GRADRIV1 High Voltage/Frequency Driver Module

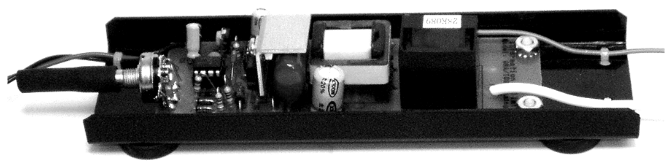


Figure 7-1 shows a universal high voltage modular power supply project will provide you many options. This “sweetheart” of a circuit has features making it a priceless tool for the high voltage researcher and experimenter. Circuit operates on 11 to 15 volts DC drawing 3 amps under full load allowing portable battery or 115 volts AC via a converter. Out put voltage is a 60 kHz high frequency current that is fully short circuit protected. The high frequency also makes possible low storage energy voltage multiplier stacks for high voltage dc sources as well as being an excellent plasma driver when used direct. Out put current is fully adjustable via a control pot. Unit is excellent for powering neon and all types of gas filled vessels using one or two electrodes or can power objects simply by proximity. It easily retrofits to our voltage multipliers modules that provide DC voltages up to 100 Kv and currents of up to .3 milliamperes. The current limiting and control feature make this combination an excellent choice for charging capacitors for low loss charging and 12 volt portable operation. Also an excellent choice for powering large and small anti gravity craft, ozone air purification and other applications requiring a high voltage current controlled source. Module is shown built on a rugged printed circuit board and is mounted in a plastic channel.

Specifications

Open circuit voltage...........7500 peak at 60 kHz
Short circuit current.............10 Milliamperes short circuit protected
Input 11 to 15 volts DC at 3 amps fully loaded
Adjustable current by duty cycle controlled pulse
Compact 7 x 2 1/8” x 1 1/8” size weighing less than 5 ounces!
Easily retrofits to our voltage multipliers
This is an intermediate level project requiring basic electronic skills. Expect to spend $25 to $50. All parts are readily available with specialized parts through Information Unlimited (www.amazing1.com) and are listed in Table 7-1.

High voltage DC output is obtained from this module using a COCKCROFT WALTON voltage multiplier with multiple stages of multiplication as required. Note this method of obtaining high voltages was used in the first atom smasher ushering in the nuclear age!
The multiplier section requires a high voltage AC source for input supplied by the circuit transformer (T1) producing 6-8 Kv at approximately 30 kHz. You will note that this transformer is of a unique design being

owned by our company *Information Unlimited*. The part is very small and lightweight for the power produced.

Circuit Description Reference Figure 7-2

The primary of T1 is current driven through inductor (L1) and switched at the desired frequency by FET switch (Q1). Capacitor (C15) is resonated with the primary of T1 and zero voltage switches when the frequency is properly adjusted. *(This mode of operation is very similar to class E operation)*. The timing of the drive pulses to Q1 is therefore critical to obtain optimum operation.

The drive pulses are generated by a 555 timer circuit (I1) connected as an astable multi-vibrator with rep rate determined by the setting of trim-pot (R1) and fixed valued timing capacitor (C2).
I1 is now turned on and off by a second timer (I2). This timer operates at a fixed frequency of 60 kHz but has an adjustable "duty cycle" (ratio of on to off time) determined by the setting of control pot (R10) . I1 is now gated on an off with this controlled pulse now providing an adjustment of output power.

When the unit is interfaced with a DC voltage multiplier, an over voltage protection spark gap is placed across the output and is easily set to breakdown at a preset voltage level for circuit protection. Even though the output is short circuit protected against continuous overload, constant hard discharging of the output can cause damage and must be limited. A pulse current resistor (R17) helps to protect from these catastrophic current spikes.

Power input is controlled by switch (S1) that is part of control pot R10. Actual power can be a small battery capable of supplying up to 2 amps or a 12 volt 2-3 amp converter for 115 microseconds
.

Construction

The circuit is shown built using the more challenging *perforated* circuit board often required for a science fair project. A *printed* circuit board is individually available and requiring that you only identify the particular part and insert it into the respective holes as noted. The *printed* circuit board is plainly marked with the part identification. Soldering in now very simple as you solder the component leads to the conductive metal traces on the underside of the board.

The *perforated* board approach is more challenging as now the component leads must be routed and used as the conductive metal traces. We suggest that the builder closely follow the drawings on this section and mark the actual holes with a pen before inserting the parts.. Start from a corner using as a reference and proceed from left to right. ***Note that the perforated board is the preferred approach for science projects as system looks more homemade.***

Board assembly steps

1. Layout and identify all parts and pieces. Verify with parts list, separate resistors as they have a color code to determine their value. Colors are noted on parts list. *If you are a beginner it is suggested to obtain our GCAT1 GENERAL CONSTRUCTION PRACTICES AND TECHNIQUES. This informative literature explains basic practices that are necessary in proper construction of electromechanical kits.*
Order #GCAT1.........................$5.00

2. Fabricate a piece of .1" grid perforated board to a size of 5 x 3". Locate and drill holes as shown figure 7-3. An optional printed circuit board is individually available. See table 7-1

3. Fabricate metal heat sink for Q1 from a piece of .063 aluminum 1.5 x .75 inches as shown on inset figure 7-4.

4. Assemble L1 as shown on figure 7-4 inset. This part is individually available assembled. Order#

5. If you are building from a perforated board it is suggested to Insert components starting in the lower left hand corner as shown figure 7-5. Pay attention to polarity of capacitors with polarity signs and all semiconductors.
Route leads of components as shown and solder as you go cutting away unused wires. Attempt to use certain leads as the wire runs or use pieces of the #24 buss wire. Follow dashed lines on assembly drawing as these indicate connection runs on underside of assembly board. The heavy dashed lines indicate use of thicker #20 buss wire as this is a high current discharge path.
Figures 7-6 and 7-7 shows the available printed circuit board and is listed as an available part Table 7-1

6. Attach external leads as shown figure 7-5.

7. Double check accuracy of wiring and quality of solder joints. Avoid wire bridges, shorts and close proximity to other circuit components. If a wire bridge is necessary, sleeve some insulation onto the lead to avoid any potential shorts.

8. Fabricate a channel from a piece of 1/16" plastic material. Lay in assembly and secure at corners using silicon rubber adhesive. You may also enclose in a suitable plastic box.

Testing steps

9. Preset trimpot R1 to mid range and R10 to full ccw. Short out the output leads using a short clip lead.

10. Obtain a 47K 1watt resistor and construct the spark gap “dummy load” as shown on figure 7-2.

11. Obtain a 12 volt dc 3 amp power converter* or 12 v 4 amp rechargeable battery*

12. Connect up input to power converter and connect scope set to read 100 volts and sweep time of 5 usecs to drain of Q1.

13. Apply power and quickly adjust R1 to the wave-shape shown on inset figure 7-2. Note an input current dip of 100 milliamps or less. Check the heat sink of Q1 noting only warm. ***Note factory built units usually tune in with pot set to 11:00 O :CLOCK*****.**

14. Remove clip lead short in step 9 and connect in dummy load. Apply power and rotate R10 CW noting the input current smoothly increasing to 1.5 amps and the spark increasing in energy. This control is varying the ratio of “off to on” time and nicely controls the system current.

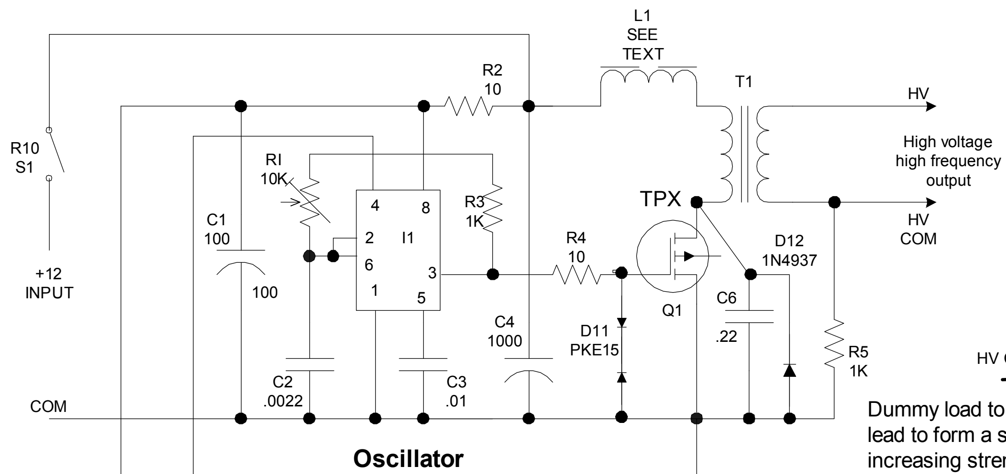
Note that this system can easily provide 30 watts of usable power.

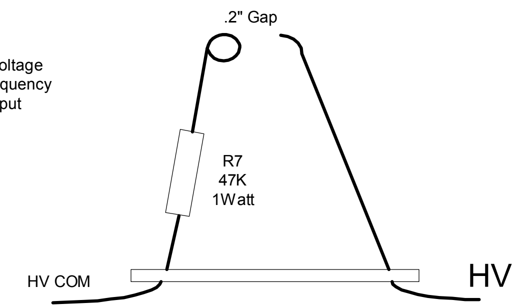
Table 7-1 Parts List

Ref#	Qty	Description	DB#
R1		10K Trimpot vertical	
R2,4	2	10 ohm 1/4 watt resistor (br-blk-blk)	
R3,5,8,9	4	1 K 1/4 watt resistor (br-blk-red)	
R7	1	47 k 1 watt resistor (yel-pur-or)	
R10		10 K 17 mm pot and switch	
C1		100 mfd / 25 volts vertical electro radial leads	
C2		.0022 mfd 50 volt greenie plastic cap (222)	
C3,8	2	.01 mfd / 50 volts disk (103)	
C4		1000 mfd / 25 volt vertical electrolytic capacitor	
C6		.22 mfd / 250 volt metallized polypropylene	
C9		1 mfd 25 volt vertical electro cap	
C7		.1mfd 50 volt cap INFO#VG22	
D3,4	2	IN914 Silicon diodes	
D11	1	PKE15 15 Volt transient suppressor	
D12		1N4937 Fast switching 1kv diode	
Q1		IRF540 mosfet transistor TO220	
I1,2	2	555 dip timer	
T1		Mini switching transformer 7Kv 10 ma.	#IU28K089
L1	2	6 Uh inductor see text on assembly	#IU6UH
PBOARD		5 X 2.8" X .1 grid perforated board. Fab to size per fig 1-2	
PCGRA		Optional printed circuit board	#PCGRA
WR20R	12"	#20 vinyl red wire for positive input	
WR20B	12"	#20 vinyl black wire for negative input	
WR20G	12"	#20 vinyl green wire for output ground to craft return	
WR20KV	4"	20 Kv silicon high voltage wire for output	

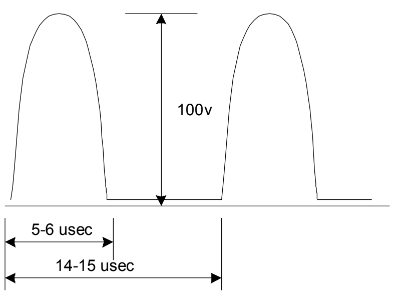
WR20BUSS	18"	#20" buss wire for spark gap and heavy leads fig 1-5	
WR24BUSS	12"	#24 buss wire for light leads fig 1-5	
HSINK		1.5 X 1" .063 AL plate fabbed as per fig 4	HSINK
SW1	1	6-32-1/2 Ph screw	SW1
NUT	4	6-32 kep nut	NUT
12DC/3		115 Vac to 12Vdc/3amp converter	#12DC/3
BAT12		12 volt 4 amp hour rechargeable battery	#BAT12
BC12K		Battery charger kit for above BAT12	#BC12K
12DC/3		115 Vac to 12Vdc/3amp converter	#12DC/3
BAT12		12 volt 4 amp hour rechargeable battery	#BAT12
BC12K		Battery charger kit for above BAT12	#BC12K

Figure 7-2 Driver Schematic

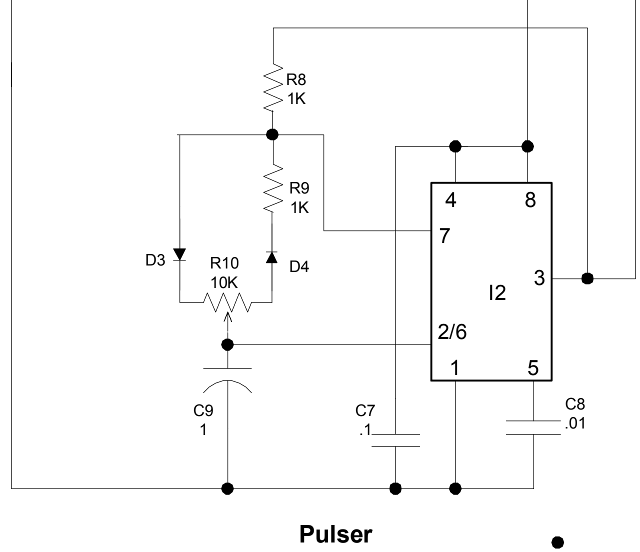


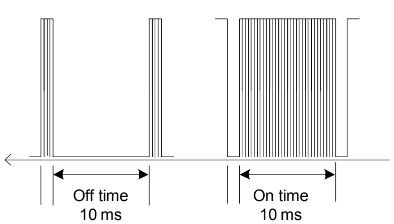


Dummy load to verify operation. Secure a 47K 1 Watt resistor and a stiff wire lead to form a sparkm gap od .2 inches. Apply power and note discharge increasing strength as R10 is turned CW. Full power operation should draw 1.5 amps. Wave shape on scope should only slightly change. Heat sink should be only slightly warm.



Connect scope to test point TPX. Adjust R1 to the wave shape shown with unit connected to a 12 volt 3 amp supply.



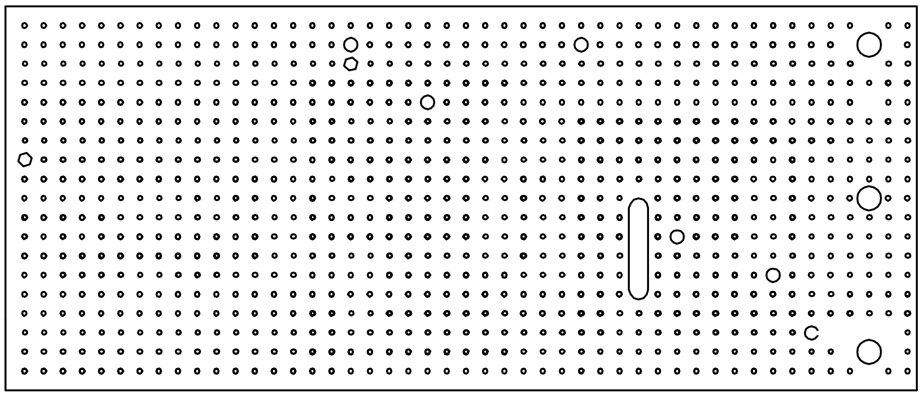


Low output setting of R10 | High output setting of R10

Wave shape obtained at TPX when controlling R10. Output voltage is now controlled by the ratio of on to off time at pin 4 of I1.. Input current should be less than .1 amp when R1 is properly adjusted and R10 at minimum power setting (FCCW)

Figure 7-3 Driver board fabrication

These three holes for attaching optional multiplier board



The circuit section is 4.8" x 2.9" .1 x .1 perforated board. Drill eight .063" holes in this perforated section and eleven in the

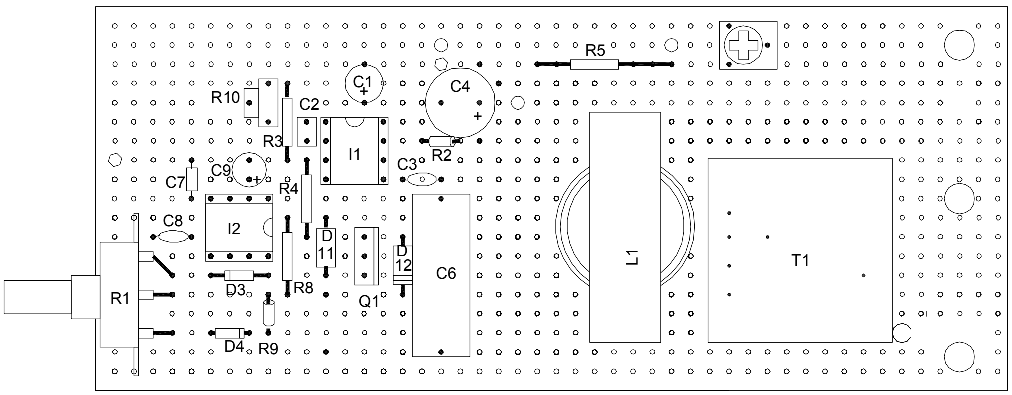
Drill the three .125" holes for attaching to the optional multiplier board used for high voltage dc applications.

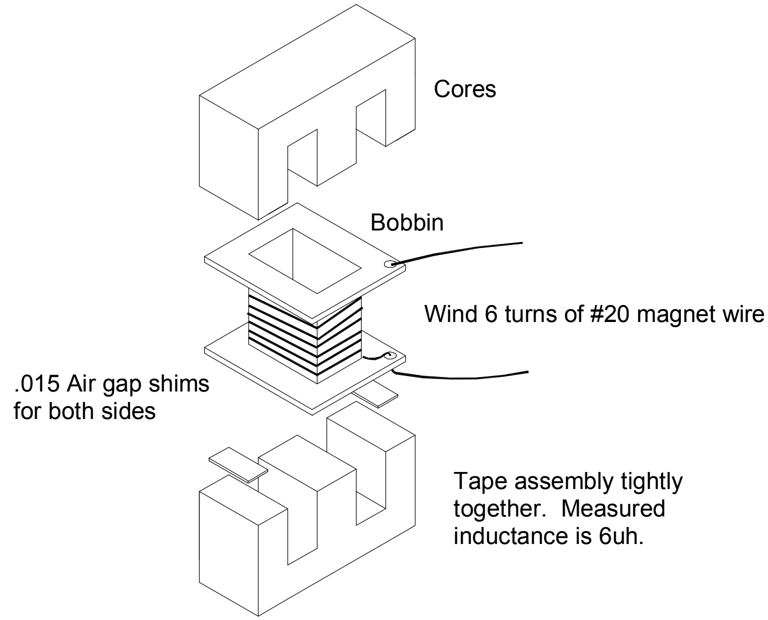
Drill and drag the .125" slot as shown. This cutout and the enlarged holes are for mounting transformer T1.

Hole diameters are not critical.

Always use the lower left hand corner of perf board for position reference.

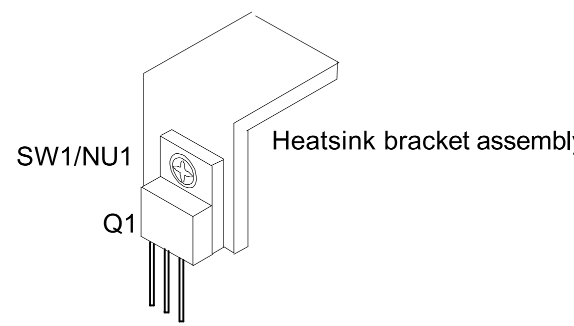
Figure 7-4 Parts identification





Note polarity of C1,C4,C9,D3,D4, D12 and D20A-D20J

Note position of I1,I2,Q1



HSINK Bracket fabricated as per
step 3 from 1/16" aluminium piece.
Note hole for attaching tab of Q1

Fig 7-5 Wiring connections and external leads

See fig 6A and B for enlarged views of this figure.

Thick dashed lines are direct connection runs beneath board of #20 buss wire (WR20BUSS) and are extended for the spark switch electrodes.

Thinner dashed lines are #24 buss wire (WR24BUSS) and component leads wherever possible.

Triangles are direct connection point junctions.

Solid black lines are external leads for input and output lines. Use red (WR20R) for +12 input.
Use green (WR20G) for lifter - connection.
Use black (WR20B) for com -12 input

Use 1/8-3/16 wide smooth globular solder joints for connections to C20A-J and D20A-J, R7 and HV output points. Thisis contrary to normal soldering but is necessary to prevent corona leakage.

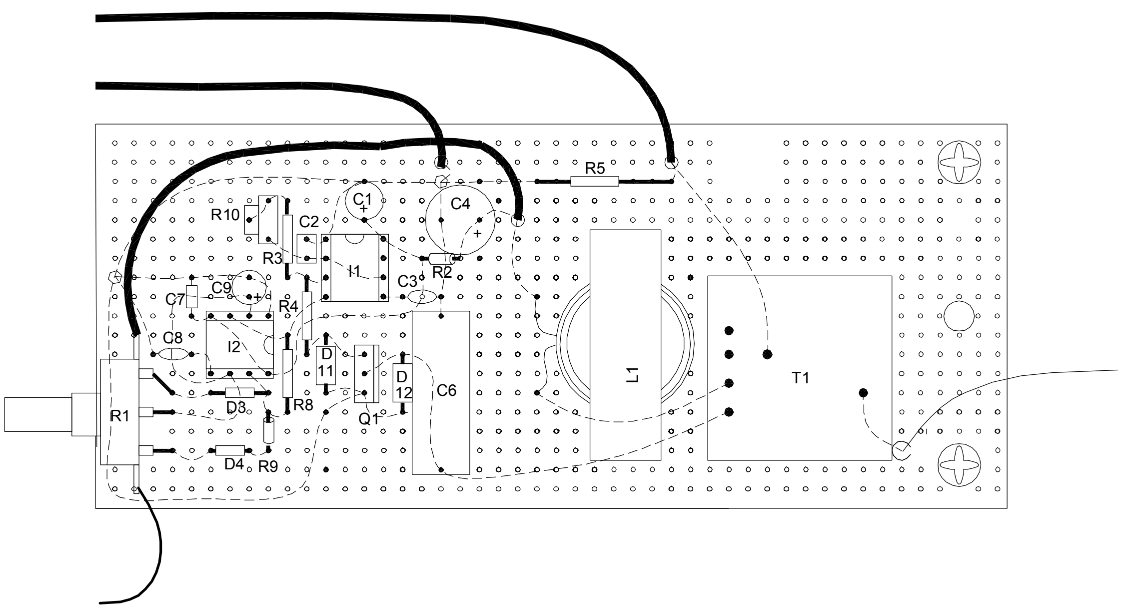


Figure 7-6 Printed circuit board parts identification

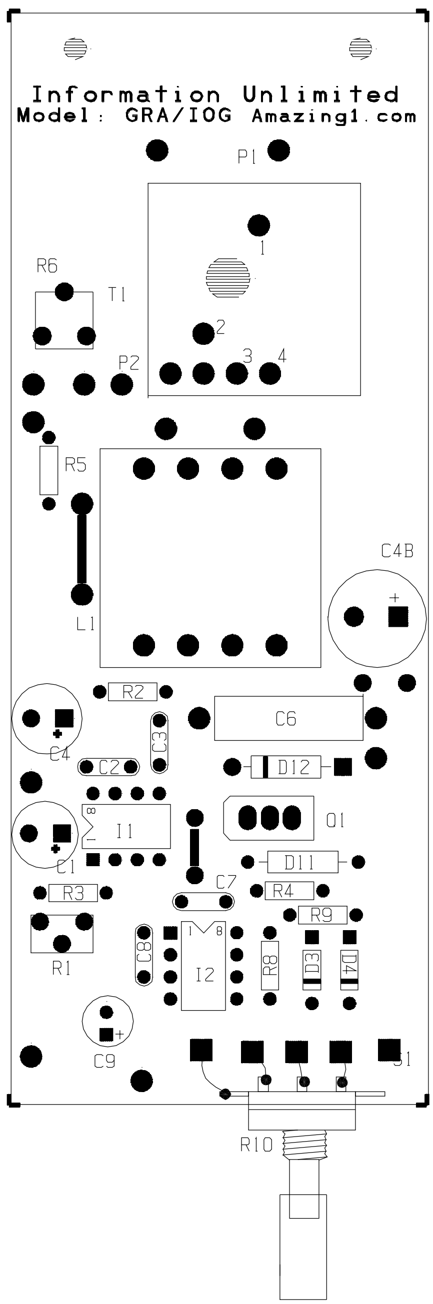


Figure 7-7 Printed Circuit Board Foil Traces