[Mirrors]

How to Repair and Test Audio Power Amps

(Especially the BIG ones...)

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[Document Version: **1.00**] [Last Updated: **3/26/96**]

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1. About the Author

HOW TO REPAIR and TEST AUDIO POWER AMPS (especially the BIG ones)

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This document assumes you have some experience fixing low power amplifiers. Some skill, experience and patience (& luck ?) is needed to work on these things.

Plug: I'm the FAQ Maintainer for the groups: comp.sys.m68k and comp.arch.bus.vmebus

You can find those FAQs - and many more - at URL:
http://www.oritools.com/info/

Hope this provides useful information to someone. Good luck!

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2. Introduction

These notes are for audio power amplifiers made from discrete transistors as opposed to those using modules such as the STK series. While many of the concepts illustrated here are useful for smaller power level amplifiers, the large power capacity of some amps need particular techniques. A slight defect that might get by in a small amplifier probably will not in

a big one.

BTW, o/p stands for Output

I used to work on big amps all the time - I always used Motorola O/P transistors - Japanese ones never seemed to last very long. Neither did ECG replacements.

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I used NPN -   MJ15011   (10a,250v)
               MJ15022   (16a,200v)
               MJ15024   (16a,250v)

       PNP -   MJ15012, MJ15023, MJ15025
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These are the TO-3 metal cases. For amplifiers with plastic packages the originals will probably need to be obtained.

I always had **REALLY** good luck with these. There are many other good numbers. RCA parts are also very good, I just couldn't get them easily around here. Output transistors are not so expensive if you buy them properly. $5 to $7 or so up here in Canada. ECG is much more expensive.

The Motorola data disk is available via ftp from site nyquist.ee.ualberta.ca in directory /pub/motorola/specinsecs and is called spec6.zip (323KB)
It can help you select part numbers.

It matters not so much whether you use a 10 or 16 or even 5 amp transistor - the Vceo is important - 200 to 250 volts is appropriate for the higher power amplifiers. The o/p transistors will be paralleled using low value emitter resistors so gain (Hfe) matching is not much of a problem.

In more modern Japanese amps, they have lately been using hi-gain driver transistors. Similar type parts must be used so the circuits work properly. If the ECG manual says the part is hi-gain; you probably need to get the manufacturer's original part.

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3. Here's the scoop

1. If you can use a variac - do so. If you try the amp out by simply plugging it in you will soon have used up hundreds of dollars of parts. If you can't get a variac, you might use one or two low wattage light bulbs (in series) in series with the + & - power supply leads for testing purposes. DO NOT put the lamps in series with the AC line cord. The internal capacitors will still get charged up (although more slowly) to near full power levels. An incandescent lamp dimmer will not work very well either so do not use one.

2. An oscilloscope and audio oscillator are almost imperative. They do not have to be very good. They would be used to look for hi-frequency oscillations and to view the waveform to make sure it is the same as the input signal. They can also be used to set the bias.

3. Don't use any load while doing preliminary tests - no sense adding extra current if a fault still exists. Sometimes a really poorly designed amplifier will oscillate without a load. If so, add a fairly high value load resistor - maybe 100 ohms or so.
4. Replace all the o/p devices, even if a few are still good. They may have been stressed rather badly. I often use those that are still good for testing purposes - they are expendable. Since the o/p transistors are paralleled, for initial testing purposes you can use just one each of the NPN and PNP pairs - saves money if you blow it all up again. (this problem is minimized with the variac). Don't run it up to full power yet.

   It is not so imperative to replace non-defective driver parts. If the drivers are all-right, it has been my experience that it is acceptable to not change them. In fact, changing all those transistors with replacements is probably asking for needless trouble. I don't recommend the practice.

   Check all the low ohms power resistors in the emitter circuits of the output transistors. These will be less than 1 ohm and 2, 5 or 10 watts capacity. Look for other resistors that are discolored. Check them and look for shorted diodes. If the amplifier has a small transistor attached to the heatsink as part of the bias circuit - check this transistor for dead shorts.

   In fact, as a general rule, transistors and diodes can be checked very fast with an ohmmeter since most defective parts will be a dead short rather than leaky junctions. As such, in-circuit testing is sometimes all that is needed and removal of the part may not be necessary.

5. Use good mica insulators and good silicone grease - not too much though. The o/p transistors should not get much hotter than its heatsink when operating under a reasonable load.

6. Use clip leads to make voltmeter connections with the power off - it is too easy to make a slip...and...**KA-POWW!** (personal experience speaking here) (PESH) This is most true when operating the amp at full voltage. At low operating voltages, there is much less chance of damage.
7. Use your senses too - look for the usual stuff - hot parts, burning smells, crackly sounds and pieces of parts falling out of the chassis.

8. Don't work on it for too long or if you get frustrated. Put it aside.
9. Rig up something to discharge the power supply filter electrolytics. A resistor across each will do fine. These caps store a lot for a long time. You might try 100 or 200 ohms or so. Measure the discharge time.

10. Some amps will work without o/p transistors and when feeding a high resistance load. This is often useful for repairing driver problems and not having to worry about destroying good o/p devices.

11. Don't fix amps using headphones on your head. Please! If that amp suddenly starts to work and the volumes are set too high - BANG!

12. If you do this for a living, measure and write the power o/p in watts RMS per channel on

the bill. Customers love this information and it costs virtually nothing to give out.

13. Be careful - capacitors and transistors can explode shooting out smoke and/or tiny plastic bits. Nobody wants electrical shocks either.

14. Don't be superstitious but a prayer can work wonders.

15. If the amplifier has a speaker protection relay - you will want to short the contacts for testing purposes. You can't wait for the relay to normally turn on to see if the amp is working or not. If a fault still exists, by the time you get the variac turned up enough to turn the relay on - it may be too late.

    Solder 2 short wires across the contacts. Don't use jumper cables as they will probably fall off at the wrong time and maybe short something out. Do not leave the relay shorted after the repair is done. The relay must be able to be turned on by the amplifier circuitry - or something is still wrong with the amplifier.

16. For testing purposes - the amplifier will dissipate the most heat at about 1/3 of its full power output with a sine wave input. <**really! - a calculus adventure will show this**> This is a good test for automatic fans and overheat limit switches.

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4. Four things to watch out for

Too much bias current
: Voltage drop across emitter resistors too high. this should be in the 10 -30 mv range or so. 10 volts is definitely too high. The emitter resistors are the larger ones with values of less than 1 ohm. The heat sinks of the amplifier will get too hot. As a maximum, I like to see them get "just" warm. Some manufacturers purposefully run their amps hotter than most - but you should still be able to hold your hand on the heat sinks.

Hi-frequency oscillation
: You can't hear it, the scope shows it easily and the amp gets too hot with no signal. The Emitter voltage is not high. Sometimes a hum is heard in the speaker. This problem is much more common than you may think and may destroy the amp and/or the speakers especially the tweeters. This consumes great deal of power that will not make it out to the speakers as music. I have seen 250 watt amps putting a mere 15 watts into the speakers.

Clipping
: clipping occurs at different signal levels on the top and bottom of the o/p waveform. This is not right. Generally, you can run the input signal up to clipping on an amp and it should not hurt it. If it blows, there was probably something wrong with it. As proof, I offer that teenagers listening to metal rock do this all the time.

Putting driver transistors in backwards
: This is really easy to do. (PESH) For testing purposes, you can set the bias to zero...or

just leave the controls where they are in case you turn it up rather than down.

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5. Final Test

My final test used to be: run amp at full power and short the output with a screwdriver. The amp should survive with perhaps only a fuse blown. I don't do this anymore - modern Japanese amps are junk nowadays.(IMHO) They are not as robust as they could be. The bias setting is not critical (as some would have you believe). The zero-voltage setting is a little more critical. (At idle) a voltage (AC or DC) on the speaker terminals (with no input signal) indicates a fault. Most amps don't have an adjustment for this anymore. If there is a DC voltage (perhaps 0.3 volts or more) there is a circuit fault.

The problem with big amps is the amount of current in the power supplies. Welder is not too harsh of a term. I have found American designed transistors (Motorola, RCA, etc) to be much more robust than Japanese or Asian parts. European parts have high quality but are hard to find in North America.

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6. Setting the Bias Current

The output transistors always need to be turned on a small amount so as one transistor stops conducting and the other starts; the transition is seamless.

Too much bias and the amp gets hot and uses up power for nothing. Not enough and low volume sounds will be distorted while loud sounds will not sound as all that bad. Low bias can be observed on an oscilloscope as an inflection or bump at the zero voltage point of the output waveform.

The bias can be increased at this point until this inflection -just- disappears. Alternatively, the bias can be adjusted for a small voltage drop across the o/p transistor emitter resistors. These resistors have very low resistance values - often 1 ohm or less. The voltage drop should be quite low - perhaps .01 to .03 volts or so. It is hard to say: that is why I like use my 'scope.
