Deluxe Series 2000 Motion Sensor Alarm System

LAB 4

Introduction

The objective of this laboratory is to give you experience with discrete BJT transistor design and exposure to the problem of conceptual design. Given a conceptual design problem, we'd like for you to come up with a prototype circuit design and implementation. For this reason you may notice that the specification for this lab design problem is somewhat vague. To make things more interesting, we will give extra credit to the groups which are able to design the circuit using fewer components than the TAs design[1].

Various sensors could be used for this monitoring, but one of the simplest would be one which can sense changes in light. For this reason we are providing you with a phototransistor. The spec sheet is on the course web page. Design your circuit so that the alarm sounds while motion is detected, and keeps going off for a short time (approx 30 sec.) after the motion stops. For the alarm you will need to build an oscillator that produces an audible frequency, and you will drive this signal into a high-frequency transducer which is also provided as part of the lab kit.

Note that the motion sensor that you will design will sense a disturbance in the light source from the ceiling lights in the lab as you (for example) move your hand to shadow it. So using this circuit as part of a home-security alarm would require some minimum amount of light from a source that is on the opposite side of the path for which you are trying to sense motion. We're not going to try to build the light source in the lab, just the sensor circuit and oscillator. Over the summer you can add the light source part of the circuit and use this design to play practical jokes on your family.

Week 1: Sensor and Timing Circuit

For this week's lab design a circuit that is able to detect the momentary change in light. For this part of the lab, consider the BJT as a voltage controlled current source, and recall the current to voltage relationship of a capacitor. It is possible to meter current through a capacitor, to create a time dependent voltage level. This voltage level can be used to drive an LED, and enable the connection between the

1. Fewer components generally translates to lower manufacturing costs, hence larger profits!

oscillator, and the speaker. Thus, one possible block diagram of the circuit is as shown in Figure 1.

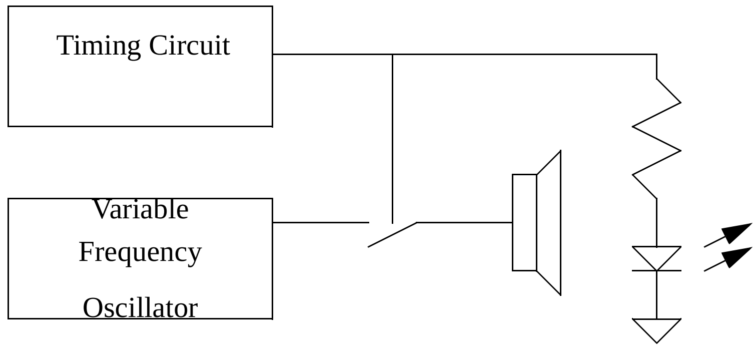

Figure 1

Week 2: Oscillator

For this weeks's lab, design a *transistor-level* (no opamps please) oscillator which is capable of oscillating at a frequency between 1kHz and 10kHz. Some example oscillators can be found in the textbook[1], or in one of the many analog circuits books that you will find in the library. **Prior to coming to lab, choose an oscillator configuration, and design the circuit on paper. Simulate it in Spice, and choose appropriate component values.** In lab, build your oscillator and use it to drive a high-frequency speaker. Demonstrate to your TA that you have a working circuit, and that it drives the speaker at the required frequency. Bring this circuit to next week's lab.

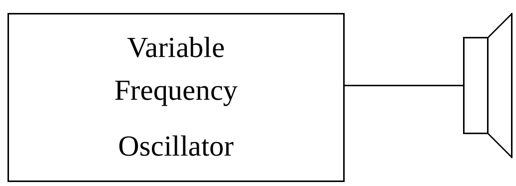

Figure 2: Variable frequency oscillator.

Week 3: Final Circuit Assembly

Now that you have built the main portions of this circuit design, use week three for the final assembly and testing of the prototype product. Parts List:

1 phototransistor

1 high-frequency speaker

As many PNP transistors, NPN transistors, and passive components as you need.

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1. For example, refer to transistor-level LC oscillator shown on page 988 in the text.