**Lab – Bipolar Junction Transistors in Active Mode**

**Objectives:**

I. Measure and graph the collector characteristic curves for *a* bipolar junction transistor.

2. Use the characteristic curves to determine the *dc* of the transistor at a given point.

**Equipment and Materials:**

Resistors: One 100 resistor, one 30 k resistor, One 2N3904 *npn* transistor (or equivalent)

Breadboard and two variable DC power supplies, two Digital Multi-meters

Diagram

Description automatically generated

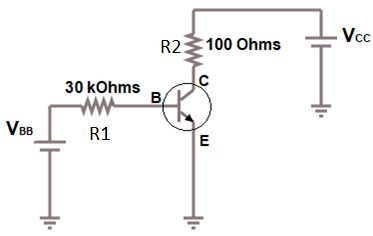
*Figure 1 – Pin configuration for 2N3904 NPN Transistor*

**Procedure:**

1. Measure and record the resistance of the resistors listed in Table 1.

|  |  |  |
| --- | --- | --- |
|  |  | |
| **Resistor** | **Value from Color Code** | **Measured**  **Value** |
| **R1** | **30 k** |  |
| **R2** | **100 ** |  |

Table 1

1. Connect the common-emitter configuration circuit illustrated in Figure 1. The purpose of *R1* and *R2* is to limit the current through the transistors to a safe level. Start with both power supplies set to 0 V. Slowly increase *VBB*until *VR1* is 1.5 V. This sets up a base current of 50 A which can be shown by applying Ohm's law to R1.

*Figure 2 – Common Emitter Circuit[[1]](#endnote-1)*

1. Do not disturb the setting of VBB and slowly increase Vcc until +2.0 V is measured between the transistor's collector and emitter. This voltage is VCE. Measure and record the voltage across R2 (VR2) for this setting. Record VR2 in Table 2 in the column labeled Base Current = 50 A

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **Current Gain, bdc** | | | | | |
| **Vce** | **IB=50mA**  **VR2 Ic** | | **IB=100mA**  **VR2 Ic** | | **IB=150mA**  **VR2 Ic** | |
| **2.0V** |  |  |  |  |  |  |
| **4.0V** |  |  |  |  |  |  |
| **6.0V** |  |  |  |  |  |  |
| **8.0V** |  |  |  |  |  |  |

**Table 2**

1. Compute the collector current, Ic, by applying Ohm's law to R2. Use the measured voltage, VR2, and the measured resistance, R2, to determine the current. Note that the current in R2 is the same as Ic for the transistor. Enter the computed collector current in Table 2 in the column labeled Base Current = 50 A.
2. Without disturbing the setting of *VBB,*increase Vcc until 4.0 V is measured across the transistor's collector to emitter. Measure and record VR2 for this setting. Compute the collector current by applying Ohm's law as in step 4. Continue in this manner for each of the values of VCE listed in Table 2.
3. Reset *VCC* ,for 0 V and adjust *VBB* until VR1 is 3.0 V. The base current is now 100 A.
4. Without disturbing the setting of *VBB,*, slowly increase Vcc until VCE is 2.0 V. Measure and record VR2 for this setting in Table 2 in the column labeled Base Current = 100 A. Compute Ic for this setting by applying Ohm's law to R2*.* Enter the computed collector current in Table 2.
5. Increase Vcc until Vcs is equal to 4.0 V. Measure and record VR2 for this setting. Compute Ic as before. Continue in this manner for each value of Vcc listed in Table 2.
6. Reset Vcc for 0 V and adjust *VBB* until VRI is 4.5 V. The base current is now 150 µA.
7. Complete Table 2 by repeating steps 7 and 8 for 150 mA of base current.

11. Plot three collector characteristic curves using the data tabulated in Table 2. The collector characteristic curve is a graph of VCE (x-axis), versus *IC* (y-axis) for a constant base current. Choose a scale for *IC* that allows the largest current observed to fit on the graph. Label each curve with the base current it represents. Graph the data in Excel and make sure that all three curves are displayed on the same graph.

**Data and Observations:**

Describe the results of your graph in your notebook. Does the graph look linear or non-linear (i.e. – does it curve)?

1. All schematic diagrams were created with Falstad circuit simulator (https://falstad.com/circuit/) [↑](#endnote-ref-1)