5 Ways to Blow Up Your Loudspeakers

#1

Clip Distortion

Excessive clip distortion, or 'clipping' produces massive heat build-up in loudspeaker coils and can easily burn them out. See below for more details.

#2

Badly Matched Amplifiers

An amplifier that is way too powerful for your loudspeakers is likely to blow them up. It might come as a surprise that using an amplifier without enough power can also blow up your loudspeakers. In fact, loudspeakers function much better with extra power available. See below for more details.

#3

Excessive Compression & Limiting

Limiters are NOT the answer to an idiot on the desk. Contrary to popular opinion, compression and limiting do not always protect loudspeakers. Compressor/limiters can actually add to the problem and cause your loudspeakers to fail! See below for more details.

#4

Feedback and Other Nasties

Feedback - like clip distortion and excessive limiting - can blow up your loudspeakers. Cutting the power incorrectly can also damage your system. For more information on how to be a bad boy (or girl), see below.

#5

Incorrect Use of Loudspeakers

Apart from using a guitar as an axe to inflict damage on loudspeakers etc, we've come up with a novel way of blowing up a loudspeaker. Check out our anti-gravity device and YouTube video here:

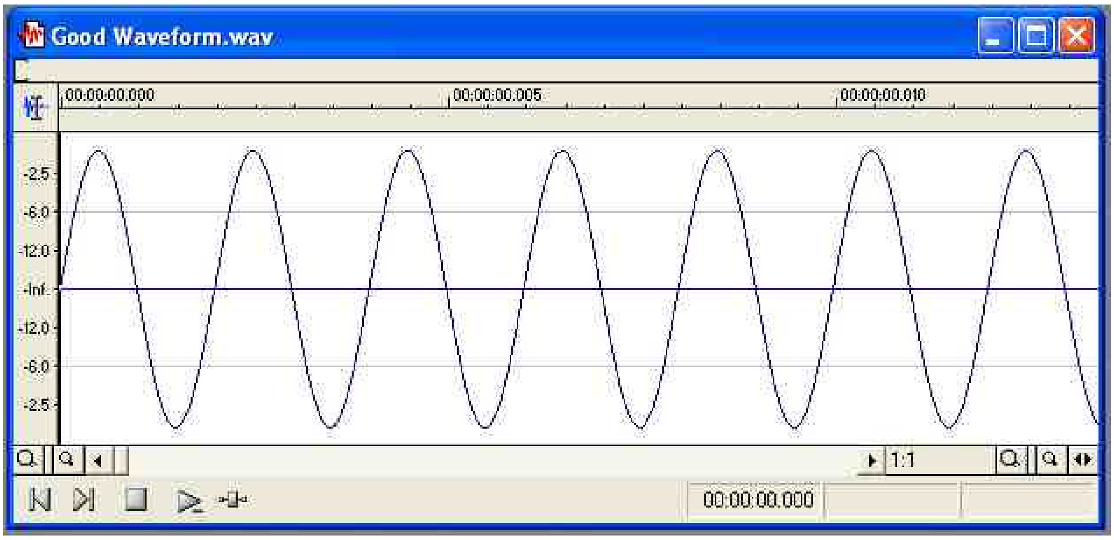
http://www.youtube.com/watch?v=aiNnLyvJS3E

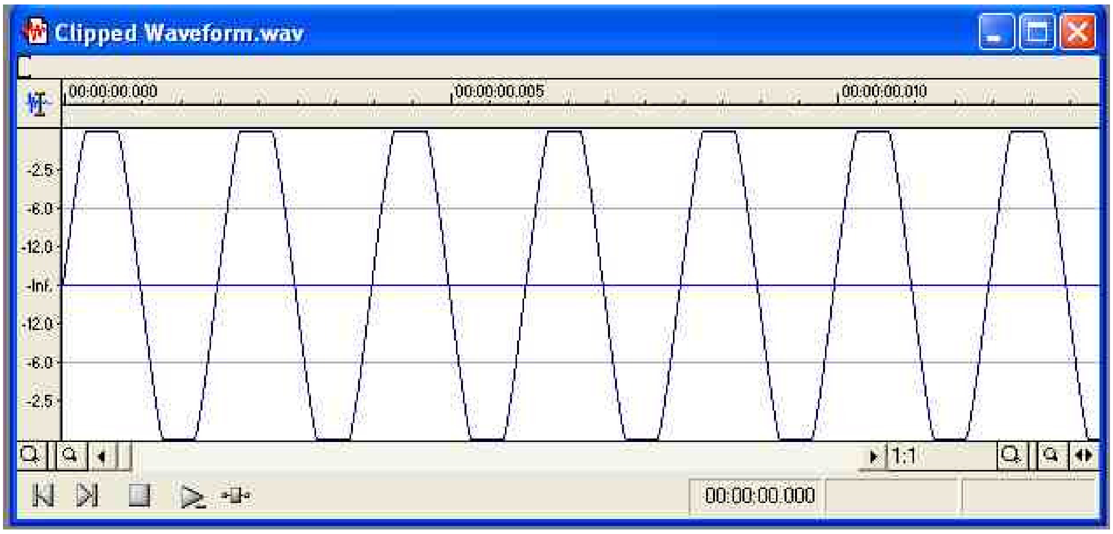
Clip Distortion

So, what is clip distortion? It happens when a signal has been overdriven. So what is overdrive?

All amplifiers and preamplifiers have a maximum voltage that they can generate. If you force a signal through that is too big, it cannot be recreated. Instead, the amplifier will just stop when it hits the maximum. This is true for amplifiers that "go up to 11" as well as those that "only go to 10". Neither amplifier can produce 13.

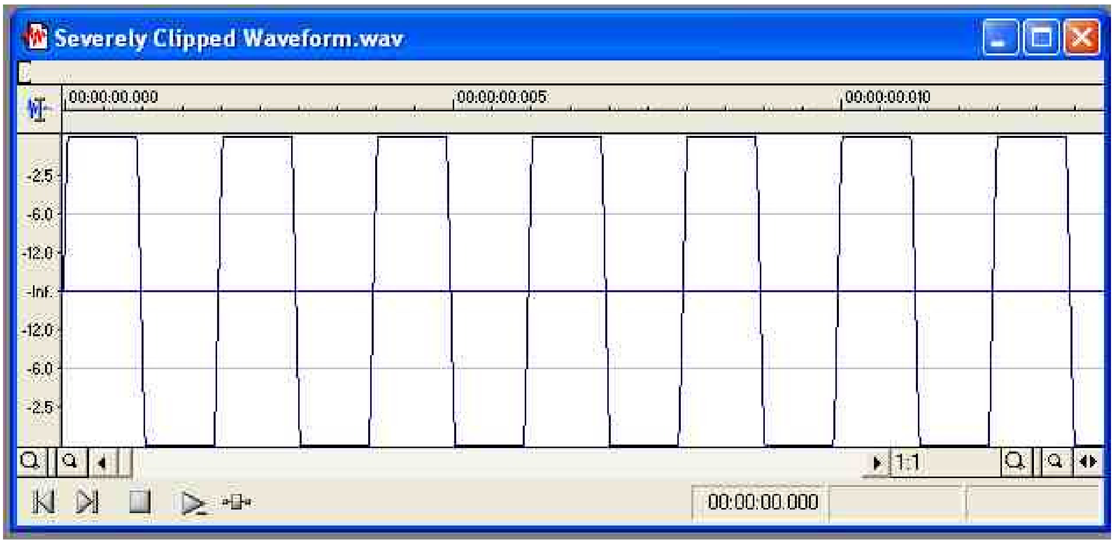
The following pictures show a 'healthy' sine wave and the same wave that is 'clipping':





Two things have happened to the clipped sine wave. The tops of the wave have been lopped off and the slopes of the wave are steeper. Both of these effects can cause damage to a loudspeaker's 'voice coil'. Please see below for more detail.

Here’s the same sine wave with even more clipping:



The effects are now so severe that we almost have a ‘square wave’.

Let’s consider the loudspeaker and how it must react to the different waveforms. Loudspeakers are not very efficient at converting electrical power into sound. As a result, much energy is wasted as heat. If too much power is applied, the heat will build up and the loudspeaker coil will burn out. If the power and heat are kept under control, the loudspeaker will continue to work.

In the top drawing of a ‘healthy’ sine wave, the loudspeaker assembly will be in constant motion – more power is being converted to motion - and this motion has a cooling effect on the coil assembly.

In the second drawing, the clipped sine wave is forcing the loudspeaker assembly to stay still for longer periods of time at full voltage (see the bottom and top of the wave). While no power is being converted to motion, there is no cooling effect, and the life expectation of our coil is getting shorter…

The third drawing is a suicide mission for our poor, tired voice coil. Not only do we expect it to stay still at its end stops at maximum power, but we also expect it to change its back and forth motion so rapidly that it can’t keep up (see the very steep slope on the waveform). The weight, or mass, of the assembly means there’s a limit to how fast it can go (hence an elephant can’t run as fast as a cheetah). In reality, it flails around a lot and gets hotter and hotter. Life is very short for our square-waved voice coil!

Fortunately, many systems have warning lights that glow RED when a clipped signal is present. These can be found on mixing desks, amplifiers and all sorts of professional audio toys. These ‘clip lights’ glow RED for a reason. They mean “Danger! Stop!” Clipped signals are bad for loudspeaker components.
Clipped signals also create problems for amplifiers. Amplifiers get hot too. Even if the amplifier itself is not clipping, it can still amplify a clipped signal originating before the amplifier - with the same lethal outcome for your loudspeakers.

A good way to avoid blowing up your loudspeakers is to pay attention to *all* the clip lights. The obvious answer is to turn the signal down until they don’t light at all or, at the very least, only occasionally.

Badly Matched Amplifiers

We've looked at Clip Distortion and why it's bad for loudspeakers. Now let's consider your choice of amplifier - and how a bad choice can do a very good job of blowing up your loudspeakers.

If your amplifier delivers much more power than your loudspeaker can handle, the voice coil could burn out. Other symptoms include broken diaphragms and loudspeaker cones etc. Click here to see our video of a loudspeaker that is seriously over-powered.

However, under-powering your loudspeakers can be a highly effective way to blow them up as well. This will seem counter-intuitive, or plain crazy, to some. So here's the explanation for why over-powering by a reasonable margin is better.

There are two things to consider here:

1) A loudspeaker is not a light bulb
2) Audio signals do not require a constant power

Let's consider a domestic 100-Watt light bulb plugged into a 230V, 50Hz mains supply. It will consume 100 Watts of power. Normally it will last for months like this without ever burning out. Every night it will continue to consume 100 Watts of power, perhaps until bedtime.

It is important to realise that nothing is changing here. The voltage remains the same. The 50Hz bit remains the same. The light bulb does not change…

Changing just one thing could alter our bedtime reading. If we increase the voltage to 400 volts, the bulb will glow brighter and consume more power. This would undoubtedly shorten its life. Changing the frequency of the mains to 10Hz instead of 50Hz would also change things – although I'm not sure how you'd do that. You could change the bulb for a more powerful version, which, of course, would consume more power. You could have five or six 100-Watt bulbs attached to your mains supply, if you liked, and they would still only consume 100 Watts each.

So why should a 100-Watt loudspeaker be any different? Why not just plug it in to any old amplifier? Why might a 2,000-Watts amplifier blow it up? Surely it would just consume 100 Watts? What would happen if I only had 50 Watts of amplifier power?

Unlike the light bulb, all these factors are changing constantly with a loudspeaker. With an audio signal, instead of a steady 230 Volts, the voltage goes up and down constantly – as does the power. The frequency is not a constant 50Hz (50 cycles per second); instead it could be anything between 20Hz and 20,000Hz. This also affects the power consumption. A loudspeaker is a 'complex load'.

Since most audio signals are not constant, the power consumption is not constant either. Audio signals will have loud transient peaks with quieter bits in between.

When we consider that heat build-up is a major enemy of our loudspeaker, a reasonable audio signal will allow some resting (or 'chilling') time for our loudspeaker coil. So it can handle the occasional peak (above the rated power) without too much of a problem. In fact, if the amplifier can deliver these peaks *without distortion, your loudspeaker will be quite happy turning them into good sound.*

If your amplifier is a bit weedy however, and doesn't deliver the goodies in terms of power, you will be tempted to drive it harder. Doing so will most likely cause clip distortion in the amplifier, which, if severe enough, will do a nice job of melting your loudspeaker's voice coil.

If you use an amplifier that is about 1.5 times more powerful than your loudspeaker rating, you will increase the reliability. Doing so avoids the amplifier clipping which our ears don't mind too much – we perceive it as 'loudness'. Many people like a bit of distortion much more than their loudspeakers do. However, if you overdrive the loudspeaker (not the amplifier) it will complain – you'll hear it – and, hopefully, you'll have time to correct the situation before any damage is done.

So, unlike a light bulb that draws 100 Watts continuously, our 100-Watt loudspeaker will be happier with 150 Watts driving it occasionally. It's a complex load, so if you provide much more power it could easily consume it (and it might die in the process!).

Excessive Compression and Limiting

Most limiters are installed with the prime objective of protecting the system, *to prevent the amplifiers from delivering excess power to the loudspeakers*. You may be surprised to learn that limiters can actually *add* to the problem and *cause* loudspeaker failures!

Limiters limit the peaks of the audio signal. They do not prevent the average level of the signal from rising. In fact, they could be said to encourage it. Nothing prevents the overall level of the signal from rising. The limiter only prevents peaks above the threshold from being passed. This can be very similar to clipping if the system is driven hard.

Compressors make the audio peaks less pronounced. High compression ratios behave in a very similar way to limiters, raising the average level of the audio signal.

If the average level of the signal is too high, heat build-up in the loudspeaker's voice coil can result in driver failure. Naturally, this will only happen if the signal is constantly above the threshold of the compressor/limiter for a sustained time.

If set and used correctly, compressor/limiters can certainly help reduce transient peaks, but they will not protect the system from being overdriven. In some ways they can make the situation worse.

Feedback and Other Nasties

Feedback

What is feedback? Most people recognise it as a high-pitched squeal, or a low, rolling boom through a PA system. Feedback, like its name suggests, is when 'sound' from a loudspeaker enters a microphone (feeds back to it) and amplifies it repeatedly. So the 'sound' gets louder, is amplified more - and so on. Left unchecked, feedback is a great way to blow up your loudspeakers. It does so by over-driving the amplifier(s) and loudspeaker(s) Clip distortion is very likely.

The reason that 'sound' is in quotes above, is that feedback is a little more complex than just 'sound feeding back'. To be precise, it is a set of related frequencies of the sound that gets triggered and grows by repetition. A number of factors influence the dominant frequency (or pitch) of feedback which include:

- Frequency response of the loudspeaker
- Frequency response of the microphone
- Frequency response of the system in between loudspeaker and microphone
- Frequency response of the room
- Frequency content of the triggering sound
- Loudspeaker placement
- Distance from microphone to loudspeaker

Without going into too much detail, if one frequency is more dominant than others, the system is more likely to feed back at that frequency, or harmonics of it.

Interestingly, Vivian Capel in his excellent book *Acoustic Feedback: How to Avoid it* does not consider the distance from the microphone to loudspeaker as being relevant to the dominant frequency. In fact, you can alter the dominant feedback frequency by moving a microphone very close to a loudspeaker and moving it 'in and out' (try this with a speaker you don't care about too much!). If this doesn't work for you, Mr Capel is correct and I am wrong.

Guitar pickups can also be made to feed back. Actually, it's the guitar strings themselves that can be made to feed back because they vibrate sympathetically to sound from a loudspeaker (just like a microphone capsule). Jimi Hendrix put this to excellent effect and was able to use it 'musically'.

We will cover the feedback subject in more detail in the future. For now, avoid feedback - unless, of course, you want to blow up your loudspeakers.

Other Nasties

There are a few other ways to be a bad boy (or girl) with a loudspeaker system. The ones we will discuss fall into the following categories:

- Connecting and disconnecting stuff
- Wiring things wrongly
- Powering up and down incorrectly

It's a good idea to mute your system if you're connecting and disconnecting stuff. Apart from the 'cracks and pops' that you might expose your loudspeakers to (joyously bad), you might experience a sudden change in level, feedback, or any number of unexpected effects. And who is near the master faders during such connecting and disconnecting? Not you that's who. Seconds pass and your reputation is growing with every millisecond...

Of course, wiring your sub bass outputs to your high frequency (HF) drivers is an excellent way of blowing them up. It's a 'good' idea to test the low frequency end of a system first, with the HF disconnected. If things are wired incorrectly (and there are a few combinations that can lead to this) you are less likely to damage a sub bass unit with HF than an HF driver with LF – mainly because the HF will not normally have so much power behind it.

Additional cracks, pops, clunks, thumps and other nasty artefacts can be induced by powering up/down your system in the wrong order. Most audio equipment makes some kind of 'thump' when it's powered up or down, so the following order helps keep things 'nice':

- Powering up. Start with everything before the amplifiers. <u>Turn these on last.</u>

- Powering down. Start with the amplifiers. <u>Turn these off first.</u> Don't turn them off at the breakers – there might be other stuff being powered from these – turn them off with the switches provided.

Even if you fail to blow up the loudspeakers, the more cracks, pops, clunks, thumps, squeals, booms and sudden surprises you can generate, the more confidence you are likely to inspire in your clients, fellow sound engineers, band members and significant others. Try it! It's delightful!

Having a reputation for blowing up loudspeakers is surely the best way to be a bad boy, but contributing your own sounds by mechanical and electrical lunacy is a good second best.

Fuzion Ltd
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