

# Power Amplifier “Technical” Notes / Information / Theory

→ Can an “Undersized Amplifier” damage your speakers? Yes and No! It depends on how hard you push the amplifier. Example: Let’s say you use a 100-Watt amplifier with a 300-Watt speaker. If the audio sounds good and the amplifier is not “clipping,” all is good. The issue with using undersized amplifiers occurs when you start driving the amplifier harder and harder, and the amplifier starts to “Clip.” Speakers can handle short-term peaks (bursts of sound) but not consistent and “continuous” clipping from the amplifier.

→ What does that “Red” Clip Indicator on the amplifier mean? Things can go wrong quickly when that red “clip” indicator comes on. Did the clipping just come and go in short bursts, or did the clipping stay in the red for long periods? Solid Red means Stop! Just like a traffic signal. Once the signal stays in clip and the signal starts distorting – equipment starts overheating, and damage can occur. The amplifier is now beginning to drive the speaker cone past its limits. Once excessive “clipping” occurs, the speaker cones stop moving. The excessive clipping has changed the audio signal (an AC signal) to a DC signal, which is very harmful to speakers. The “high-frequency components” of the speaker are usually the first to become damaged. Again, short bursts of clipping will be fine, but when you start to see “Solid Red,” it’s time to stop!

## Important Technical Note:

There is a correct way (sequence) to turn on and off a sound system. Turning on and off a sound system randomly can eventually cause potential damage to equipment and speakers.

There is a power on / off sequence that you should use when turning your sound system on and off.

### Powering on / off sound systems – Proper Sequence:

- Powering System ON = Turn on all processors, electronics first – then turn on the amplifiers last.
- Powering System OFF = Turn off the amplifiers first and wait 20 seconds – then turn off all the processors, electronics last.



Whirlwind PLR-PS2 with Rack Lighting

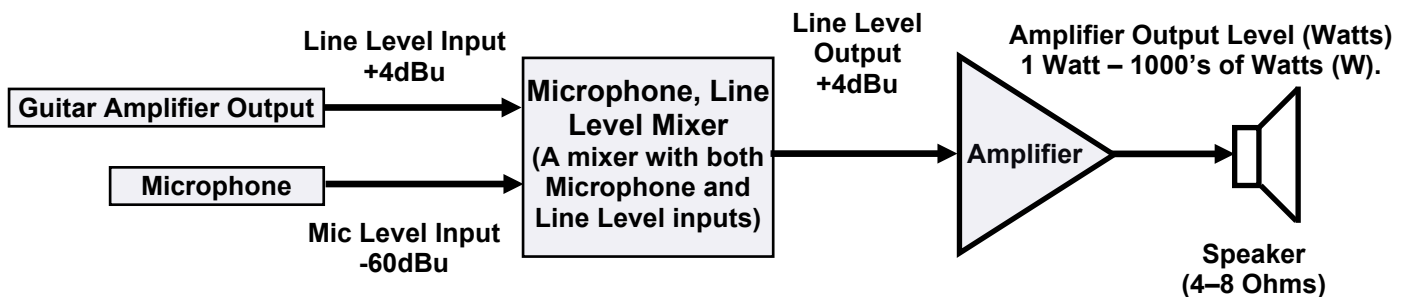
**Power Sequencers:** A power sequencer / surge suppressor can turn on / off your equipment in “time intervals” by pressing just one button / switch.

## [Video Clip!](#)

## Power Amplifiers – Basics / Notes / Theory

### Power Amplifier Levels / Wattage – What you Should know and Understand

There is some confusion regarding amplifier power, amplifier loudness, what size amplifier is needed, and amplifier volume controls that we will try and resolve in this section. The diagram below demonstrates the different power levels from Instruments and Microphones to the Amplifier and Speaker. Take a look!



\*The Mixer will take the Microphone input and amplify it (using a pre-amp).

\*The Mixers output will be combined and also be Line Level output.

[Video Clip!](#)

It is important to note that the power output levels associated with audio power amplifiers can be high, and also that a poor input signal (weak signal) can affect an amplifiers output (making the amp less efficient).

Amplifier level is a term used to designate the strength of an audio signal used to transmit analog sound information between an audio amplifier and speakers. Amplifiers will receive a "line level" signal at its input, which will then be "amplified" through the amplifier's circuits to the speakers.

### Amplifier Level Notes:

- The voltage associated with amplifier levels is usually measured in Wattage (Watts, W).
- Amplifier levels are dependent on the size (wattage) of the amplifier (1 Watt - 4000 Watts or more).
- Amplifier levels are also dependent on the “load” they see. For example: If an amplifier is connected to a 4-ohm speaker – the amplifier is “seeing” a 4-ohm load. As stated earlier: Impedance is measured in ohms, and can be defined as “resistance (opposition to the flow of electrical current representing audio signals).

### Typical Power Amplifier Ratings Example:

	Stereo (Watts Per Channel)			Bridged Mono Mode
Impedance	8 Ohms	4 Ohms	2 Ohms	4 Ohms
Wattage	330 Watts	575 Watts	900 Watts	1800 Watts

In this example you can see that as the Impedance of the Load (the speakers) gets higher, the Amplifiers wattage will be lower. As the Impedance of the Load gets lower, the Amplifiers wattage will be higher.

**Warning:** If the impedance of the speakers (load) is ever 0 Ohms (zero ohms), this would be considered a “Short.” And there is a good chance the amplifier will “fail or burn up” due to this “short circuit” condition.

A “Best Practice” regarding amplifiers is first to ensure you understand the amplifier’s wattage rating (which is stamped on the back of the amplifier). Second, you will need to know your speaker’s rating (4-ohms? 8-ohms? Wattage?) in order to verify the “Load” that you’re connecting to the amplifier. These two crucial steps will ensure that you are correctly “matching” the amplifier’s “output” wattage to the speaker’s “input” wattage.

**What is Bridged Mono Mode?** When you switch an amplifier to “bridged mono mode” (usually via a switch on the amplifier) both amplifier channels are “combined” to drive a single output. As you can see in the example above the power in bridged Mono Mode is extremely high (1800 Watts at 4-ohms for this amplifier). Use caution and read the amplifiers manual prior to using the Bridge Mono Mode. Double check settings, connections, and wattages prior to powering up the amplifier – and always make sure that the speaker you plan to use has a wattage rating high enough to match the amplifiers wattage (or the speaker could be damaged).

### [Bridged Mono Mode - Video Clip!](#)

### What size Amplifier do you really need?

It will depend on your speaker’s specifications. You will first need to look at the speaker’s data sheet and find the specification called “Continuous Power Rating” (also referred to as Power Capacity, Power Handling).

**Amplifiers:** The amplifier ratings that are important for audio technicians to know would be “RMS” Mean Power (root mean square / continuous) and “Peak” power ratings. These are ratings that are needed in order to find and match the correct speakers to your amplifier. Caution: You may have an amplifier that is rated at 50W continuous (or RMS), but when fully driven, it can put out 150-watt peaks. Make sure that you connect a speaker (or speakers) that can handle the power levels of this particular amplifier rating.

**Speakers:** Similarly, RMS Mean power, or root mean square (RMS) power handling, refers to how much continuous power the speaker can handle. The peak power handling value refers to the maximum power level the speaker can utilize in “short bursts.” For example, a speaker with a 30W RMS rating and a peak rating of 60W means that speaker can comfortably run with 30 watts of continuous power, with occasional bursts of up to 60W. Many speaker manufacturers give you both values for a given speaker. Both values are essential. See spec notes below using an Electro-Voice speaker.

The Specification sheet for the Electro-Voice TX-1181 Subwoofer Speaker Cabinet (right) indicates that the Power Handling is 500 watts Continuous, and 2000 watts Peak (short bursts). The Power Rating states 2000W but keep in mind that this is actually the Peak rating (short intervals / bursts) the speaker can handle.

Power Rating	2000W
System Power Handling (Continuous/Program/Peak)	500//2000Watts

## Amplifier / Speaker Impedance Matching - Notes

- Using higher impedances than those of the "rated" load of the amplifier will reduce the amplifier's power being delivered to the speakers. Ex: Amp's rated load is 200-Watts at 8-ohms, and you use a speaker that is 16-ohms – The amplifier will now only output around 100-Watts with this 16-ohm load. This will not affect the other characteristics of the amplifier (such as distortion).
- Using Lower impedances than those of the "rated" load of the amplifier (depending on how low the impedance is) should be avoided, as this could cause the amplifier to "overwork." This can cause some amplifiers to overheat. In some cases, too low of an impedance (under 1 - 1.5 ohms, for example) could be seen as a "short circuit" to the amplifier.

Tech Note – Wattages add whether they are in Series or Parallel. For example, if you have two speakers rated at 300-watts each connected in Series – the total wattage would be 600-watts. And if you connect these same two 300-watt speakers in Parallel, the total wattage would also be 600 watts.

### Understanding how the Decibel (dB) relates to Amplifier Size (This was covered briefly on Page 21, but relates to this section as well).

[Video Clip!](#)

We learned on Page 21 that a +3dB change in Sound Pressure level is the minimal practical change most listeners can easily hear. With power amplifiers, in order to produce this +3dB change, you would need to "double" the power (wattage) of your amplifier. Yes, you would need to "double the wattage" of the amplifier you currently use to get this extra +3dB change!

**Example:** If you have a 200W amplifier, you would need a 400W amplifier to get the extra 3dB of sound pressure level. That's all that doubling the power amplifier wattage will give you. With this being said – A 300W amplifier and a 350W amplifier would be relatively the same. Upgrading from a 300W to a 350W amplifier would be somewhat pointless regarding system "level" changes!

A +6dB change in Sound Pressure level is easy for listeners to hear. This change is considered the "Goal" for changes in system levels. To produce a +6dB change, you must increase the power by "4 times" your amplifier's current power (wattage). Ex: If you have a 200W amplifier, you would need an 800W amplifier to get the extra 6dB of sound pressure level you need for this system-level change.

Do you need your system to be "Twice as Loud?" This will require a +10dB change in Sound Pressure level. To produce a +10dB change, you need to increase the power by "10 times" your amplifier's current power (wattage). Ex: If you have a 200W amplifier, you would need a 2000W amplifier to get the extra 10dB of sound pressure level you need to hear the system as "Twice as Loud." If you want to "Half" the loudness, you would require a -10dB change in Sound Pressure level (replace the 2000W amplifier with a 200W amplifier).

You should now have a better understanding of how the decibel relates to amplifier size. The best way to avoid these issues is to ensure you have the correct size amplifiers and speakers from the start of the project/installation. This is what is called the "Planning and Design Stage." Find out how many speakers are needed, and what the power handling specs are, etc. Once you have this information, you can match the speakers with the correct size amplifier. This will ensure a smooth installation process.

**Real-Life System Installation Failure** - An audio contractor was hired to design and install speakers in a large building (a "Ride" inside the building) with 9-10 different zones. When it was time to "Commission" (test, evaluate) the system, our General Contractor walked the building with the audio contractor (they did not invite me), and all the levels were acceptable – so the General Contractor signed off on the installation. When I showed up, the audio contractor was gone, and I was told the system was mine to maintain. Since I wasn't allowed to attend the first system walk, I asked for a second one. I was told it would be a waste of time, but I demanded we do the walk. We walked around the building and went through all the zones, and the levels appeared adequate. The General Contractor commented, "Well, that was a waste of time." I asked if they could run the ride and turn on the AC system. With the Ride and AC system on – you could barely hear any audio coming from the speakers. I was asked to adjust the levels but found that the amplifiers were turned all the way up and were on the verge of clipping – there was no way to turn anything up! It was evident that the power amplifiers were incorrectly matched to the speakers. They had installed amplifiers rated at 250W per Channel, but the speaker specifications / rating was 375W continuous per Channel. This could have been avoided, but apparently, someone skipped the "planning and design" stage of the installation. A lot of extra labor and expense went into correcting this "preventable" mistake.

## Is an Amplifiers Volume Control really a Volume Control?

It is important for Audio Technicians to understand that power amplifier volume controls (level/gain controls) are actually "Input Sensitivity Controls" (also referred to as "Input Attenuators"). They are incorrectly referred to as amplifier "volume controls" and have nothing to do with the amplifier's output stage. The input controls on power amplifiers essentially determine what "Input" level will cause the power amplifier to produce its full power, and they do not change any available output power the amplifier may have. It's also a misconception that turning down the volume control on an amplifier can reduce the "Signal to Noise Ratio" and help a system's "Dynamic Range." This is not a valid point. All this info may sound confusing, but it's the reality regarding the amplifiers misunderstood "volume control."



Typical "Input Sensitivity" controls on a Power Amplifier. Commonly and incorrectly referred to as "Volume" or "Gain" controls. This amplifier got it right and labelled their controls "ATTEN" (For Attenuator).

What happens when you send a signal that is too strong to an amplifier's inputs? How do you know you're "overdriving" the amplifier's input? Clipping occurs, which is bad for the power amplifier and speakers. You really know you're sending too much signal to the amplifier if the amplifier is turned all the way down and it's still clipping. A few red lights intermittently here and there will be ok, but never keep the signal in a constant clipping state – the amplifier could be damaged, and you could end up with blown speakers.



[Video Clip!](#)

## What else can cause Clipping?

A couple other things that can cause Amplifier clipping.

- The amplifier cannot provide the needed power to the speakers connected to it, and is working way too hard.
- The speaker or speaker cable can be defective and have a possible short. Amplifiers do not like "short circuits."
- Overheating – Heat is another main cause of amplifier clipping, when left too long in this state the amplifier usually goes into CLIP / Protection mode first, but can actually burn up over time. Keep your amplifiers well ventilated.

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