# EE236: Experiment 13
# Characterising an Unknown Device

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November 1, 2018

## 1 Aim of the experiment

The experiment aims to realise the I-V Characteristics of an Unknown Device/Circuit and hence identify te circuit. Prior to this, the I-V Characteristics of a Bipolar Junction Transistor will be calculated.

## 2 Observations and Inferences

### 2.1 Bipolar Junction Transistor

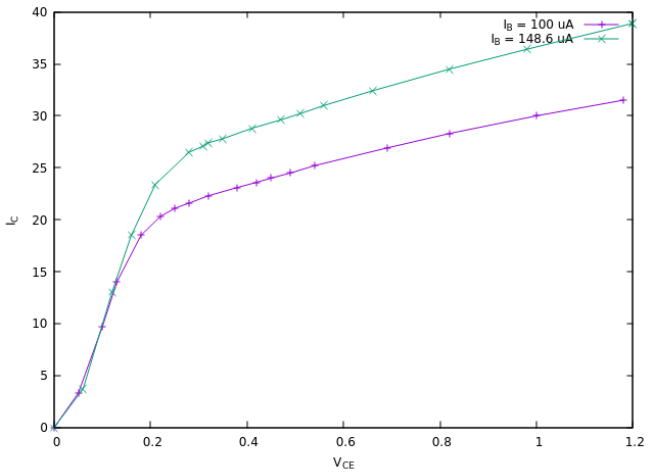



Figure 1: $I_C - V_{CE}$ Characteristics for Varying $I_B$

The previous plot for the $I_C - V_{CE}$ characteristics was created using the following data obtained in the lab:

| $I_B = 100\ \mu A$ | | $I_B = 148.6\ \mu A$ | |
|---|---|---|---|
| $V_{CE}$ | $I_C$ | $V_{CE}$ | $I_C$ |
| 0.00 | 0.00 | 0.000 | 0.00 |
| 0.05 | 3.29 | 0.056 | 3.65 |
| 0.10 | 9.67 | 0.120 | 13.04 |
| 0.13 | 13.98 | 0.156 | 18.48 |
| 0.18 | 18.52 | 0.205 | 23.38 |
| 0.22 | 20.33 | 0.281 | 26.53 |
| 0.25 | 21.08 | 0.308 | 27.06 |
| 0.28 | 21.59 | 0.323 | 27.41 |
| 0.32 | 22.32 | 0.349 | 27.82 |
| 0.38 | 23.06 | 0.411 | 28.83 |
| 0.42 | 23.59 | 0.467 | 29.64 |
| 0.45 | 24.00 | 0.512 | 30.23 |
| 0.49 | 24.50 | 0.558 | 30.95 |
| 0.54 | 25.16 | 0.660 | 32.37 |
| 0.69 | 26.90 | 0.821 | 34.45 |
| 0.82 | 28.29 | 0.978 | 36.35 |
| 1.00 | 30.03 | 1.200 | 38.90 |
| 1.18 | 31.49 | - | - |

The equations obtained for the linear region of the plots are given below. From these, we may calculate the Early voltage (x-intercept):

| $I_B$ | Equation of the plot | Early voltage |
|---|---|---|
| 100 $\mu A$ | $y = 10.182x + 19.719$ | -1.937 V |
| 148.6 $\mu A$ | $y = 12.355x + 24.184$ | -1.957 V |

## 2.2 Unknown Device

The given device consisted of three pins which we identified in the following manner:

1. Terminal 1 - Long Red Wire

2. Terminal 2 - Short Red Wire

3. Terminal 3 - Blue Wire

Hence we obtained the following readings where the first mentioned terminal was placed positive:

| Terminal 1 / Terminal 3 | | Terminal 2 / Terminal 3 | | Terminal 1 / Terminal 2 | |
|---|---|---|---|---|---|
| V (V) | I (mA) | V (V) | I (mA) | V (V) | I (mA) |
| -3.00 | 0.00 | -3.00 | 0.00 | -3.00 | 0.00 |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.22 | 0.00 | 0.33 | 0.00 | - | - |
| 0.45 | 0.05 | 0.47 | 0.07 | - | - |
| 0.50 | 0.10 | 0.53 | 0.15 | - | - |
| 0.53 | 0.15 | 0.59 | 0.25 | - | - |
| 0.61 | 0.29 | 0.64 | 0.37 | - | - |
| 0.75 | 0.60 | 0.72 | 0.54 | - | - |
| 0.86 | 0.91 | 0.80 | 0.76 | - | - |
| 0.96 | 1.16 | 0.87 | 0.92 | - | - |
| 1.06 | 1.43 | 1.00 | 1.27 | - | - |
| 1.24 | 1.93 | 1.11 | 1.56 | - | - |
| 1.53 | 2.76 | 1.22 | 1.88 | - | - |
| 1.70 | 3.27 | 1.73 | 3.35 | - | - |
| 1.97 | 4.08 | 1.93 | 3.97 | - | - |
| 2.19 | 4.76 | 2.23 | 4.86 | - | - |
| 2.62 | 6.04 | 2.61 | 6.00 | - | - |
| 3.00 | 7.19 | 3.00 | 7.18 | 3.00 | 0.00 |

As can be noticed, the first and second measurements signify a diode connected in the required fashion and a resistor in series, whereas the third represents two diodes connected with the p-side meeting (back-to-back connection).

Hence, from the performed experiment, we realise that the circuit consists of a star connection of two back-to-back diodes and a resistor meeting at the intersection of the two diodes. Shown below is the circuit diagram for the same:

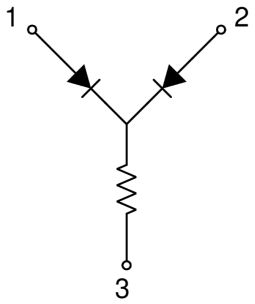
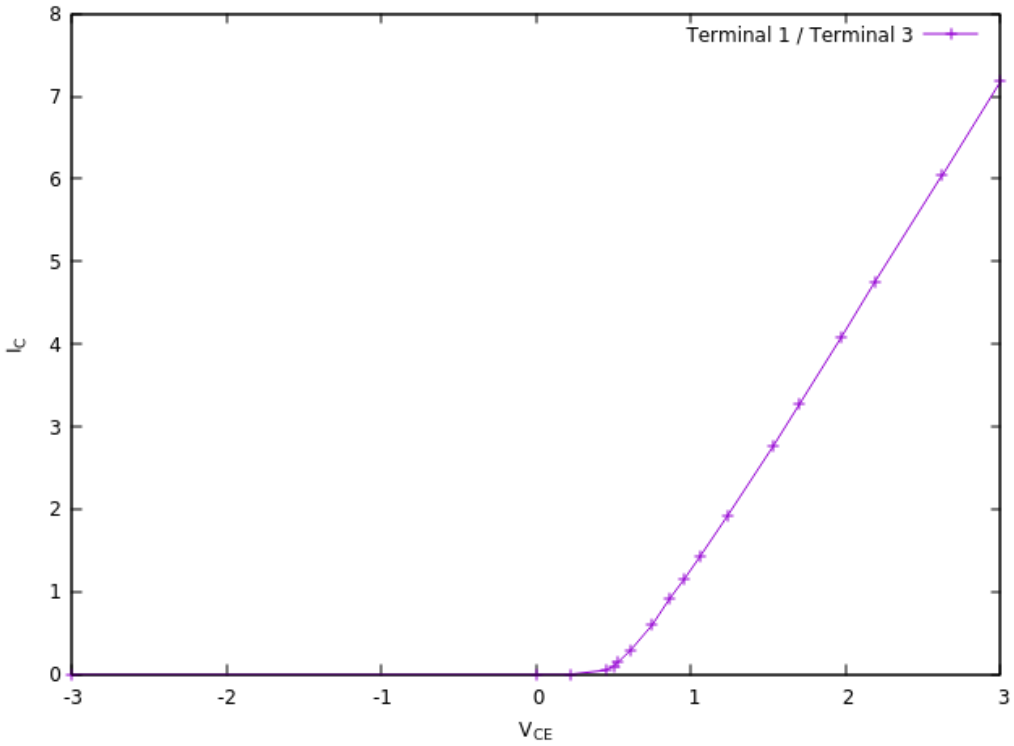


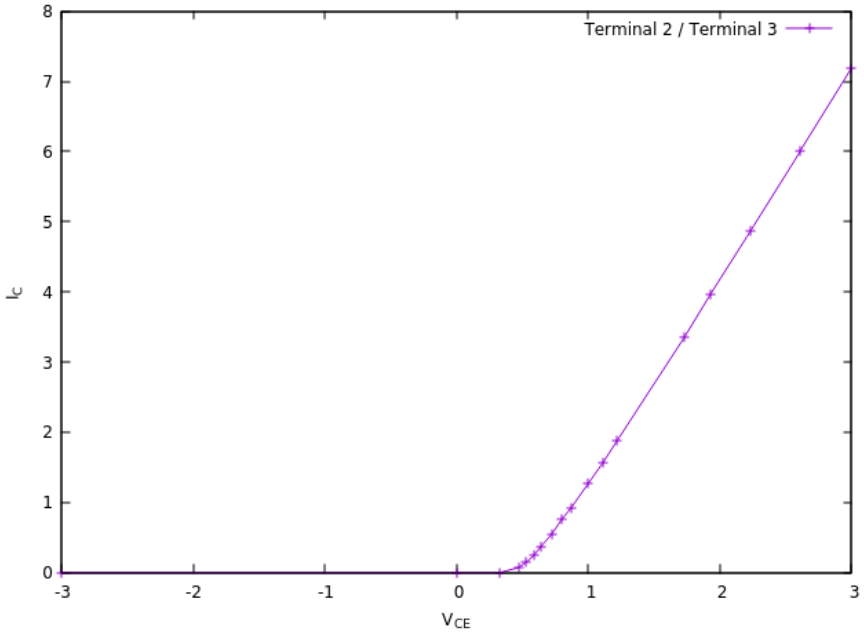

Figure 2: Equivalent Circuit Diagram

We can plot the I-V Characteristics from the data calculated as shown:

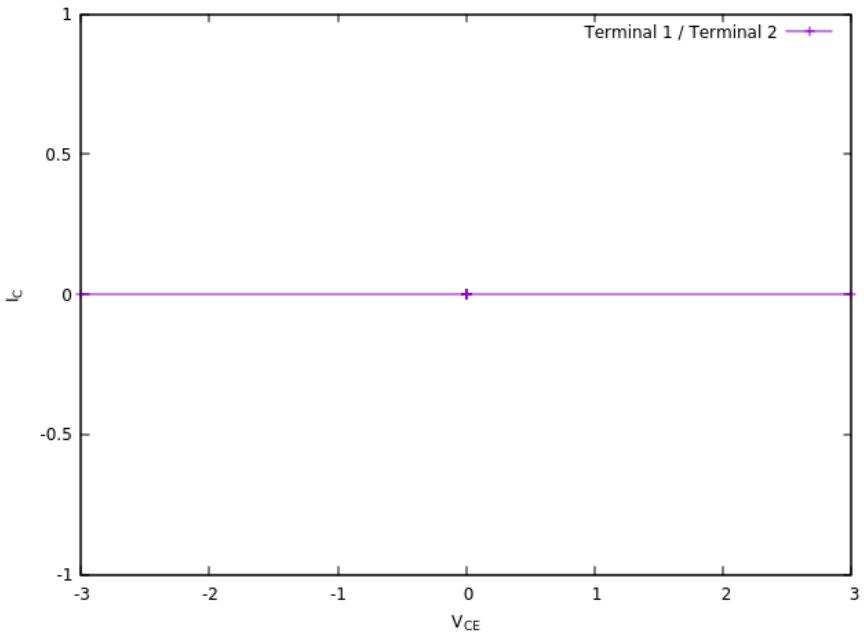



(a) Terminal 1 / Terminal 3

Figure 3: I-V Characteristics of Unknown Device




(a) Terminal 2 / Terminal 3




(b) Terminal 1 / Terminal 2