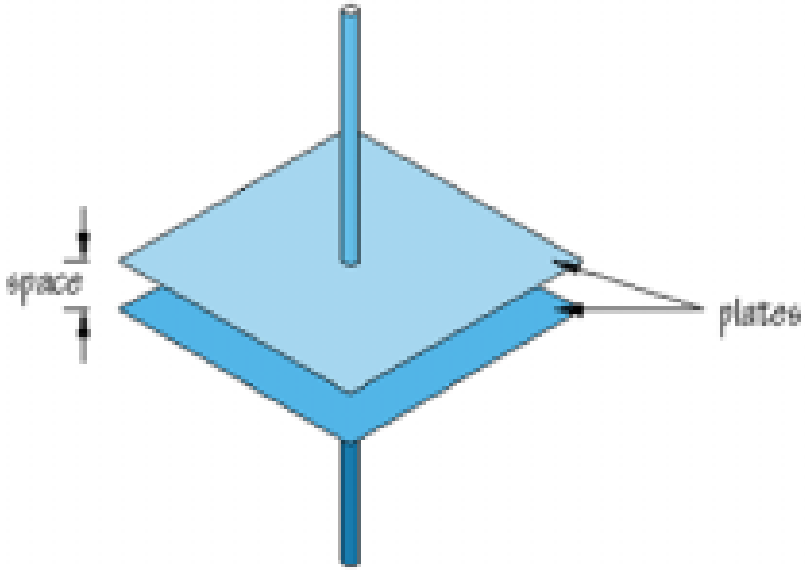
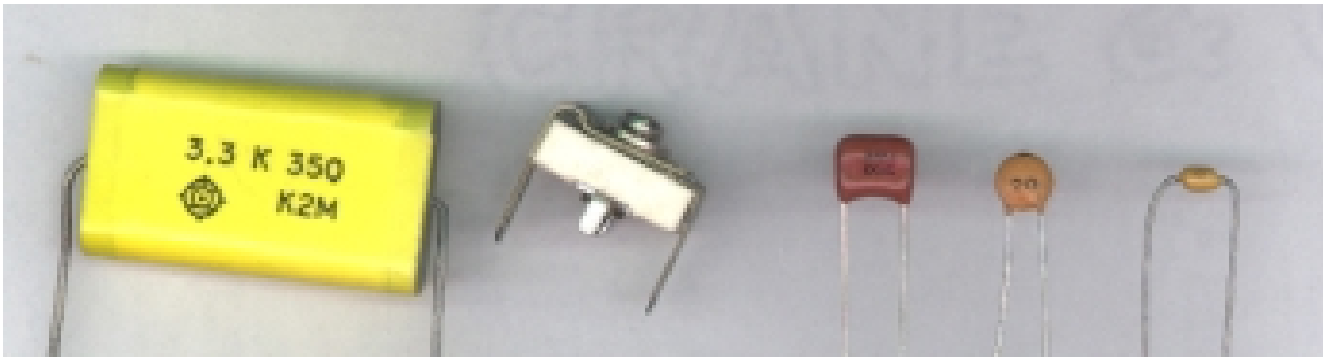
Lecture 5

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

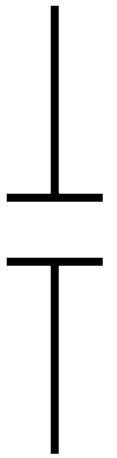


Mylar Ceramic

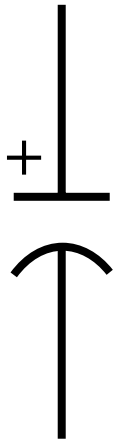
Electrolytic

Negative lead (-)

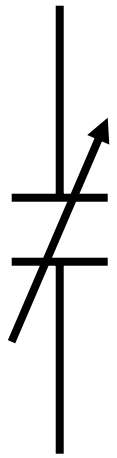
Capacitor Symbols



Fixed capacitor

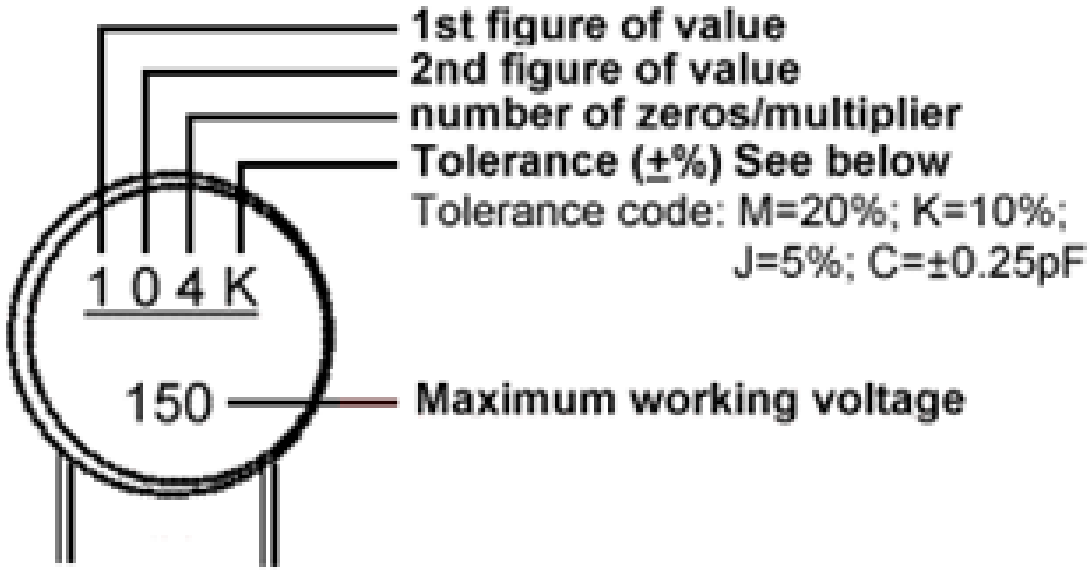


Polarized capacitor



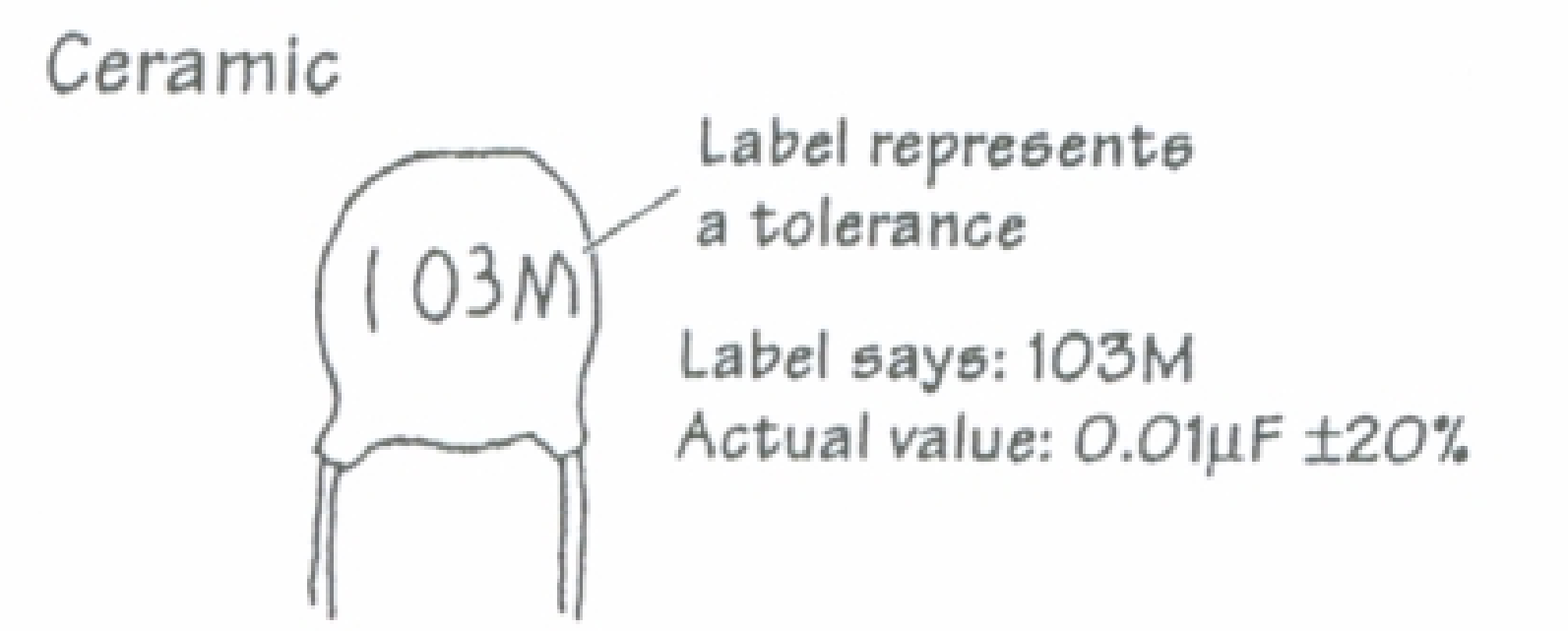
Variable capacitor

How to Read Capacitor Value

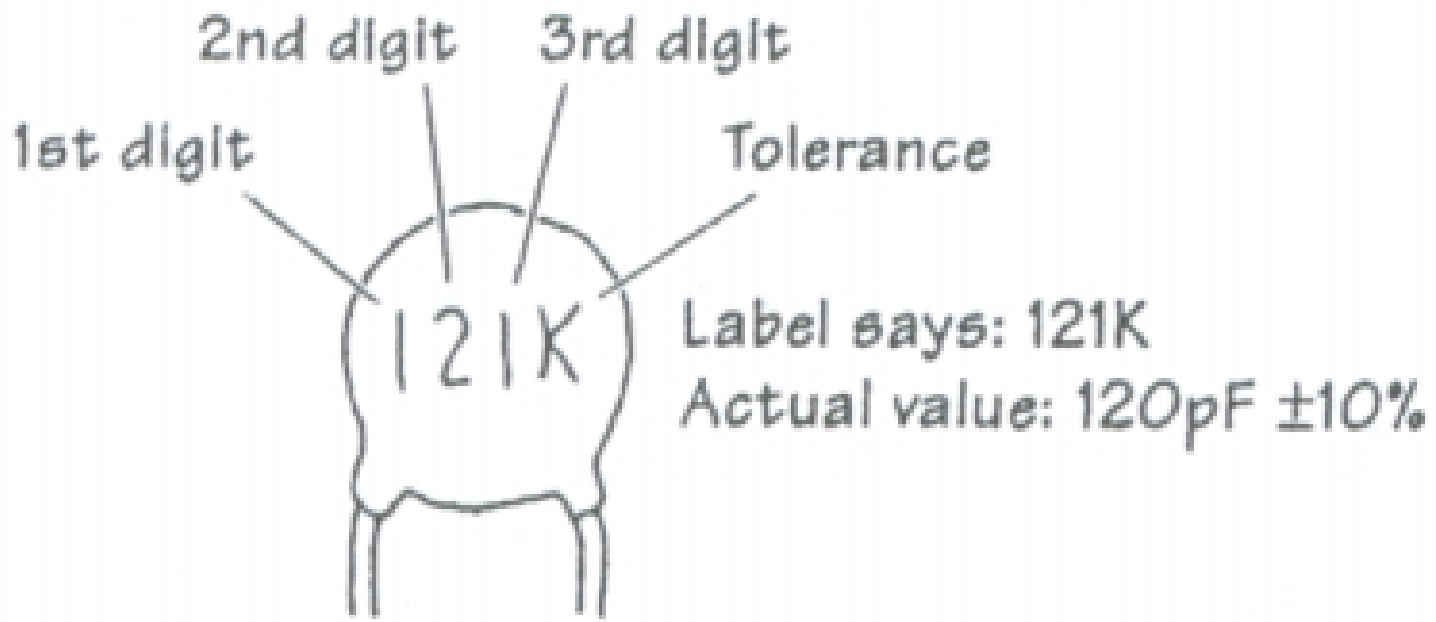


- The first two figures give us 10, the third figure gives us 0000, and the letter 10%. We normally express this as 0.1µF.

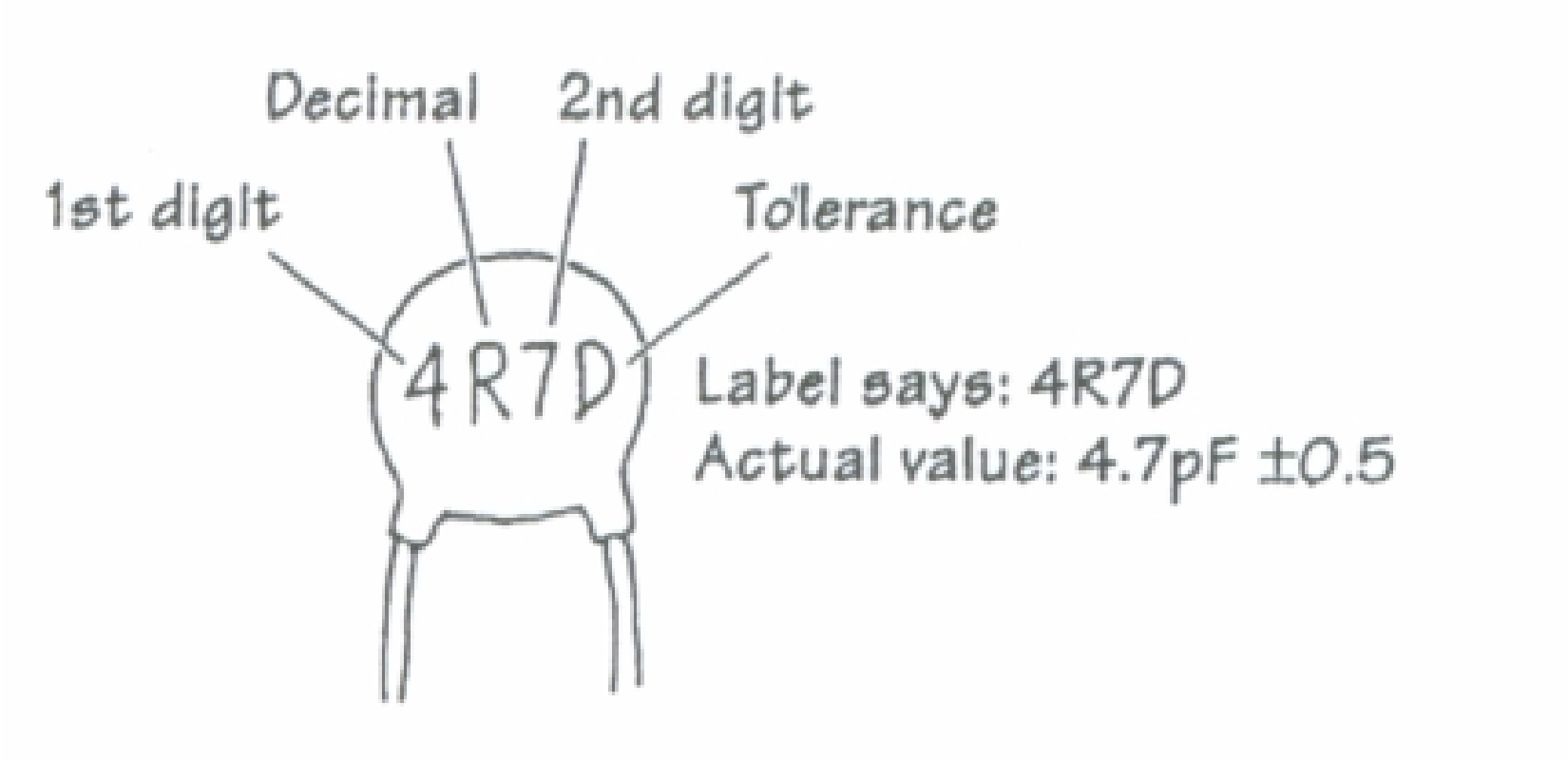
Example: Capacitor Value 1



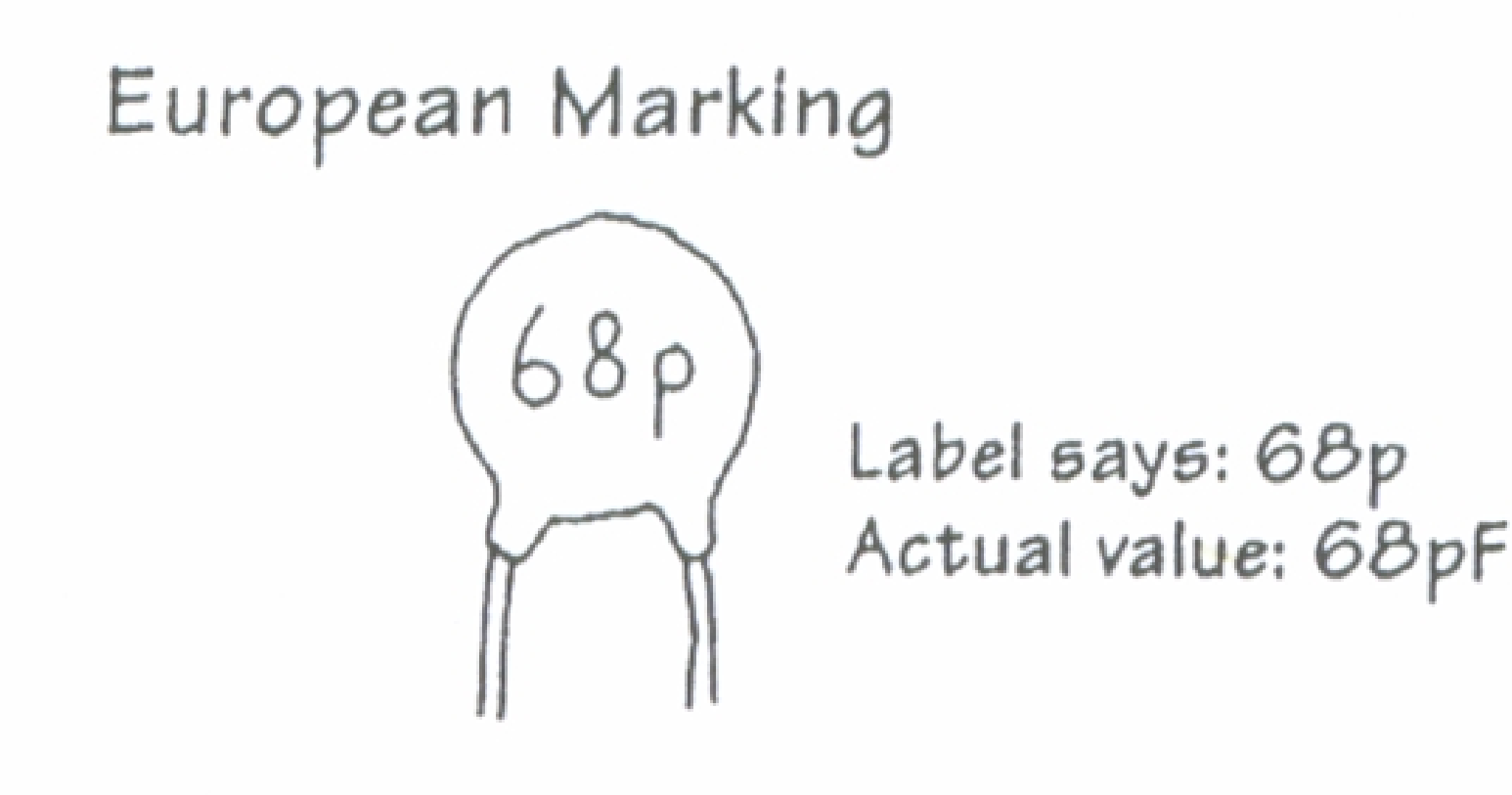
Example: Capacitor Value 2



Example: Capacitor Value 3

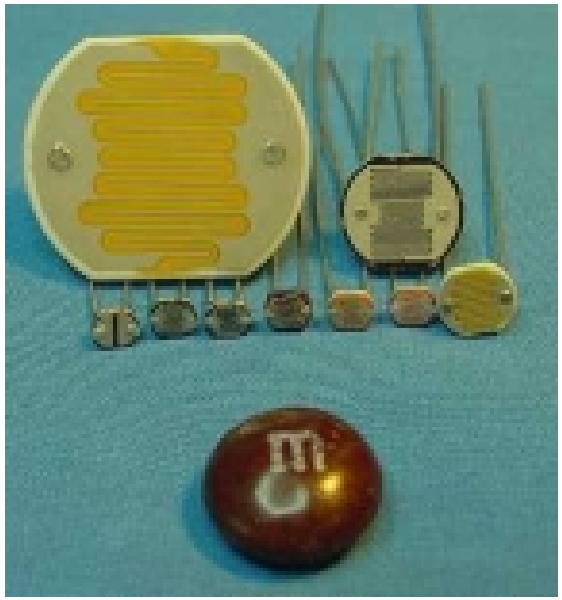


Example: Capacitor Value 4

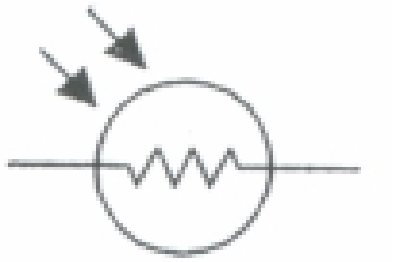


Lecture 6

Photoresistors

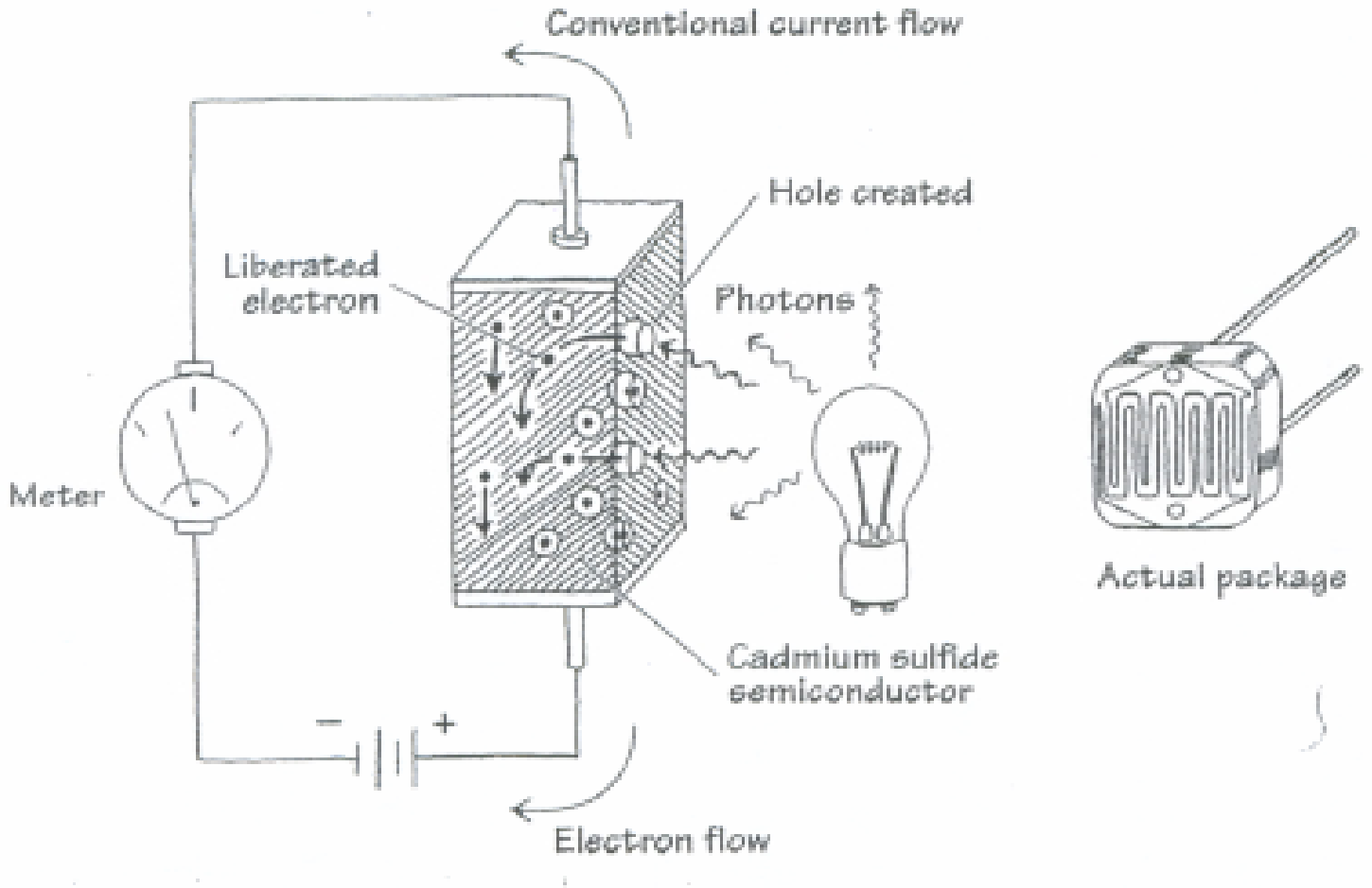


- Light sensitive resistors
- Resistance decreases when light intensity increases

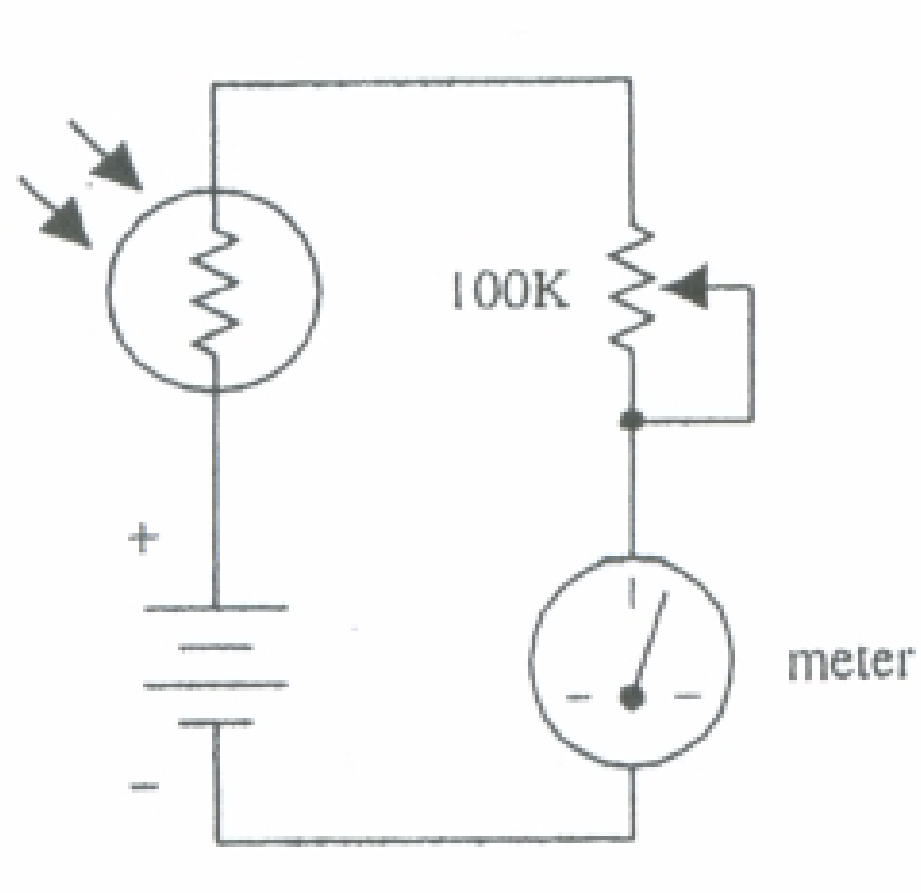


Symbol

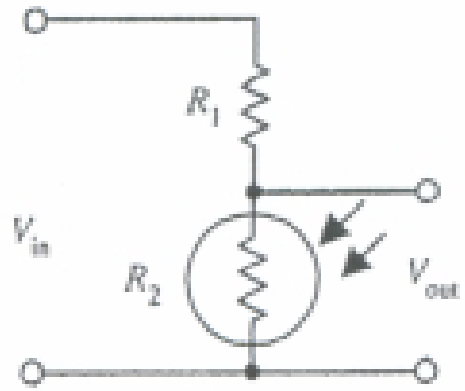
Photoresistor: How It Works

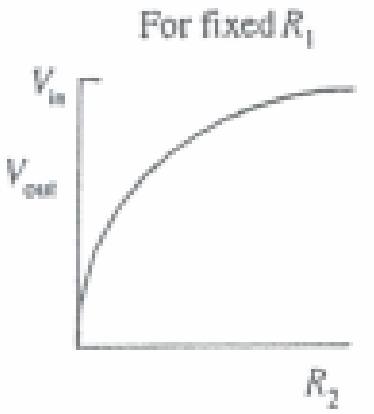


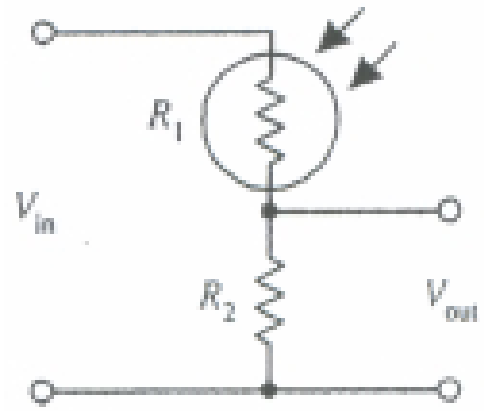
Simple Light Meter

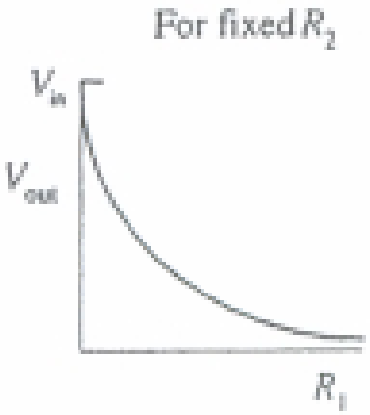


Light Sensitive Voltage Divider

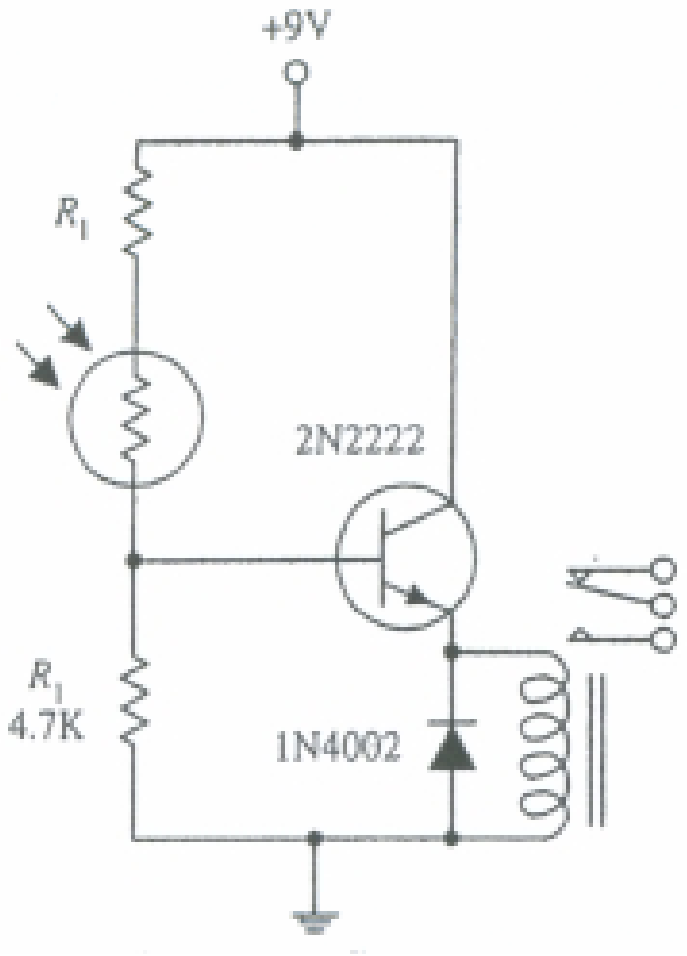




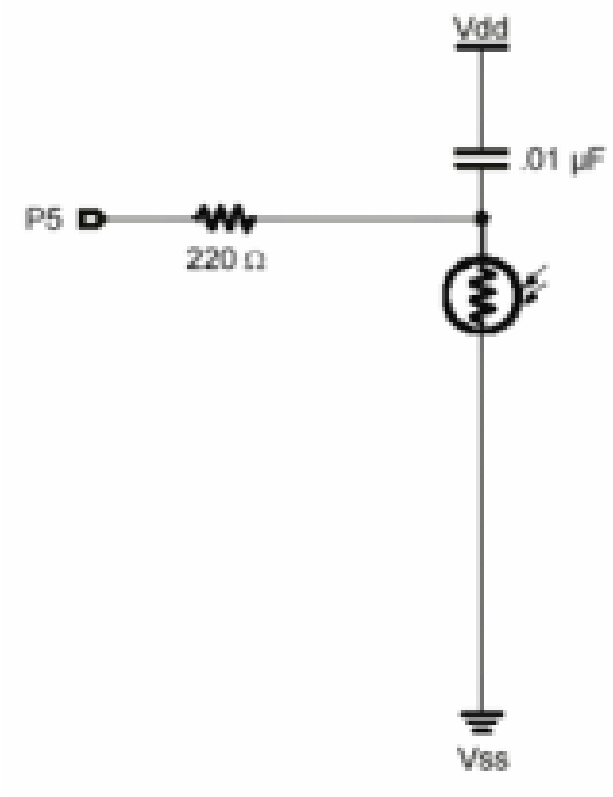




Light Activated Relay

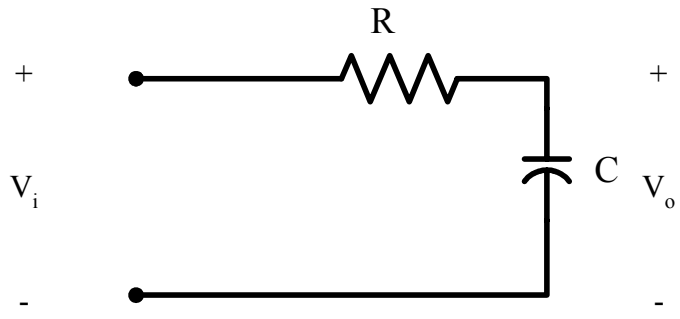


Photoresistor with BS2

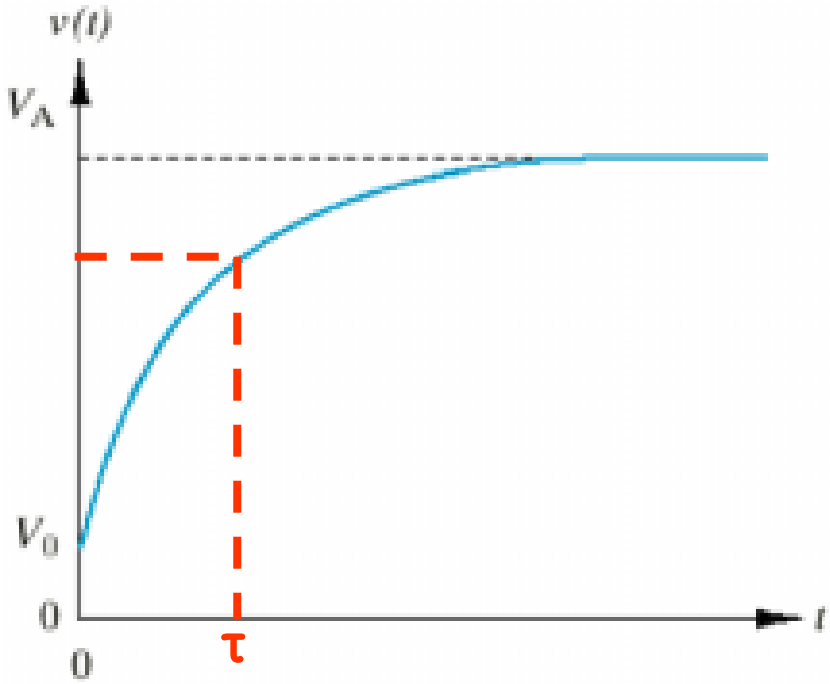


- Usually connect with a capacitor
- Use RCTime command to find out light intensity

RC Circuit



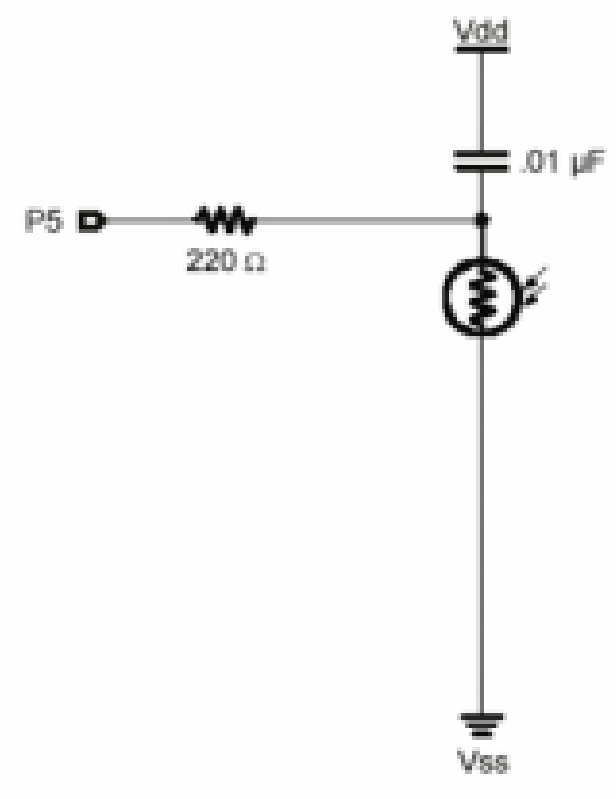
$$\frac{V_o(s)}{V_i(s)} = \frac{1}{RCs+1}$$



RC is time constant, τ

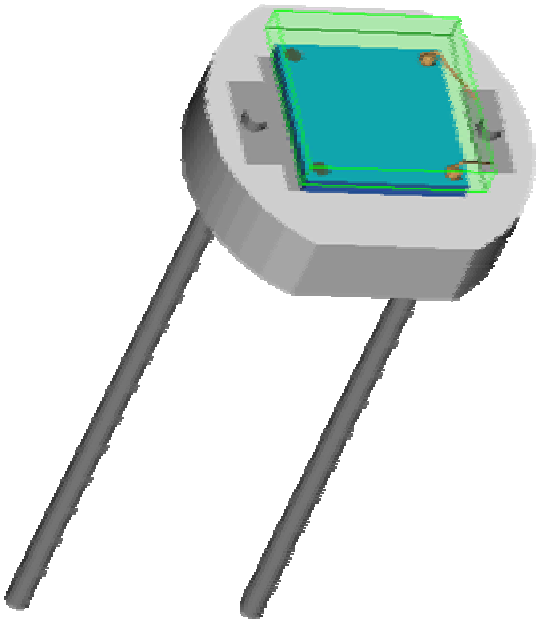
63.2% of the voltage output in steady state (V_A)

Rctime with BS2

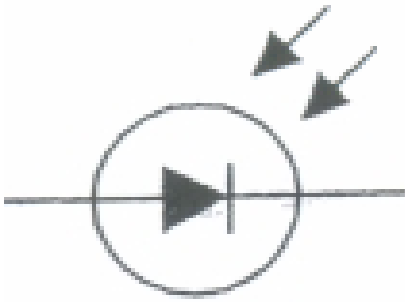


- Software version of analog to digital converter
- Pbasic rctime command
  - Rctime Pin#, state, variable
- Example code
  - High 5
  - Pause 3
  - Rctime 5,1, tau

Photodiode

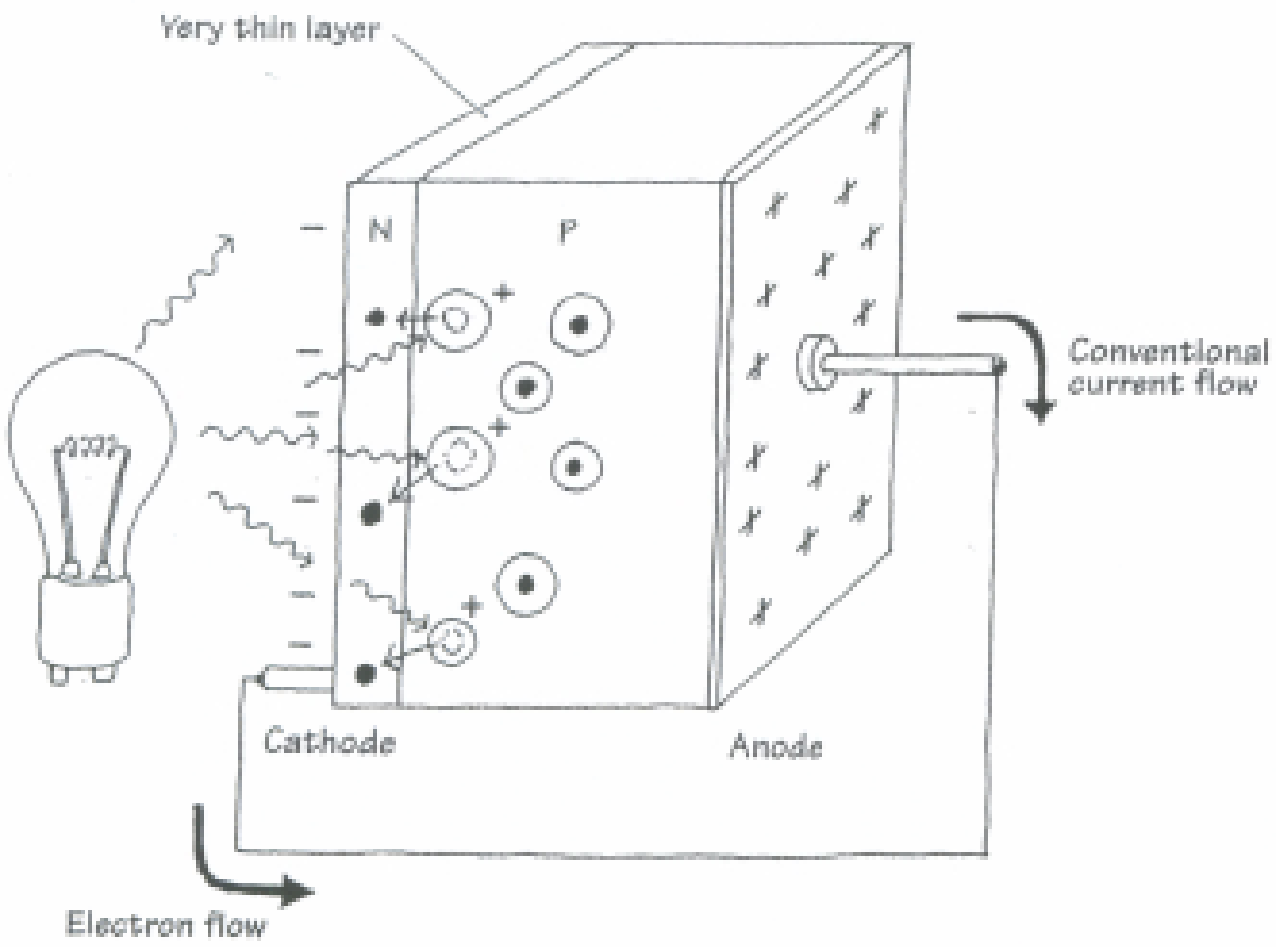


- Transforms light energy to electric current
- Very linear
- More sensitive than photoresistor

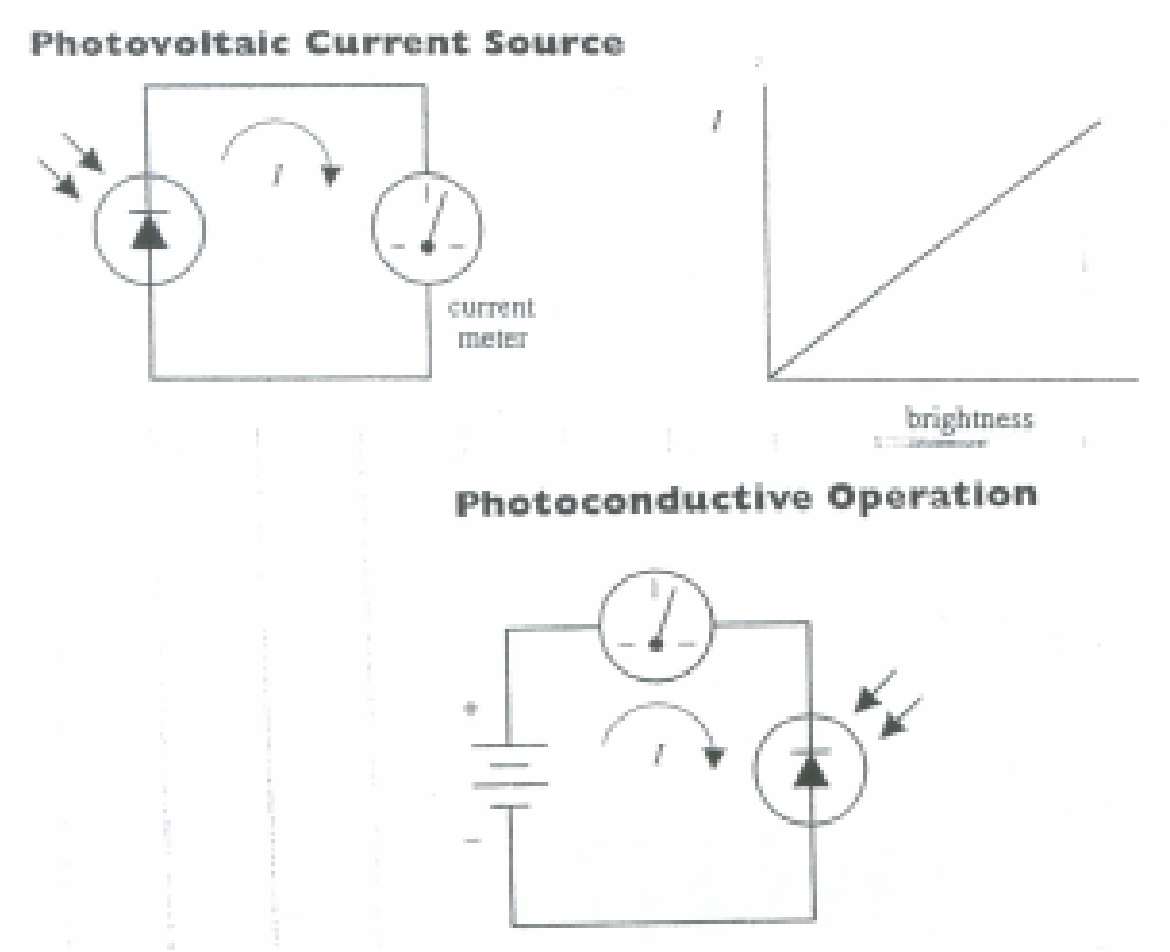


Symbol

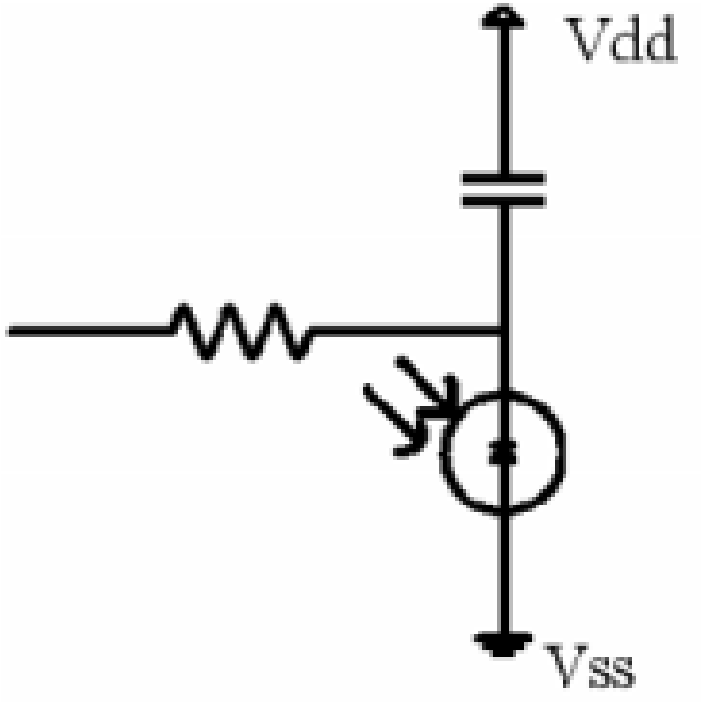
Photodiode: How It Works



Photodiode Applications



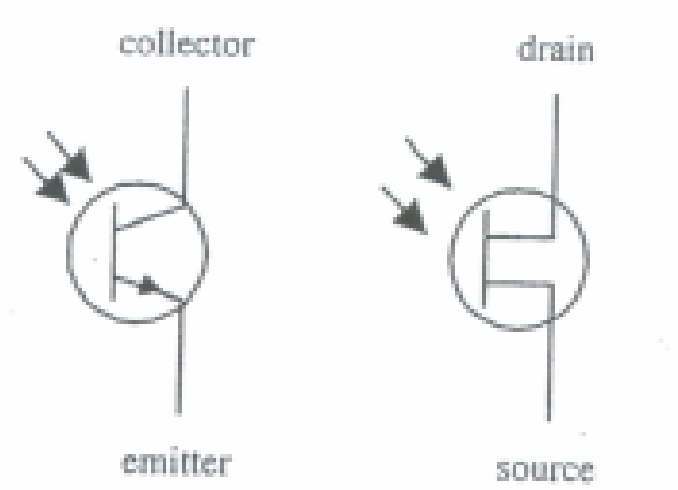
Photodiode with BS2



- Polarity: cathode connects to the ground

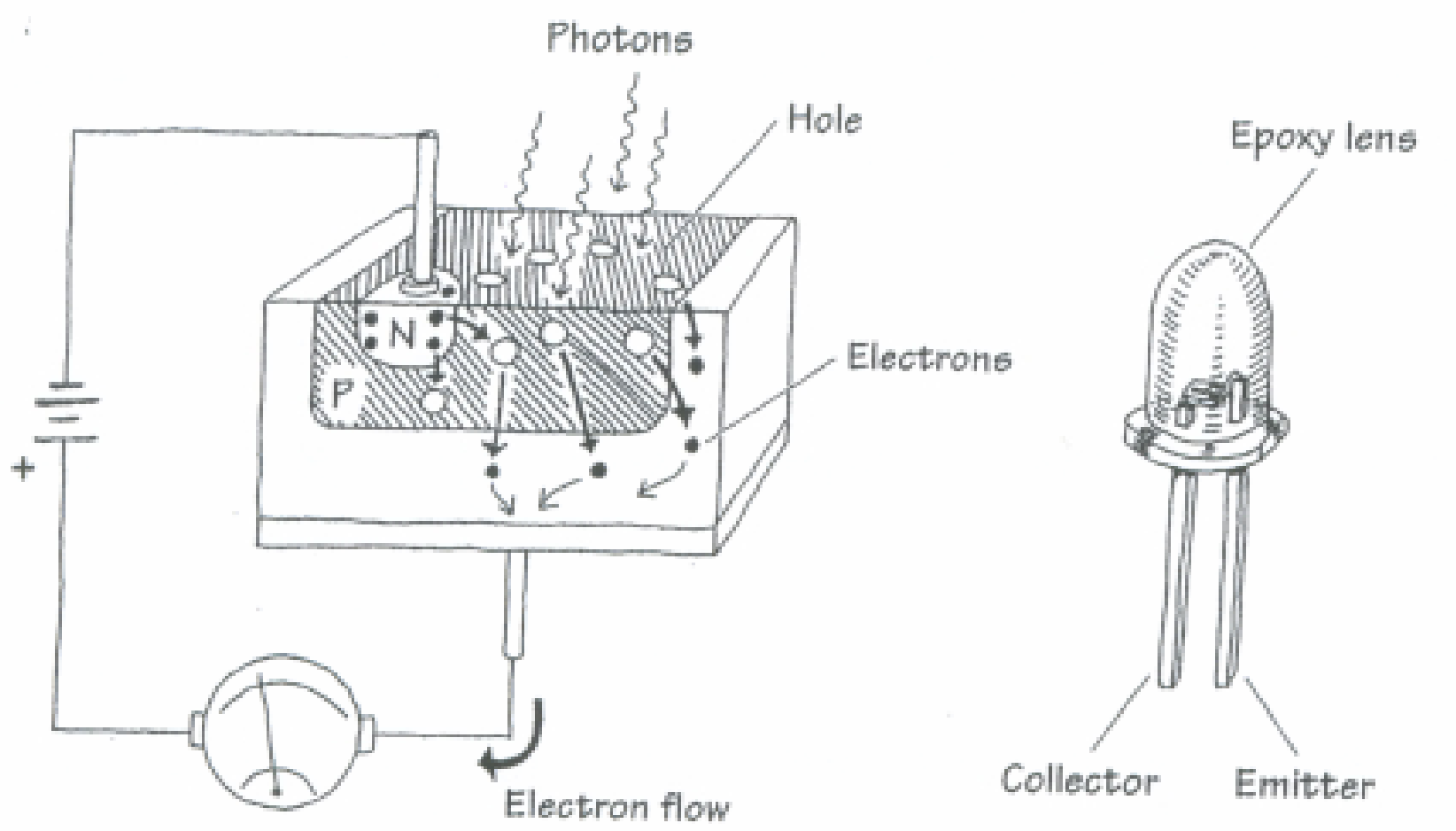
Phototransistor

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

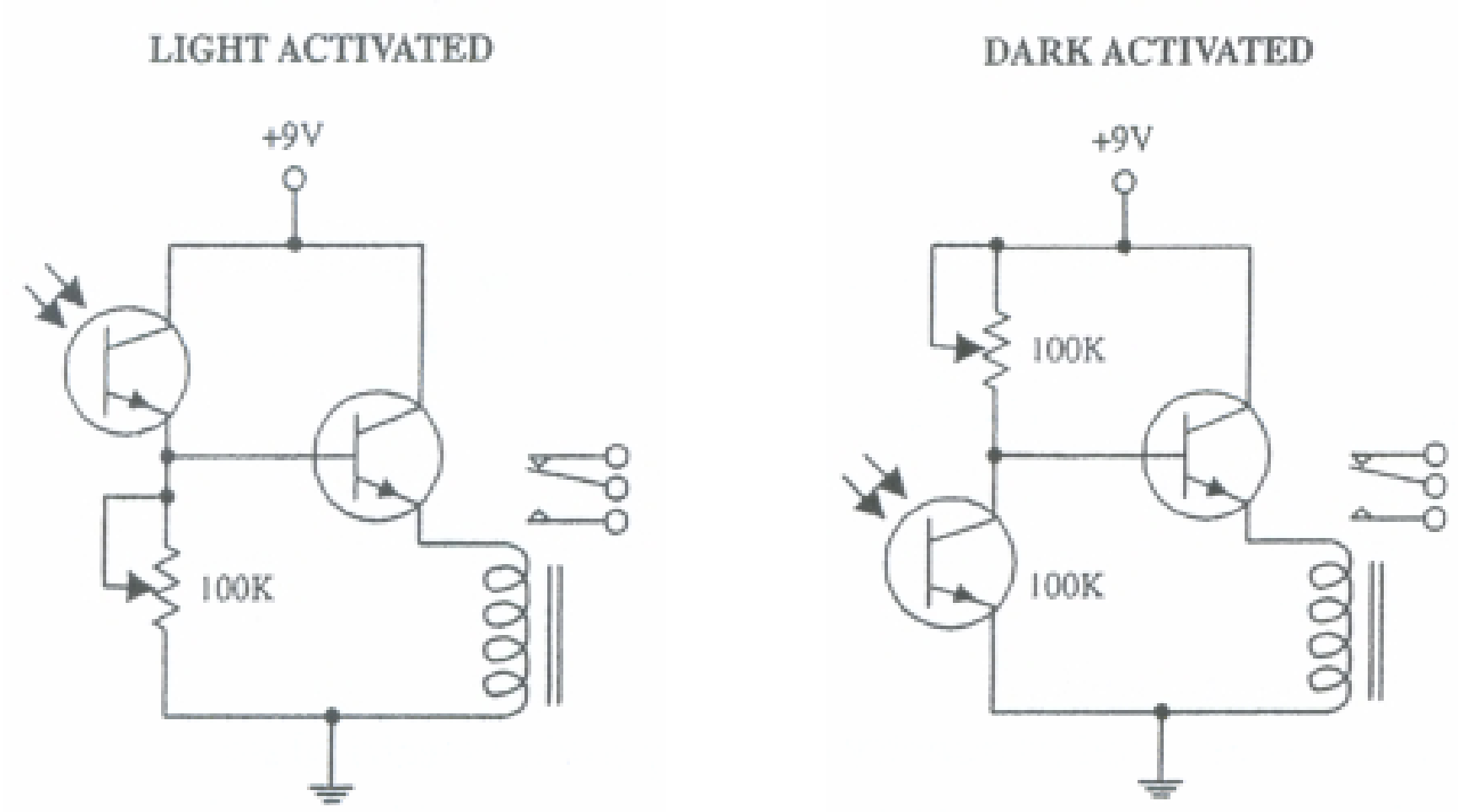


Phototransistor **Photo FET**

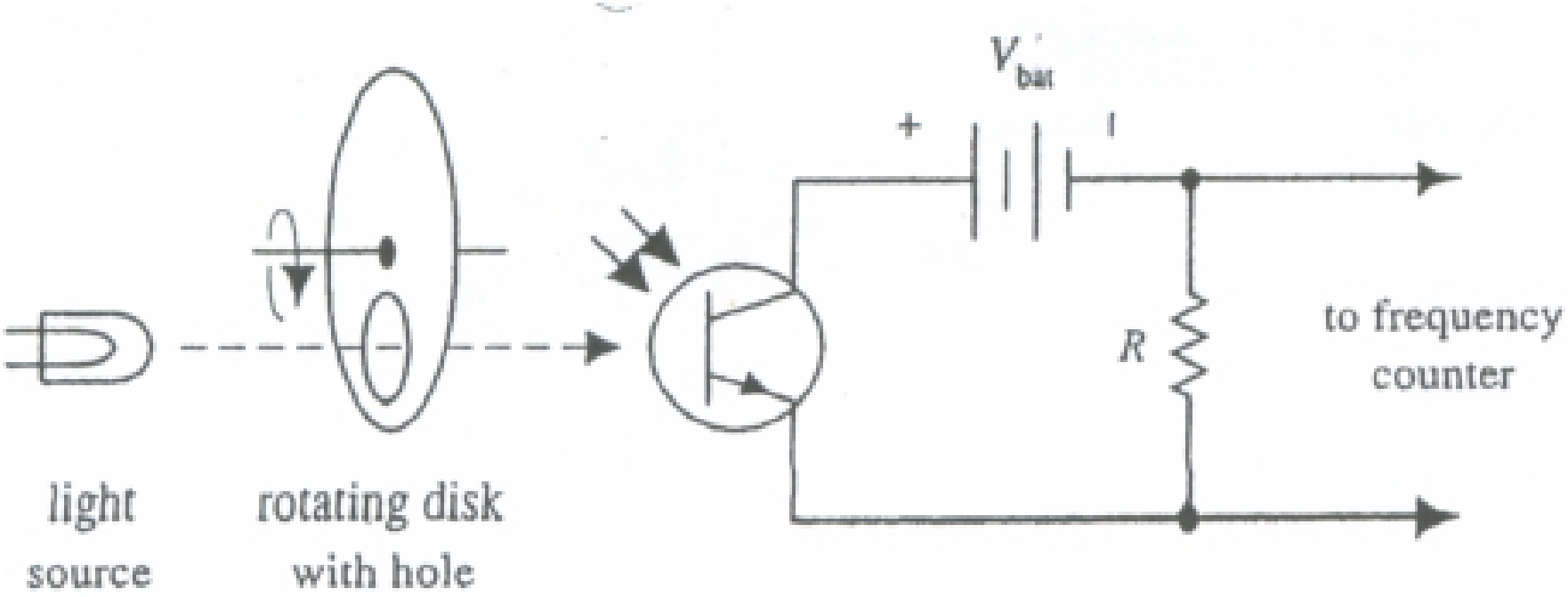
Phototransistor: How It Works



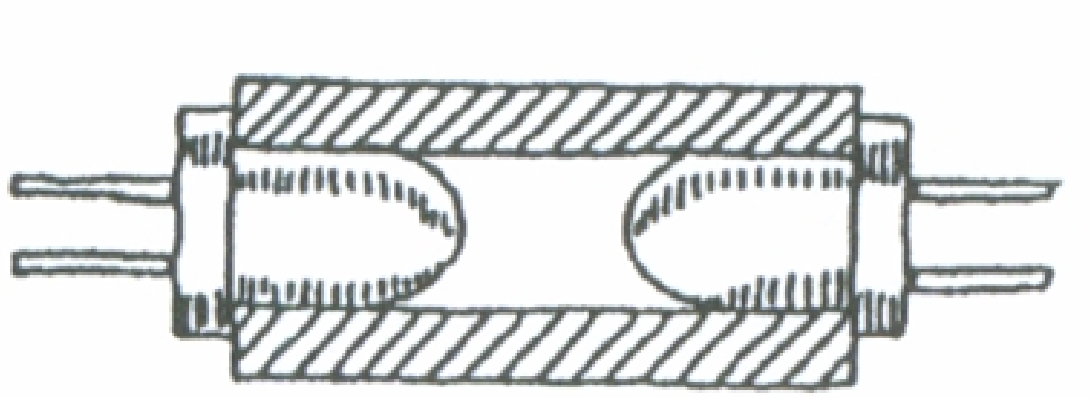
Phototransistor Applications



Tachometer

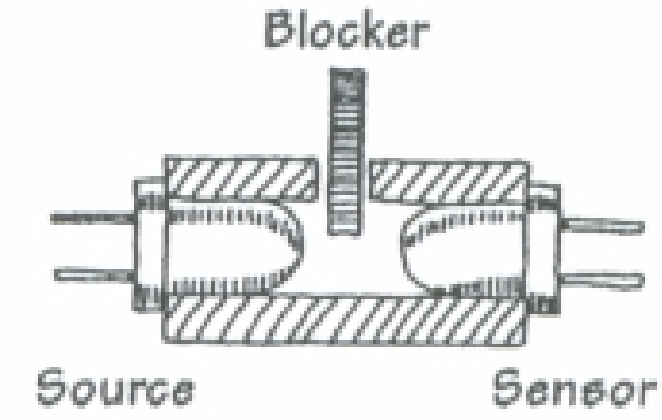

V_{bat}
+
R
to frequency
counter
light
source
rotating disk
with hole

Optoisolators 1

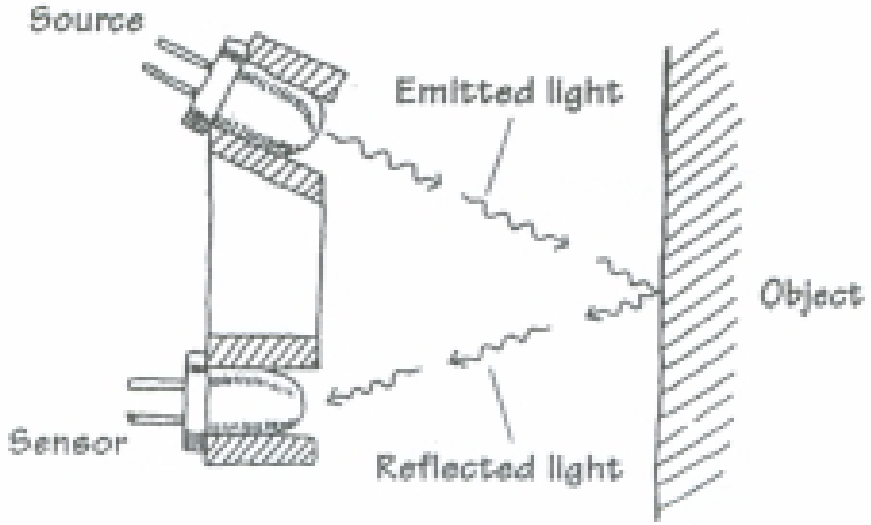


Closed Pair

Optoisolators 2

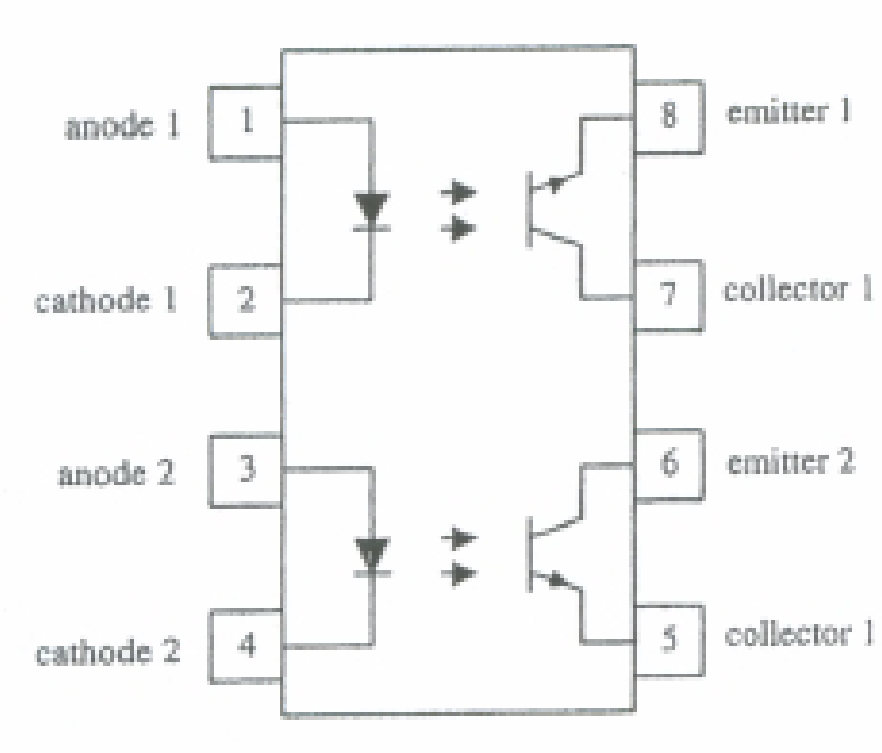


Slotted Pair



Reflective Pair

Optoisolators 3



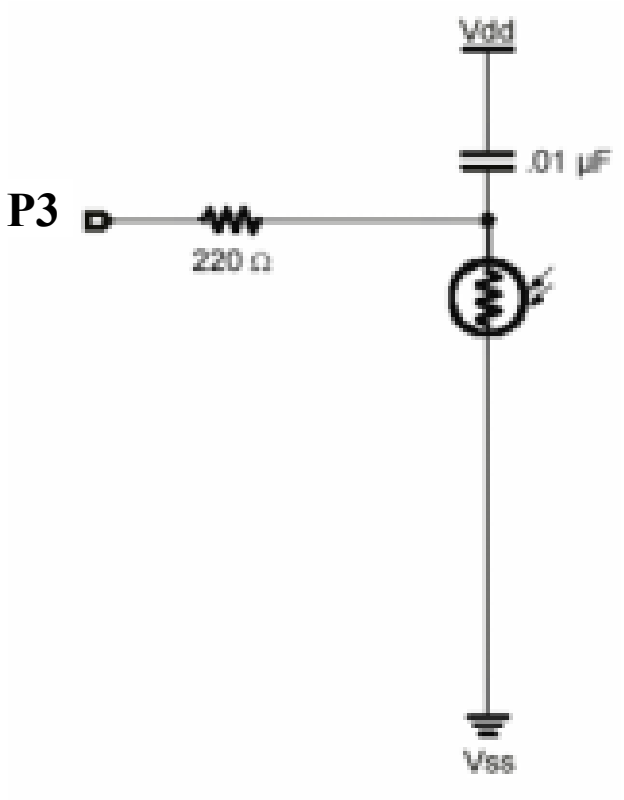
Integrated Optoisolators

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

Rctime with BS2

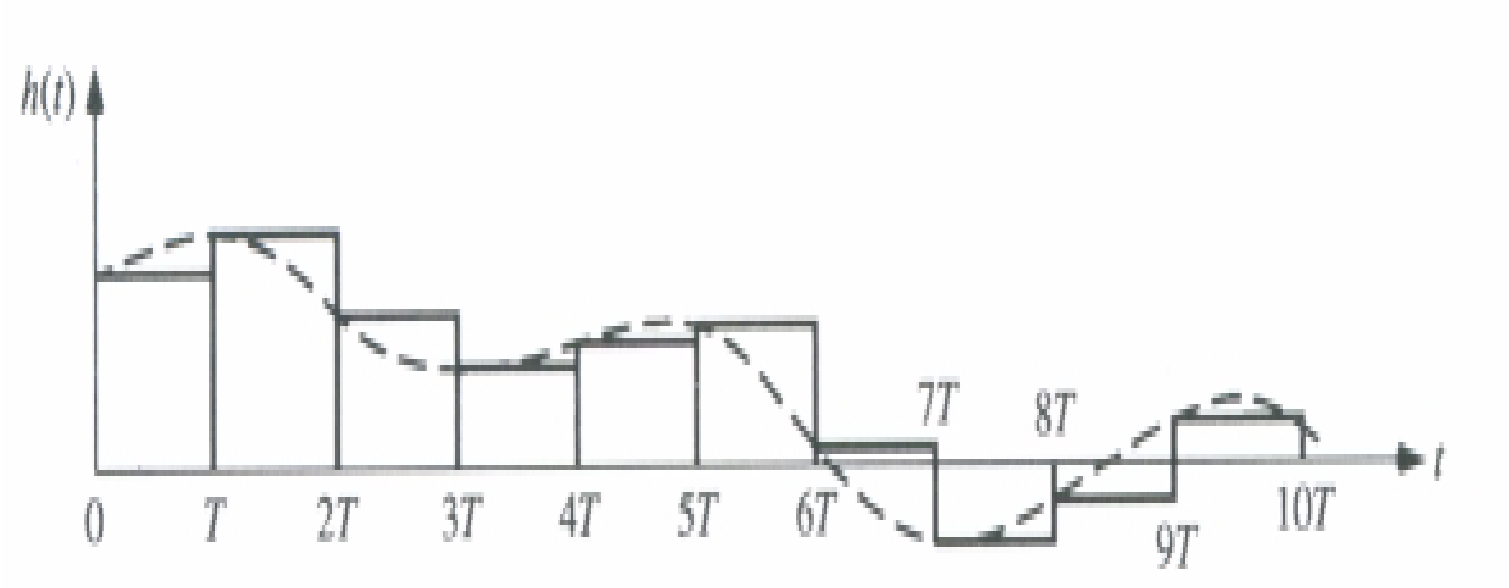


- Software version of analog to digital converter
- Pbasic rctime command
  - High 3
  - Pause 3
  - Rctime 3,1, tau

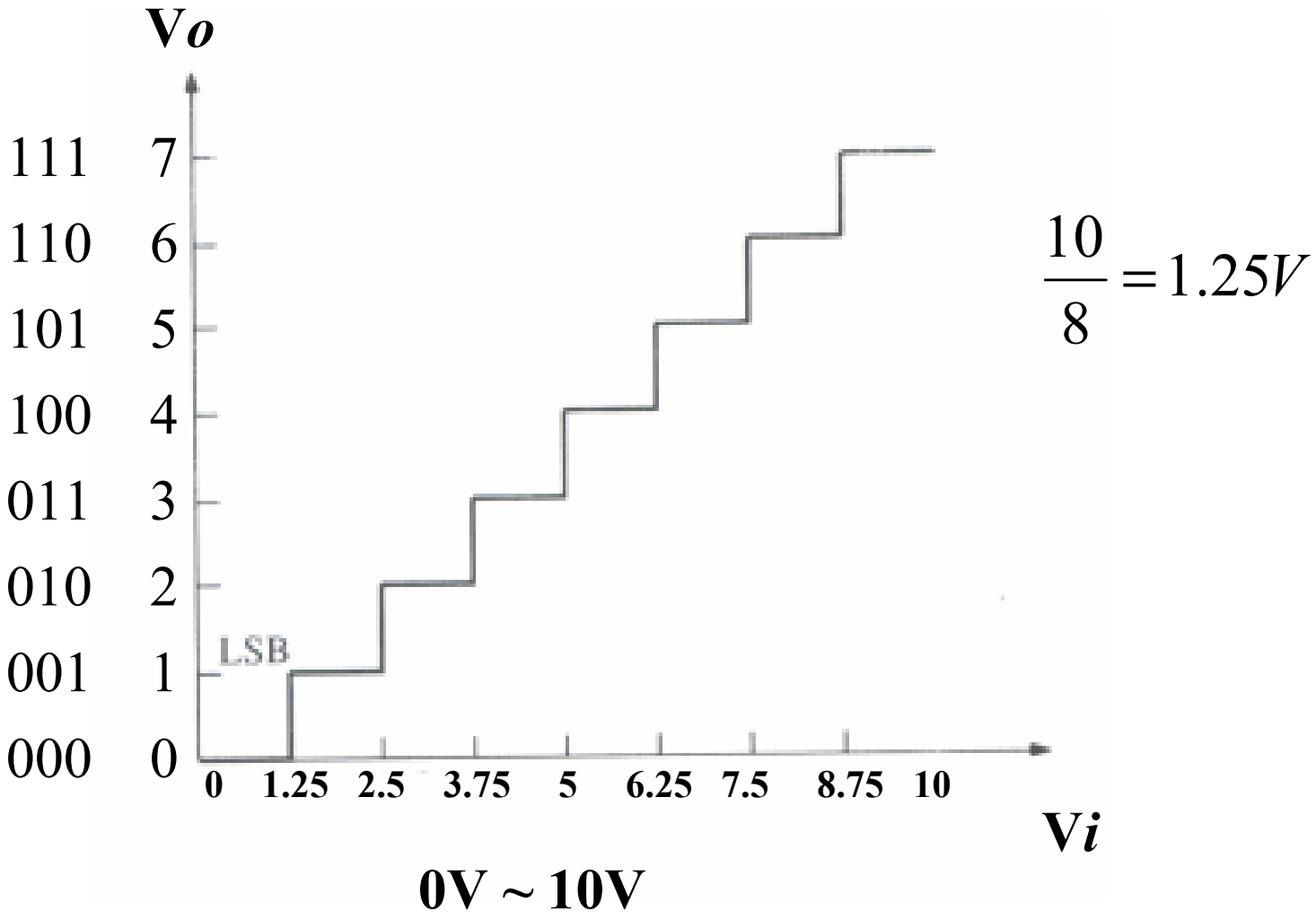
Analog to Digital Conversion

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

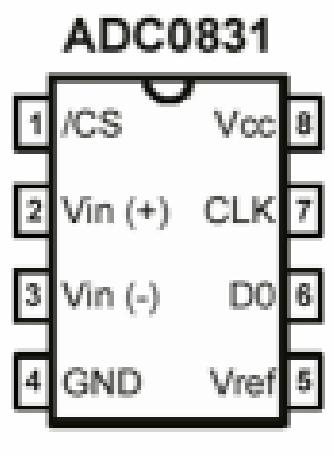
Sampling



Quantization and Coding

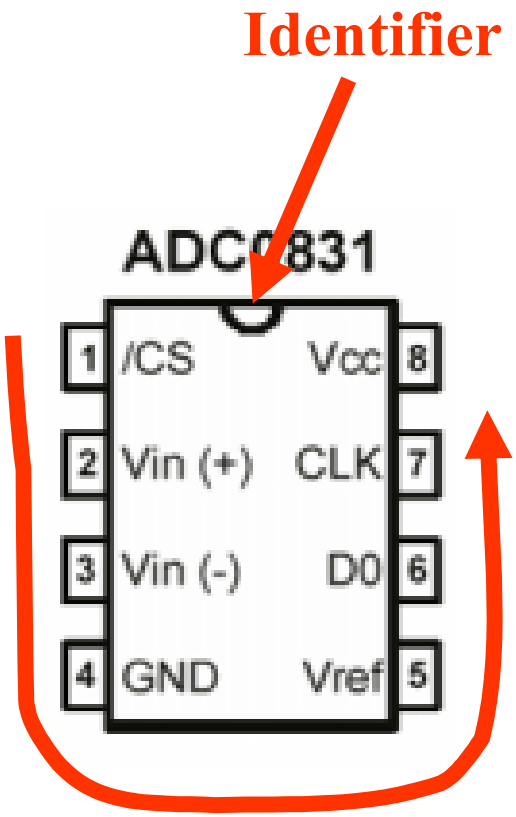


ADC



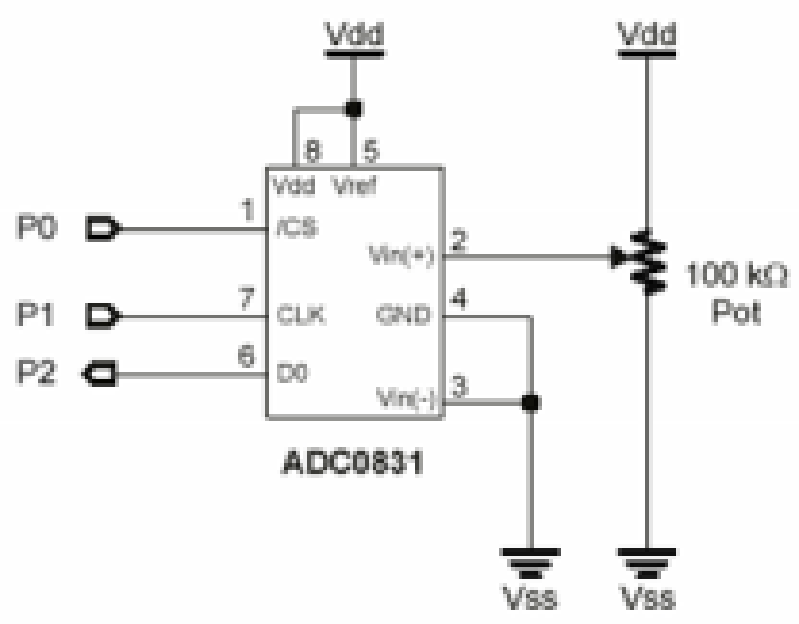
- Analog to digital converter
- 8-bit successive analog to digital converter
- 0V to 5V input range
- Single 5V power supply

ADC Pin Description



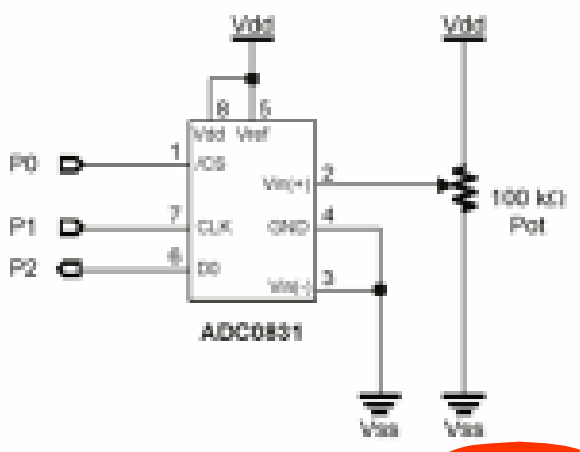
Pin	Description
Pin 1	ADC is ready to do conversion when it is low
Pin 2	0 to 5V analog input need to be digitized
Pin 3	Zero offset adjustment
Pin 4	Ground
Pin 5	Span adjustment
Pin 6	8 bit ADC output
Pin 7	Clock signal from BS2
Pin 8	Regulated 5V (Power supply)

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
Low 1
Pulsout 1,210
Shiftin 2, 1,MSBPOST, [adcbits\8]
```

Serial communication

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

Sample Code for ADC 2

```
Q var word
R var word
Q = 13 /5
R = 13 // 5
Debug ? Q
Debug ? R
```

Quotient

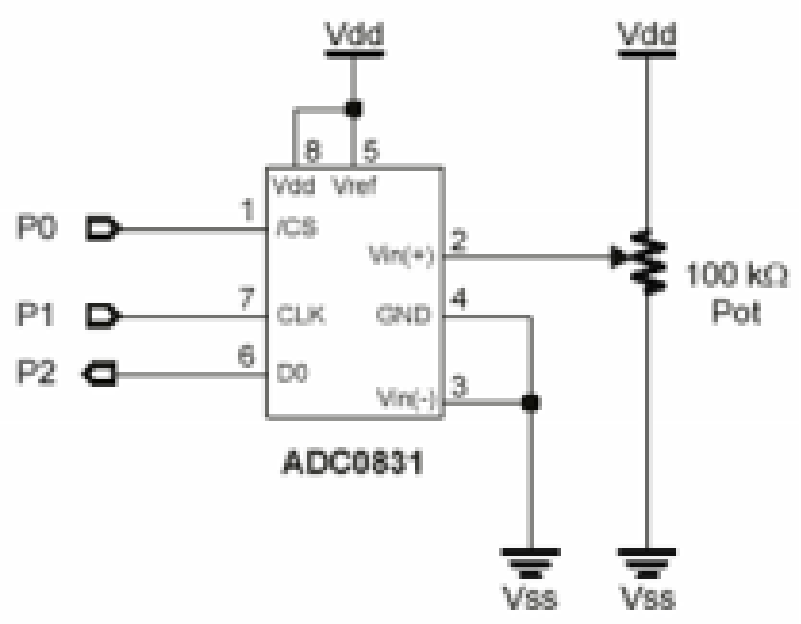
Remainder

Debug window shows;

Q= 2

R= 3

ADC with BS2-2

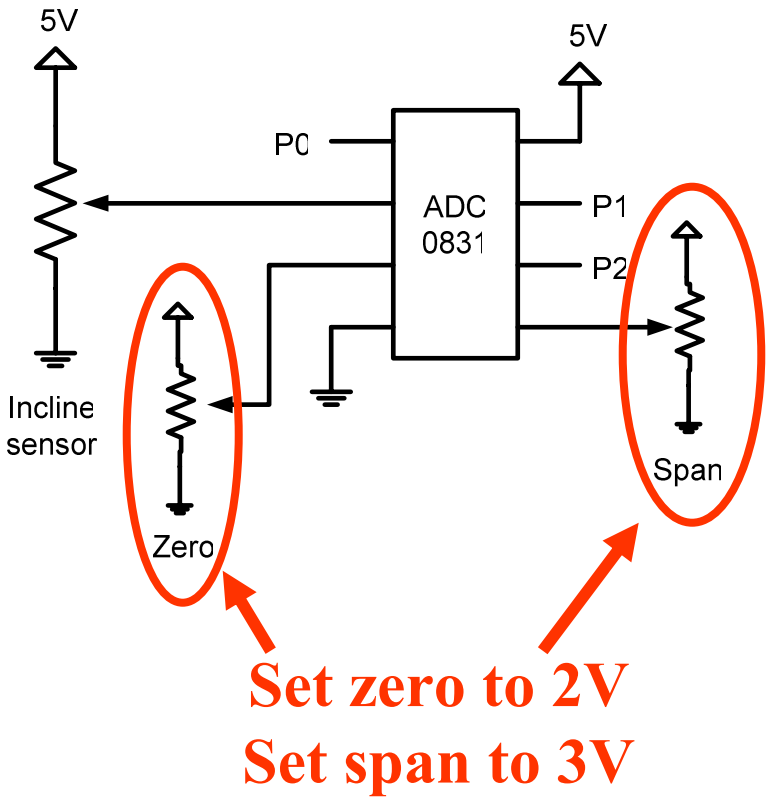


- 2V to 5V limited analog input using a potentiometer
- Output is from 102 to 255
  - 8 bits resolution

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

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

ADC with BS2-3

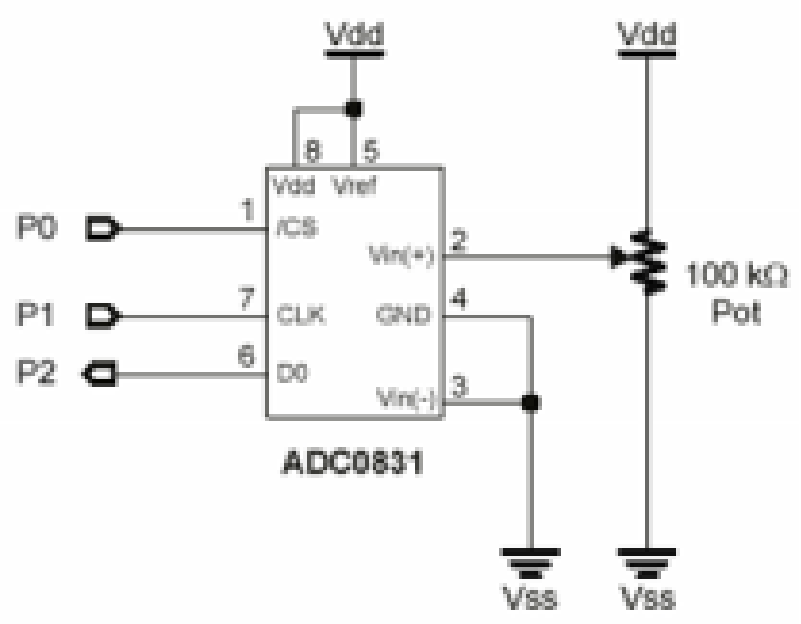


- Using two potentiometers zero and span can be adjusted to get full 8 bit resolution

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

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

ADC with BS2-4

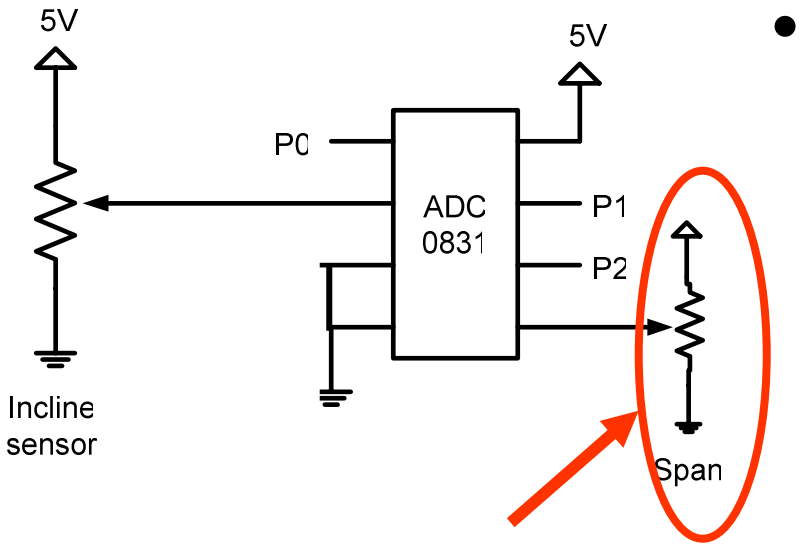


- 0V to 4V limited analog input using a potentiometer
- Output is from 0 to 204
  - 8 bits resolution

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

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

ADC with BS2-5



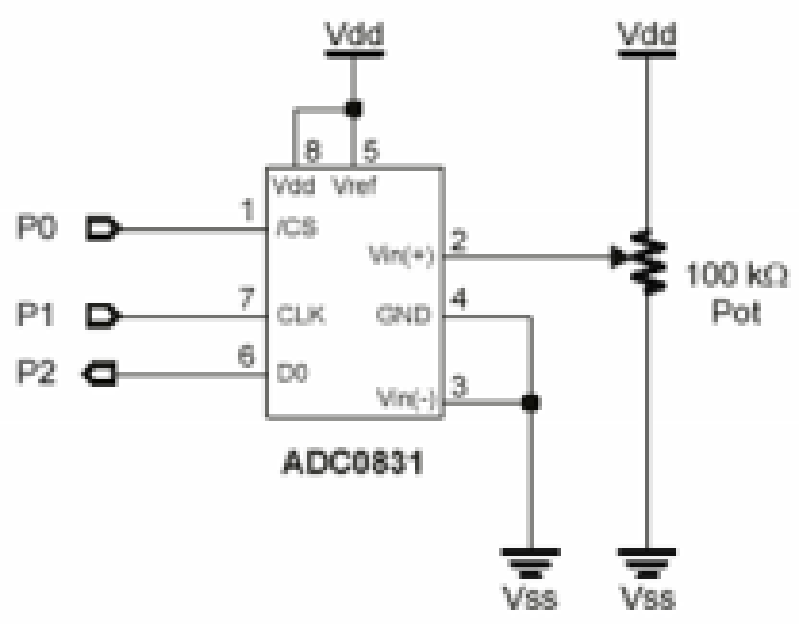
Set to 4V

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

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

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

ADC with BS2-6

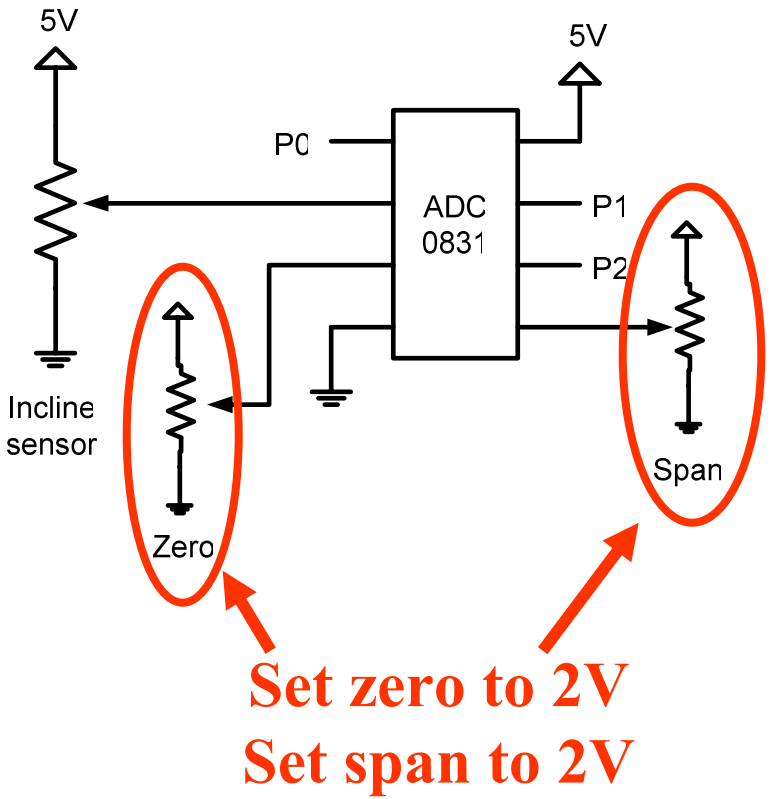


- 2V to 4V limited analog input using a potentiometer
- Output is from 102 to 204
  - 8 bits resolution

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

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

ADC with BS2-7



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

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

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

ADC0831 Experiments

Experiments	Chapters
What's micro controller	
Basic A and D	1, 3
Earth measurements	
Robotics	
StampWorks	27
Others	

Lecture 8

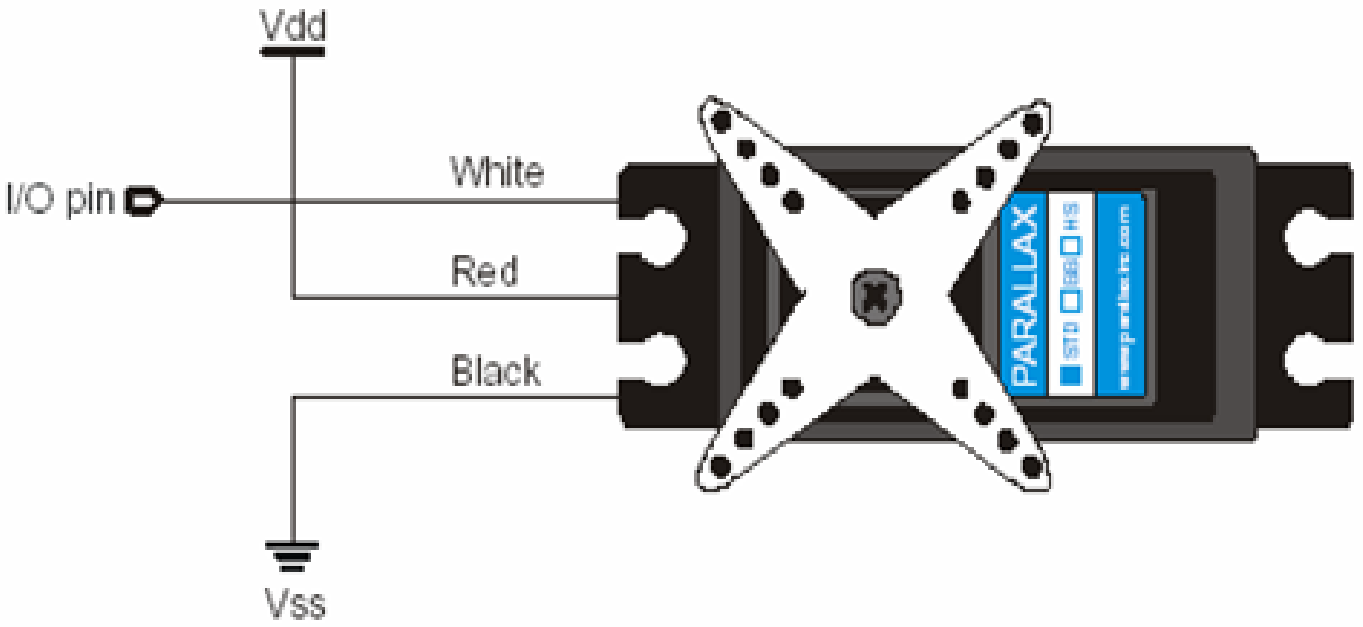
Servo Motor

- DC motors with feedback position control
- As long as the coded signal exists on the input line, the servo will maintain the angular position of the shaft
- As the coded signal changes, the angular position of the shaft changes

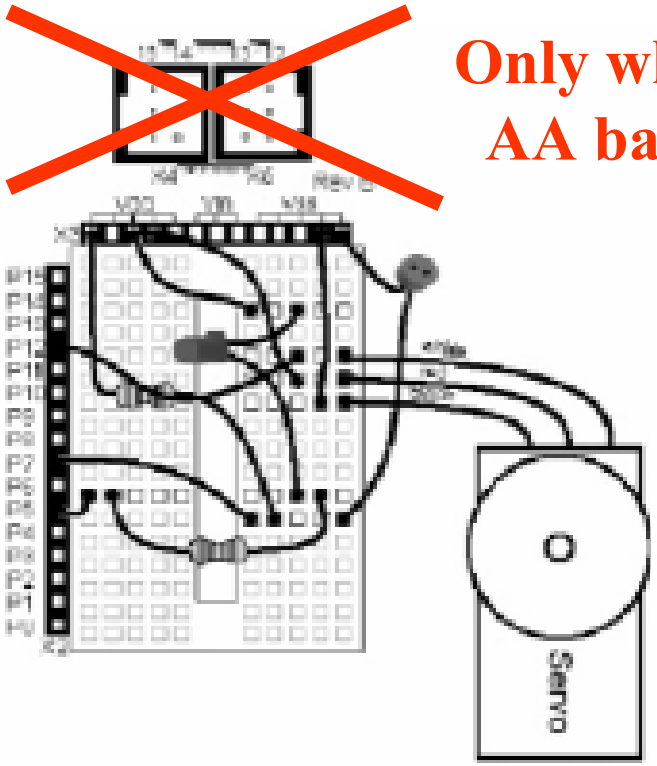
Servo Motor: How It Work?

- Consists of some control circuit and a potentiometer
- This potentiometer allows the control circuitry to monitor the current angle of the servo motor
- If the shaft is at the correct angle, then the motor shuts off
- If the circuit finds that the angle is not correct, it will turn the motor in the correct direction until the angle is corrected

Servo Motor Wiring



Servo Motor with BS2



Only when you use AA battery pack

2 servo motors only

Need another capacitor for additional servo motors

Sample Code

```
X var byte
Output 12

Here:
For X = 1 to 100
Pulsout 12, 500
Pause 10
Next
Pause 500

For X = 1 to 100
Pulsout 12, 1000
Pause 10
Next
Pause 500

Goto Here
```

Pulsout Pin #, Duration

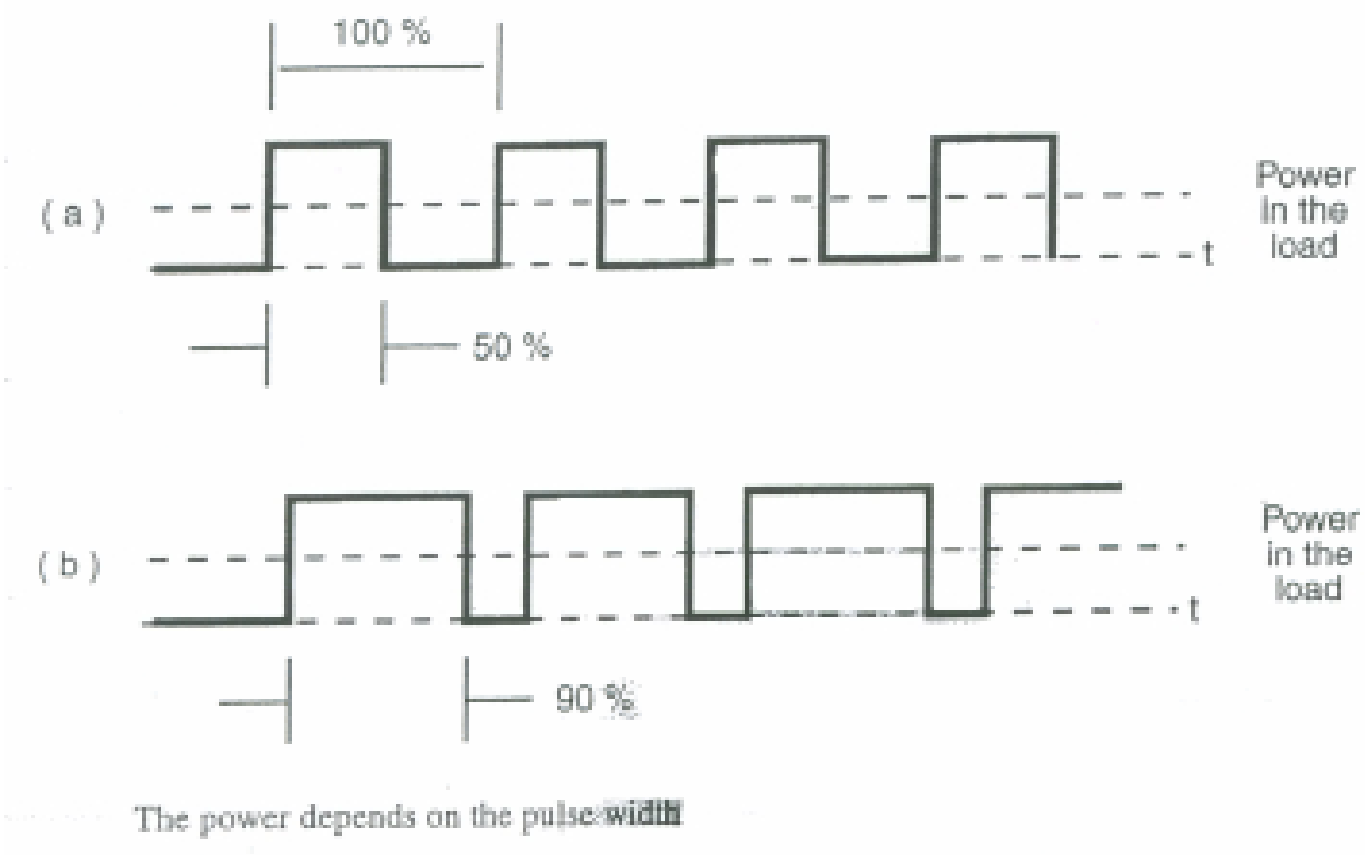
12 is pin number of BS2

500 means 1milisecond

PWM

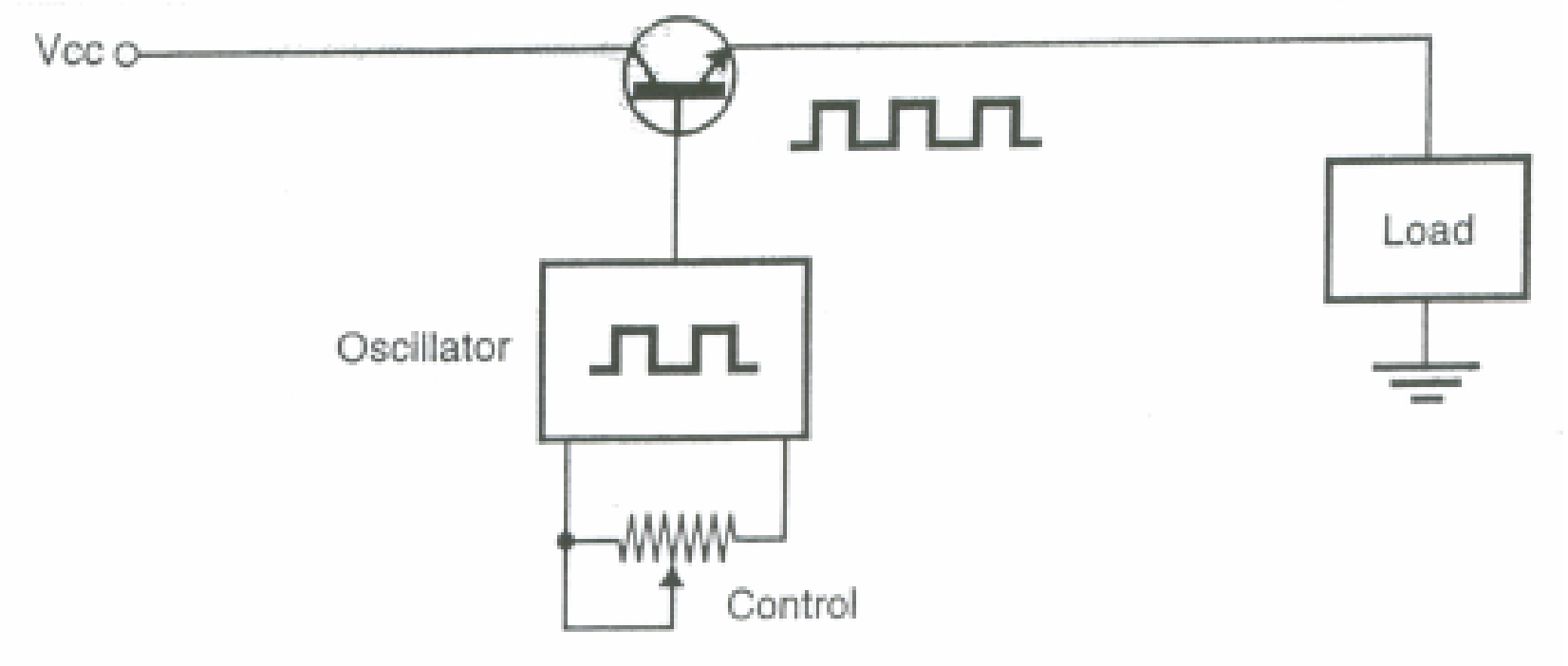
- Pulse-Width-Modulation
- An efficient method to deliver controlled amount of power to loads such as motors
- Use square voltage pulses
- Modulation
  - Process of controlling the duty cycle of square wave
- Pulse-width-modulator
  - The circuit used to achieve modulation tasks

PWM - Duty Cycle



Amount of power delivered to load depending on duration of each pulse

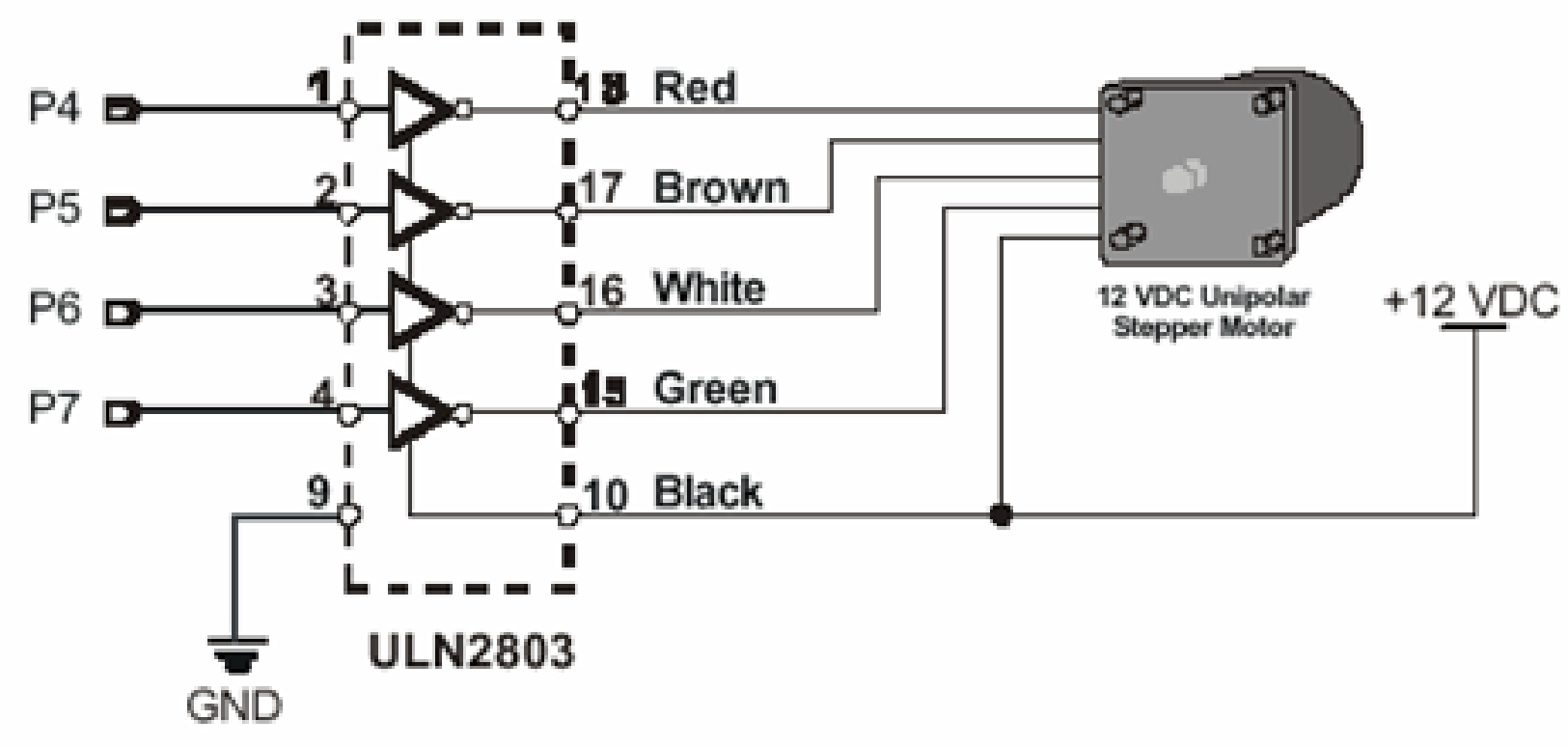
The Basic PWM Control



Stepper Motor

- Do not spin freely with just power
- Driven by the interaction (attraction and repulsion) of magnetic fields
- With proper sequence of the on-off pattern of the magnetic fields, the stepper turns (when it's not, the stepper sits and quivers).

Stepper Motor with BS2



ULN 2803 high-current transistor driver

Motor Experiments

Experiments	Chapters
What's micro controller	3 and 4
Basic A and D	
Earth measurements	
Robotics	
StampWorks	25 and 26
Others	