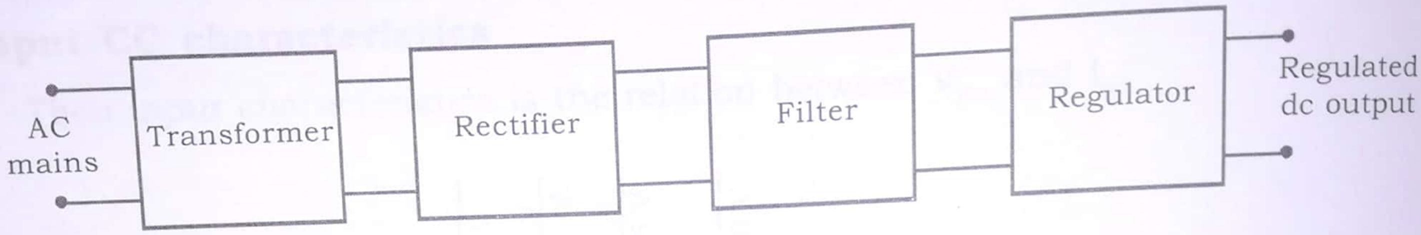
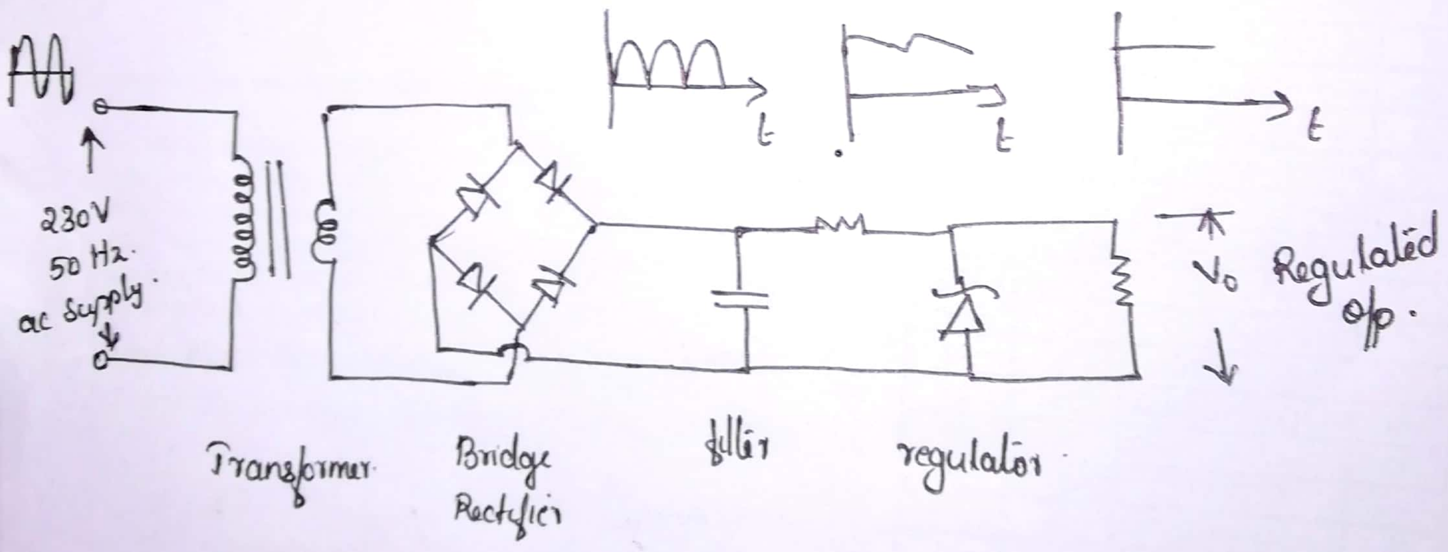
10.1 Block Diagram of DC Power Supply

The block diagram of a regulated dc power supply is shown in figure.



The transformers steps down the ac supply into an ac voltage of required level and it is given to a rectifier. The rectifier converts the ac input voltage to a pulsating dc voltage. This is passed through a filter. The filter eliminates the fluctuations in the rectified voltage and produces a relatively smooth dc voltage. The regulator is a circuit that maintains a constant dc voltage for variations in the input line voltage or in the load.

ckt diagram



Scanned by CamScanner

Power Supply Characteristics

The quality of power supply depends on different factors such as its load voltage, load current, voltage regulation, source regulation, output impedance, ripple ~~injec~~ rejection etc.

1. **Load Regulation: (LR)**

It is also called load effect. It is the change in regulated o/p voltage when the load current changes from minimum to maximum value. ie

$$LR = V_{NL} - V_{FL}$$

V_{NL} → load voltage at no load.
V_{FL} → load voltage at full load.

V_{NL} occurs when the load resistance is infinite ~~(o/p~~ (out terminals are open circuited) and V_{FL} occurs when the load resistance is of the minimum value.

$$\% LR = \frac{V_{NL} - V_{FL}}{V_{FL}} \times 100.$$

2) **Minimum Load resistance:** The load resistance at which a power supply delivers its full-load current at rated voltage is referred to as a minimum load resistance.

$$R_{L\,min)} = \frac{V_{FL}}{I_{FL}}$$

3) **Source or Line regulation: (SR)**

It is defined as the change in regulated o/p voltage for a specified range of line voltage typically 230V ± 10 percent

$SR = V_{HL} - V_{LL}$.

$V_{HL} \rightarrow$ o/p votg with high i/p ac line voltage

$V_{LL} \rightarrow$ o/p voltg with low i/p ac line voltg.

$$\% \, SR = \frac{V_{HL} - V_{LL}}{\text{Nominal load vltg}} \times 100$$

The o/p voltg under specific operating conditions is known as the nominal load voltage.

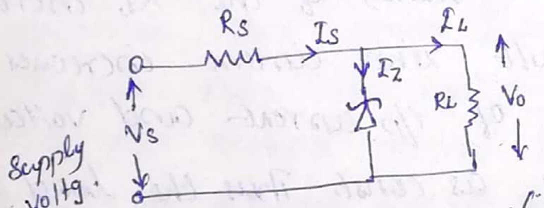
Output Impedance: A regulated power supply is a very stiff dc voltage source. This mean that the o/p resistance is very small.

Voltage Regulators:

A regulator may be constructed from a zener diode or discrete transistor or integrated circuits.

~~Discrete Transistor Voltage regulator.~~

Zener diode voltage regulator: (Zener diode shunt regulator)



Zener diode functions as an ordinary diode when it is forward biased. It is a specially designed device to operate in the reverse bias. When it is in reverse breakdown region, the zener voltage V_z remains almost constant irrespective of current I_z through it. A series resistor R_s is used to limit the zener current to less than its max. current rating. $I_s = I_z + I_L$. ∴ R_s is known as series current limiting resistor.

$I_L \rightarrow$ current through R_L.

For proper operation the i/p voltage must be greater than the zener voltage.

Now consider two cases

1) **Regulation with varying input voltage:** In this case, the Load

resistance R_L is fixed and the i/p voltage V_s varies within the limits. As the i/p vltg. increases, the i/p current (I_s) also increases. This increases the current through zener diode, without affecting the load current (I_L). The increase in i/p current will also increase the voltage drop across R_s, thereby keeping the load voltage (V_L) as const. If the i/p voltage is decreased, the i/p current also decreases. As a result, the current through zener will also decrease. Consequently, the voltage drop across series resistance will be reduced. Thus V_L and I_L remains const.

2) <u>Regulation with varying load resistance:</u>

Here the i/p voltage (V_s) is kept fixed and the load resistance (R_L) varies. Variation of R_L changes the current (I_L) through it, thereby changing voltage (V_L) across it. When R_L decreases, I_L increases. This causes the zener current to decrease. As a result, the i/p current and the voltage drop across R_s remains const. Thus the load voltage (V_L) is also kept const. On the other hand, if the R_L increases, the I_L decreases. As a result, zener current increases. This again keeps the values of i/p current and voltage drop across series resistance as const. Thus the load voltage remains const.

<u>Disadvantages of Zener diode shunt regulator</u>

1) The max. load current, which can be supplied to load resistor (R_L) is limited to $I_{Z(max)} - I_{Z(min)}$, which is usually of few milliamperes.

2). A large amount of power is wasted in the zener diode and in R_s in comparison with the load power.

3). The regulation factor and the o/p resistances are not very low.

<u>Design of R_L</u>

$$R_L = \frac{V_L}{I_L}$$

$$V_L = V_Z.$$

<u>Design of Series resistance R_s</u>

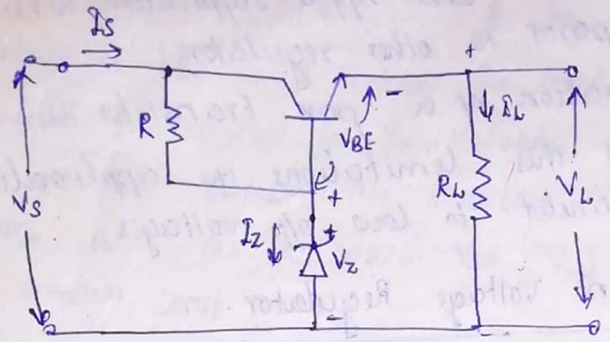
$$R_{S\,max} > R_S > R_{S\,min}$$

$$R_{S\,max} = \frac{V_{S\,max} - V_Z}{I_S}$$

$$R_{S\,min} = \frac{V_{S\,min} - V_Z}{I_S}$$

Here the transistor is formed as series pass transistor

Transistor Series Regulator [Emitter Follower Voltage Regulator]



$V_{BE} + V_L - V_Z = 0$

$V_L = V_Z - V_{BE}$

Here transistor is connected in series with the load, ∴ the ckt is known as series regulator. This ckt is also called as emitter follower, because the transistor behave as an emitter follower. The transistor behaves as a variable resistance, whose value is determined by the amount of base current.

The load voltage (V_L) is equal to the difference of zener voltage (V_Z) and the base-to-emitter voltage V_{BE}.

ie $V_L = V_Z - V_{BE}$. —①

Suppose that the value of load resistance is increased, Then the load current decreases and the load voltage tends to increase. From the eqn ① we can see that any increase in V_L will decrease the V_{BE} because the zener voltage is fixed. Then the forward bias of the transistor is reduced, which reduces its level of conduction. This increases the V_{CE}. This in turn will slightly decrease the input current to compensate for the increase in the value of load resistance, so that load voltage may remain at a const. value.

$I_C = I_E + I_B$

ie $V_L \uparrow \rightarrow V_{BE} \downarrow \rightarrow V_{CE} \uparrow \rightarrow V_L \downarrow$

In other words when $R \downarrow \rightarrow I_L \uparrow$.

ie ~~vst~~ $V_L \downarrow \rightarrow V_{BE} \uparrow \rightarrow V_{CE} \downarrow$ — then transistor will cause the slight increase in input current to compensate for the decrease in R_L. So the o/p voltage remains const.

Disadvantages

1) The o/p voltage cannot be maintained absolutely const because both V_{BE} and V_Z decrease with the increase in room temp

Vs ↑

(2) It cannot provide good regulation at high currents because of small amplification provided by one transistor

(3) It has poor regulation and ripple suppression w.r.t. i/p variations as compared to other regulators.

(4) The power dissipation of a pass transistor is large

Because of this limitations, the application of this regulator is limited to low o/p voltages.

Scanned by CamScanner