9.16 Voltage Follower (Unity Gain Amplifier)

APJAKTU : 2009-10, 2010-11, 2013-14

- A circuit in which the output voltage follows the input voltage is called **voltage follower** circuit.
- The voltage follower circuit using op-amp is shown in the Fig. 9.16.1.
- The node B is at potential V_{in}.
- The node A is also at the same potential as B i.e. V_{in} according to the concept of virtual ground.

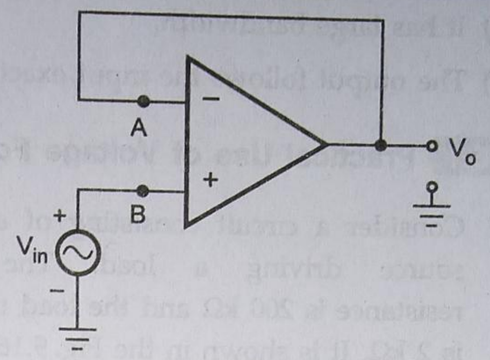

Fig. 9.16.1 Voltage follower

$$\therefore \quad V_A = V_B = V_{in} \qquad \ldots (9.16.1)$$

- Now node A is directly connected to the output. Hence we can write,

$$V_o = V_A \qquad \ldots (9.16.2)$$

Equating the equations (9.16.1) and (9.16.2),

$$\boxed{V_o = V_{in}} \qquad \ldots (9.16.3)$$

- For this circuit, the **voltage gain is unity.**
- Thus the output voltage V_o is equal to the input voltage V_{in}. If V_{in} increases, V_o also increases. If V_{in} decreases, then V_o also decreases. Thus output follows the input hence the circuit is called voltage follower circuit.
- It is also called **source follower, unity gain amplifier, buffer amplifier** or **isolation amplifier.**

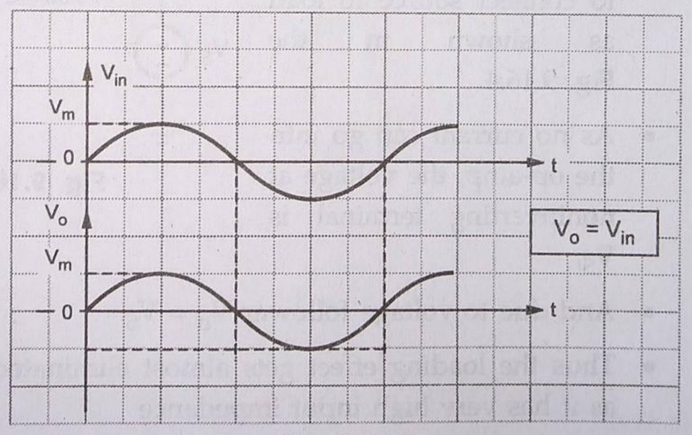

Fig. 9.16.2

- The input and output waveforms are shown in the Fig. 9.16.2.

Advantages of voltage follower :

1) Very large input resistance, of the order of MΩ .
2) Low output impedance, almost zero.

- Hence it can be used to connect high impedance source to a low impedance load, as a buffer. This eliminates the loading effect.

3) It has large bandwidth.

4) The output follows the input exactly without a phase shift.

9.16.1 Practical Use of Voltage Follower

- Consider a circuit consisting of a voltage source driving a load. The source resistance is 200 kΩ and the load resistance is 2 kΩ. It is shown in the Fig. 9.16.3.

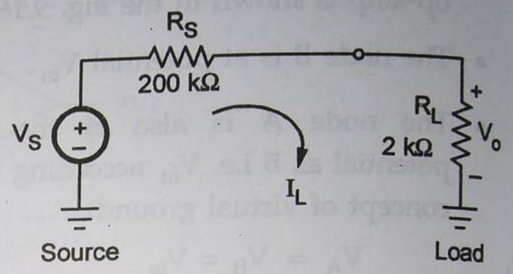

Fig. 9.16.3 Source driving load

- According to potential divider.

$$V_o = \frac{V_S R_L}{R_S + R_L} = 0.0099\ V_S \approx 0.01\ V_S$$

- Thus only 0.01 times V_S is available to drive the load and there is severe attenuation. This is nothing but loading effect.
- Now use voltage follower to connect source to load as shown in the Fig. 9.16.4.

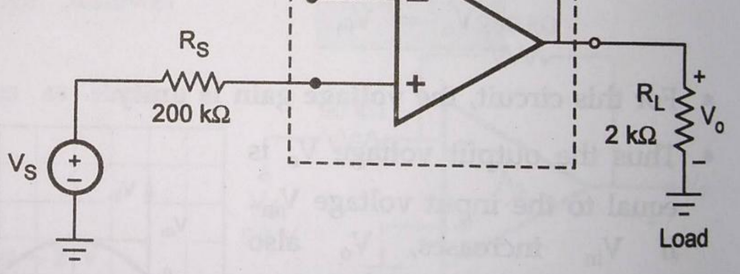

Fig. 9.16.4 Reducing loading effect

- As no current can go into the op-amp, the voltage at noninverting terminal is V_S.
- And due to voltage follower $V_o = V_S$.
- Thus the loading effect gets almost eliminated due to the use of voltage follower as it has very high input impedance.

Review Questions

1. *Draw and explain the circuit of unity gain amplifier using op-amp. Where is it used and Why ?*
   APJAKTU : 2009-10, 2010-11, 2013-14, Marks 10
2. *State the advantages of voltage follower circuit.*