Experiment 9

Bipolar Transistor Characteristics

1- Objects of the Experiment:

- Base-emitter diode characteristic for open collector.
- Representing the relationship $I_C\ (I_B)$ with V_{CE} as parameter (V_{CE} = constant).
- Measurement methods for determining the relation between V_{CE} and I_C.

2- Principles

There are two types of bipolar transistors: npn transistors doping and pnp transistors doping as shown in Figure 1.

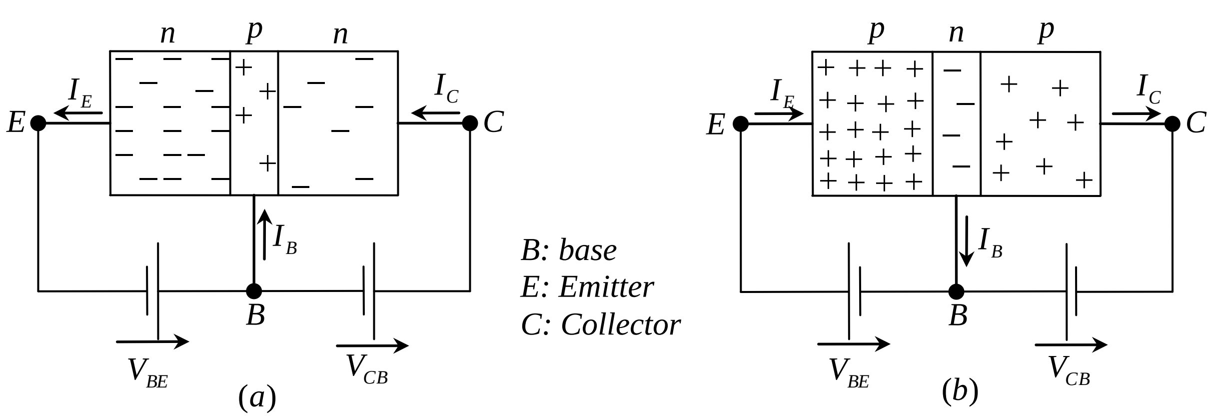

***Figure 1**. (a) npn transistors doping; (b) pnp transistors doping*

Emitter: this zone emits charge carriers into the middle zone (base).

Collector: This zone collects charge carriers.

I_B causes a flood of charge carriers in the weekly-doped base. The vast majority of these charge carriers are removed via the collector by V_{CB}.

I_C is dependent on I_B and $I_C >> I_B$: a small base current can control a relatively large collector current I_C.

3- Equipments

1 resistor 1kΩ / 2W	577 44
1 resistor 100Ω / 2W	577 32
1 resistor 10kΩ / 0.5W	577 56
1 Potentiometer 10kΩ / 1W	577 925
1 Potentiometer 1kΩ / 1W	577 92
1 Transistor BD 137, NPN	578 67
1 multimeters	
1 Power supply unit	726 88
1 Plug-in board 297X300	72650
1 Set of bridging plugs 19mm	501 48
1 Set of connecting leads	501 532

4- Setup and carrying out the experiment

4-1- Base-emitter diode characteristic for open collector

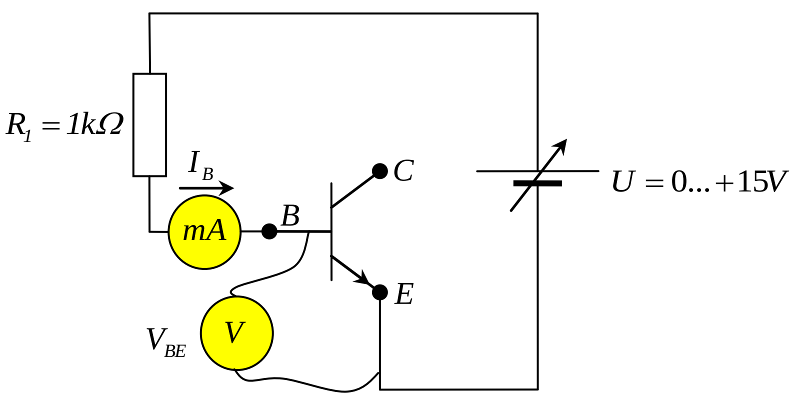

Figure 1. Base-emitter diode characteristic for open collector

The characteristic of $I_B = f(V_{BE})$ is called the transistor input characteristic.

- Assemble the circuit as shown in Figure 1.

- Measure the relation between I_B and V_{BE} and enter the values in Table 1.

Table 1

V_{BE} (V)	I_B (mA)
0.1	

0.3	
0.5	
0.6	
0.65	
0.7	
0.75	
0.8	

- Prepare a sheet of graph paper for plotting I_B versus V_{BE}. You should make I_B the vertical axis and V_{BE} the horizontal axis. Each axis should be labeled and appropriate units indicated. The graph should have a title.
- Plot your data from Table 1 and draw the graph of $I_B = f(V_{BE})$.

4-2- Control characteristic and current amplification

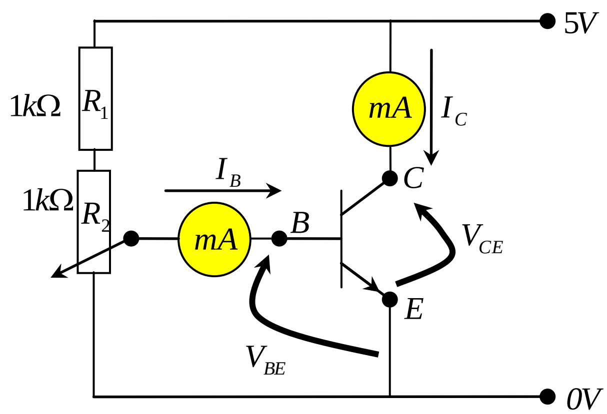

Figure 3.

The base voltage V_{BE} is set using potentiometer R_2. This controls the base current I_B which then in turn causes the current I_C.
- Assemble the circuit as shown in Figure 3.
- Adjust the potentiometer in both directions.
- Measure the collector currents witch correspond to the base currents given in Table 3. Enter these values into the second column.

Table 3.

I_B (μA)	I_C (mA)
10	
20	
50	
80	
100	
200	
300	
500	

- Prepare a sheet of graph paper for plotting I_C versus I_B (Table 3). You should make I_C the vertical axis and I_B the horizontal axis. Each axis should be labeled and appropriate units indicated. The graph should have a title.
- Plot your data on the graph.
- Draw best fit line to the points on your graph. The best fit line must be drawn by using method of least squares
- Determine the slope of your line.
- Roughly describe the relationship between I_B and I_C.

4-3- Transistor output characteristic

- Assemble the circuit as shown in Figure 4.
- Set a base current $I_B = 100\ \mu A$ using the base potentiometer (10kΩ). You must maintain the base current at a constant magnitude.
- Set the voltage V_{CE} given in Table 4 using the collector potentiometer (1kΩ), measure the corresponding value V_2 and calculate V_1 in each case. (Make sure that I_B is reset as required.)

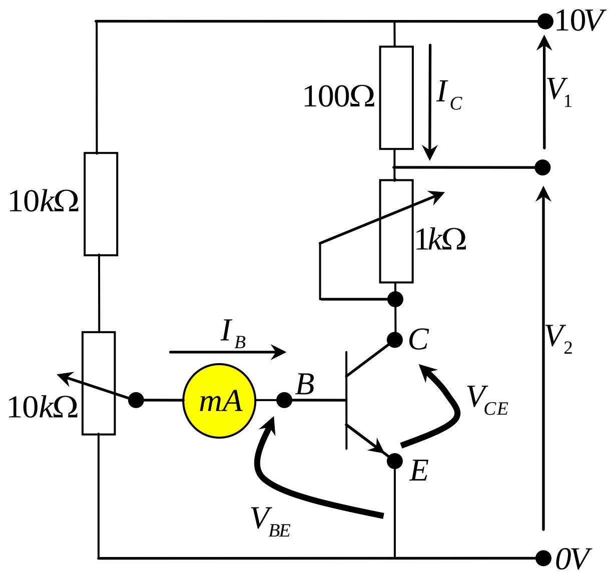

Figure 4. Measurement method for determining the relationship between V_{CE} and I_C.

- Calculate the corresponding collector currents and enter V_1 and I_C values in Table 4.
- Repeat the procedure for the base currents $I_B = 200\ \mu A$, $I_B = 300\ \mu A$, $I_B = 400\ \mu A$, and $I_B = 500\ \mu A$ (Tables 5 – 8).

Table 4.

$I_B = 100\ \mu A$			
V_{CE} (V)	V_2 (V)	V_1 (V)	I_C (mA)
0			
….			
….			
….			
….			
….			
0.6			

Table 5.

$I_B = 200\ \mu A$			
V_{CE} (V)	V_2 (V)	V_1 (V)	I_C (mA)
0			
….			
….			
….			
….			
….			
0.6			

Table 6.

$I_B = 300\ \mu A$			
V_{CE} (V)	V_2 (V)	V_1 (V)	I_C (mA)
0			
….			
….			
….			
….			
….			
0.6			

Table 7.

$I_B = 400\ \mu A$			
V_{CE} (V)	V_2 (V)	V_1 (V)	I_C (mA)
0			
….			
….			
….			
….			
….			
0.6			

Table 8.

$I_B = 500\ \mu A$			
V_{CE} (V)	V_2 (V)	V_1 (V)	I_C (mA)
0			
….			
….			
….			
….			
….			
0.6			

- Prepare a sheet of graph paper for plotting I_C versus V_{CE} (Table 4-8). You should make I_C the vertical axis and V_{CE} the horizontal axis. Each axis should be labeled and appropriate units indicated. The graph should have a title.
- Plot your data on the graph.
- Describe the curve of the parameter $I_B = 100\ \mu A$.
- Compare the high base current curves with the low ones.

5- Conclusion

Make a general conclusion about the experiments and the results obtained.