IIND YEAR

EEE

EE8451- LINEAR INTEGRATED CIRCUITS AND APPLICATIONS

UNIT-V

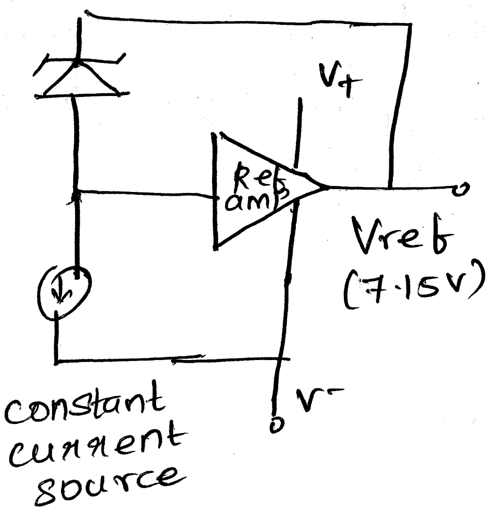
APPLICATION ICs

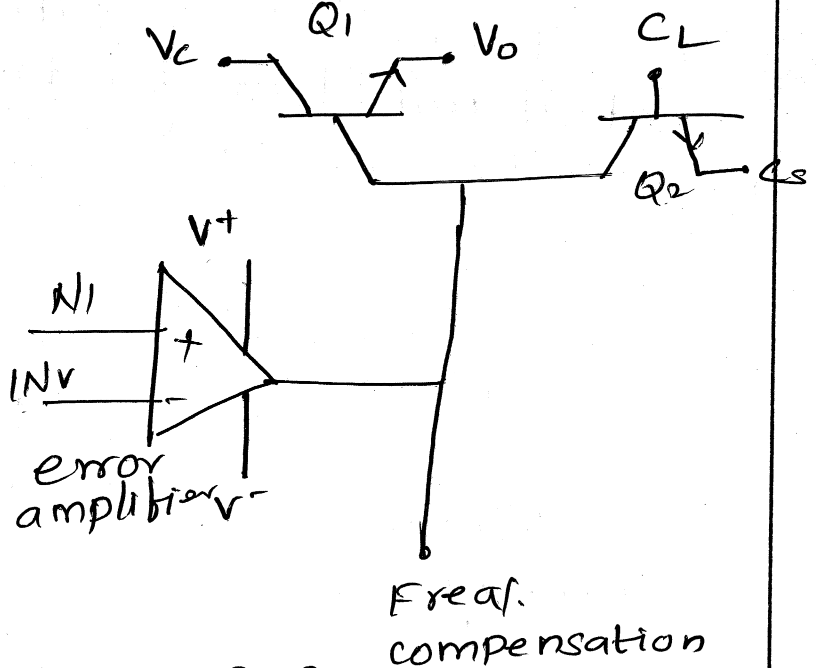
IC 723 GENERAL PURPOSE REGULATOR:

* In three terminal fixed voltage regulators have the following limitations.

  1. No short circuit protection
  2. output voltage is fixed

* The limitation have been overcome in the 723 general purpose regulators.
* The zener diode, a constant current source and reference amplifier produce a fixed voltage of about 7 volts at the terminal Vref.
* The constant current source forces the zener to operate at a fixed point so that the zener output a fixed voltage.





* The power transistor Q_1 is in series with unregulated power supply Vin and regulated output voltage V_o.
* So it must absorb the difference between these two voltages whenever any fluctuation in output voltage V_o occurs.

* The transistor Q_1 is also connected as an emitter follower and therefore provides sufficient current gain to drive the load.

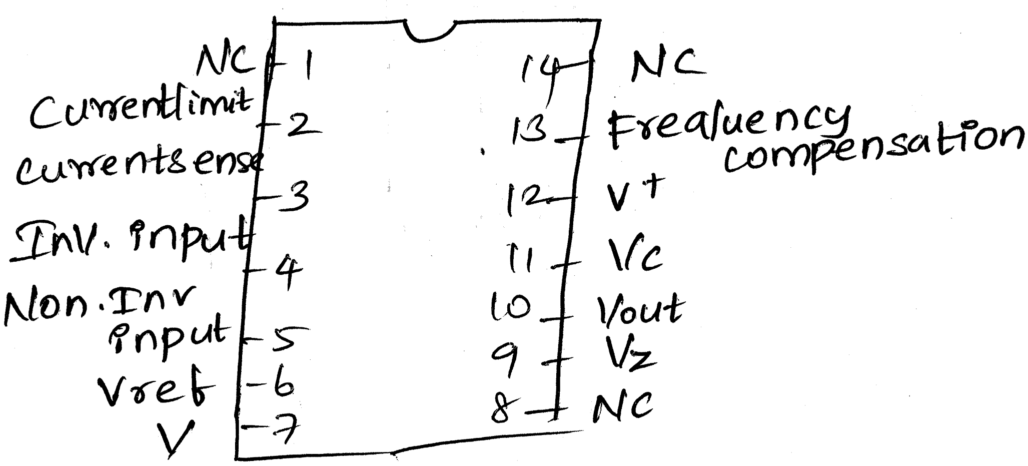
* The output voltage is sampled by R_1-R_2 divider and fed back to the (-) input terminal of the op-amp error amplifier.

* This sampled voltage is compared with the Vref. The output Vo of the error amplifier drives the series transistor Q_1.

* If output voltage increases (ie) due to variation in load current, the sampled voltage βV_o also increases.

$$\beta = \frac{R_2}{R_1+R_2}$$

* In turn reduces output voltage Vo of differential amplifier due to 180° phase difference provided by op-amp Vo is applied to base of Q_1 which is used as an emitter follower



PIN DETAIL OF IC723

A voltage regulator is an electronic circuit that provides a dc voltage independent of load current, temperature and ac line voltage variations.

The circuit consist of 4 parts
1. Reference voltage circuit
2. Error amplifier
3. series pass transistor
4. Feedback network

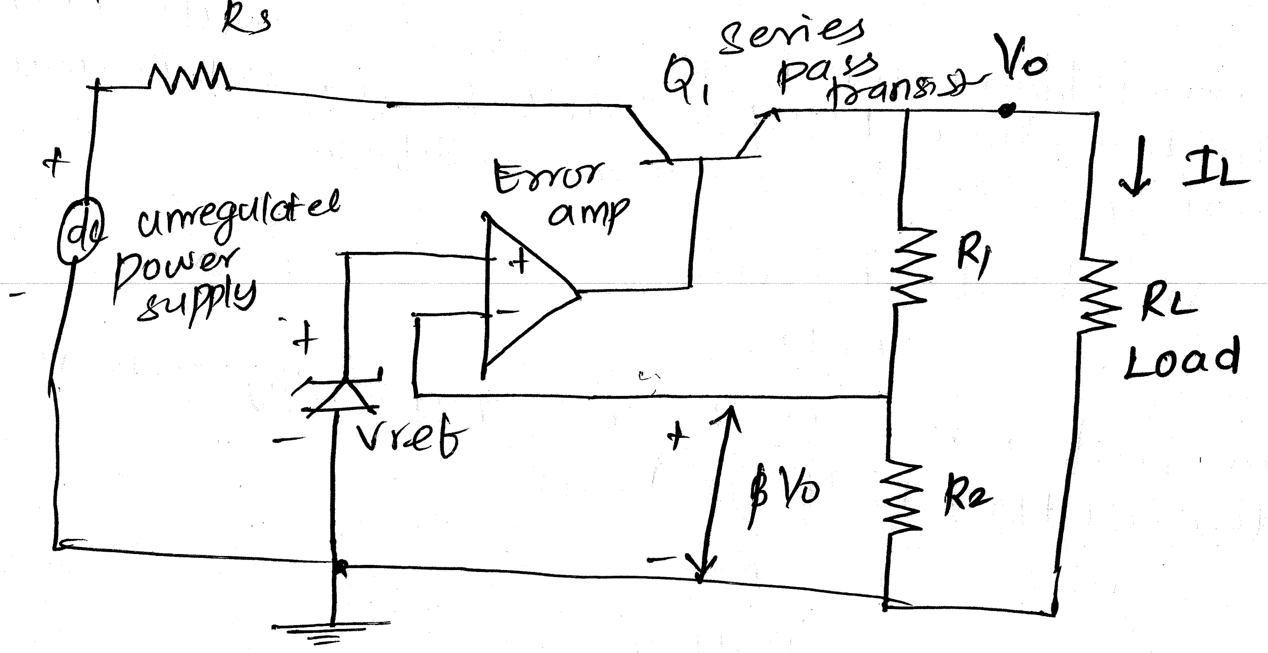
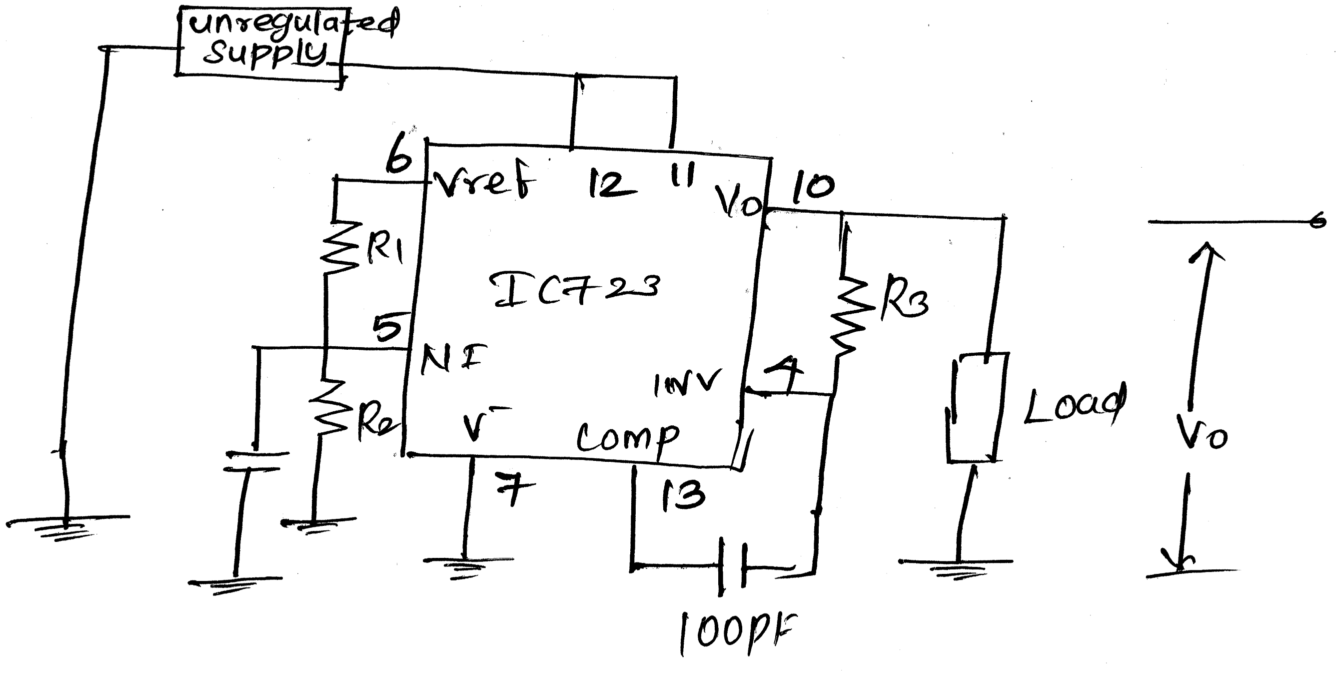


FIG: SERIES REGULATORS

MODES OF IC 723 REGULATOR



LOWPOWER REGULATOR USING IC723

* A simple positive low voltage regulator (2V to 7V).

* The Voltage at NI terminal of the error amplifier due to $R_1 R_2$ divider is

$$V_{NI} = V_{ref} = \frac{R_2}{R_1+R_2}$$

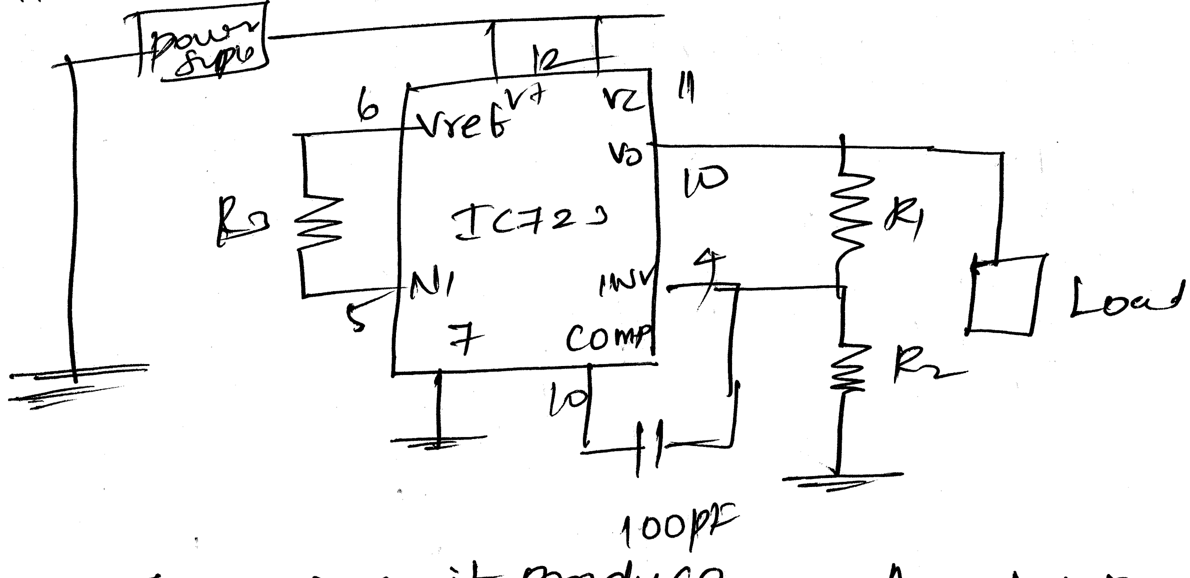
* The difference between V_{NI} and output Voltage V_o which is directly fedback to the INV terminal is amplified by the error amplifier

$$V_o = V_{ref} \frac{R_2}{R_1+R_2}$$

The reference voltage is typically 7.15 V. So the output voltage V_o is

$$V_o = 7.15 \times \frac{R_2}{R_1+R_2}$$

HIGH VOLTAGE REGULATOR USING IC 723



* The circuit produce regulator output voltage greater than 7V. The NI terminal connects directly to Vref through R_3.

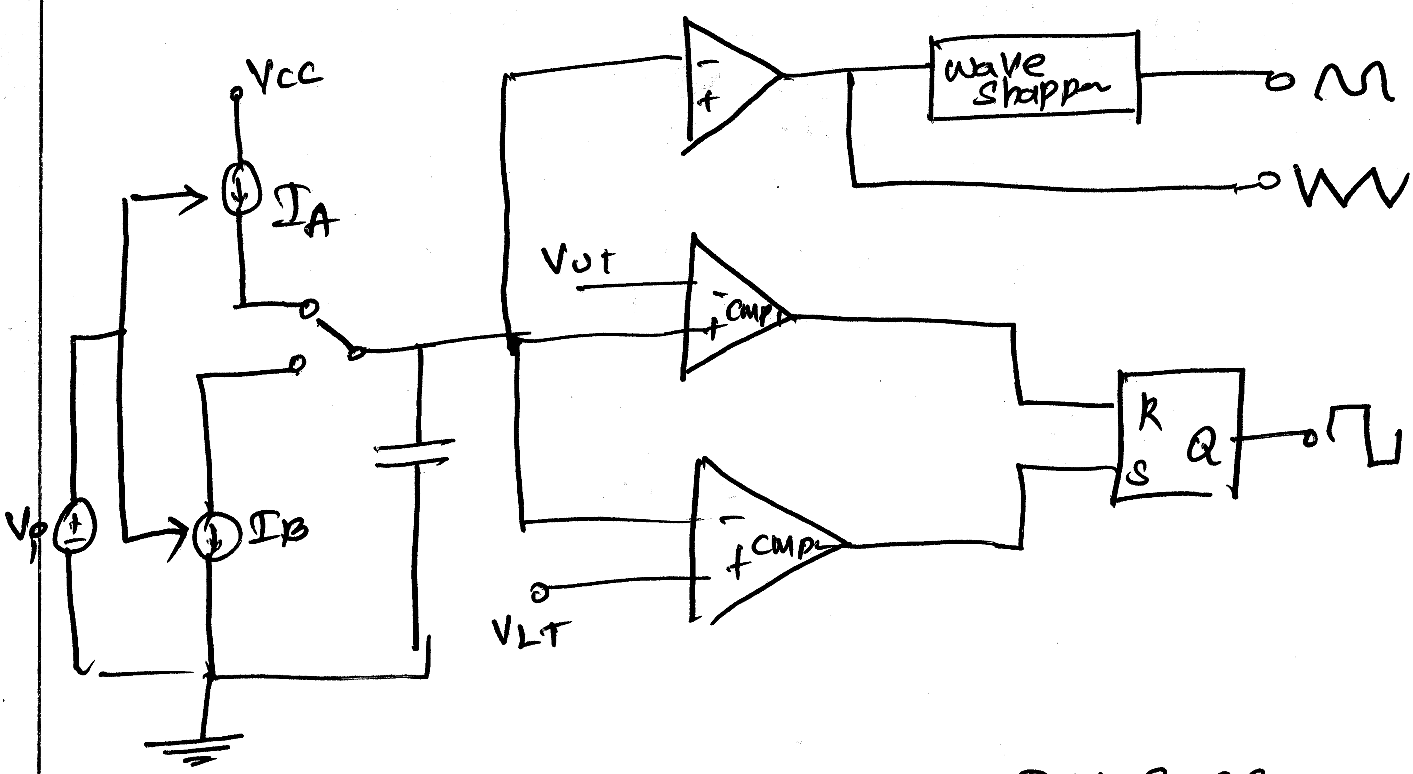
$$A_v = 1 + \frac{R_1}{R_2}$$

$$V_o = V_{ref}\left(1 + \frac{R_1}{R_2}\right)$$

$$V_o = 7.15\left(1 + \frac{R_1}{R_2}\right)$$

ICL 8038 FUNCTION GENERATOR:

* Function generators are designed to provide the basic waveforms such as square wave, triangular wave and sine wave.
* They are also called as waveform generators.
* The operation of ICL 8038 is based on charging and discharging of a grounded capacitor C, whose charging and discharging rates are controlled by programmable current generators I_A and I_B respectively.
* When switch is at position A, the capacitor charges at a rate determined by current source I_A.
* Once the capacitor voltage reaches the threshold value V_{UT} switch position to change from position A to B.



BLOCK DIAGRAM OF ICL 8038 FUNCTION GENERATOR

FREQUENCY OF OUTPUT WAVEFORM:

$$f_{out} = \frac{1}{T}$$

$$T = T_c + T_d$$

$$T_c = \Delta V_c \times \frac{1}{\text{charging current}} \times C$$

$$I = \frac{V}{R}$$

$$T_c = \frac{V_{cc}}{3} \times \frac{R_A}{V_i} \times C$$

$$\boxed{T_c = \frac{R_A C V_{cc}}{3 V_i}}$$

The discharging time T_d can be given as

$$T_d = \Delta V \times \frac{1}{\text{discharging current}} \times C$$

$$= \frac{V_{cc}}{3} \times \frac{1}{\left(\frac{2V_i}{R_B} - \frac{V_i}{R_A}\right)} \times C$$

$$= \frac{V_{cc}}{3} \times \frac{1}{\frac{2V_i R_A - V_i R_B}{R_A R_B}} \times C$$

$$= \frac{V_{cc} \times R_A R_B \times C}{3 (2V_i R_A - V_i R_B)}$$

$$= \frac{V_{cc}}{3V_i} \times \frac{R_A R_B}{(2R_A - R_B)} \times C$$

$$T_d = \frac{C R_A V_{cc}}{3V_i}\left(\frac{R_B}{2R_A - R_B}\right)$$

$$T = T_c + T_d$$

$$= \frac{C R_A V_{cc}}{3V_i} + \frac{C R_A V_{cc}}{3V_i}\left(\frac{R_B}{2R_A - R_B}\right)$$

$$= \frac{C R_A V_{cc}}{3V_i}\left[1 + \frac{R_B}{2R_A - R_B}\right]$$

$$= \frac{C R_A V_{cc}}{3V_i}\left[\frac{2R_A - \cancel{R_B} + \cancel{R_B}}{2R_A - R_B}\right]$$

$$T = \frac{R_A C V_{cc}}{3V_i}\left[\frac{2R_A}{2R_A - R_B}\right]$$

$$f_{out} = \frac{1}{T}$$

$$= \frac{3V_i}{R_A C V_{cc}}\left(\frac{2R_A - R_B}{2R_A}\right)$$

Duty cycle is given as

$$\% d = \frac{T_c}{T_c + T_d} \times 100$$

$$= \frac{\dfrac{C\,R_A V_{CC}}{3V_i}}{\dfrac{C\,R_A V_{CC}}{3V_i} + \dfrac{C\,R_A V_{CC}}{3V_i}\left(\dfrac{R_B}{2R_A - R_B}\right)} \times 100$$

$$= \frac{C\,R_A V_{CC}/3V_i}{\dfrac{C\,R_A V_{CC}}{3V_i}\left(1 + \dfrac{R_B}{2R_A - R_B}\right)}$$

$$= \frac{1}{\dfrac{2R_A - R_B + R_B}{2R_A - R_B}}$$

$$= \frac{2R_A - R_B}{2R_A} \times 100$$

$$\boxed{\% \, d = \left(1 - \frac{R_B}{2R_A}\right) \times 100}$$

Specifications:

Supply Voltage: ± 18V or 36V

Power dissipation: 750mW

Input Voltage: max of supply voltage level

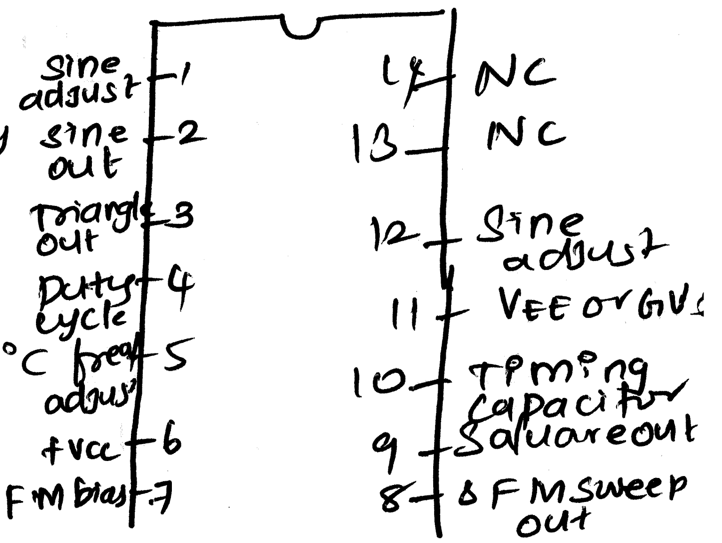
Input current: 25mA

Output sink current: 25mA

Storage temperature range: 65°C to 125°C

Distortion: 1%

Linearity: 0.1%



Video Amplifier LM 733 / μA 733

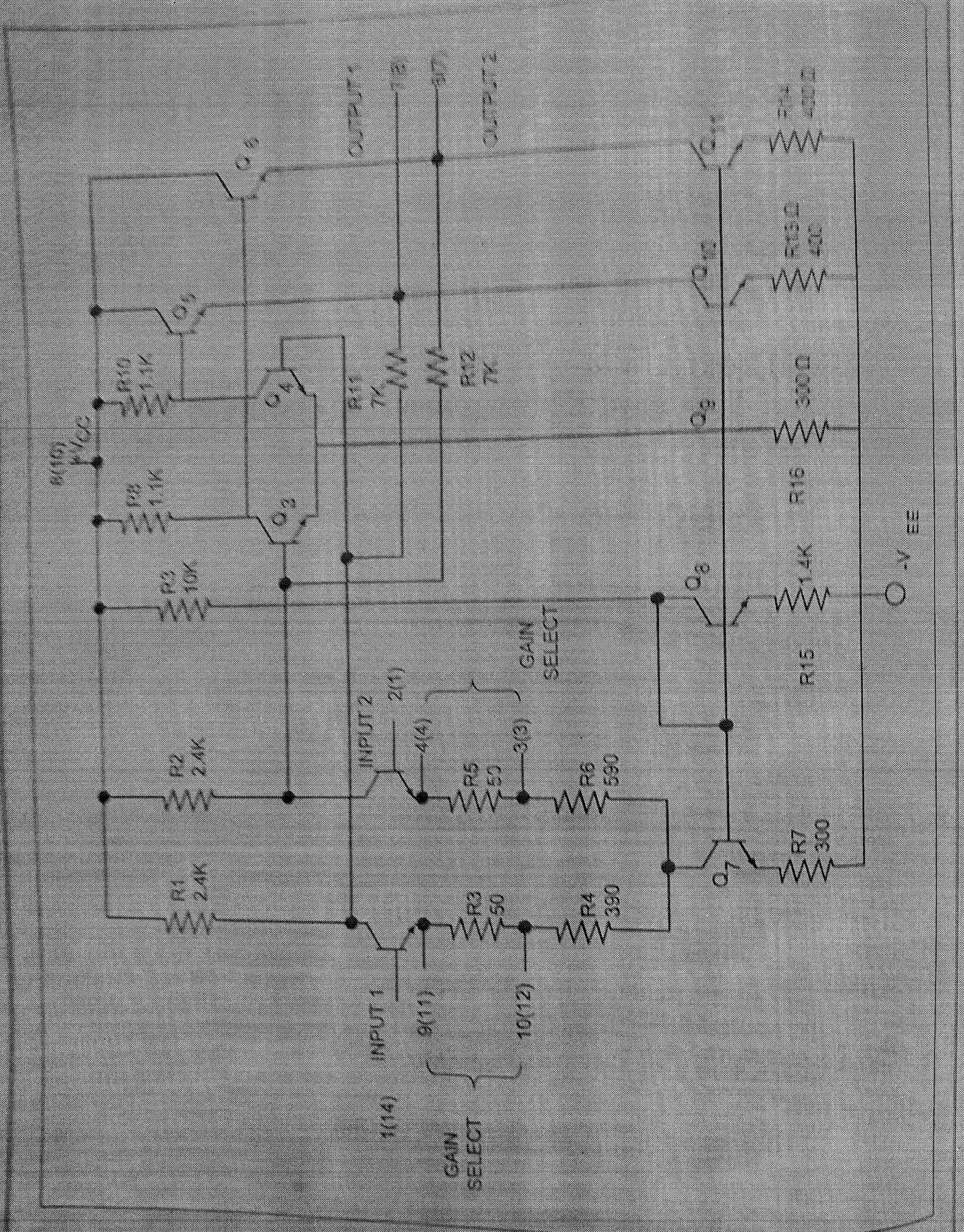
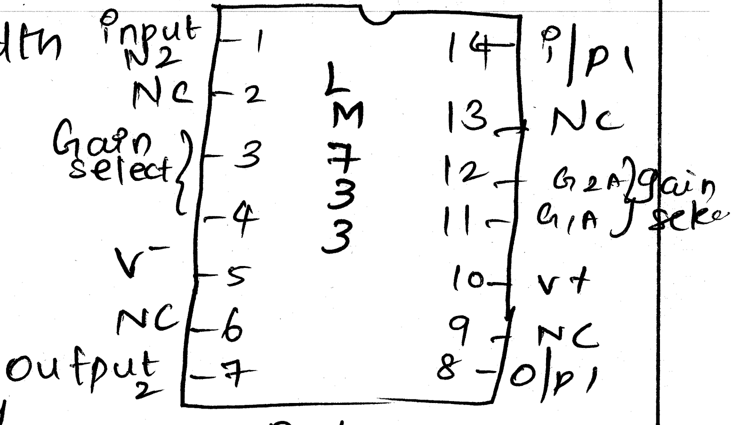


Fig. 5.25 (b) Video amplifier

VIDEO AMPLIFIER: LM 733IC

* It consists of a two stage differential input, differential output and wideband Video amplifier
* The internal series-shunt feedback width with low phase distortion and high gain stability
* The emitter follower output provides a high current drive and low impedance.

FEATURES:



PIN DIAGRAM OF LM733

* It has wide band width of 120 MHZ
* It offers an input resistance of 250KΩ
* Gains 10, 100 and 400 are selectable
* External frequency compensation not required
* It provides high CMRR

OPERATION:

* It consists of two cascaded BJT differential amplifier stage and a balanced emitter follower stage
* The wideband width is achieved by a value of load resistance for the two differential amplifier stage.
* The input stage comprises Q_1, Q_2 and the load resistors R_1 and R_2. The transistor Q_7 provides current sink biasing for the first differential stage
* The second stage formed by Q_3 and Q_4 driver by balanced output available from

the first stage resistors R_9 and R_{10} act as load for differential stage.

* The balanced output from the second stage drive to emitter follower stage realized by Q_5 and Q_6 respectively Q_{10} and Q_{11} acts as current sink bias for the emitter followers.

* Resistor Q_{11} and Q_{12} provide the negative feedback from the output terminals of the second stage.

* The diode connected transistor Q_8 alongwith R_8 and R_{15} provides the overall biasing for the circuit by driving the current sink biasing.

AUDIO POWER AMPLIFIER: LM 380

* The small signal amplifiers are Voltage amplifiers and the large signal power amplifier supply a large signal current to load such as Speakers and motors.
* The monolithic power transistors used in audio power amplifiers.

FEATURES:

* Voltage range: 5V to 20V
* operates with Low quiescent power gain
* Voltage range of 34 dB can be achieved
* It can deliver high peak current of 1.3 A max
* High input impedance
* Low distortion.

Functional diagram description:

The internal schematic consists of four stage

(i) PNP emitter follower

(ii) Differential amplifier

(iii) Common emitter

(iv) Quasi complementary emitter follower

* Transistor Q_1 and Q_2 forms first PNP emitter follower input stage
* output drives Q_3 - Q_4 PNP differential Pair
* Q_5 and Q_6 act as collector load for PNP differential pair
* The transistor Q_7 and Q_8 form current mirror and this establish collector current of Q_9

* The transistor Q9 forms common emitter amplifier stage
* The capacitor C connected between base and collector Q9 provides the internal compensation
* Q10 and Q12 produce aluasi complementary emitter follower stage

PIN DIAGRAM