Power Supply

Fundamentals

A power supply is an electronic device that supplies electric energy to an electrical load. The primary function of a power supply is to convert one form of electrical energy to another and, as a result, power supplies are sometimes referred to as electric power converters. Some power supplies are discrete, stand-alone devices, whereas others are built into larger devices along with their loads. Examples of the latter include power supplies found in desktop computers and consumer electronics devices.
A good power supply consists of mainly 3 elements-

1. *Source*
2. *Protection circuit*
3. *Regulation circuit*

Power Supplies can be of two types-

1. ***Linear** Power Supply*
2. ***Switching** Power Supply*

LINEAR P.S

A linear power supply operates on the principle of a voltage divider i.e. it constantly changes resistance to regulate the output voltage. In an ideal case, the current that goes into it is the same as the current that goes out of it. The transistor is operated in active region. It has high power wastage and is thus comparatively less efficient though it has excellent noise immunity. It also has a faster transient response. These are relatively simple and easy to design. Its only disadvantage is that it only reduces the voltage that is it acts like a step down type of transformer.

SWITCHING P.S

The transistor operates in the cut off and saturated region. The voltage of a switched mode power supply constantly oscillates and the circuitry

uses this to decide when to connect and disconnect from the source. As it stays in the cut off and saturated region, the static power dissipation is minimal, though dynamic power dissipation is significant. It has a higher efficiency than linear power supply but is considerably more complex. It suffers from low noise immunity. This type of power supply is used in most electronic gadgets like Laptops, mobile phones etc. It is of **3** types-

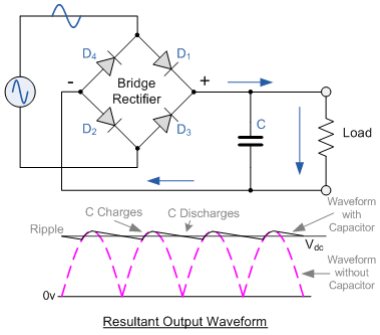
1. Buck- Buck converter produces a DC output in a range from 0V to just less than the input voltage.
2. Boost- Boost increases the input (battery) voltage to a level required to drive a load at the desired current level.
3. Buck Boost converter is a type of switched mode power supply that combines the principles of the Buck Converter and the Boost converter in a single circuit. Like other SMPS designs, it provides a regulated DC output voltage from either an AC or a DC input.

Conversion of input power to output power

RECTIFICATION

A rectifier circuit is a circuit which converts AC input power into DC output power. Presently a semi-conductor junction rectifier is used.

Transformers are attached to the rectifier circuit to bring the alternating current (A.C) voltage down to the required level. With the help of the transformer, the alternating current (A.C) voltage can be increased or decreased with a small amount of power loss. Moreover, transformers also help in increasing the safety of the equipment being used. PN diodes are also used for the rectification process along with the transformers. PN diodes help in getting a better rectification of current. The diodes are generally attached in a separate circuit having one, two, or four diodes.



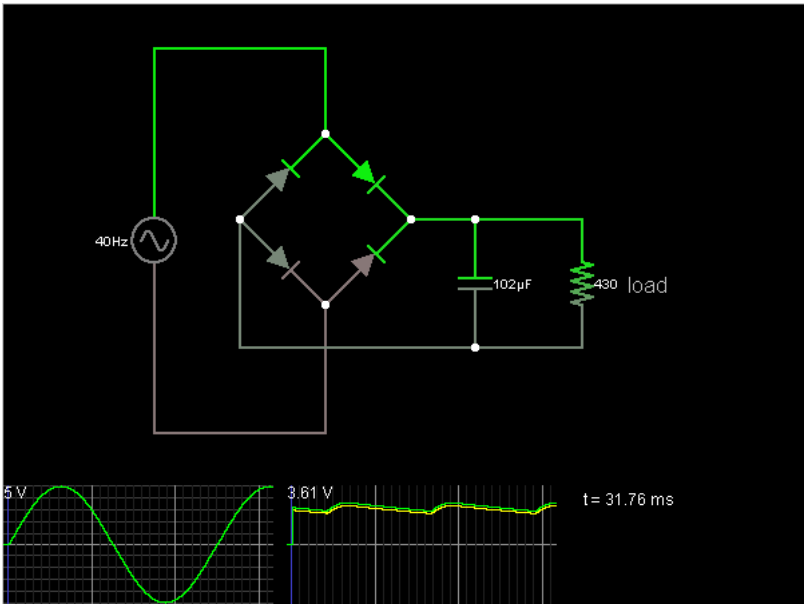
Resultant Output Waveform

The output result is a unidirectional direct current, smooth in quality. A single rectifier can only produce a half-wave rectification, which though unidirectional, is not continuous in flow and has several ripples in it. In order to reduce these ripples in the direct current, a capacitor is used. Thus, a capacitor helps in smoothing the alternative current (A.C) voltage after the rectification process.
The R-C filter circuit is used to reject input noise. Smoothing capacitor helps reduce the ripples in the circuit which converts the pulsating DC output after rectification to a constant DC voltage. The other capacitor is the reservoir capacitor. An electrolytic capacitor is used as a reservoir capacitor.

It acts as a temporary storage for the power supply output current. The reservoir capacitor is large electrolytic, usually of several hundred or even a thousand or more micro-farads, especially in mains frequency PSUs. This very large value of capacitance is required because the reservoir capacitor, when charged, must provide enough DC to maintain a steady PSU output in the absence of an input current; i.e. during the gaps between the positive half cycles when the rectifier is not conducting.

A combined reservoir capacitor and low pass filter it is possible to remove 95 percent or more of the AC ripple and obtain an output voltage of about the peak voltage of the input wave.

To obtain a ripple free constant dc supply we need to apply appropriate valued capacitor. This value of capacitor is obtained by input voltage that we get from transformer .In this case we opted for a step down transformer which provides output of 12 V.The peak is obtained at value of about 12*1.414=16.8 V.



Generally the available values of capacitors are 16 V, 25V; etc. This type of zener arrangement for regulated supply is used for circuit using small supply current. Zener diode provides constant voltage only for the case of constant current and temperature. Hence we need to provide constant current to zener diode in order to provide constant Figure 5.2: Filter circuit reference voltage.So this configuration was not used for designing the regulated voltage circuit.

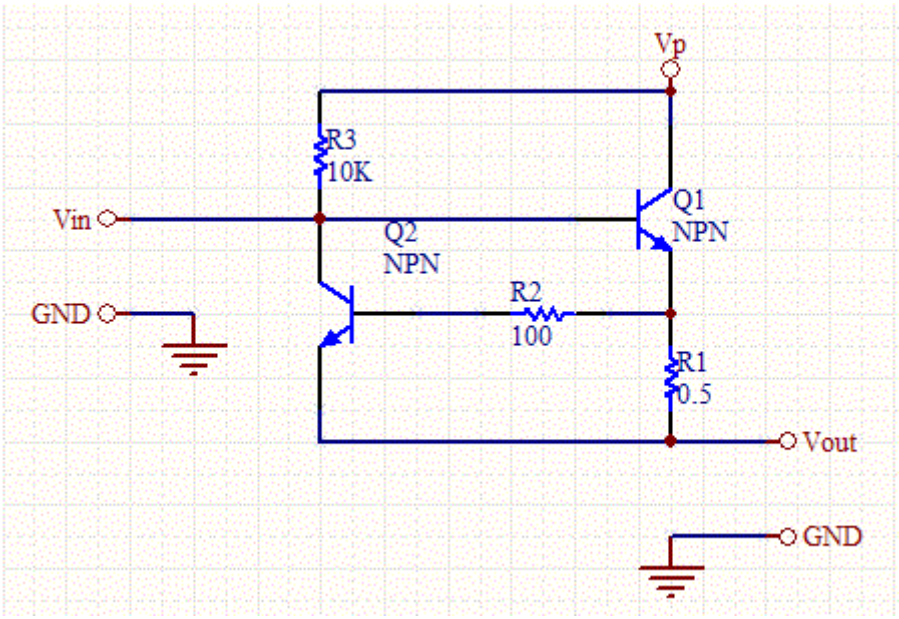
As far as power efficiency is required, we observe high power loss. Assuming current through zener is 1A,where output is 5.1V value of resistor required is (17-5.1)/1= 12,here power loss is obtained as 17-5.1=12W.The efficiency of power supply is very low; hence it is not a good power supply design.

Some other short comings of using the above circuit:

1. Vout is settable to a precise value.
2. For widely varying load current a high rated zener is required to handle dissipation at low load current.

Short Circuit Protection

Short circuit protection is often a desirable feature to add to power amplifiers or power supplies, for both safety concerns and protection of circuitry.



The circuit in the schematic below can be used to protect the output power transistor Q1. Under normal circumstances, where there is a typical load, the voltage across R1 is negligible, an Q2 is turned off and the circuit acts normally. When Vout is shorted a voltage develops across R1, resulting in Q2 Turning off. Since the base of Q1 is pulled towards ground by Q2, it is turned off, and current through it is limited or completely shut off, thus protecting it from overheating.