# CG1111: Engineering Principles and Practice I

## Photoelectric Sensors

InfraRed Emitter & Detector

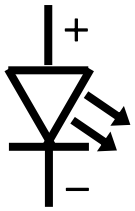
Light Dependent Resistor

# Contents

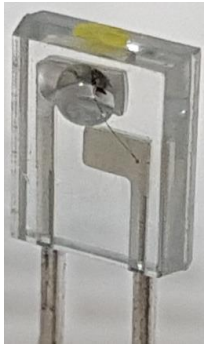
- ✓ IR Light Emitting Diode (IR LED) Emitter
- ✓ IR Phototransistor Detector
- ✓ IR Direct vs Indirect Incidence Setup
- ✓ Light Dependent Resistor (LDR)
- ✓ Related Sensor Terminology

# IR LED Emitter

- Usually made of Gallium Arsenide (GaAs) or Aluminium Gallium Arsenide (AlGaAs)
- A special purpose LED that emits light in the InfraRed range of wavelength between 700 nm and 1 mm (invisible to the human eye)
- Different IR LED Emitters can emit IR of different wavelengths, similar to how different general purpose LEDs can emit light of different colors



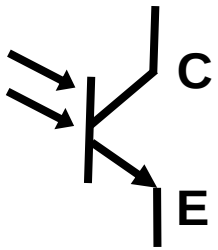

IR LED Emitter Symbol



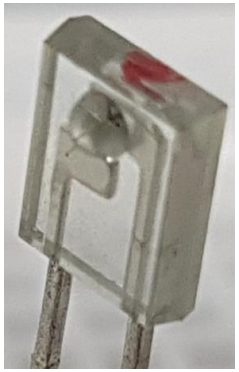
IR LED Emitter available in the DSA lab

# IR Phototransistor Detector

- Sensitive to the IR light
- Works like a normal transistor except that its base current is controlled by the amount of incident IR light
- The voltage across its collector (C) and emitter (E) terminals varies proportionally to the IR light received
- Works best with IR Emitter that emits IR light of matching wavelength



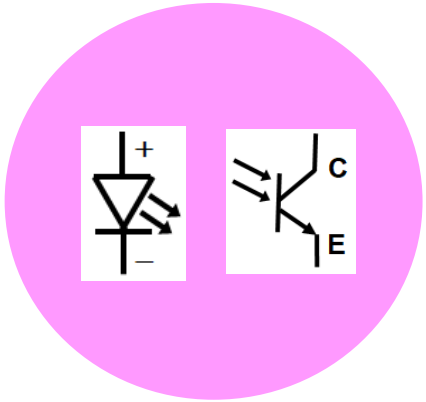

IR Detector Symbol



IR Detector available in the DSA lab

# IR Sensor

Combining the IR phototransistor with IR Emitter (thus known as IR sensor or IR pair), they can be used as proximity sensor, distance sensor, motion sensor, in wireless communication e.g. remote control

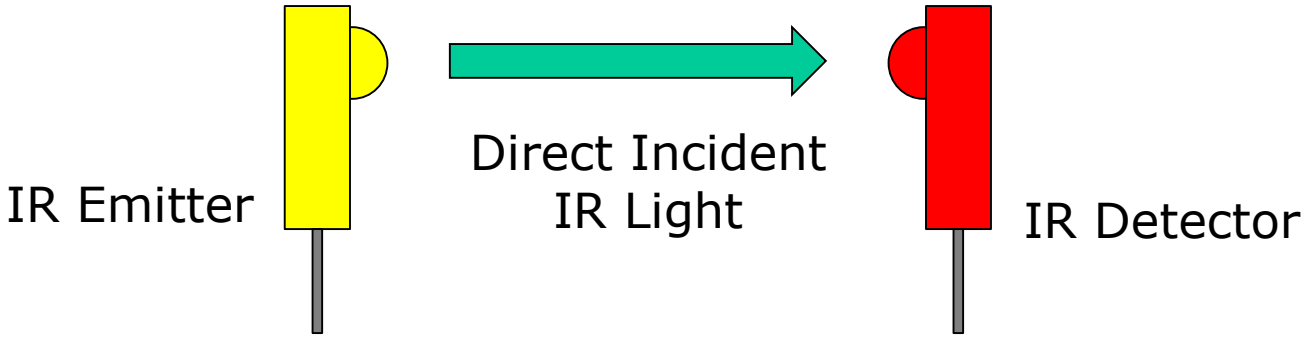






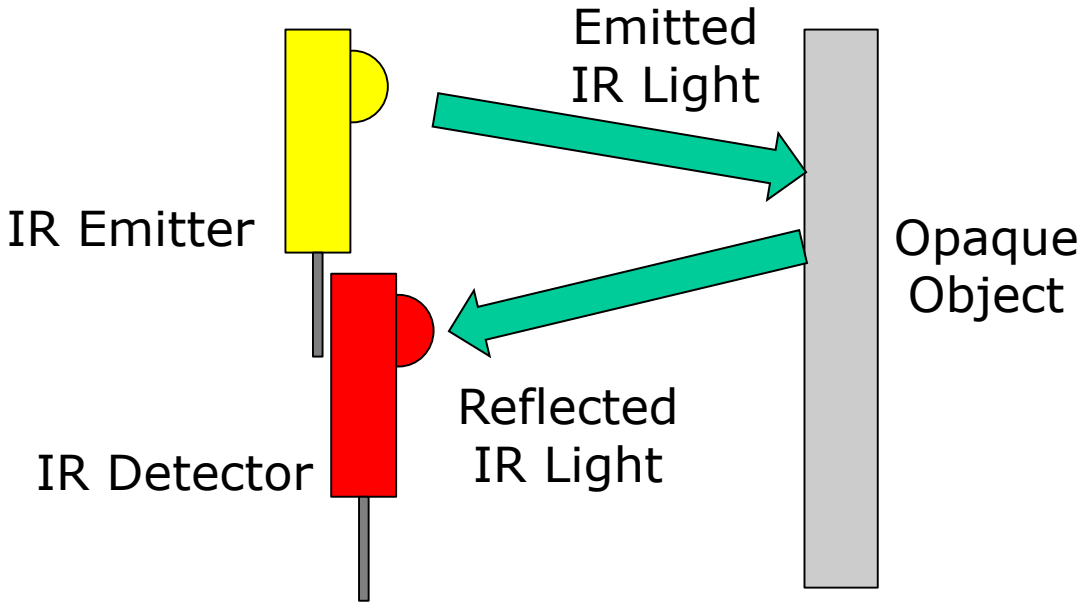
Source: https://www.pongee.com/product-DC-24V-Contactless-Infrared-Sensor-Exit-Button-PBT-211IRB-24V.html

# IR Direct Incidence




- IR Emitter is placed directly in front of the IR Detector
- Almost all light from the IR Emitter is incident on the IR Detector
- An invisible light of IR radiation is created between the Emitter and the Detector
- When an opaque object is placed in this light path, obstructing the passage of the emitted IR radiation, the IR Detector output voltage changes
- This mechanism is commonly used in burglar alarms, object counters, etc

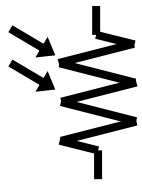
# IR Indirect Incidence




- The IR Emitter and Detector are placed side by side with the opaque object in front of them
- The emitted IR light is reflected by the opaque object and indirectly incident on the IR Detector
- The distance of the opaque object from the IR sensor affects the amount of IR light detected and the IR Detector output voltage

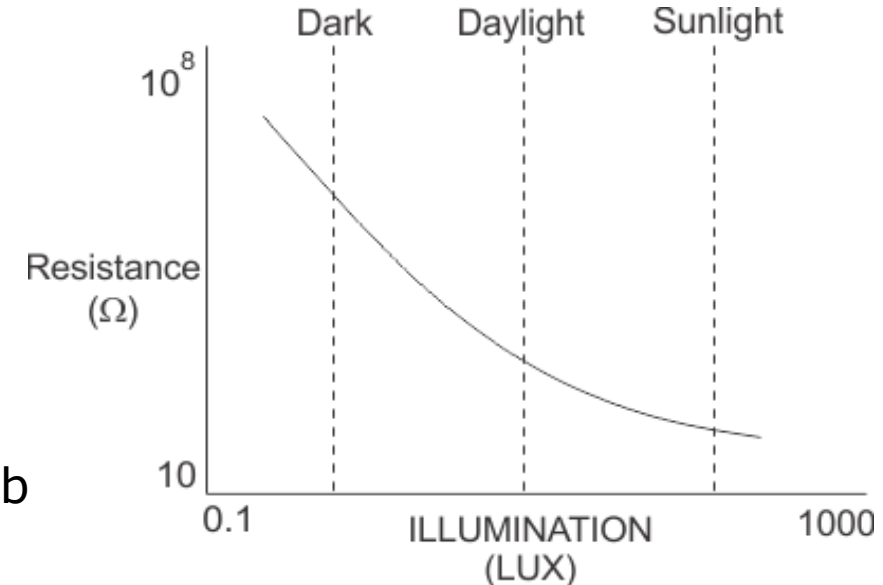
# Light Dependent Resistor (LDR)

- Also known as Photoresistor, is a light-controlled variable resistor
- Resistance of LDR varies with changes in the amount of light incident on it (illuminance)
- The lower the brightness, the higher its resistance:
  - In the dark, LDR resistance can be as high as several mega ohms
  - In bright light, its resistance is only in the order of a few 100 ohms
- Its illuminance vs resistance relationship is not linear!



LDR Symbol

LDR available in the DSA lab



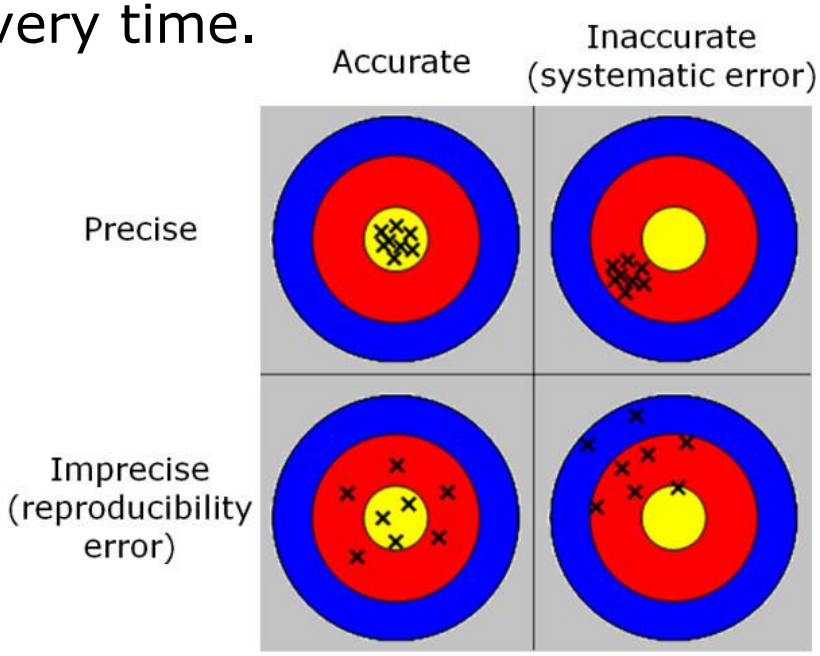
# Light Dependent Resistor (continued)

- Made of a high resistance semiconductor - either Cadmium Sulfide (CdS) or Cadmium Selenide (CdSe)
- Pros: Low cost, rugged construction, bidirectional
- Cons: Relatively slower response time and consumes more power compared to phototransistor and photodiode (not in syllabus)
- LDR is suitable for applications where many different levels of light intensity need to be measured
- Typical applications: camera shutter control, automatic night lights switch, dimmer control, position sensor, etc

# Related Sensor Terminology

1. **Accuracy**: The maximum difference that will exist between the actual value (the "true value" by accepted standards) and the indicated value at the sensor's output.

2. **Precision**: The degree of reproducibility among several independent measurements of the same value under specified conditions. In other words, if exactly the same value were measured a number of times, an ideal sensor would output exactly the same value every time.




https://www.researchgate.net/figure/Illustration-of-accuracy-versus-precision_fig1_242016279

# Related Sensor Terminology (continued)

3. **Sensitivity**: The amount of change in a sensor's output in response to a change at its input, i.e. the slope of the output characteristic curve. More generally, the minimum input of physical parameter that will create a detectable output change.

4. **Response time**: The time it takes for the sensor's output to reach its final value. A measure of the speed of the sensor in response to a change at its input.

5. **Calibration**: A test during which a series of known measurand values are applied to a sensor so that adjustments can be made to the sensor in order to minimize errors.

# THANK YOU