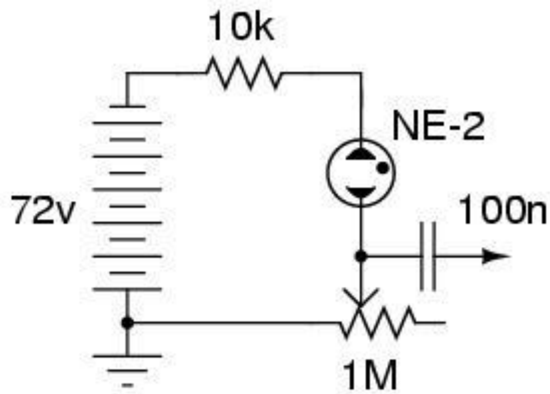
Plasma Diode Detector

Recently I bought a gross of neon bulbs for various experiments, they are quite cheap in large quantities. While researching neon glow discharges I found a few mentions of their use for microwave demodulation. I've used them for quite a while as sniffers for RF and strong electric fields, even as thyratrons, but I never thought about using their nonlinear diode like properties for demodulation.

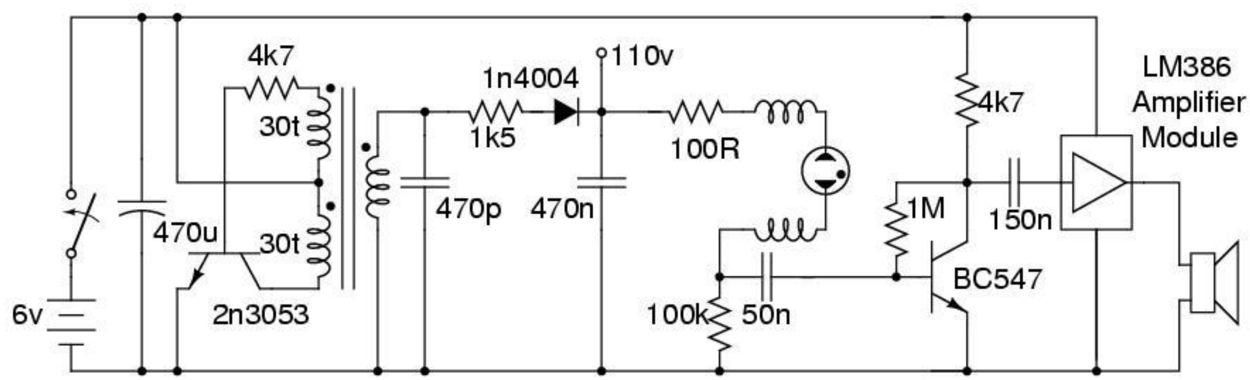


Bias Testing Circuit

While Christmas shopping at a $2-store I saw some cheap and nasty 9v batteries on sale for about $1 each, figuring I could use them for a B+ battery in tube experiments, or some other no-fuss moderate voltage supply, I bought all of them. When this neon experiment came along, I had just the right power supply for experimentation. Using 8 of them and a 1M pot I experimented with biasing a neon bulb and observing the current through it via the voltage across the pot, picked off via a new nano capacitor. It worked very well for such a primitive setup, just a bunch of alligator clips and Blu-Tack holding the prototype together on the bench, the 1kHz AM signal from my RF oscillator was clearly visible on the CRO as a few millivolts above the noise floor while the end of the coax was held near the neon bulb.

Further experimentation with the biasing showed that the current was more important than the voltage in giving the best sensitivity and lowest distortion. While this 1980 Ham Radio article I found in my research suggests altering both parameters I found keeping the voltage above the striking voltage was fine as long as a large series resistance was used to limit the current to the point where a gentle glow was just covering the inner surface of the cathode. Balancing the discharge on the edge of collapse was not needed for my particular bulbs, although there was much variation in strike voltage and best bias current. In practice I found only 3dB or so difference in optimal bias and just giving the bulb 100 volts through 100k.

Building the practical device was a little more complicated, a bunch of 9v batteries is quite heavy and bulky. An inverter had to be built to produce the voltage, and AF amplification had to be provided to drive headphones or a small speaker.



The inverter transformer was wound on a bobbin and ferrite E-core set. The primary windings are 30 turns each, of 0.5mm wire. The secondary winding is 0.2mm wire, wound by trial and error to provide about 110 volts. The primary and secondary layers separated by a layer of PVC tape. The 470p capacitor across it helps improve its efficiency. The 1N4004 was replaced with a Schottky device but little improvement was observed, so the 1N4004 was returned. There is no bleeder resistor across the storage cap, be careful, or add a meg or so resistor across the cap.

The AF amp is a single transistor pre-amp stage, followed by a DSE K5604 LM386 amplifier module. This module is available as a fairly cheap kit (about $5 when I bought 10 of them a few years back) the size and good PCB offers a nice short-cut for building a simple audio amplifier. Here is a picture of the unit without the audio amp module in place. The switch was later replaced with the headphone socket and power supplied externally, I ran out of room inside the box.

Note the RF chokes wound on 1W 10M resistors to isolate the plasma from the supply, preventing the RF from being shunted. The detector seems to work fine from about 5MHz to many, many GHz. As in the Ham Radio article I tried making coupling loops out of flashing Aluminium, they worked quite well for higher frequencies, but for lower frequencies directly coupling the RF to the leads of the neon bulb worked better than capacitive coupling through the glass.

Placing the detector at the focus of a parabolic dish worked well. I could hear the output of a 24GHz motion detector from across the room, chopped with a metal shutter on a small electric motor to give it some AM.

Source: http://www.vk2zay.net/article/49