Fig. 2 below*). This is because the audio signal cannot exceed the voltage rail limitations of the audio circuit.

Reason #3: ***Mix Transparency:*** This refers to the overall perceived sound quality of mix. A good mix successfully maintains the dynamic signature of the audio signal (within the capabilities of the circuit). This results in a mix that "breathes" and has "punch". Inversely, poor gain structure can produce a mix that lacks definition and is "muddy".

Reason #4: ***Real-world integration within a sound system:*** It's a little-known fact that mixing consoles usually produce the highest output buss levels when compared to other line-level components within a sound system; with the exception of power amplifiers. This audio signal level can be as high as +28dBu (19.5 VAC). Most line-level audio components typically have maximum input voltage limits between +10 to +18dBu (2.4 to 6.2 VAC).

For example, let's say you have a mixing console whose output is connected directly to a system equalizer. As the audio signal leaves the mixing console and enters the equalizer, it is clipped by the lower voltage rail of the equalizer (*see Fig 3 below*).

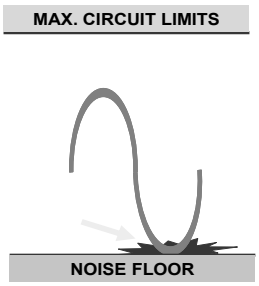

Fig. 1 *– Example of poor Signal-to-Noise performance within an audio circuit*

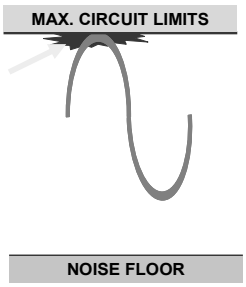

Fig. 2 *– Example of poor Headroom performance within an audio circuit*

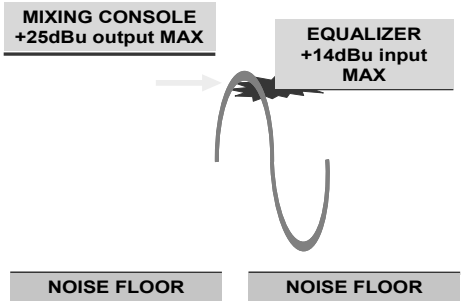

Fig. 3 *– Example of a poor Gain Relationship within a sound system signal chain*

The dB Summation Theory

"Coherent signals of equal value (and in-phase) will sum to an increase of 3dB higher than each original signal"

The Target Gain Method is based upon the inverse of this theory. and its principle goals are:

- Improving audio signal-to-noise performance
- Ensuring adequate headroom of the audio signal
- Providing a clearer, more transparent mix
- Providing a visual reference for the mix session after the sound check

The Target Gain is accomplished by maintaining an average output buss voltage of approx. ***0dB*** of the mixing console (*see Fig. 4*).

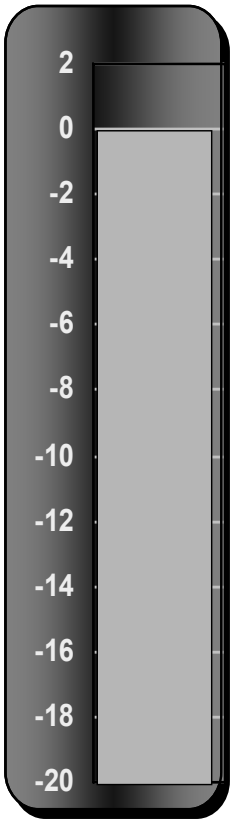

Fig. 4 *– With an optimized Target Gain, the output buss level should be around 0dB, as shown on the output meter*

Establishing the Needed Target Gain

Let's start with the mixing console INPUT CHANNEL STRIP.

First, you need to determine the Number of Input Channels to be used for the mixing session. Then you will need to determine your Target Gain for each input channel. To do this, you will apply the following formula:

TARGET GAIN = -10 x log (NUMBER OF CHANNELS USED)

EXAMPLE:
Let's say that you will be using **16** channels for this particular mixing session.

TARGET GAIN = -10 x log (16)

TARGET GAIN = -10 x 1.2

TARGET GAIN = ***-12.0 dB***

Applying the Target Gain Levels

Once you have the proposed Target Gain value, you can now proceed with setting the mixing console input levels for your mix session. In doing this, perform the following steps:

- STEP 1: Ensure that all the mixing console input channels are muted
- STEP 2: Position all mixing console faders to the unity (or 0dB) position - including channel, groups, and masters
- STEP 3: PFL channel 1
- STEP 4: With the audio input signal being produced, adjust the mixing console input channel trim control so that the level indicated by the PFL (Pre-Fader Listen) meter is as close to the Target Gain value as possible (use a selectable input pad if necessary and/or if the console is equipped with one)

Repeat steps 3 and 4 for all mixing console input channels that will be used for the mix session.

In performing these steps, you will ensure that you are getting the best possible performance from the mixing console. This is accomplished with an average sum buss output voltage at or near 0.775V (0 dBu) - this is considered nominal voltage (or unity).

Real-World Compromises

As with anything in sound reinforcement audio, there will be compromises. Some of the issues you may face would be:

- Cannot get the vocals loud enough over the band
- Cannot get sufficient level for the speaker's microphone

These are examples of the most common situations you will likely to be faced with. In handling these issues, you will need to establish new Target Gain groups for these channels - that is, treating these key channels as if they would be the only ones used during the mix session.

Going back to our previous example, we established a Target Gain value of *–12.0 dB* for *16* channels. In doing this we may find that the vocals do not have sufficient gain to be heard over the band. To solve this issue, perform the following steps:

- STEP 1: Establish a new Target Gain value for the *vocal channels only* (i.e.: *4* channels @ *-6.0 dB* each)
- STEP 2: Apply the new Target Gain level to the vocal channels as previously described

You will now find that the vocals have very sufficient level in relationship to the band instruments.

IMPORTANT: When considering the speaker's microphone channel (i.e. pastor's microphone), the ideal approach is to adjust the target gain as if it were the only channel in use; because most often it will be. Also, this will give you plenty of headroom when having to reinforce the speaker during moments of ministering – where the band is playing behind the speaker.

Making It All Happen

Now that you have set the mixing console input levels, it's time to mix. During the sound check, leave the channel and buss faders at unity (0dB) and adjust the trim levels of each channel accordingly as needed to acquire a properly balanced mix of the instruments. Doing this ensures that:

- You have a good visual starting point for your mix (0dB)
- You have the best possible SNR for the mixing console
- You have sufficient headroom as the mix builds during the performance
- You have sufficient fader throw to accentuate solos during music
- You are more likely to emulate a CD-quality mix for the audience

NOTE: If the mixing console is used also as a stage monitor console, then care will have to taken to maintain the input trim levels during sound check; as the stage foldback mixes are typically pre-fader, and adjustments could affect what the musicians could hear.

These steps outlined above will help set you apart as a proficient sound operator. Also, this process can be applied with *any* mixing console, in *any* venue, on *any* sound system, and with consistent and repeatable results. I recommend that you become very familiar with the signal path flow of the console on which you perform your mixes. This will ensure that you fully understand what's happening as you tweak, tweak, tweak……..:^)

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