Remote Sensing of an IR Beacon

Pre-Lab Questions

1. What is the absolute maximum current that the TLN110 IR LED can take?
2. What is the maximum voltage between emitter and collector that must not be exceeded for the SDB8405 phototransistor?
3. How much current can the output of a 555 IC source or sink?

Purpose

- To explore the use of the 555 timer to produce a square wave signal at a specified frequency
- To investigate how an IR beacon can be detected and used as a navigational aid
- To practice using op-amps to condition a relatively weak analog signal into a signal that can be used effectively by the Handy Board

Components

Qty.	Item
1	Handy Board with expansion board and serial interface/charger
1	Serial cable with DB-9 to DB-25 adapter
1	RJ-11 cable
1	SDB8405 phototransistor
1	TLN110 IR LED
4	1 kΩ resistors
2	2.2 kΩ resistors
1	1 MΩ resistor
2	100 kΩ trim pots
2	0.01 μF capacitors
3	0.1 μF capacitors
1	10 μF capacitor
1	1N4148 diode
1	555 timer
1	TLC27L4 quad op-amp
2	solderless breadboards

Introduction

In this lab you will investigate how to construct a 1 kHz flashing IR beacon and how to detect its orientation, so that it can be used as a navigational aid. The tasks involved in this laboratory experiment are to be divided among the students in the class in the following way:

- construction of the IR beacon, 2 teams of 2 people will build two beacons (one beacon per team)
- construction of the detection circuit, 2 teams of 2 people will build two detectors (one detector per team)
- interface to the Handy Board and software, 2 teams of 2 people will interface the detector to the Handy Board and write a program that will indicate when the detector is pointed at the beacon (one program for each team)

The beacon will be constructed using a 555 timer. The detector will consist of a phototransistor configured as an emitter follower. The signal from the detector will be filtered and amplified, and a peak detector will be used to present to the Handy Board an analog voltage that depends strongly on the orientation of the detector relative to the beacon.

Procedure

Building the beacon flasher (Teams 1 and 2)

1. Wire the beacon flasher circuit per the schematic shown in Figure 1. Look at the output of the 555 on the 'scope. Adjust the 100 k pot so that the frequency of the output waveform is 1 kHz. Does the signal behave differently if the 0.1 µF capacitor is removed? If yes, how so?

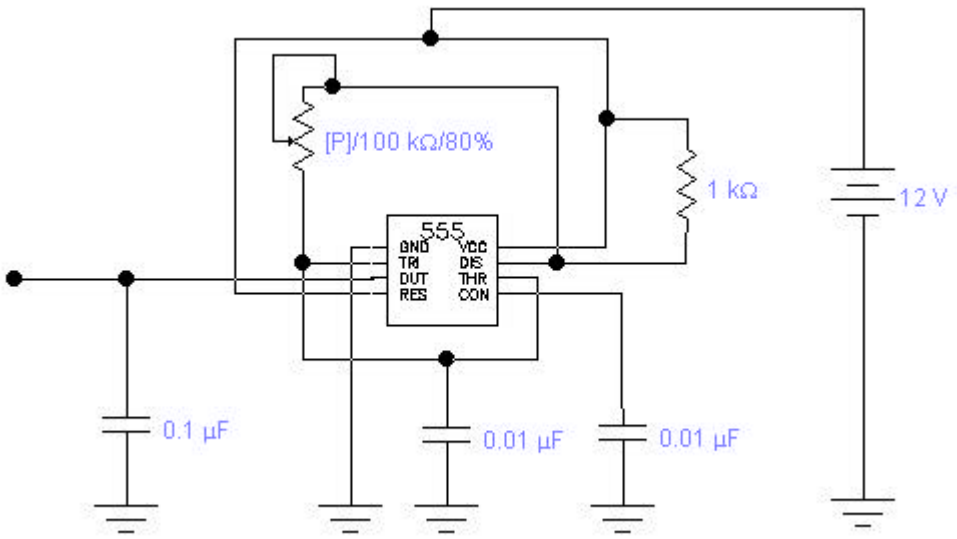

Figure 1 Schematic of 555 timer circuit to generate the IR LED drive signal. Varying the resistance of the potentiometer will vary the frequency of the output signal. Set the potentiometer to give a 1 kHz signal at the output. Does the signal behave differently if the 0.1 µF capacitor is removed? If yes, how so?

2. Once you are satisfied that the circuit is working properly, add a current limiting resistor to the output so that you can flash the TLN110 IR LED. What value of current limiting resistor should you choose if the current is to be limited to 10 mA? Add the IR LED.

Building the detector (Teams 3 and 4)

3. Build the detection circuit as shown in Figure 2. It is suggested that you build ***and*** test each amplifier (voltage follower (2 each) and non-inverting amplifier) ***separately***, so that you are confident that each one works as expected. Once you know that each amplifier is giving you what you expect, then connect the two voltage followers together, and test that their combination gives you what you expect, etc. If the IR beacon flasher is not available to drive the phototransistor, instead simulate the emitter follower with a small amplitude sine wave. The end goal is to see a signal at the output of your detector whose amplitude increases as the amplitude of the input increases.

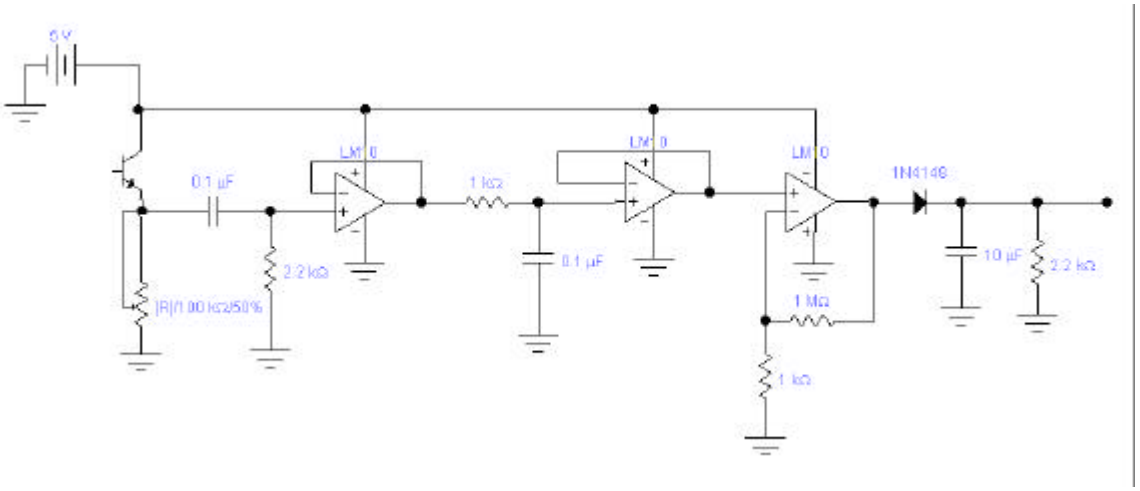

Figure 2 Schematic of detection circuit. The transistor at the left of the diagram is the SDP8405 phototransistor. Each op-amp shown is 1/4 of a TLC27L4.

Programming the Handy Board (Teams 5 and 6)

4. Write a program that will take the output of the detector, and will allow you to determine that the detector is pointing straight at the IR beacon. Until the time that a detector becomes available from one of the other teams, you may want to simulate the output of the detector using the variable power supply applied to one of the analog inputs through a current limiting resistor.

Putting it all together

5. Once all the teams finish their respective pieces, try various combinations of beacons, detectors, and detection software, to see how your hardware and software functions.
6. Take some time to explain your work to the teams that worked on other tasks.