E2.1: Getting started with a Transistor (Bipolar Junction Transistor)

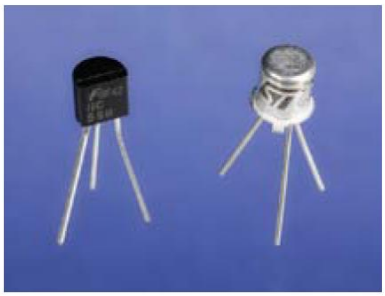
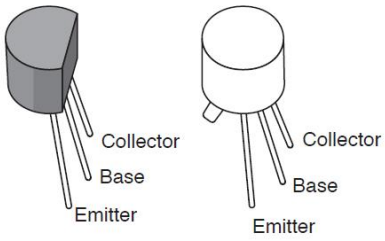
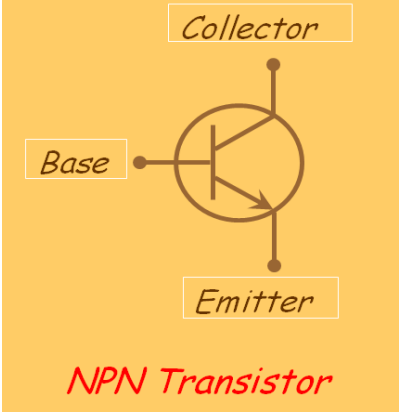
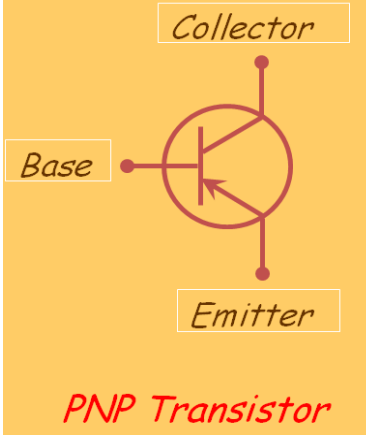


Figure 2-83. *A typical transistor is packaged either in a little metal can or a molded piece of black plastic. The manufacturer's data sheet tells you the identities of the three wire leads, relative to the flat side of a black plastic transistor or the tab that sticks out of a metal-can transistor.*







ESSENTIALS

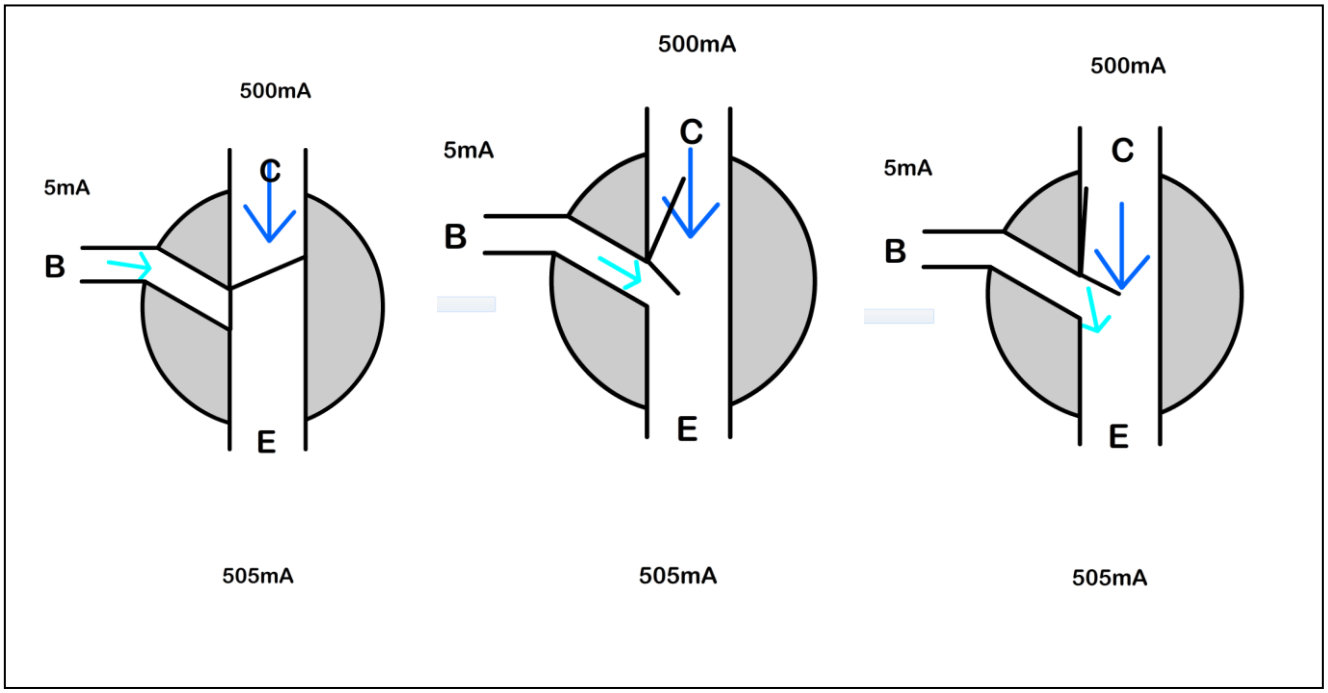
All about NPN and PNP transistors

A transistor is a semiconductor, meaning that sometimes it conducts electricity, and sometimes it doesn't. Its internal resistance varies, depending on the power that you apply to its base.

NPN and PNP transistors are bipolar semiconductors. They contain two slightly different variants of silicon, and conduct using both polarities of carriers—holes and electrons.

You can think of a bipolar transistor as if it contains a little button inside, as shown in Figures 2-89 and 2-90. When the button is pressed, it allows a large current to flow. To press the button, you inject a much smaller current into the base by applying a small voltage to the base. In an NPN transistor, the control voltage is positive. In a PNP transistor, the control voltage is negative.

Continue at pg 76-77 on recommended text book



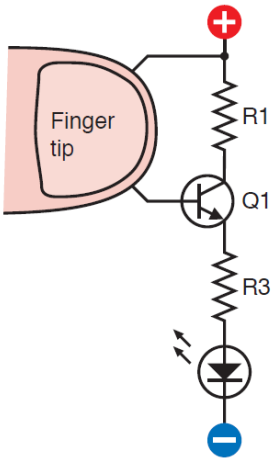
Deliverables: A writeup that describes the Bipolar Junction Transistor (BJT) and the experiment with the2N2222 as a switch, based on the schematic given

Procedure:

1. Gather the components that are necessary prior to the start of this experiment.
2. Assess the necessary risk factor and possible mitigation associated with this experiment.
3. Establish the hypothesis associated with this experiment and the desired outcome.
    a. Q1 replaced with a wire.
    b. Q1 replaced with a PNP
4. Design the testing methodology for this experiment.
5. Assemble the circuit on a breadboard with the required components based on the schematic given.
6. Collect the data, such as observation during experiments, readings recorded on DMM, and more.

Ponder
Want to have **FUN** with transistor as a switch?
What items could replace the fingertip as an input source?

R1: 180Ω
R2: 10K
R3: 680Ω
Q1: 2N2222 or similar
D1: LED



Never Use Two Hands

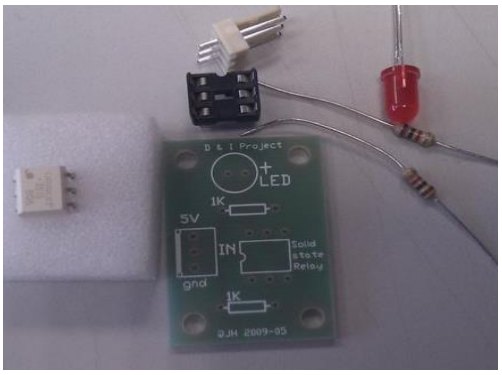
The fingertip switching demo is safe if the electricity passes just through your finger. You won't even feel it, because it's 12 volts DC from a power supply of 1 amp or less. But it's not a good idea to put the finger of one hand on one wire, and the finger of your other hand on the other wire. This would allow the electricity to pass through your body. Although the chance of hurting yourself this way is extremely small, you should never allow electricity to run through you from one hand to the other. Also, when touching the wires, don't allow them to penetrate your skin.

Comparison of transistor or relay switching. Continue at pg77

	Transistor	Relay
Long-term reliability	Excellent	Limited
Configurable for DP and DT switching	No	Yes
Ability to switch large currents	Limited	Good
Able to switch alternating current (AC)	Usually not	Yes
Can be triggered by alternating current (AC)	Usually not	Optional
Suitability for miniaturization	Excellent	Very limited
Sensitive to heat	High	Moderate
Ability to switch at high speed	Excellent	Limited
Price advantage for low-voltage low-current	Yes	No
Price advantage for high-voltage high-current	No	Yes
Current leakage when "off"	Yes	No

The choice between relays or transistors will depend on each particular application.

Can't get enough of electronic switching? Want more?? Check out Solid State Relay. http://en.wikipedia.org/wiki/Solid_state_relay



Check out my experiment http://shin-ajaran.blogspot.com/2011/10/arduino-solid-state-relay-ssr.html

E2.2 Fun with Transistor as an amplifier

Parts required

1. A few pieces of LED
2. 2N2222, TIP31C
3. 3.5mm Audio jack with audio cables
4. 9V battery Supply

Procedure

1. Refer to the wiring diagram on the right.
2. Analyse the electrical requirements of this circuit, assuming the battery is 9V, using Ohm's Law. Determine the maximum number of LED that can be possibly driven with standard brightness.
3. Refer to the TIP31C data sheet at the appendix.
    a. Determine the electrical characteristic of this transistor, such as the pin arrangements, wiring.
    b. Determine the maximum current at the base and collector that can be handled by this transistor.
    c. Determine the maximum voltage at the BE-junction and the CE-junction can be handled by this transistor.
4. Compare and contrast the features of TIP31C with the 2N2222 use in Act1.2, state the major electrical differences and the possible application scenario of the TIP31C.
5. Choose a transistor and wire up the schematic on the breadboard, plug in the audio jack to a device that is capable of audio out, such as MP3 players, smart phones, laptop, music player.
6. Record your observations with both TIP31C and 2N2222. Explain which transistor would be the more suitable candidate, assuming that the deal breaker is the number of LEDs could be driven.
7. Repeat step5 without any transistor and record your observations.

Deliverables

1. You are required to demonstrate the working circuit with an audio source.
2. You are required to explain the working principles of this transistor, and possible heat management technique.

Ponder

1. Describe the relationship between current at the base and current at the collector when the BJT transistor is working at the active region.
2. Determine the relationship between $V_{CC} = I_C R_C + V_{CE}$
3. Describe the relationship between the base current ~=0 and voltage at CE-junction when the transistor working in cut-off region.
4. Describe the relationship between the collector current and the base current, and voltage at CE-junction when the transistor working in saturated region.

Fun

1. Modifications based on this circuit? Share your ideas!
2. Identify what are the components required to make it happened.
3. Determine the modifications required to implement your idea.
4. Implement your idea.