Block Diagram

Power supply is a device that supplies electric power to a load.

The block diagram of a d.c. power supply is shown in Fig. 1.1.

Step-down transformer: The high voltage a.c. input (220-240V) is converted to a lowvoltage (5V, 9V, 12V etc.) using a step-down transformer of appropriate turns ratio.

Rectifier: The a.c. output from the transformer secondary is then rectified using conventional silicon rectifier diodes to produce an unsmoothed (pulsating d.c.) output.

Reservoir/Filtering Circuit: The unsmoothed output from rectifier is smoothened by reservoir/filtering circuit (a high value capacitor). The capacitor helps to smooth out the voltage pulses produced by the rectifier.

Voltage Regulator: The stabilizing circuit (a series transistor regulator and a Zener diode voltage reference) stabilizes and produces a constant voltage.

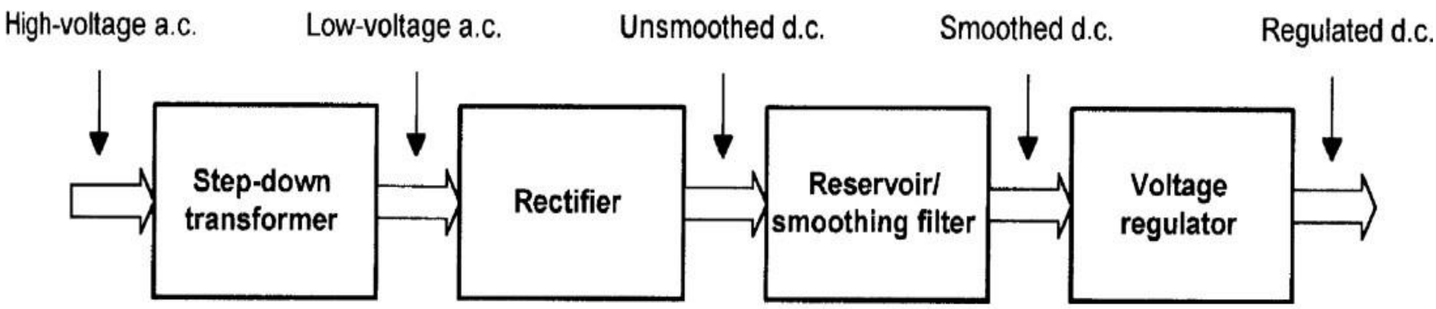


Fig. 1.1: Block diagram of d.c. power supply

1.1.1 Rectifiers

A rectifier is a device that converts alternating current (ac) to direct current (dc).

Semiconductor diodes are commonly used for converting ac to dc.

Rectifiers can be classified as:

1. Half wave rectifier.
2. Full wave rectifier.
    - Bi-phase rectifier.
    - Bridge rectifier.

1.1.2 Half wave rectifiers

The simplest form of rectifier circuit uses a single diode and operates only in positive ornegative half cycles of the supply, known as half-wave rectifier.

Figure 1.2 shows a simple half wave rectifier circuit.

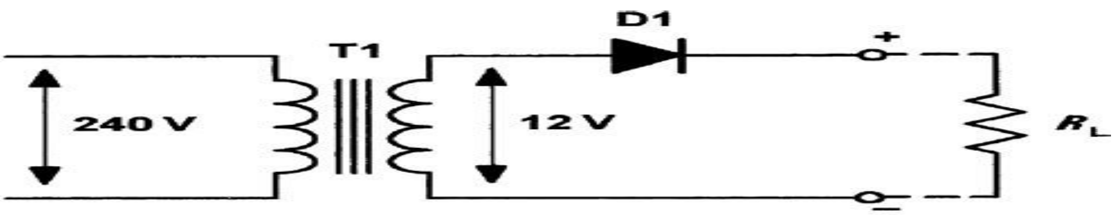


Fig. 1.2: A simple half-wave rectifier circuit

The mains voltage (220 to 240V) applied to primary of step-down transformer.

Secondary of transformer steps down the 240V rms to 12V rms (turns ratio 20:1).

Operation: Diode D1 will allow the current to flow in the direction is shown in fig. 1.3.

D1 will be forward biased during each positive half-cycle & behaves as a closed switch.

When the circuit current flows in opposite direction, the voltage bias across the diodewill be reversed, causing the diode to be reverse biased and act like an open switch.

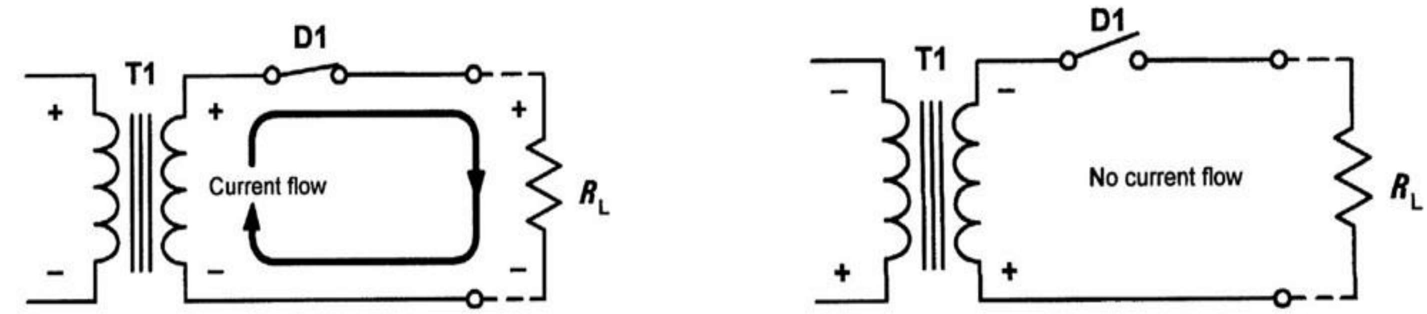


Fig. 1.3: (a) D1 conducting (positive half cycle) (b) D1 not conducting (negative half cycle)

During the positive half-cycle, the diode will drop 0.6V to 0.7V forward threshold voltage normally associated with silicon diodes.

However, during the negative half-cycle the peak ac voltage will be dropped across D1 when it is reverse biased.

Problem 1.1: A mains transformer having a turns ratio of 44:1 is connected to a 220 V rms. mains supply. If the secondary output is applied to a half-wave rectifier, determine thepeak voltage that will appear across a load.

Solution: The rms secondary

voltage is be given by:

$V_S = V_P / 44 = 240 / 44 = 5V$

The peak voltage developed

after rectification will be

$V_{pk} = 1.414 \times 5 = 7.07V$

The actual peak voltage dropped across the load will be

(Assuming Silicon diode): $V_L = 7.07 - 0.6 = 6.47V$

Half Wave Rectifier with a Reservoir Capacitor

Figure 1.4 (a) shows a Half Wave Rectifier with a Reservoir Capacitor.

During the first positive half-cycle, output from secondary will charge C1 to peak value seen across RL. Hence C1 charges to maximum at the peak of positive half-cycle (16.3V).

The time required for C1 to discharge is very much greater and is determined by the capacitance value and the load resistance, RL.

During this time, D1 will be reverse biased & will be held in its non-conducting state.

As a consequence, the only discharge path for C1 is through RL.

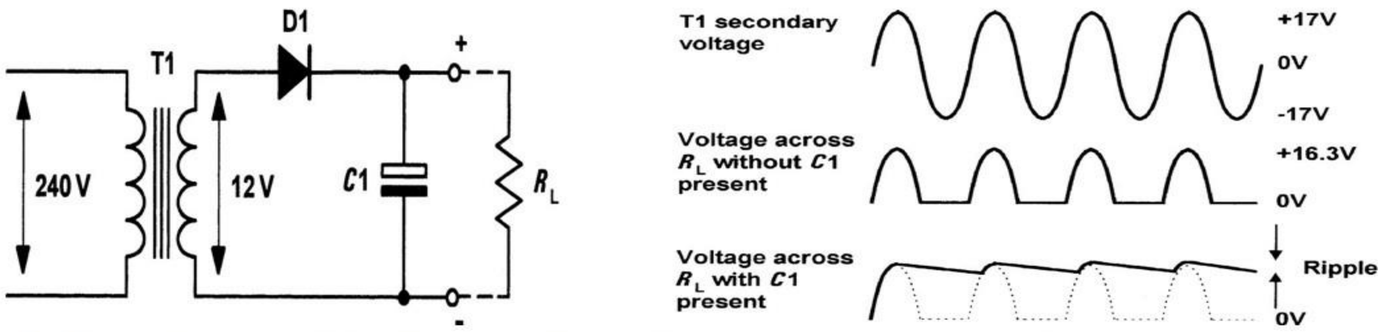


Fig. 1.4: (a) Half wave rectifier with Reservoir Capacitor (b) Voltage Waveforems

C1 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.

The circuit of Fig. 1.4(a) is thus able to maintain a constant output voltage across RL.

Fig. 1.4(b) shows the secondary voltage waveform together with the voltage developed across RL with and without C1 present.

Half wave Rectifier with Smoothing Circuit

Output of reservoir circuit consists of ripple which is undesirable & shall be removed.

Figure 1.5 shows half wave rectifier’s circuit with smoothing filters.

Two components R & C or L & C acts as a filter to remove ripple.

The amount of ripple is reduced by an approximate factor equal

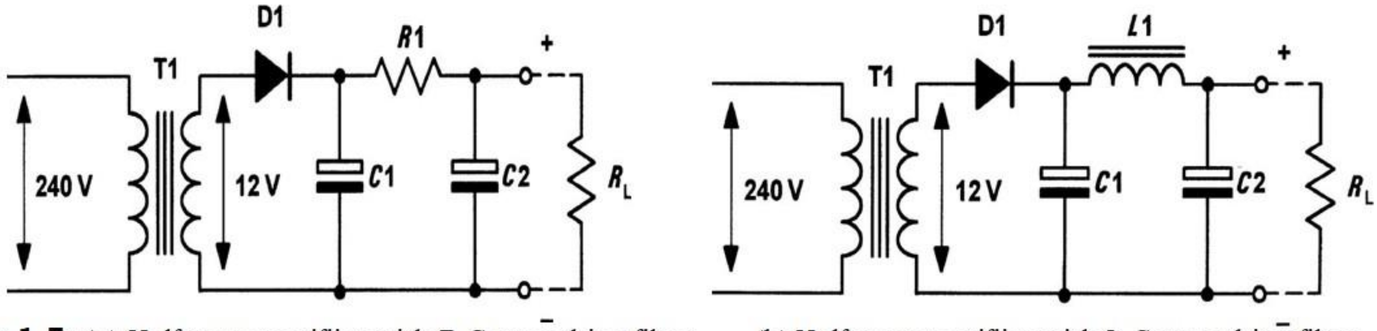


Fig 1.5: (a) Half wave rectifiier with R-C smoothing filter (b) Half wave rectifiier with L-C smoothing filter

to:

$$\frac{X_C}{\sqrt{R^2 + X_C^{\,2}}}$$

Problem 1.2: The *R–C* smoothing filter in a 50 Hz mains operated half-wave rectifier circuit consists of R1 = 100Ω and C2 = 1,000μ F. If 1 V of ripple appears at the input of the circuit, determine the amount of ripple appearing at the output.

Solution: The reactance of the capacitor, *C*2, at the ripple frequency (50 Hz):

$$X_C = \frac{1}{2\pi fC} = \frac{1}{6.28 \times 50 \times 1{,}000 \times 10^{-6}} = 1000/314 = 3.18 \text{ ohm}$$

The amount of ripple at the output of the circuit is given by:

$$V_{ripple} = 1 \times \frac{X_C}{\sqrt{R^2 + X_C^{\,2}}} = 1 \times \frac{3.18}{\sqrt{100^2 + 3.18^2}} = 0.032\text{V} = 32 \text{ mV}$$

1.1.3 Full Wave Rectifiers

The rectifier circuit that can convert both positive and negative half cycles of ac signalinto dc signal are called full wave rectifier circuits.

The two basic forms of full wave rectifier are: Bi-phase type and Bridge rectifier type.

1.1.4 Bi-Phase Full Wave Rectifiers

Fig. 1.6 shows a simple bi-phase rectifier circuit.

Mains voltage (240 V) is applied to the primary of the step-down transformer (T1) which has two identical secondary windings, each providing 12 V rms.

On positive half-cycles, point A will be positive with respect to point B and point B will be positive with respect to point C. In this condition D1 will allow conduction while D2 will not allow conduction. Thus D1 alone conducts on positive half-cycles.

On negative half-cycles, point C will be positive with respect to point B and point B will be positive with respect to point A. In this condition D2 will allow conduction while D1 will not allow conduction. Thus D2 alone conducts on negative half-cycles.

The operation of the bi-phase rectifier circuit with the diodes replaced by switches is shown in Fig. 1.7. In fig. 1.7 (a) D1 is shown conducting on a positive half-cycle while in Fig. 1.7 (b)

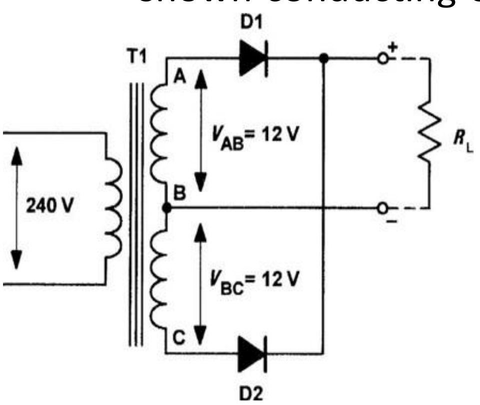


Fig. 1.6: Bi-Phase Rectifier Circuit

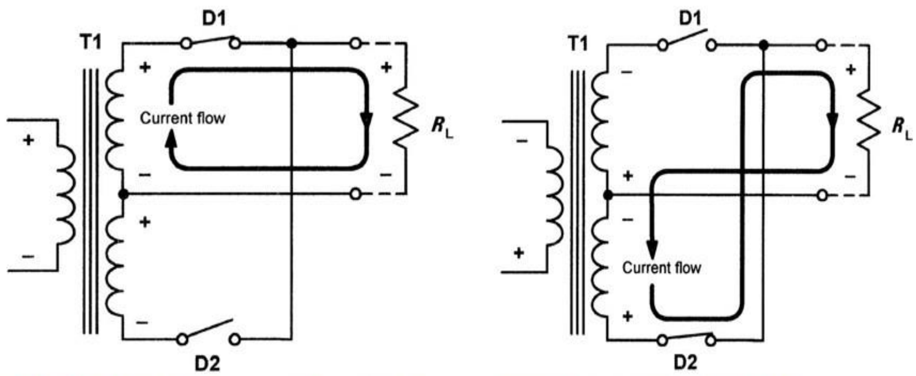


Fig. 1.7: (a) Bi-phase rectifier with D1 conducting & D2 not conducting (b) Bi-phase rectifier with D2 conducting & D1 not conducting

D2 is shown conducting.

Bi-Phase Rectifier with Reservoir Circuit

Fig. 1.8(a) shows a reservoir capacitor C1 connected to ensure that the output voltageremains at, or near, the peak voltage even when the diodes are not conducting.

The C1 charges to maximum (16.3V) at the peak of the positive half-cycle and holds thevoltage at this level when the diodes are in their non-conducting states.

The time required for C1 to discharge is very much greater and is determined by thecapacitance value and the load resistance R_L.

During this time, D1 and D2 will be reverse biased and held in a non-conducting state.As a consequence, the only discharge path for C1 is through R_L.

Fig. 1.8(b) shows voltage waveforms with and without C1 present.

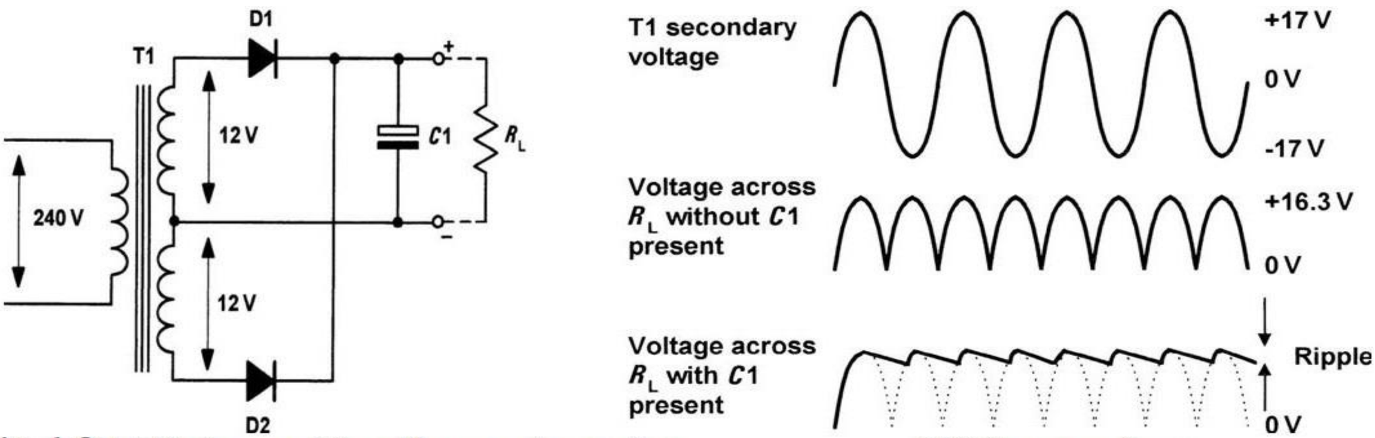


Fig. 1.8: (a) Bi-phase rectifier with reservoir capacitor (b) Voltage waveforms

1.1.5 Bridge Rectifier

An alternative to the use of the bi-phase circuit is that of using a four-diode bridgerectifier in which opposite pairs of diode conduct on alternate half-cycles.

This arrangement avoids the need to have two separate secondary windings.

A full-wave bridge rectifier arrangement is shown in Fig. 1.9.

Mains voltage (240V) is applied to the primary of a step-down transformer (T1).

The secondary winding provides 12V rms and has a turns ratio of 20:1.

On positive half-cycles, point A will be positive with respect to point B. In this condition D1 and D2 will allow conduction while D3 and D4 will not allow conduction.

On negative half-cycles, point B will be positive with respect to point A. In this condition D3 and D4 will allow conduction

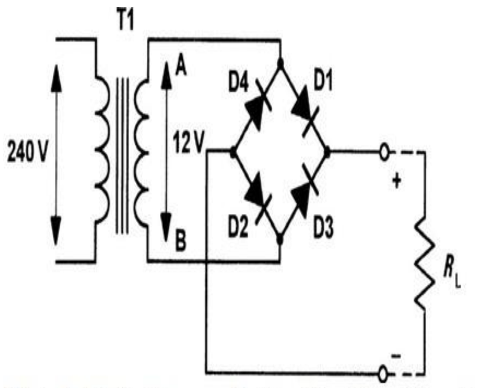


Fig. 1.9: Full wave Bridge Rectifier Circuit

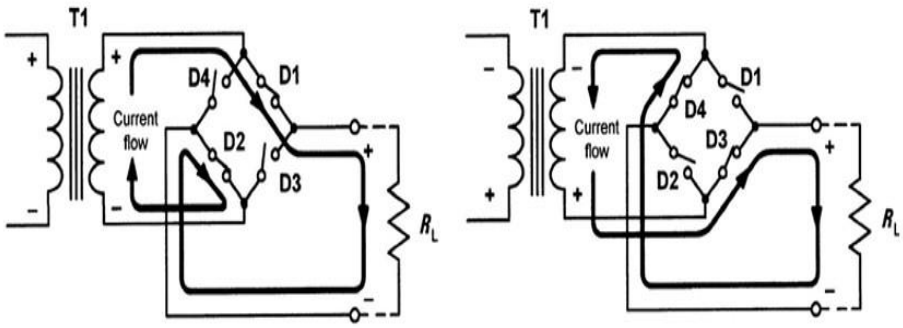


Fig. 1.10: (a) Bridge Rectifier with D1 & D2 conducting and D3 & D4 not conducting (b) Bridge Rectifier with D1 & D2 not conducting and D3 & D4 conducting

while D1 and D2 will not allow conduction.

Fig. 1.10 shows the bridge rectifier circuit with the diodes replaced by four switches. D1 & D2 are conducting on positive half-cycle (fig. a) while D3 & D4 are conducting on negative half cycle (fig. b).

Bridge Rectifier with Reservoir Capacitor

Fig. 1.11(a) shows a reservoir capacitor C1 connected to ensure that the output voltage remains at, or near, the peak voltage even when the diodes are not conducting.

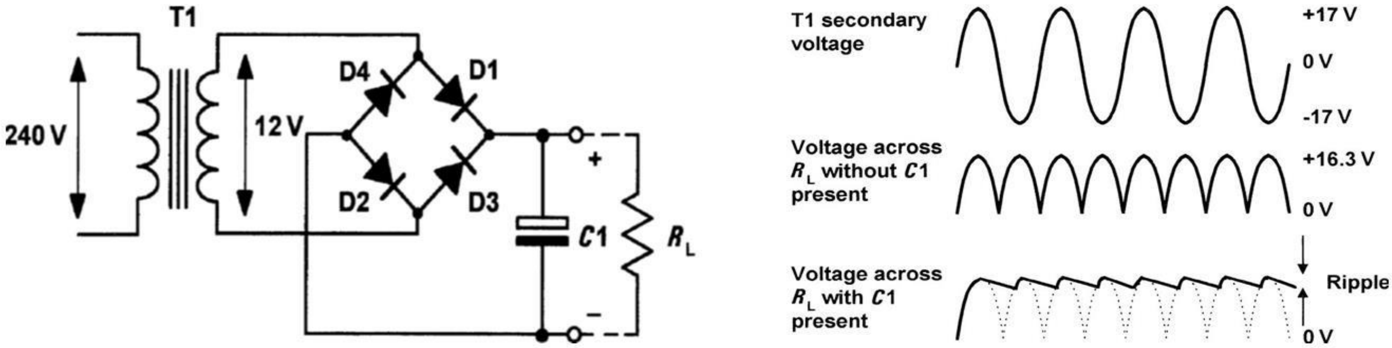


Fig. 1.11: (a) Bridge rectifier with reservoir capacitor (b) Volatge waveforms

1.1.6 Voltage Regulator

A voltage regulator provides a constant DC output voltage that is independent of AC linevoltage variations, load current and temperature.

A simple voltage regulator is shown in Fig. 1.12.

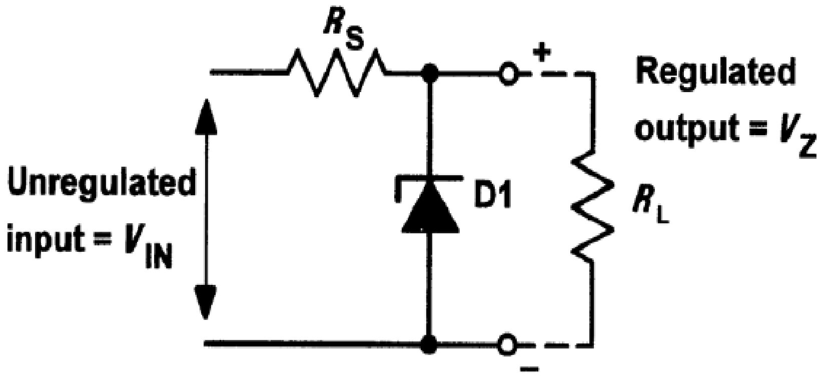


Fig. 1.12: A shunt Zener voltage regulator

R_S is included to limit the Zener current to a safe value when the load is disconnected. When a load (R_L) is connected, Zener current (I_Z) will fall as current is diverted into load resistance.

The output voltage (V_Z)

will remain at the Zener

voltage until regulation

fails at the point at which

potential divider formed by R_S & R_L produces a lower output voltage that is less than V_Z.

The Zener voltage is given by:

$$V_Z = V_{IN} \times \frac{R_L}{R_L + R_S}$$

where V_{IN} is the unregulated input voltage.

Thus the maximum value for R_S can be calcul

$$R_S \text{ max.} = R_L \times \left(\frac{V_{IN}}{V_Z} - 1 \right)$$

The power dissipated in the Zener diode will be given by $P_Z = V_Z \times I_Z$

Hence the minimum value for R_S can be determined from the off-load condition when:

$$R_S \text{ min.} = \frac{V_{IN} - V_Z}{I_Z} = \frac{V_{IN} - V_Z}{\left(\frac{P_Z \text{ max.}}{V_Z} \right)} = \frac{(V_{IN} - V_Z) \times V_Z}{P_Z \text{ max.}} = \frac{V_{IN}V_Z - V_Z^2}{P_Z \text{ max.}}$$

The internal resistance appears at the output of the supply

and defined as change inoutput voltage to change in output

current

$$R_{out} = \frac{\text{change in output voltage}}{\text{change in output current}} = \frac{\Delta V_{out}}{\Delta I_{out}}$$

where,

ΔV_{OUT} represents a small change in output (load) current and ΔI_{OUT} represents a corresponding small change in output voltage.

The regulation of a power supply is given by the relationship:

$$\text{Regulation} = \frac{\text{change in output voltage}}{\text{change in line (input) voltage}} \times 100\%$$

Ideally, the value of regulation should be very small.

Problem 1.3: A 5 V Zener diode has a maximum rated power dissipation of 500 mW. If the diode is to be used in a simple regulator circuit to supply a regulated 5 V to a load having a resistance of 400 ohms, determine a suitable value of series resistor for operation in conjunction with a supply of 9 V.

Solution: The maximum value for the series resistor is:

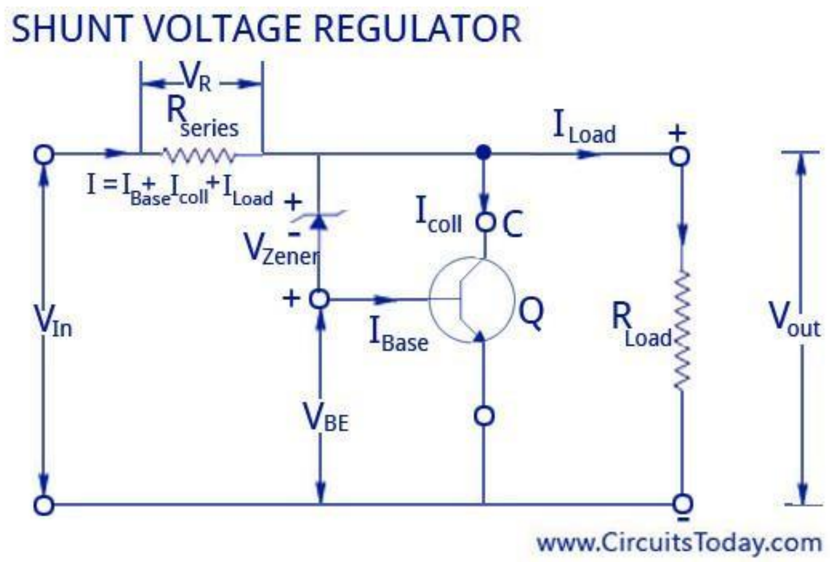
$$R_S \text{ max.} = R_L \times \left(\frac{V_{IN}}{V_z} - 1\right) = 400 \times \left(\frac{9}{5} - 1\right) = 400 \times (1.8 - 1) = 320\ \Omega$$

The minimum value for the series resistor is:

$$R_S \text{ min.} = \frac{V_{IN}V_Z - V_Z^2}{P_Z \text{max.}} = \frac{(9 \times 5) - 5^2}{0.5} = \frac{45 - 25}{0.5} = 40\ \Omega$$

Hence a suitable value for R_S would be 150 ohms (Midway between two extremes).

Zener controlled Transistor shunt voltage regulator



Operation

As there is a voltage drop in the series resistance Rseries the unregulated voltage is also decreased along with it. The amount of voltage drop depends on the current supplied t the load Rload. The value of the voltage across the load depends on the zener diode and the transistor base emitter voltage Vbe.

Thus, the output voltage can be

written asVout = Vzener + Vbe =

Vin – I.Rseries

The output remains nearly a constant as the values of Vzener and Vbe are nearly constant.This condition is explained below.

When the supply voltage increases, the output voltage and base emitter voltage of transistorincreases and thus increases the base current Ibase and therefore causes an increase in the collector current Icoll (Icoll = β.Ibase).

Thus, the supply voltage increases causing an increase in supply current, which inturn causes a voltage drop i the series resistance Rseries and thereby decreasing the output voltage. This decrease will be more than enough to compensate for the initial increase in output voltage. Thus, the output remains nearly a constant. The working explained above happens in reverse if the supply voltage decreases.

When the load resistance Rload decreases, the load current Iload increases due to the decrease in currents through base and collector Ibase and Icoll. Thus, there will not be any

oltage drop across Rseries and the input current remains constant. Thus, the output voltage will remain constant and will be the difference of the supply voltage and the voltage drop in the series resistance. It happens in reverse if there is an increase in load resistance.

Limitations

The series resistor causes a huge amount of power loss.

1. The supply current flow will be more through the transistor than it is to be through the load.
2. The circuit may have problems regarding over voltage mishaps.

Voltage Multiplier

The voltage multiplier is an electronic circuit that delivers the output voltage whose amplitude (peak value) is two, three, or more times greater than the amplitude (peak value) of the input voltage.

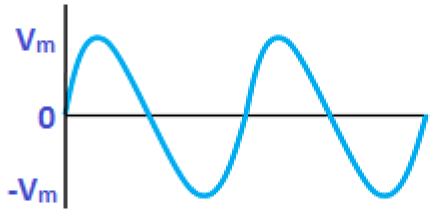
The voltage multiplier is an AC-to-DC converter, made up of diodes and capacitors that produce a high voltage DC output from a low voltage AC input.

Types of voltage multipliers

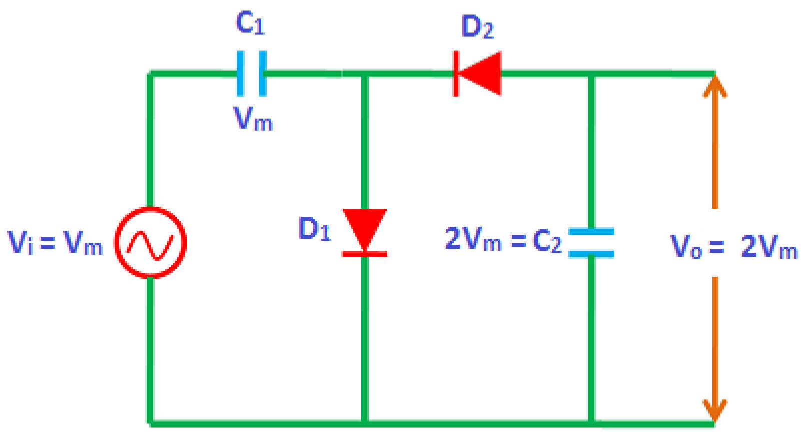
Voltage multipliers are classified into four types:

1. Half-wave voltage doubler
2. Full-wave voltage doubler
3. Voltage tripler
4. Voltage quadrupler

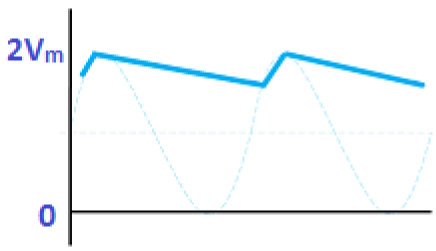
Half-wave voltage doubler



Input waveform



Half-wave voltage doubler



Output waveform

During positive half cycle:

The circuit diagram of the half-wave voltage doubler is shown in the above figure. During the positive half cycle, diode D1 is forward biased. So it allows electric current through it. This current will flows to the capacitor C1 and charges it to the peak value of input voltage I.e. Vm.

However, current does not flow to the capacitor C2 because the diode D2 is reverse biased. So the diode D2 blocks the electric current flowing towards the capacitor C2. Therefore, during the positive half cycle, capacitor C1 is charged whereas capacitor C2 is uncharged.

During negative half cycle:

During the negative half cycle, diode D1 is reverse biased. So the diode D1 will not allow electric current through it. Therefore, during the negative half cycle, the capacitor C1 will not be charged. However, the charge (Vm) stored in the capacitor C1 is discharged (released).

The diode D2 is forward biased during the negative half cycle. So the diode D2 allows electric current through it. This current will flows to the capacitor C2 and charges it. The capacitor C2 charges to a value 2Vm because the input voltage Vm and capacitor C1 voltage Vm is added to the capacitor C2. Hence, during the negative half cycle, the capacitor C2 is charged by both input supply voltage Vm and capacitor C1 voltage Vm. Therefore, the capacitor C2 is charged to 2Vm.

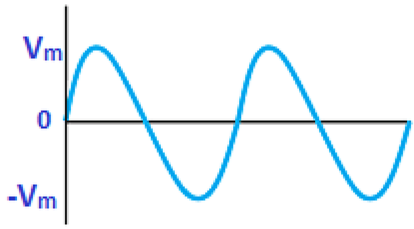
Full-wave voltage doubler

The full-wave voltage doubler consists of two diodes, two capacitors, and input AC voltage source.

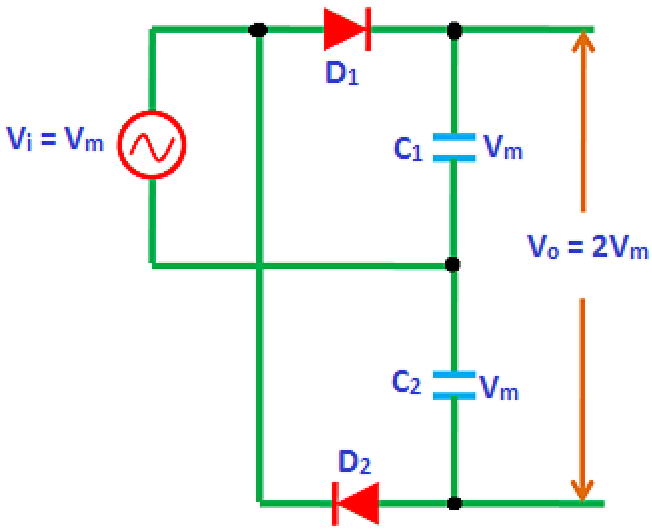
During positive half cycle:

During the positive half cycle of the input AC signal, diode D1 is forward biased. So the diode D1 allows electric current through it. This current will flows to the capacitor C1 and charges it to the peak value of input voltage , Vm.

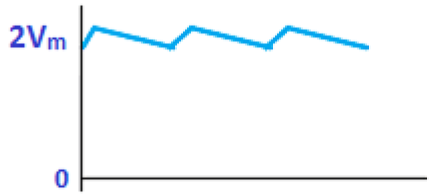
Diode D2 is reverse biased during the positive half cycle. So the diode D2 does not allow electric current through it. Therefore, the capacitor C2 is uncharged.



Input waveform



Full-wave voltage doubler



Output waveform

During negative half cycle:

During the negative half cycle, diode D_2 is forward biased whereas diodes D_1 and D_3 are reverse biased. Hence, the diode D_2 allows electric current through it. This current will flows to the capacitor C_2 and charges it. The capacitor C_2 is charged to twice the peak voltage of the input signal ($2V_m$). This is because the charge (V_m) stored in the capacitor C_1 is discharged during the negative half cycle.

Therefore, the capacitor C_1 voltage (V_m) and the input voltage (V_m) is added to the capacitor C_2 I.e Capacitor voltage + input voltage = $V_m + V_m = 2V_m$. As a result, the capacitor C_2 charges to $2V_m$.

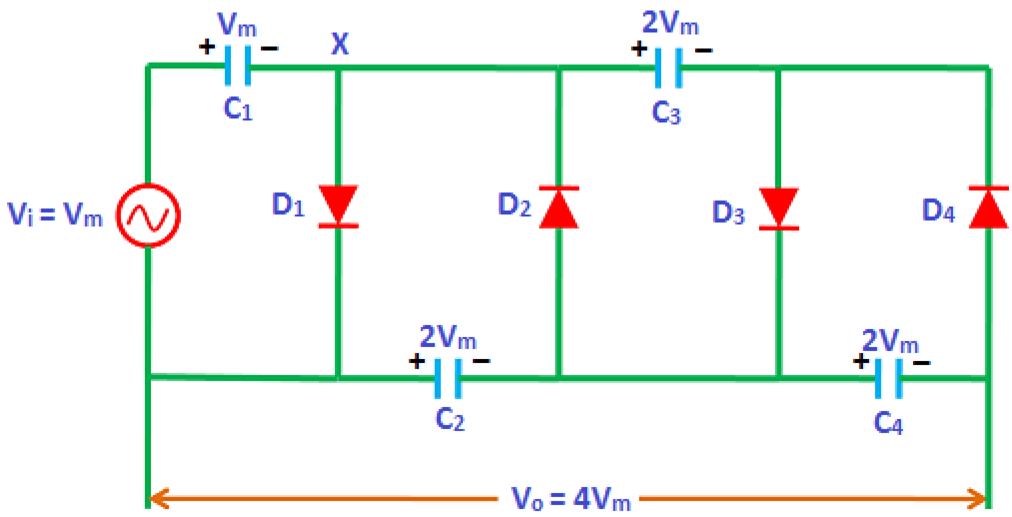
During second positive half cycle:

During the second positive half cycle, the diode D_3 is forward biased whereas diodes D_1 and D_2 are reverse biased. Diode D_1 is reverse biased because the voltage at X is negative due to charged voltage V_m, across C_1 and diode D_2 is reverse biased because of its orientation. As a result, the voltage ($2V_m$) across capacitor C_2 is discharged. This charge will flow to the capacitor C_3 and charges it to the same voltage $2V_m$.

The capacitors C_1 and C_3 are in series and the output voltage is taken across the two series connected capacitors C_1 and C_3. The voltage across capacitor C_1 is V_m and capacitor C_3 is $2V_m$. So the total output voltage is equal to the sum of capacitor C_1 voltage and capacitor C_3 voltage I.e. $C_1 + C_3 = V_m + 2V_m = 3V_m$.

Therefore, the total output voltage obtained in voltage tripler is $3V_m$ which is three times more than the applied input voltage.

Voltage Quadrupler



Voltage Quadrupler

The voltage quadrupler can be obtained by adding one more diode-capacitor stage to the voltage tripler circuit.

During first positive half cycle:

During the first positive half cycle of the input AC signal, the diode D_1 is forward biased whereas diodes D_2, D_3 and D4 are reverse biased. Hence, the diode D_1 allows electric current through it. This current will flows to the capacitor C_1 and charges it to the peak value of the input voltage I.e. V_m.

During first negative half cycle:

During the first negative half cycle, diode D_2 is forward biased and diodes D_1, D_3 and D_4 are reverse biased. Hence, the diode D_2 allows electric current through it. This current will flows to the capacitor C_2 and charges it. The capacitor C_2 is charged to twice the peak voltage of the input signal ($2V_m$). This is because the charge (V_m) stored in the capacitor C_1 is discharged during the negative half cycle.

Therefore, the capacitor C_1 voltage (V_m) and the input voltage (V_m) is added to the capacitor C_2 I.e Capacitor voltage + input voltage = $V_m + V_m = 2V_m$. As a result, the capacitor C_2 charges to $2V_m$.

During second positive half cycle:

During the second positive half cycle, the diode D_3 is forward biased and diodes D_1, D_2 and D_4 are reverse biased. Diode D_1 is reverse biased because the voltage at X is negative due to charged voltage V_m, across C_1 and, diode D_2 and D_4 are reverse biased because of their orientation. As a result, the voltage ($2V_m$) across capacitor C_2 is discharged. This charge will flow to the capacitor C_3 and charges it to the same voltage $2V_m$.

During second negative half cycle:

During the second negative half cycle, diodes D_2 and D_4 are forward biased whereas diodes D_1 and D_3 are reverse biased. As a result, the charge ($2V_m$) stored in the capacitor C_3 is discharged. This charge will flow to the capacitor C_4 and charges it to the same voltage ($2V_m$).

The capacitors C_2 and C_4 are in series and the output voltage is taken across the two series connected capacitors C_2 and C_4. The voltage across capacitor C_2 is $2V_m$ and capacitor C_4 is $2V_m$. So the total output voltage is equal to the sum of capacitor C_2 voltage and capacitor C_4 voltage I.e. $C_2 + C_4 = 2V_m + 2V_m = 4V_m$.

Applications of voltage multipliers

Voltage multipliers are used in:

- Cathode Ray Tubes (CRTs)
- Traveling wave tubes
- Laser systems
- X-ray systems
- LCD backlighting
- hv power supplies
- Power supplies
- Oscilloscopes
- Particle accelerators
- Ion pumps
- Copy machines

Amplifier

An amplifier is an electronic device that increases the voltage, current, or power of a signal. Amplifiers are used in wireless communications and broadcasting, and in audio equipment of all kinds. Many different types of amplifier are found in electronic circuits.

The main types of amplifier are,

1)AC Coupled Amplifier 2) DC Coupled amplifier 3) Large signal Amplifier

4)Small signal Amplifier 5) Audio frequency amplifier 6) Wide Band Amplifier

7)Radio Frequency Amplifier 8) Low Noise Amplifier

AC coupled amplifier

In AC coupled amplifier, stages are coupled together in a such a way that Dc levels are isolated and all the components of ac signal are transferred from stage to stage. Application: Biopotential Amplifier(ECG,EMG,CT Scan, Patient monitoring Device)

DC coupled amplifier

In DC coupled amplifier, DC is not isolated from the stages of an amplifier, Both DC and AC are pass from one stage to next stage. Application : Low frequency Amplification such as sensors and Transducers.

Large signal amplifier

Large signal Amplifier are amplified to an appropriate level of signal like 1v to 100v. Application :Used last stage in electronic system

Small signal Amplifier

Small signal Amplifier amplified up to 1v. Application : Designed to reduce the effect of noise. Sensors such as photo device , to drive relay , loud speaker.

Audio Frequency Amplifier

This amplifier is used to amplify radio signal frequency in the range of 20Hz to 20KHz. Application: : Talking toys, hearing aid

Wide Frequency Amplifier

Amplify very wide of frequencies like tens of frequency to mega Hz of frequencies. Application : Cable TV , Antenna, CRO

Radio Frequency Amplifier

It amplified radio frequency wave like 100KHz to 1 Ghz. Application :Commercial and defense avionics , space and deep face , electronic war fare, naval application , mobile Internet.

Low Noise Amplifier

This amplifier amplify low noise signal like less than 10mv. Application :Radio Telescope ,cellular Telephone , gps receivers , wireless LAN, Satellite communication

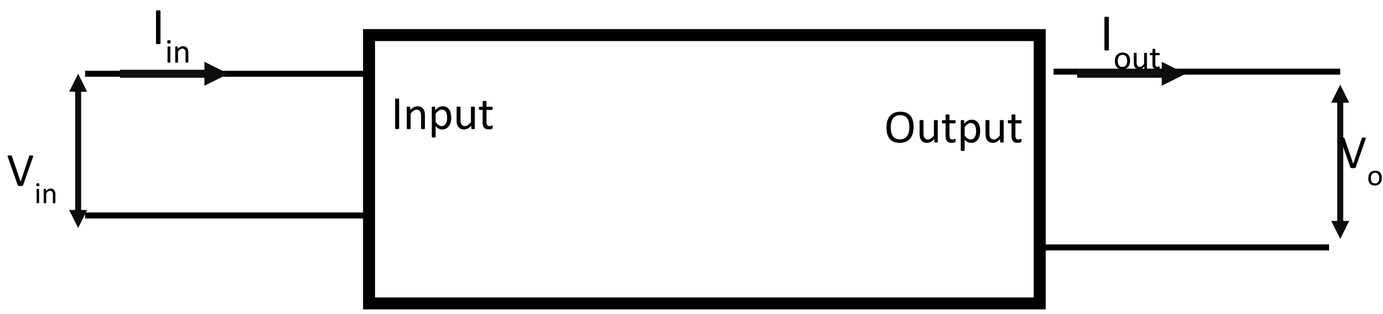
Gain

It is the measure of the amount of amplification happens on signal. Gain is the ratio of output voltage to Input Voltage, Output Current to Input Current or output power to input power

Voltage Gain $A_v = V_{out}/V_{in}$

Current Gain $A_i = I_{out}/I_{in}$

Power Gain $A_p = P_{out}/P_{in}$



Power Gain $A_p = P_{out}/P_{in}$

In terms of voltage and current $A_p = V_{out} * I_{out} / V_{in} * I_{in}$

$= V_{out} / V_{in} * I_{out} / I_{in} = A_v * A_i$

Problem1

An Amplifier produces an output voltage of 2V of an input of 50mV

If in this condition input and output current of 4mA and 200 mA respectively, Determine

1)Voltage Gain

2)Current Gain

3)Power Gain

A_v =2V/50mV=1000/25 =40

A_i =50

A_p=2000

Input Resistance

Input resistance is the ratio of input voltage to input current and it is expressed in ohms. The input of an amplifier is normally purely resistive (i.e. any reactive component is negligible) in the middle of its working frequency range (i.e. the **mid-band**). In some cases, the reactance of the input may become appreciable (e.g. if a large value of stray capacitance appears in parallel with the input resistance). In such cases we would refer to **input impedance** rather than input resistance.

F**requency response**

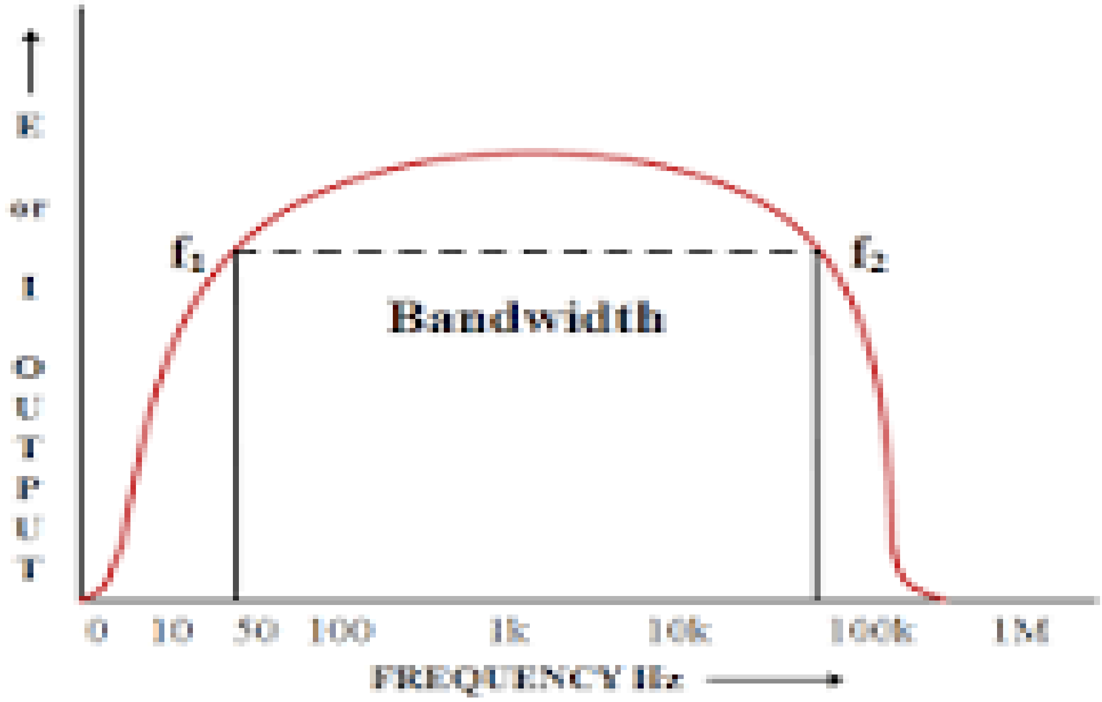
For any electronic circuit, the behavior of amplifiers is affected by the frequency of the signal on their input terminal. This characteristic is known as the **frequency response**.

Frequency response is one of the most important property of amplifiers. In the frequency range that amplifiers have been designed for, they must deliver a constant and acceptable level of gain. The frequency response depends directly on the components and the architecture chosen for the design of the amplifier.

Frequency response of an amplifier is usually specified in upper and lower cut off frequencies.

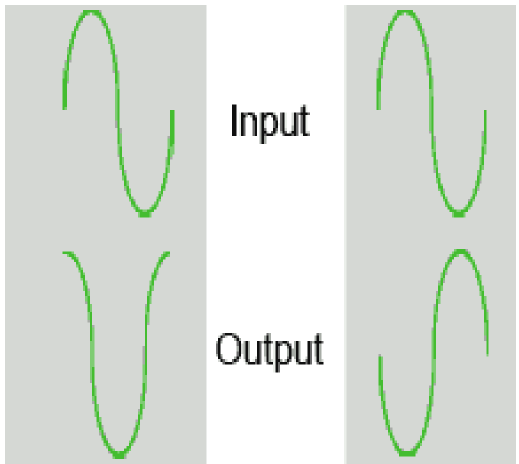
Bandwidth T

he bandwidth represents the amount of frequencies or the band of frequencies that the amplifier is most effective in amplifying. The bandwidth(BW) of an amplifier is the difference between the frequency limits of the amplifier. Let upper limit of frequency be f1 and lower limit be f2 then bandwidth. BW=f1−f2.



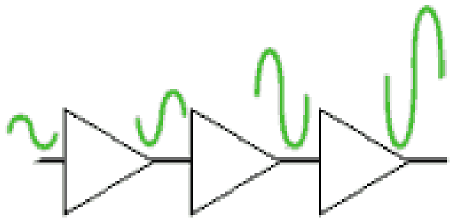
Phase shift

Phase shift in an amplifier is the amount by which the output signal is delayed or advanced in phase with respect to the input signal expressed in degrees.



90° phase change

180° phase change common in amplifiers



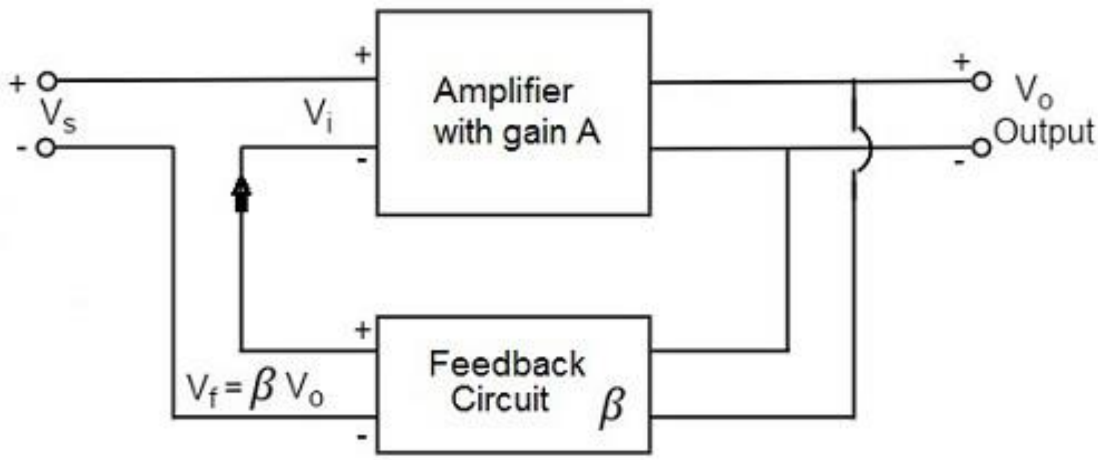
180° phase shift caused by transistor action in each stage of a three stage amplifier

Negative Feedback

Feedback is the process by which a fraction of the output signal, either a voltage or a current, is used as an input. If this feed back fraction is opposite in value or phase ("anti-phase") to the input signal, then the feedback is said to be **Negative Feedback**, or *degenerative feedback*.

Negative feedback also has effects of reducing distortion, noise, sensitivity to external changes as well as improving system bandwidth and input and output impedances.

Negative Feedback is the most common form of feedback control configuration used in process, micro-computer and amplification systems.



$$V_i = V_s - V_f = V_s - \beta V_o$$

The quantity $\beta = V_f/V_o$ is called as feedback ratio or feedback fraction.

Let us consider the case of negative feedback. The output V_o must be equal to the input voltage (V_s - βV_o) multiplied by the gain A of the amplifier.

Hence,

$$(V_s - \beta V_o)A = V_o$$

$$AV_s - A\beta V_o = V_o$$

Or

$$AV_s = V_o(1 + A\beta)$$

Therefore,

$$V_o/V_s = A/(1 + A\beta)$$

Let A_f be the overall gain (gain with the feedback) of the amplifier. This is defined as the ratio of output voltage V_o to the applied signal voltage V_s, i.e.,

$$A_f = \text{Output voltage}/\text{Input signal voltage} = V_o/V_s$$

So, from the above two equations, we can understand that,

The equation of gain of the feedback amplifier, with negative feedback is given by

$$A_f = A/(1 + A\beta)$$

Exercise Problems

- Am Amplifier with negative feedback Applied has an open loop voltage gain 50 and one –tenth of output feedback to its input(β=0.1).Determine over all voltage gain with negative feedback applied.

  Ans:8.33

- In the above problem, amplifiers open loop gain increases by 20%,Determine the percentage increase in overall voltage gain.

  Hint: Av= Av+20%Av .Increase in voltage gain expressed as ration of change in over all gain with respect to the current gain

- AN Integrated circuit that produces open loop gain of 100, is to be used as an basis of an amplifier stage having precise voltage gain of 20,dtermin the amount of feedback required.

  Hint: Av'=Av/1+ βAv

  β = 1/Av' -1/Av

  Multistage Amplifier

  If the gain obtained by a single-stage **amplifier** is not sufficient, then we will connect multiple transistors to increase the gain of the AC input signal. Since multiple stages are present between the input and output of this circuit, it is known as a Multistage amplifier.

  In Multi-stage amplifiers, the output of first stage is coupled to the input of next stage using a coupling device. These coupling devices can usually be a capacitor or a transformer. This process of joining two amplifier stages using a coupling device can be called as **Cascading**.

  CC Amplifier

- Its voltage gain is less than unity.
- It is not suitable for intermediate stages.

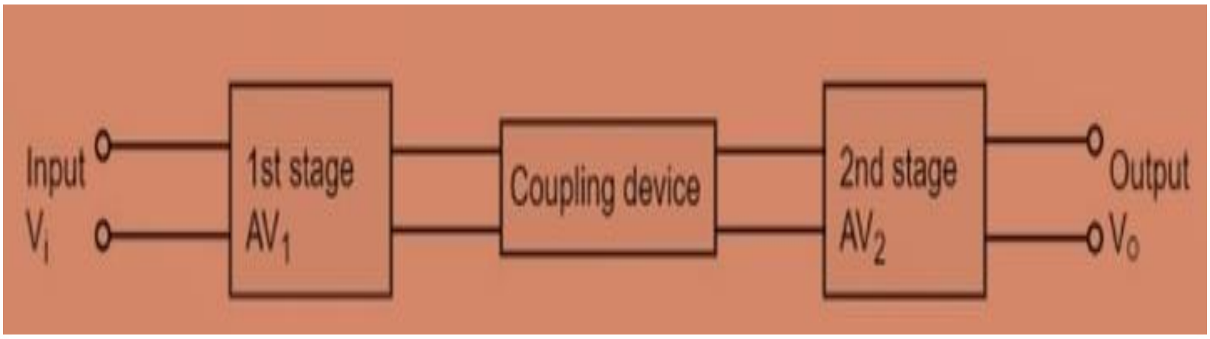
  CB Amplifier

- Its voltage gain is less than unity.
- Hence not suitable for cascading.

  CE Amplifier

- Its voltage gain is greater than unity.
- Voltage gain is further increased by cascading.

- The characteristics of CE amplifier are such that, this configuration is very suitable for cascading in amplifier circuits. Hence most of the amplifier circuits use CE configuration.
- The overall gain is the product of voltage gain of individual stages.
- Av=Av1*Av2 = v2/v1 *vo/v2 = vo/v1
- Where A_V = Overall gain, A_{V1} = Voltage gain of 1st stage, and A_{V2} = Voltage gain of 2nd stage.



Coupling Devices

In Multi-stage amplifiers, the output of first stage is coupled to the input of next stage using a coupling device. These coupling devices can usually be a capacitor or a transformer.

Need of Coupling in Multistage Amplifier

- **1.** Coupling in an amplifier is needed to connect multiple successive stages in a cascade.
  2. Proper amplifier coupling is needed to avoid effect in DC biasing when multiple amplifier stages are connected.
  3. Coupling is needed to increase the overall gain of the amplifier.
  4. Coupling is needed to reduce noise when multiple amplifier stages are connected.
  5. Proper coupling is needed to reduce the wastage of power.

Types of Coupling in an Amplifier

1)Capacitor coupling

2)Transformer coupling

3)Direct Coupling

Direct Coupling

When the output of an amplifier stage is directly connected to the input of the next stage then it is called Direct Coupling. In the Direct Coupling technique, no coupling device(such as a resistor, capacitor, inductor) is used.

Direct Coupled Amplifier Applications

1. Direct Coupled Amplifiers are used for low-frequency applications, such as sensors, transducers, etc.
2. Direct Coupled Amplifiers are used to amplify DC signals also.
3. They are used for low current applications such as Buzzer, Tonner, etc.

Advantages of Direct Coupled Amplifier

1. It does not use any coupling elements that's why the circuit is very simple and easy to make.
2. This circuit is very low-cost.
3. This circuit can amplify both the AC and DC signals.

Disadvantages of Direct Coupled Amplifier

1.It is suitable for low-frequency applications only.
2. It is suitable for low-current applications only.
3. It has a very low bandwidth.
4. The Q-point is not stable due to temperature variations.

RC coupling in amplifier

- C is connected in parallel with resistor R, this is the bypass capacitor used to provide the low reactance path for unwanted noise signal.

Advantages of RC Coupled Amplifier

1. It is suitable for high-frequency applications.
2. Its Q-factor is stable and has a smooth bandwidth.
3. It provides constant gain over a wide frequency range.

4. As it uses cheaper coupling devices such as resistors, capacitors, it is low- cost and economical.

Disadvantages of RC Coupled Amplifier

1. The main disadvantage is it has very poor impedance matching characteristics.
2. Due to the effective load resistance, it provides low voltage and power gain.
3. It is not suitable for Low-frequency applications.
4. These amplifiers become noisy with increasing their age.

Transformer Coupling in Amplifier

When the output of the amplifier stage is connected to the input of the next stage through a transformer, then it is called a transformer-coupled amplifier. The transformer used to couple two stages is called a coupling transformer.

Transformer Coupled Amplifier Applications

1. Transformer Coupling in amplifier is mainly used for impedance matching.
2. Transformer coupled amplifiers are used as power amplifiers to drive high power speaker load.
3. Transformer coupling is used in high power audio amplifiers.

Advantages of Transformer Coupled Amplifier

1. It provides a very high gain.
2. It provides a very good impedance matching property.
3. These amplifiers have high efficiency and low losses.

Disadvantages of Transformer Coupling Amplifier

- 1. These amplifiers have poor frequency response, the gain decreases with an increase in frequency.

  2. These amplifiers are costly because of using the transformer as a coupling device.

3. Humming noise occurs in the transformer.