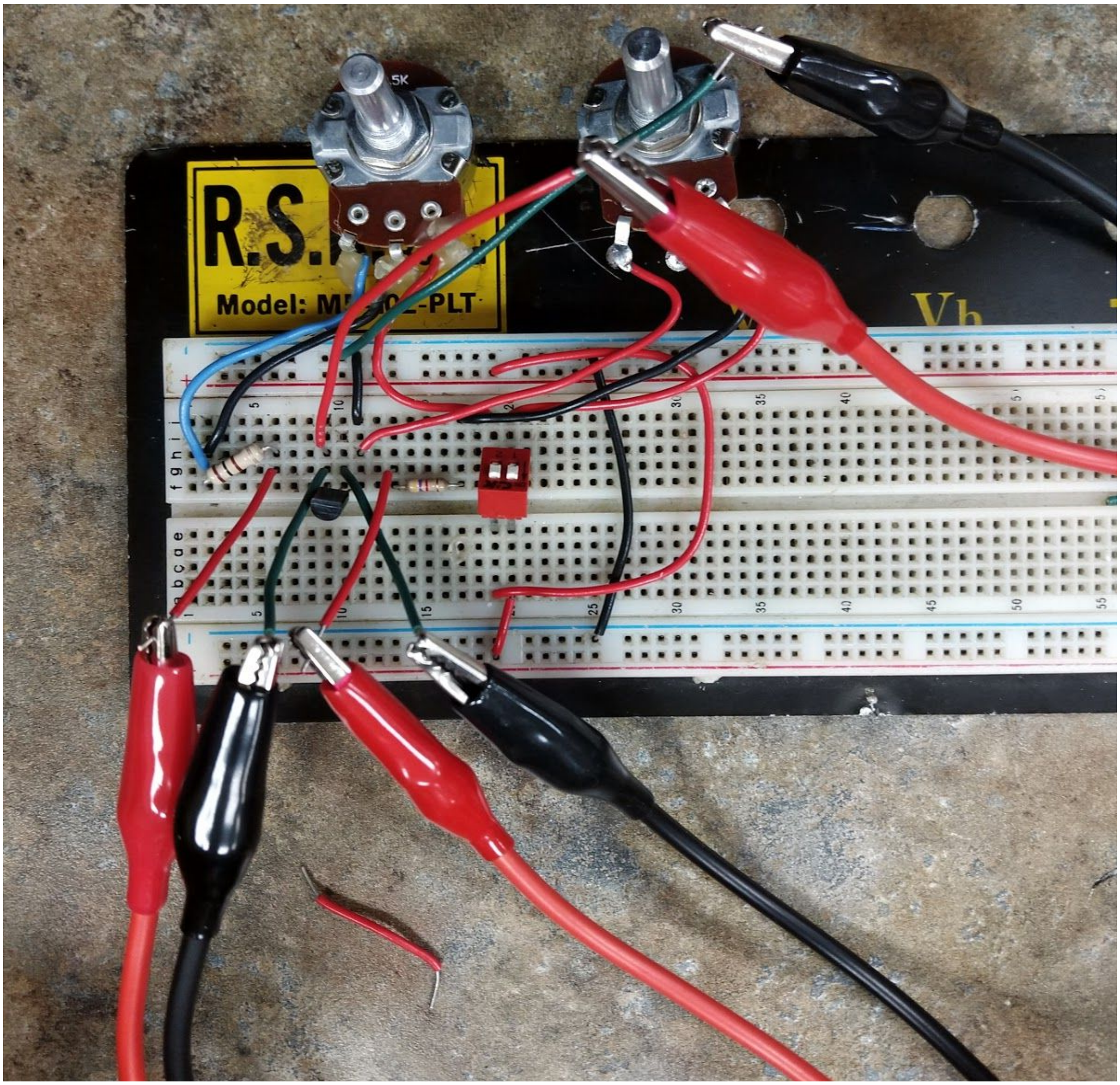
Experiment 11

Current Gain (β) In A Common-Emitter Configuration



By: Thomas Buckley, Aidan O'Leary, Josh Pinoos, Zachary Welch

01/07/19-01/11/19

Objective: The objective of the lab was to measure the effects on collector-current when base-current is varied and to determine the current gain of the circuit (Beta).

Materials:

- **Power supply: 1.5-V and 9-V dc sources**
- **2-Digital Multimeters**
- **A 100 and a 4,700 ohm resistor**
- **A 2N3904 Transistor**
- **2,500 and 5,000 Ohm Potentiometers**
- **2 SPST Switches**
- **Computer with Multisim installed**
- **Breadboard and Wire**

Procedure:

1. To begin the lab the common-emitter circuit in figure 1-1 was built in multisim.
2. Once constructed current and voltage meters were placed in the circuit as seen in figure 1-2.
3. Before power was supplied R4 was set to max resistance and the two switches were closed.
4. Next, the two variable resistors were set so the base current was 10 μA and the voltage across the emitter and collector was 6 volts; recorded the collector current in the table below.
5. Then in the next several steps, the base current was adjusted to 30 μA, 40 μA, and 50 μA while maintaining an emitter-collector voltage of 6 volts. For each of the base amperages, the collector amperage was measured and then recorded in the multisim table. The change in current between steps for the base and collector was calculated and recorded in the table below.
6. Then switch one and two were open and beta was calculated and recorded in the table below.
7. It was found that the current gain (beta) being compared between steps 2 and 5 is larger than the beta of steps 4 and 5.
8. All values measured and calculated for multisim were also measured and calculated for the physical portion of the lab in the circuit shown in figure 1-3.

Figure 1-1

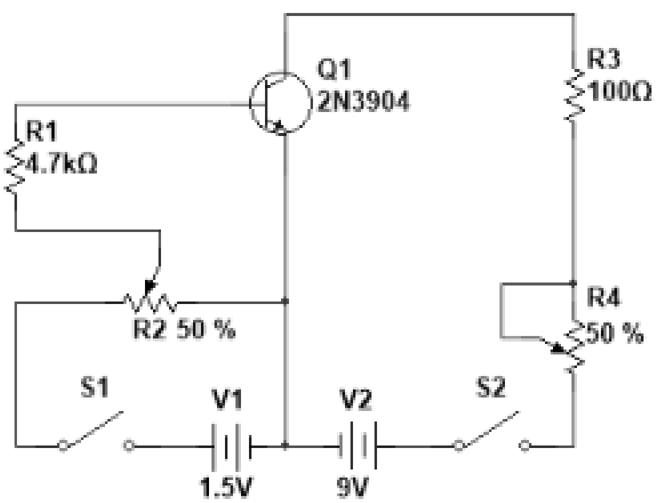
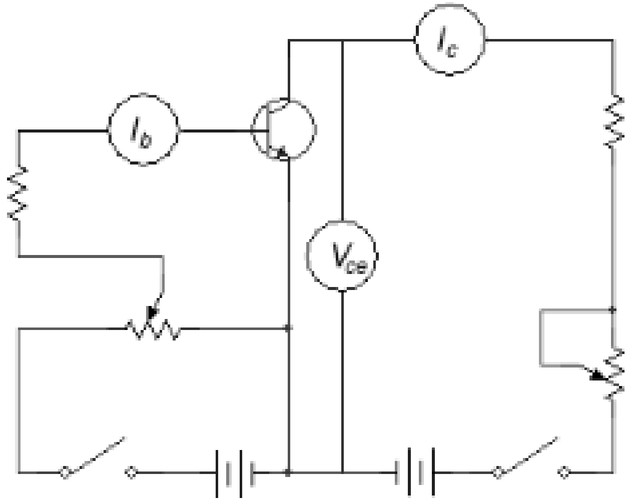


Figure 1-2



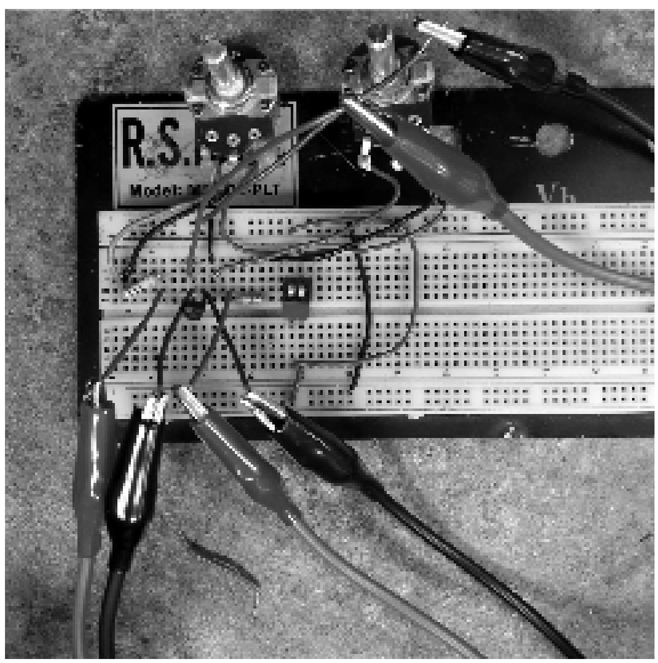


Figure 1-3

Real World

Step	**I_B** μA	**I_C** mA	**ΔI_B** μA	**ΔI_C** mA	***Beta***	***Alpha***
2	10.3	1.48	N/A	N/A	N/A	N/A
3	30.3	4.55	20.0	3.07	153.5	0.9935
4	39.9	5.92	29.6	4.44	150.0	0.9934
			9.5	1.37	144.2	0.9931
5	51	7.62	40.7	6.14	150.9	0.9934
			20.7	3.07	148.3	0.9933
			11.1	1.7	153.2	0.9935

Multisim

Step	**I_B** μA	**I_C** mA	**ΔI_B** μA	**ΔI_C** mA	***Beta***	***Alpha***
2	10	1.50	N/A	N/A	N/A	N/A
3	30	5.00	20	3.50	175.0	0.9943
4	40	6.63	30	5.13	171.0	0.9942
			10	1.63	163.0	0.9939
5	50	8.54	40	7.94	198.5	0.9949
			20	3.54	177.0	0.9944
			10	1.91	191.0	0.9948

Questions:

1. **Using the value of Beta determined in this experiment, find Alpha. Show formula and all work.**

$$\alpha = \frac{\beta}{1 + \beta}$$

All calculated values for alpha are in the tables above.

2. **What is the difference in β computed in step 5 (large input change) with β computed using the values in steps 4 and 5 (small change)?**
   The change between step 5's calculated beta to step 2's beta was larger than the change between 4 and 2 since the change in I_C is greater than I_B.

Discussion:

In the packet, the lab called for a 2N6004 transistor but a 2N3904 transistor was used instead because they are similar and were the only kind of transistor available to use. When creating the data table for this lab it took several tries in order to properly make and complete it. This is because the table that was given in the lab paper didn't give enough information about the construction of the table, it had a column for "delta currents" but didn't describe whether it was for **Δ** I_B or **Δ**I_C . To solve this issue all the information that we had gathered about the circuit in both multisim and real world were used to create the final table.

Conclusion:

When base current (input current) is increased or decreases in a common emitter circuit, the collector current also increases and decreases with it. Beta (current-gain) is determined by dividing the change in the collector current by the change of the base lead current when the collector-emitter voltage is constant and a change in base current will also change the beta.