PVM500/DIDRIVE10 Instructions for Conventional and Resonant Loads

Hydrogen and Chemical Production, Corona Cell, Plasma, Dielectric Driver and other applications

Instructions

The PVM500 operates on 115VAC only. (To use with 220VAC wall power, you will need a step down transformer that converts 220VAC to 115VAC, and that can handle at least 300 watts of power. The TR220/110/300 is available on our website, or you may already have your own to use.)

CAUTION: *plasma displays and small objects can easily be damaged by the abrupt resonant power rise of this system. Always start with VA1 set at about 5 to 10%, and increase slowly. Use your own judgement on damage point of your load.*

Controls and Inputs

VA1	Independent voltage level control
S1/RFreq	Main power switch and frequency control
S2	HI/LO voltage switch enables voltage doubler – always start in LO position. **Always start with this switch in the “LO” position; and keep in the LO position when using 220VAC wall power**
Rdc	Duty-cycle/power control. *See duty cycle explanation*
NEON1	Power on indicator
AMP	Meter 0-3 amps for power input monitoring
FUSE	4 amp slo-blow
J2	Remote control port with TTL input
J1	Frequency monitoring port (frequency output)

Operation: before providing power to your load, first determine whether it is a straightforward resistive load (non-resonant), or the more complex reactive and resistive load (resonant). See the following explanations.

Non-Resonant

Instructions for Conventional Resistive (Non-Resonant) Loads

Resistive loads are energized by direct contact with the energizing electrodes; an example would be a simple neon tube. In this mode of operating the unit automatically compensates for the negative resistance presented by the load. This is a common characteristic of any type of an energized gas. This feature also allows the load to be a short circuit without circuit damage.

There are many applications for a device with these properties; example powering a gas laser, a Jacob's ladder as a museum demonstration piece, driving a voltage multiplier, and many other direct contact applications.

1. Connect HV output lead to load. Note output is referenced to chassis ground that is earth ground via the green lead of the power cord.
2. Verify that the **HI**/**LO** switch is in the down position, **VA1** is FCCW (fully counter clockwise), **S1** is FCCW and **Rdc** is FCCW/OFF.
3. Plug into a 115VAC source and rotate **VA1** a quarter turn. Apply power via rotating **S1**/**RFreq** control until it clicks on noting that the **NEON1** indicator lamp comes on. **Note: Units made before Jan 2013**. **NEON1** lamp only comes on when **VA1** is set for above 60 vac
4. Slowly adjust **S1**/**RFreq** until the display or meter starts to activate. Note that the **S1**/**RFreq** control increases frequency in the CCW direction. Now slowly rotate **VA1** CW noting desired effect. Note reading on the **AMP** meter for reference.
5. Now set **Rdc** to the desired current reading or display texture. Some loads may cause premature shutdown in using **Rdc**

CAUTION: Contact with the bare metal controls and other objects may cause annoying burns. This is especially noticeable when powering single ended plasma displays that are within several meters of the user. Insulated tubing may be placed on the control shafts to help avoid these annoying shocks and burns.

Resonant

Instructions for Complex Resonant Loads

A complex resonant load in the case of most plasma cells is where the plasma is applied by using capacitive plates on the outside of the containment structure, or one external cylindrical contact and one internal electrode. Example: many ozone cells are made this way.

An unfortunate disadvantage of using this type of cell structure is that in the complex notation the capacitance is very low, producing a very high reactance that becomes the dominant value, so now the impedance is mostly a function of this high capacitive reactance. This means a very high voltage must be applied to the device to get any power into the much lower resistance part of the load. This is not acceptable and causes many problems. A large high-voltage power transformer and strain on many circuit components as well as being very inefficient and costly are but a few. To get the most for your money, the capacitive reactance of the complex impedance must be tuned out. This is accomplished by operating at a resonant frequency, as determined by the capacitance of the cell and the internal structure of the transformer. Each transformer can achieve resonant frequency operation within a range of load capacitances, but transformers can be easily swapped out to provide a wide degree of flexibility that will cover almost all normal capacitive values.

A more comprehensive explanation is at the end of this document

1. Connect HV output lead to load. Note output is referenced to chassis ground that is earth ground via the green lead of the power cord.
2. Verify that the **HI**/**LO** switch is in the down position, **VA1** is FCCW, S1 is FCCW and **Rdc** is fully FCCW/OFF.
3. Plug into a 115 vac source and rotate **VA1 QUARTER** range. Apply power via rotating **S1**/**RFreq** control until it clicks on noting that the **NEON1** indicator lamp comes on. **Note: Units made before Jan 2013**. **NEON1** lamp only comes on when VA1 is set for above 60 vac
4. Slowly adjust **S1**/**RFreq** until the display or meter starts to activate. IMPORTANT! This adjustment tunes the load capacitance to the units intrinsic leakage inductance of the output transformer and should be cautiously set to a peak reading. It preferably should be set on the CCW side of the peak meter reading. Note that the S1/RFreq control increases frequency in the CCW direction. Now slowly rotate VA1 CW noting desired effect. Note reading on the **AMP** meter for reference.
5. Repeat step 4 if necessary for required effect.
6. You may switch the **HI**/**LO** to HI for more power if output is below .5 amps in the LO position. Do not allow to exceed 3 amps and check transformer and circuit for heating and any excessive corona around transformer or leads.
7. Now set **Rdc** to the desired current reading or display texture. Some loads may cause premature shutdown in using **Rdc**

Special Notes

Always check the output transformer for excessive heating, corona or arcing preferably in the dark. Do not allow to operate in this state as the transformer will burn out. It may take 30 minutes for transformer to overheat. ***However if you burn out the transformer it is easily replaced and readily available***
Even though the output lead is rated for 40 kV, it must be clear of all conductive objects to prevent high frequency/voltage breakdown.

Certain loads may have different Q factors that will effect operation. Q factors is determined by the ratio of circuit reactance to resistance of the load. Reactance being the inductive and capacitive values at resonance. The resistance part is determined by your load resistance, component losses and the amount of useful corona or plasma ionization or whatever it is you need. *It might be wise to refresh your "j" operator or polar notation math skills*
Always attempt to operate **RF freq just slightly** below the current peak as indicated on the **AMP** meter. This is especially important when operating above 2 amps to avoid overheating the switching transistors.

CAUTION: Contact with the bare metal controls and other objects may cause annoying burns. This is especially noticeable when powering single ended plasma displays that are within several meters of the user. Insulated tubing may be placed on the control shafts to help avoid these annoying shocks and burns.

NOTE

Resonant Rise Please Read as This is Important for proper operation of this product!!!

Please note that the voltage that this unit will generate is not a function of the turns ratio on the transformer. We set the transformer to usually produce a voltage of 40,000 V pk-pk. The transformer secondary circuit mathematically is equated as a voltage source driving an inductive reactance. This reactance is controlled by the airgap in the secondary only of the transformer, the number of turns, and the frequency that you happen to be tuning to. This is the inductance part of the resonant system that tunes out the capacitive reactance of your load. Now when you connect this to your load which is capacitive you're going to tune the frequency and obtain a resonant rise in voltage that is going to be dependent on the Q of the circuit you are driving. So now the voltage output is a function of these parameters. You now control the voltage with the voltage control that is on the unit to prevent a potential transformer failure.
Our higher powered units have built-in protection circuitry that will shut the system down should the voltage on the transformer exceed the rating that the transformer is insulated for. Usually this is at least 40,000 KV pk-pk, 20KV pk, 15KV rms as at resonance waveshape is sinusoidal.

Duty Cycle

Our duty cycle controlled power has many advantages over other methods of power distribution. When power is controlled by a variac or other voltage reducing mechanisms, output to the load decreases by Ohms Law where power = E x I, and the load sees a reduced voltage to control power. Both voltage and amps are simultaneously decreased as they are dependent functions on one another. An example is in attempting to dim a gas discharge tube such as a piece of neon or fluorescent tubing. As the voltage is decreased the tube dims to a point where now the gas discharge pulls from the ends, or extinguishes. Loads such as HHO reaction cells, corona or ozone production, paint spraying, flocking, or other chemical reactions suffer simultaneous voltage and current changing as dictated by the load resistance.

Duty cycled controlled power utilizes the time domain of the voltage. The waveform sketches show various ratios of the voltage wave form over a 1 second period. The sketch at A shows 10 volts at 100% "time on." The power produced in a 5 ohm resistor is simply volt squared divided by load resistance, in this case 10^2/5=20 watts. Sketch B shows a 50% "time on." One might think that the power is now 10 watts…but this is WRONG! For the 1-second period the voltage is discontinuous. It is 10 volts for half the 1 sec period and zero for the other half. The load sees full voltage and full current therefore full power of 20 watt for 1/2 sec. The energy for the one sec period is 5 joules. As the time "on" decreases the load still sees full voltage for the "on" interval, but now proportionately less energy in joules.

A plasma such as ionized neon gas in a long glass tube clearly shows this neat effect. The display can be reduced to a snake like thin line of energized plasma. The plasma would not pull from the ends of the discharge tube but would be obviously very dim. This is the result of very short full voltage pulses at corresponding current but much less joulean energy as energy = $\int vi(t)$

The load (if a gas discharge tube, solid state Tesla coil, HHO gas generator or those mentioned above) will now maintain the operational benefit of full voltage intervals but greatly reduced energy due to the shorter time "on".

If you dimmed the same tube by reducing the entire voltage time domain you would get dimming with display pulling away from the end electrodes and becoming very inhomogeneous. Other devices would function very erratically due the lack of voltage during the "on" time of the period.

To summarize: you can control the power to a device by control of the current without reduction of the applied voltage. The device operates at normal voltage and current for a variable domain in time

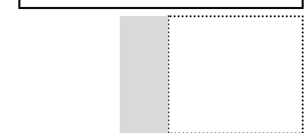
100% duty cycle

10 VOLT LEVEL
FOR 1 SEC INTO
5 OHM LOAD
Pt=20 WATTS

50% duty cycle

10 VOLT LEVEL
FOR .5 SEC INTO
5 OHM LOAD
Pt= ~~10~~ 5 WATTS

25% duty cycle



10 VOLT LEVEL
FOR .25 SEC INTO
5 OHM LOAD
Pt= ~~5~~ 1.25WATTS

TRANSFORMER RESONANT SPECIFICATIONS FOR THOSE WHO WISH TO USE FOR HIGHER LOAD CAPACITY UP TO >1µFD

Transformers use our own standard tooled UU69 ferrite core with the following specs: CORE is 69 x 39 x 23 mm, u=2000 Ae=2.3 cm sq Le=22.9

Approximate Values for Load Capacity 2500 Turn Included Bobbin ***Note primary air gap remains at 2 mils***

2500 turns 0 gap =16.5 H (6.2M)@60kHz ……………. .04 pfd Self resonant/60kHz

2500 turns 4 mil gap =8.5 H(3.2M)@60kHz..…….….. .31pfd/60kHz

2500 turns 8 mil gap =5.7 H(2.1M)@60kHz ………… .46 pfd/60kH

2500 turns 20 mil gap =2.9H(1M)@60kHz ………… .91 pfd/60kHz

2500 turns 0 gap =16.5 H (2.07M)@20kHz ……………3.8 pfd 20kHz

2500 turns 4 mil gap =8.5 H(1.06m)@20kHz…………… 7.5 pfd/20kHz

2500 turns 8 mil gap =5.7 H(.72M)@20kHz ……….. 11 pfd/20kHz

2500 turns 20 mil gap =2.9H(.36M)@20kHz ……….. 22 pfd/20kHz

Approximate Values for Load Capacity 1000 Turn Optional Bobbin

1000 turns 0 gap =2.6 H(+j.98M)@60kHz ………………. 2.7 pfd/60kHz

1000 turns 4 mil gap = 1.36 H(+j.51M)@60kHz ……….....5 pfd/60kHz

1000 turns 8 mil gap =.9 H(+j.34M)@60kHz)……………..7.8 pfd/60kHz

1000 turns 20 mil gap =.46 H(+j.17M)@60kHz …………15 pfd/60kHz

1000 turns 0 gap =2.6 H(+j.33M)@20kHz ……………….24 pfd/20kHz

1000 turns 4 mil gap = 1.36 H(+j.17M)@20kHz…………46 pfd/20kHz

1000 turns 8 mil gap =.9 H(+j.11M)@20kHz…….……….70 pfd/20kHz

1000 turns 20 mil gap =.46 H(.j05M)@20kHz…………138 pfd/20kHz

The above possible combination of the 1000 turn coil combined with the adjustable frequency of from 20 to 64 kHz allow resonating any capacitive cell from 2.7 to 138 pfd and provides plenty overlap by just changing the airgap in the secondary of the transformer.

TRANSFORMERS with the 1000 potted turns or 2500 potted turns secondary coil will have 2 mils air gap per side. You may take apart and change the gap on the secondary side ***ONLY*** to bring larger load capacities within tuning range. Leads must be as short as possible for low capacitive loads <2.5 pfd

We have roughly calculated transformer secondary turns at the frequencies of 20 to 65 kHz for those who need to go 1nf, 10nf 100nf and >1ufd. These are the following optionally available coils covering all ranges. The 2500 potted coil is supplied with all units. Hand wound coils are easily pruned by removing or adding turns.

FLYPVM500/2500

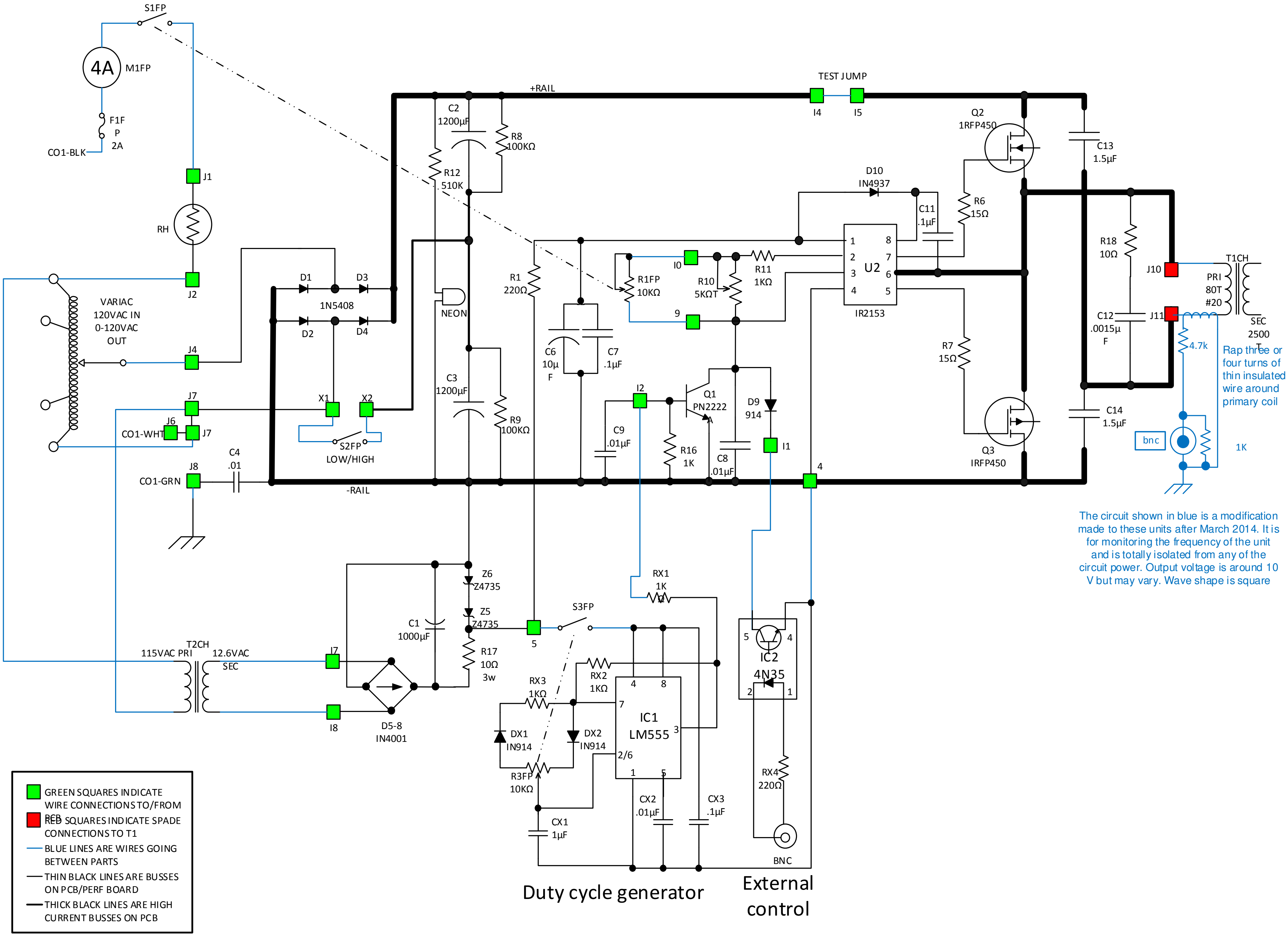
Similar looking to the FLYPVM400 but intended for resonant operation. 30kV pk at 20ma, 15kHz-60kHz operating frequency, with 3" size large ferrite core and flexible silicon output lead. 2500 turns #35 on secondary with silicon output lead. Primary is included.. UU69 large core is air gapped and can easily be adjusted to change the resonant frequency and is noted on the PVM500 instructions. Output voltage will vary as to the external load complexity being the load capacity and resistance. For end point grounded circuits. (We can manufacture these, and variations, in large volume for the trade -- contact us for details.) Here is an example of a PVM500 schematic.

FLYPVM500/2500 Replacement of ***complete original*** transformer should you burn it out. Ready to install as a replacement **…CONTACT US FOR PRICING**
COIL2500L 2500 turn secondary coil only for replacement. Fits above transformer and is less costly…. Coil Bobbin only ... **CONTACT US FOR PRICING**

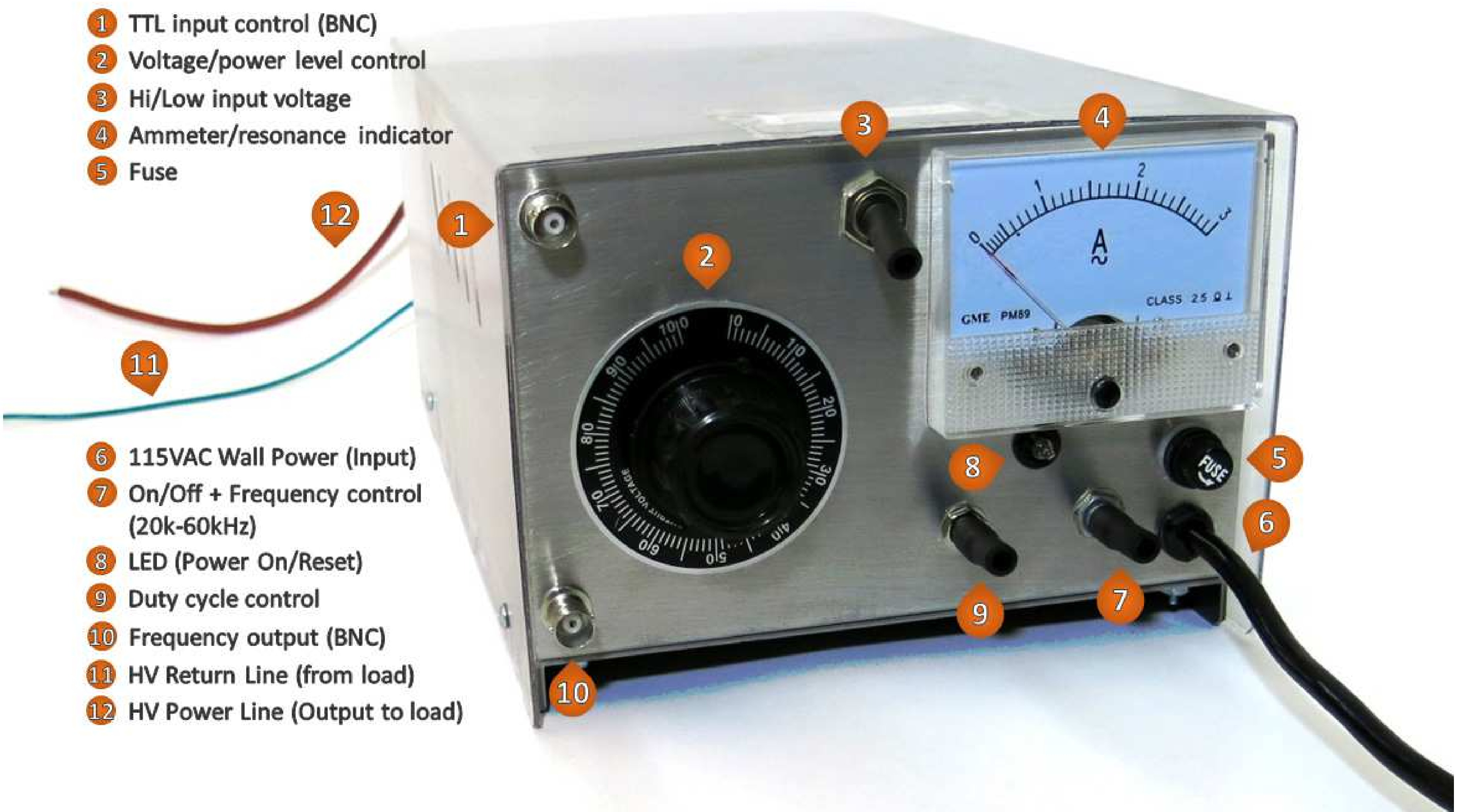
FLYPVM500/1000 Optional transformer 1000 turns for capacitive loads of < 150 pfd. Ready to install in PVM500 Plasma generator **CONTACT US FOR PRICING**
COIL1000L 1000 turn secondary coil only for replacement. Fits above transformer and is less costly…. Coil Bobbin only **CONTACT US FOR PRICING**
#COIL560 turns non potted *hand wound* coil tunes 100 to 1000 pfd between 20 to 65 Khz… **CONTACT US FOR PRICING**
#COIL200 turns non potted *hand wound* coil tunes .001 to .01 ufd between 20 to 65 Khz… CONTACT US FOR PRICING …
#COIL50 turns non potted *hand wound* coil tunes .01 to .1 ufd between 20 to 65 Khz.......................... CONTACT US FOR PRICING
#COIL15 turns non potted *hand wound* coil tunes .1 to >1 ufd between 20 to 65 Khz.................. CONTACT US FOR PRICING

lease take note that the maximum voltage across a capacitive load is a function of the circuit Q and can peak to levels that can destroy the load under test, output transformer and associated circuitry. *Therefore the unit in not totally “user friendly” and is intended for use by those experienced in powering up these resonant capacitive loads. Caution as the output transformer can be easily damaged if allowed to spark over encapsulation.*

PVM500 REV 915



REV1116


1 TTL input control (BNC)
2 Voltage/power level control
3 Hi/Low input voltage
4 Ammeter/resonance indicator
5 Fuse
6 115VAC Wall Power (Input)
7 On/Off + Frequency control (20k-60kHz)
8 LED (Power On/Reset)
9 Duty cycle control
10 Frequency output (BNC)
11 HV Return Line (from load)
12 HV Power Line (Output to load)
A
CLASS 2.5
GME PM89
FUSE