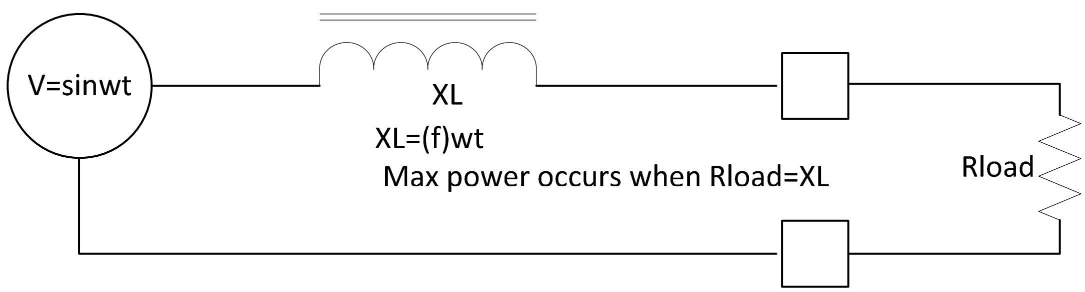
TECH DATA ON NON-RESONANT AND RESONANT LOADS

This plasma driver system can drive both non resonant resistive and complex resonant loads.

Resistive Non-Resonant Loads

The advantage of a ***straight resistive*** load is that the amount of voltage the load sees is dictated by the turns ratio of the transformer. The current drawn is a function of the real resistance of the load and the Inductive reactance of XL as the frequency that the unit is tuned to. Now the current will vary as the frequency is changed because the transformer secondary is basically a reactants and therefore the source impedance increases as you increase the frequency and vice versa as you decrease the frequency. The equivalent circuit for this approach is shown below.



XL increases with frequency and vice versa. This is not a resonant function but is dependent on turns ratio of transformer and freq of XL. This is a very useful feature controlling load power by only changing the frequency control!

The reactance also limits the short circuit current to a safe value and is all reactive energy.

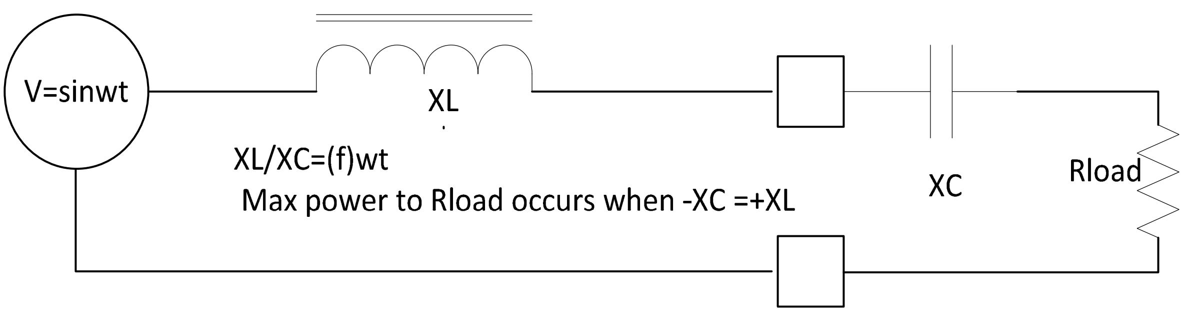
A good example of a resistive load is gas vessels with internal electrodes...

Complex Resonant Loads

A ***complex load*** is usually capacitive in nature due to the structure of the plasma cells and containment geometries. This now presents a different problem as to get any current into the system requires that the capacitive part of the load be eliminated and this is accomplished by varying the frequency of the generator to a point where the capacitive reactants of the load equals the inductive reactants of the secondary coil being the voltage source. The system is designed so that it works with a majority of the requirements that customers and experimenters have for cell structure usually being somewhere between 10 and 200pF. Note the system is not limited to those values and can have an optional transformer made to tune out higher values of capacitance.

The amount of real power is the actual plasma or and Corona discharge formed in the real resistance of the load. The capacitive electrodes used in the geometry of the plasma structure as the capacitive part of the load and now produces a complex impedance when written in complex form is (R-Jx) see drawing schematic. When the cell of the containment structure capacitance is tuned out you will get a voltage peak from a resonant rise. The only limiting factor controlling the current now is the real resistance of the load. This can take on a range of values dependent on the Q factor of the load. This function has much to do with the amount of power that can be taken without exceeding the voltages or the ratings of the transformer. This is a series resonant system when tuned therefore unlike anti-resonance or a parallel circuit, the lower the resistance the higher the Q, as equal to X/R. So basically the power that you can deliver to your system depends a lot on the values you choose for your load. How-ever because the frequency of this unit can tune from 20 to almost 100 kHz it does give you a factor of controlling these parameters to a great extent.

One of the features of this unit is a current control by adjustment of the duty cycle. This feature allows your load to see the same voltage however it will be chopped so that when integrated over a period, the power will be controlled by the ratio of time on to time off and of course this allows tremendous flexibility when you have loads that want to draw high amounts of current over the ratings of the units.



As you adjust the frequency, a point will occur where you will get a sharp rise in current as noted on the ammeter. This is where the -XC=+Xl as a (f)wt and cancels out leaving only the Rload allowing more current/power to the load dependent on the circuit Q.

Impedance of resonant as a $f(1/t)$ $Z = (X^2 + R^2)^{1/2}$ $Q=X/R$

NOTE: Care must be taken when first tuning for the resonance peak. Start with the input voltage at 20%. Make adjustment between the duty cycle control and input voltage. You can damage your load or the unit if over powered!

ADDENDUM: Example letter to customer

The specifications that you have required on your order can be met. However at a higher frequency than 70 kHz you may not be able to get the full 2000 Watts. This power supply is primarily designed to drive resonant loads where the real resistance in the complex impedance expressed in complex form (R + JX). The amount of power that can be drawn will be a function of the circuit (Q) of your resonant circuit. So there are certain variables that the user must be familiar with to operate this unit to its full extent. We have tried in the instructions, explain to the user these basic functions. There are several hundred of these out in the tech field without problems once the user is shown or becomes knowledgeable of complex impedances.

The power supply can also be operated in the nonresonant mode when driving virtually a pure resistance load and will operate throughout a wide band of frequencies only dropping off at the higher frequencies due to the inductive reactants of the driver transformer.

In the resonant mode of operation, these devices have the capability to tune out the capacitance of the cell or plasma container. This feature produces a resonant rise in current now allowing efficient power transfer to the real resistance of the load being the energy transferred to the actual plasma. When operated in this resonant mode the voltage generated is not a function of the turns ratio of the transformer. These transformers have been set to produce a maximum voltage of 10 to 20,000 V rms by the turns ratio. In resonant operation the transformer secondary circuit mathematically is equated as a voltage source driving an inductive reactance. This reactance is controlled by the air-gap in the secondary, the number of turns, and the selected operating frequency. Now the inductance part of the resonant system tunes out the capacitive reactance of the load by adjusting the frequency control. When connected to a capacitive load the frequency should be tuned to obtain a resonant rise in voltage that is going to be dependent on the Q of the circuit being driven. So now the voltage output can be a function of these parameters and be considerably more than what is available when operated in the conventional un-tuned mode! The duty cycle control adjusts the current. See Duty Cycle download for more information.

A certain amount of knowledge helps to effectively operate the unit as in some cases it must be tuned to the output capacitance and resistance of the load. This is basic boilerplate technology to any electronics engineer and simply involves the handling of complex numbers, polar notation or simple impedance matching algebraic formulas.