

Gain Staging for Zoom Music

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Note: This is a preliminary document and as such may contain errors. Your feedback is appreciated.

Gain staging means setting the proper audio levels at each stage in an audio path. Proper gain staging allows you to get good sound levels without excessive system noise, distortion, and other audio issues such as dropouts. Proper gain staging isn't difficult, but it does require some effort, and a bit of a learning curve, to get it right.

One of the biggest problems with gain staging for online audio is that your computer and software (Zoom, for example) don't give you really good visual clues to tell you when your gain is too high, unlike mixers, audio interfaces, and digital audio workstation (DAW) software. Those systems all have visual indicators that show you when your input gain is too high ("clipping") or too low. In other words, you need to train your ears to listen for optimum sound levels.

First, a couple of definitions: *Gain* refers to the audio level on an input, while *volume* refers to the audio level on an output.

When the gain is too high you will get distortion and other audio artifacts. When gain is too low, the difference between the signal and the always present system noise, called the *noise floor*, is too low, resulting in excessive hiss and similar sounds. Background noise exists in all audio and video systems. Noise is always present in electrical and electronic systems. In audio, you need to make sure the signal is so strong that it is far enough above the noise floor that background noise is inaudible, but not so strong that it over-powers the ability to produce a clean sound.

The output volume of one system can be the input gain of another. For example, if the output volume of a home audio amplifier is too high, it can over-power the speakers, causing distortion, and possibly damaging the speakers. If the output volume of the speakers is too high, it can over-power the ability of your ears, your personal audio input system, to hear properly, potentially causing pain and even ear damage. In any audio system, balance is key.

Scenario #1: A single, directly-connected microphone.

This applies to built-in mics, PC mics (designed to plug into the mic port on many laptops and desktop PCs), USB mics, and dynamic mics with XLR-to-USB cable.¹ In Zoom, go to Settings,

¹ With the right cable and/or adapter, you might be able to plug a dynamic stage mic into the mic input port, but the sound level will likely be very low. You cannot plug a condenser mic in this way.

Audio, and first un-check “Automatically adjust microphone volume. Then set the microphone input level tot between half and three-quarters of the full level.²

Scenario #2: One or more microphones or instruments connected through a USB audio mixer.

Everything above applies, but you first must set your input gain and output levels on the mixer. The advantage of using a mixer is that you have a high degree of control over both input and output levels. Also, some mixers allow you to apply effects, including compression and reverb.

On each channel, you'll have a “gain” control (sometimes called a “trim” control) and a fader or level control. You will also typically have a “clip” LED and a “pan” control. The gain controls the input to the channel's preamp. The clip LED tells you when that level is too high and is over-driving the preamp. Adjust the gain as high as you can without clip LED lighting up. Set the fader or level control to “unity,” or 0db. The pan controls determine how much of each signal goes to each stereo output channel. I usually pan my vocal to about the 2:00 o'clock position my guitar to about the 10:00 o'clock position, but you may want more or less separation. (Panning only matters if you are using Zoom in stereo mode.)The mixer will also have a pair of “main” faders, which should have their own volume indicators. Set these to unity as well. When you are in your Zoom session you can use the channel faders to fine-tune the balance between channels and the main faders to fine-tune the output level. As with the channel gain settings, you want your main faders set to just below clipping. At this point, with the help of another session participant, you can adjust the Zoom microphone input level for the proper volume.

Scenario #3: One or more microphones or instruments connected through a USB audio interface without digital audio workstation (DAW) software.

This approach gives you control over the input gain of attached microphones and instruments, but does not allow you to add effects. As with a mixer, you must set the input gain for each connected device on the audio interface first. Set it to the highest level you can without the clipping LED lighting, then, with the help of another session participant, set your final output level with the Zoom microphone input level control. Most audio interfaces have no pan control, so you may not want to use Zoom in stereo mode unless you are using DAW software (below) to provide more control.

Scenario #4: One or more microphones or instruments connected through a USB audio interface with DAW software.

This approach gives you a high degree of audio control and the ability to apply multiple effects at the cost of increased complexity, including the use of additional routing software or additional software applications. For example, on Windows, I route from my inputs to my audio interface to

² USB microphones will have an additional audio level control. Follow the manufacturer's recommendations for the initial setting of this control.

my DAW to OBS³ (Open Broadcast Software) to Zoom. To route from the DAW to OBS I use a routing plugin, and to route from OBS to Zoom I use a virtual audio cable. With MacOS the process is likely somewhat simpler, but still requires the use of third-party routing software.

As with an interface without a DAW, you must set the input gain for each connected device on the audio interface first. You then need to set both the input and output levels in the DAW, followed, with the help of another session participant, by setting the microphone input level in Zoom for proper volume. If you are using Zoom in stereo mode you will want to pan your guitar and vocal channels appropriately.

³ You can also use OBS with a mixer, but its use is beyond the scope of this document. I use OBS with a mixer because it gives me much better control over video.