Experiment-3

Infrared Transmitters and Receivers

BACKGROUND INFORMATION:

As next-generation electronic information systems evolve, it is critical that all people have access to the information available via these systems. Examples of developing and future information systems include interactive television, touchscreen-based information kiosks, and advanced Internet programs. Infrared technology, increasingly present in mainstream applications, holds great potential for enabling people with a variety of disabilities to access a growing list of information resources. Already commonly used in remote control of TVs, VCRs and CD players, infrared technology is also being used and developed for remote control of environmental control systems, personal computers, and talking signs.

IR Advantages:

1. Low power requirements: therefore ideal for laptops, telephones, personal digital assistants
2. Low circuitry costs: $2-$5 for the entire coding/decoding circuitry
3. Simple circuitry: no special or proprietary hardware is required, can be incorporated into the integrated circuit of a product
4. Higher security: directionality of the beam helps ensure that data isn't leaked or spilled to nearby devices as it's transmitted
5. Portable
6. Few international regulatory constraints: IrDA (Infrared Data Association) functional devices will ideally be usable by international travelers, no matter where they may be
7. High noise immunity: not as likely to have interference from signals from other devices

IR Disadvantages:

1. Line of sight: transmitters and receivers must be almost directly aligned (i.e. able to see each other) to communicate
2. Blocked by common materials: people, walls, plants, etc. can block transmission
3. Short range: performance drops off with longer distances
4. Light, weather sensitive: direct sunlight, rain, fog, dust, pollution can affect transmission
5. Speed: data rate transmission is lower than typical wired transmission.

Near infrared spectrum extends from 750 nm to 1400nm. The far field infrared (FIR) defined as the wavelength range between 1mm and 50μm. There is also a spectrum as called mid infrared (MIR) between NIR and FIR spectrum. A variety of sources and detectors are available to the expermentalist.

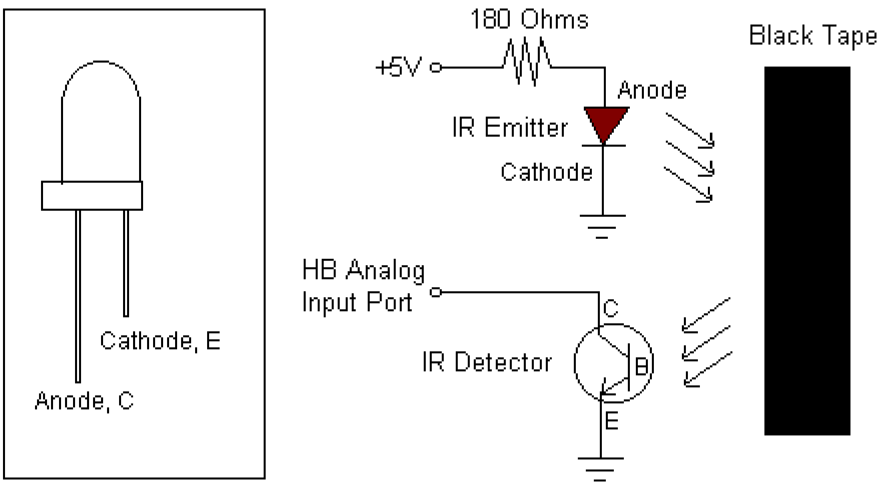
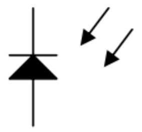
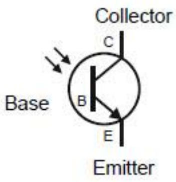


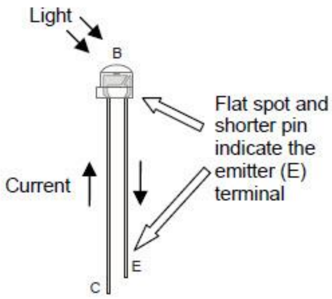
Fig. A simple circuits of infrared emitter and sensor.

Fig. IR Emitters IR Sensors



Schematic of photodiode



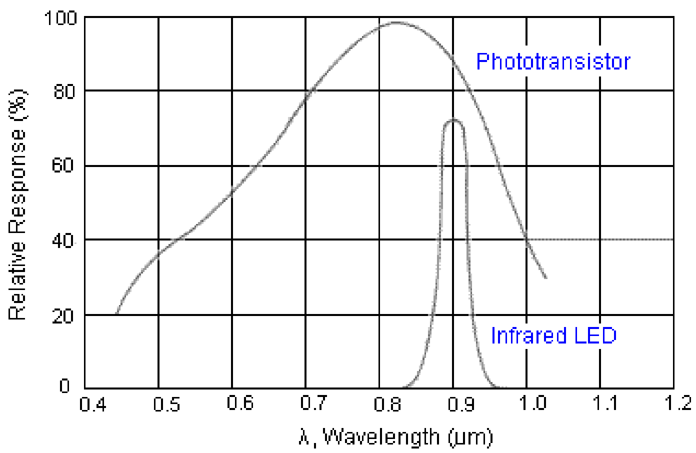


Schematic of phototransistor

All silicon photosensors (phototransistors, etc.) respond to the entire visible radiation range as well as to infrared. In fact, all diodes, transistors, Darlingtons, triacs, etc. have the same basic radiation frequency response. This response peaks in the infrared range.

This is why manufacturers offer infrared-emitting diodes. Their goal is to maximize the signal-to-noise ratio, by using an emitter with the best match to the phototransistor response. However, note the response is very broad and virtually any light source will work.

Basically, a phototransistor can be any bipolar transistor with a transparent case. There are some variations provide advantages. For example, a focusing lens can be built into the case for directional sensitivity. Coatings can be applied to block some higher or lower wavelengths. The transistor itself may provide higher gain, or higher frequency, or lower capacitance, etc.



Spectral Responsivity of a Phototransistor

Responsivity, R_λ

The responsivity of a silicon photodiode is a measure of the sensitivity to light, and it is defined as the ratio of the photocurrent I_P to the incident light power P at a given wavelength:

$$R_\lambda = I_P/P$$

In other words, it is a measure of the effectiveness of the conversion of the light power into electrical current.

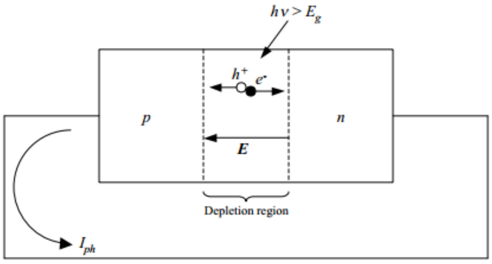
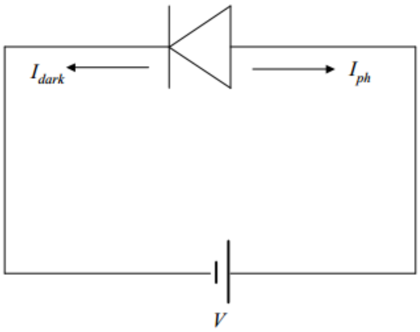
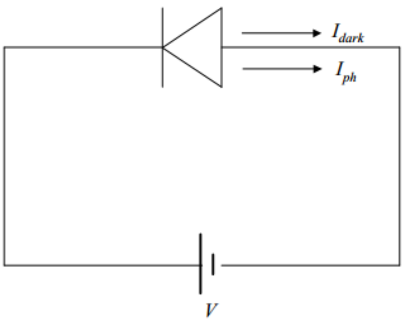


Fig. Generation of reverse photocurrent through photon absorption

The drifting charge generates a reverse current that is proportional to the number of incident photons called the photocurrent, I_{ph}.



A forward biased photodiode



A reverse biased photodiode

Application of a reverse bias (photoconductive mode) can greatly improve the speed of response and linearity of the devices. This is due to increase in the depletion region width and consequently decrease in junction capacitance. Applying a reverse bias, however, will increase the dark and noise currents.

The photovoltaic mode of operation (unbiased) is preferred when a photodiode is used in low frequency applications (up to 350 kHz) as well as ultra low light level applications. In addition to offering a simple operational configuration, the photocurrents in this mode have less variations in responsivity with temperature.

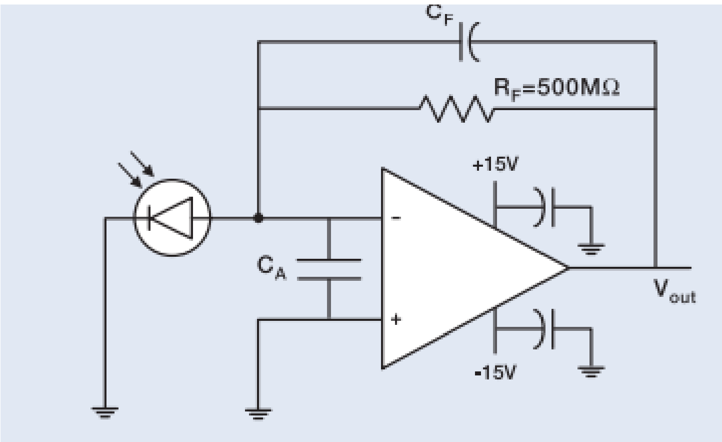


Fig. Photovoltaic mode of operation circuit example: Ultra low level light / low speed

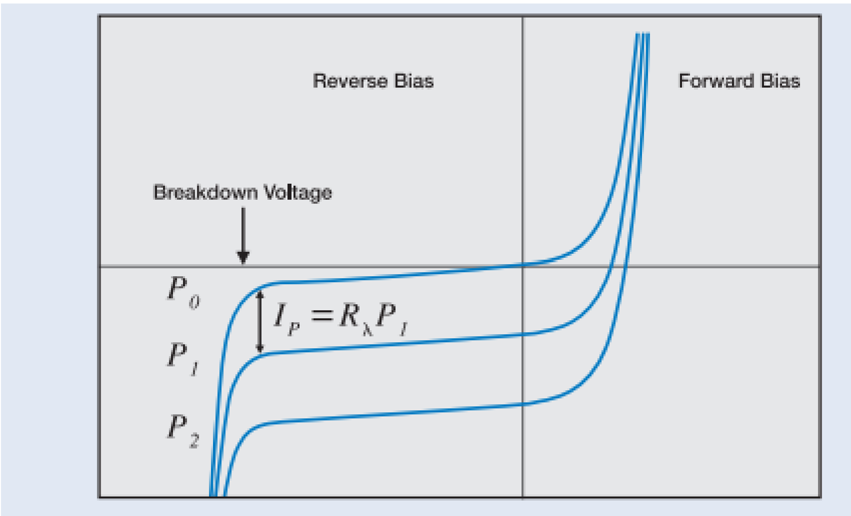


Fig. Characteristic I-V Curves of a photodiode for Photoconductive and Photovoltaic modes of operation.

Experiment-3: Infrared Transmitters and Receivers

AIM: The investigation Infrared Transmitters and Receivers with regard to their operating principles.

EQUIPMENT

Power Supply

Oscilloscope

Voltmeter, Ampermeter

Infrared led, photodiode, phototransistor

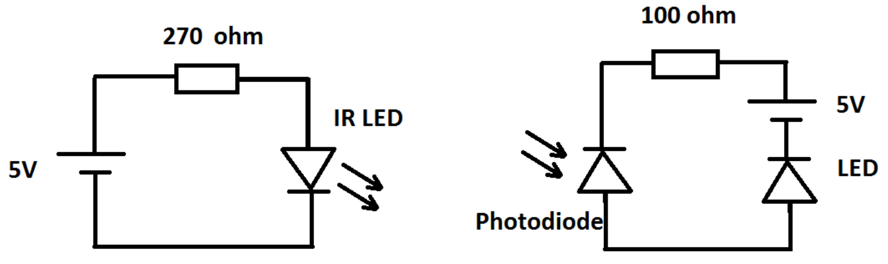
Resistors 100Ω, 270Ω, 1K, 50K (trimpot), BC547

Optical filters: FR-400, RG695

The experiment consists of 2 parts.

PROCEDURE -1:

1. Connect the infrared transmitter and receiver circuits on the breadboard with their active surface facing each others as shown in the figure.



2. When the transmitter and receiver circuits are powered, see the LED on the receiver circuit. The LED should light up.

3. Now take an object such as a piece of paper or a thick card and put it in between the emitter and the detector. The LED should turn off indicating the sensor does not detect any IR light. Determine what kind of object block and allow infrared light.

4. Remove the LED and connect the an Ampermeter (in mA) in this terminals.

5. Complete the following table below by adjusting receiver-transmitter distance and measuring the current.

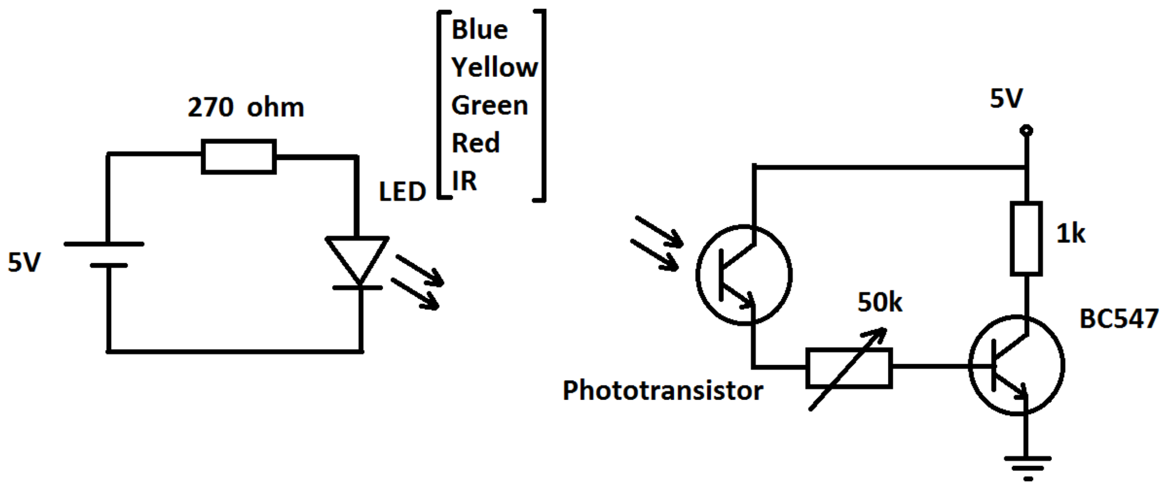
Distance (cm)	**Current (mA)**
2	
4	
6	
10	
15	
20	
25	

6. Repeat the experiment by placing filters of FR-400 and RG-695 between IR transmitter and receiver and complete the following table and comment on your results.

Distance (cm)	**Current (mA) (FR-400 placed)**	**Current (mA) (RG-695 placed)**
2		
4		
6		
10		
15		
20		
25		

PROCEDURE -2:

1. Connect the infrared transmitter and receiver circuits on the breadboard with their active surface facing each others as shown in the figure. Switch on the receiver circuit and Switch off the transmitter circuit.



2. Measure the voltage across 1kΩ resistor in daylight for different value of adjustable resistor of 50 kΩ according to table below.
3. Repeat the experiment in dark and complete the following table and comment on your results.

Adjustable Resistor (kΩ)	Voltage (V) (in daylight)	Voltage (V) (in dark)
1		
2		
4		
10		
30		
40		
50		

4. Switch on the transmitter circuit by using blue LED. By adjusting the 50 kΩ resistor make sure that the transistor is not working in saturation regime.

5. Putting in all LEDs on the transmitter circuit respectively, measure the voltage across 1k ohm resistor and complete the following table and comment on your results.

Voltage on 1kΩ Resistor				
LED Blue	**LED Yellow**	**LED Green**	**LED Red**	**LED IR**

REFERENCES

1. http://trace.wisc.edu/docs/ir_intro/ir_intro.htm

2. http://www.xantech.com/training_mod/how_ir_works/index.htm

3. http://www.oec-gmbh.de/files/pdfs/applicationnotes/photodiode%20characteristics%20and%20applications.pdf