

ECEN 489: Laboratory 1

A microcontroller is an integrated circuit containing a processor core, memory and programmable input/output peripherals. These devices are typically used in embedded systems. A major distinction between a microprocessor and a microcontroller is that the latter is build to interface to the outside world. This facilitates the development of projects that entail both hardware and software components.

Buffer Stage

The output of a typical microcontroller can only deliver a very limited amount of current. As such, it is generally unadvisable to connect a device directly to the output pin of the microcontroller, especially when the intended load is poised to draw much current. One often needs to use a buffer stage to drive the device. The interposed buffer prevents the load circuit from driving excess current from the microcontroller and interfering with its operation.

Transistor: A transistor is a semiconductor device used to amplify and switch electronic signals and electrical power. Because the controlled (output) power can be higher than the controlling (input) power, a transistor can be used to implement a buffer stage.

Electrical Relay: A relay is an electrically operated switch. Such devices are used whenever it is necessary to control a circuit by a low-power signal with complete electrical isolation between the controlling and controlled circuits. Relays can be used to control a high-voltage circuit with a low-voltage signal or a high-current circuit with a low-current signal.

Report Items

1. Describe the operation of a voltage follower.
2. Sketch diagrams of voltage followers that use a single transistor for the two cases below. Each sketch should contain labels for a voltage source, a ground, a microcontroller signal, a load circuit and the transistor terminals.
 - (a) Bipolar junction transistor (npn) with appropriately labeled terminals: emitter (E), base (B) and collector (C).
 - (b) MOSFET with appropriately labeled terminals: source (S), gate (G), drain (D).

Diode and Protective Circuits

A diode is a two-terminal device with an asymmetric conductance. It typically features low resistance to current flow in one direction, and high resistance in the opposite direction. The electrode through which the current flows into the diode is called the anode, whereas the cathode is the electrode through which current flows out of the device. Thus, current always flows from the anode to the cathode.

Zener Diode: A Zener diode allows current to flow in the forward direction in the same manner as an ideal diode, but it will also permit it to flow in the reverse direction when the voltage is above its breakdown voltage. As such, it can be employed to protect other semiconductor devices from momentary voltage pulses.

LED: A light-emitting diode (LED) is a special type of diode that can emit visible light. The two terminals on an LED have different lengths. The longer leg is the anode, and the shorter leg is the cathode. It is important to be able to distinguish between the two terminals when assembling a circuit.

Current-Limiting Resistor: A current-limiting resistor can be used to imposing an upper limit on the current that may be delivered to a load with the purpose of protecting the circuit generating or transmitting the current from harmful effects due to a short-circuit or similar problem in the load. A light-emitting diode (LED) is an example of a load that may require a current-limiting resistor.

Report Items

1. Sketch a diagram of a circuit protected by a Zener diode. The diagram should contain a source, a ground, a load circuit and a Zener diode.
2. Explain how to select the Zener diode.
3. Sketch a diagram of an LED protected by a current-limiting resistor. The diagram should contain a source, a ground, an LED and a resistor.
4. Explain how to choose the current-limiting resistor.

Laboratory Items

1. Implement a simple buffer stage on a protoboard with a transistor, two current-limiting resistors and an LED.
2. Suppose that you are given a protective Zener diode, how would you use it to make a safer circuit?
3. How can you modify your buffer stage to include an electrical relay aimed at driving large loads?

Parts: Protoboard, BJT 2N2222 transistor, electrical relay, protective Zener diode, LED, resistors, battery pack, wires.