A NEW PLASMA BALL MODIFICATION DESIGN

1. **Obtaining the Plasma Ball**

My Plasma Ball was obtained on Ebay from a Californian importer. It is 1" smaller than the Thunderballs but seems to radiate about the same sized fields around the ball. It is called "Big 7 inch Plasma Ball Light Party Lamp Sound Activated". It cost US$19.5 plus mailing charges, and it arrived in Canada in fine working condition. My lot # was 260240333259 (may stll be viewable) It was supplied by:
Gadgets Gizmos and Beyond, Hai Li. 1005 E. Las Tunas Dr #501, San Gabriel, Ca 91776
I had a smooth transaction even with export to Canada. Fig. 1 shows this PB.

I think he has other Big 7 PBs on Ebay as well, and I expect he can import more to USA from his source in China; he probably only operates privately on Ebay. The unit had no name anywhere on its box or the ball or instructions, except "Made in China". Aren't they all! I consider this a near equivalent to the Thunderball, and easily modifyable for our purposes; a most interesting and potentially useful find. This PB version has a flyback transformer type DS4069 as on the Thunderballs, but the circuit board has a slightly different layout than the Thunderballs, so this circuit is carefully analysed below, and modifications are suggested. I modulated the PB from a signal generator, not a computer but it should be feasible to hook up some of Ken's drivers and software if needed.

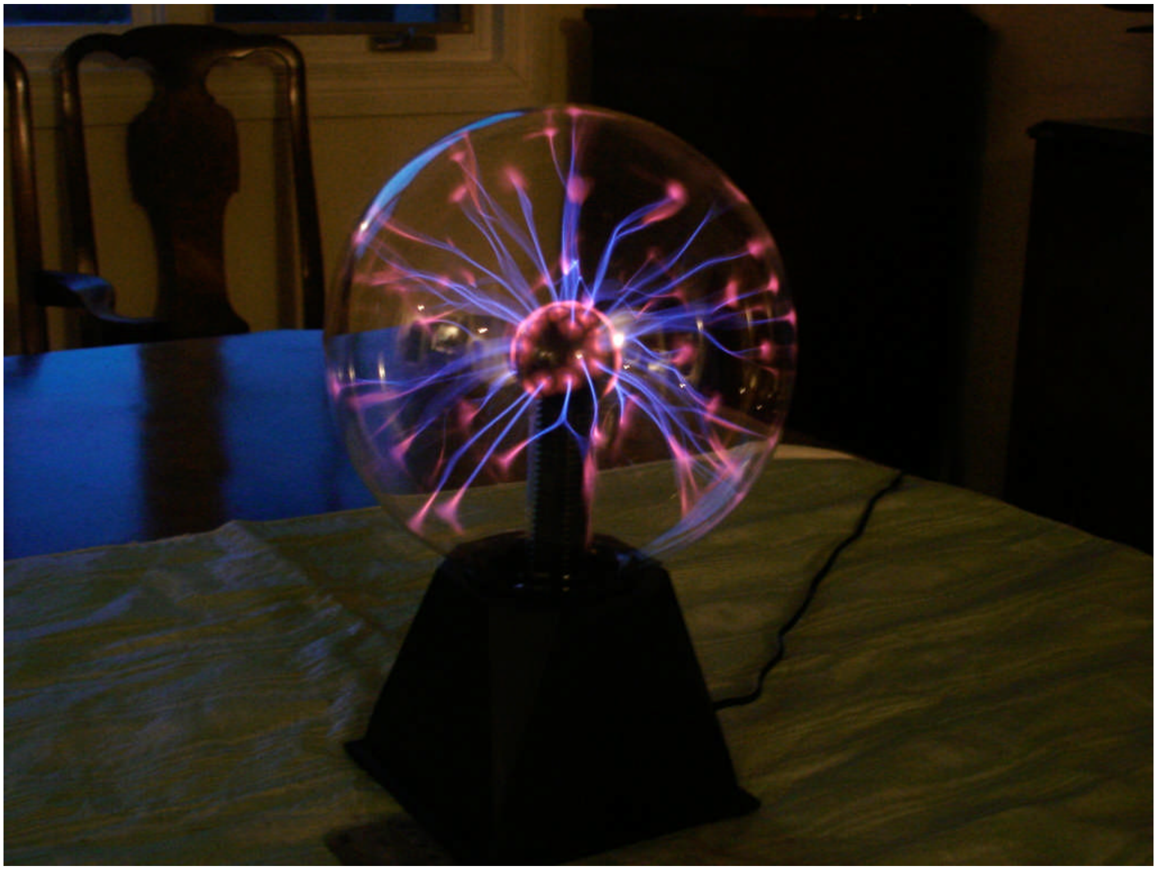

Fig 1. Unmodified Plasma Ball as Received.

2. Circuit Board

The circuit board and all solid state devices (ICs) are very clearly marked on this version of plasma ball, as shown in the Fig 2, and the data sheets for the ICs are obtainable from <www.datasheetcatalog.com>. I back-engineered it so as to modify it for our purposes.

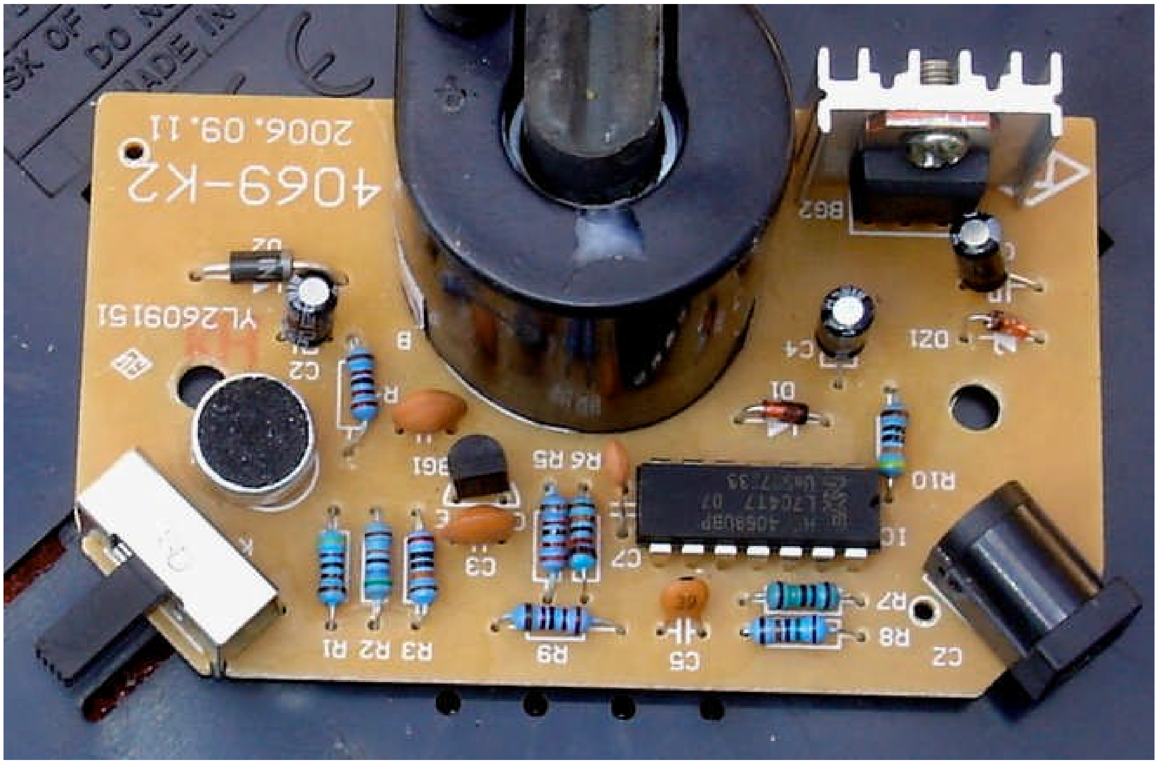

Fig 2. Topside View of Circuit Board.

The circuit diagram of the main control segment of the 7" Plasma Ball is shown in Fig 3. There are three solid state devices. The TIP122 mounted on the heatsink drives the flyback transformer, while the Hex Inverter HEF4069 provides the 28 kHz oscillations and buffer amplifiers for the plasma ball and audio control segments. A microphone detects sound waves, and is fed to an NPN transistor Type STC9014N. To my mind this transistor is very oddly wired but this is what appaers to be in the circuit.

The component values are as follows (Resistors are 1% types, in ohms)

R1	4700	R6	33,000	C1	104
R2	560,000	R7	1,000,000	C2	1 uF
R3	200,000	R8	150,000	C3	104
R4	22,000	R9	22,000	C4	1 uF
R5	22,000	R10	430	C5	39
				C6	1 uF
				C7	122

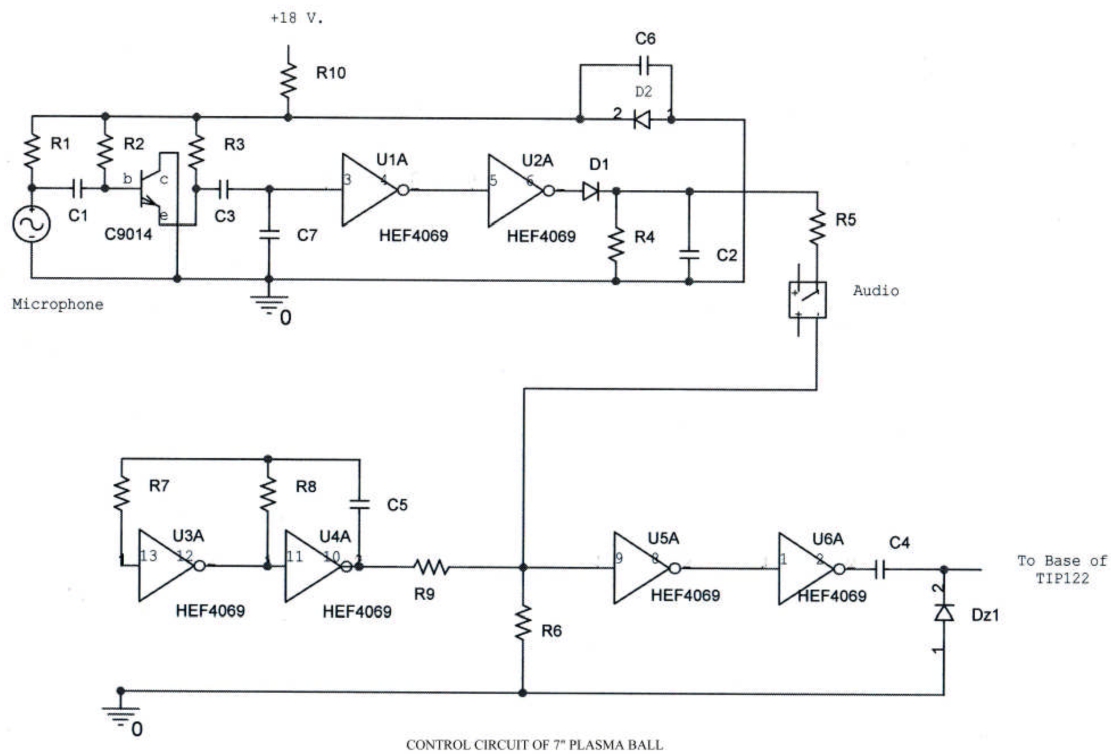

Fig 3 Main Control Segments of the Big & inch Plasma Ball Circuit.

The power unit that came with the PB is labelled as 12V 500 ma, but it measured as 18V open circuit. I could not measure the loaded voltage as the unit was then inside the PB case, so the voltage could be anywhere between 18V and 12V, before the R10 resistor.

3. Circuit Operation

It is believed that the circuit operates roughly as follows. When the audio is switched off, the Inverters U3 and U4 provide the 28 kHz signals that are buffered by the two subsequent Inverters U5 and U6. C4 is a 1 uF capacitor which passes the signals to the base of the TIP122. Diode DZ1 appears to limit the inputs to positive half cycles of the 28 kHz input. My measurements of the ball as received gave the following values

Frequency detected on open lead from Frequency Counter Type Victor VC3165 = 28.6 kHz

Radiated fields from unmodified Plasma Ball, as measured on a Trifield Broadband Meter were as follows

Distance from centre of Plasma Ball (cm)	Electric Field Value (kilovolts/metre)
22.5	100
27.5	20
46	10
81	5
220	1

Distance from centre of Plasma Ball (cm)	Magnetic Field Value (milligauss)
12.5	1.1
24.5	0.85
29	0.6
40.5	0.2

The electric field measurements are encouraging as they obey the expected inverse square law response ; ten times the distance from the ball centre gives a field reduction of by a factor of one hundred

4.Audio Mode.

When switched to the audio mode and no sound is present at the microphone, the plasma is extinguished. Clearly the voltage on the input to U5 is forced to an "off" condition. In the audio mode, the microphone signal is fed through the NPN transistor in its unconventional configuration and to the main buffer amplifiers U1 and U2. The diode D1 selects one polarity and the result is heavily damped by the large capacitor C2 (1 uF). The voltage on this capacitor switches on the plasma contol amplifier U5

When a burst of sound appears the voltage on Pin 9 (U5) changes and U5 again passes the 28 kHz signal, so the ball glows. If the sound ceases for a short while, the voltage on pin 9 decays again with a time constant governed by R4 and C2 , slightly modified by R5+R6 , roughly 15000 ohms and 1uF for a time decay of about 15 ms. So the device only responds to sound bursts of a few millisecond duration and is useless for feeding in square wave RIFE frequencies as it stands. So we will modify it a little, removing that 1uF capacitor C2 for a start.

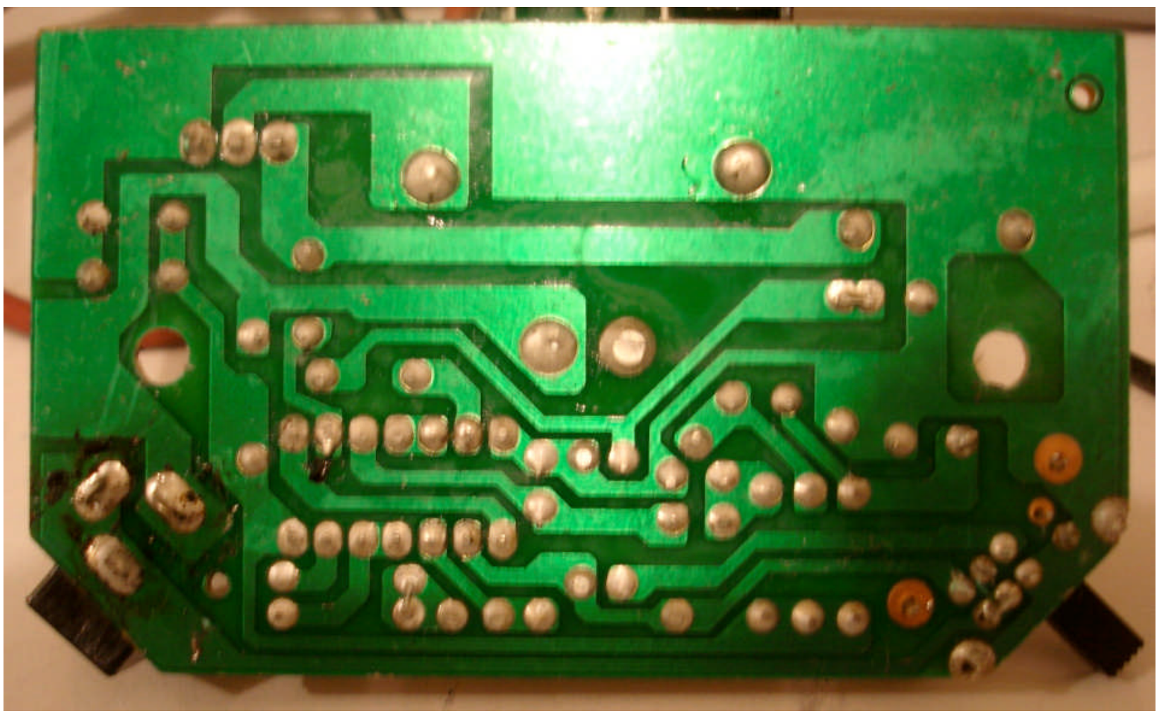

Fig 4. Circuit Board, Power on the left, switch on the right

5. Modification of the Circuit Board.

To my way of thinking, it may not be best to input directly to the base of the TIP122 as others have tried, because one is bound to mismatch the impedance there and one does not use the power of the Hex Inverted drivers at all. so one can either inject directly into Pin 9 of U5, which could affect the oscillations in U3 and U4, or input at U1 pin 3 with square waves having disabled C2 completely. Then C7 and C3 and the microphone transistor will not be needed either . I happen to have a signal generator and do not need to worry about computer feeding. In the long run I am considering feeding it with a GB-4000 frequency generator in its gated pulse mode. I selected the U1 pin 3 method and carried out the following modifications

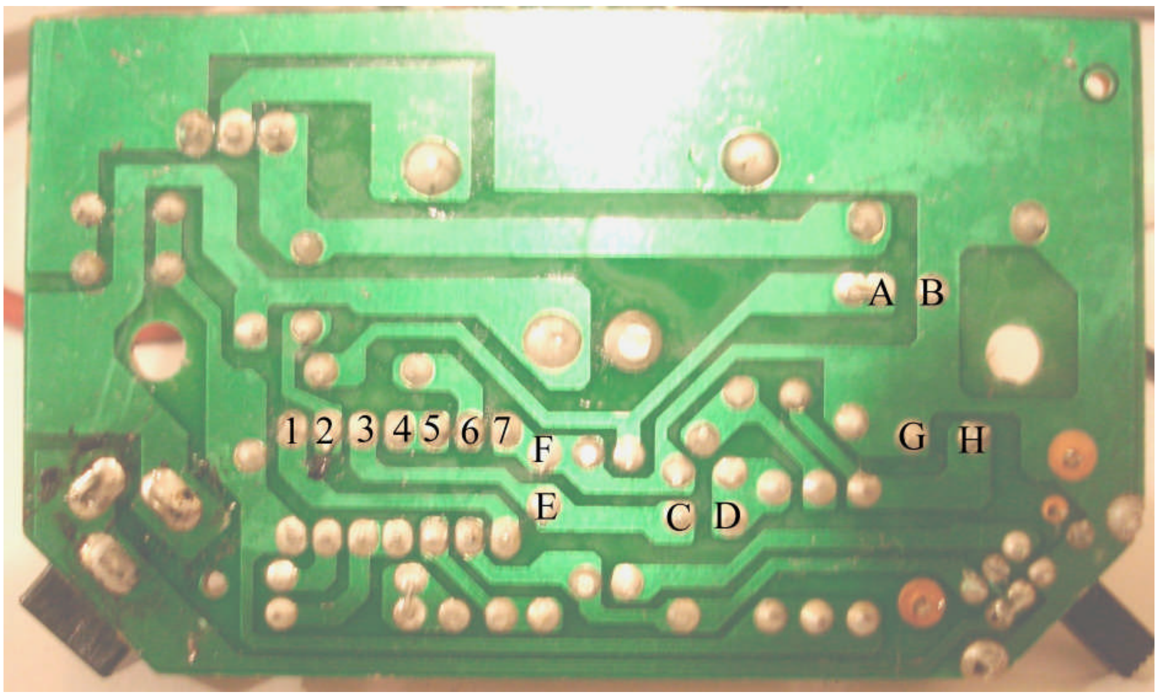

Fig 5. Pin Numbers on HEF4069, and Key Component Locations.

1. Unsoldered and removed the microphone (at GH), C2(at AB), C3(at CD) and C7(at EF)
2. Soldered a coaxial cable (centre connection) to the circuit board trace for pin 3 of U1 in the same hole originally used for Capacitor C7, which is at E
3. Soldered the coaxial outer connection to the microphone ground connection, G, after the microphone had been removed.
4. Inserted a coaxil socket in the base pyramid to which this new input cable was connected, so that one can plug in a lead on the outside of the ball with the required modulation square wave.
5. Reassembled, and ensured that the HV probe was well inserted into the centre tube of the ball
6. Put some air holes in the base of the PB, but I did not change the TIP122 or its heatsink. So far it has not burnt out.

The above figure shows where the connections are to the components that must be removed.

The cable is connected to point E and grounded to point G. Fig 6 shows the resulting modified board. The coaxial cable will eventually be connected to a coaxial socket on the base of the PB, which should be mounted well clear of the TIP122 heatsink.

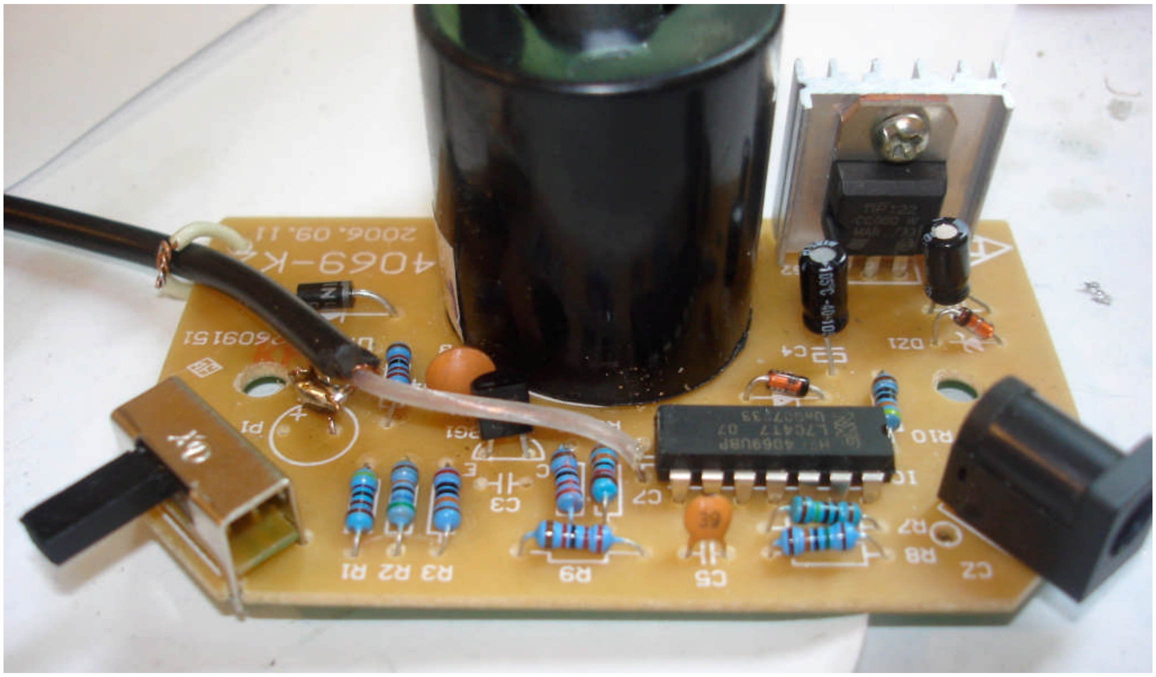

Fig 6. Location of New Audio Feed Cable on Modified Board. Capacitor C3 is Removed

6. Results

Note that these modifications do not affect the non-audio segment so the performance of the PB should be unaffected by the modifications in the non-audio mode. When switching to the new audio mode, the plasma ball lights up unless the input modulation cable is connected to the signal generator or other square wave source. This is because the input to U1 is then floating. However, the ball turns off when the signal generator is attached. When a square wave signal of a few volts is applied, the Plasma Ball is square wave amplitude modulated as expected. The frequency can be changed over a range of 1 Hz to at least 2000 Hz or more (7% modulation) and the 'scope trace on open leads held near the ball shows a well modulated waveform as shown in Fig 6.

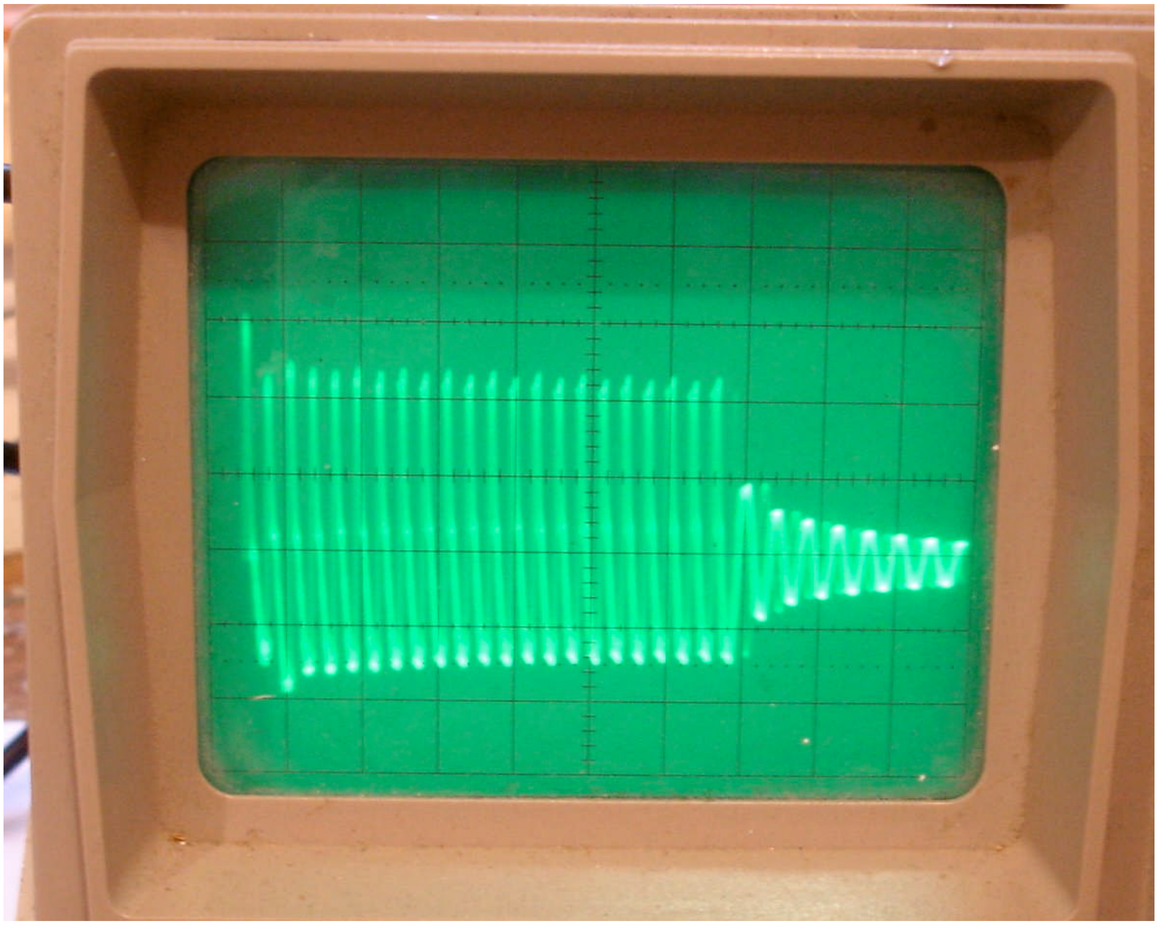

Fig 6. PB Signal Amplitude Modulated by 1000 Hz Squarewave

The ‘scope probe was just lying unconnected near the PB, and some 60 Hz noise was also present from the electricity supply line. Modualted by squarewave frequencies below 10 Hz, the PB flickers very obviously at the modulation rate, which forms a good check if you do not possess a 'scope.

The output electric power (as measured by the Trifield Broadband Meter) in the non-audio and audio modes was fairly similar. If anything there was a little stronger field in the amplitude modulated mode than in the unmodulated mode, as measured by the Trifield, for 728 Hz amplitude modulation (wonder why I chose that particular frequency !) .   So far the TIP122 has not burnt out, and I consider the modification to be successful.

Finally, the legal statement. I am a retired engineer, not a doctor, and make no medical claims for this experimental device, and can accept no medical questions of any type about it; I am simply not qualified to answer them. On the engineering aspects, I may be able to help further.