BIO AMPLIFIERS

Generally, Bio signals are having low amplitude and low frequency. So amplifiers are needed to boost the amplitude level of the bio signals. The output of this amplifier is displayed as EEG or ECG waveform. These amplifiers are known as bio amplifiers or bio medical amplifiers.

Need of Bio Amplifier:

Bio amplifiers must have high input impedance. Now generally, bio potential amplifiers with 2MΩ of input impedance are used. For various applications 10MΩ of input impedance is used as desired value. Bio amplifier circuit must have isolation and protection circuits. These circuits are used to protect them patients from micro shock and macro shock.

Voltage gain of bio amplifier should be more than 100db. Constant gain should be maintained throughout the required bandwidth. Output Impedance of bio amplifiers should be small. Drift free amplifiers can act as good bio amplifiers. CMRR of bio amplifiers should be more than 80db. The gain of the amplifier must be correctly calibrated.

Differential Bio Amplifier:

A differential amplifier produces an output an output voltage that is proportional to the difference between the voltage applied to the two input terminals.

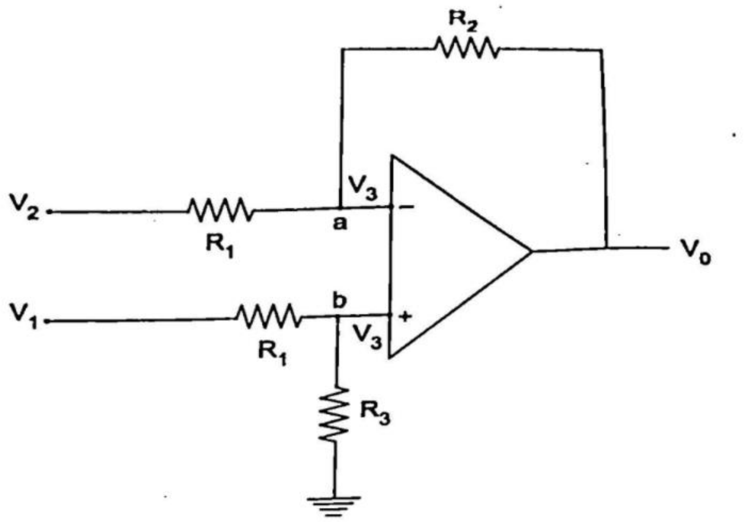

Fig: Differential Amplifier

Differential modes of operation of the differential bio amplifier:

There are three different modes of operation listed below

1. Single Ended Mode:

- When either V_1 or V_2 is equal to zero, the operation of the differential amplifier is known as single ended mode of operation.
- If V_1=0 the differential amplifier is operating in the non-inverting mode and if V_2=0 it is operating in the inverting mode.

2. Differential Mode:

- In this mode, the two input signals are equal but have opposite polarity at every instant of time.

$$\therefore V_1 = -V_2 = V_0$$

We have seen that

$$V_0 = \frac{R_2}{R_1}(v_2 - v_1)$$

$$V_0 = \frac{2R_2}{R_1} v_0$$

- In this case the input signals are called differential mode signals.
- Since an operational amplifier, has a pair of differential input terminals, it is easily connected for use in a differential configuration.
- The differential voltage at the input terminals of the OP-amp is zero, that is nodes a and b are at the same potential designated as V_3.
- The nodal equations at a is

$$\frac{v_3 - v_2}{R_1} + \frac{v_3 - v_0}{R_2} = 0 \qquad (1)$$

- The nodal equation at b is

$$\frac{v_3 - v_1}{R_1} + \frac{v_3}{R_2} = 0 \qquad (2)$$

- Rearranging, we get

$$\left(\frac{1}{R_1} + \frac{1}{R_2}\right) v_3 - \frac{v_2}{R_1} = \frac{v_0}{R_2} \qquad (3)$$

$$\left(\frac{1}{R_1} + \frac{1}{R_2}\right) v_3 - \frac{v_1}{R_1} = 0 \qquad (4)$$

- Subtracting (4) from (3) we get

$$\frac{1}{R_1}(v_i - v_2) = \frac{v_0}{R_2}$$

$$v_0 = \frac{R_2}{R_1}(v_1 - v_2)$$

3. Common Mode:

- The input voltages appearing at the input terminals 1 and 2 are identical both in amplitude and phase at every instant of time and the circuit is said to be operating in the common mode.

  $V_1=V_2=V_{CM}$

  $V_0=0$

- These input signals are called common mode signal.
- Thus the common mode input signals produce no voltage at the output of the ideal amplifier.