Final Year Project

***Remote volume control, Power supply*, and *Headphone amplifier* design for a studio series stereo audio amplifying system**

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Project Advisor

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School of Science and Technology

University of Management and Technology

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In partial fulfillment of the requirements for the degree of

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In

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Advisor Signature:-_____________

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First of all, we are grateful to ALMIGHTY ALLAH, who gave us the strength to achieve our goals. Without HIS divine help, we could do nothing. Secondly, we would like to pay deep regard to our parents who, with their selfless and extreme love, were always there to give us the required motivation, courage and confidence to complete our tasks. We would like to salute them because of their patience in managing with our busy routines and tight schedules. We are also extremely thankful to Mr. Rizwan, our project advisor, who gave us the dsired knowledge and right direction to move forward. He was really cooperative through our complete voyage and provided us with each and every facility whenever and whatever was required for our project. He remained with us from the start till the end and though he used to be busy with his own work, he, when we needed help, was there for us. We would also like to thank all relevant teachers including Mr. Asif Hussain, Mr. Asim Butt, Mr. Mohsin Ali, who were there to guide us in technical matters.

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ABSTRACT

A switched-mode power supply (switching-mode power supply, SMPS, or simply switcher) is an electronic power supply that incorporates a switching regulator in order to be highly efficient in the conversion of electrical power. An SMPS is usually employed to efficiently provide a regulated output voltage. Unlike a linear power supply, the pass transistor of a switching mode supply switched very quickly (typically between 10KHz to 1MHz) between full-on and full-off states, which minimizes wasted energy. In this design, AC to DC convertor, SMPS circuit, having a power MOSFET for switching operation and a PWM based feedback circuit for driving the switching of the MOSFET, is designed.

We have taken a input of 220V AC, and of frequency 50Hz, it is stepped down. After being stepped down, it is rectified and passed through filter capacitor to give an unregulated DC voltage. The process of chopping is done via MOSFET, which works as a switch to control the output voltage here. A high frequency diode bridge is used with the help of fast recovery diodes 1N4148. Capacitor is then used to remove any ripples and regulate the outputs. At the end, voltage regulators are used to give results close to the desired values.

Control circuitry or the feedback portion includes generation of square wave which is then converted in triangular, via op-amp integrator circuit. This control circuitry is used to control the gating signal produced by the MOSFET, which in turn controls the output voltage value. If the output voltage value is higher than desired one, the pulse width of gating signal reduces and vice versa, which automatically compensated for the changes in output voltages and stabilizes it.

DEDICATION

First of all we are very thankful to ALLAH ALMIGHTY who has given us enough courage to complete. Then it is dedicated to our kind teacher **Sir Muhammad Rizwan** & **Our Parents** who enlightened our minds with Knowledge, tried to include the spirit of hard work and dedicational us so that we could have a bright future in terms of being good human and turn out to be competent Engineers with powers to take challenging engineering problems.

Table of Content

Table of Contents — Page No.

Chapter # 01

Basic Power Supplies

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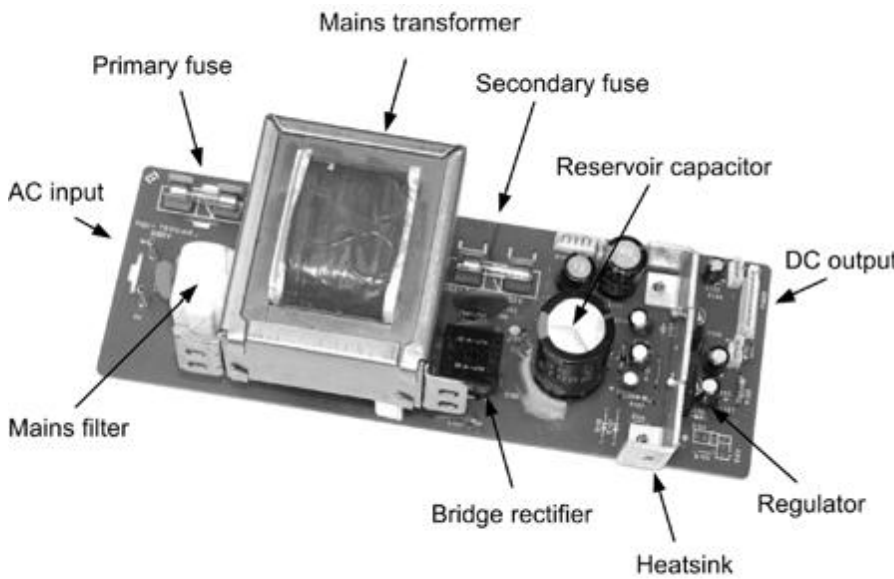
Basic Concept of Power Supplies

One of the basic building blocks of electronics is building our own power DC power supplies from an AC source of 220V AC. It simply provides the system with consistent and repeatable power supply. On experiencing a failure within itself, it fails gracefully and not allows the failure to reach the system.

The Block Diagram of D.C power supply is



Since the mains input is at a relatively high voltage, a step-down transformer of appropriate turns ratio is used to convert this to a low voltage. The AC output from the transformer secondary is then rectified using conventional silicon rectifier diodes to produce an unsmoothed (sometimes referred to as **pulsating D.C.**) output. This is then smoothed and filtered before being applied to a circuit which will **regulate** (or **stabilize**) the output voltage so that it remains relatively constant in spite of variations in both load current and incoming mains voltage.

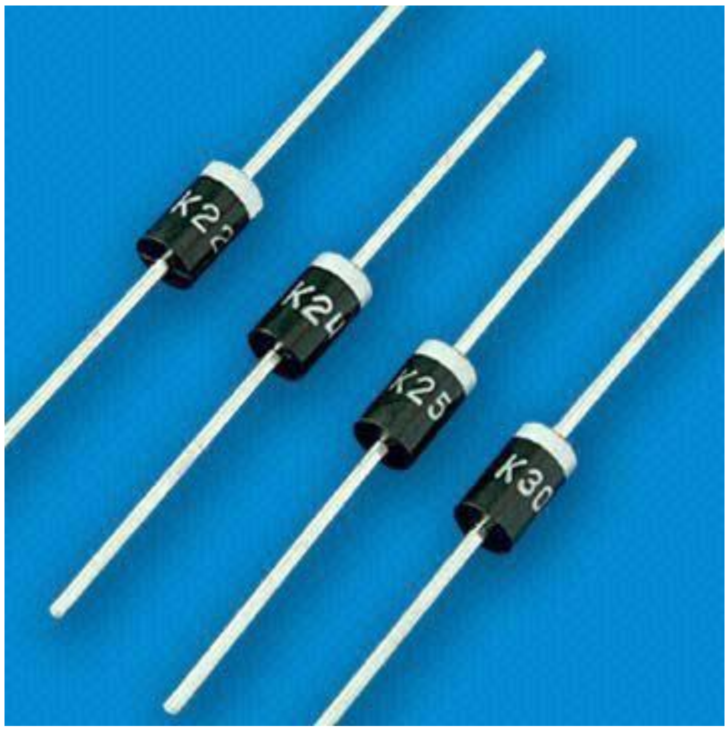
The iron-cored step-down transformer feeds a rectifier arrangement (often based on a bridge circuit). The output of the rectifier is then applied to a high-value **reservoir** capacitor. This capacitor stores a considerable amount of charge and is being constantly topped-up by the rectifier arrangement. The capacitor also helps to smooth out the voltage pulses produced by the rectifier. Finally, a stabilizing circuit (often based on a **series transistor regulator** and a zener diode **voltage reference**) provides a constant output voltage. We shall now examine each stage of this arrangement in turn.

Components of power supply in a arranged form

- Step Down Transformer
- Rectifier
- Reservoir /smoothing filter
- Voltage Regulator

Firstly, basic unidirectional component is to be discussed.

1. **Diodes**



These **semiconductor** materials form the basis of diodes, thyristors, triacs, and transistors and integrated circuits. Structure of an atom and showed that it contains both negative charge carriers (electrons) and positive charge carriers (protons). Electrons are in constant motion as they orbit around the nucleus of the atom. Electron orbits are organized into shells. The maximum number of electrons present in the first shell is 2, in the second shell 8, and in the third, fourth and fifth shells it is 18, 32 and 50, respectively. In electronics, only the electron shell furthermost from the nucleus of an atom is important. It is important to note that the movement of electrons only involves those present in the outer **valence shell**.

If the valence shell contains the maximum number of electrons possible the electrons are rigidly bonded together and the material has the properties of an insulator. If, however, the valence shell does not have its full complement of electrons, the electrons can be easily loosened from their orbital bonds, and the material has the properties associated with an electrical conductor. An isolated silicon atom contains four electrons in its valence shell. When silicon atoms combine to form a solid crystal, each atom positions itself between four other silicon atoms in such a way that the valence shells overlap from one atom to another.(covalent bonding).

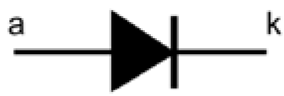
In its pure state, silicon is an insulator because the covalent bonding rigidly holds all of the electrons leaving no free (easily loosened) electrons to conduct current. If, however, an atom of a different element (i.e. an **impurity**) is introduced that has five electrons in its valence shell, a surplus electron will be present. These **free electrons** become available for use as **charge carriers** and they can be made to move through the lattice (crystal view of covalent bonding of silicon) by applying an external potential difference to the material. Similarly, if the impurity element introduced into the pure silicon lattice has three electrons in its valence shell, the absence of the fourth electron needed for proper covalent bonding will produce a number of gaps into which electrons can fit. These gaps are referred to as **holes**. Once again, current will flow when an external potential difference is applied to the material and again its have a property of semiconductor.(the term simply indicates that the substance is no longer a good insulator or a good conductor but is somewhere in between!).

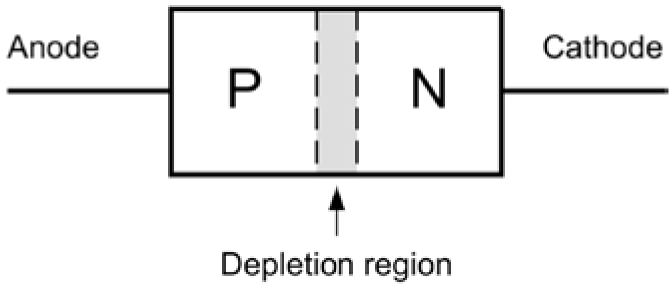
The process of introducing an atom of another (impurity) element into the lattice of an otherwise pure material is called **doping.** When the pure material is doped with an impurity with five electrons in its valence shell (i.e. a **pentavalent Impurity**) it will become an **N-type** material. If, however, the pure material is doped with an impurity having three electrons in its valence shell (i.e. a **trivalent impurity**) it will become **P-type** material. N-type semiconductor material contains an excess of negative charge carriers, and P-type material contains an excess of positive charge carriers.

Semiconductor diodes

When a junction is formed between N-type and P– type semiconductor materials, the resulting device is called a diode. This component offers an extremely low resistance to current flow in one direction and an extremely high resistance to current flow in the other.

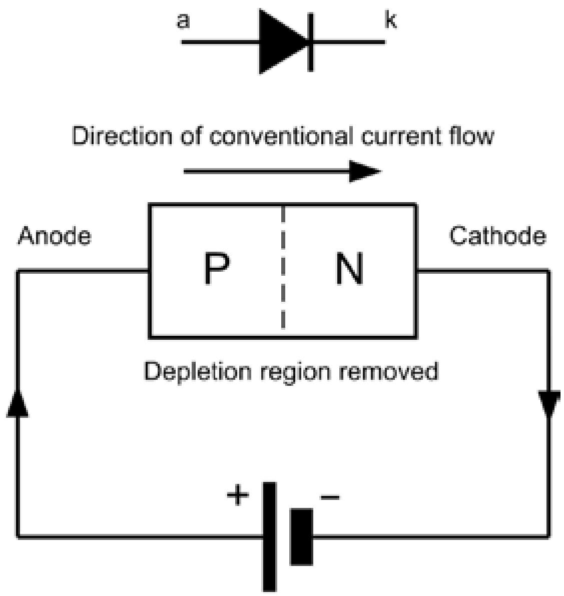
An ideal diode would pass an infinite current in one direction and no current at all in the other direction. In addition, the diode would start to conduct current when the smallest of voltages was present. In practice, a small voltage must be applied before conduction takes place. Furthermore a small **leakage current** will flow in the **reverse direction**. This leakage current is usually a very small fraction of the current that flows in the **forward direction**.



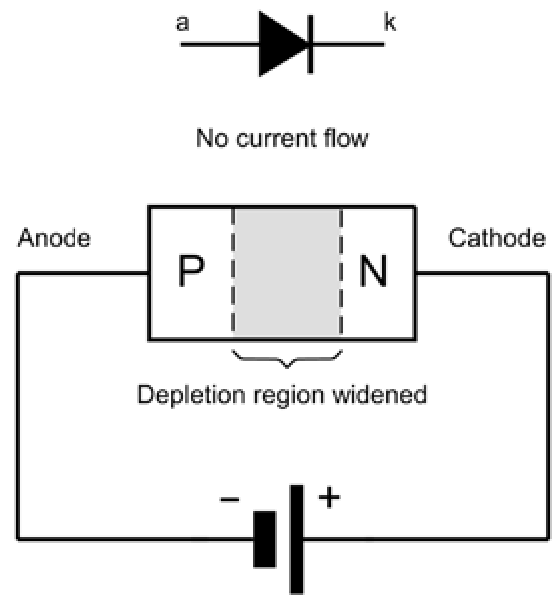


If the P-type semiconductor material is made positive relative to the N-type material by an amount greater than its **forward threshold voltage** (about 0.6 V if the material is silicon and 0.2 V if the material is germanium), the diode will freely pass current. If, on the other hand, the P-type material is made negative relative to the N-type material, virtually no current will flow unless the applied voltage exceeds the maximum (breakdown) voltage that the device can withstand. Note that a normal diode will be destroyed if its **reverse breakdown voltage** is exceeded.

With no externally applied potential, electrons from the N-type material will cross into the P-type region and fill some of the vacant holes. This action will result in the production of a region either side of the junction in which there are no free charge carriers. This zone is known as the **depletion region**. Figure below shows a junction diode in which the anode is made positive with respect to the cathode. In this **forward-biased** condition, the diode freely passes current. Figure below also shows a diode with the cathode made positive with respect to the cathode. In this **reverse-biased** condition, the diode passes a negligible amount of current. In the freely conducting forward-biased state, the diode acts rather like a closed switch. In the reverse biased state, the diode acts like an open switch.

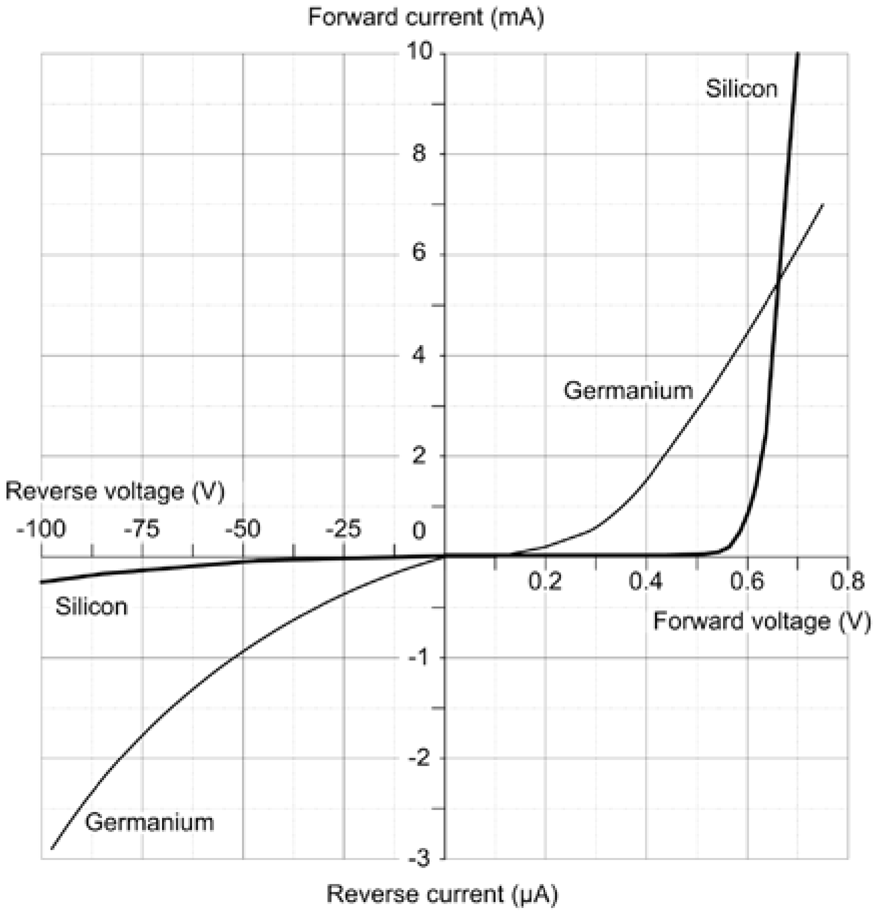


(a) Forward biased P-N junction



(b) Reverse biased P-N junction

As these new charge carriers enter the semiconductor material, they will move toward the junction and combine. Thus, current flow is established and it will continue for as long as the voltage is applied. As stated earlier, the **forward threshold voltage** must be exceeded before the diode will conduct.



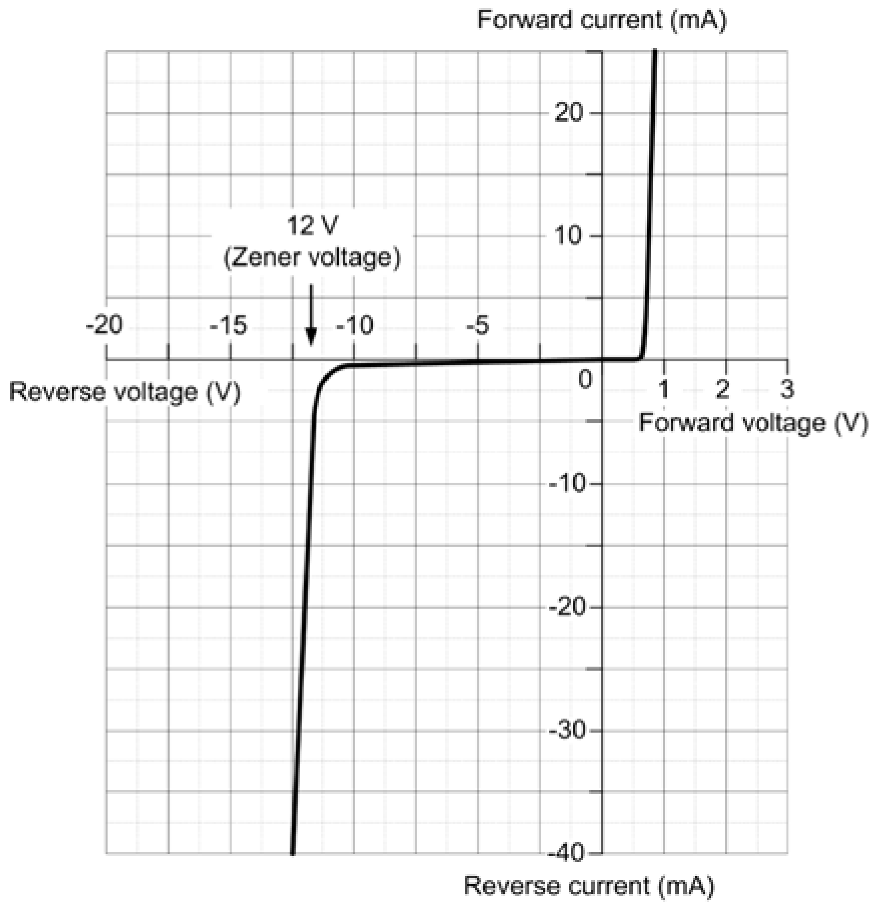
In the case of a reverse biased diode, the junction area becomes an insulator, and current flow is inhibited. The reverse breakdown voltage is usually very much higher than the forward threshold voltage.(200V) When use as rectifiers, manufacturers often quote **peak inverse voltage** (**PIV**) or **maximum reverse repetitive voltage** (**VRRM**) rather than maximum reverse breakdown voltage.

Diodes are often divided into parts according to the nature of work

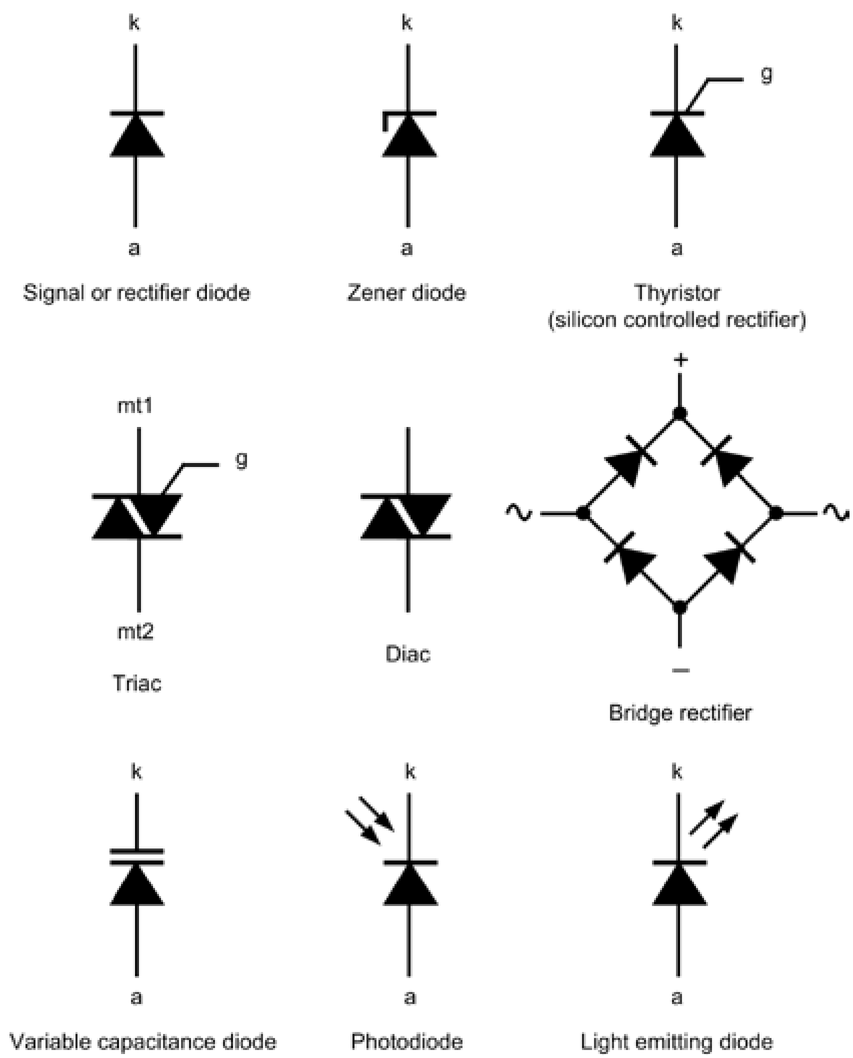
- ✓ Signal (giving path to the current)
- ✓ Rectifier(conversion from AC to DC)

Zener Diodes

Zener diodes are heavily doped silicon diodes which, unlike normal diodes, exhibit an abrupt reverse breakdown at relatively low voltages (typically less than 6 V). A typical characteristic for a 12 V zener diode is shown in below.



When a diode is undergoing reverse breakdown *and provided its maximum ratings are not exceeded* the voltage appearing across it will remain substantially constant (equal to the nominal zener voltage) regardless of the current flowing. This property makes the zener diode ideal for use as a **voltage regulator.**

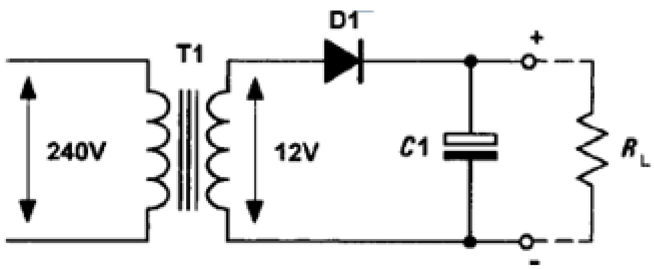


Rectifiers

The simplest form of rectifier circuit makes use of a single diode and, since it operates on only either positive or negative half-cycles of the supply, it is known as a **half wave** rectifier. A simple half-wave rectifier circuit. Mains voltage (220 to 240 V) is applied to the primary of a step-down transformer (T1). The secondary of T1 steps down the 240 V r.m.s. to about 24 V r.m.s. (the turns ratio of T1 will thus be 240/24 or 10:1). Diode D1 will only allow the current to flow in the direction shown (i.e. from cathode to anode). D1 will be forward biased during each positive half-cycle (relative to common) and will effectively behave like a closed switch. When the circuit current tries to flow in the opposite direction, the voltage bias across the diode will be reversed, causing the diode to act like an open switch. During the positive half-cycle, the diode will drop the 0.6 V to 0.7 V forward threshold voltage normally associated with silicon diodes. However, during the negative half-cycle the peak a.c. voltage will be dropped across D1 when it is reverse biased.

Reservoir and Smoothing Circuits

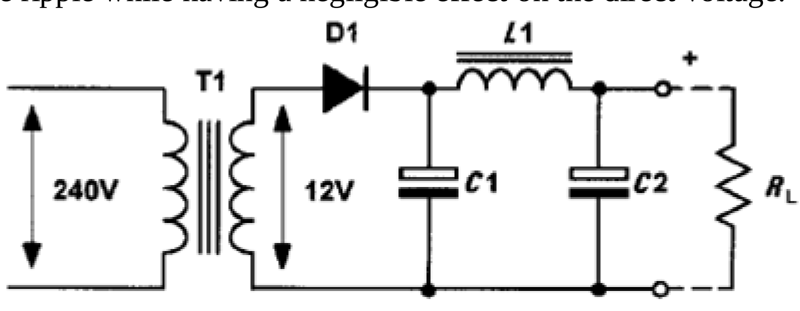
The capacitor, *C*1, has been added to ensure that the output voltage remains at, or near, the peak voltage even when the diode is not conducting. When the primary voltage is first applied to T1, the first positive half-cycle output from the secondary will charge *C*1 to the peak value seen across *R*L. Because *C*1 and *R*L are in parallel, the voltage across *R*L will be the same as that across *C*1. The time required for *C*1 to charge to the maximum (peak) level is determined by the charging circuit time constant (the series resistance multiplied by the capacitance value). In this circuit, the series resistance comprises the secondary winding resistance together with the forward resistance of the diode and the (minimal) resistance of the wiring and connections. Hence *C*1 charges very rapidly as soon as D1 starts to conduct.



*C*1 is referred to as a **reservoir** capacitor. It stores charge during the positive half-cycles of secondary voltage and releases it during the negative half-cycles. This gives rise to a small variation in the d.c. output voltage (known as **ripple**). Since ripple is undesirable we must take additional precautions to reduce it. That of simply increasing the discharge time constant. This can be achieved either by increasing the value of *C*1 or by increasing the resistance value of *R*L. Increasing the value of C1 is a more practical alternative and very large capacitor values (often in excess of 4,700 μF) are typical.

Improved Ripple Filters

The circuit below also offers the advantage that the minimum d.c. voltage is dropped across the inductor. Figure below shows the circuit of a half-wave power supply with an *L*–*C* smoothing circuit. At the ripple frequency, *L*1 exhibits a high value of inductive reactance while *C*1 exhibits a low value of capacitive reactance. The combined effect is that of an attenuator which greatly reduces the amplitude of the ripple while having a negligible effect on the direct voltage.

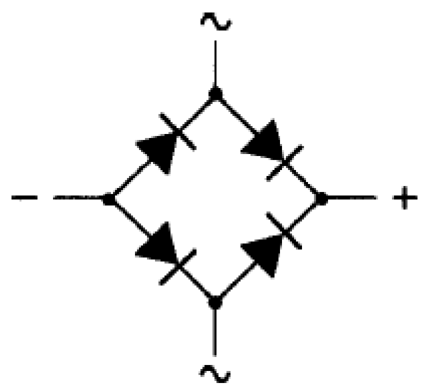


the pulses of voltage developed across *R*L will occur at a frequency of 100 Hz (*not* 50 Hz). This doubling of the ripple frequency allows us to use smaller values of reservoir and smoothing capacitor to obtain the same degree of ripple reduction (recall that the reactance of a capacitor is reduced as frequency increases).

Bridge Rectifier Circuit

An alternative to the use of the bi-phase circuit is that of using a four-diode bridge rectifier (see Fig. below) in which opposite pairs of diode conduct on alternate half-cycles. This arrangement avoids the need to have two separate secondary windings.

- For the positive half cycle D1 & D2 conduct and voltage across Load Resistor
- For the negative half cycle D3 & D4 conduct and voltage across Load Resistor.



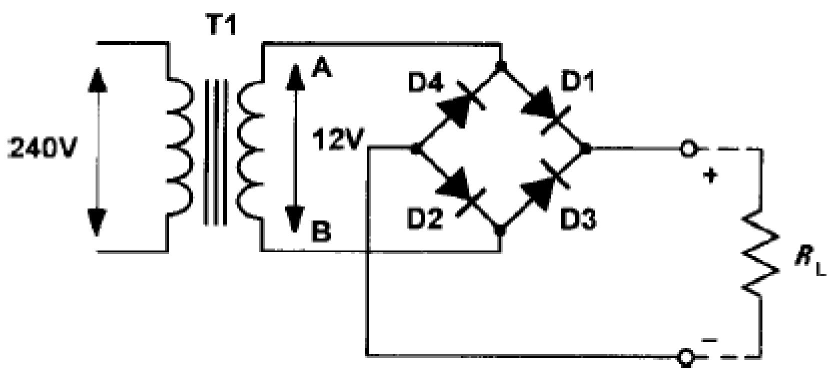
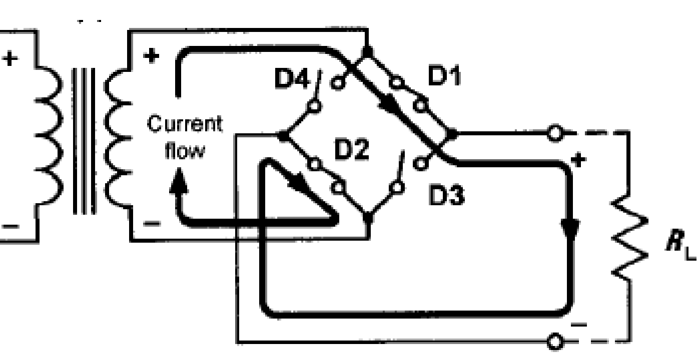


Figure 6.15 Full-wave bridge rectifier circuit



(a)

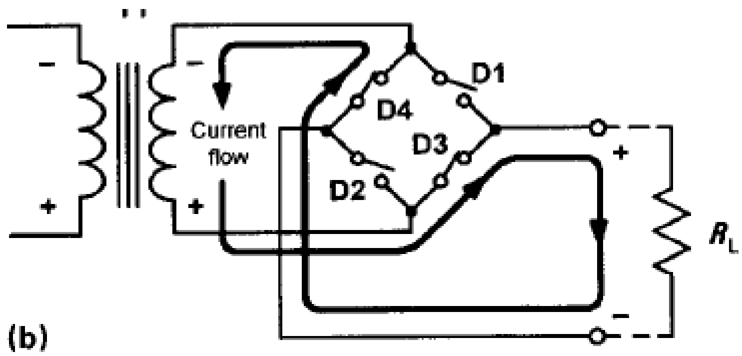
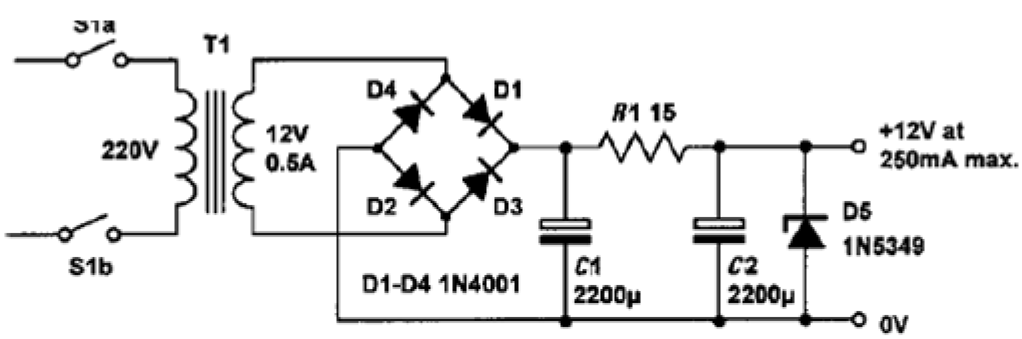
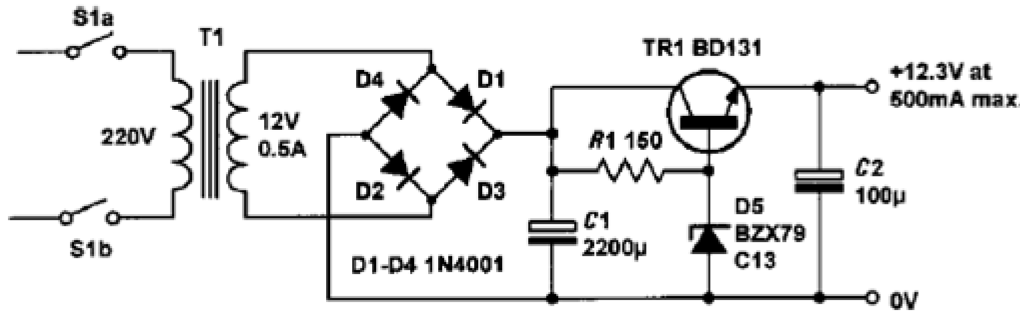


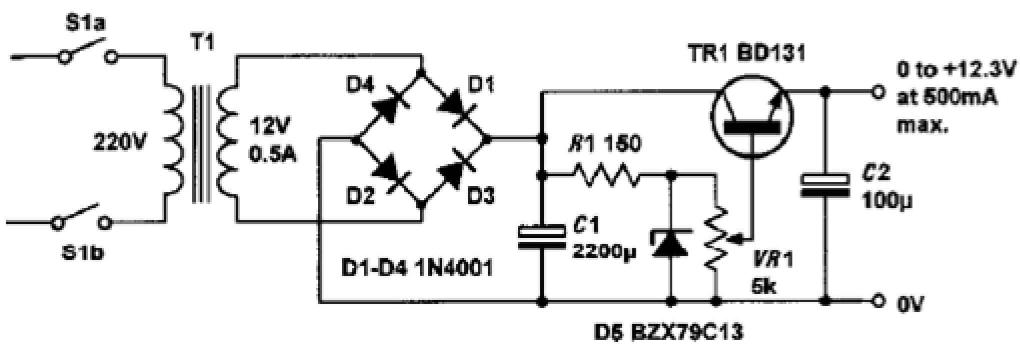
Figure 6.16 (a) Bridge rectifier with D1 and D2 conducting, D3 and D4 non-conducting (b) bridge rectifier with D1 and D2 non-conducting, D3 and D4 conducting

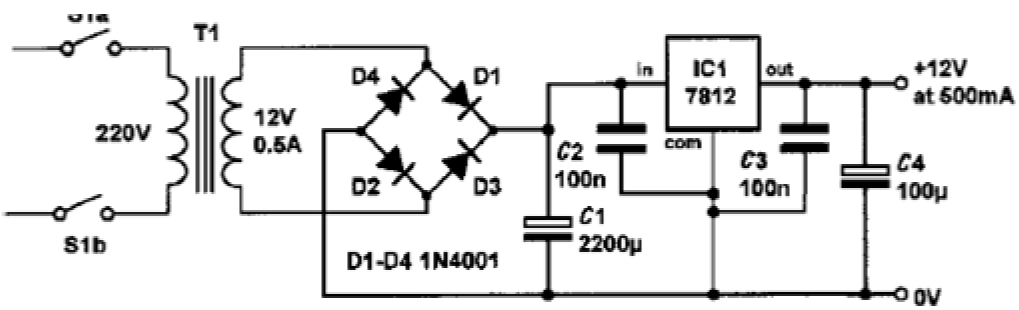
We attach capacitor with parallel combination with Load resistor, that give voltage when diodes not conduct and in this case also the valve of the capacitor is less because we need less discharging time.

We can implement a power supply in many different ways. Few possible ways are :




S1a
T1
TR1 BD131
+12.3V at
500mA max.
D4
D1
220V
12V
0.5A
R1 150
C2
100µ
D2
D3
D5
BZX79
C13
C1
2200µ
S1b
D1-D4 1N4001
0V


S1a
T1
TR1 BD131
0 to +12.3V
at 500mA
max.
D4
D1
220V
12V
0.5A
R1 150
C2
100µ
D2
D3
C1
2200µ
VR1
5k
S1b
D1-D4 1N4001
0V
D5 BZX79C13


T1
IC1
7812
in
out
+12V
at 500mA
D4
D1
220V
12V
0.5A
com
C2
100n
C3
100n
C4
100µ
D2
D3
C1
2200µ
S1b
D1-D4 1N4001
0V