University of Minnesota-Duluth

EE 2212

Electronics I

Lab 8: NPN BJT Bias

March 29, 2018

Author:
Brice Johnson
Jonathan Machler

Supervisor:
Dawson Rosell

Abstract

The Q-point of a transistor is an important concept to understand, it simplifies the modeling of said transistors massively. Below and above the Q-point, the model gets slightly more complicated. The mode between forward active and saturation can be found by measuring various parameters and qualities of a biased base input signal. This lab uses that signal manipulation to find the Q-Point of an NPN transistor.

Introduction:

The Q-Point of a transistor is the line where the transistor goes from forward active to saturation. At this point of operation, the transistor can be modeled as an Ideal voltage dependent current source. The purpose of this lab is to find the bias necessary to put this transistor on the Q-point line.

Background:

The characteristic curve of a transistor,V_{ce} Vs I_c produces a set of curves that accurately show how altering the base current changes the collector voltage. When a line is drawn from the $V_{ce} = 0$ condition to the $I_c = 0$ condition, the set of intersections that you get is called a Q-point. The objective of this lab is to find the Q-point of the 2N2222 transistor.

Procedure:

A simple transistor circuit is constructed (schematic 1), and a waveform is supplied to the base via the IN element. There is a DC bias Supplied in by V2, but both the IN and V2 are supplied to the circuit via an arbitrary waveform generator. There is a DC Voltage supplied via a DC power supply through an input resistor.
I_c can be derived by measuring the collector voltage, from KCL. $I_c = \frac{V_{in}-V_c}{R_1}$. with our input parameter of 10 Volts, and input resistance of 5k, we get $I_c = 0.002 - \frac{V_c}{5000}$. To find our base current, we can apply KVL again to the base voltage, and with our preset parameter $V_{DC} = 1.5V$, and $R_{in} = 100k$, we get the equation $I_b = 0.000015 - \frac{V_{in}-V_b}{100000}$. This means that we can plot $\frac{I_c}{I_b}$ on the oscilloscope, of which the slope $(\frac{\mathrm{d}I_c}{\mathrm{d}I_b})$ over a certain period would be our Q-point.

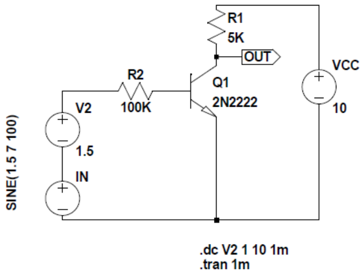
Materials needed for lab:

- Breadboard
- Waveform generator
- Oscilloscope
- 2N2222 NPN Transistor.

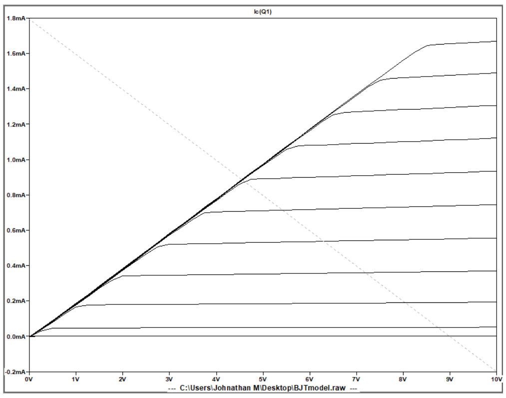
1 Schematics

Measurement and Analysis of Results:

We used the slope of the O-scope to calculate a slope of -0.2 mA/Volt, which doesn't seem unreasonable.

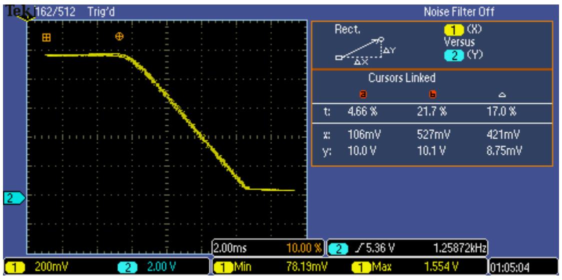


(a) Schematic

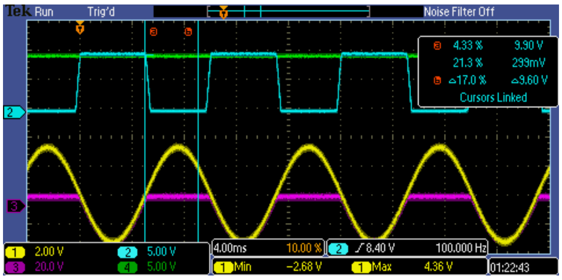


(b) calculated Q-point

Figure 1: SPICE Values



(a) Schematic



(b) calculated Q-point

Figure 2: SPICE Values

2 Graphs:

Conclusion:

With a measured Q-point (line) of -0.2mA/Volt, the line does not seem unreasonable. We did however, have some trouble finding the X-intercept of the line, which is vital to finding the bias needed in order to make a proper amplifier.