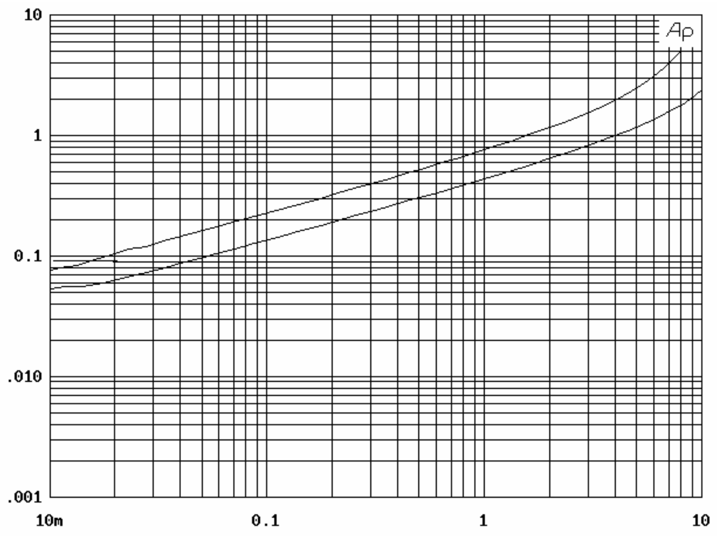

FIG 3 LIGHT BULBS VS CURRENT SOURCE

Installment 2 – Cascode Modulation

In ZV8 we spent some time discussing the triode-like character of the power JFET at low voltages, where both the transconductance and “plate” (Vds) characteristics show exponential behaviour. With such a device, you can exploit distortion cancellation by carefully choosing the load line of operation so that the variation in gain versus current is cancelled against the gain versus voltage so that the distortion of the device is dramatically reduced.

This phenomenon was only discussed in ZV8, and here is where we will put it to use. In many examples, correctly varying the Vds versus Ids (Drain-Source current) in the JFET would involve more complex circuitry, but on this rare occasion Mother Nature does us a favor. The optimal voltage variation can be had across resistors R1 – R3 which are coincidentally close to the value selected to give the JFET the correct DC self-biased value at 2 amps.

In Figure 2 C5 is placed so that the AC voltage at the Source of Q2 tracks the Source of Q1, holding the Vds of Q1 at a relatively constant DC value of about 2 to 3 volts. This is classic cascode operation. But a truly constant Vds for Q1 is not the lowest distortion load line for the device. Because we want to cancel two nonlinear characteristics, the optimal Vds across Q1 will be DC plus a finite AC voltage at around -600 mV per amp, which was determined by testing at 1 watt. In figure 4 we achieve this by grounding one leg of C5 - the simplest change imaginable. Figure 5 shows the difference.

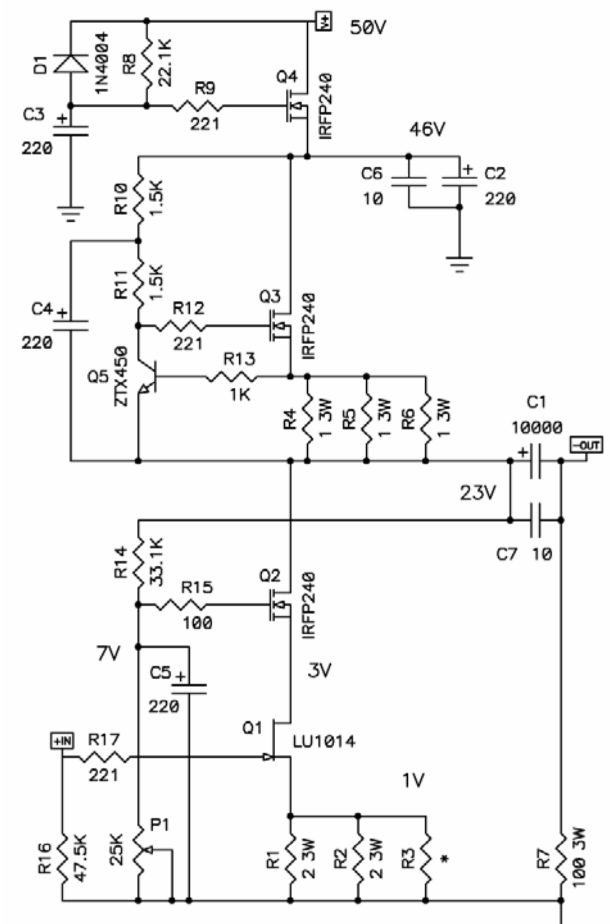

FIG 4 CASCODE MODULATION

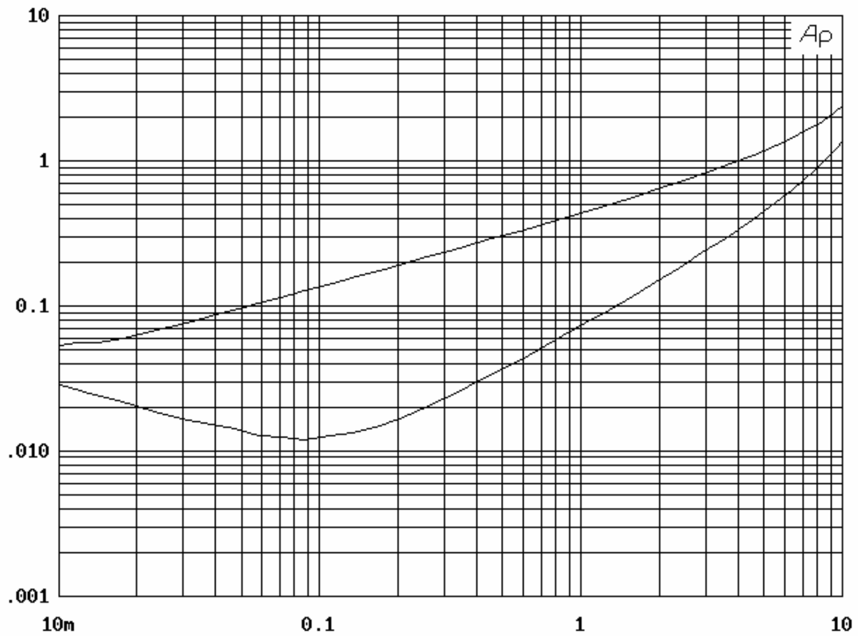

FIG 5 CONSTANT VS MODULATED CASCODE

Installment 3 – Negative Feedback

The first two alterations improve the 1-watt performance by an order of magnitude, but it's still a current source. You might elect to stop here if a current source meets your needs. If you want a damping factor, we will apply some loop feedback, as seen in Figure 6.

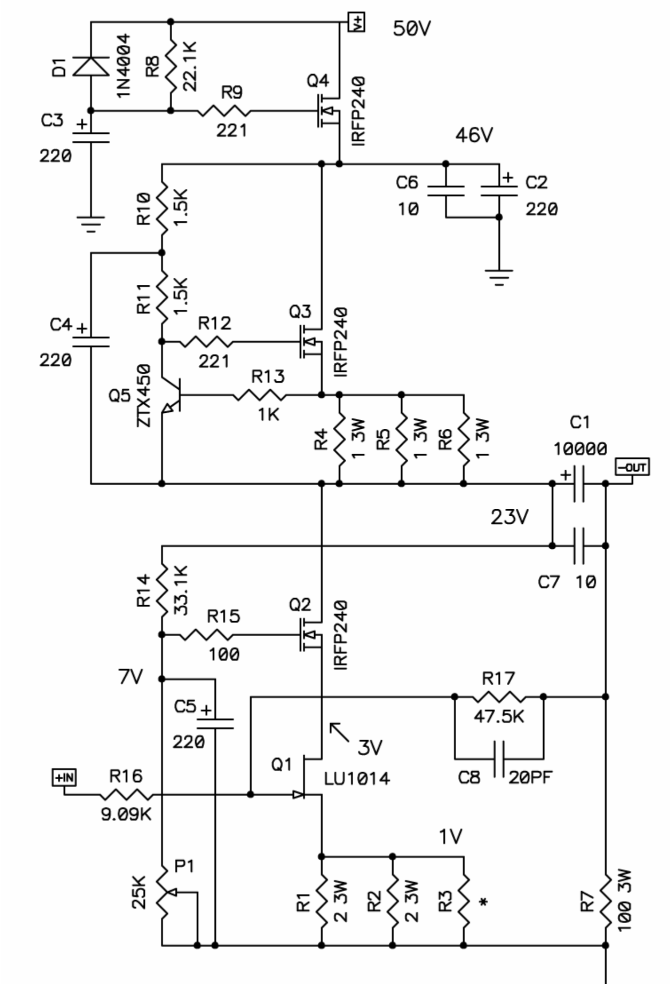

FIG 6 NEGATIVE FEEDBACK

Figure 6 is different from Figure 4 with R16, R17 and C8 forming a negative feedback loop. Like most of its Zen predecessors, ZV9 uses feedback to lower the output impedance. Roughly, R17 divided by R16 determines the gain and R16 determines the input impedance. With the values shown we use about 10 dB of feedback to get a damping factor of about 3 and a distortion reduction of about half. C8 imposes a small amount of compensation that makes the square wave look good. Figure 7 shows the comparison with and without feedback. Note that the improvement is not uniform – with simple low feedback circuits it often is not.