ECE 480
Sensors

Types of Sensors

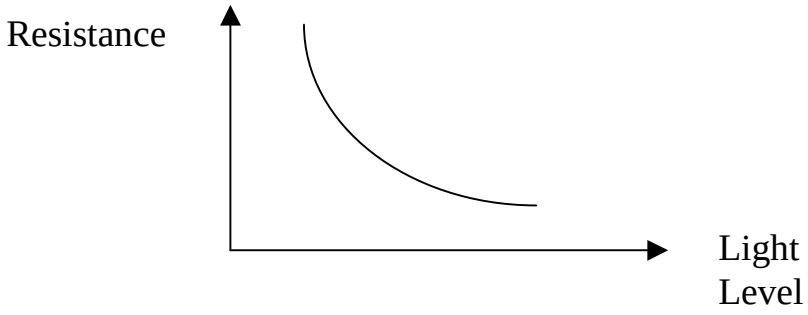
- Light
- Pressure
- Temperature
- Direction-Compass
- Magnetic Field
- Location
- Acceleration
- Motion/Displacement
- Time Interval

Light Sensing

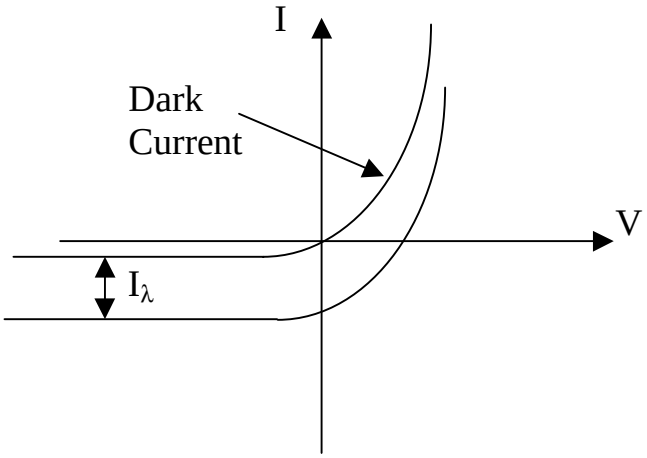
Common types:

- Photoconductor
- Photodiode
- Phototransistor

Photoconductor: (Light sensitive semiconductor resistor)



Photodiode:



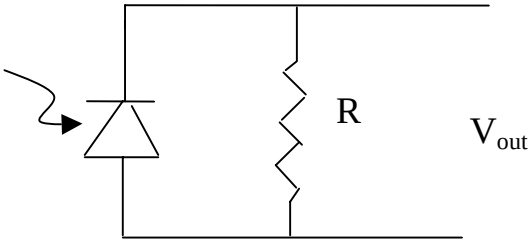
$I=I_o[\exp(eV/kT)-1]-I_\lambda$

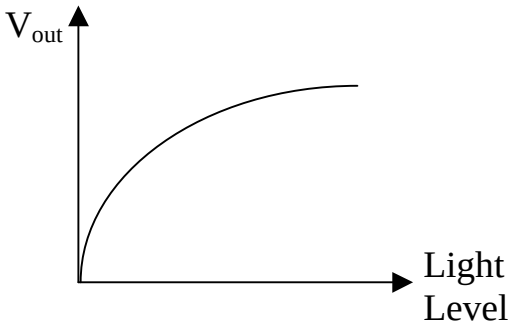
I_λ is proportion to the light level

Responsivity: example (1 A/W)

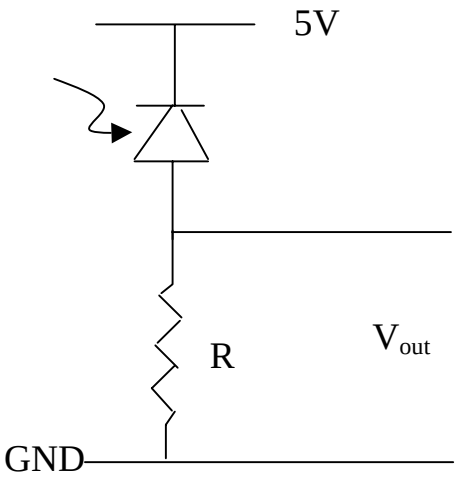
Example Circuits for Photodiodes

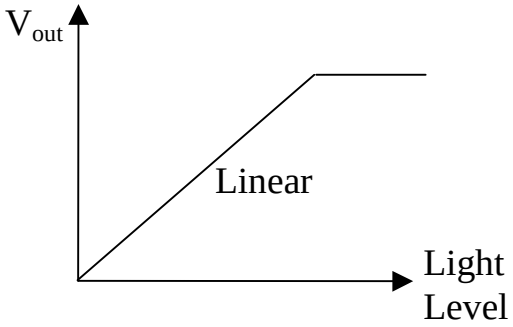
Simpliest:





Reverse Bias the diode:



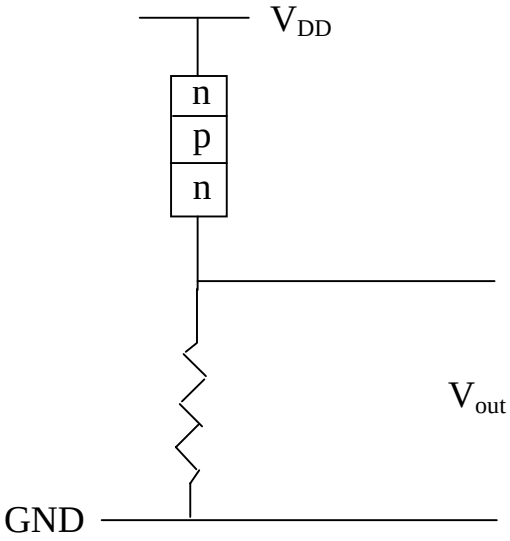


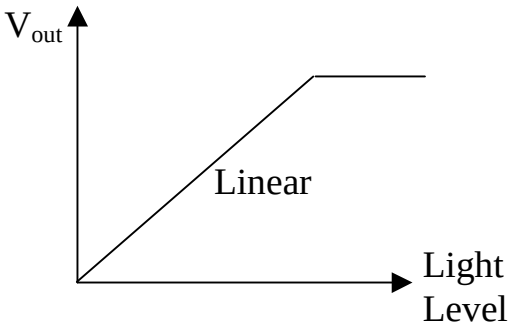
Phototransistor

The npn or pnp transistor has no base connection. The light absorbed provides the base current.

Responsivity typically 100-1000 A/W

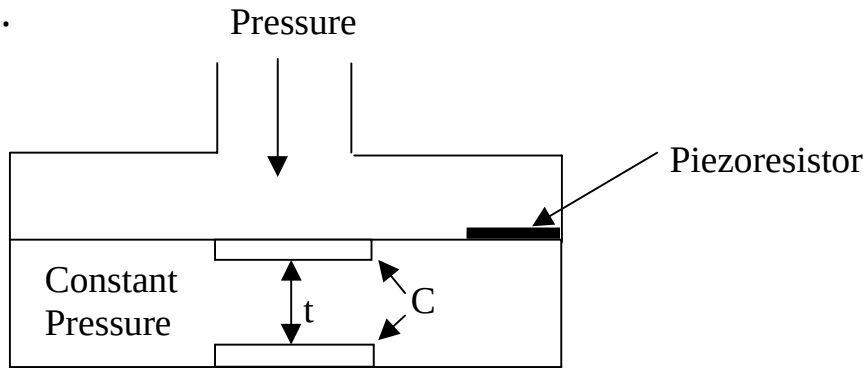
Typical circuit:





Pressure Sensors

Most pressure sensors work by sensing the deflection of a membrane.



$$C=\varepsilon A/t$$

Temperature Sensors

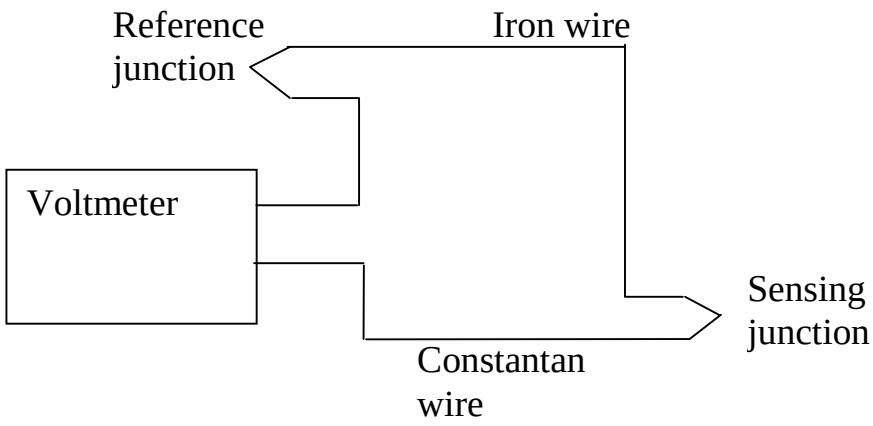
Common Types:

- Thermocouple
- Thermistors
- IC Temperature Sensors- Analog and digital
- Optical temperature sensors

Thermocouples

The junction between two dissimilar metals generates a small voltage . The voltage is on the order of 50μV/C.
Widest temperature range: -270C to 2500 C

Example:

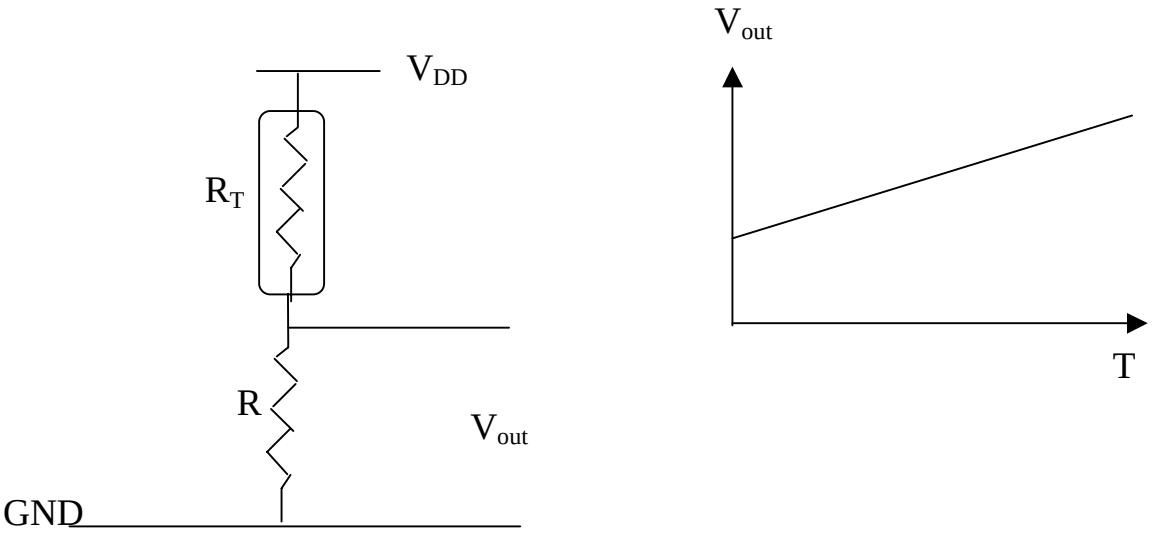


Thermistors
Thermally sensitive semiconductor resistor.

Example sensitivity is -4%/C

Typical ranges: -30 C to 100 C
accuracy: 0.1-1.0 degrees C

Example Thermistor Circuit



IC Temperature Sensors- Analog

Example 1: Two Terminal Temperature Sensor

LM135/LM335: Viewed as a zener diode with the voltage set by the temperature. 10 mV/K

AD590: Viewed as a constant current course with the current proportion to the temperature: 1μA/C

LM 20: Low power

IC Temperature Sensors- Digital

TC74: Digital Thermal Sensor- Used I^2C-serial port

LM 74: SPI Digital Temperature Sensor

Serial Communications Protocols for between chip communication

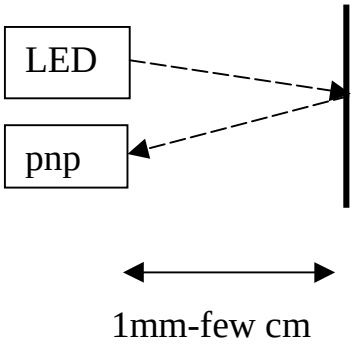
I^2C: Inter Intergrated Circuit
- 2 wires
- SDA and SCL signals
- Each chip can have its own address

SPI/Microwire/QSPI
- 3 wires
- SI/O Slave I/O
- SC Slave Clock
- CS chip select (no address)

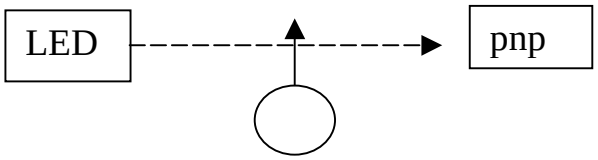
Position/Proximity/Rotation Sensors

Reflective Object Sensor

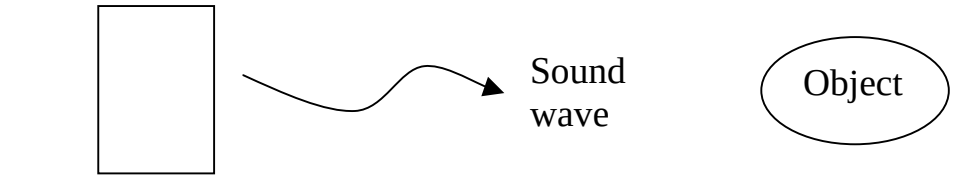
Example: QRB1133



Blocked Beam Optical Sensor



Ultrasonic Transducer



Transducer can transmit
and/or receive

Ultrasonic transducers can be used to sense if an object is present at a certain distance, the level of a liquid in a tank, the flow of a liquid (via doppler effect), and presence of bubbles in a flow system. Parameters: beam angle, sensitivity, sound level, frequency

Rotational Position- Optical Encoder:

Sensors the rotation a shaft: sensitivity can range from dividing the circle into 2 to 1000's of division.

Example: MAS50

Magnetic Field Sensing

Hall Effect Sensor

Used to detect rotating speed: say of a motor
Used to detect position

Example: See spec sheet of 2 wire CMOS Hall Effect Sensor
HAL55x

Electronic Compass

Example: See Specification Sheet for VECTOR 2X

Position Sensing

Example: GPS unit

Acceleration Sensing

Example: ADXL150-