Design a simple DC power supply
**Executive Summary**

Electrical power is the rate of movement of electrons that create energy. As a result of the electronic age many products need electrical power to perform certain activities. Being able to manipulate electrical power comes at a cost. In today's world there is always the bottom line, cost. Power supplies are the devices that can manipulate electrical power to be used in various applications. Power supplies can be expensive but there are cheaper alternative solutions that can produce the same output. A power supply includes conversion steps and has to be reliable enough not to damage what it is hooked up to. Both aspects need specific parts in a certain orientations to create those specific outputs. Throughout this note there where be many suggestion on how to create a cheap reliable power supply.

**Objective**

To create a cheap, reliable, and effective DC power supply. There is a basic design that can be adjusted to fit many applications. This supply needs to be small so it can be versatile to be applied in many products.
Introduction

Power is used in everyday life. Ever since the basic ideas of power were thought up by Nikola Tesla and others, then implemented in today's power system, people have been craving power. People need power to run their homes, cars, computers, etc. To be able to manipulate power is vital to today's society. Power is defined as (Voltage)*(Current) the current within this equation comes in two flavors AC and DC. Every circuit designed today needs power to be applied for the circuit to function. DC is the basis for most circuit designs that goes into everyday products. If a circuit has no power a circuit would not be able to perform its desired function. A variable DC power supply, seen in every electronics lab, on the market today costs around $300. These lab power supplies are very good for testing a circuit in the lab but not useful to be used in a product application. These power supplies can be very bulky and not very mobile. There is a need for a power supply that is cheap, reliable, efficient, and small.

Background

The power that comes into the house travels, sometimes, hundreds of miles to get there. Through this processes AC current is used. AC or alternating current has different phases depending on the application. These phases are created by the physical offset of the original power generator. In contrast to AC there is DC or direct current. DC doesn't alternate the current, it outputs a steady current to be applied to circuits. DC is useful in circuit design because many of the components do not function well if an AC is applied. AC is the current that is brought to a normal house wall socket. Through the wall socket many different devices are plugged in and used everyday but most of these devices need DC to operate correctly. When a plug is inserted into a wall socket there is an AC to DC conversion that takes place.
This is commonly done by using a full-wave rectifier. The full wave rectifier in figure 1 allows an input of AC and creates a small ripple current, seen in figure 2, which is close enough to a DC representation.

![Figure 1: Full-Wave Rectifier](image1.png)

![Figure 2: Current Across load](image2.png)

This is a result from the orientation of the diodes. As the voltage changes polarity different diodes are turned on and off creating the ripple effect seen across the load which can be seen in figure 2. The concept of AC is very important to building a power supply because the main source of power in a home is AC. The conversion method shown in figure 1 is the method that will be applied to the cost effective power supply.

**Linear Regulators**

Once a ripple output is established from the Full wave rectifier a stable voltage needs to be created. A stable voltage is needed for consistent operation from the connected circuit. The cheapest and most cost effective way is to use a linear regulator. A regulator does exactly what the name says, it regulates the voltage. Using the voltage input a regulator generates an internal voltage for the regulator to compare the output to be able to hold the output constant. There are two types of regulators fixed and variable. A fixed regulator is set internally to output a specific voltage, +5V, -12V etc. A variable regulator can be set to a wide
range of voltages. This is done by constructing a resistance divider at the output and varying one resistor to obtain the desired DC output. Therefore a variable regulator is very useful if the voltage needs to be varied. This can be seen below in figure 3. The regulator that was chosen was the LM317. This regulator can take in a voltage as high as +40V and as low as +3V. The value of voltage would correspond to what voltage level was needed at the output. For example, if an application needed +5V, +10V would be needed at Vin to compensate for heat losses and voltage drops that go on within the regulator.

\[ V_{OUT} = V_{REF} \left(1 + \frac{R_2}{R_1}\right) + I_{ADJ}R_2 \]

**Figure 3: LM317 Application**

**Figure 4: Equation for output voltage**

In figure 4 the equation can be used to create the desired output voltage that is needed for a specific application. Everything within the equation is kept constant except R2. The other values are constants given as: Vref = 1.25V, R1 = 240Ω, Iadj=50-100μA. Lastly, R2 can be either raised to create a larger output voltage or lowered to create a lower output voltage. Using this regulator helps to obtain a constant output voltage that can be obtained at a low cost.
Final Design

The complete DC power supply design in figure 5 combines the full wave rectifier and the LM317 regulator. This design is simple and is low cost. The main problem is that it is not very efficient. This set up would not be good in a battery application but if the application can be plugged into the wall this set up can save a lot of money. The total cost is around $3.00. This design takes the power from the wall, which has AC. Then using a regulator takes ripple current from the rectifier and outputs a constant DC output. This DC output is very useful to power microchips and different ICs.

Conclusion

The power supply that has been designed provides a good alternative to a more expensive power supply. The power supply has few components, covers a small area, and is very simple in design.
Works Cited


“TESLA: Life and Legacy.” PBS. TESSCO. 1 Apr. 2009