

6 Bipolar Junction Transistor Characteristics

Name _____

Date _____

Class _____

Reading:

Floyd and Buchla, *Analog Fundamentals: A Systems Approach*, Section 3-1

Objectives:

After performing this experiment, you will be able to:

1. Measure and graph the collector characteristic curves for a bipolar junction transistor.
2. Use the characteristic curves to determine the β_{DC} of the transistor at a given point.

Summary of Theory:

A bipolar junction transistor (BJT) is a three-terminal device capable of amplifying an ac signal. The three terminals are called the base, emitter, and the collector. BJTs consist of a very thin base material sandwiched in between two of the opposite type materials. They are available in two forms, either *npn* or *ppn*. The middle letter indicates the type of material used for the base, while the outer letters indicate the emitter and collector material. The sandwiched materials produce two *pn* junctions. These two junctions form two diodes — the emitter-base diode and the base-collector diode.

BJTs are current amplifiers. A small base current is amplified to a larger current in the collector-emitter circuit. An important characteristic is the dc current gain, which is the ratio of collector current to base current. This is called the dc beta (β_{DC}) of the transistor. Another useful characteristic is the dc alpha. The dc alpha is the ratio of the collector current to the emitter current and is always less than 1.

For a transistor to amplify, power is required from dc sources. The dc voltages required for proper operation are referred to as bias voltages. The purpose of bias is to establish and maintain the required operating conditions despite variations between transistors or changes in circuit parameters. For normal operation, the base-emitter junction is forward-biased and the base-collector junction is reverse-biased. Since the base-emitter junction is forward-biased, it has characteristics of a forward-biased diode. A silicon bipolar transistor requires approximately 0.7 V of voltage across the base-emitter junction to cause base current.

Materials Needed:

Resistors: One 100 Ω resistor, one 33 k Ω resistor
One 2N3904 *npn* transistor (or equivalent)

For Further Investigation:

Option 1: Transistor curve tracer

Option 2: One rectifier diode (1N4001 or equivalent)

One small power transformer with a 12.6 V ac output

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