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Physics 398 EMI

12 – 20 – 02

Carvin X-100B Amplifier

The project I had in mind originally for this class was to take an existing amp I had (my Marshall Valvestate head) and basically gut it and covert it into a tube amplifier. However, upon seeing that the amp in question still worked perfectly, Professor Errede decided that maybe we didn't want to ruin something that wasn't broken in the first place.

So I eventually decided to work on this Carvin head. It's the same model as the Carvin XV-112 and XV-212, but in this case Carvin shipped it only as the amp, instead of those other two where it was attached to speakers as a combo. The amp looked pretty dinged up, so we ordered a matching quad of EL34's and three 12AX7A's so we could turn the amp on and find out which parts worked and which did not.

Before the tubes arrived, I just had to wait, so I tried to clean up the circuit board as well as I could, and I checked through for any components which looked smoked out. However, all of the parts looked just fine. The one outstanding blemish on the amp is that one of the corners of the chassis is bent up a little bit, as if somebody dropped the amp at some point.

After the weeks it took for the tubes to arrive, we discovered that the amp actually worked perfectly. Aside from a few cosmetic blemishes, everything was great, and it sounded wonderful. Only a couple things needed my attention. The fuse in the back was

missing (giving us the original assumption that something had blown it), and this strange rectangular piece of plastic which was supposed to hold the fuse and cover it from the outside elements was missing as well. I called Carvin to try to replace this fuse-holder piece, but they stopped making this series of amps a long time ago, and none of their new amps use this strange piece. So basically I'm leaving that fuse in the back uncovered, and we'll just hope nothing happens to it.

The only actual adjustment I had to make to the amp was tightening a few of the volume and EQ knobs. I put star washers on and tightened them all up, and now they work just fine.

Once we finally got the tubes, I was able to measure a few things in the amp. Before I could measure, though, I had to make an 8 ohm load to hook the amp up to, so that I didn't have to bother everyone in the lab by testing my amp using actual loud speakers. For this load, I hooked up two 12 ohm 25 Watt resistors in parallel connected to two 1 ohms in series. Now I was able to finally start my measurements.

When I first plugged the tubes in to the amp, I wanted to measure some voltages in the circuit to make sure everything actually was working as intended. I measured the plate voltage and found it to be typical, around 473 Volts. I also measured the EL34's to see how well they actually matched. To do this, I used a device designed by Professor Errede, which measures the voltage across one of the pins in each tube when the tubes are plugged in and running and the amp is turned on. I found the voltage across the pins of the four tubes to be 16mV, 14mV, 15mV, and 18mV – an average of 15.75 mV. So the tubes matched, but not *perfectly*. However, this is ideal with "matching tubes". It turns out that, if the tubes match too well, the sound is too smooth and even, and eventually it

gets boring. For this reason, tubes are commonly sold not in exactly matching quads, but very close to it.

Now this amp, when running, sounds amazing. When looking online for any reviews of the amp, the only complaints I could find were that it was "too clean". This says a lot about the quality of sound you get from this amp. It is a very complicated circuit (see attached circuit diagram). It almost looks like a solid state circuit diagram, were it not a tube amp. The amp is a very interesting design. The player is given far more control over the sound quality than in most amps I've seen before. The amp has two separate sets of knobs or switches to adjust the EQ. One of these is an active EQ which always affects the sound, and the other is a passive EQ which can be set to either "Rhythm" or "Lead". This EQ is then activated whenever that channel is active, in addition to the other EQ which still affects the sound. This is a great design, because the player has great control now over the difference in tone between the lead and rhythm channels.

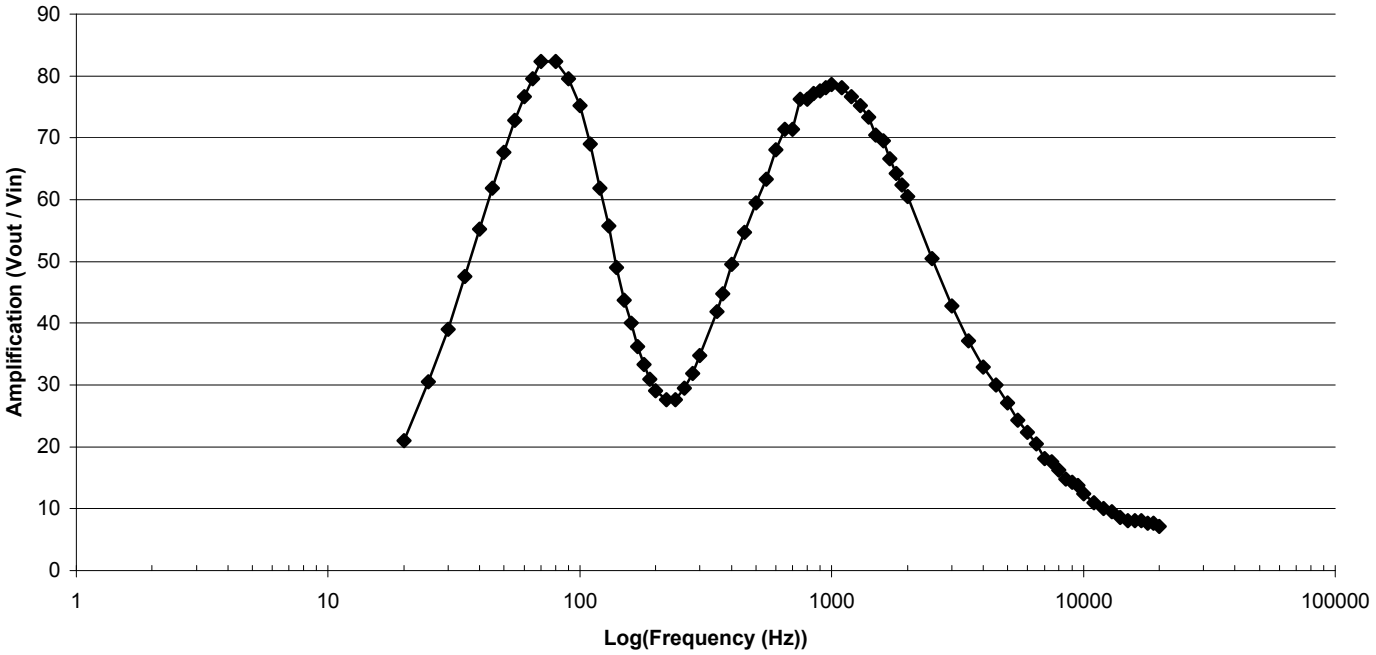
The amp has three channels, a "rhythm" channel, a "lead" channel, and a "hi lead" channel. It also has "bright" effect you can add to the rhythm channel by pulling out the rhythm volume knob. I didn't exactly know what this would do to the sound, so I decided to measure it and find out.

Attached to this paper are 5 graphs I made from the frequency response of the amp. I was hesitant at first to spend much time measuring frequency response, but after measuring just the rhythm and lead channels on flat EQ, and after seeing how interesting the graphs were of these channels, I couldn't resist measuring just a few other settings of the amp to see what sort of difference you get with all the different channels.

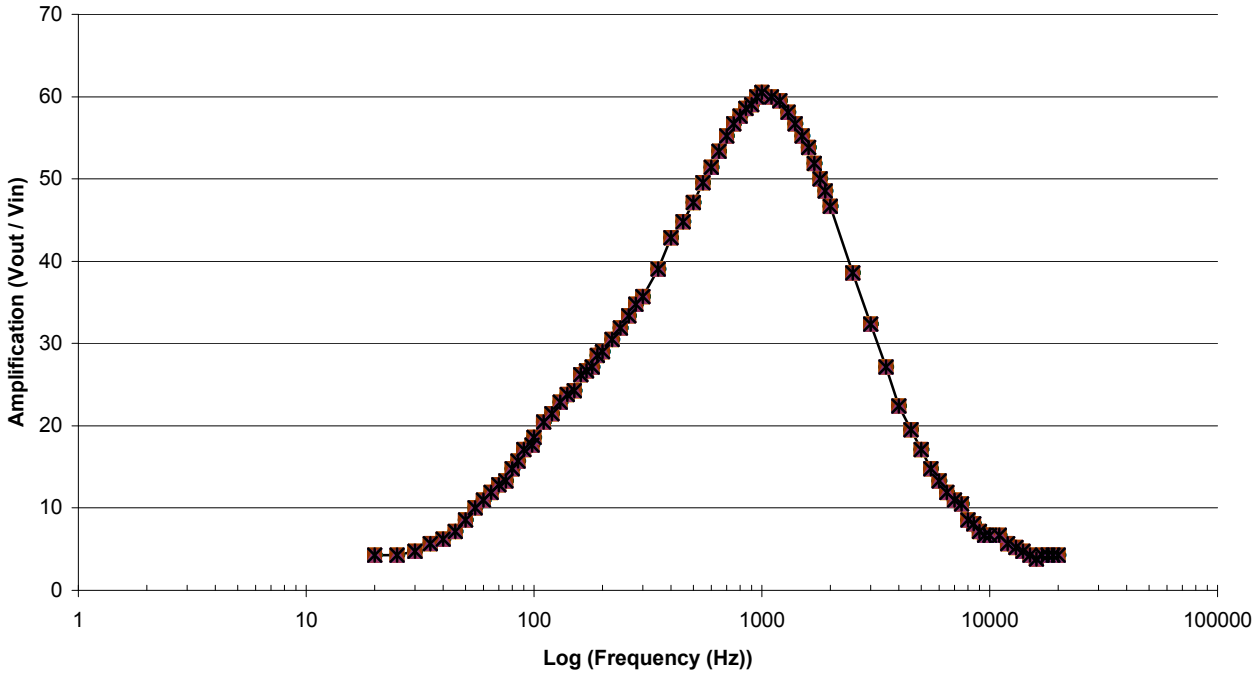
It turns out that the amp is set for a naturally scooped-out sound on the rhythm channel, and just heavy on the treble and mid for the lead channel. At first I just thought that the rhythm channel was set heavy on bass and treble, and very low on mid. So I figured that if I put the active mid control at 10, and kept the bass and treble at 5 (where they had been this whole time), I could perhaps flatten out the graph a little bit for the rhythm channel. However, upon looking at the attached frequency response graphs, it was evident that putting mid on 10 basically just enhanced the peak that the graph had around the mid-treble levels, and slightly decreased the response at the lower levels. It turns out that this is basically the same thing the "bright" feature does as well. So the rhythm channel of the amp is always going to have a sort of scooped-out sound, whereas the lead channels are smooth, single-peak response graphs.

Also you will notice that all of these graphs look very nice and smooth. This goes especially for the hi-lead channel, which gives far more amplification than any of the other settings, but seems to be the smoothest graph, as well as the graph with the widest peak. This, again, says a lot about the sound quality of this amp. It has a very smooth frequency response, and the amplification increases at a very smooth rate. The amp sound exceptionally clean at very high volume levels.

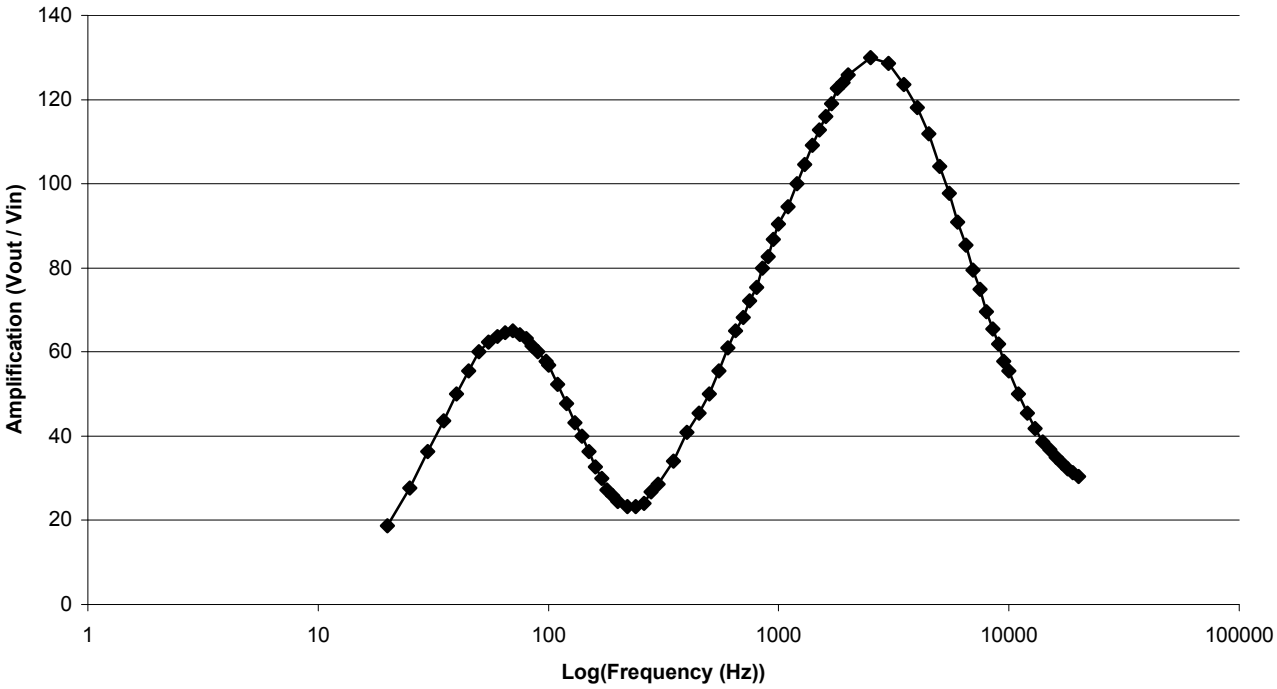
Frequency response on Rhythm channel (volume at 2, flat EQ)



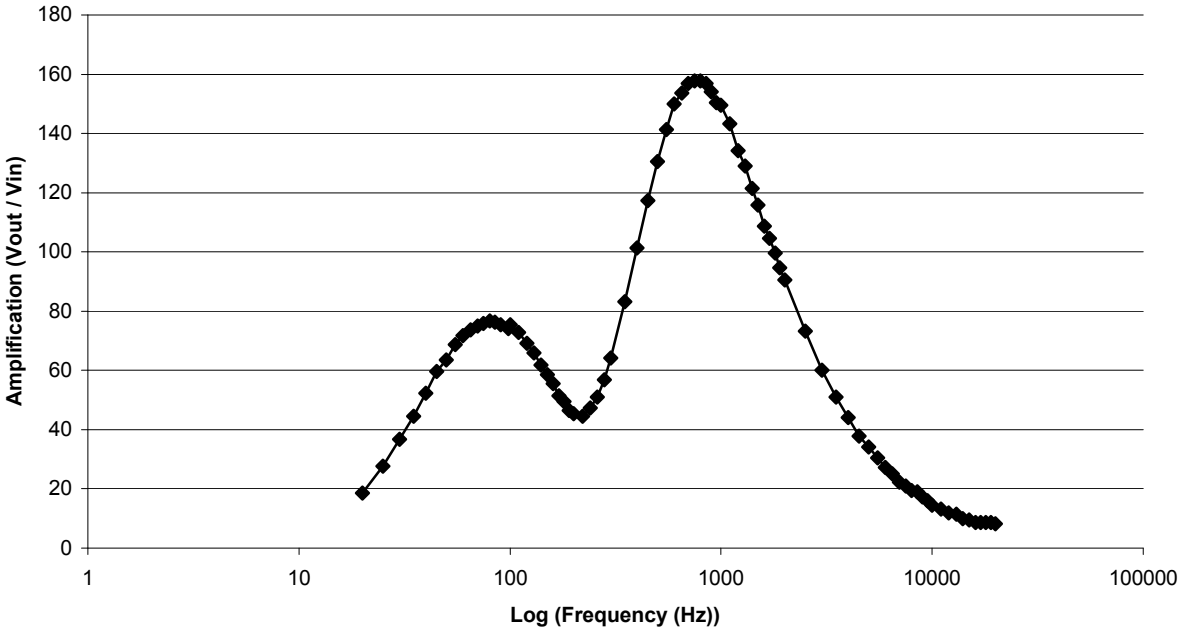
Frequency response with Lead Drive on (volume at 2, flat EQ, EQ still on rhythm)

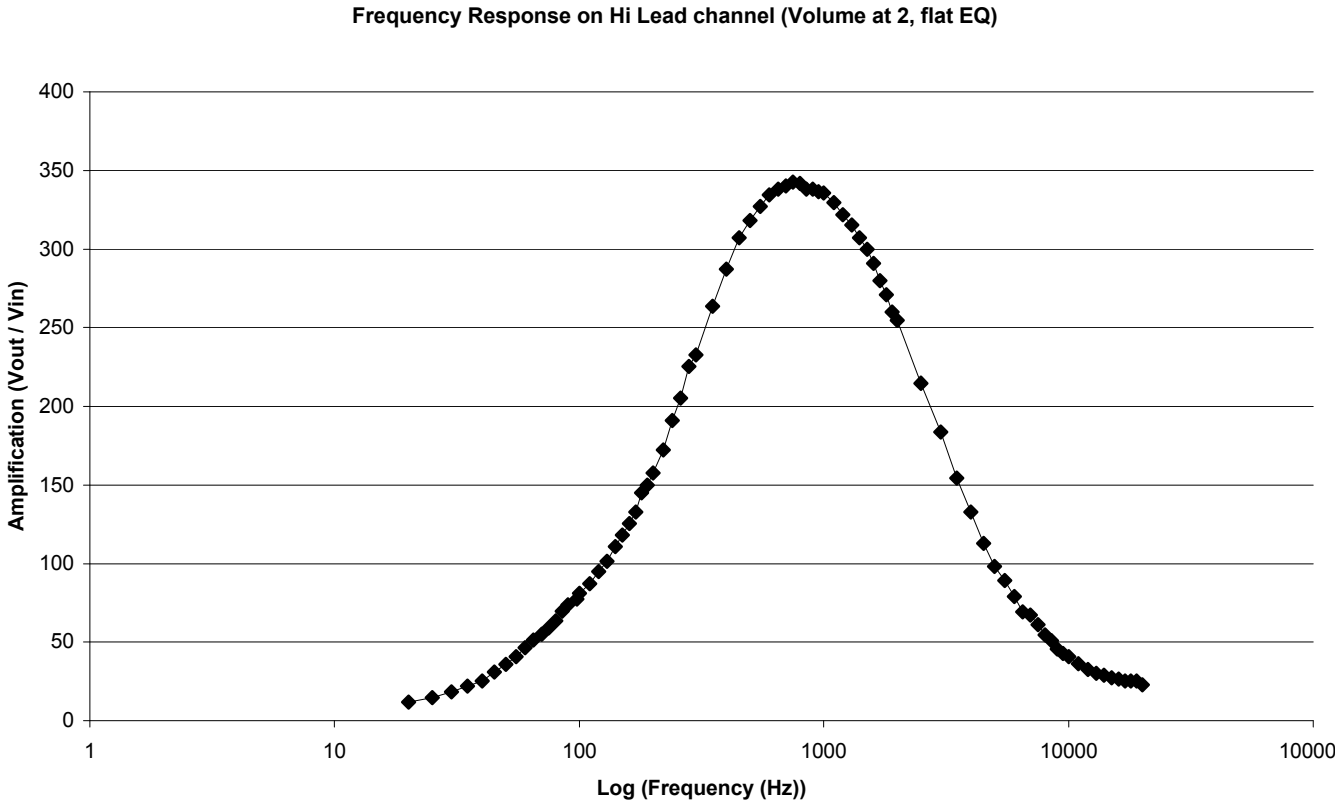


Rhythm channel with "Bright" pulled on, and EQ flat



Frequency response on rhythm channel, with active Mid set at 10 (bass and treble each at 5)





After measuring the frequency response of the amp, I spent the rest of the semester building the cabinet in which I would put the amp. I had had on idea that it would take so long to just build the cab, and I was originally planning on also buying a footswitch and wiring it up to work for this amp. However, building the cab took so much time that I will have to get the footswitch after this semester is over.

Also, just before beginning my work on the cab, Ryan Lee, another student in the lab, came in with a non-functional Peavey Head that he thought I could work on for a while. He and I looked at the inside of that amp, and we found a resistor that was looking pretty smoked out, and after replacing it, that amp worked just fine. This was two amps already that people without any knowledge of electronics got rid of, when it turns out that they required minimal work, and it was usually easy to see what was wrong with them, even for a person as inexperienced in electronics myself.

So I finally began work on the cabinet. The person who had sold the amp to me originally had originally intended on fixing the amp up for himself, and so he did some minor adjustments and modifications of the circuit, as well as beginning work on the cabinet. He had glued and nailed four pieces of plywood together to make the bare box for the amp, as well as attaching runners along the inside on which the amp is supposed to rest.

The first thing I did was cut a piece of wood to make the grill for the front. The grill has absolutely no acoustic function, it is just there to make the head look similar to whatever cabinet speaker you hook up. I simply measured the opening in the front of the box and cut out a rectangular piece of plywood to fill it. I spray-painted the plywood black, and then covered it up with some grill cloth.

Professor Errede was kind enough to use his router and curve the edges of the box. Then I went through and relocated a few of the nails which were too close to the edges, and covered all the holes and cracks in the box up with wood filler. I also had to sand down the heads of some of the nails which were too close to the edges so that they didn't stick out straight when the rest of the box curved away below them. I then went

through and sanded the edges of the box and the walls so that, once I covered it with tolex, one wouldn't be able to see any of the box's imperfections.

The next step was to stain the inside of the cabinet. Careful to not stain parts which I planned on covering with tolex, I stained the entire inside with a beautiful cherry stain. It now looks very nice, blended with the black of the tolex on the outer sides of the box.

Then I covered the box with tolex. This had to be the hardest part about making the cab. We had to cover the box with two pieces of tolex instead of wrapping it with one large piece, so we decided to cover the top and sides with one piece and then cover the very bottom with another piece, so that nobody would be able to see the seams. Professor Errede and I covered the tolex and box with excessive amounts of glue, and we started stretching the tolex over the box and stapling it down. We did this while the glue was still wet to leave more room for error, and it is a good thing we did. After a lot of stretching and even more glue fume inhalation, we were finished with this step. Professor Errede and I then went through and trimmed the excess tolex off with a razor blade. We cut off enough tolex after it was stuck down so that the pieces would butt up into eachother at the corners, and we tried to leave as thin a layer as possible covering the underside of the top wall, so that the amp wouldn't get stuck up on any tolex going into and out of the amp. Even after we did this, the amp did get stuck a few times, and I had to cut out a little path in the tolex so that one particularly-jutting-out part of the amp was able to smoothly make the trip out of the cab.

After the tolex was on, I added metal corner pieces and a handle and feet. The corner pieces were from Fender, and they were meant for cabs made with ¾" wood

(which is standard for amplifier cabinets). However, the guy who made this cabinet, while using some exceptionally strong plywood, made it with wood that was a little bit thinner than this. So the corner pieces were a little too big. I tried to stretch them out as well as possible when I screwed them in, so that hopefully they would compress against the cabinet, but without the tools they use in these professional amp companies, I couldn't get it to be perfect. After these corners were in, I decided to put the feet in a little more towards the center of the amp than would be expected, to try to make this head fit better on smaller cabinet speakers, because it's always a pain when you get a head which has to stand at a slant because its feet aren't big enough to straddle a cabinet speaker, but they aren't close enough together to actually both stand on the cabinet. For the handle, I decided to put it at the middle of where the power transformer was in the amp, because that is pretty much the center of mass of the amp, and hopefully that will make carrying the amp a little easier than if I had just put the handle in the middle.

For the last step, I drilled holes with which I would fasten the amp once it was inside the cab. To do this, I made a template of the amp with a couple pieces of paper I had taped together. I then measured how far in I wanted the amp to rest, and using the template I was able to place these holes perfectly, and finish my amp.

So, in conclusion, I learned a lot about the process of building an amplifier cabinet, and how hard it is to make an amp look decent. I also learned a lot about how this amp in particular functions, and how it was designed. I probably understand this amp more than any other amp I've ever had. I have a good idea of what sort of response the amp will give me under different conditions and settings, and, of course, I have a far better understanding of amplifiers and electronics in general. If I were to take this class

again, I would try not to waste as much time in the beginning of the year waiting for tubes and deciding on what to do for a project. I also would have liked to do a little more work on the electronics side of the amp, but I just happened to be lucky this time in finding a “broken” amp that actually worked. The end.