Electronic Circuits I – Laboratory 03

Base Bias: CE Configuration

#	Student ID	Student Name	Grade (10)	Instructor signature
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Delivery Date	

Objective

The objective of this exercise is to explore the operation of a basic common emitter biasing configuration for bipolar junction transistors, namely fixed base bias. Along with the general operation of the transistor and the circuit itself, circuit stability with changes in beta is also examined.

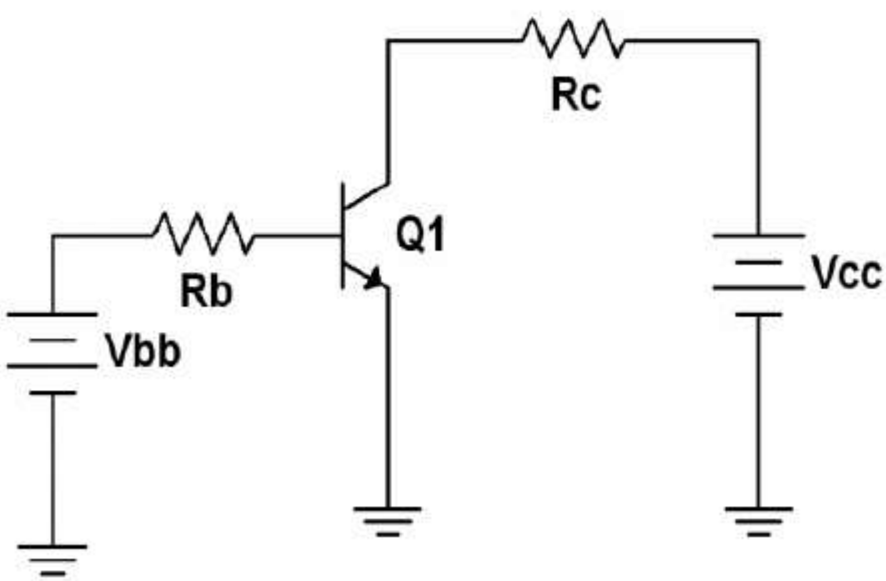
Theory Overview

For a bipolar junction transistor to operate properly, the base-emitter junction must be forward biased while the collector-base junction must be reverse biased. This will place VBE at approximately .7 volts and the collector current IC will be equal to the base current IB times the current gain β. For small signal devices, the current gain is greater than 100 typically. Thus, IC>>IB and IC≈IE.

The common emitter configuration places the emitter terminal at ground. The base terminal is seen as the input and the collector as the output. Using a fixed base supply, the base current is dependent on the value of the base resistor via Ohm's law. Consequently, any variation in current gain across a batch of transistors will show up as an equivalent variation in collector current, and by extension, a variation in collector-emitter voltage VCE.

Equipment

(1) Dual Adjustable DC Power Supply
(1) Digital Multimeter
(3) Small signal NPN transistors (2N3904)
(1) 1.2 k Ω resistor ¼ watt
(1) 330 k Ω resistor ¼ watt



Procedure

A Quick Check

controls to get as close to 2.2 volts as possible. Record the displayed voltage in the first column of next table 3. Using the general purpose DMM set to the DC voltage function, set the range to 20 volts full scale. Measure the voltage at the ouput jacks of the power supply. Be sure to

Base Bias

2. Consider the circuit of Figure 1 with Vbb = 11V, Vcc = 15V, Rb = 330 k and Rc = 1.2 k. Assume VBE = .7 volts. Further, assume that beta is 150 (a typical value for this device in this application). Calculate the expected values of IB, IC and IE, and record them in the “Theory” columns of Table 1. Note that the theoretical values will be the same for all three transistors.

3. Based on the expected value of IC, determine the theoretical value of VCE and record it in Table 3.2. Also, fill in Table 3.2 with the typical (theoretical) beta value of 150.

4. Build the circuit of Figure 3.1 with Vbb = 11V, Vcc = 15V, Rb = 330 k and Rc = 1.2 k. Measure and record the base, collector and emitter currents, and record them in the first row of Table 3.1. Determine the deviations between the theoretical and experimental currents, and record these in Table 1.

5. Measure the base-emitter and collector-emitter voltages and record in the first row of Table 3.2. Based on the measured values of base and collector current from Table 3.1, calculate and record the experimental betas in Table 2. Finally, compute and record the deviations for the voltages and for the current gain in Table 2.

6. Remove the first transistor and replace it with the second unit. Repeat steps four and five using the second row of Tables 1 and 2.

7. Remove the second transistor and replace it with the third unit. Repeat steps four and five using the third row of Tables 1 and 2.

Design

8. One way of improving the circuit of Figure 1 is to redesign it so that a single power supply may be used. As noted previously, the base current is largely dependent on the value of VBB and RB. If the supply is changed, the resistance can be changed by a similar factor in order to keep the base current constant. This is just an application of Ohm’s law. Based on this, determine a new value for RB that will produce the original IB if VBB is increased to the VCC value (i.e., a single power supply is used). Record this value in Table 3.

9. Rewire the circuit so that the original RB is replaced by the new calculated value (the nearest standard value will suffice). Also, the VBB supply should be removed and the left side of RB connected to the VCC supply. Measure the new base current and record it in Table 3. Also determine and record the deviation between the measured and target base current values.

Results and data analysis

Table 1

Transistor	IB Theory	IB Exp	%D IB	IC Theory	IC Exp	%D IC	IE Theory	IE Exp	%D IE
1									
2									
3									

Table 2

Transistor	VBE Thry	VBE Exp	%D VBE	VCE Thry	VCE Exp	%D VCE	β Theory	β Exp	%D β
1									
2									
3									

Table 3

Calculated RB	Actual RB Used	IB Measured	% Deviation IB

Questions and Conclusions

1. Are the basic transistor parameters borne out in this exercise? That is, are the approximations of VBE=.7 and IC=IE valid?

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2. Is the typical beta value of 150 highly accurate and repeatable?

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3. Which circuit parameters are affected by beta changes? Which parameters appear to be immune to changes in beta?

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4. Comparing Tables 1 and 2, is there a notable pattern between the deviations for beta and collector current? Why/why not?

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5. In the circuit of Figure 1, what must RB be set to if VBB = 5V and the desired base current is 10 µA?

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