How to Set Amplifier Gain Properly: A Step-by-Step Guide

What is Gain Control?

The gain control on an amplifier is not designed to function as a volume controller. Instead, it is used to match the output voltage of the source unit to the amplifier's input. When the gain is set to its minimum position (usually fully counterclockwise), the amplifier can still produce its maximum rated power, but it requires the highest signal voltage allowed by the input circuitry to do so.

When the gain control is turned fully clockwise, the amplifier will reach its maximum rated output with a much lower input voltage. This setting increases the risk of clipping the amplifier's output, which can potentially damage the speakers.

Example:

- Amplifiers input voltage range is 125mV – 10V
    - With gain control in the fully counterclockwise position, it requires 10V of signal input to reach maximum rated output.
    - With the gain control in the fully clockwise position, it requires 125mV of signal input to reach maximum rated output. Anything above that signal level will lead to distortion and clipping from the amplifier.

What is a range selector (Hi-Lo switch)?

This is an optional input voltage selection switch designed to better match your amplifier's input gain control range with your source unit's output signal (speaker level vs. RCA level).

- **Speaker Level (Hi Level):** This refers to the speaker wires used to drive a speaker directly, with maximum output signal voltages typically ranging from 10V to 40V.
- **RCA Level (Low Level):** This signal is not intended to drive a speaker directly; instead, it is designed as a pre-amp to be fed into an amplifier that will power the speaker. RCA level signals typically range from 125mV to 4V. This is also known as 'line level' sometimes.

Why is gain setting important?

Properly setting the gain is essential because source units have varying output voltages, especially between RCA and speaker-level outputs. If the gain is incorrectly set, the biggest risk is damaging your speakers from clipping. Clipping occurs when the amplifier attempts to produce more power than it is designed for, and in extreme cases, the amplifier itself can also be damaged.

Additionally, improper gain settings can affect the sound quality of your system. You may experience issues such as system noise (electronic background noise that gets amplified), insufficient volume, or an imbalanced frequency response in systems with active crossovers. This is especially common in multi-channel systems that use active crossovers built into the amplifiers.

What are some of the problems that may occur when gain is set incorrectly?

- **Gain set too low** - The system may not play as loudly as desired, or there may be a lack of frequency response in the ranges set by the crossovers. This can result in specific frequencies not being loud enough to balance the overall frequency response in an actively crossed-over system.
- **Gain set too high** – distortion from clipping, engine noise, system noise, lack of precise control of volume, and frequencies playing louder than others in actively crossed over systems.

Can you accurately set your gains by ear?

With dynamic (constantly changing) music, it's especially hard to hear exactly when distortion starts. In blind listening tests, most listeners begin to hear distortion on full-range speakers in a quiet room at around **3–10% THD**. For subwoofers, the threshold is much higher — typically around **30% THD**. Setting gain by ear often leads to setting the gain too high, which can result in more distortion than you want—and even damage your equipment over time.

What is a clean signal?

Usually, we refer to a *clean signal* as an audio signal with less than **1% Total Harmonic Distortion (THD)**. In simple terms, it means the sound is clear and free from unwanted distortion. When setting up your system, the goal is to keep distortion below 1% throughout the entire signal path—from your source unit all the way to your speakers.

In the "Setting Gain with an Oscilloscope" section of this guide, you'll find a visual example showing the difference between a **clipped** waveform (more than 1% THD) and an **unclipped** waveform (less than 1% THD), which represents a clean signal.

How do I know what volume level to set my source unit to for setting Gain?

It is important to know the highest output level the source unit will play before reaching 1% total harmonic distortion. This is necessary to achieve the cleanest signal to your speakers.

This can be found with a 0dB sinewave test tone, an oscilloscope, distortion detecting device, or an amplifier with distortion detecting built in. If these tools are not an option, we recommend setting volume to 75% of maximum output. If there is audible distortion heard, back the volume down until it sounds clean and clear to the ear (this "by ear" method for finding the distortion point on the source unit will only be possible with the source unit amplifier or factory amplifier still connected to the speakers.).

In the following amplifier gain setting section, we go over finding the source unit maximum output using the output of the amplifier. This is only possible when there is nothing else in-between the source and the amp. If there is a signal processing device in-between, an oscilloscope or distortion detecting device will need to be used on the output of the source unit. Check out the Pro Tips section for more information.

What is gain overlap?

Gain overlap occurs when the amplifier gain is set higher than the matched source unit and is measured is increments of decibels (dB). Understanding gain overlap is important for optimizing the overall sound quality and preventing distortion or damage to your equipment.

Not all recordings are created equal—older tracks are often quieter and may require higher volume levels to match the output of more modern recordings. To address this, we recommend starting with a **3dB gain overlap** for full-range speakers and **5dB** for subwoofers. This allows for adequate volume without introducing to much unwanted distortion.

Since distortion is harder to detect in the lower frequencies produced by subwoofers, a slightly higher gain overlap is generally acceptable. For a 5dB overlap, use a **-5dB test tone** during the gain-matching process. If you listen to music that is recorded very low, you can use **10db** overlap if necessary.

Basic gain setting for single amplifier:

There are three ways to set gains

1. **With a voltmeter** – Good but you are unable to determine how clean a signal is.
2. **With an oscilloscope** – Great but a bit more difficult to visualize. Gives you the ability to use any frequency sinewave you would like, to account for frequency peaks in source unit frequency response.
3. **With a clipping indicator built into amplifier or DD-1** – Great and easy to visualize but not as accurate as an oscilloscope. Sometimes limited with what frequency sinewave you can use.

Setting gain with voltmeter:

You will need:

- Voltmeter – shows output voltage of amplifier
- Test tones – 50Hz and 1000Hz sine waves in your chosen overlap - 0, -3, -5 and-10dB
- Voltage chart – Wattage and speaker resistance to voltage
- Screwdriver or adjustment tool to control gain on an amplifier

Process:

1. Disconnect speaker wires from the amplifier to be set up, as well as signal input or speaker wires from any other amplifier currently connected in the system so no damage to your speakers or ears occurs as test tones are played.
2. On amplifier, set all gain controls to their minimum positions and all crossovers to their minimum effective positions (i.e. subwoofer amp low pass turned all the way up).
3. On source unit, defeat any EQ, crossovers, loudness, and tone controls to flat or neutral positions including listening position if adjustable.
4. Connect Voltmeter to the speaker output channel to be adjusted. Black (Com) probe to speaker negative and Red (Volts) probe to speaker positive and set to read AC voltage $(\tilde{V})$.
5. Play a test tone in the source the system will be mostly used with (CD, USB, 3.5mm phone auxiliary, Android Auto, CarPlay, etc.). This is important because all sources will be slightly different in output levels. For full range amplifiers, use a 1KHz tone and for subwoofer amplifiers use a 50Hz.
6. Set source unit to the maximum undistorted output. If this is not known, see "How do I know what level to set my source to?". Make sure you note the volume number and **never exceed this level or damage may occur.**
7. Switch to a test tone with a dB overlap. To get the most out of your amplifier, we recommend a -3dB overlap on full range amp sections and -5dB overlap on subwoofer amplifiers.
8. Open the voltage chart and find the AC voltage you will be setting your output voltage to by picking the wattage and impedance of your chosen equipment. (**You must be sure the amplifier you are setting up can produce the desired output without clipping**)
9. Start increasing the gain level of the amplifier with the gain control or setup software. Monitor the voltage level on your voltmeter as you turn the gain up to make sure you do not exceed the desired AC voltage output level in the power chart.
10. This is your max gain setting. Do not turn gain or bass boost up from this point. Check out our Pro Tips section for how to blend full range and sub channels as well as what to do with bass boost and other settings.

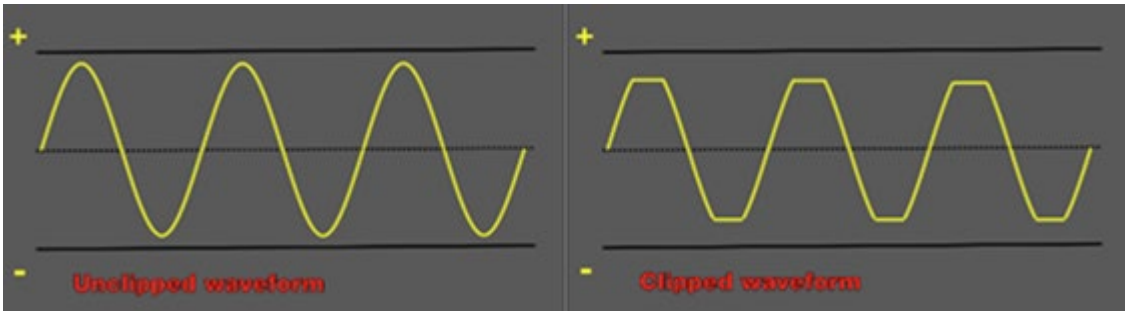
Setting gain with Oscilloscope:

You will need:

- Oscilloscope – shows waveforms of signal
- Test tones – 50Hz and 1000Hz sine waves in your chosen overlap - 0, -3, -5 and-10dB
- Screwdriver or adjustment tool to control gain on an amplifier

Process:

1. Disconnect speaker wires from the amplifier to be set up, as well as signal input or speaker wires from any other amplifier currently connected in the system so no damage to your speakers or ears occurs as test tones are played.
2. On amplifier, set all gain controls to their minimum positions and all crossovers to their minimum effective positions (i.e. subwoofer amp low pass turned all the way up).
3. On source unit, defeat any EQ, crossovers, loudness, and tone controls to flat or neutral positions including listening position if adjustable.
4. Connect oscilloscope test probe to the speaker output channel to be adjusted.
5. Play test tone in the source the system will be mostly used with. (CD, USB, 3.5mm phone auxiliary, Android Auto, CarPlay, etc.). This is important because all sources will be slightly different in output levels. For full range outputs, use 1KHz tone and for subwoofer amplifiers use 50Hz. These testing frequencies do not have to be exactly 1KHz or 50Hz.
6. Make sure oscilloscope is set for the proper voltage and time division need for testing. You may have to adjust the voltage range of the oscilloscope as you increase the output level with the gain adjustment on the amplifier. Consult oscilloscope manual for instructions on how to do this.
7. Start increasing the volume level of the source unit and watch the waveform on the oscilloscope. Make sure you can see the entire waveform from top to bottom on the screen. You may need to increase the voltage/division setting to see a complete waveform.
8. Once you see the top and bottom of the waveform start to flatten out, stop increasing volume. Decrease volume until the waveform is once again smooth and rounded. The source unit maximum output is now found. **Never exceed this level or damage may occur.**
9. Switch to a test tone with a dB overlap. To get the most out of your amplifier, we recommend a -3dB overlap on full range amp sections and -5dB overlap on subwoofer amplifiers.
10. Start increasing the gain level of the amplifier with the gain control and watch the waveform on the oscilloscope.
11. Once you see the top and bottom of the waveform start to flatten out, stop increasing gain adjustment. Decrease the gain adjustment until the waveform is once again smooth and rounded.
11. This is your max gain setting. Do not turn gain ore bass boost up from this point. Check out our Pro Tips section for how to blend full range and sub channels as well as what to do with bass boost and other settings.



Setting gain with clipping indicator on amplifier or DD-1:

You will need:

- Test tones – 50Hz and 1000Hz sine waves in your chosen overlap - 0, -3, -5 and-10dB
- Screwdriver or adjustment tool to control gain on amplifier
- DD-1 (if not using clipping indicator on amplifier)

Process:

1. Disconnect speaker wires from the amplifier to be set up, as well as signal input or speaker wires from any other amplifier currently connected in the system so no damage to your speakers or ears occurs as test tones are played.
2. On amplifier, set all gain controls to their minimum positions and all crossovers to their minimum effective positions (i.e. subwoofer amp low pass turned all the way up).
3. On source unit, defeat any EQ, crossovers, loudness, and tone controls to flat or neutral positions including listening position if adjustable.
4. If you are using a DD-1, connect probes to your speaker output channel to be adjusted and turn on device.
5. Play a 0dB test tone in the source the system will be mostly used with. (CD, USB, 3.5mm phone auxiliary, Android Auto, CarPlay, etc.). This is important because all sources will be slightly different in output levels. For full range outputs, use 1KHz tone and for subwoofer amplifiers use 50Hz (DD-1 will need a 40Hz signal instead of 50Hz for operation).
6. Turn source volume up until the amplifier clipping indicator illuminates and then back it down one notch. Note the volume number and never exceed this level or damage may occur. If the distortion detection light does not illuminate, your source unit is clean at maximum volume
7. Switch to a test tone with a dB overlap. To get the most out of your amplifier, we recommend a -3dB overlap on full range amp sections and -5dB overlap on subwoofer amplifiers.
8. Start increasing the gain level of the amplifier with the gain control and watch for illumination of the clip indicator on amplifier or light on distortion detector.
9. Once you see the light illuminated, decrease the amplifier gain until the light fades away.
10. This is your max gain setting. Do not turn gain or bass boost up from this point. Check out our Pro Tips section for how to blend full range and sub channels as well as what to do with bass boost and other settings.

Pro Tips

Using Bass Boost or SHOCwave

These features can significantly enhance how your music sounds, depending on the recording and the overall system response in your vehicle. However, boosting certain frequencies can lead to earlier distortion in those areas. For example, if your system lacks bass around 40Hz and you apply a 3dB Bass Boost centered at 40Hz, you're effectively increasing the amplifier's gain in that specific frequency range. Think of this EQ adjustment as a *secondary gain control*. Bass Boost should not be used to increase overall subwoofer volume—that's determined by the amplifier, subwoofer, and enclosure. If you choose to use Bass Boost or SHOCwave, you should re-set your amplifier gain afterward.

Setting Gain with EQ Adjustments

If you've already set your gain and then applied EQ boosts—or if you're working with a signal that includes non-adjustable EQ boosts—you'll need to re-set your gain using a test tone at the frequency with the highest output. You can determine this frequency by playing a slow sweep tone (20Hz–20kHz) while monitoring with a multimeter, or by using pink noise and an RTA (Real-Time Analyzer). Once the peak frequency is identified, use a test tone at that frequency to set your gain.

Blending Full-Range Channels with Sub Bass

After gains are set and all speakers are connected; some fine-tuning may still be required. Listen to your system carefully and determine if the subwoofer sounds overpowering or if the full-range speakers are too dominant. If you have access to an RTA, play pink noise and examine your system's frequency response.

- If the bass is overpowering the highs, a remote bass knob is the best solution, allowing you to adjust bass levels as needed for different songs. If that's not available, it's perfectly acceptable to turn down the subwoofer gain slightly.
- If the high frequencies are louder than the subwoofer, and you've confirmed that the subwoofer is properly wired (phase is correct, crossovers are set properly, etc.), you may need to reduce the gain on your full-range amplifier.