

Lab 1: Differential Amplifier Input Stage

PURPOSE: To have students explore the differential pair and its properties.

REQUIRED: Oscilloscope
Function Generator
Digital Multimeter
CA3046 Transistor Array
10K Ω ¼ watt Resistor
20K Ω ¼ watt Resistor
4.7K Ω ¼ watt Resistor
100 Ω ¼ watt Resistor
680 Ω ¼ watt Resistor

REFERENCES: Textbook, class notes

I. Introduction

The differential pair is the most widely used circuit building block in analog integrated circuits. Among many applications, it forms the input stage of every operational amplifier. A basic BJT differential pair consists of two *matched* transistors Q_1 and Q_2 . A major special component used in this experiment is the CA3046, a 5-transistor array, whose connection diagram and schematic are shown in Figure 1.1. As seen from this figure, it consists of five *matched* npn transistors, two of which share a common emitter connection. For what follows, a CA3046 array can be used.

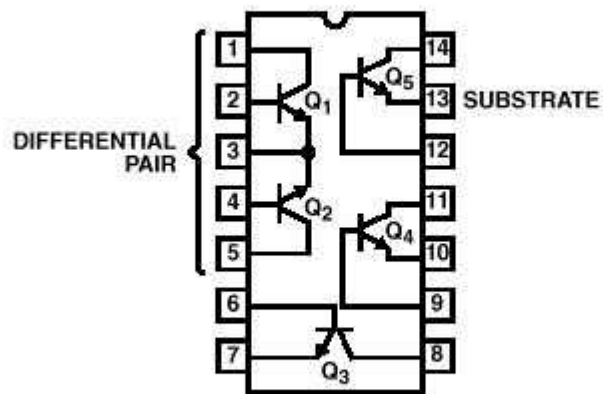


Figure 1.1. The Top View of the CA3046 Transistor Array.

II. PROCEDURE

A. Resistor Based Input Stage

1. Construct the resistor based input stage shown in Figure 1.2.
2. Connect pin 13 to V_{EE} whether or not Q_5 is used.
3. Measure all resistors.
4. *DC Analysis:* Ground v_1 and v_2 . Measure V_B , V_C , and V_E for each transistor. Calculate I_E for each transistor.

5. *Common Mode Gain:* Apply the same $1\text{ V}_{\text{p-p}}$, 10 kHz sinusoid to v_1 and v_2 . Measure v_{O1} and v_{O2} . Calculate the common mode gain.

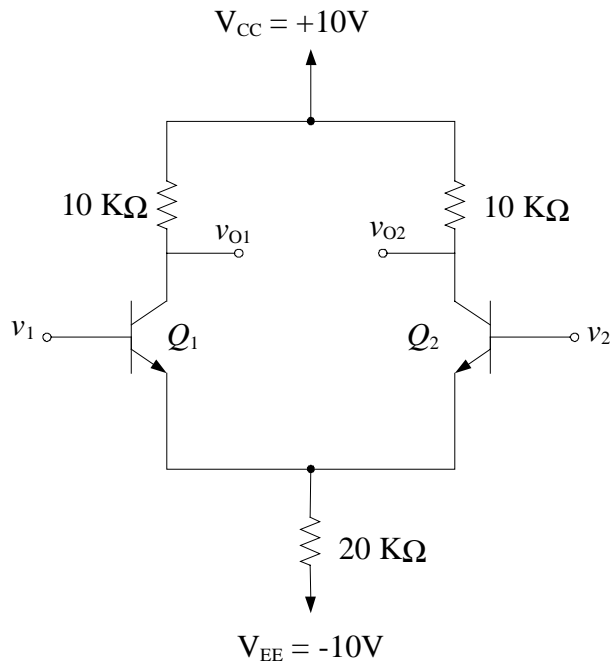


Figure 1.2. Resistor Based Input Stage for Common-Mode Measurements.

6. *Differential Mode Gain:* Construct the circuit shown in Figure 1.2 while adding the voltage limiting circuit of Figure 1.3 to the bases of both transistors. Ground v_2 and apply a $100\text{ mV}_{\text{pp}}$, 10-kHz sinusoid to v_1 . Measure v_{O1} and v_{O2} . Calculate the differential mode gain.

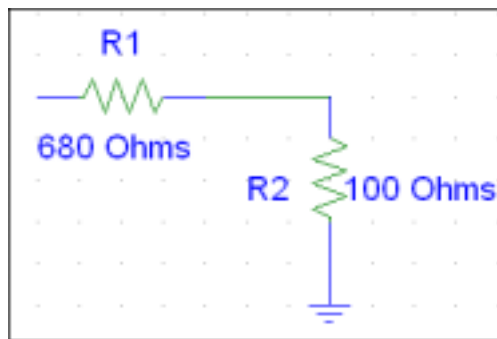


Figure 1.3. Voltage Limiting Circuit.

7. Perform a PSPICE analysis of the circuits for steps 4 through 6.
8. For the report:
 - a) Compare the measured common mode gain and differential mode gain with their theoretical and simulated values.
 - b) Calculate the CMRR and compare it with the value obtained from PSPICE.
 - c) Discuss any discrepancies between measured, theoretical, and simulated results.