SINGLE INPUT, UNBALANCED OUTPUT DIFFERENTIAL AMPLIFIER

The circuit shown below is a dual-input balanced-output differential amplifier. Here in this circuit ,the input signals vin1, are applied to the bases B1 Q1 .The output vo is measured at C2..

Circuit Diagram:-



***AC Analysis***:-

To perform ac analysis to derive the expression for the voltage gains Ad and input resistance Ri of a differential amplifier:

1) Set the dc voltages +VCC and –VEE at 0

2) Substitute the small signal re equivalent models for the transistors

Figure below shows resulting ac equivalent circuit of the single input unbalanced output differential amplifier



AC EQUIVALENT CIRCUIT FOR DUAL-INPUT BALANCED OUTPUT DIFFERETIAL AMPLIFIER

Writing Kirchhoff’s voltage equations for loops 1 and 2 gives us

vin1 – Rin1ib1 – reie1 – RE (ie1-ie2) = 0 (1)

vin1 – Rin1ib1 – reie1 -reie2 = 0 (2)

Substituting current relations ib1 = ie1/β ac yields

vin1 – Rin1 ie1/β ac – reie1 – RE (ie1+ie2) = 0 (3)

vin1 – Rin1 ie1/β ac – reie1 -reie2 –= 0 (4)

Generally, Rin1/β ac values are very small therefore we shall neglect them here for simplicity and rearrange these equations as follows:

(re+RE) ie1 -REie2 = vin1 (5)

reie1 + reie2 = vin1 (6)

Eqns (5) and (6) can be solved simultaneously for ie1 and ie2 by using Cramer’s rule:

ie1= $\frac{\left|\begin{matrix}vin1&-RE\\vin1&re\end{matrix}\right|}{\left|\begin{matrix}(re+RE)&-RE\\re&re\end{matrix}\right|}$

ie2= $\frac{\left|\left|\begin{matrix}(re+RE)&vin1\\re&vin1\end{matrix}\right|\right|}{\left|\begin{matrix}(re+RE)&-RE\\re&re\end{matrix}\right|}$

ie1 = [vin1 (re)+ vin1RE]/[ re (re+2RE)]

ie1 = [vin1 (re+ RE)]/[ re (re+2RE)] (7) and

ie2 = [vin1 (re+RE)- vin1re]/[ re (re+2RE)]

ie2 = [vin1 RE]/[ re (re+2RE)] (8)

The output voltage is

vo = vc2

=RCic2 (9)

= RCic2

Substituting current relations in eqn(9), Generally,RE>>re, which implies that (re+2RE) = 2RE and (re+RE) = RE.

 we get

vo = = (RC/2re) (vin1 )

 we can write the voltage-gain equation of the single-input unbalanced-output differential amplifier as follows:

Ad = vo /vin = RC/2re  (10)

***Differential Input Resistance***:-

Differential input resistance is defined as the equivalent resistance that would be measured at either input terminal with the other terminal grounded.

Ri1 = |vin1/ib1|Vin2=0

=|vin/(ie1/βac)|Vin2=0

Substituting the value of ie1, we get

Ri1 = βacvin1/[{(re+RE)vin1/ re (re+2RE)}] (11)

=[βac(re2+2reRE)]/(re+RE)

=[βac re(re+2RE)]/(re+RE)

Generally,RE>>re, which implies that (re+2RE) = 2RE and (re+RE) = RE.

Therefore eqn(11) can be rewritten as

Ri1 = βacre(2RE)/RE = 2βacre (12)

***Output Resistance***:-

Output resistance is defined as the equivalent resistance that would be measured at either output terminal w.r.t ground.

Ro1 = Ro2 = RC (13)

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