Topic :- Current Source.

PG - Sem III

For a differential-mode signal we want R_E and V_{EE} to be large, so as to act as a "current source." Since a current source has a very large internal resistance, a high value of CMRR can be obtained.

In the circuit of fig (1), the controlled current value is

$$I_o = \frac{R_2 V_{EE}}{R_1(R_1+R_2)}$$

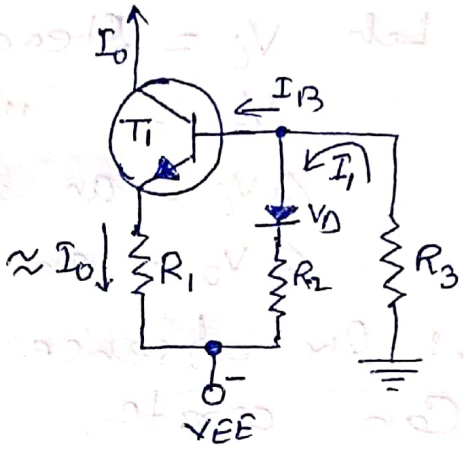

Fig (1)

The transistor T_1 has current feedback introduced by $R_1 I_o$ and has a very large output resistance. This accounts for the large CMRR obtained when R_E of a differential amplifier is replaced with this constant-current circuit.

Level Transistor

The dc level shifter of transistor is shown in fig (1). The input is supplied to the base of the transistor T_1 which operates as an emitter follower. The output is taken from emitter of the transistor T_3 which is also an emitter follower to provide a low output resistance. Transistor T_2 is a simple constant-current device, with its base current supplied by a fixed reference; then $I_C = h_{FE} I_B$.

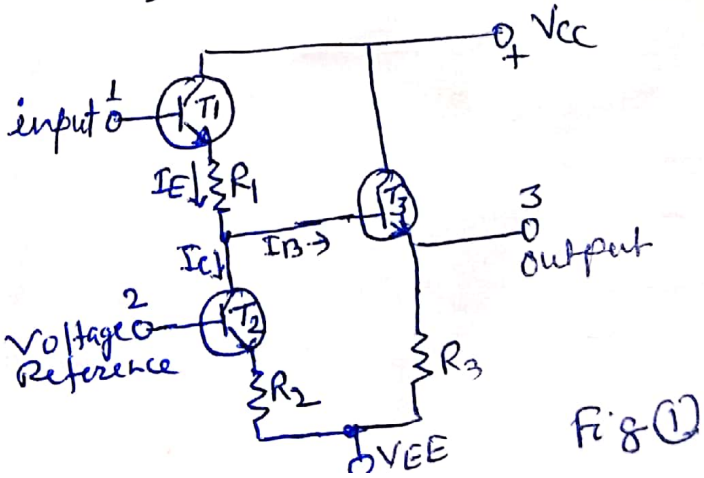

Fig (1)

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With I_B of T_3 small, we have I_E of T_1 approximately equal to I_C and constant. Therefore $R_1 I_E$ is constant. Along the signal path from input-1 to output-3, we have

$$V_{BE1} + R_1 I_E + V_{BE2} = K \text{ (volts)} \longrightarrow (1)$$

Let V_i = Steady input voltage

V_o = " output "

ΔV_i = an input change at 1

ΔV_o = an output change at 2

∴ In absence of any signal levels. we can write.

$$K = (\Delta V_i + V_i) - (\Delta V_o + V_o) \longrightarrow (2)$$

As change in input is transferred to the output

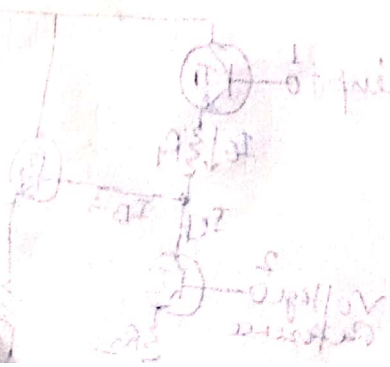
$$\therefore \Delta V_i = \Delta V_o \longrightarrow (3)$$

And, from eqn (2) & (3), we have.

$$K = V_i - V_o$$

$$\therefore V_o = V_i - K \longrightarrow (4)$$

The reduction in V_i i.e $(V_i - K)$ is called "level-shift". this reduction in level is largely determined by the choice of R_1.



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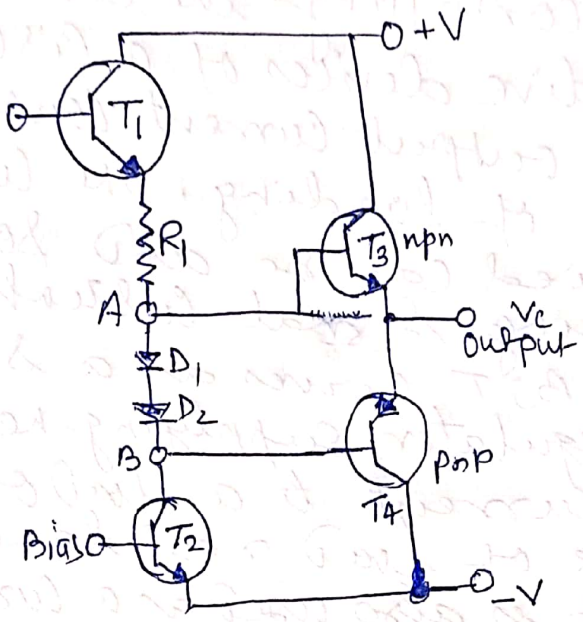
A COMPLEMENTARY SYMMETRY OUTPUT

Fig (1) shows the complementary transistor output which is used in some amplifiers.



Fig(1)

Transistor T_1, resister R_1, diodes D_1 and D_2 form a level-shifter circuit. Transistor T_3 is npn and transistor T_4 is pnp. A positive voltage at A raises the current in T_3, but a positive voltage at B lowers the current in T_4. The difference current is shunted to the load. Similarly, a negative voltage at A lowers the current in T_3 and rises the current in T_4, and T_4 shunts current out of the load.

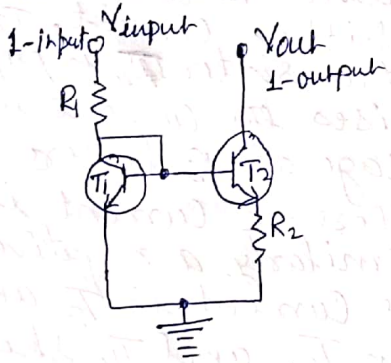
The voltage at A and B differ only by the constant-diode drop in D_1 & D_2. Any signal output from T_1 will be transferred to the amplifier output. Although the output transistor T_3 and T_4 have no voltage gain, they are able to supply appreciable current to the load and provide a power gain.

(Ref:- Ryder 209-212

Current Mirror

A current mirror is a circuit designed to copy a current through one active device by controlling the current in another active devices of a circuit, keeping the output current constant regardless of loading. The current being copied can be and sometimes is a varying signal current.

A BJT serves as a simple current regulator, supplying nearly constant current to a load over a wide range of load resistances, therefor it is also used as a current mirror. The circuit connection of BJT as a current mirror is shown in fig(1)



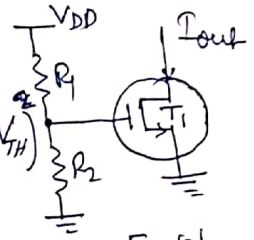
Fig(1)

There are various methods for coupling the transister. But if each has low gain, direct coupling process is used. In fig(1) Transister T_1 & T_2 are coupled directly which provide bias voltage from the preceding stage. The bias condition of T_2 are influenced by those of T_2. The PVT variables are amplified.

The MOSFET devices that have equal gate-source voltages and operates in saturation carry equal currents. The basic current Mirror using MOSFET is shown in fig (2).

Assuming T_1 is in saturating, we can write

$$I_{out} \approx \frac{1}{2}\mu_n C_{ox}\frac{W}{L}\left(\frac{R_2}{R_1+R_2}V_{DD}-V_{TH}\right)$$



Fig(2)

The threshold voltage V_{TH} may vary from 50 to 100 mV from wafer to wafer.

A current-mirror is used to couple emitters in a differential input stage to linearize the difference signals for them to share the current in anti-phase.

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