

## Chapter: 4 Voltage Regulator

### Voltage Regulation

An exemplary power supply always has constant voltages on output terminals, irrespective of the values of current received. However, output voltages, in a practical power supply change with the value of its load current. Specifications of a power supply also contain its full load current ratings ( $I_{FL}$ ), which is the maximum current received through the supply. When full load current is being achieved, at that point, terminal voltages of the power supply are called full load voltages ( $V_{FL}$ ). No-load voltages ( $V_{NL}$ ) when no current is being received from the supply (zero current), terminal voltages of the power supply at that time are called no-load voltages. Measurement of efficiency of a power supply, through which it could be ascertained, how better a power supply is, enables a power supply to keep it on a constant voltage between no load and full load conditions. Its percent voltage is called regulation.

### Line Regulation

When there is a change in the input voltage that is ac voltage of the power source the circuitry used known as a regulator which retains the constant value of voltage at the output. Line regulation is known as a percentage variation in the output voltage according to resultant variation in the input voltage. Line regulation also defined in percentage voltage. For instance, the line regulation of 0.05 percent volts indicates that the output voltage varies 0.05% when there is input voltage has increment or decrement single volt. Line regulation can be found with the use of a given formula.

$$\text{Line regulation} = (V_{out}/V_{in})100\%/V_{in}$$

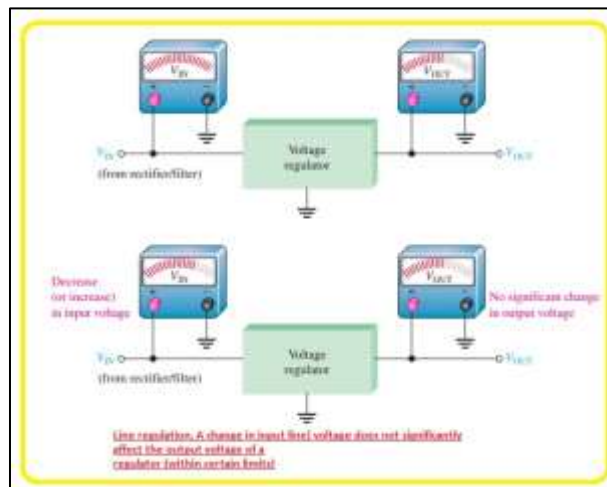


Figure 4.1 Line regulation

### Load Regulation

The quantity of current passing in the load varies according to the change in load resistance the voltage regulator should retain an almost constant output voltage about the load as shown in below figure. Load regulation can also be defined as the percentage variation in the output voltage in the variation in the load current. The other way to define the load regulation is percentage variation in

the output voltage from no-load state to full load state. In an alternative way the load regulation can be defined as percentage variation in the output voltage for every mA alteration in the load current. For instance, the load regulation of 0.01 percent millimeter indicates that the output voltage varies by 0.01 % when the load current rises or decreases 1 mA.

$$\text{Load regulation} = (V_{NL} - V_{FL})/V_{FL} \times 100\%$$

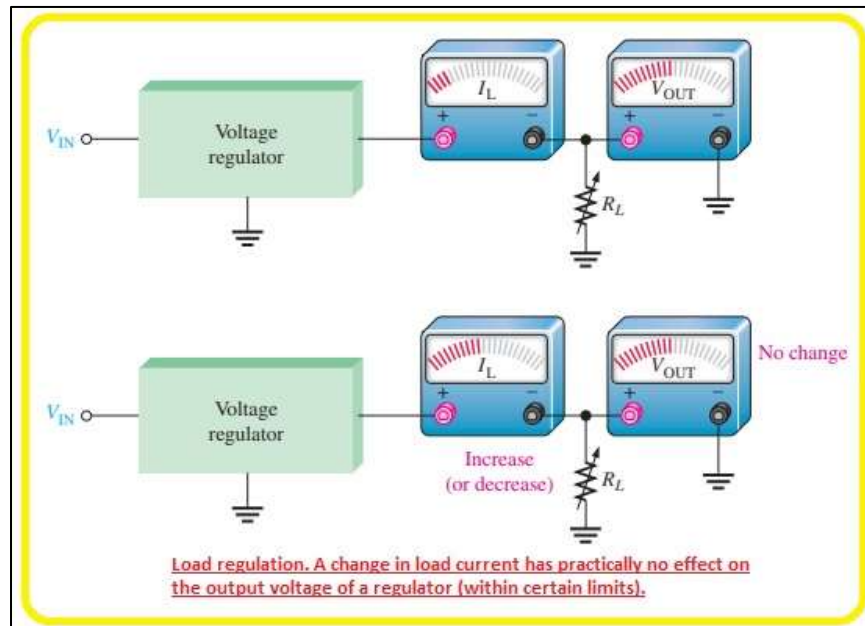


Figure 4.2 Load regulation

## Voltage Regulators

To control voltage levels, a voltage regulator is used. It is also called a closed-loop control system because it provides feedback via examination of output voltages. It compensates for every tendency of output voltages and increases or decreases supply voltage automatically according to requirement. Thus, the objective of a regulator is to eliminate any changes in output voltage. There are two types of voltage regulators.

1. Series Voltage Regulator
2. Shunt Voltage Regulator

## Comparison of Series & Shunt Voltage Regulator

Sr. No.	Series Voltage Regulator	Shunt Voltage Regulator
1	The control element is in parallel with the load.	The control element is in series with the load.
2	Only small current passes through the control element which is required to be diverted to keep output constant.	The entire load current $I_L$ always passes through the control element.
3	Any change in output voltage is compensated by changing the current $I_{sh}$ through the control element as per the	Any change in output voltage is compensated by adjusting the voltage across the control element as per the

	he control signal.	control signal.
4	The control element is low current, high voltage rating component.	The control element is high current, low voltage rating component.
5	The regulation is poor.	The regulation is good.
6	Efficiency depends on the load current.	Efficiency depends on the output voltage.
7	Preferred for fixed voltage applications	Preferred for fixed as well as variable
8	Simple to design.	Complicated to design as compared to shunt regulators
9	Examples: Zener Shunt regulators, transistorized shunt regulator etc.,	Examples: Series feedback type regulator, series regulator with pre-regulator and feedback limiting etc.,

### Zener Diode Voltage Regulator

When the zener diode is operated in the breakdown or zener region, the voltage across it is substantially constant for a large change of current through it. This characteristic permits it to be used as a voltage regulator. Fig. 4.3 shows the circuit of a zener diode regulator. As long as input voltage  $V_{in}$  is greater than zener voltage  $V_Z$ , the zener operates in the breakdown region and maintains constant voltage across the load. The series limiting resistance  $R_S$  limits the input current.

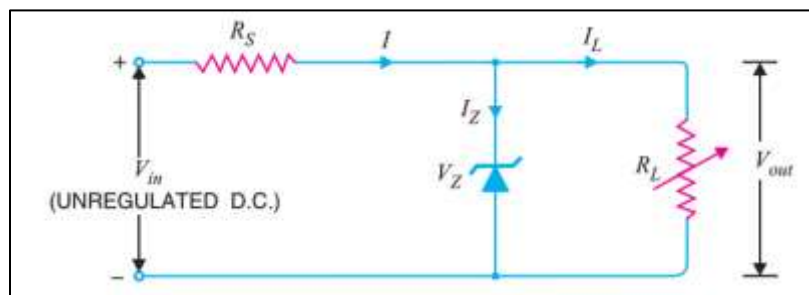


Figure 4.3 circuit of zener diode regulator

### Series Voltage Regulator

A regulator, the control element (normally a transistor) which is mounted within a series of input voltage and output voltage, is known as a series voltage regulator.

In figure 4.2, a functional block diagram of a series type regulator has been shown. A functional diagram works as a useful model so that the principles of a series regulator model could easily be understood. Output, senses variations in a simple circuit, output voltage, and error detector compares simple voltage with a reference voltage, and thus provides signals to control element for maintaining a constant output voltage. Along with a filter capacitor, unregulated DC input supplied through a rectifier (shown as  $V_{in}$  in the diagram), is passed on to the control element mounted in the regulator, through the output of which, regulated output voltages ( $V_o$ ) are produced. Control Element is a device, by means of which constant output voltages are acquired by adjusting its operating state according to needs. As a control element is being fixed in series between ( $V_{in}$ ) and ( $V_o$ ), therefore, such type of regulator is also called series type voltage regulator. A sampling circuit

produces feedback proportionate to the output voltage ( $V_o$ ). These feedbacks are received by the comparator circuit in the form of a signal, which through mutual comparison of the reference signal and feedback signal provides its output to the control element in the shape of the control signal. This control signal adjusts the operating state of a control element.

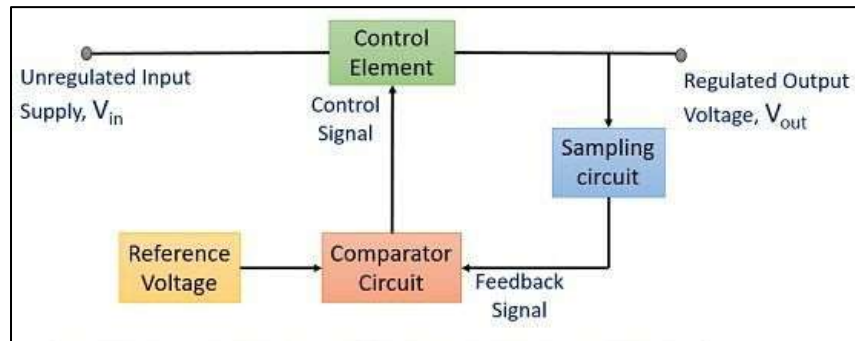


Figure 4.4 Block diagram of series voltage regulator

For example, if  $V_o$  reduces due to an increase in load, the comparator produces such an output, due to which control element increases ( $V_o$ ). In other words,  $V_o$  increases automatically until the comparator circuit, sensing fresh variations between the feedback signal and reference voltage, starts providing a new control signal to the control element. Similarly, the comparator circuit passes such a control signal to the control element as a result of an increase in  $V_o$ , as a result of which  $V_o$  decreases. For further clarification, a block diagram of a series voltage regulator has been shown in figure 4.3.

### Shunt Voltage Regulator

A regulator, the control element of which is parallel to the load, is known as a shunt regulator. Functional block diagram of a shunt regulator is shown in figure 4.4. Components in the block diagram perform exactly the same functions which components in a series regulator use to perform. However, it has to be remembered that the control element in a shunt voltage regulator is parallel to the load, which it is called a shunt regulator. The control element, in case of changes in load current ( $I_L$ ) maintains a constant load voltage on load, by passing a low or high shunt current ( $I_{SH}$ ) from within it.

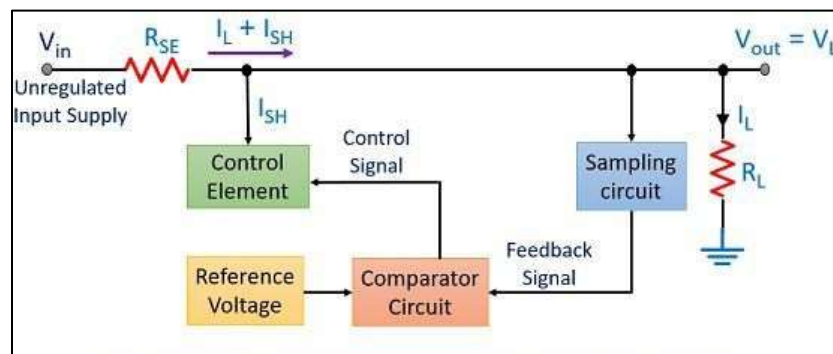


Figure 4.5 Shunt voltage regulator block diagram

If the control element is considered a variable resistance as per the diagram, the process of the control element becomes easy to understand. For example, in case of a decrease in load voltage, the resistance of the control element increases automatically, thus small current flows towards the control element, and load voltages increase. Inversely, if load voltages are increased, the resistance of the control element gets low, thus load voltage decrease due to the passing of more current through the control element.

In other words, source resistance ( $R_s$ ) on the input or unregulated side of the diagram; assumes the shape of a voltage divider, due to parallel mounting of the control element and ( $R_L$ ). Thus, when the resistance of a control element increases, the resistance of the parallel combination increases, and load voltage also increase as a consequence of voltage divider action.

### **Integrated circuit voltage regulators**

Integrated circuit voltage regulators are available as series regulators or as switching regulators. The popular three-terminal regulators are often used on separate pc boards within a system because they are inexpensive and avoid problems associated with large power distribution systems (such as noise pickup).

An IC based voltage regulator can be classified in different ways. A common type of classification is 3 terminal voltage regulator and 5 or multi terminal voltage regulator. There is a third set of classification as,

1. Fixed positive voltage regulator
2. Fixed negative voltage regulator
3. Adjustable voltage regulator
4. Dual-tracking voltage regulator

### **Fixed Positive Voltage Regulator 78xx Family**

This IC regulator provides a fixed positive output voltage. Although many types of IC regulators are available, the 7800 series of IC regulators are the most popular. The last two digits in the part number indicate the dc output voltage. For example, the 7812 is a + 12V regulator whereas the 7805 is a + 5V regulator. *These IC's include thermal shutdown protection and internal current limiting.* The 78XX series are primarily used for fixed output voltages, but with additional components, they can be set up for variable voltages or currents. The 78xx Voltage regulators are sometime referred to as (L78xx, LM78xx, or MC78xx). When required to supply a specific voltage to your circuit from a higher voltage input 78xx family of voltage regulators are champion still commonly used today in a considerable no of electronic devices due to their reliability robustness and simplicity. The 78xx series of voltage regulators are used in regulated power supplies. They are Available in different models can be referred to as 78xx series, 7800 series and it is sometimes prefixed with LM or the MC depending on the manufacturer.

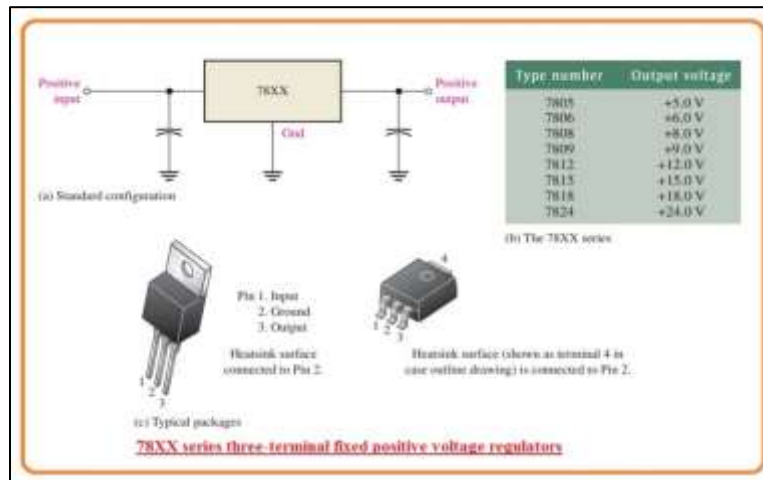


Figure 4.6 78XX series three-terminal fixed positive voltage regulators.

- **Pin 1:** it is left hand pin connected to +VE or red terminal on a suitable battery acting as supply voltage input or  $V_{IN}$ .
- **Pin 2:** It is the centre pin and the heat sink tab is connected to ground both on your supply voltage -VE or black terminal on the battery and it is also to the ground of your target circuit Shown as V or **GND** on your schematic. The centre pin may sometimes be cropped with the heat sink tab taking over its function.
- **Pin 3:** it is the output voltage that your target circuit will use as **V+**.

#### Advantages of 78xx:

- It is very easy to use just select the required 7800 series regulator and place it in circuit for it to work.
- It is very few additional electronic components are required using the basic circuit only capacitors are required for the input and output.
- It is Low cost these linear voltage regulators can be obtained for a very low cost.

#### Disadvantages of 78xx:

- 7800 series regulators are a voltage linear regulator and therefore they offer a low efficiency compared to switch mode power supplies.
- 7800 series regulators chip requires a voltage drop cross it to work typically this voltage is around 2.5V minimum and more is better.
- 7800 series regulators are old technology and more modern integrated circuits would normally be used these days

#### Fixed Positive Voltage Regulator LM340 Series

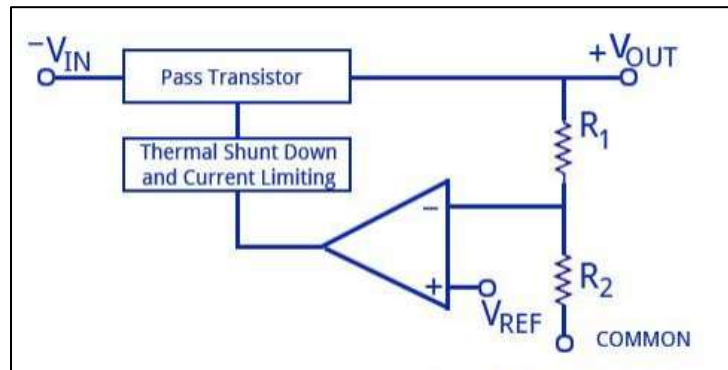


Figure 4.7 General Block Diagram of LM340 Series

The voltage regulator using LM340 IC is the most used voltage regulator IC. As shown in the block diagram above, the built-in reference voltage  $V_{ref}$  drives the non-inverting input of the operational amplifier. There are many stages of voltage gain for the op-amp used here. This high gain helps the op-amp to make the error voltage between the inverting and non-inverting terminals to be almost zero. Thus, the inverting input terminal value will also be the same as the non-inverting terminal,  $V_{ref}$ . Thus, the current flowing through the potential divider can be written as  $I = V_{ref}/R_2$ . The resistor  $R_2$  shown in the figure is not an external component connected to the IC, but an internal resistor that is built inside the IC during manufacture. Due to the conditions above, the same current flows through  $R_1$ . Thus the output voltage can be written as  $V_{out} = V_{ref}/R_2 (R_1 + R_2)$  this shows that the output of the regulator can be controlled by putting desired values for  $R_1$  and  $R_2$ . The IC has a series pass transistor that can handle more than 1.5 A of load current *provided that enough heat sinking is provided along with it. Like other IC's, this IC also has thermal shutdown and current limiting options.* Thermal shutdown is a feature that will turn off the IC as soon as the internal temperature of the IC rises above its preset value. This rise in temperature may mostly be due to excessive external voltage, ambient temperature, or even heat sinking. The preset cut-off temperature value for LM340 IC is 175° C. Because of thermal shutdown and current limiting, devices in the LM 340 series are almost indestructible.

### Fixed Negative Voltage Regulators 79xx Family

The Negative voltage regulators are equally important as positive voltage regulators. The 79xx series of voltage regulators are the usually used negative voltage regulators. They are three terminal regulators and is available with fixed output voltages of -5V, -12V and -15V. The 79XX series is the negative output counterpart to the 78XX series, however the pin assignments are different on this series. Other specifications are basically the same

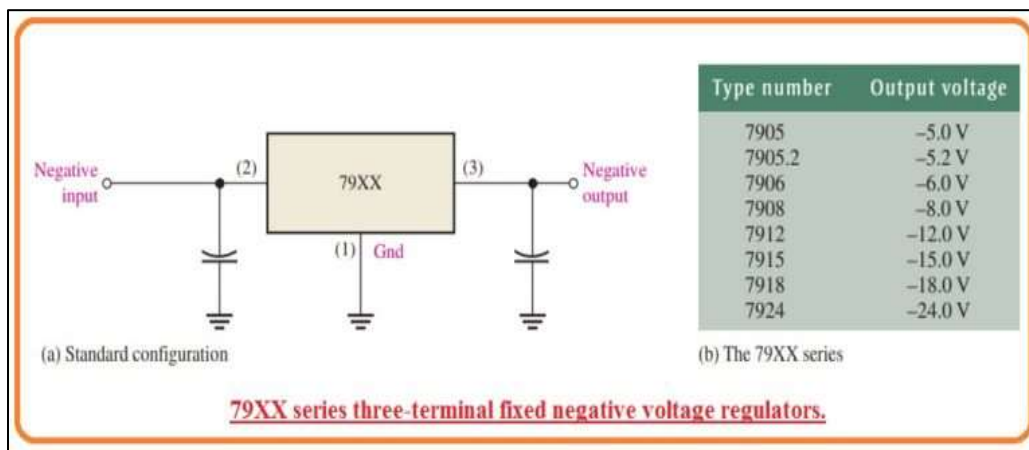


Figure 4.8 79XX series three-terminal fixed negative voltage regulators.

### Linear Adjustable Positive Voltage Regulators

The LM317 is an example of a three-terminal positive regulator with an adjustable or variable output capacity as shown in figure 4.7. There is a fixed reference voltage of +1.25 V between the output and adjustment terminals. There is no ground pin. The basic arrangement is can be seen in the below figure.

The output voltage is calculated by:

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

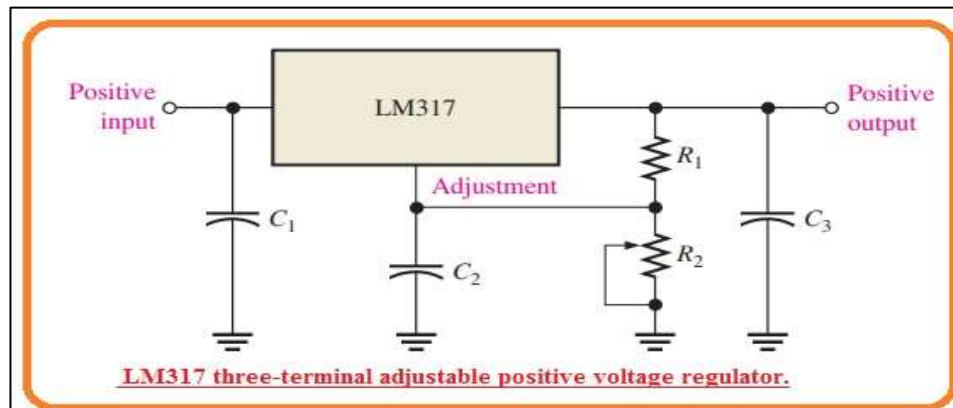


Figure 4.9 LM317 three-terminal adjustable positive voltage regulator.

The capacitor is used for decoupling and has not any effect on the dc operation. Note that there is an input-output and variable terminal. The exterior fixed-resistance and outer variable resistance offer the output voltage variance or adjustment. The value of  $V_{Out}$  can be changed from 1.2 volts to 37 volts according to the value of resistance. The LM317 can offer large then the 1.5 amperes output current to the output. LM317 is functioning like a floating regulator since the adjustment terminal is not linked with the ground but floats the value of voltage about the resistance  $R_2$ . It permits the output voltage to be larger than the fixed voltage regulator.

## Linear Adjustable Negative Voltage Regulators

The LM337 is a negative output opposite part of LM317 and the finest category of this category of the integrated circuit. Similar to the LM317 LM337 needs 2 exterior resistances for output voltage regulation can be seen in the below figure. The value of output voltage can be varied from -1.2 volts to -37 volts according to the value of resistance. The operation of the capacitor in this circuitry is to do decoupling and has no effect at dc operation.

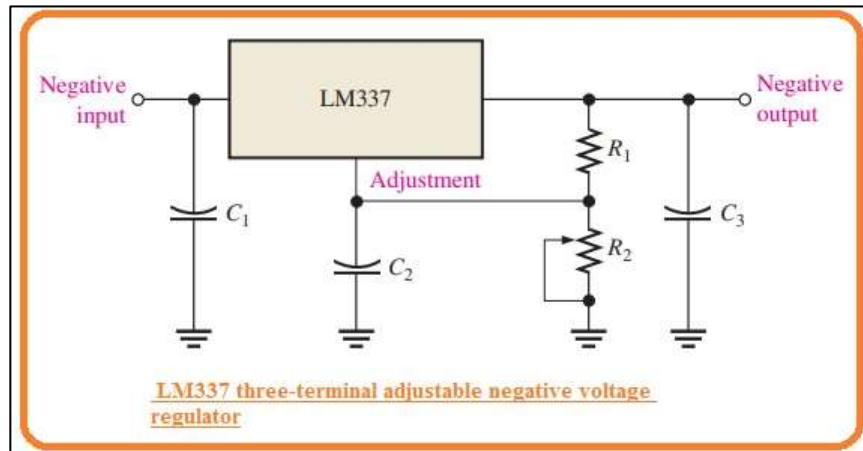


Figure 4.10 LM337 three-terminal adjustable negative voltage regulator.

## Linear Adjustable General Purpose Voltage Regulator – IC 723:

The 723 voltage regulator is commonly used for series voltage regulator applications. It can be used as both positive and negative voltage regulator. It has an ability to provide up to 150 mA of current to the load, but this can be increased more than 10A by using power transistors. It also comes with comparatively low standby current drain, and provision is made for either linear or fold-back current limiting. LM723 IC can also be used as a temperature controller, current regulator or shunt regulator and it is available in both Dual-In-Line and Metal Can packages. The input voltage ranges from 9.5 to 40V and it can regulate voltage from 2V to 37V.

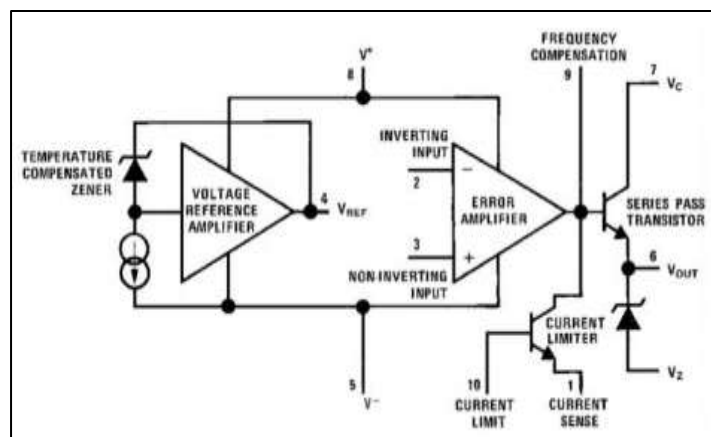


Figure 4.11 functional block diagram of IC723.

### Features of IC723:

- Unregulated dc supply voltage at the input between 9.5V & 40V
- Adjustable regulated output voltage between 2 to 3V.
- Maximum load current of 150 mA ( $I_{Lmax} = 150\text{mA}$ ).
- With the additional transistor used,  $I_{Lmax}$  up to 10A is obtainable.
- Positive or Negative supply operation
- Built in short circuit protection.
- Very low temperature drift and High ripple rejection.

### Regulated Power Supply:

Almost all basic household electronic circuits need an unregulated AC to be converted to constant DC, in order to operate the electronic device. All devices will have a certain power supply limit and the electronic circuits inside these devices must be able to supply a constant DC voltage within this limit. This DC supply is regulated and limited in terms of voltage and current. But the supply provided from mains may be fluctuating and could easily break down the electronic equipment, if not properly limited. This work of converting an unregulated alternating current (AC) or voltage to a limited Direct current (DC) or voltage to make the output constant regardless of the fluctuations in input, is done by a regulated power supply circuit. The electronics circuit uses semiconductor components and devices which requires stable dc voltage for their operation. The Batteries, cells cannot be used because they are costly and inconvenient to use. So it is necessary to convert the available AC voltage of mains supply into D.C. voltage and can be used for operation of electronic circuits. In short a dc power supply is an electronic circuit which generates dc voltage using ac as input. If output of dc power supply remains unaltered under the variation of load current or input ac then it is called as regulated power supply.

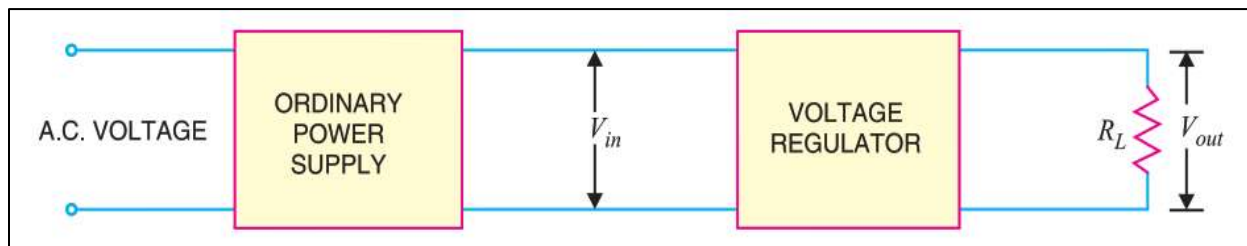


Figure 4.12 Block diagram of regulated power supply.

### Why Regulated Power Supply is required?

In an unregulated power supply, that is, under ordinary power supply conditions, the voltage regulation is not good. Changes in the load current cause the output voltage to change as well. Again, the variations in the input ac voltage causes the output voltage to change as well.

- Under practical situations, there are a lot of factors, there are a lot of variations in ac line voltage that are not in our control. This causes the dc output voltage to fluctuate. Most of *the electronic circuits wouldn't work properly on such output voltage fluctuations. Hence we need a regulated dc power supply.*

- The internal resistance of ordinary power supply is relatively large ( $> 30 \Omega$ ). This in turn affect the load current drawn from the supply. These variations in dc voltage may result in the erratic operation of electronic circuits. Hence we need a regulated dc power supply.

### DC Regulated Power Supply:

A DC Power supply which maintains the output voltage constant irrespective of AC mains fluctuations or load variations is known as regulated dc power supply. It has following components.

A regulated power supply consists of an ordinary power supply and voltage regulating device. Fig. 4.13 shows the block diagram of a regulated power supply. The output of ordinary power supply is fed to the voltage regulator which produces the final output. The output voltage remains constant whether the load current changes or there are fluctuations in the input ac voltage.

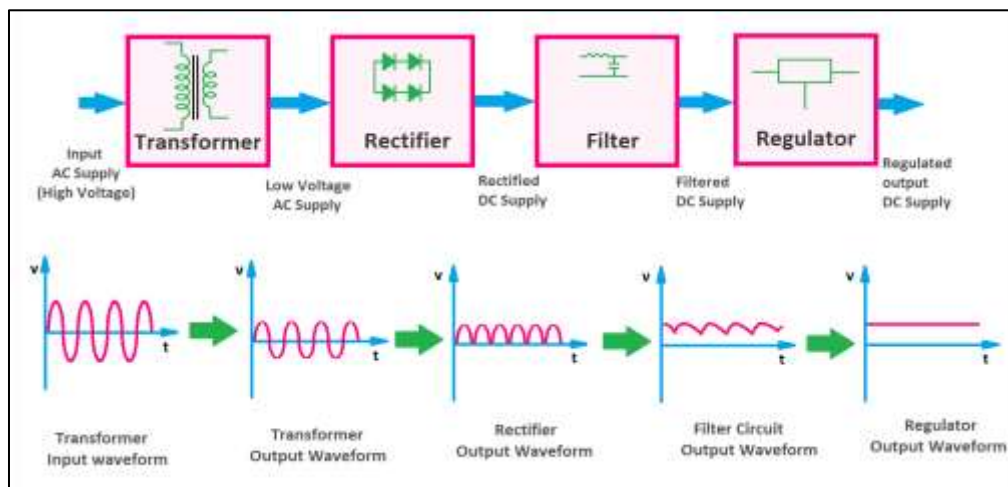


Figure 4.13 block diagram of DC regulated power supply.

1. Transformer: It converts high ac voltage to low ac voltage.
2. Bridge Rectifier: It converts ac input voltage to dc voltage.
3. Filter Circuit: It reduces ripples which is present in output of rectifier.
4. Regulator Circuit: Eliminates ripple by setting DC output to a fixed voltage.

### Transformer

The transformer is a device that transfers the electrical energy from one circuit to another circuit by changing the voltage level. Here, in this circuit, a step-down transformer is used that is used to step down the voltage. Generally, it takes the 220V supply as input and provides 12V or 24V or 6V as the output according to the circuit output requirement. By changing the *turn's* ratio of the transformer, the output voltage can be changed. The transformer is not an essential part of a regulated power supply circuit, it is only used when voltage steps down is required. If the output 230V DC supply is required, then there is no requirement for a transformer.

## Rectifier Circuit

The rectifier is an electrical or electronic circuit made of PN Junction Diodes. The main function of the rectifier circuit is to convert the AC supply into a DC supply. It takes the Alternating current or AC power supply as input and gives the direct current or DC power supply as output. The rectifier is the second block of the regulated power supply. Both half and full-wave rectifier circuits can be used. The half-wave rectifier circuit rectifies one-half cycle only and makes more power loss but the full-wave rectifier circuit rectifies both half cycles and makes a very low power loss. For, this reason the center tapped full wave rectifier or bridge rectifier circuit is mostly used.

## Filter Circuit

The output of the rectifier circuit cannot provide the pure DC supply. There are some ripple or AC components available in the DC power supply. To remove those ripples or make the DC supply pure, a filter circuit is used. The output of the rectifier is connected to the input of the filter circuit. Generally, a pure capacitor filter, LC filter, or pi filter is used. According to nature, a capacitor block DC and allow AC, so it can be connected in parallel for the filtration. On the other hand, an inductor can block AC and allow DC, so it can be connected in series for filtration purposes. The pi filter uses both the inductor and capacitor in the same circuit for the filtration.

## Regulator Circuit

It is the last and most important block of the regulated power supply. The regulator actually does the regulation. The regulator circuit uses different types of regulating components and devices such as a Series inductor, Zener Diode, IC 78XX series, IC 317, etc. A Zener diode can regulate voltage by just connecting it in reverse bias. IC 7805 is the most common usable regulator IC. It always provides a constant 5V DC voltage as its output. A Zener diode may not have the 100% efficiency but the integrated circuits provides the most possible efficiency. Zener diode helps to regulate the voltage only whereas the voltage regulator ICs can take care of load current also.

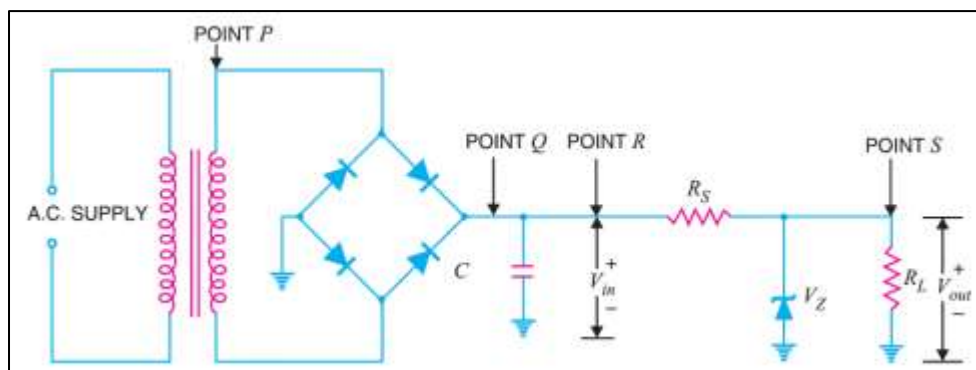


Figure 4.14 circuit of DC regulated power supply.

Fig. 4.14 shows the complete circuit of a regulated power supply using zener diode as a voltage regulating device. As you can see, the regulated power supply is a combination of three circuit viz., (i) bridge rectifier (ii) a capacitor filter C and (iii) zener voltage regulator. The bridge rectifier converts the transformer secondary ac voltage (point P) into pulsating voltage (point Q). The pulsating dc voltage is applied to the capacitor filter. This filter reduces the pulsations in the rectifier

dc output voltage (point R). Finally, the zener voltage regulator performs two functions. Firstly, it reduces the variations in the filtered output voltage. Secondly, it keeps the output voltage ( $V_{out}$ ) nearly constant whether the load current changes or there is change in input ac voltage.

The regulated DC power defines a DC power supply which maintains the DC voltage constant irrespective of AC input fluctuations in load resistance values. Commonly the bridge rectifier is used in regulated power supply. Its function is to convert the AC mains voltage to the rectified DC voltage. The voltage contains small amount of ripple the pulsating voltage is passed through the filter circuit. Its function is to bypass the filter. The pulsating opposes the AC fluctuations. This voltage is applied to the voltage regulator. Its function is to maintain the output DC voltage constant irrespective of fluctuations in AC mains voltage and variations in currents load. Thus, the regulated power supply gives the stable DC voltage across the load.

Fig. 4.15 shows the waveforms at various stages of regulated power supply. Note that bridge rectifier and capacitor filter constitute an ordinary power supply. However, when voltage regulating device is added to this ordinary power supply, it turns into a regulated power supply.

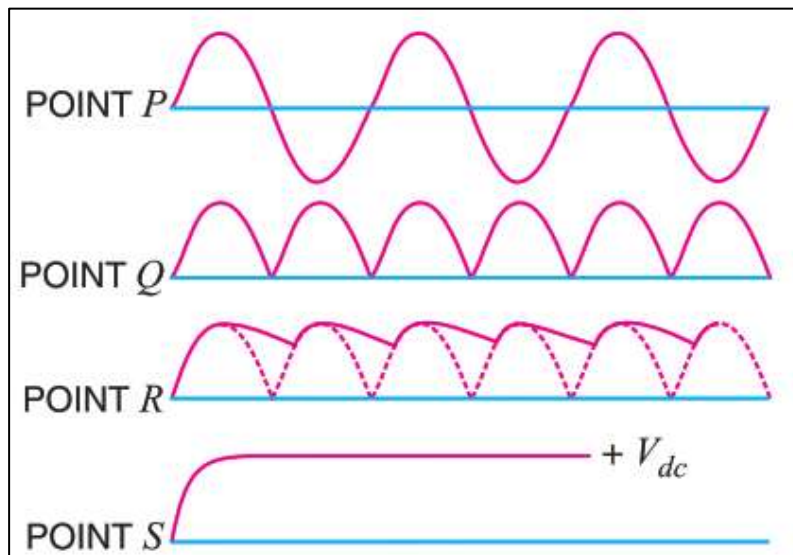


Figure 4.15 waveforms at various stages.

### Features of Regulated Power Supply

- Efficiency ranging from 20% to 25%.
- Less complex circuit and less weight.
- Give faster response.
- The cost and noise level is low.

### Switched-mode power supply (SMPS)

SMPS, an acronym for Switch Mode Power Supply is a type of power supply unit that produces regulated dc output by using semiconductor switching techniques. Basically, here the regulated dc output signal is converted form of ac or dc unregulated input signal. It is sometimes also known as switched mode power supply or switching mode power supply. This power supply unit is designed

to provide the energy to load from source by using switching devices. It operates by rapidly switching a transistor between two efficient operating states: cutoff, where there is a high voltage across the transistor but no current; and saturation, where there is a high current through the transistor but at a very small voltage drop.

Essentially, the transistor operates as a power switch that creates an AC voltage from the DC input voltage. This AC voltage can be stepped up or down and then filtered back to DC. SMPSs are popular due to their high efficiency and high power density. The table below compares some of the salient features of both linear and switched mode power supplies. The main advantages of a switching regulator over a linear regulator are the higher efficiency and the greater flexibility offered by output voltages that are less than, greater than, or of opposite polarity to the input voltage. Fig. 4.16 shows functional block diagram of SMPS.

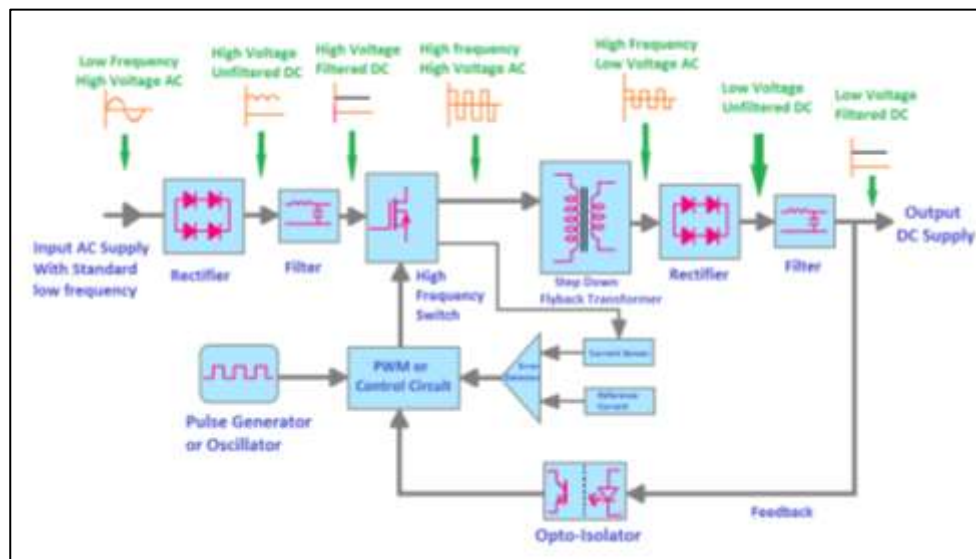


Figure 4.16 Functional Block Diagram of SMPS

## Working principles of SMPS

In the SMPS device, the switching regulators are used which switches on and off the load current to maintain and regulate the voltage output. Suitable power generation for a system is the mean voltage between off and on. Unlike the linear power supply, the SMPS carry transistor switches among low dissipation, full-on and full-off phase, and spend much less time in high dissipation cycles, which decreases depleted strength.

Initially, the unregulated ac input signal from the source is provided to the input rectifier and filter circuit. Here the ac input signal is rectified to generate a dc signal and further smoothed to remove high-frequency noise component from it. The dc output (still in unregulated form) is fed to the power transistor that acts as a high-frequency switch.

Here the dc signal undergoes chopping (switching). This circuit acts as an ideal switch i.e., when the power transistor (chopper circuit) is in on state, current passes through it with negligible voltage drop, and dc signal is obtained at the output terminal of the transistor. However, under the off state

of the power transistor, no current passes through it and leading to cause maximal voltage drop within it. Thus, at the output side, no voltage will be present. Hence, according to the switching action of the power transistor dc voltage will be obtained at its output side. The chopping frequency plays a crucial role in maintaining the desired dc voltage level.

The obtained dc signal at the output of the chopper circuit is then fed to the primary winding of the high-frequency power transformer. Here the step-down transformer converts the high voltage signal into a low voltage level which is further provided as input to the output rectifier and filter unit. This simply filters out the unwanted residuals from the signal in order to provide a regulated dc signal as the output. The control circuitry present here acts as the feedback circuit for the complete unit. This involves a comparator along with a pulse width modulator (PWM). The dc output from the rectifier and filter is fed to the control circuit where the error amplifier which acts as a comparator, compares the obtained dc voltage with the reference value.

If the dc output is greater than the reference value then the chopping frequency is to be decreased. The decrease in chopping frequency will reduce the output power and so the dc output voltage. However, if the dc output is less than the reference value then the chopping frequency is increased. When chopping frequency is raised then the dc output voltage will get increased. The pulse width modulator in the above circuit is responsible for generating a fixed frequency pulse width modulated waveform whose duty cycle controls the chopping frequency. Basically, the duty ratio is the ratio of on-time to the overall cycle time (i.e., on + off) time. Hence, by making necessary adjustments in the width of the pulses, the chopping frequency gets adjusted hence, regulated dc output can be obtained.

### **Advantages**

1. It is highly efficient than linear power supplies. Typically, the efficiency of SMPS lies between **60% – 95%**.
2. Due to the high-frequency operation of the device, the overall size is small and less bulky. Thus, is compact.
3. It is inexpensive because heat dissipation is less.
4. The obtained output voltage can be more or less than the supply input.

### **Disadvantages**

1. The transient spike generation due to switching action is one of the major issues. This may lead to cause RF interference thus, isolation is mandatory.
2. The circuit is complex. Also, voltage regulation (controlling) is tricky.
3. Proper filtration is necessary to deal with noise and spikes.

### **Applications of SMPS**

The devices invented under the latest technologies require a highly efficient power supply which is offered by SMPS. Thus, it finds applications in various power amplifiers, personal computers, security and railway systems, television sets, motor drives, etc.

## **Types of SMPS**

SMPS is the Switched Mode Power Supply circuit which is designed for obtaining the regulated DC output voltage from an unregulated DC or AC voltage. There are four main types of SMPS such as

- DC to DC Converter
- AC to DC Converter
- Fly back Converter
- Forward Converter

The AC to DC conversion part in the input section makes the difference between AC to DC converter and DC to DC converter. The Fly back converter is used for Low power applications. Also there are Buck Converter and Boost converter in the SMPS types which decrease or increase the output voltage depending upon the requirements. The other type of SMPS include Self-oscillating fly-back converter, Buck-boost converter, Cuk, Sepic, etc.

## **References**

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