Name: **Roll # :**

Score: **Signature:** **Date:**

Differential Amplifier

OBJECTIVE:

- To understand the operation of differential amplifier.

EQUIPMENTS:

- Oscilloscope.
- Function generator.
- DC power supply (± 15V).
- Digital Multimeter.
- Two, BJT NPN (BC 107).
- Connecting wires.
- Resistors:
  - Two, 4.7 KΩ.
  - Two, 2.2 kΩ.
  - Two, 1 kΩ.
  - Two, 100 kΩ.
  - One, 10 kΩ.
  - One, 5 kΩ

THEORY DISCUSSION:

In many situations it is often required to amplify the difference between two signal inputs without any reference to ground. An amplifier which performs this function is called a DIFFERENCE or DIFFERENTIAL Amplifier.

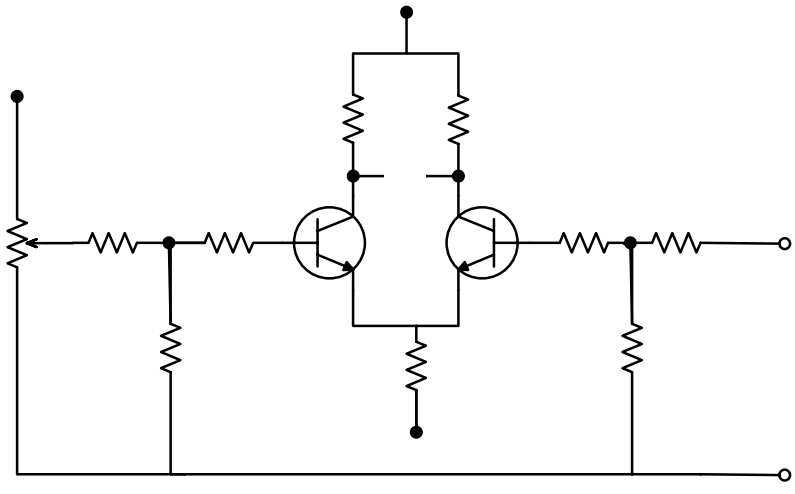

Figure # 01

Differential amplifier consists of two transistors with two inputs and two outputs. Ideally the circuit is symmetrical; i.e. two transistors Q_1 and Q_2 have identical characteristics. The emitter resistor is common to both the transistors and Collector resistor are equal $R_{C1} = R_{C2}$. The amplifier output is given by the equation:

$$V_{out} = A(V_1 - V_2); \qquad \text{Ideally}\ldots\ldots\ldots(1)$$

The term A is the amplification factor referred as gain, of the transistors and is considered to be identical for both devices. In Practice however, their parameters will differ such that,

$$V_{out} = A_1V_1 - A_2V_2, \ldots\ldots\ldots\ldots\ldots(2).$$

Differential amplifier produces the output proportional to the difference of the two inputs signal. If the Common Mode signals(the signals having same phase and same magnitude) are applied at the input of a perfect differential amplifier, the output would be zero(ideally). In Practice this is not so and small variations in output occurs. This variation is called the common mode gain (A_c).

The gain for an output difference signal that is when V_1 and V_2 are not equal is called Differential Gain (A_d). Thus the factor to show how good a differential amplifier circuit is called the COMMON MODE REJECTION RATIO (CMMR). Where CMMR is given by the equation:-

$$CMMR = \frac{A_d}{A_{CM}} \ldots\ldots\ldots\ldots\ldots\ldots..(3).$$

PROCEDURE:

STEP # 1: Calculating the Differential Gain:

1. Assemble the Circuit shown in figure # 01.
2. Adjust the input 1 to 0.5V by variable power supply.
3. Also adjust the input 2 to -0.5V by using 10kΩ potentiometer.
4. As these two inputs differ in polarities they will be called as differential inputs.
5. Measure the output across RC1 and RC2.
6. The differential gain can be calculated as ,

$$A_d = V_{out}/V_d \text{ Where } V_d = V_1 - V_2 \ldots\ldots\ldots\ldots\ldots\ldots \text{ (a)}$$

STEP # 2: Calculating the Common Mode Gain:

1. Replace the -15V supply at input 2 to +15V.
2. Apply common mode inputs i.e. V1 = V2 = 1V.
3. For common mode the amplifier should produce no output (ideally). Practically there is a output voltage.
4. Measure the output using the voltmeter.
5. The common mode gain can be calculated as,

$$A_{CM} = V_{out}/V_{CM}, \text{ where } V_{CM} = 1/2(V_1 + V_2)\ldots\ldots\ldots\ldots \text{ (b).}$$

STEP # 3: Calculating the CMMR:

1. The Common mode rejection ration can now be calculated from the values obtained from the equation (a) and (b) as,

$$CMMR = \frac{A_d}{A_{CM}} \ldots\ldots\ldots\ldots\ldots\ldots.. (3).$$

OBSERVATION:

Operating Mode	V_1	V_2	V_{in}	V_{out}	Gain $(A) = V_{out}/V_{in}$	CMMR= A_d/A_{CM}
Differential Mode						
Common Mode						

Review Question:

Q # 01. What is a differential Amplifier?
Ans: _____

_____

Q # 02. What is the Common Mode Gain?
Ans: _____

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Q # 03. Define the differential Mode Gain?
Ans: _____

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Q # 04. Define CMMR? And what does it shows?
Ans: _____

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CONCLUSIONS: _____.

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