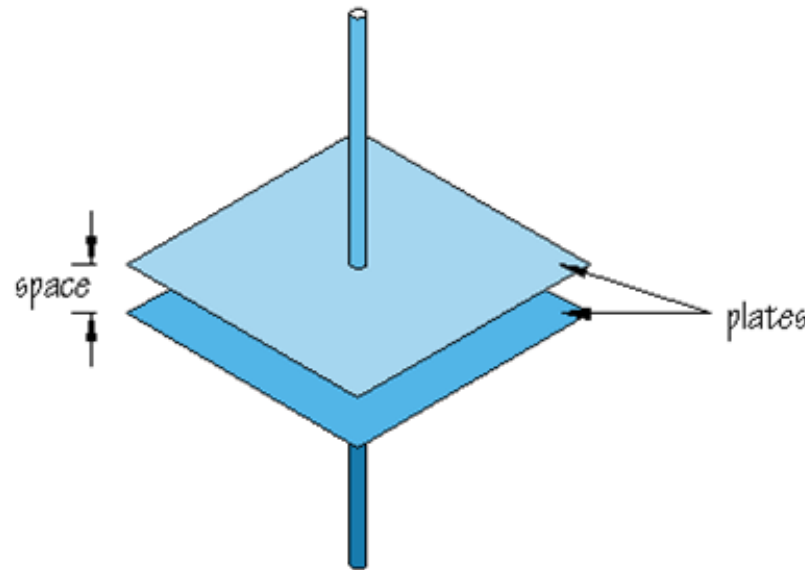


Lecture 5

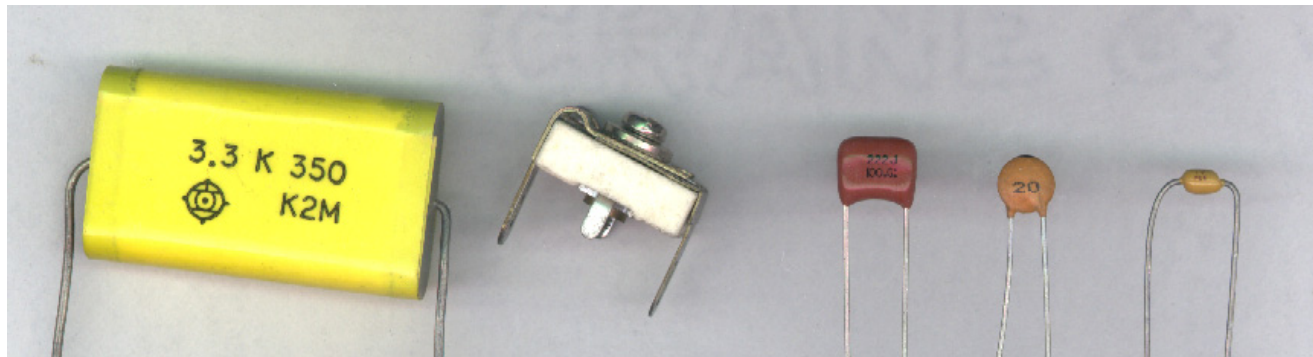
Capacitors

Capacitors 1

- Store electric charge
- Consists of two **plates** of a conducting material separated by a space filled by an insulator
- Measured in units called **farads, F**

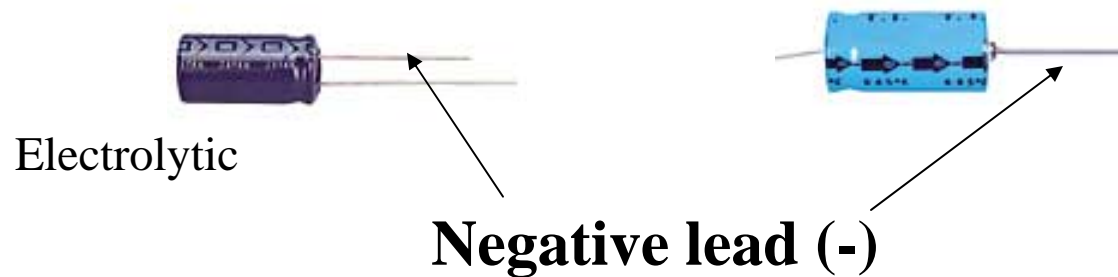


Capacitors 2



Mylar

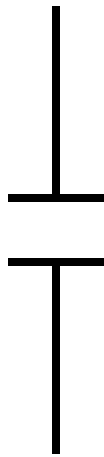
Ceramic



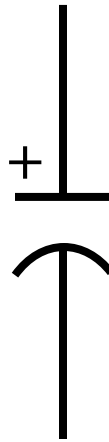
Electrolytic

Negative lead (-)

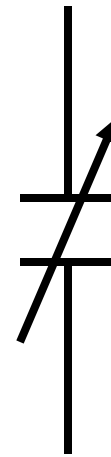
Capacitor Symbols



**Fixed
capacitor**

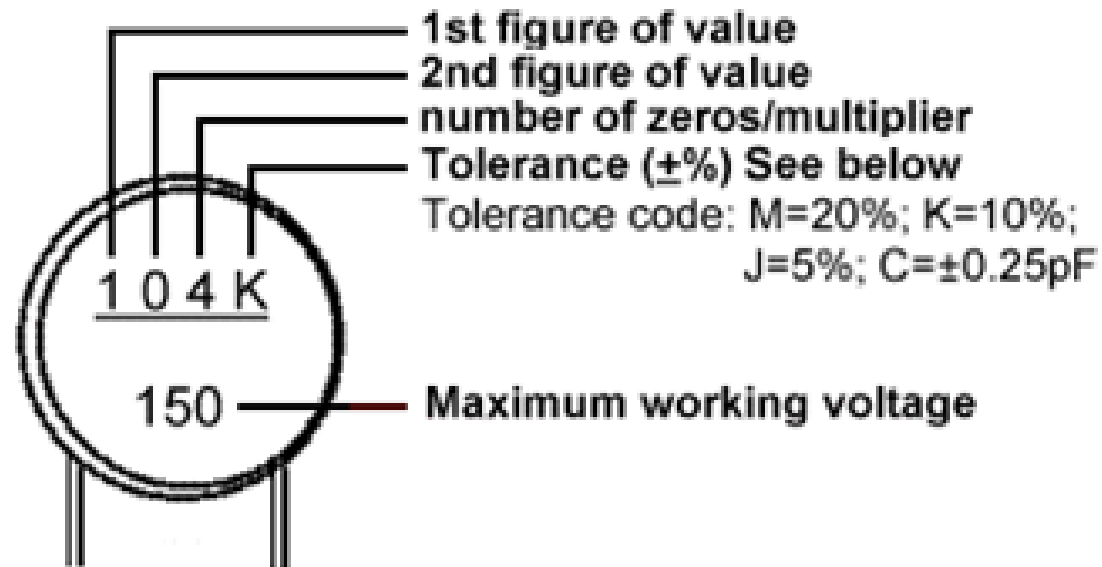


**Polarized
capacitor**



**Variable
capacitor**

How to Read Capacitor Value



- The first two figures give us 10, the third figure gives us 0000, and the letter 10%. We normally express this as $0.1\mu\text{F}$.

Example: Capacitor Value 1

Ceramic

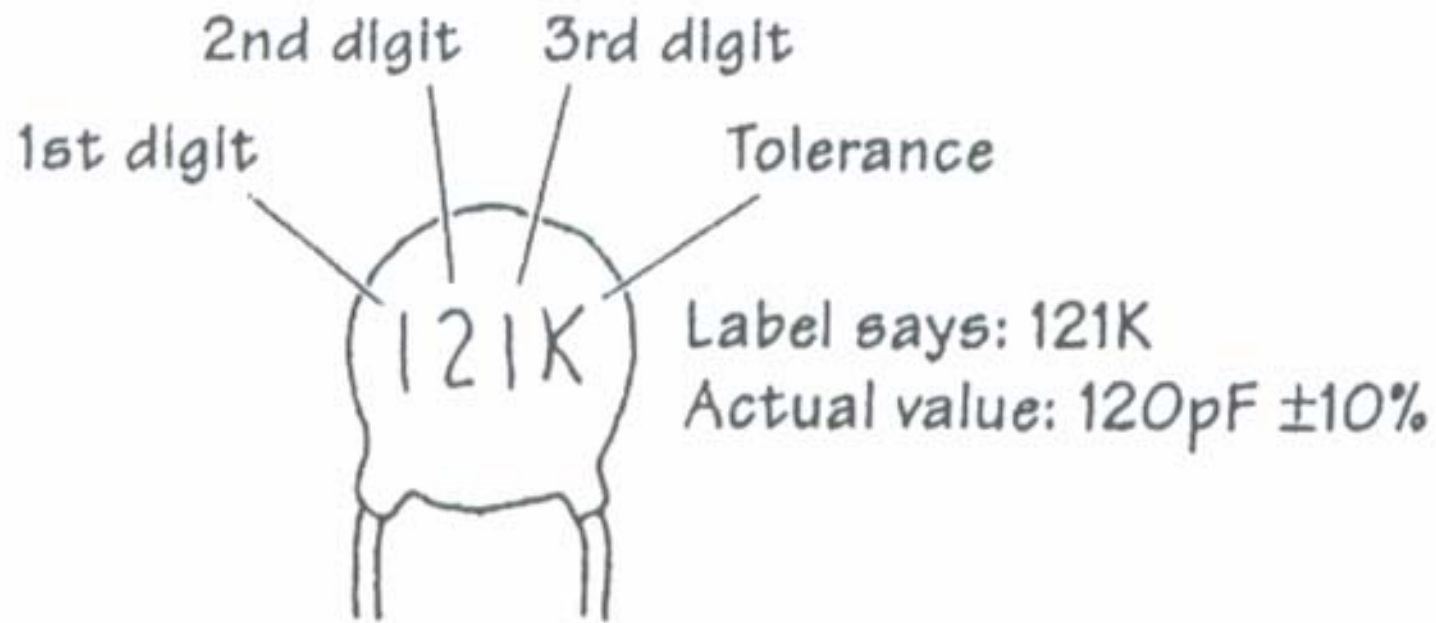


Label represents
a tolerance

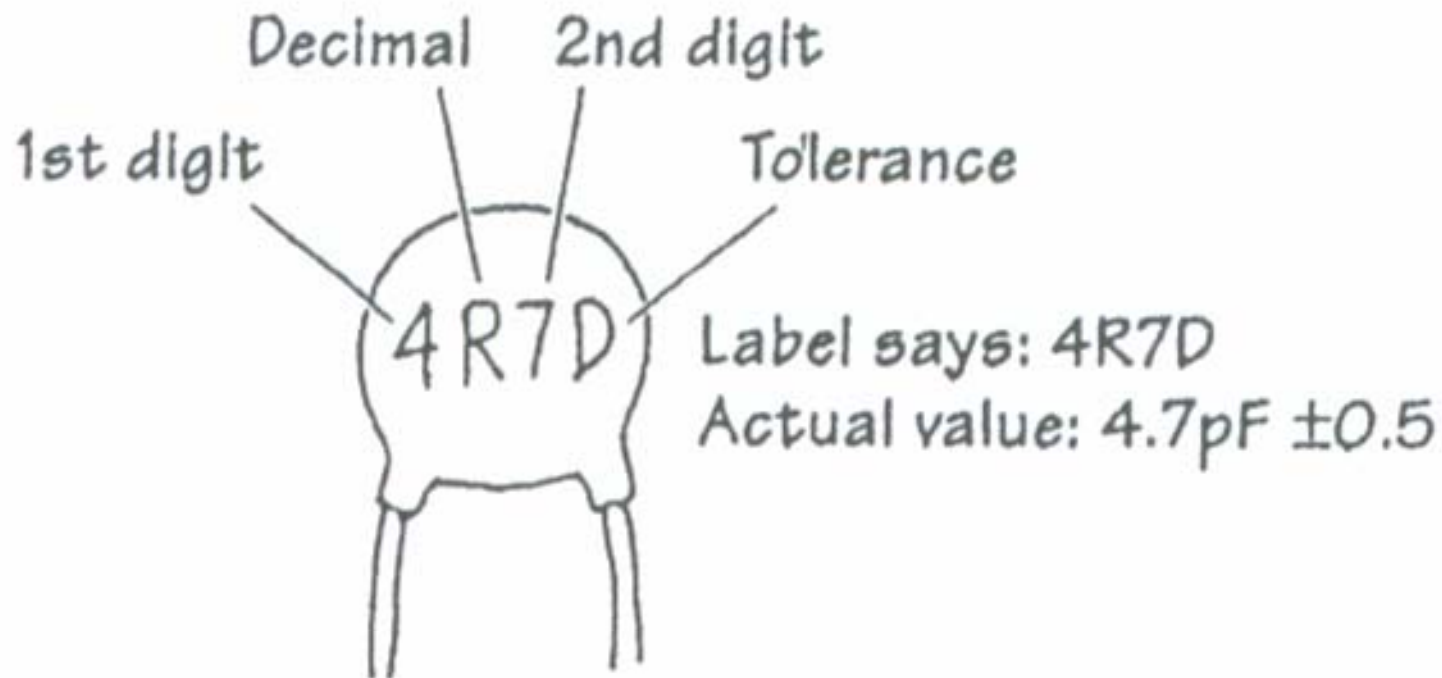
Label says: 103M

Actual value: $0.01\mu\text{F} \pm 20\%$

Example: Capacitor Value 2



Example: Capacitor Value 3



Example: Capacitor Value 4

European Marking

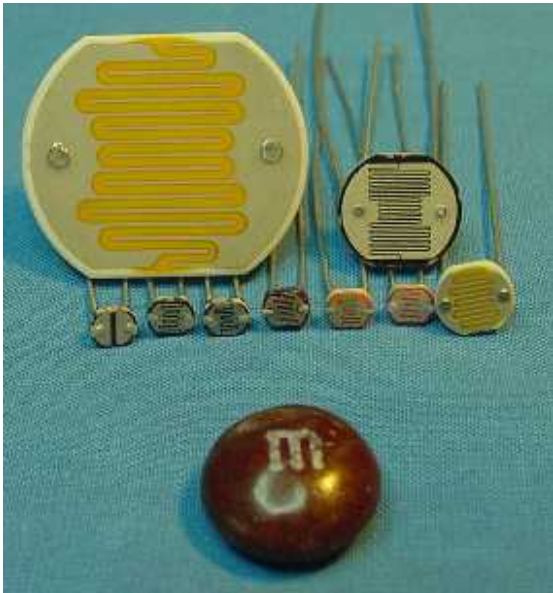


Label says: 68p
Actual value: 68pF

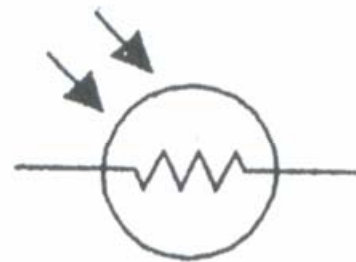
Lecture 6

Optoelectronics

Photoresistors

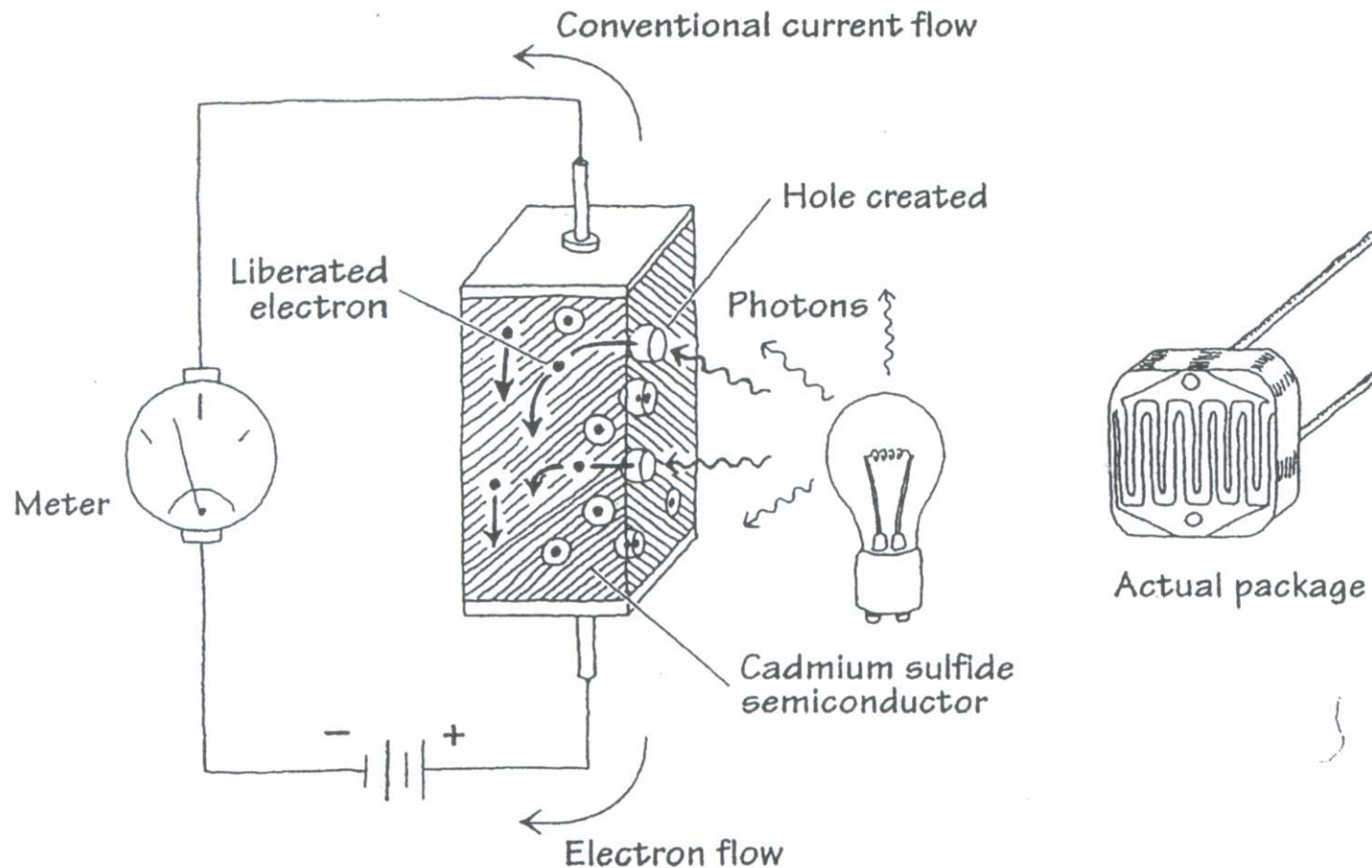


- Light sensitive resistors
- Resistance decreases when light intensity increases

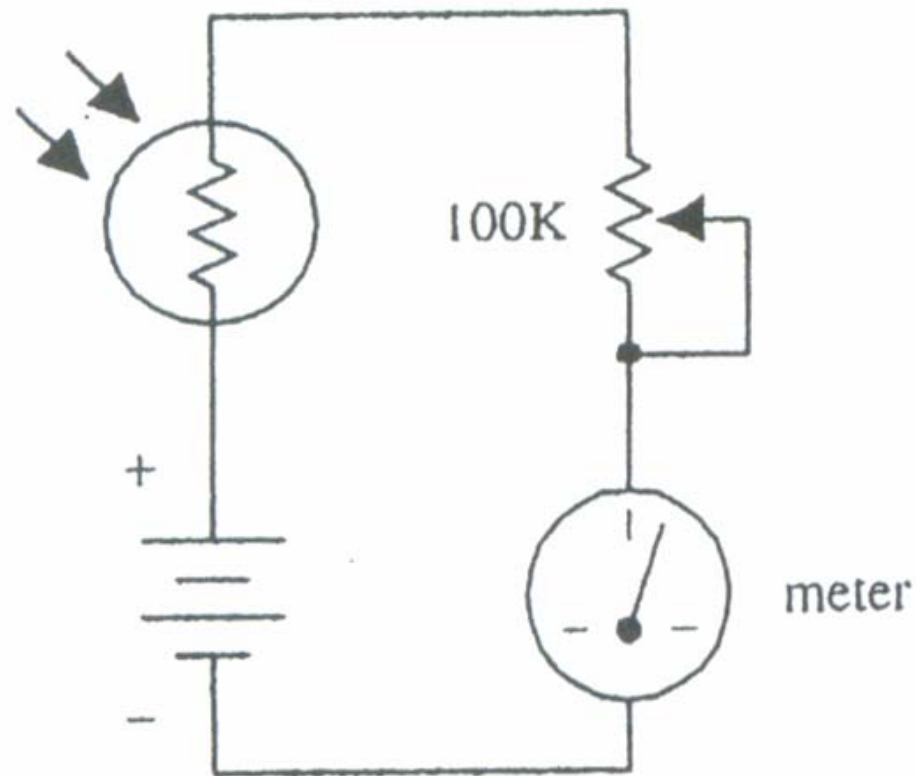


Symbol

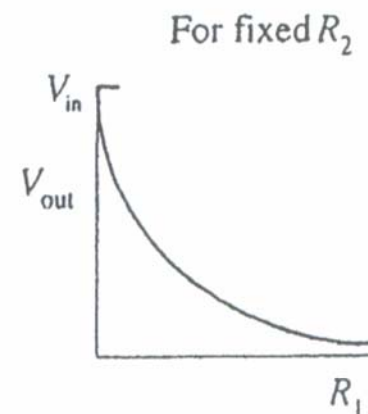
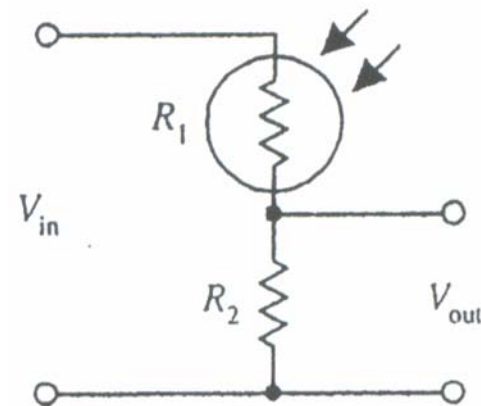
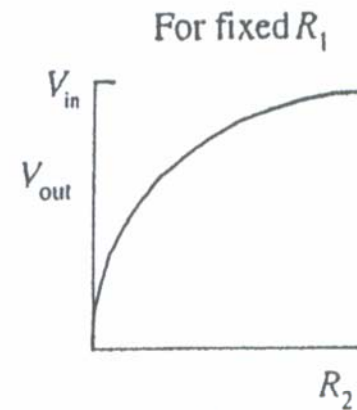
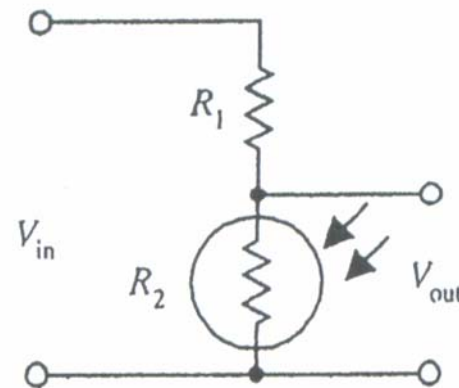
Photoresistor: How It Works



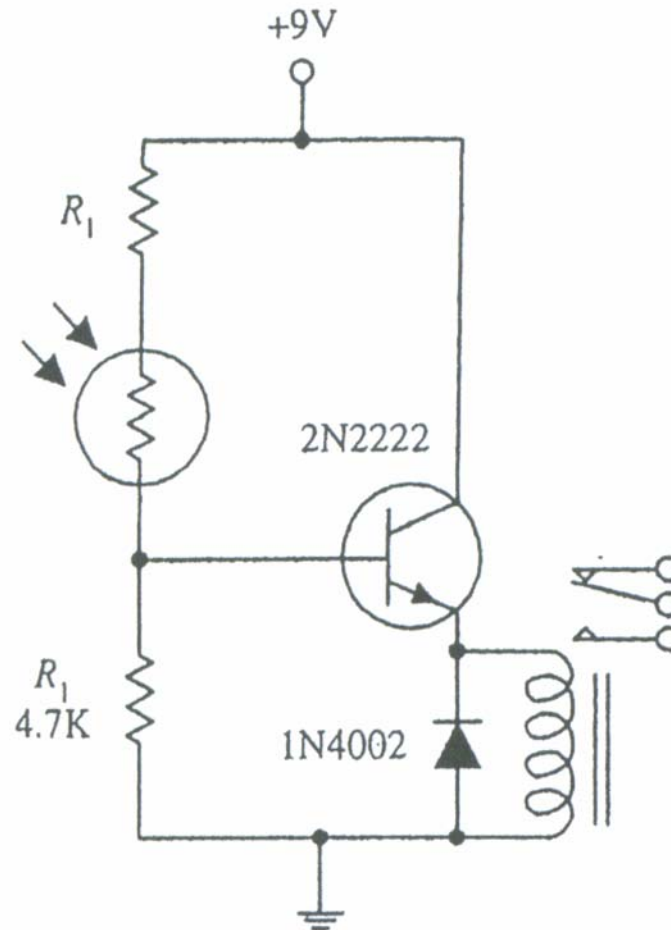
Simple Light Meter



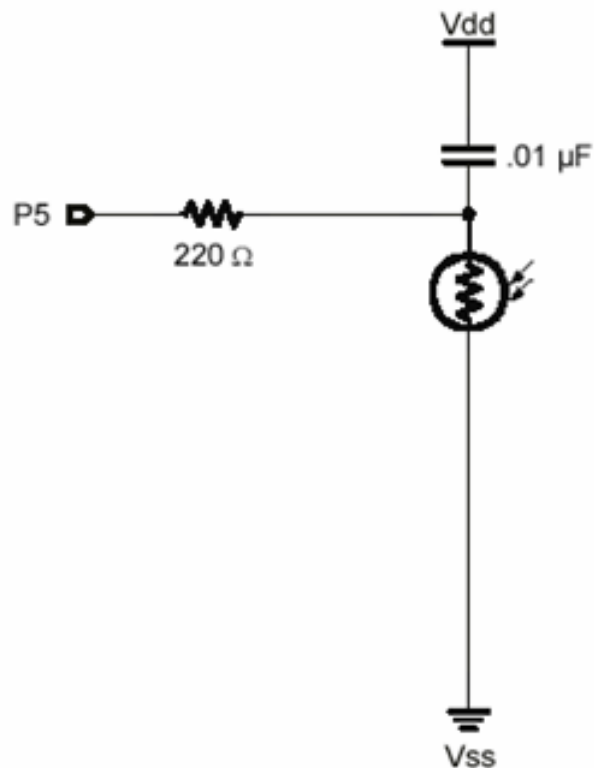
Light Sensitive Voltage Divider



Light Activated Relay

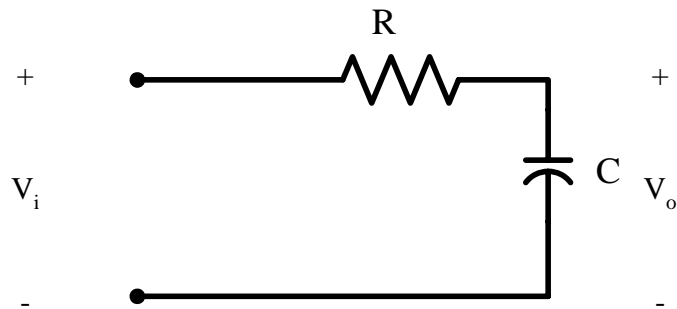


Photoresistor with BS2



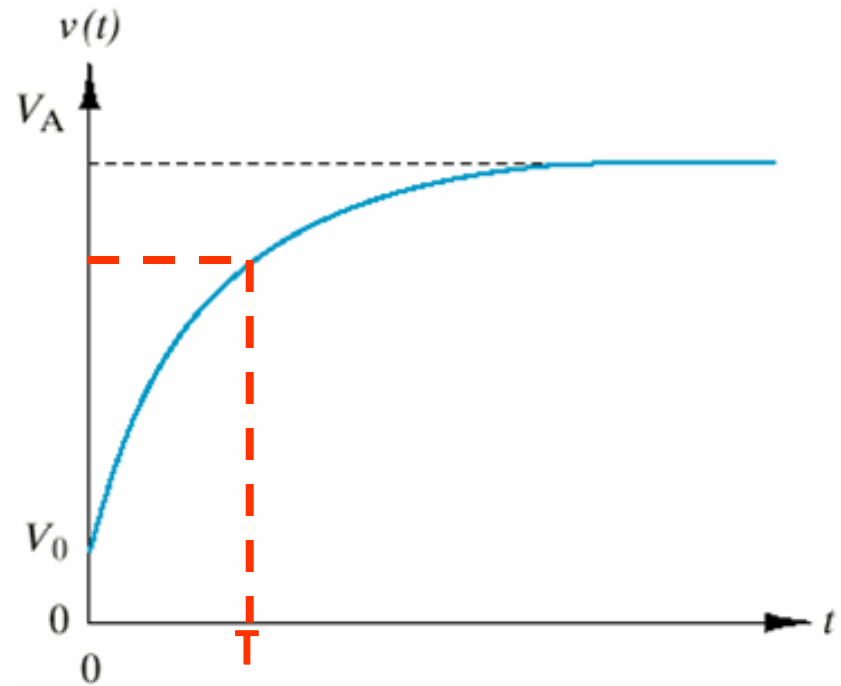
- Usually connect with a capacitor
- Use RCTime command to find out light intensity

RC Circuit

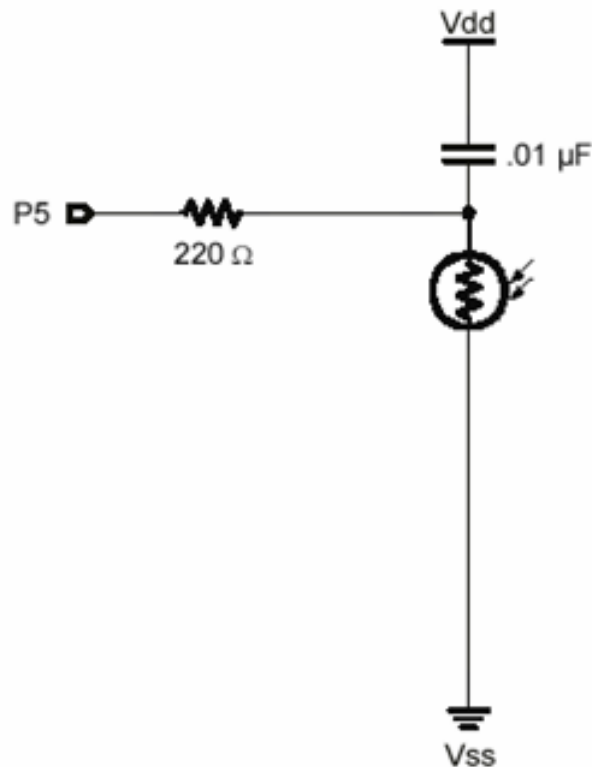


$$\frac{V_o(s)}{V_i(s)} = \frac{1}{RCs + 1}$$

RC is time constant, τ

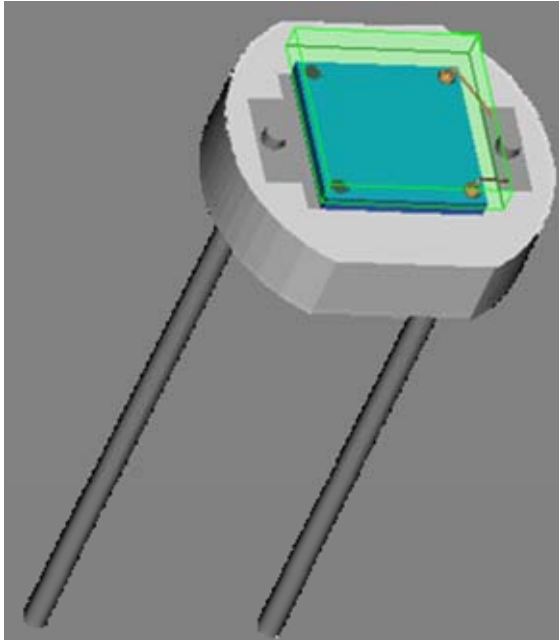


Rctime with BS2

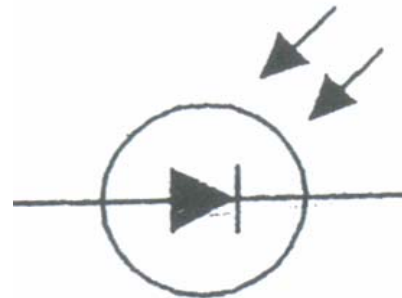


- Software version of analog to digital converter
- Pbasic rctime command
 - Rctime Pin#, state, variable
- Example code
 - High 5
 - Pause 3
 - Rctime 5,1, tau

Photodiode

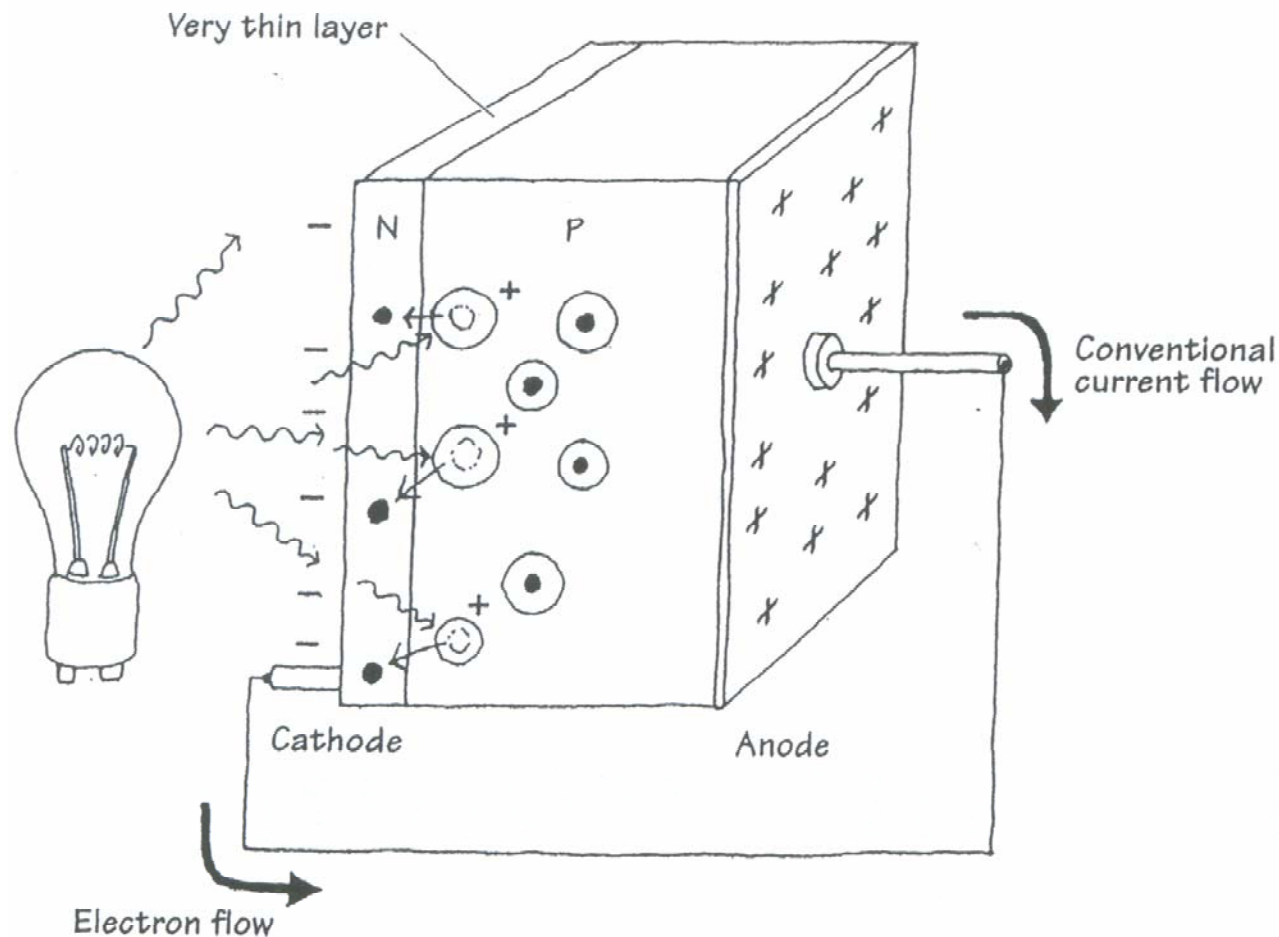


- Transforms light energy to electric current
- Very linear
- More sensitive than photoresistor



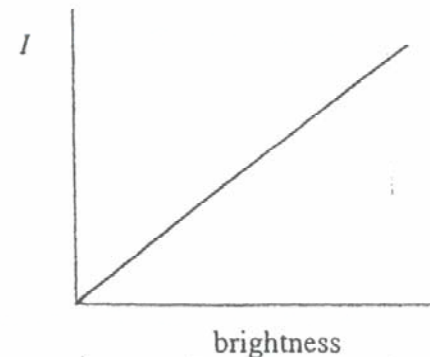
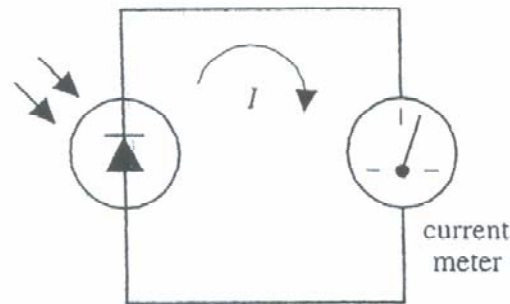
Symbol

Photodiode: How It Works

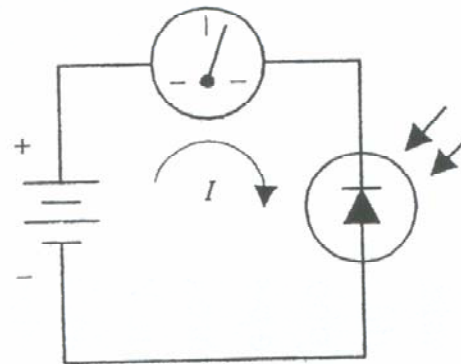


Photodiode Applications

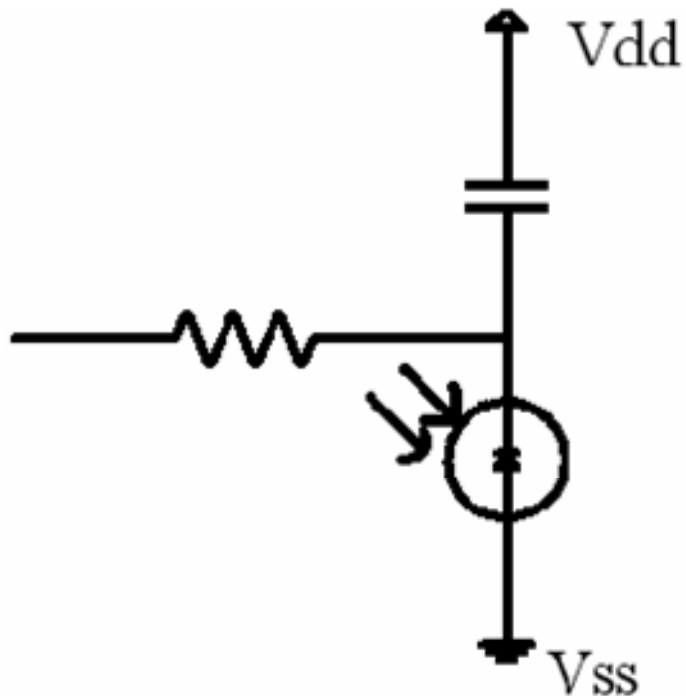
Photovoltaic Current Source



Photoconductive Operation



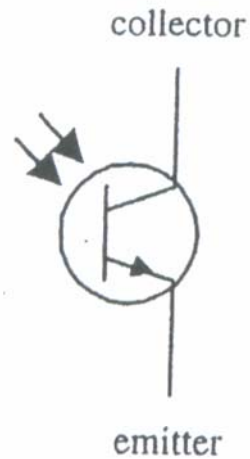
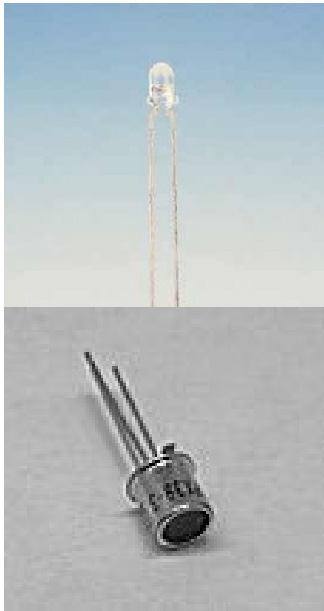
Photodiode with BS2



- Polarity: cathode connects to the ground

Phototransistor

- The base lead of a BJT is replaced by a light sensitive surface



Phototransistor

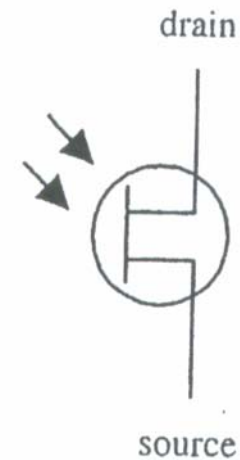
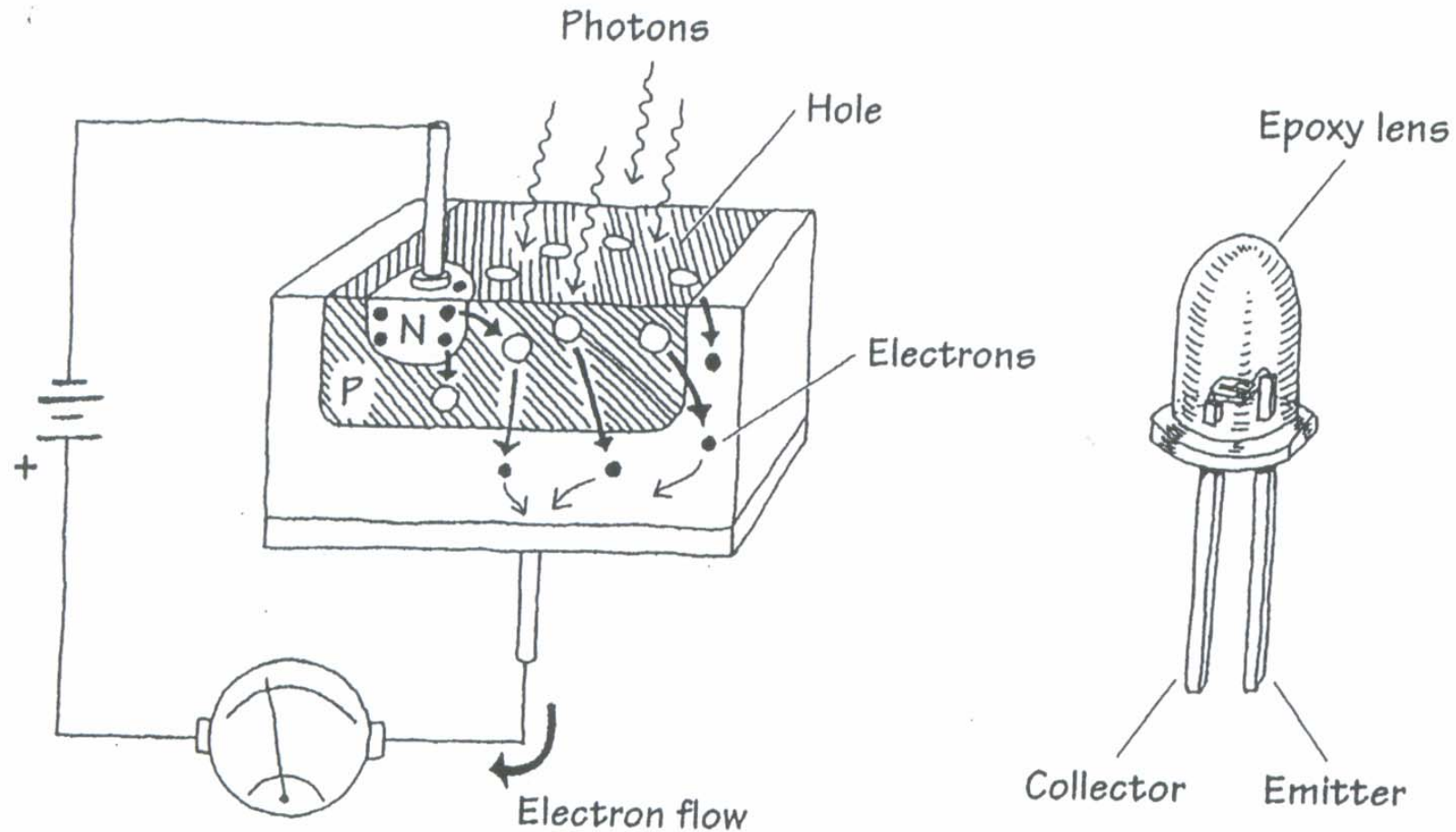


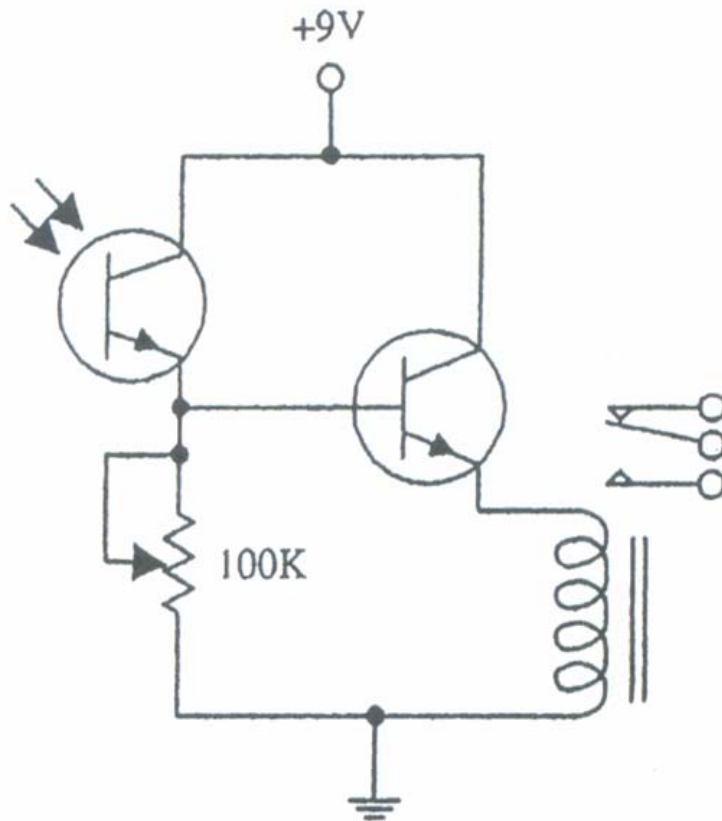
Photo FET

Phototransistor: How It Works

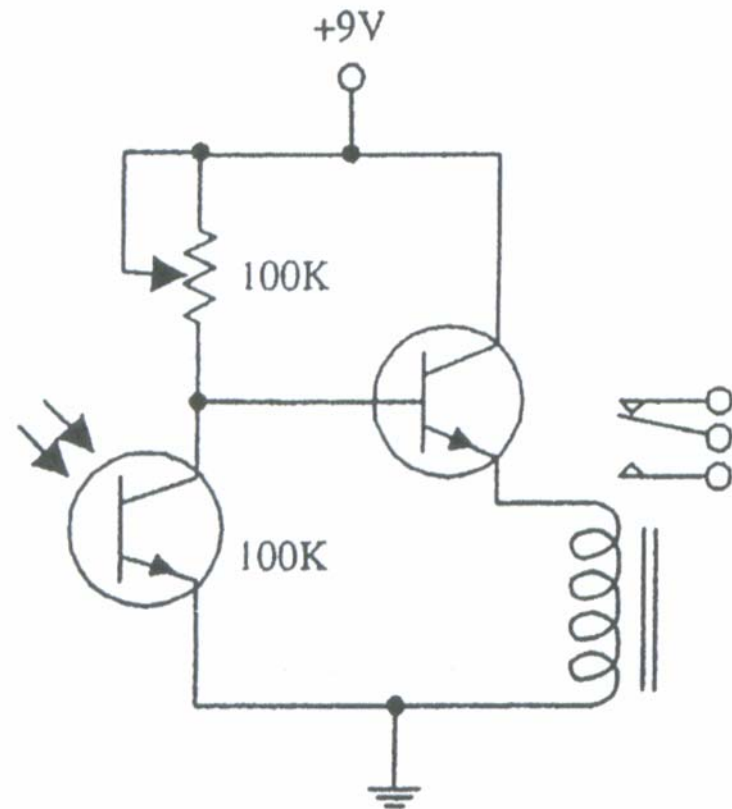


Phototransistor Applications

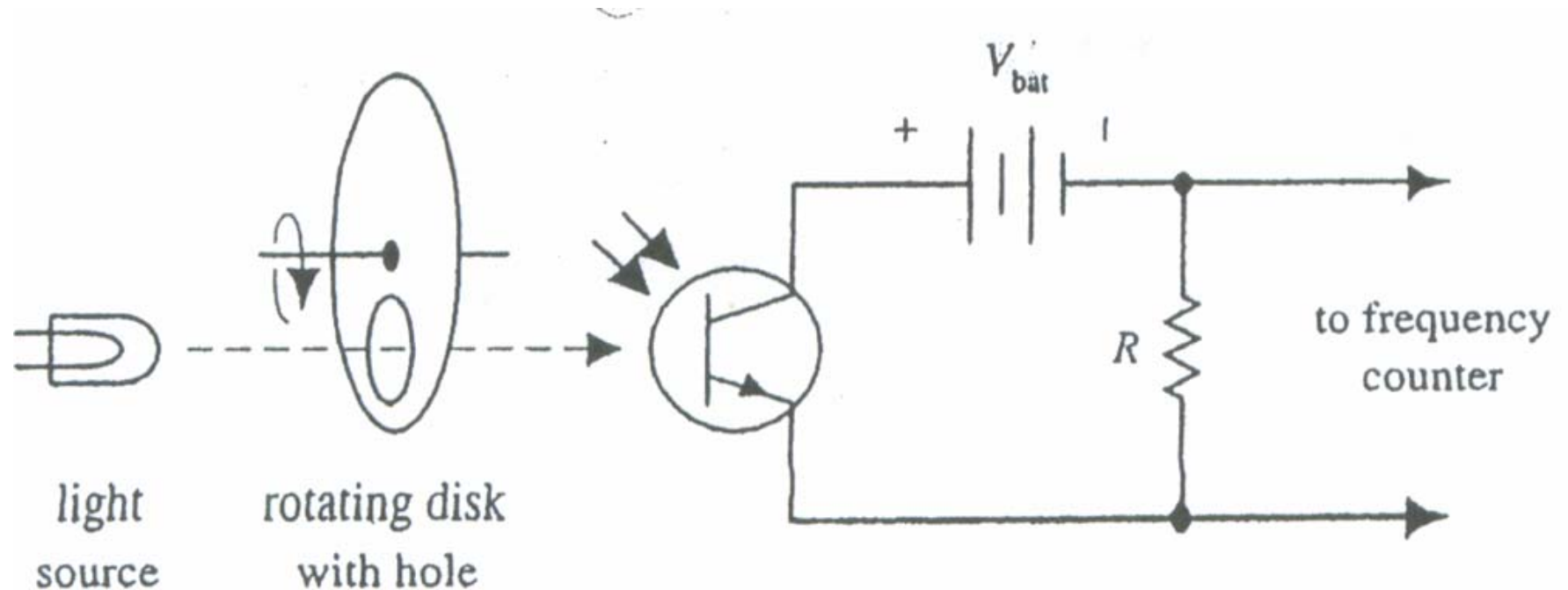
LIGHT ACTIVATED



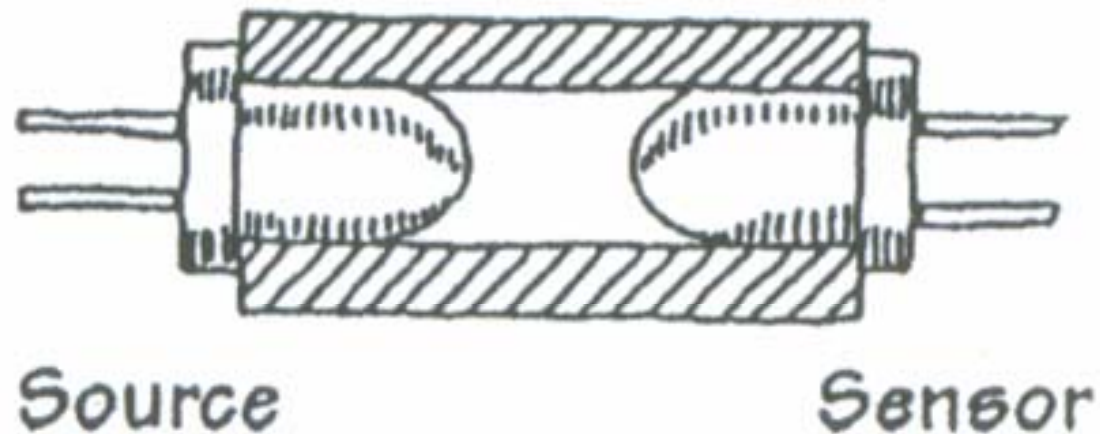
DARK ACTIVATED



Tachometer

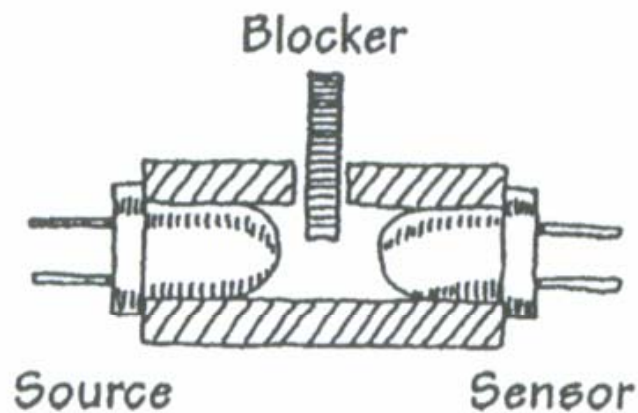


Optoisolators 1

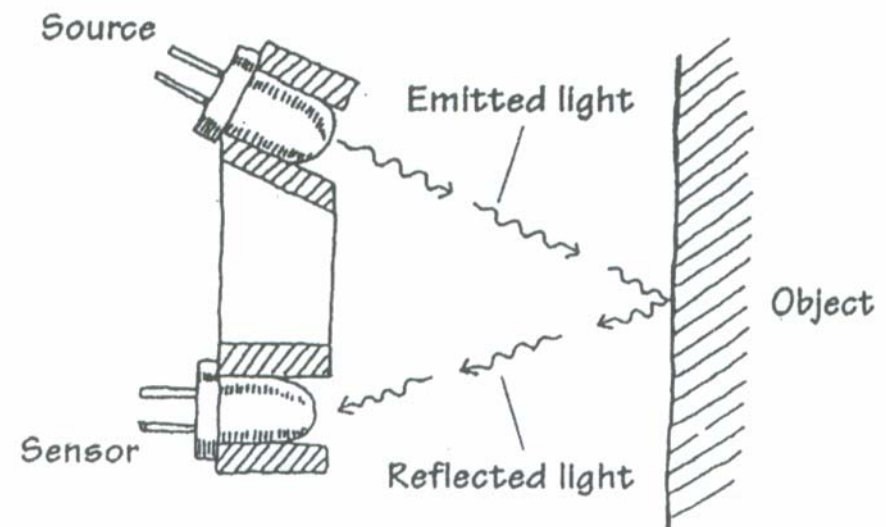


Closed Pair

Optoisolators 2

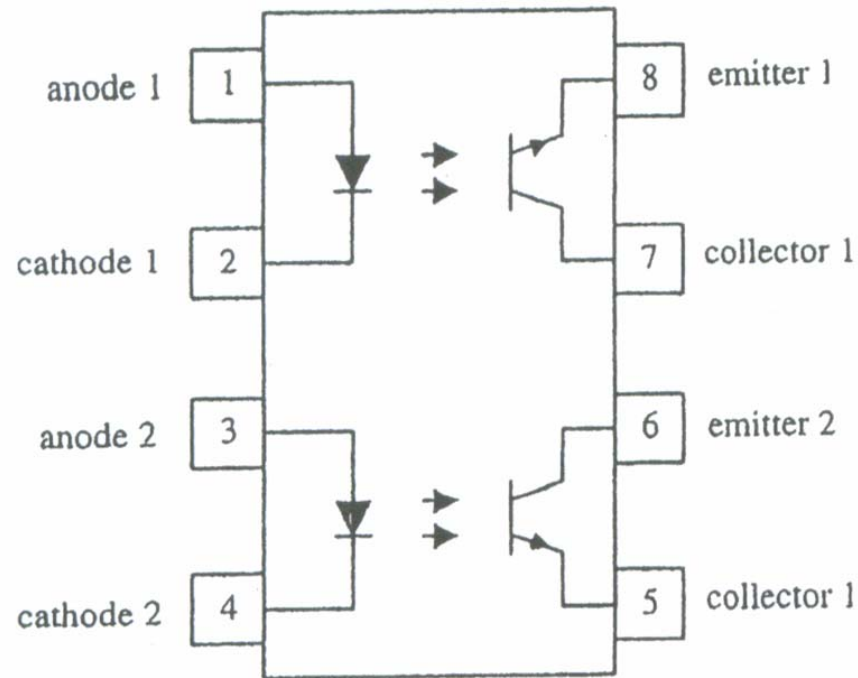


Slotted Pair



Reflective Pair

Optoisolators 3



Integrated Optoisolators

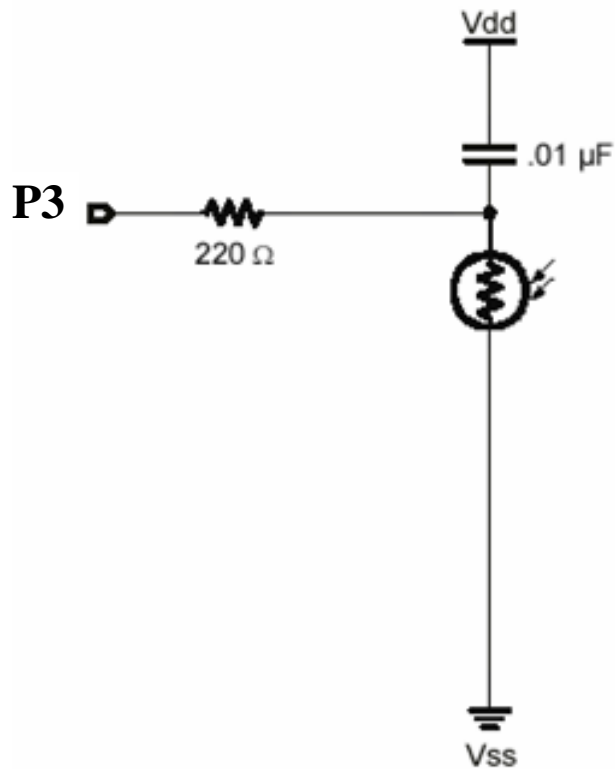
Optoelectronic Sensors Experiments

Experiments	Chapters
What's micro controller	
Basic A and D	8
Earth measurements	4 (except DS1620)
Robotics	
StampWorks	5, 7, and 19
Others	

Lecture 7

ADC

Rctime with BS2

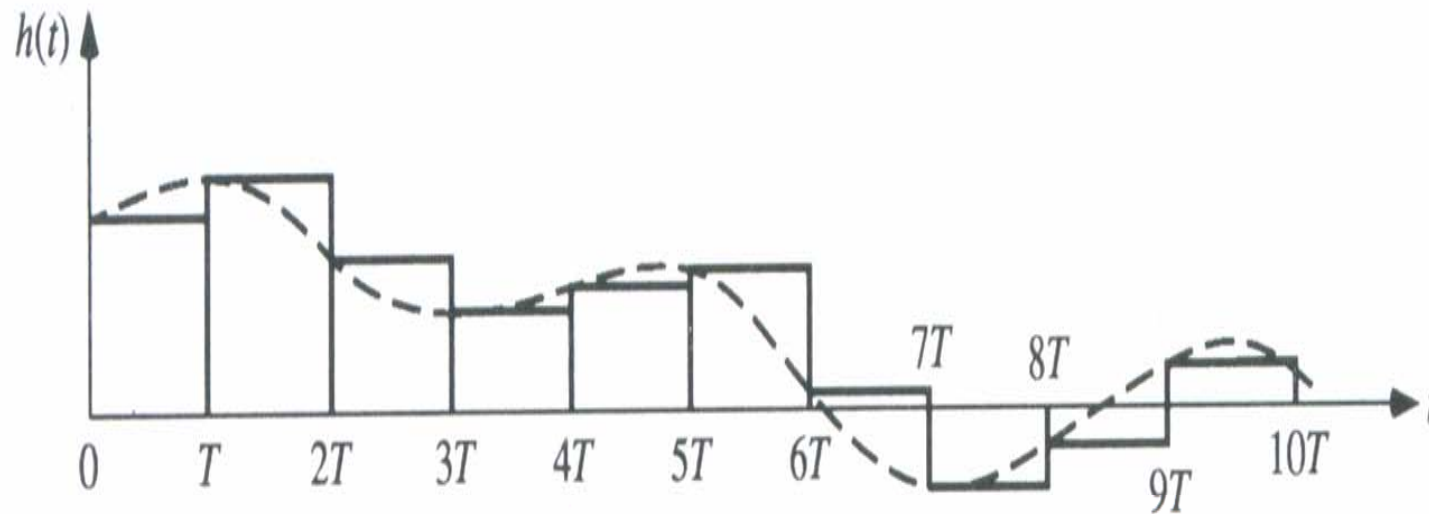


- Software version of analog to digital converter
- Pbasic rctime command
 - High 3
 - Pause 3
 - Rctime 3,1, tau

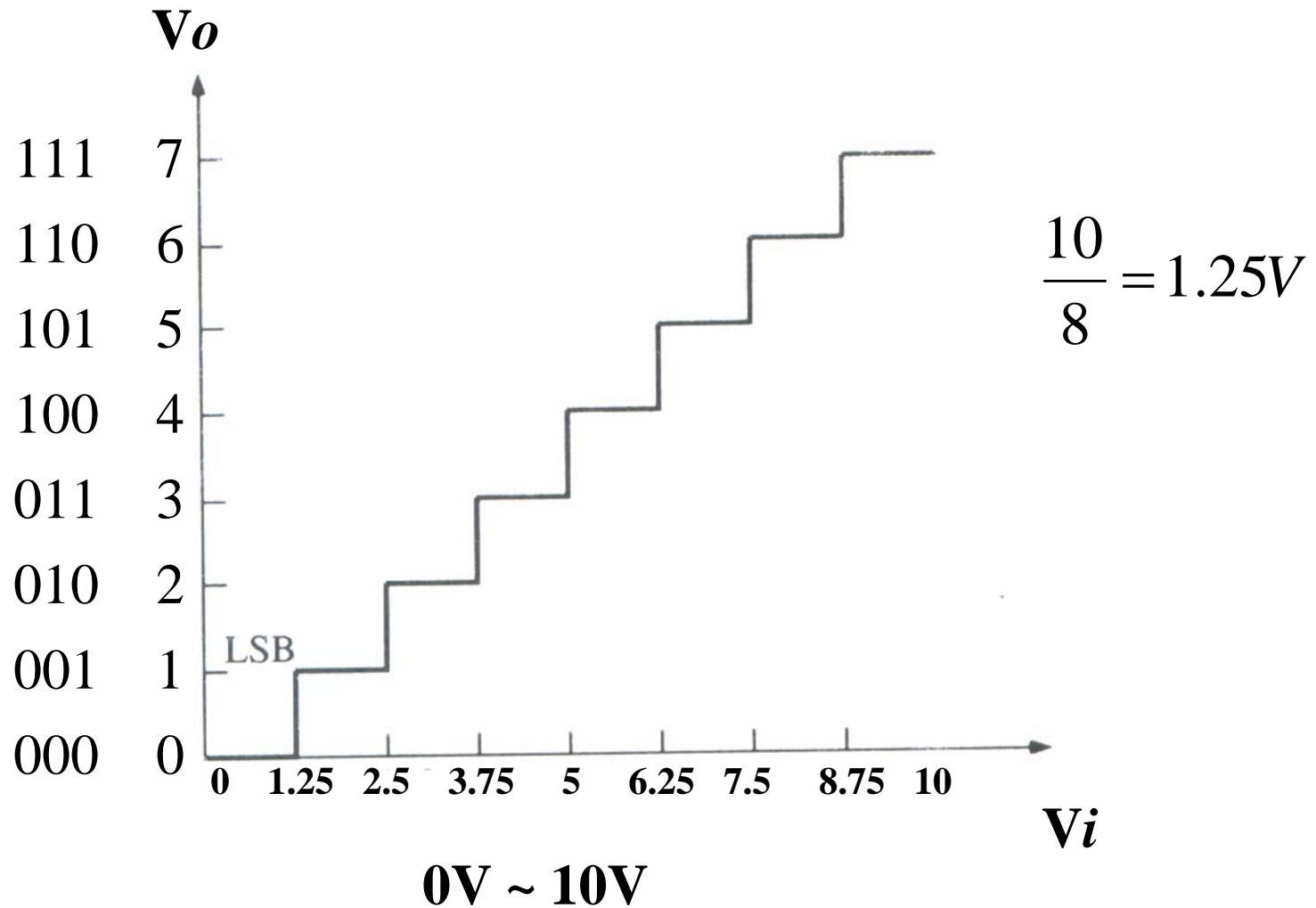
Analog to Digital Conversion

- Process of converting an analog signal to a digital number
- Three step procedure
 - Sampling (sample and hold)
 - Quantization
 - Coding

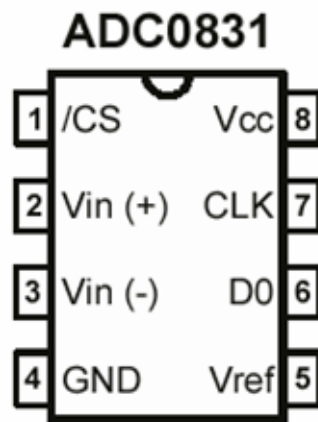
Sampling



Quantization and Coding



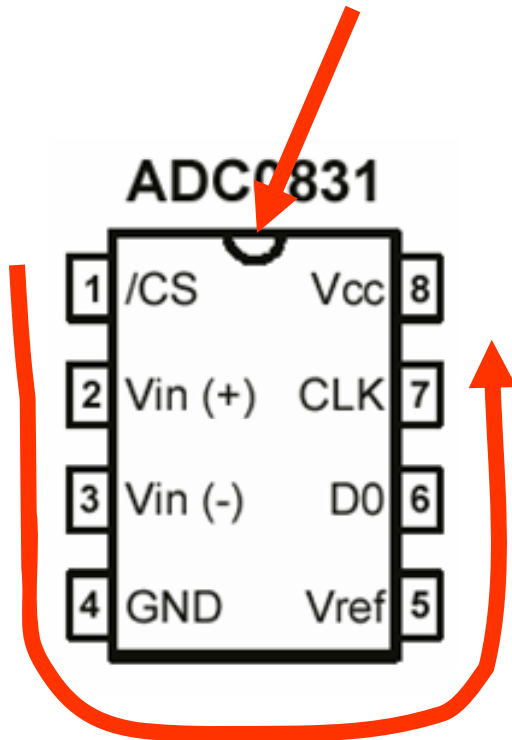
ADC



- Analog to digital converter
- 8-bit successive analog to digital converter
- 0V to 5V input range
- Single 5V power supply

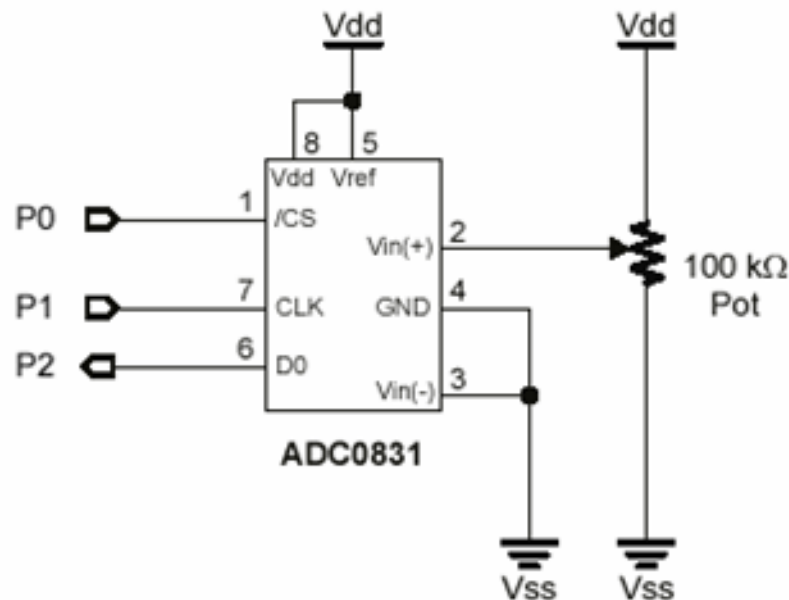
ADC Pin Description

Identifier



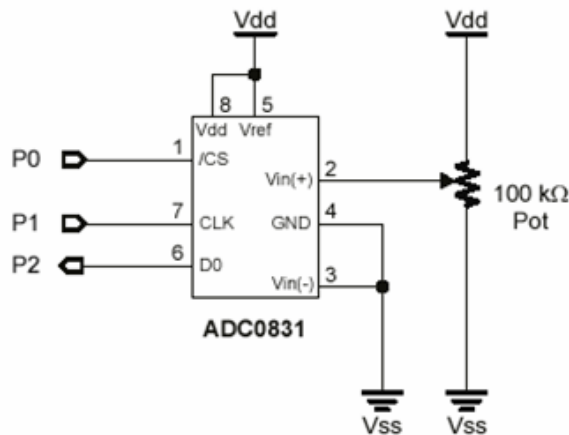
Pin	Description
Pin 1	ADC is ready to do conversion when it is low
Pin 2	0 to 5V analog input need to be digitized
Pin 3	Zero offset adjustment
Pin 4	Ground
Pin 5	Span adjustment
Pin 6	8 bit ADC output
Pin 7	Clock signal from BS2
Pin 8	Regulated 5V (Power supply)

ADC with BS2-1



- 0V to 5V analog input using a potentiometer
- Output is from 0 to 255 – 8 bit resolution

Sample Code for ADC 1



adcbits var byte

High 0

Low 0

Shiftin 2, 1, MSBPOST, [adcbits\8]

High 0

**Serial
communication**

Shiftin Data_pin, Clock_pin, mode, [variable\bits]

Sample Code for ADC 2

Q var word

Debug window shows;

R var word

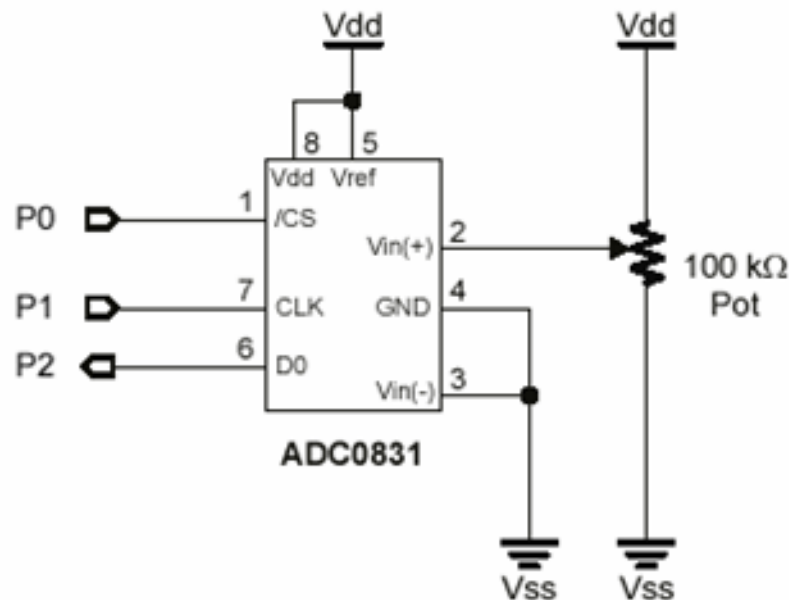
Q = 13 / 5 **Quotient** → Q = 2

R = 13 // 5 **Remainder** → R = 3

Debug ? Q

Debug ? R

ADC with BS2-2

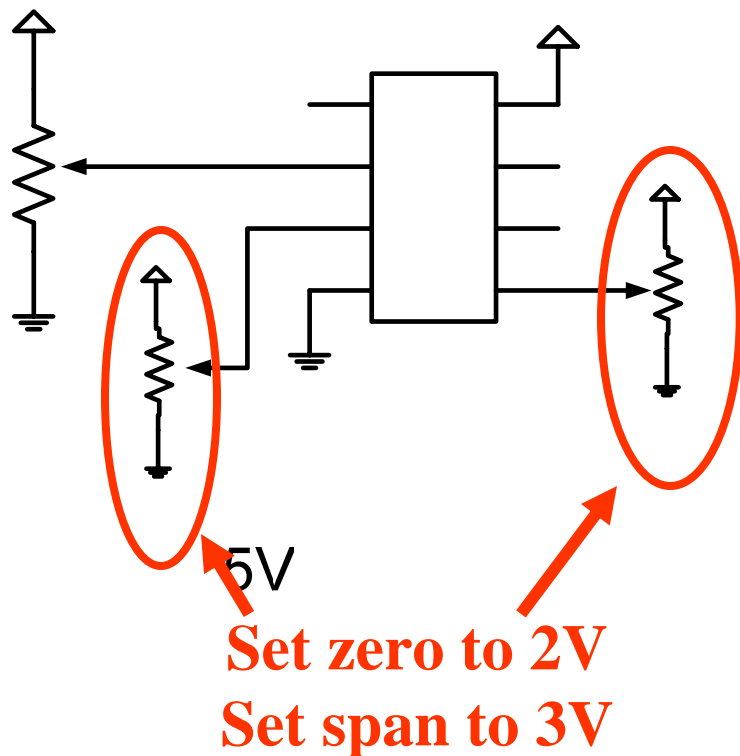


- 2V to 5V limited analog input using a potentiometer
- Output is from 102 to 255
 - 8 bits resolution

$$\frac{2V}{5V} \times 255 = 102$$

$$\frac{5V}{5V} \times 255 = 255$$

ADC with BS2-3



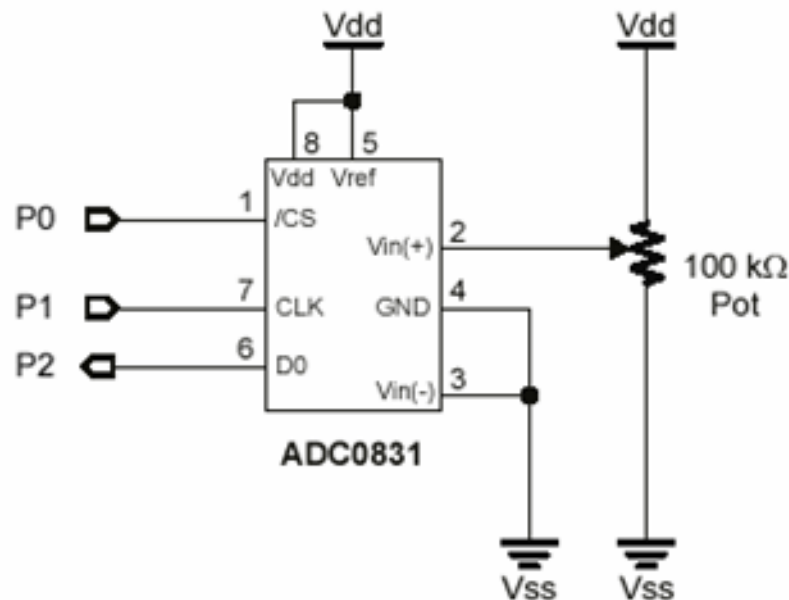
- Using two potentiometers zero and span can be adjusted to get full 8 bit resolution

$$\frac{(2 - 2)V}{3V} \times 255 = 0$$

$$\frac{(5 - 2)V}{3V} \times 255 = 255$$

P0

ADC with BS2-4

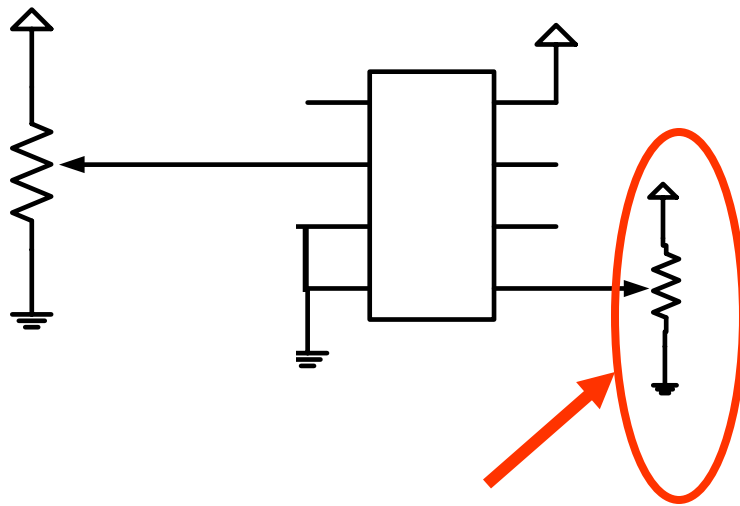


- 0V to 4V limited analog input using a potentiometer
- Output is from 0 to 204
 - 8 bits resolution

$$\frac{0V}{5V} \times 255 = 0$$

$$\frac{4V}{5V} \times 255 = 204$$

ADC with BS2-5



Set to 4V

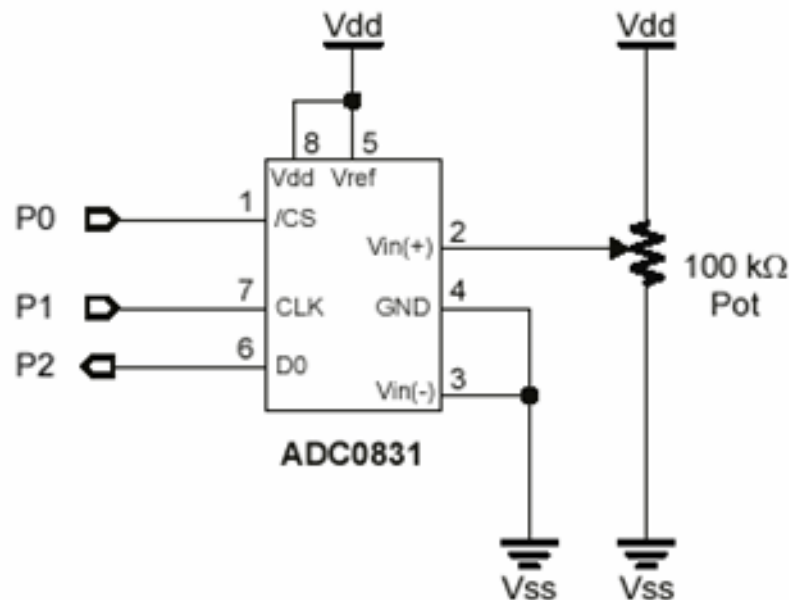
- Using another potentiometer to span can be adjusted to get full 8 bit resolution

$$\frac{0V}{4V} \times 255 = 0$$

$$\frac{4V}{4V} \times 255 = 255$$

P0

ADC with BS2-6

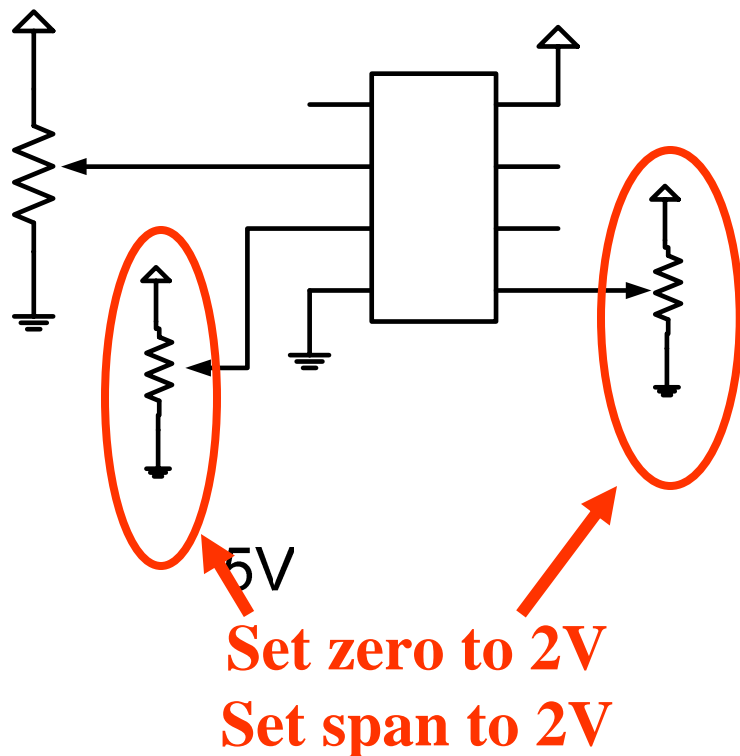


- 2V to 4V limited analog input using a potentiometer
- Output is from 102 to 204
 - 8 bits resolution

$$\frac{2V}{5V} \times 255 = 102$$

$$\frac{4V}{5V} \times 255 = 204$$

ADC with BS2-7



- Using 2 potentiometers zero and span can be adjusted to get full 8 bit resolution

$$\frac{(2-2)V}{(4-2)V} \times 255 = 0$$

$$\frac{(4-2)V}{(4-2)V} \times 255 = 255$$

P0

ADC0831 Experiments

Experiments	Chapters
What's micro controller	
Basic A and D	1, 3
Earth measurements	
Robotics	
StampWorks	28
Others	