DUAL INPUT, BALANCED OUTPUT DIFFERENTIAL AMPLIFIER

The circuit shown below is a dual-input balanced-output differential amplifier. Here in this circuit ,the two input signals (dual input), vin1 and vin2, are applied to the bases B1 and B2 of transistors Q1 and Q2.The output vo is measured between the two collectors C1 and C2 which are at the same dc potential. Because of the equal dc potential at the two collectors with respect to ground, the output is referred as a balanced output.

Circuit Diagram:-



DC Analysis:-

To determine the operating point values (ICQ and VCEQ) for the differential amplifier, we need to obtain a dc equivalent circuit. The dc equivalent circuit can be obtained simply by reducing the input signals vin1 and vin2 to zero. The dc equivalent circuit thus obtained is shown in fig below. Note that the internal resistances of the input signals are denoted by Rin because Rin1 = Rin2.Since both emitter biased sections of the differential amplifier are symmetrical (matched in all respects), we need to determine the operating point collector current ICQ and collector to emitter voltage VCEQ for only one section. We shall determine the ICQ and VCEQ values for transistor Q1 only. These ICQ and VCEQ values can then be used for transistor Q2 also.



DC EQUIVALENT CIRCUIT FOR DUAL-INPUT BALANCED OUTPUT DIFFERETIAL AMPLIFIER

Applying Kirchhoff’s voltage law to the base-emitter loop of the transistor Q1,

Rin IB- VBE - RE (2IE) +VEE = 0 (1)

But

IB = IE/βdc since IC = IE

Thus the emitter current through Q1 is determined directly from eqn (1) as follows:

IE = (VEE - VBE)/ (2RE + Rin / βdc) (2)

where VBE = 0.7V for silicon transistors

VBE =0.3V for germanium transistors

Generally, Rin/βdc<< 2RE.Therefore, eqn (2) can be rewritten as

ICQ=IE = (VEE - VBE)/2RE  (3)

From eqn (3) we see that the value of RE sets up the emitter current in transistors Q1 and Q2 for a given value of VEE. In other words, by selecting a proper value of RE, we can obtain a desired value of emitter current for a known value of –VEE. Notice that the emitter current in transistors Q1 and Q2 is independent of collector resistance RC.

Next we shall determine the collector to emitter voltage VCE. The voltage at the emitter of transistor Q1 is approximately equal to VBE if we assume the voltage drop across Rin to be negligible. Knowing the value of emitter current IE(=IC),we can obtain the voltage at the collector VCC as follows:

VC = VCC - RCIC

Thus the collector to emitter voltage VCE is

VCE = VC - VE = (VCC – RCIC) – (-VBE)

VCEQ= VCE = VCC+VBE - RCIC  (4)

Thus for both transistors we can determine the operating point values by using the eqns (2) and (4), respectively, because at the operating point IE=ICQ and VCEQ=VCE

Remember that the dc analysis eqns (2) and (4) are applicable for all 4 differential amplifier configurations as long as we use the same biasing arrangement for each of them.