

FIG 7 FEEDBACK VS NO FEEDBACK

Installment 4 – The Aleph Current Source

Those familiar with ZV4 will probably figure out why I chose the particular current source of Figure 2 - it easily converts to the non-constant current source used in the Aleph series of amplifiers and as described in patent # 5,710,522.

ZV4 describes this current source in greater detail, but referring to Figure 8, the current source has the addition of C9, R18 and R19 that set the current source AC value to track an arbitrary fraction of the output. Usually we set this value around 50%, and we can use it to “ghost” the complex load impedance at a negative multiple of the load value. With the values chosen in Figure 8, an 8 ohm load would look like 16 ohms to the JFET gain device. By raising the apparent load impedance, the current source lowers the distortion of Q1 while still leaving it in control of the output. With tubes, variations of this idea have been called SRPP and SEPP output stages, although the distinction between an input and output stage is somewhat blurred in a single stage amplifier.

At one watt, the improvement is a factor of about 5, and at 10 watts a factor of about 10. Because the current source increases the open loop gain by about 6 dB, the damping factor jumps up to about 6, and the output gain goes up about a decibel or so. As the open loop gain is still finite, the input impedance is higher than the input resistor R16 at about 10 Kohm. The –3 dB bandwidth of the circuit is about 1 Hz to 80 KHz.

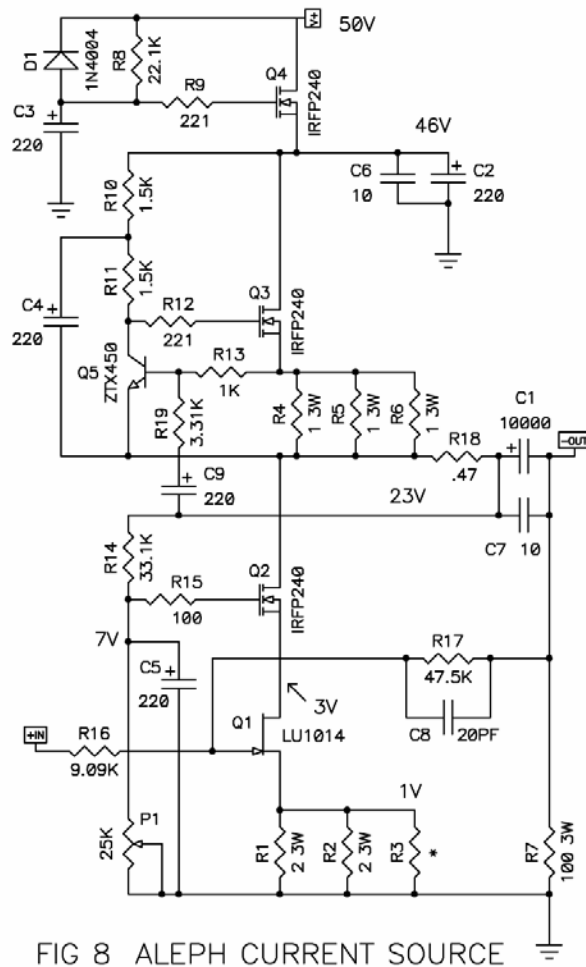
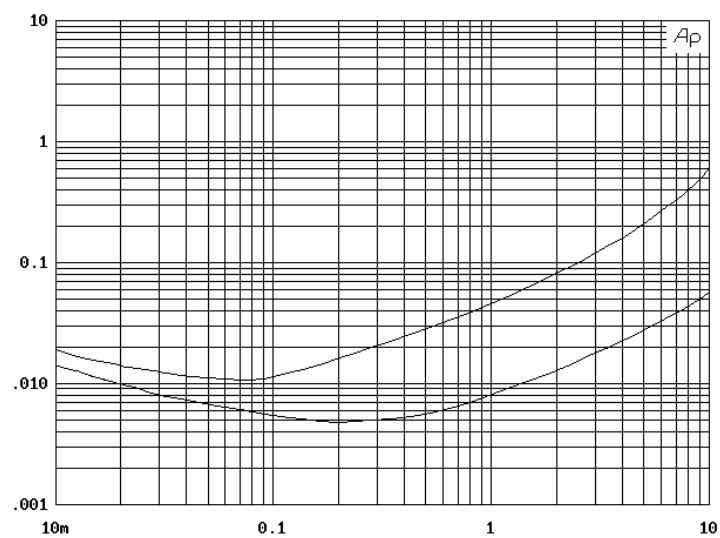


Figure 9 shows the performance difference with and without the two resistors and capacitor that enable the Aleph current source at about 50% gain.



A Few Construction Notes

I made reference to choosing the value of R3 to get the lowest distortion. The best way to do this is to use a 5 ohm power potentiometer and measure the distortion for lowest possible value while adjusting P1 for output DC. This requires a distortion analyzer. Tweaking the various resistor values in the amplifier, I have seen 1-watt distortion as low as .003% at 1 watt.

Since most of you don't have a distortion analyzer, I have an alternate method of determining the value of R3 based on the Vgs value of the Lovoltech LU1014 JFET in the test setup of figure 10. Using a 3 volt supply capable of greater than an amp, measure the Vgs of the device while the transistor case is still near room temperature. Most of them will sit between 1.0 and 1.1 volts, and you can use the graph to estimate the best value of R3 usually between 1 and 3 ohms.

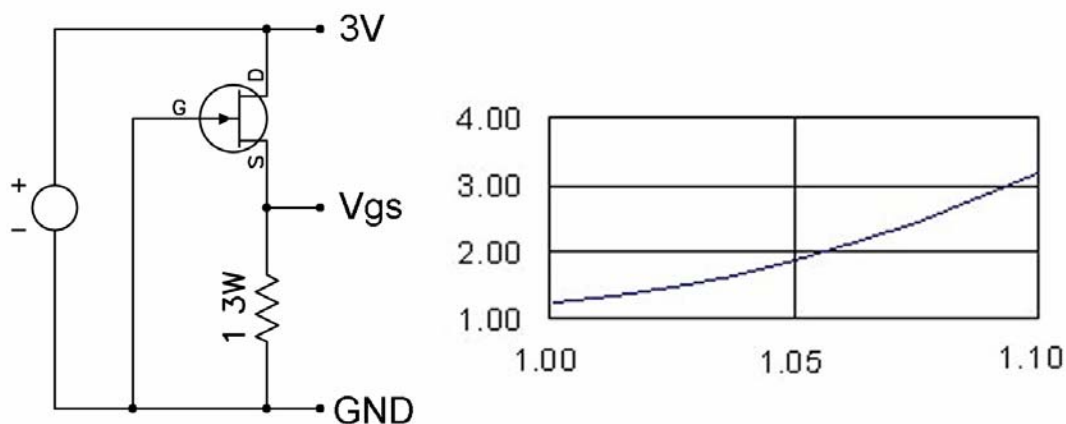


FIG 10 Vgs TEST AND VALUE OF R3 vs Vgs

As yet another alternative if you don't want to test the devices, I recommend that you simply select R3 so that the Vds of the JFET in the amplifier is 2.5 volts with the output DC figure of 23 volts. More often than not, this is close to the sweet spot.

This amplifier idles at about 100 watts per channel, which means that each channel needs a heat sink rated at .25 deg C. per watt. The Lovoltech LU1014D requires significant heat sinking also, as will operate at 4 to 6 watts continuously. Because of the high dissipation on Q2 and Q3, I recommend mica insulators with thermal grease.

The characteristics of all the semiconductor devices in the circuit will drift a bit with temperature, so you will find yourself readjusting values as the circuit warms up to a steady state. This also indicates a short warm up time for the amplifier, which is generally less than an hour.

Unless otherwise specified, the schematics use ¼ watt metal film resistors and 50 volt capacitors, but you will note the 3 watt power resistors (I used the Panasonics from Digikey).

The Lovoltech devices are not yet in common distribution, and currently the best source for small quantities is the group buys arranged on www.diyaudio.com.

Conclusion

When the first Zen amplifier was published 12 years ago, I did not particularly imagine the course the exploration would take. A single-stage amplifier is attractive on a number of levels - it serves as an excellent base for tutorial projects, partly because it isolates concepts involved in amplification but mostly because the simplicity invites beginners to try it.

Of course a single gain stage amplifier has a purely esthetic value. The challenge is to make the best simple amplifier possible and hope that the minimalist character of the signal chain allows the most information through with the least coloration.

Remarkably, we seem to have made real progress. The original Zen amplifier we measured .6% harmonic distortion at 1 watt, and here we see about 1/100th of that figure. I believe that the best correlation between measured performance and subjective listening occurs with simple circuits, giving rise to the obvious question - does this sound 100 times better?

No, only about 10 times better.

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