* **Switching regulator topologies:**

Disadv of linear vtg. reg:

1. use of Xmer makes ckt bulky & expensive.
2. filter cap values are large to ↓ ripples. (as low freq^n 50 Hz).
3. efficiency < 50 %
4. Vin > reg. o/p vtg.
5. P_D is more.

Switched mode Power supplies [SMPS] :-

Limitations of linear vtg. Reg:

1. The step down transformer used in p.s. ckt is bulky & expensive.

2. Large value filter capacitors are required. (due to low freq^n 50Hz operation).

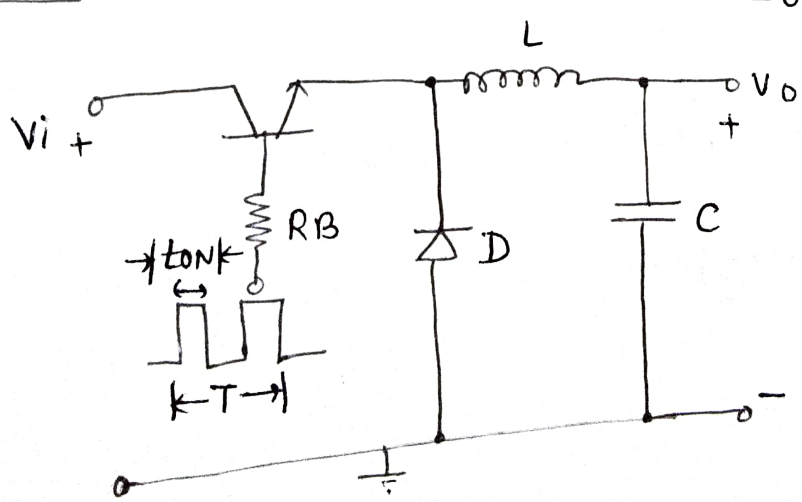
3. efficiency is less than 50%.

4. Input vtg. must be more than the required O/P regulated voltage.

5. The diff^n bet^n I/P & O/P vtg. drop a/c. the linear pass transistor & dissipates power.

- SMPS operates on principle of chopping the unregulated DC supply vtg. by the use of a transistor switch & filtering the high freq^n components using a high freq^n filter.
- Thus Vo is regulated by varying the duty cycle of the switching period of the transistor.

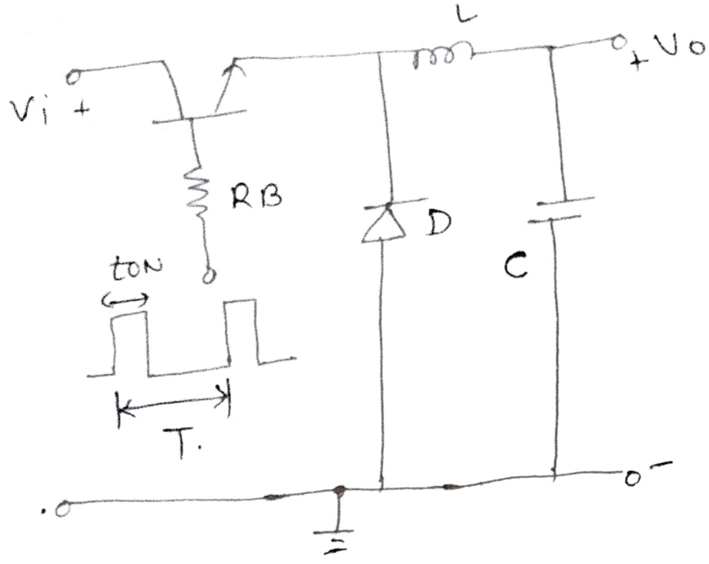
Operating principle of a switching regulator :-



- Uses control logic & oscillator circuits. The oscillator allows the control element to be switched ON & OFF. The control element usually consists of a transistor switch, an inductor & a diode.
- for each switching ON at the base of the transistor, energy is pumped into the magnetic field associated with the inductor which is a transformer winding in practice. This energy is given to the load at the desired vtg. level. By varying the duty cycle or freqn of switching, one can vary the stored energy in each cycle & thus control the O/P vtg.
- As a switch can only be ON or OFF, it either allows energy to pass or stop, but does not itself dissipate energy. since only the energy required to maintain O/P vtg, at a particular load current is drawn, there is no dissipation & hence, a higher efficiency is obtained.
- Energy is pumped in discrete jumps, but the O/P vtg. is kept constant by capacitor storage.

<u>Adv of switching regulators</u>:-

- smaller, lighter package
- low cost
- eliminates 50 Hz line freqn components.



: principle of switching reg :

- switched mode reg. overcome these limitations.
- operates on chopping unreg. dc supply vtg. by using transistor switch & filtering HF components using HPF.
- Thus Vo is regulated by varying duty cycle of switching period of transistor.

Disadv. of switching reg :-

1. ↑ noise due to switching at HF. (Heavy filtering is req.)
2. due to limited transient response, switching regulator is normally slower than linear vtg. reg.
3. more complex.

Hence used for high power levels around 100 W.

Types of switching reg.

1) Transformed based type.
2) Buck switched type &
3) Boost switched type.

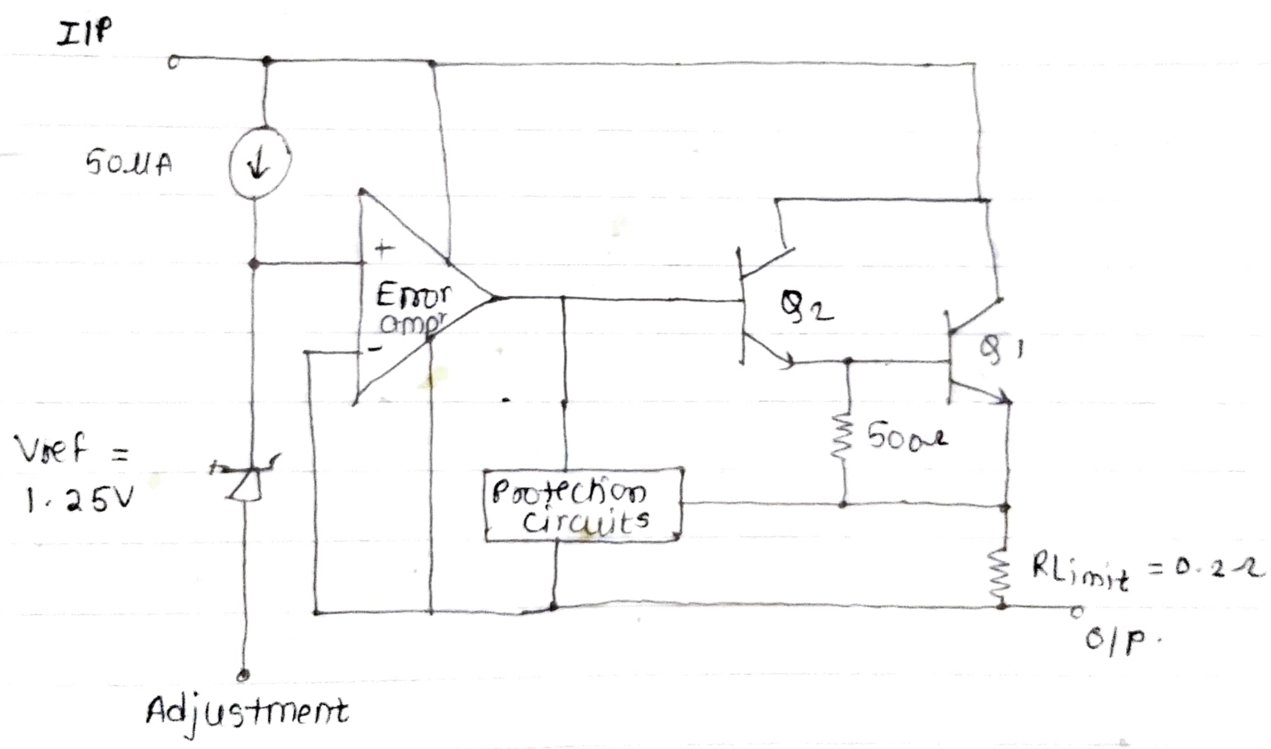
3-terminal adjustable vtg regulators:
LM 317, LM 337.

- Some applns requires
  1. regulated vtg. source with precise variable &
  2. some supply vtg. which are not available from std. fixed vtg reg.
- Such 3 terminal adjustable +ve & -ve vtg reg. are LM 117 / LM 317 & LM 137 / LM 337.

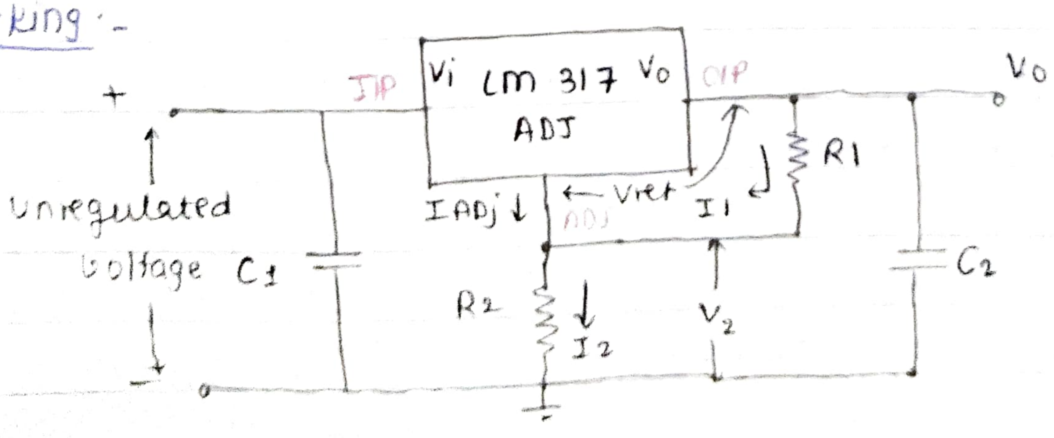
1. LM 317 / LM 117 : Adj. +ve vtg regulators :-

- O/P current = 0.1 A to 1.5A
  vtg range of O/P = 1.2 V to 37 V.

Internal dia :-



Working :-



- $V_{ref} = 1.25V$ betⁿ O/P & adj terminal. → appears a/c R_1.

∴ $I_1 = \frac{V_{ref}}{R_1}$.

I_1 → flows thro' → R2 ← IADJ

∴ $I_{R2} = I_1 + I_{ADJ}$.

∴ $V_{R2} = I_{R2} \cdot R_2 = (I_1 + I_{ADJ}) \cdot R_2$.

∴ O/P vtg, Vo is

$$V_o = V_{ref} + V_{R2} = V_{ref} + R_2 [I_1 + I_{ADJ}].$$

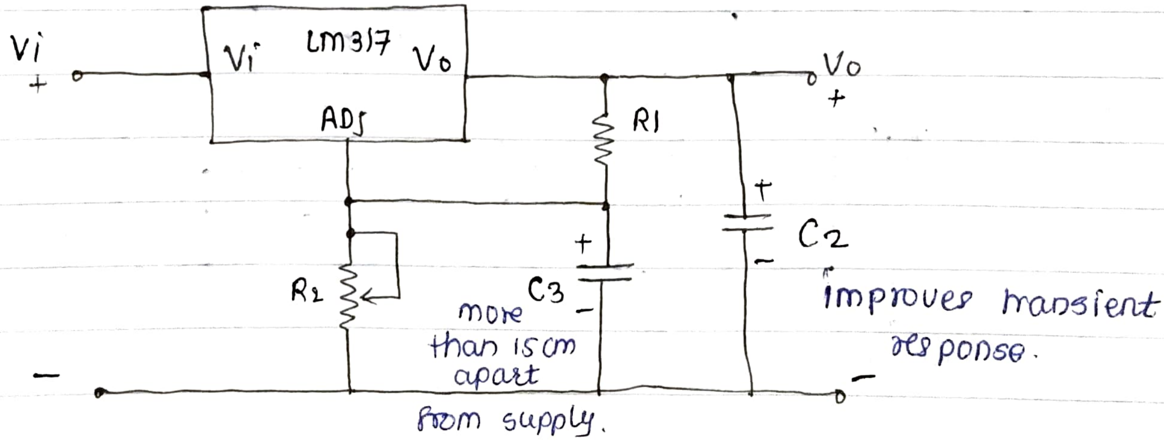
substitute $I_1 = \frac{V_{ref}}{R_1}$ in above eqⁿ.

$$V_o = V_{ref} \left[1 + \frac{R_2}{R_1}\right] + I_{ADJ} R_2.$$

↑ error added → ↓ → by ↓ R2.

Then $V_o = 1.25 \left[1 + \frac{R_2}{R_1}\right]$.

The LM 317 adj +ve vtg. regulator is as shown below:



Ex.1: LM 317 has $R_1 = 240\Omega$ & $R_2 = 2K\Omega$ If $I_{ADJ} = 50\mu A$ & $V_{ref} = 1.25V$ find Vo

$$V_o = V_{ref}\left(1 + \frac{R_2}{R_1}\right) + I_{ADJ} R_2 = 11.77V.$$

Ex.2: Design adj +ve vtg. reg. using 317 for Vo = 4 to 12V. & $I_o = 1A$

→ max. I_{ADJ} for LM 317 = $100\mu A$.

Let $R_1 = 240\Omega$ & $V_{ref} = 1.25V$

$$V_o = V_{ref}\left[1+\frac{R_2}{R_1}\right] + I_{ADJ}R_2.$$

for $V_o = 4V$

$$4 = 1.25\left[1+\frac{R_2}{240}\right] + 100\times10^{-6}\times R_2.$$

$$\boxed{\therefore R_2 = 0.52\ K\Omega}$$

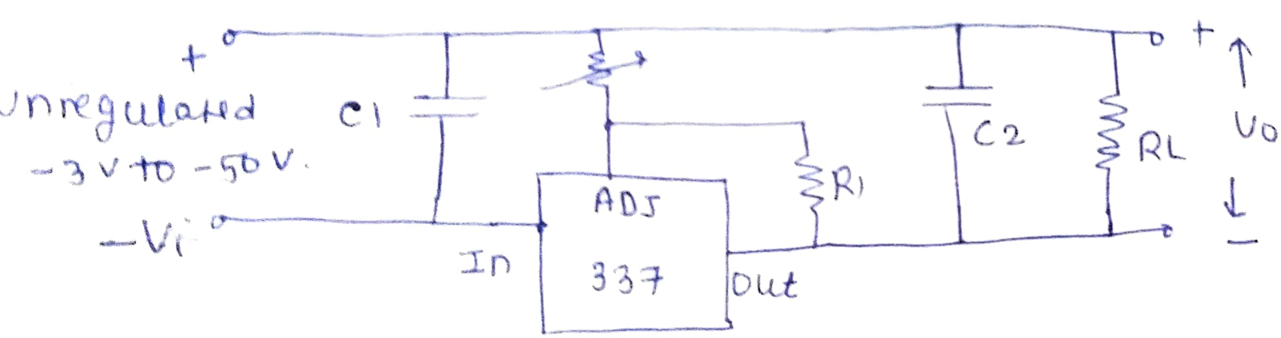
for $V_o = 12V$

$$12 = 1.25\left[1+\frac{R_2}{240}\right] + 100\times10^{-6}\times R_2.$$

$$\therefore R_2 = \frac{10.75}{5.3\times10^{-3}} = 2.01\ K\Omega.$$

$R_2 \rightarrow 0.52K\Omega$ to $2.01K\Omega \Rightarrow$ use $3K\Omega$ linear pot

* Lm 137 / Lm 337 : Adj -ve vtg. regulator :-



$$V_o = 1.2\left[1+\frac{R_2}{R_1}\right].$$