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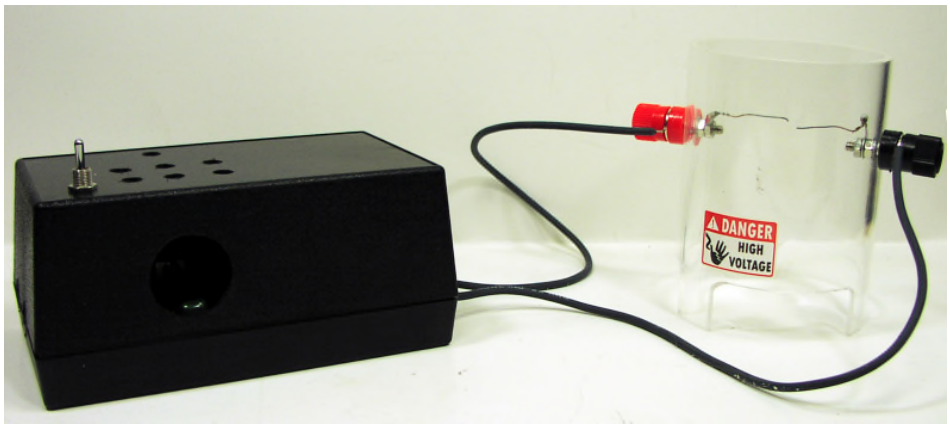
Plasma Arc Speaker Kit

PAS-01K



See high voltage safety guide pg 3

Manual and Construction Booklet For Plasma Arc Speaker Kit

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Important Safety Warning

This is a high voltage device that is intended for use by adults. Children should not build or operate this kit. This kit is not intended for children!

Assembly of this kit requires high-temperature soldering and the use of sharp edged components and cutting tools. Some included components may become hot, leak, or explode if used improperly. Images strongly recommends that you wear safety glasses when building or working with any electronic equipment.

High voltage discharges and shocks can cause injury and/or death. Additionally high voltage electricity as generated by this assembled kit can cause damage to property. SI Images disclaims liability for damage or injury caused by the use of the Fly Back Generator Kit. By using this product, you agree not to hold Images liable for any injury or damage related to the use or to the performance of this product. This product is not designed for, and should not be used in, applications where the malfunction of the product could cause injury or damage.

High Voltage Safety

The plasma arc speakers are high voltage devices. If you are not familiar with working with high voltage devices we do not recommend you build this device. While this high voltage it is not necessarily lethal. A person's health has an impact on the amount of current that could be lethal. Also, if you have a biomedical implanted device like a pacemaker do NOT build this device. If you have a weak heart do NOT build this device.

An electrical shock can cause you to jump, move or fall and can thereby cause a secondary injury, unrelated to the electric shock itself. Take the following precautions and treat all high voltage power supplies with the respect they deserve.

Follow these simple guidelines and rules.

1) Keep one hand in your pocket. Only use your other hand to work with the high voltage equipment. This reduces the probability of accidentally passing high voltage current across your heart from hand to hand.

2) Set up your work area away from possible grounds that you may accidentally contact. Keep your work area neat and clean to easily identify high voltage wires and grounds.

3) Be sure the floor is dry and wear preferably rubber-soled shoes.

4) Prove to yourself the high voltage power supply is off, by unplugging the device's electrical power cord. Don't trust power switches that could be hit or pressed and accidentally turned on.

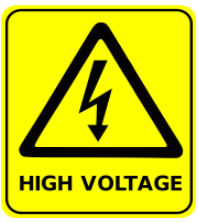
5) Discharge all high voltage before working on the device. This means attaching a wire to the circuit ground and touching the high voltage output terminal with the grounded wire. This will dissipate any stored high voltage charge.

6) Do not work on high voltage apparatus when you are tired and not alert even if it means a delay.

7) Never charge a capacitor using the high voltage power supply. Even small high voltage capacitors can deliver lethal current!

8) Never leave the power supply plugged in while unattended.

9) Do not use the generator if you have a heart condition, are pregnant, or have any condition or health issue that might render you susceptible to electrical shocks.



10) Keep your mobile phone, personal computer, tablet, or other personal devices at least ten (10) feet away from the generator as they may be permanently damaged.

11) You must furnish your own power source for this kit. Never use an incompatible or incorrect power source as it may result in the generator overheating or fire.

12) Use safety precautions when soldering and assembling the kit.

13) Do not use the kit except as assembled per the instructions contained herein.

14) Do not add, substitute or remove components to the kit assembly.

WARRANTY

IF YOU DO NOT AGREE TO THESE CONDITIONS, YOU SHOULD NOT PURCHASE THE PRODUCT. IN NO EVENT SHALL IMAGES SI BE LIABLE FOR ANY INCIDENTAL, SPECIAL, CONSEQUENTIAL OR PUNITIVE DAMAGES, OR FOR ANY COSTS, ATTORNEY FEES, EXPENSES, LOSSES OR DELAYS ALLEGED TO BE AS A CONSEQUENCE OF ANY DAMAGE TO, FAILURE OF, OR DEFECT IN ANY PRODUCT INCLUDING, BUT NOT LIMITED TO, ANY CLAIMS FOR LOSS OF PROFITS. SOME STATES DO NOT ALLOW THE EXCLUSION OR LIMITATION OF INCIDENTAL OR CONSEQUENTIAL DAMAGES, SO THE ABOVE LIMITATION OR EXCLUSION MAY NOT APPLY TO YOU. THIS WARRANTY IS EXCLUSIVE AND IN LIEU OF ALL OTHER EXPRESS WARRANTIES, WRITTEN OR ORAL. TO THE EXTENT PERMITTED BY LAW, SI IMAGES DISCLAIMS ANY IMPLIED WARRANTIES, INCLUDING WITHOUT LIMITATION ANY IMPLIED WARRANTY OF MERCHANTABILITY. OR FITNESS FOR A PARTICULAR USE OR PURPOSE; TO THE EXTENT SUCH DISCLAIMER IS NOT PERMITTED BY LAW, SUCH IMPLIED WARRANTIES ARE LIMITED TO THE DURATION OF THE APPLICABLE.

EXPRESS WARRANTY AS DESCRIBED ABOVE. SOME STATES DO NOT ALLOW LIMITATIONS ON HOW LONG AN IMPLIED WARRANTY LASTS, SO THE ABOVE LIMITATION MAY NOT APPLY TO YOU, THIS WARRANTY GIVES YOU SPECIFIC LEGAL RIGHTS, AND YOU MAY ALSO HAVE OTHER RIGHTS WHICH VARY FROM STATE TO STATE.

Background Information

Plasma, as it is referred to herein, is a high temperature highly ionized gas. (Not the plasma as in "blood plasma") Plasma is considered the fourth state of matter, after solid, liquid and gas. It is the most abundant state of matter in the known universe. May be hard to believe for us living on Earth, as we may think the other states of matter, like earth (solids), is much more prevalent. However stars are made up of plasma, and the closest star to our planet, the sun, easily surpasses the mass of all its orbiting planets.

A high temperature highly ionized gas (plasma) is electrically conductive. A plasma arc speaker first creates a high voltage electrical plasma arc between two electrodes. The plasma is a gaseous diaphragm. Conventional speakers use a solid diaphragm. The gaseous diaphragm of the plasma arc speaker is essentially mass-less and can easily respond to high frequency audio sound. By jiggling the ions in the plasma by varying the electrical signal we can cause the gaseous diaphragm to vibrate and create sound waves in the air.

History

Interestingly, the roots of this form of speaker can be traced back to William Duddell in 1899 before the invention of incandescent lamps. At this time, electrical arcs between two carbon electrodes were used to create light. These electric arc lamps often produced audible hissing sound. Duddell connected a tuned circuit made of a capacitor and inductor across the arc and discovered he could generate a tones that corresponded to the resonant frequency of the tuned circuit. Building upon this information, he wired a keyboard to play different tones through the electrical arc. He demonstrated his work to the London Institute of Electrical Engineers, playing "God Save the Queen" on what is considered the first electronic musical instrument. This invention became known as the singing arc.

In 1968 Popular Electronics magazine published an article titled "Flame Loudspeaker" describing the work of three scientists A.G. Cattaneo, Wayne Babcock and K.L. Baker. This article described using a high temperature flame (low temperature plasma) to generate sound. The experimenters used

an oxygen-acetylene torch to create a high temperature flame. Cooler flames from a propane torch could be used, but needed to be seeded with an easily ionized material such as potassium nitrate to generate a useable amount of low temperature ions. Seeding also increased the volume output of the high temperature flame speakers. Two tungsten electrodes were inserted into the heart of the flame, a few inches apart from one another. The audio signal was boosted to 300 to 500 volts in order to jiggle the low temperature plasma to tease out some sound.

The flame speaker sound could be made sweeter, by using a high voltage DC biasing voltage and allowing the audio signal to modulate the flame plasma over the DC signal.

Commercial Applications

Plasma speakers are incorporated into one of the world's most expensive speakers, the Acapella Sphäron "Excalibur". This speaker cost is between $350,000-500,000 USD and weights in excess of 1200 lbs. The plasma speaker portion of the speaker produces the higher frequency sound.

High Voltage Caution - Please review the High Voltage Safety Guidelines found on page 3 prior to beginning construction.

Warning - Audio Playback Devices:

There is always a chance that the high voltage could jump to the low voltage side of the device and damage the audio player device. Use audio device at your own risk. We are not responsible for any damage to your audio devices. Use only inexpensive audio devices.

How it works

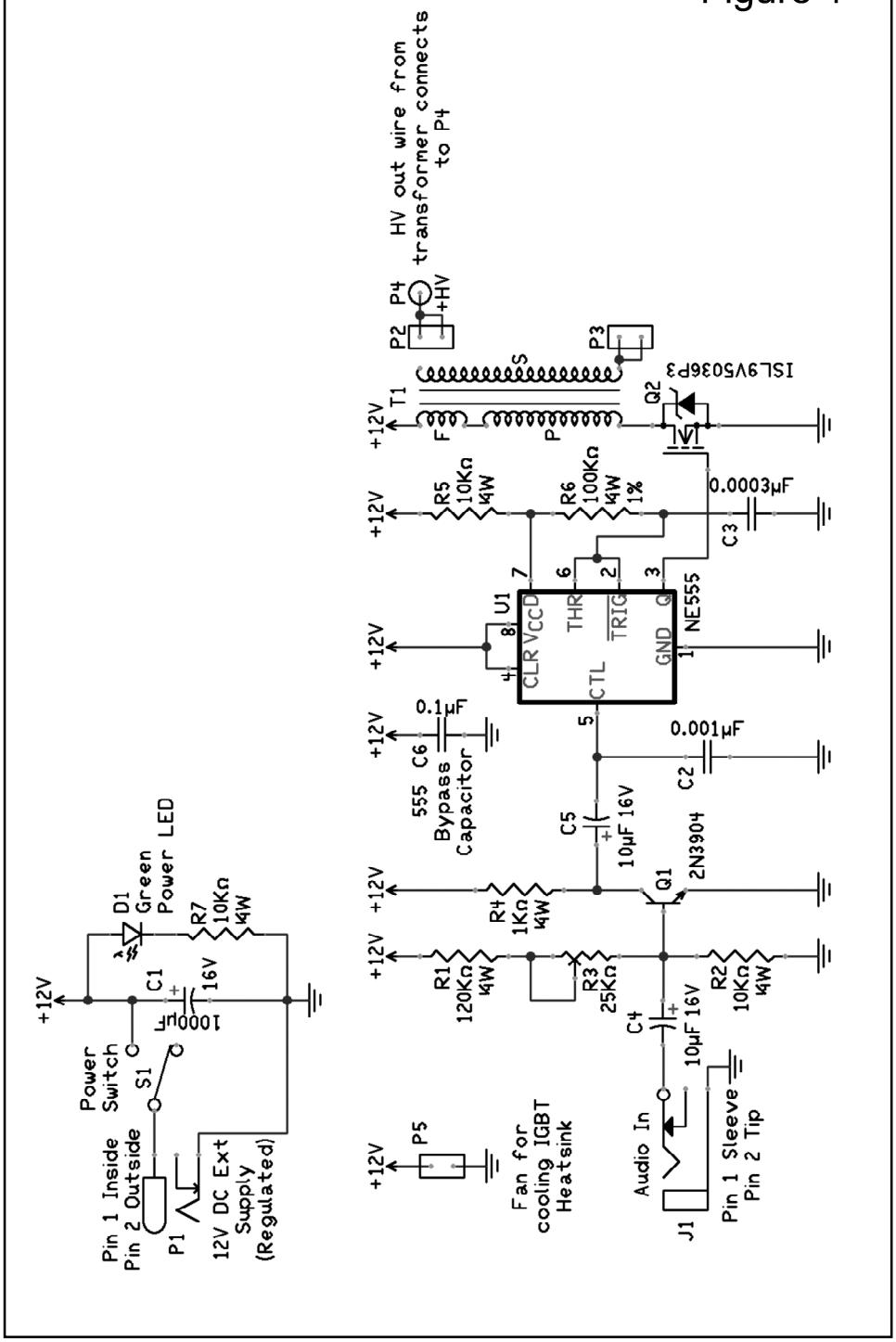
Many published schematics on building a plasma arc speaker on the internet use either a 555 Timer or TL494 PWM Controller. There are many variations of these circuits depending upon the high voltage transformer used. I choose to use the 555 Timer for my design. Most of these internet designs use the output of the 555 to a standard power transistor or MOSFET to switch current on and off to the high voltage transformer. My design uses a unique power component, the IGBT (insulated gate bi-polar transistor) that is ideally suited for this application. More on this later.

The 555 timer is set up in astable mode. In astable mode the 555 continually outputs a frequency dependent upon the values of two resistors and a capacitor, that form a RC network connected to the 555. For my plasma speaker application I have set the 555 timer astable frequency to approximately 23 KHz. The 555 timer is set to an oscillation frequency that by itself powers the high voltage coil. The key point of choosing this frequency is that when powering the high voltage coil the output arc or plasma HV transformer does not produce any sound or tone. If it does, that sound or tone will detract from the sound quality of the plasma arc speaker when it is in use. Let's call this a base frequency or carrier frequency of the 555 timer.

Pin 5 on the 555 timer is the control voltage input. By applying a voltage to this pin it you can vary the output frequency of the timer independently from the frequency that was set by the RC network. As the voltage on pin 5 increases the oscillation frequency decreases. So varying the voltage on pin 5 creates a frequency modulation (FM) output.

Instead of just placing a static voltage on PIN 5 we are placing the output audio signal from the 2N3904 transistor. The 2N3904 is a one transistor audio amplifier. This allows the audio signal to modulate the output frequency of the 555 timer. This FM output will jiggle and vibrate the ions in our plasma to create sound.

Figure 1


+12V
D1
Green
Power LED
R7
10Kohm
4W
C1
1000uF
16V
Power
Switch
S1
Pin 1 Inside
Pin 2 Outside
P1
12V DC Ext
Supply
(Regulated)
HV out wire from
transformer connects
to P4
P2
P4
+HV
P3
T1
S
P
ISL9V5036P3
Q2
R5
10Kohm
4W
R6
100Kohm
4W
1%
0.0003µF
C3
U1
NE555
CLR
VCC
THR
TRIG
GND
CTL
0.1µF
C6
555
Bypass
Capacitor
0.001µF
C2
C5
10µF 16V
R4
1Kohm
4W
Q1
2N3904
R1
120Kohm
4W
R3
25Kohm
R2
10Kohm
4W
C4
10µF 16V
P5
Fan for
cooling IGBT
Heatsink
Audio In
J1
Pin 1 Sleeve
Pin 2 Tip

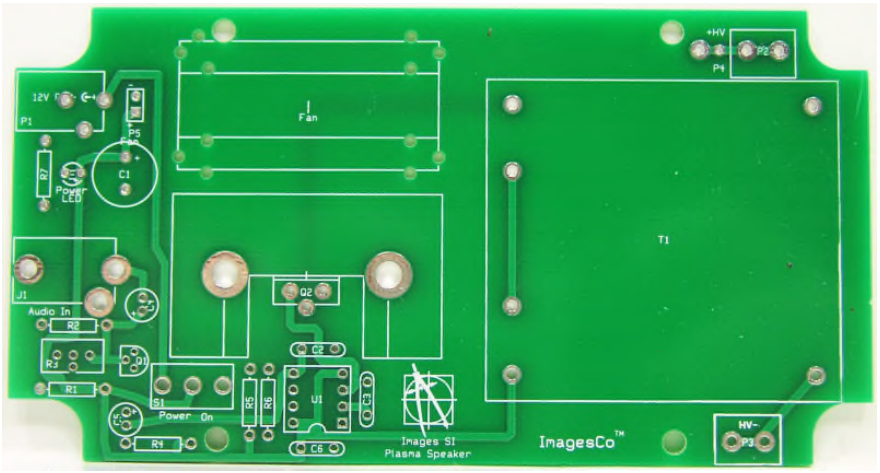


Figure 2

Circuit Construction

The schematic for the Plasma Arc Speaker is shown in Figure 1. The top silkscreen of the PCB is shown in Figure 2, above. All components are mounted and soldered to the top of the PCB.

Before beginning construction, it is important to review the HV Guidelines included on page 3 of this manual.

Begin construction by mounting and soldering the resistors in place. 10K resistors (color bands: brown, black, orange) are mounted and soldered at R2, R5, and R7. R4 is a 1K resistor (color bands: brown, black, red). R6 is a 100K resistor (color bands: brown, black, yellow). For R1 a resistor measuring between 100K and 120 K may be used (refer to Appendix A to decipher color bands).

Next mount and solder the 8 pin socket. Be sure to align the notch on the socket with the silkscreen on the PCB. This will help to insure that the 555 is orientated correctly. Insert the 555 timer with the indentation at pin 1 facing the same direction as the notch on the socket. Mount and solder the .001uf and 330pf capacitors at C2 and C3, respectively. Then install the 2N3904 transistor at Q1. Be sure to orient the transistor as outlined on the silkscreen.

Now attach the Heatsink to the high voltage transistor using the included screw and nut. Insert the transistor at Q2 with it facing the 8 pin socket. Solder the transistor and heatsink into place.

Next mount and solder the remaining capacitors. C6 is a .1uf, Capacitor. Take note of the polarization marked on the silkscreen for C1, C4 and C5. The longer lead of the Capacitor should be inserted into the hole marked +. C4 and C5 are 10uf 16V capacitors. A capacitor measuring between 470-1000uf at 16V or higher may be used at C1.

Insert and solder the potentiometer at R3. This will be used to adjusting speaker after construction. Mount and solder the power jack, and audio jack into place. The toggle switch is wired to the PC board so that it will protrude through the designated hole in the case. Attach a 7 inch piece of insulated wire to each of the switch prongs. Solder the wire attached to the center pin to the center hole in the box labeled S1. The other wire should be soldered to the left hole (located above the text, S1).

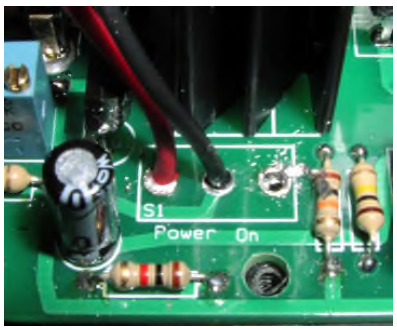


Figure 3

Now trim the wire from the HV transformer to 3 inches. Solder the transformer into place with the wire facing the right side of the PCB. Bend the wire over and solder into place at P4. The fan should be hot glued to the PCB with the label facing the heatsink. The wires are attached at P5, connecting the black wire to -, and the red wire to +. Cut the HV wire into 2 equal pieces. Attach a 9 inch length of HV wire to each of the outermost holes labeled P2 and P3.

Finally insert the LED at D1 with the longer lead in the + hole. 3/4” of the

lead above the PCB, solder into place.
Figure 4 shows an overhead view of the completed circuit.

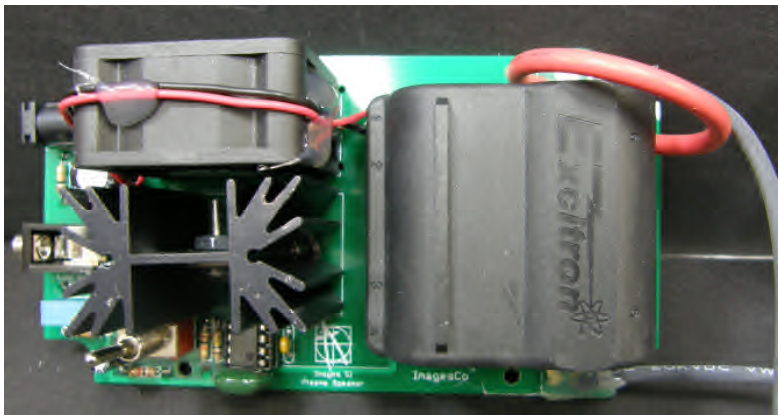


Figure 4

Assembling the Plasma Tube

Completely remove the insulation from the single stranded wire included in the kit. Remove the nuts and ring terminal from each binding post. Solder a 3 inch piece of bare wire to each of the ring terminals.

Figure 5

Now insert the red binding post into one of the holes in the plasma tube. Secure in place with a nut. Slide a ring terminal on over the nut and secure with a second nut. Repeat for the black ring binding post.

Connect the circuit to the plasma tube by way of the binding posts. The HV wire connected at P2 is attached to the red binding post; The wire at P3, the black.

Audio Input

Warning about Audio Playback Devices:
There is always a chance that the high voltage could jump to the low voltage side of the device and damage the audio player device. Use audio device at your own risk. We are not responsible for any damage to your audio devices. Use only inexpensive audio devices.

Potentiometer R3 is used to fine tune the bias for the audio to the NPN transistor amplifier. Adjust potentiometer R3 to its mid-point position when first turning on the plasma arc speaker.

The audio input signal I used was 100 millivolt peak to peak (or 0.10 volts peak to peak) from an i-pod. If the audio signal is too large it will be clipped creating a good deal of distortion in the plasma speaker's output. So if your plasma arc speaker sounds terrible, the first thing to do reduces the volume of your audio signal going into the circuit. Less may be more.

Testing the Circuit

First attach your iPod/mp3 player to the unit using the included male to male cable. Plug the wall transformer into the power jack.

Figure 6

Before turning on the circuit, adjust the electrodes as shown in Figure 6. Notice how the ends of the wire are arc so that the ends of each wire face

the opposite wire end. This is to insure the arc forms between the wire ends, which will provide the best audio quality. If the electric arc travels up and down the side of the wire, you will hear distortion.

The gap between the wire ends are approximately 0.25 (1/4") apart. You may adjust the gap accordingly. When turning on the circuit for the first time, having audio playing into the circuit's audio input. Adjust volume as necessary. If an arc does not form adjust the gap and make sure audio is being played. DO NOT touch the wires with your bare hands. Use a screw-driver or needle-nose pliers with an insulated handle to make any adjust-ments.

Casing the Unit

Once the unit has been tested, it is recommended that it be mounted inside the included case. To do so disconnect the HV wires from the binding posts. Place the circuit into the bottom section of the case, aligning the components with their corresponding cutouts. The mounting holes on the PC board should line up with the mounting posts in the bottom of the case. Secure the PCB to the bottom of the case with 4 - #4x3/8” Screws.

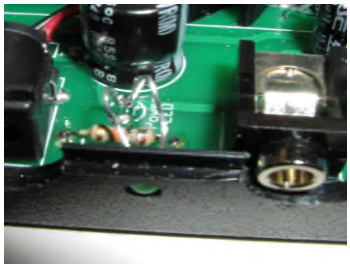


Figure 7

Run the HV wires through the holes in the case. For extra security, apply a small amount of clear silicone to the points where the wires are connected to the PCB. Bend the LED to a right angle so that the light can be seen through the hole in the case as shown in Figure 7.

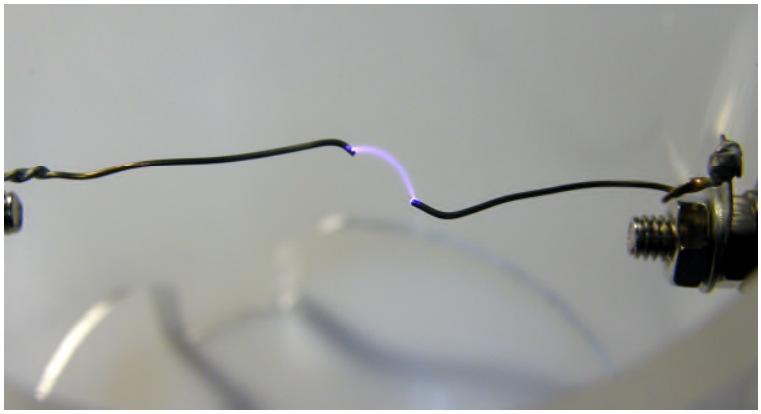
Position the top of the case so that the large round hole is centered in front of the fan. Remove all hardware from the power switch. Insert the switch through the hole in the top of the case. Secure in place with a nut. Close

case and secure with included screws through the holes in the bottom of the case.

Reattach the HV wires to the binding posts and the unit is now ready to be used.

Two high voltage labels have been included with this kit. One should be placed on the Plasma Tube; the other, on the case.

DO NOT leave the Plasma Arc speaker running for more than 10 minutes at a time.



Appendix A

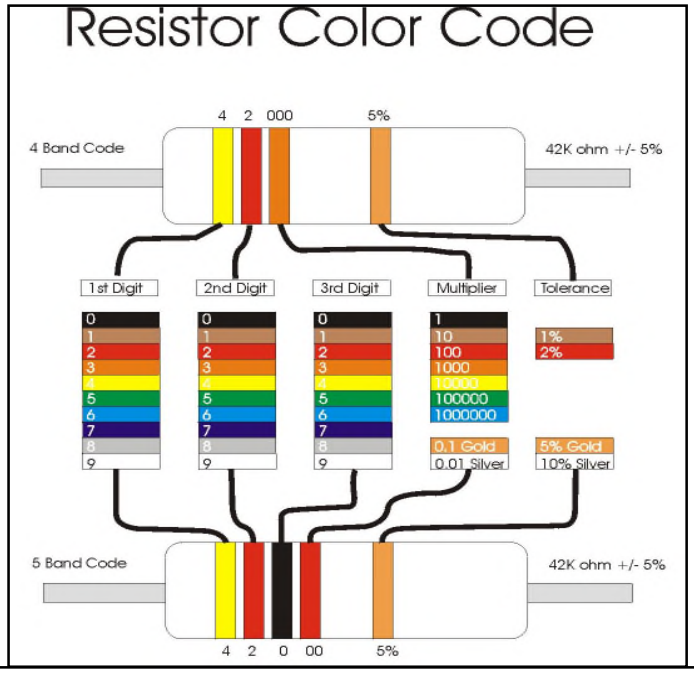
Determining Resistor Values:

Resistor values are read using the color bands on the body of the resistor. The first band is the one nearest the end of the resistor. Start reading from this band. The first band represents the first significant number, the second band, the second significant number and the third band is the multiplier. If the third band is gold or silver this indicates a multiplier value of .1 or .01 respectively.

Color	Value	Multiplier	Tolerance (%)
Black	0	1	Gold 5%
Brown	1	10	Silver 10%
Red	2	100	No Band 20%
Orange	3	1000	
Yellow	4	10000	
Green	5	100000	
Blue	6	1000000	
Violet	7	10000000	
Gray	8	100000000	
White	9	1000000000	

Example: A resistor with the following color bands Red, Red, Orange, Silver
1st Number Red = 2
2nd number Red = 2
3rd Number Orange = 3 multiplier (number of zeros) that equals 1000
Silver = 10%
Putting it all together:

Red	Red	Orange	Value	Tolerance
2	2	x 1000	= 22,000 ohms	+/- 10%



PAS-01 Parts List

Location	Part Number	Qty
	PCB-PAS	(1)
T1	HVT-01 (Transformer)	(1)
P1	PJ-102A (power jack)	(1)
S1	SW-10 (toggle switch)	(1)
R1	RES-100-120K	(1)
R6	RES-100K	(1)
R2 R5 R7	RES-10K	(3)
R4	RES-1K	(1)
R3	POT-25K-multi (can use 10K-25K) - (1)	
C1	CAP-470uf-25V	
	(can use 470-1000uf, 16V or higher) - (1)	
C2	CAP-.001uf, 100V	(1)
C3	CAP-330pf-50V	(1)
C4 C5	CAP-10uf-16V	(2)
C6	CAP-.1uf-100V	(1)
D1	Submin Green LED	(1)
J1	Jack-05 (audio jack)	(1)
U1	LM555	(1)
	ICS-8 (8 pin socket)	(1)
Q1	2N3904	(1)
Q2	HVTR (HV Transistor)	(1)
	Heatsink-03	(1)
	Screw-540x3/8"	(1)
	Nut-540x1/4"	(1)
	Fan-12VDC-40x20mm	(1)
	Plastic Tube-Plasma	(1)
	Binding Posts	(1Black, 1 Red)
	HV Wire	(1– 18 inch piece)
	Wall Transformer	(1)
	HV Labels	(2)
	Male to Male Cable	(1)
	Black Case	(1)
	Wire	(2 - 3 inch pieces)
	Screw-#4x3/8	(4)

Not Included:
iPod / MP3 Player