E F F I C I E N T L O W P O W E R S U P P L Y

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Many times we need a regulated low voltage (up to 15 or 20V) power supply with energy coming from the AC mains, but we don’t want to use transformers due the volume, price and because it is not necessary isolation from the AC. A simple resistor to reduce the voltage generates heat and, so, is very inefficient.

The solution here proposed, that in the real world worked perfectly up to about 1.5W with the components normally found in the market, for an input of 127V.

Rather than get the voltage drop on a resistor, we use the reactance of a capacitor. This, however, has a relatively high capacitance and must be for AC, and, so, it has some limitations.

The basic circuit is shown in Figure 1.

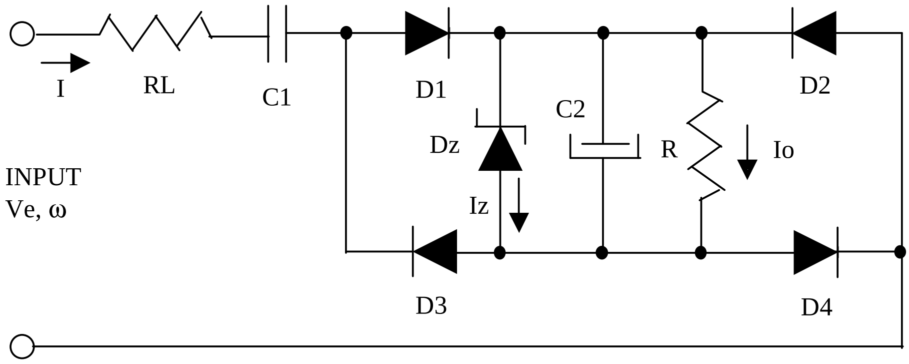

Figure 1

The full-wave rectification with a diode bridge is necessary, as the capacitor C1 charges with a DC voltage at the AC peak and doesn’t discharges any more, hindering the energy conduction from the input in the direction of the power supply. With full-wave rectification, one semi-cycle charges C1 and the other discharges it, eliminating the DC component on it. The delivered power from the input is dissipated on the zener diode and/or on the load resistor R{1}. RL is only a current peak limiter.

A practical circuit that I assembled and measured has the following components:

C1 = 2u2/250V

Vz = 15V/1W

Input = 127V

{1}In this type of regulation, the sum of the zener and load currents is constant.

RL = 10Ω

C2 = 470u/20V

R = 220Ω

D1, D2, D3 e D4 = 1N4001 or equivalent.

With these values, the current on R reaches a maximum of 70mA (that is, keeping the output voltage) with a ripple voltage of 0,5V, meaning a dissipated power of approximately 1W. If we take the consumption (disconnecting R), the power is all dissipated by the zener that must support it.

This type of supply is useful when we want to feed CMOS circuits and others with low consumption directly from the AC supply.

A word about the capacitor C1: this has to be for AC use and, therefore, cannot be a simple electrolytic capacitor{2}. Polyester capacitors dare convenient, but they are limited to few uF when designed for 250V or more. An idea may be the use of AC capacitors used in electric motors (water pumps, fans, etc), as they have high capacity varying from 10uF to more than 100uF, what can produce a power supply with enough power with good efficiency, although bulky.

Another detail is that the AC frequency may be 60Hz or 50Hz, although the C1 reactance is higher in 50Hz than in 60Hz. The AC voltage also is not critical, in the sense that, if the capacitor supports the involved voltages, the circuit becomes easily a bi-volt supply.

A similar diagram to the circuit of Figure 1, but with two diodes zener in series and with their connection point being the output 0V reference, leads to a double +V and –V regulated power supply.

The detailed analysis of this type of power supply is very experimental due the great non-linearity involved. So, if the reader wants another output voltage/current, he can try experimentally the minimum value of C1 to satisfy his needs: assembles the circuit with Dz, C2 and the load R that corresponds to his maximum consumption, diode bridge and checks the minimum value of C1 that satisfy his needs. If the ripple is excessive, he increases C2 and rechecks C1 till he gets his aim.

Obviously not always, with components easily found in the market, it is simple to get the sought results.

Be careful with electric shocks: this power supply doesn't have any isolation of the output to the input

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{2} To use two electrolytic capacitors back-to-back and protected with diodes may be an idea.

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