BACKSTAGE CLASS

Damping Factor

Soggy at best

By Bennett Prescott

Of all the misunderstood specifications in this industry, Damping Factor (DF) probably receives more misplaced significance than anything. While, aside from a few exceptions, manufacturer spec sheets are broad generalizations that shouldn't be used by anyone as the primary basis to compare anything, the DF spec is especially meaningless when used to compare or classify amplifiers. It's overblown for one very simple reason: cabling and loudspeaker resistance has a far larger effect on actual damping factor than the amplifier can ever hope to.

To illustrate my point, consider the QSC PL340, an amplifier with a damping factor of 500, which is relatively standard for a professional amplifier. To take this out of the spec sheet and into the real world, let's say I attach an 8-ohm loudspeaker to that amplifier with 50 feet of 12-gauge cable. We're not just talking about the amplifier now, we're dealing with a system comprised of various resistances, including the loudspeaker and cabling. With a little bit of calculation, I find that my system's damping factor is now 49.14... good enough for even recording studio situations (you want about 20 for PA use, more like 50 for critical listening).

That's all well and good, but of course a bigger number is better, so how about running the numbers again, this time with the Crown I-Tech 8000? This amplifier has a stated damping factor of 5,000, an order of magnitude greater than the PL340. Redoing all my painstaking calculations, I find that attached to the same 8-ohm loudspeaker with the same 50 feet of cable the result is a damping factor of 50.25, not even 1 percent better!

To really explore the relative insignificance of an amplifier's inherent damping factor, imagine we could have an amp with a damping factor of 500,000. What would that amplifier's DF be after it is plugged into our imaginary loudspeaker system? A measly 50.38, it turns out, an insignificant difference even though this amplifier has 100 times the damping factor of the I-Tech 8000 and 1,000 times the damping factor of the PL340.

OK, let's examine the other extreme, what about an amplifier with an abnormally low damping factor, say 100? The end result is still a remarkably good net DF of 44.74, not even 12 percent worse than our imaginary half-million DF amp.

That's not to say damping factor isn't important, quite the opposite, it should be kept as high as possible to make

DAMPING FACTOR DEFINED

Scientifically speaking, Damping Factor is the ratio of the resistance component of the loudspeaker's impedance to the resistance component of the amplifier's output impedance. This number is used to determine how well the amplifier is able to control the motion of the loudspeaker. Too low and the amplifier won't be able to resist back-EMF from the loudspeaker and the cone will "flop around" a little, resulting in a less clear reproduction of the signal being sent to it. This specification is almost always given with a perfect 8-ohm load attached to the amplifier, operating at a fairly low frequency (<1kHz).

sure your PA sounds as good as it can. All I'm saying is that the amplifier itself has almost nothing to do with the system's damping factor equation, which is largely controlled by the resistance of the loudspeakers and cabling attached to that amplifier.

Just how much do the cabling and loudspeakers affect that important overall damping factor spec? To find out, instead of leaving the loudspeaker and cabling the same and switching amplifiers, I'm going to show what happens when you go from the "perfect" world of 8 ohms per channel and 50 feet of 12-gauge cable to the real world, where that almost never happens.

50' of 12AWG cabling, 8-ohm speaker: 49.14
50' of 12AWG cabling, 4-ohm speaker: 24.54
50' of 12AWG cabling, 2 ohm speaker: 12.29
100' of 12AWG cabling, 8-ohm speaker: 24.88
100' of 12AWG cabling, 4-ohm speaker: 12.44
100' of 12AWG cabling, 2-ohm speaker: 6.22(ouch!)

What a dramatic difference, and all I did was run a few more loudspeakers (or lower ohm drivers) per side, or double the length of cable to my loudspeakers. A length of 100 feet of cabling isn't at all unusual, and look at how badly it destroys your overall DF if you load it down to 2 ohms... 100 feet of 12-gauge cabling with even an 8-ohm loudspeaker, an easy load to be sure, is just over the DF you want for quality PA use.

Now that you hopefully have a basic understanding of what damping factor is and how it manifests in real systems, you're no doubt interested in the best way to keep it at a reasonable level in your sound systems. The answer? Cable diameter. As a fairly real world example, I'm going to assume 100' of cabling and a 4 ohm load, which is a pretty good balance between overloading or under-loading your amplifiers. Those of you running your systems at 2 ohms per channel, especially in the very low frequencies, stop it. Here's what the damping factor of that system looks like with various gauges of cabling:

100' of cable, 4-ohm load, 16 AWG: 4.96
100' of cable, 4-ohm load, 14 AWG: 7.86
100' of cable, 4-ohm load, 12 AWG: 12.44
100' of cable, 4-ohm load, 10 AWG: 19.63
100' of cable, 4-ohm load, 8 AWG: 30.85
100' of cable, 4-ohm load, 6 AWG: 48.18

As you can see, while damping factor is an important thing to keep in mind, cable thickness is by far the dominant factor. Unfortunately, it's difficult to get better than 10 AWG into a Neutrik Speakon (and don't even talk to me about banana or, worst of all, 1/4-inch!). Long story short: use 12 or 10 AWG cabling, keep your loads 4 ohms or higher, and your cables 100 feet or shorter!

A parting shot: Let's say you had 2 feet of 16 AWG cable between an amplifier with a DF of 500 and a 4-ohm loudspeaker... your net DF would be 199.36! Of course, the only way to achieve this is to integrate the amplifier(s) into the loudspeaker enclosure, and who wouldn't want to do that? ■

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