Protecting Compression Drivers

Limiting Low Frequency Damage to Compression Drivers

Imagine, for a moment, this scenario: A small, local high school approaches you for an inexpensive sound system for their new football field. After looking over the situation, you suggest a pair of 60 watt compression drivers with large re-entrant horns, a 120 watt “package” amplifier, and a couple of cardioid-type microphones with stands. They’re happy with your proposal, it’s within their budget, so the sale is made. You install the equipment, show them how to operate it, and everyone is happy.

Or so you think. The following Monday morning you get a call from a very irate school principal who tells you that when they used the system on Saturday for the “big game” it went completely dead right in the middle of their half-time program. You send out your sharpest technician to find out what went wrong. He discovers that the voice coils are open on both drivers. You have him replace the drivers and then you personally call the principal and assure him that it was “just one of those things” and it won’t happen again. You do your best to smooth his ruffled feathers and hope that he will send any future business your way. Everybody is happy again.

Three weeks later it happens again. By now you’ve probably figured out where this is leading. What you didn’t know before was that the school “pep club” had plugged their cassette deck into the Aux input of the amplifier and were playing the latest “Top 40” rap tunes for pre-game entertainment. Of course, it didn’t quite sound like the “boom boxes” that they were used to, so they turned the bass control on the amplifier all the way up. Then the announcer discovers that if he holds the microphone up to his lips his voice takes on a deep resonant quality that he likes (cardioid proximity effect). So naturally he “eats” the microphone while he’s yelling the team cheers to whip the crowd into a frenzy to root for the home team.

The end result of all this is that there is an awful lot of low frequency power being delivered to the compression drivers. Compression drivers do not deal well with low frequencies.

But wait a minute, you say. It’s only a 120 watt amplifier and each driver is rated at 60 watts so it should be a perfect match, right? Well, in theory, that’s true. But what isn’t being taken into consideration here is the natural performance characteristics of drivers and horns. A compression driver depends upon the acoustical coupling of the horn for it to operate properly. The reason that compression drivers are called compression drivers is because, when the diaphragm moves, it “compresses” the air in front of it. There has to be a certain amount of “acoustical impedance,” or resistance, provided by the air in the throat of the horn for the diaphragm to push against. This acoustical “loading” is designed into the horn, and every horn has a specific “low frequency cut-off” point, below which that “loading” characteristic disappears, or is greatly reduced.

Sometimes this is referred to as the “usable low frequency limit” or, more accurately, “lowest frequency for full driver loading.” That frequency can be determined best by referring to the manufacturers’ specifications for the particular model of interest. If the horn and driver are operated at frequencies below that point, then the diaphragms’ movement is no longer limited by that acoustical resistance. That, coupled with the naturally greater excursions associated with lower frequencies can quickly overstress the diaphragm suspension, distorting the shape of the voice coil and fatiguing the wire connections to the coil. This can cause a rubbing coil, a totally “frozen” coil, or breaks in the coil wire, not to mention degraded sound quality. The end result is premature driver failure.

So what’s the solution? Obviously, the low frequency energy being delivered to the driver needs to be limited. But how? There are two solutions that can be implemented. The first solution involves the installation of a crossover/limiter like the Atlas Sound TSD-HF11. This small, easy to install device features a 1 Input and 1 Output configuration and includes Input and Output trim controls, selectable Hi-Pass filter, and a variable limiter to prevent excess signal from entering the amplifier. The TSD-HF11 can be used with a variety of paging horns and amplifiers as its full feature set allows individualized customization based on system requirements. This is an elegant and inexpensive solution that will solve the problem in the majority of installations. However this Time Saving Device only offers three options for low frequency cut-off so there may be scenarios where another solution is required.

If the low cut frequencies of the TSD-HF11 will not meet the requirements, Atlas Sound offers a full line of DSP products that can meet any horn speaker protection needs. This line includes the ASP-MG24, a 2x4 loudspeaker processor offering full DSP configuration of various crossover types, parametric EQ, compression, delay, and graphic EQ. Atlas Sound BlueBridge models are the newest DSP solutions available from Atlas Sound and includes units with configurations ranging from 2 I/O to 16 I/O. Contact Atlas Sound directly if you need help choosing a device that will best meet the needs of your installation.

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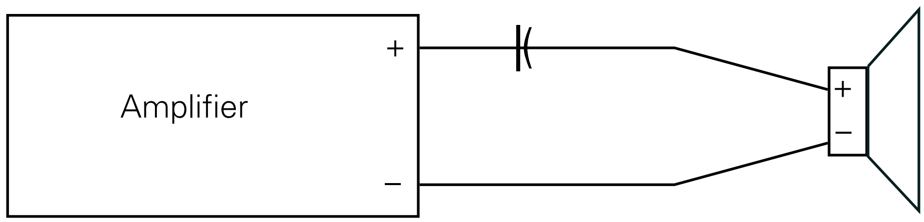
If the job's budget will not support the addition of a TSD-HF11 or DSP processing device, another solution would be to install a "crossover" capacitor on each driver as shown below:



A capacitor installed in such a fashion becomes a "high pass" filter, allowing only "high" frequencies to be delivered to the driver and blocking "low" frequencies. The point at which the capacitor starts to "roll-off" the low frequencies will be determined by the value of the capacitor and the input impedance of the driver. The driver's impedance will be either 8 or 16 ohms (typical voice coil), or the impedance of whatever tap is being used on the line matching transformer. In many cases that impedance will be indicated on the driver itself, or in the manufacturers literature. If not, it can be easily determined by using the following formula:

$$\frac{\text{Voltage}^2}{\text{Wattage}} = \text{Impedance } (\Omega)$$

Example:

$$\frac{\text{70.7 Volt Line}^2}{\text{60W Trans. Tap}} = 83.3\Omega$$

The formula for determining the proper capacitor value is a bit more complex:

$$\text{Capacitance (Farads)} = \frac{1}{2\pi\ (6.28) \times \text{Frequency (roll-off point)} \times \text{Impedance } (\Omega)}$$

Example:

$$\text{Capacitance (Farads)} = \frac{1}{6.28 \times 400\text{Hz} \times 83.3\Omega}$$

$$\text{Capacitance (Farads)} = \frac{1}{208{,}496}$$

$$\text{Capacitance (Farads)} = .0000047 \text{ Farads}$$

To convert Farads into microfarads (µf) multiply by 1,000,000 or 10^5 if you have a scientific calculator. Ie. .0000047 x 1,000,000 = 4.7µf.

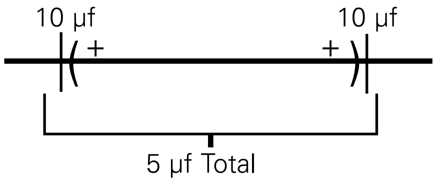
Therefore, if you were using the 60 watt tap on a compression driver equipped with a 70.7 volt line transformer, and you wanted the low frequency roll-off to begin at about 400 Hz, you should install a 4.7 µf capacitor in series with the driver input.

The next thing to consider is the capacitor itself. For audio applications such as this, it is important to use "non-polarized" types. Non-polarized capacitors are commonly used in speaker crossover networks and can be obtained from various general line electronic distributors. Radio Shack also carries some values. Mylar or polypropylene types are the best, however, they tend to be more expensive and less commonly available than aluminum electrolytics. Regular polarized electrolytics are very common (and inexpensive) and can be used in a pinch if you use two of them and connect them like this:

Connecting two polarized capacitors "front to front" as shown above essentially creates a non-polarized capacitor. The total capacitance value is determined by the following formula:

$$\text{C Total} = \frac{1}{1/C_1 + 1/C_2}$$

There is a shortcut to this formula if the two capacitors are of equal value (which they should be in this application). If the values are the same, then the total capacitance will be one-half the value of one capacitor. For example, if two 10 µf capacitors are connected in series, the total capacitance will be 5 µf.



In summary then, to assure dependable operation of a compression driver and horn, it is important to limit the low frequency energy being delivered to the driver in a manner consistent with the performance parameters of the horn that it is coupled to. Put simply: Stop those lows!

The following chart shows the low frequency cut-off of many popular horns and the input impedance of common 70.7 volt transformer taps. To determine the approximate capacitor value for your application:

1. Find the appropriate cut-off frequency in the left hand column.
2. Read across the cart to the transformer tap or voice coil impedance being used. The capacitance values shown may not be a readily available value. If not, use the closest smaller standard value. If not, use the closest smaller standard value. Doing so will raise the cut-off frequency slightly and provide a little extra protection for the driver.

Horn Low Freq Cut-Off	60W 83Ω	40W 125Ω	30W 16Ω	20W 250Ω	15W 333Ω	10W 500Ω	Voice Coil	
							16Ω	8Ω
100Hz	20 µf	12 µf	10 µf	6 µf	5 µf	3 µf	100 µf	200 µf
125Hz	15 µf	10 µf	7.5 µf	5 µf	4 µf	2.4 µf	80 µf	160 µf
150Hz	12 µf	8 µf	6 µf	4 µf	3 µf	2 µf	66 µf	132 µf
200Hz	10 µf	6 µf	5 µf	3 µf	2.5 µf	1.5 µf	50 µf	100 µf
250Hz	7.5 µf	5 µf	3.7 µf	2.5 µf	2 µf	1.2 µf	40 µf	80 µf
300Hz	6 µf	4 µf	3 µf	2 µf	1.5 µf	1 µf	33 µf	66 µf
400Hz	5 µf	3 µf	2.5 µf	1.5 µf	1.25 µf	0.75 µf	25 µf	50 µf
500Hz	4.7 µf	2.5 µf	2.3 µf	1.2 µf	1.1 µf	0.6 µf	20 µf	40 µf
650Hz	3 µf	2 µf	1.5 µf	1 µf	0.75 µf	0.5 µf	15 µf	30 µf
800Hz	2.5 µf	1.5 µf	1.2 µf	0.75 µf	0.6 µf	0.4 µf	12.5 µf	25 µf
1000Hz	2 µf	1.2 µf	1 µf	0.6 µf	0.5 µf	0.3 µf	10 µf	20 µf
1200Hz	1.5 µf	1 µf	0.75 µf	0.5 µf	0.4 µf	0.25 µf	8.2 µf	16.4 µf
1600Hz	1.1 µf	0.7 µf	0.55 µf	0.35 µf	0.22 µf	0.17 µf	6.2 µf	12.4 µf

Note: When non-standard values are indicated, use closest smaller value.

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