



Engineering Cyber-Physical Systems

# **GPIO/LED**

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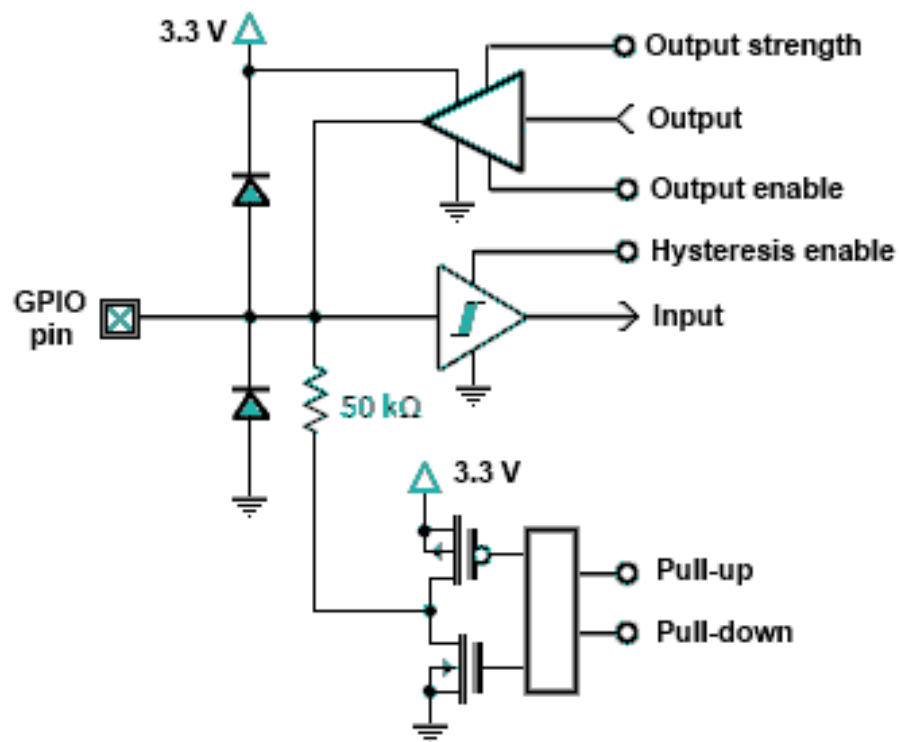
## Course Schedule

Weekly Focus	Reading	Monday	Wed	Lab
CPS Intro/UART		1/10: <a href="#">CPS Introduction</a>	1/12: <a href="#">Pi Intro/UART Bus</a>	<a href="#">Project 0 Raspberry PI Setup</a>
I2C Bus		1/17: MLK Day	1/19: <a href="#">I2C Bus Overview</a>	<a href="#">Project 1 I2C Pressure/Temperature Sensor</a>
I2C and SPI Bus		1/24: <a href="#">Pressure Sensor</a>	1/26: <a href="#">SPI Bus Overview</a>	<a href="#">Project 2 SPI Accelerometer</a>
SPI/Networking		1/31: <a href="#">Accelerometer</a>	2/2: <a href="#">MQTT</a>	<a href="#">Project 3 MQTT Sensor Data Server</a>
Networking		2/7: <a href="#">GPIO/LED</a>	2/9: <a href="#">Flask</a>	<a href="#">Project 4 Sensor LED Output</a>
Web Server		2/14: No Class	2/16: <a href="#">CPS Wrapup</a> , Exam Review	<a href="#">P5 Demultiplexer</a>
Evaluation		2/21: Exam 1	2/23: <a href="#">CE Intro/ Logic</a>	<a href="#">P6 ALU</a>



# GPIO Structure

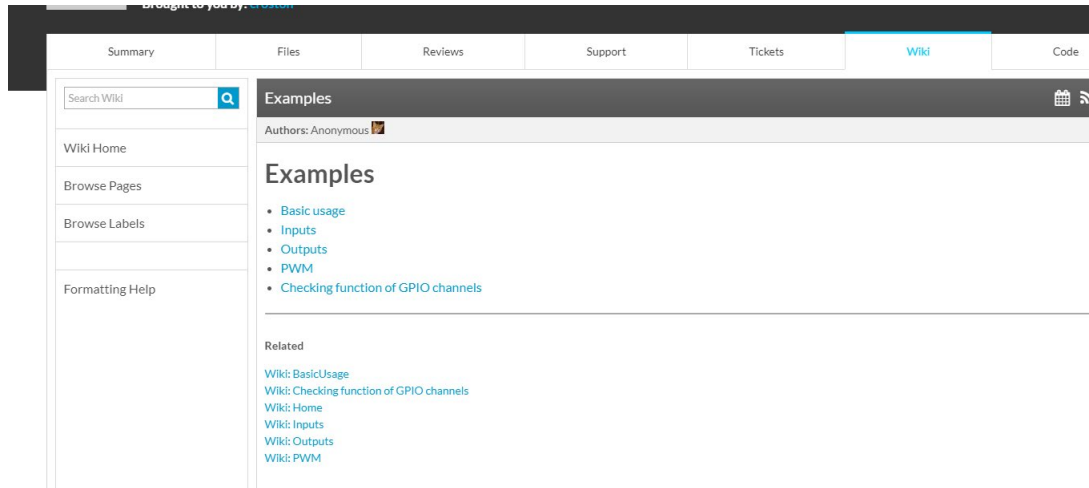
## Equivalent Circuit for Raspberry Pi GPIO pins



# GPIO Library Documentation

# Documentation for the GPIO Library

1. <https://sourceforge.net/p/raspberry-gpio-python/wiki/Examples/>



# Importing the Library

```
import RPi.GPIO as GPIO
```



# Pin Numbering

```
import RPi.GPIO as GPIO
```



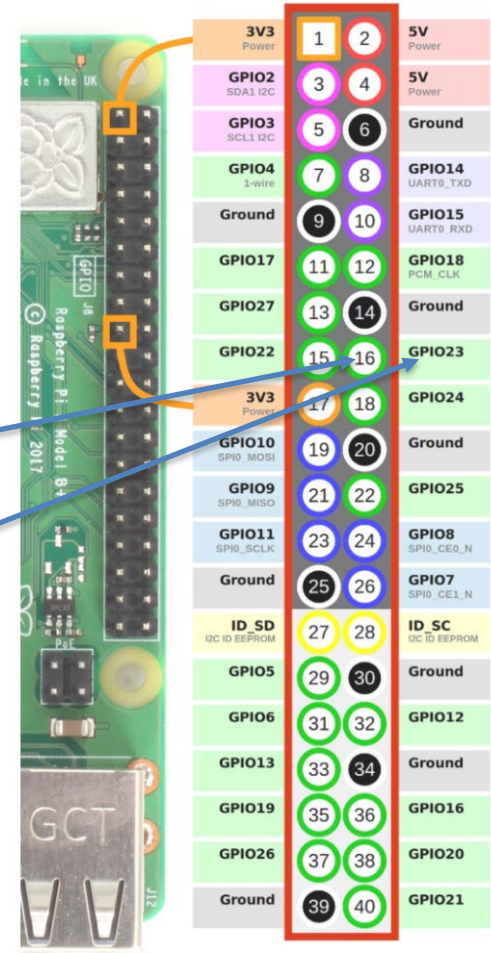


# Pin Numbering

# GPIO Pin Numbering Scheme

## 1. Used in the GPIO.setmode() Method

- GPIO.BOARD follows Header Numbering
- GPIO.BCM follows the Broadcom Chip Numbering





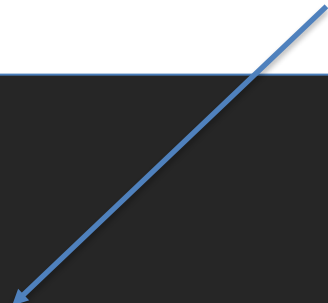
# BCM



# Pin Numbering

One or the other ...

```
GPIO.setmode(GPIO.BOARD)  
GPIO.setmode(GPIO.BCM)
```





# Input

# Pin Input Setup

One Pin

Multiple Pins

```
GPIO.setup(11, GPIO.IN)
```

```
pin_list = [11,12]
```

```
GPIO.setup(pin_list, GPIO.IN)
```



# Pin Input Read

```
pin_state = GPIO.input(11)
if pin_state == 1:
    print("Pin High")
else:
    print("Pin Low")
```





# Output



# Pin Output Setup

One Pin

Multiple Pins

```
GPIO.setup(channel, GPIO.OUT)
```

```
pin_list = [11,12]
```

```
GPIO.setup(pin_list, GPIO.OUT)
```



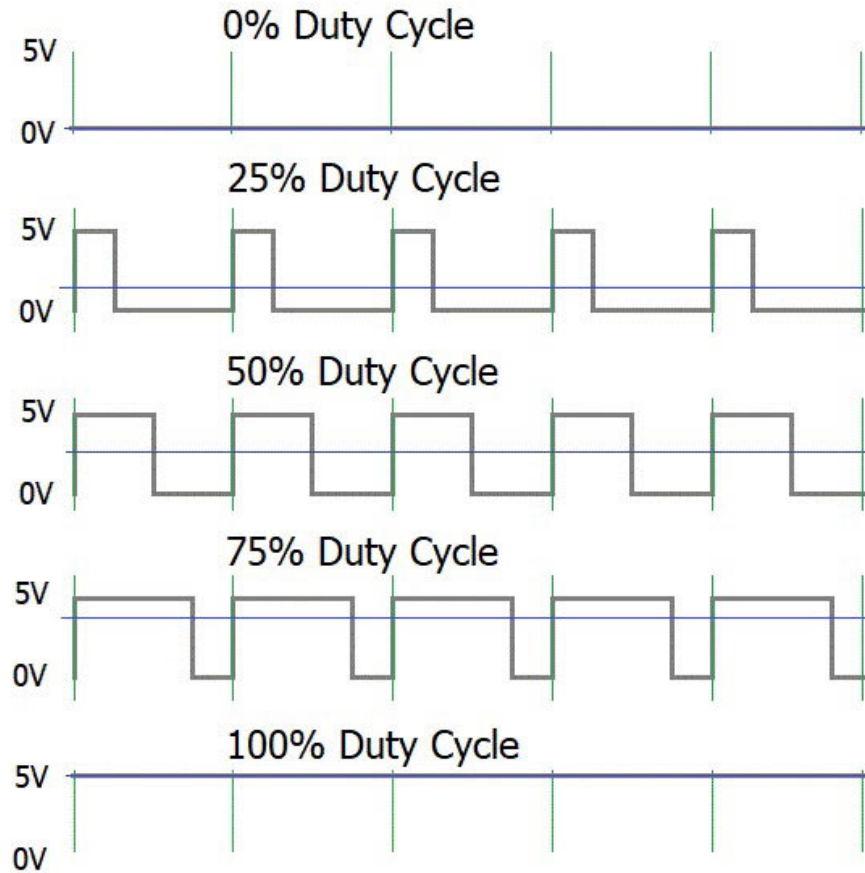
# Pin Output Write

```
# State can be 0 / GPIO.LOW / False or 1 / GPIO.HIGH / True.  
GPIO.output(11, 1)
```





# PWM



# Pin Output Setup

```
frequency_hz = 100  
pwm_out = GPIO.PWM(12, frequency_hz)
```



# Start/Stop PWM

$0 \geq \text{duty cycle} \geq 1$

```
pwm_out.start(1)
```

```
pwm_out.stop(0)
```



# Changing Duty Cycle

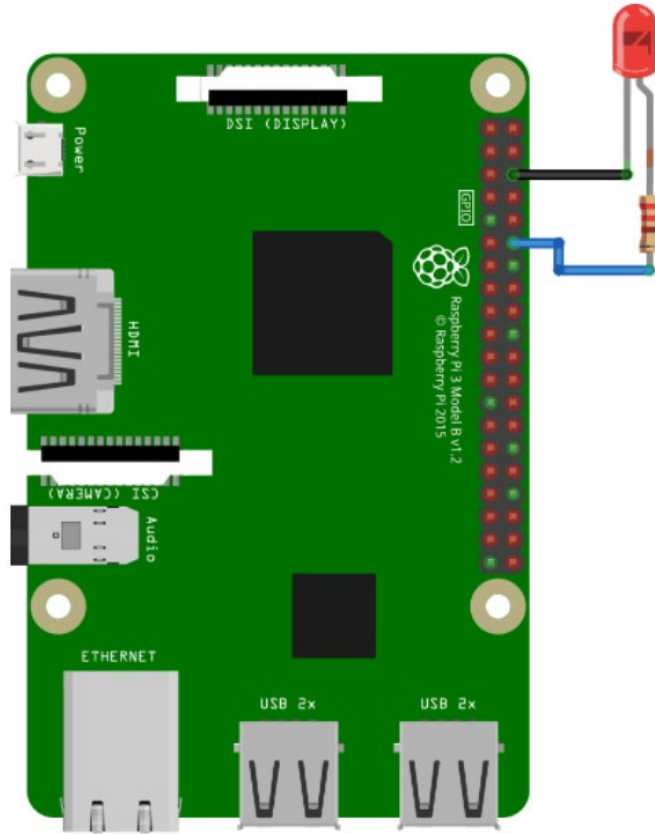
```
pwm_out.ChangeDutyCycle(0.5)
```

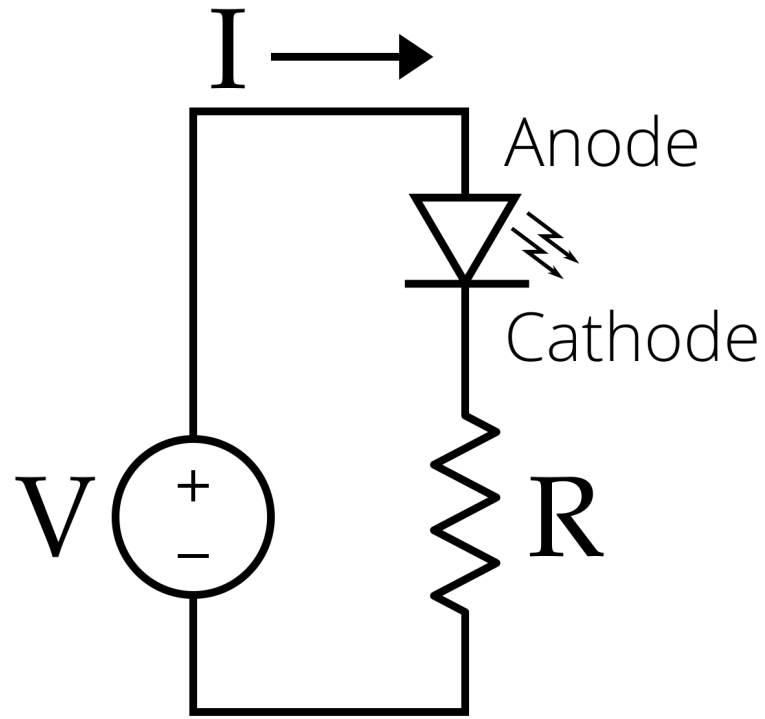




LED







# Standard LED

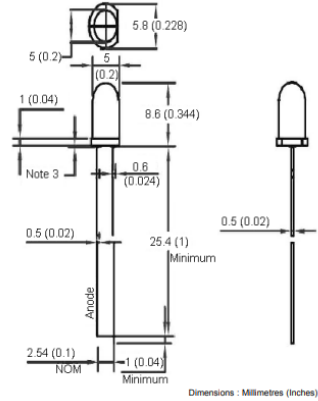
## Red Emitting Colour



### Features:

- High intensity
- Standard T-1 3/4 diameter package
- General purpose leads
- Reliable and rugged

### Package Dimensions:



### Specification Table

Chip Material	Lens Colour	Source Colour	Part Number
AlGaAs	Diffused	Red	MV5754A

### Notes:

1. Tolerance is  $\pm 0.25$  mm (0.01") unless otherwise noted
2. Protruded resin under flange is 1 mm (0.04") maximum
3. Lead spacing is measured where the leads emerge from the package

[www.element14.com](http://www.element14.com)  
[www.farnell.com](http://www.farnell.com)  
[www.newark.com](http://www.newark.com)



# Standard LED

## Red Emitting Colour



### Absolute Maximum Ratings at $T_a = 25^\circ\text{C}$

Parameter	Maximum	Unit
Power Dissipation	80	mW
Peak Forward Current (1/10 Duty Cycle, 0.1 ms Pulse Width)	100	mA
Continuous Forward Current	20	
Derating Linear From $50^\circ\text{C}$	0.4	$\text{mA} / ^\circ\text{C}$
Reverse Voltage	5	V
Operating Temperature Range	$-25^\circ\text{C}$ to $+80^\circ\text{C}$	
Storage Temperature Range	$-40^\circ\text{C}$ to $+100^\circ\text{C}$	
Lead Soldering Temperature (4 mm (0.157) Inches from Body)	$260^\circ\text{C}$ for 5 s	

### Electrical Optical Characteristics at $T_a = 25^\circ\text{C}$

Parameter	Symbol	Minimum	Typical	Maximum	Unit	Test Condition
Luminous Intensity	$I_v$		40		mcd	$I_f = 20 \text{ mA}$ (Note 1)
Viewing Angle	$2\theta_{1/2}$		25		Deg	(Note 2)
Peak Emission Wavelength	$\lambda_p$		640		nm	$I_f = 20 \text{ mA}$
Dominant Wavelength	$\lambda_d$		635		nm	$I_f = 20 \text{ mA}$ (Note 3)
Spectral Line Half-Width	$\Delta\lambda$		25		nm	$I_f = 20 \text{ mA}$
Forward Voltage	$V_f$		2	2.5	V	$I_f = 20 \text{ mA}$
Reverse Current	$I_R$	-	-	100	$\mu\text{A}$	$V_R = 5 \text{ V}$

#### Notes:

1. Luminous intensity is measured with a light sensor and filter combination that approximates the CIE eye-response curve
2.  $\theta_{1/2}$  is the off-axis angle at which the luminous intensity is half the axial luminous intensity
3. The dominant wavelength ( $\lambda_d$ ) is derived from the CIE chromaticity diagram and represents the single wavelength which defines the colour of the device

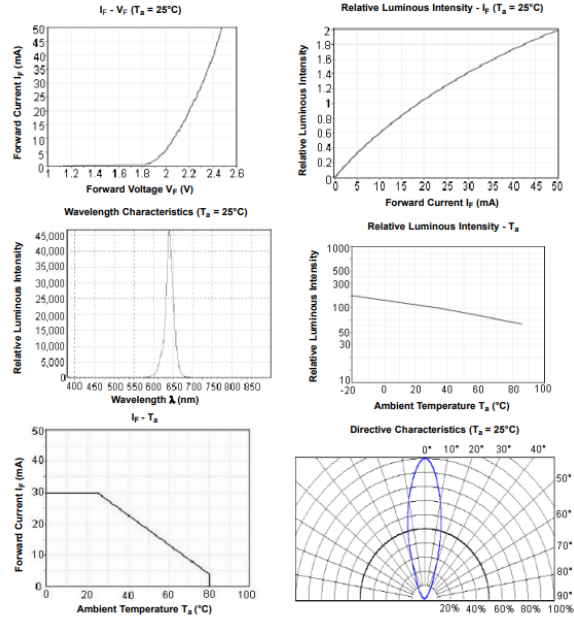


# Standard LED

## Red Emitting Colour



### Typical Characteristics



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