Gpiozero Documentation

Release 1.5.0

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Contents

CHAPTER 1

Installing GPIO Zero

GPIO Zero is installed by default in the Raspbian[1] image, and the Raspberry Pi Desktop[2] image for PC/Mac, both available from raspberrypi.org[3]. Follow these guides to installing on Raspbian Lite and other operating systems, including for PCs using the *remote GPIO* (page 43) feature.

1.1 Raspberry Pi

First, update your repositories list:

```
pi@raspberrypi:~$ sudo apt update
```

Then install the package for Python 3:

```
pi@raspberrypi:~$ sudo apt install python3-gpiozero
```

or Python 2:

```
pi@raspberrypi:~$ sudo apt install python-gpiozero
```

If you're using another operating system on your Raspberry Pi, you may need to use pip to install GPIO Zero instead. Install pip using get-pip[4] and then type:

```
pi@raspberrypi:~$ sudo pip3 install gpiozero
```

or for Python 2:

```
pi@raspberrypi:~$ sudo pip install gpiozero
```

To install GPIO Zero in a virtual environment, see the *Development* (page 89) page.

[1] https://www.raspberrypi.org/downloads/raspbian/
[2] https://www.raspberrypi.org/downloads/raspberry-pi-desktop/
[3] https://www.raspberrypi.org/downloads/
[4] https://pip.pypa.io/en/stable/installing/

1.2 PC/Mac

In order to use GPIO Zero's remote GPIO feature from a PC or Mac, you'll need to install GPIO Zero on that computer using pip. See the *Configuring Remote GPIO* (page 43) page for more information.

CHAPTER 2

Basic Recipes

The following recipes demonstrate some of the capabilities of the GPIO Zero library. Please note that all recipes are written assuming Python 3. Recipes *may* work under Python 2, but no guarantees!

2.1 Importing GPIO Zero

In Python, libraries and functions used in a script must be imported by name at the top of the file, with the exception of the functions built into Python by default.

For example, to use the `Button` (page 93) interface from GPIO Zero, it should be explicitly imported:

```
from gpiozero import Button
```

Now `Button` (page 93) is available directly in your script:

```
button = Button(2)
```

Alternatively, the whole GPIO Zero library can be imported:

```
import gpiozero
```

In this case, all references to items within GPIO Zero must be prefixed:

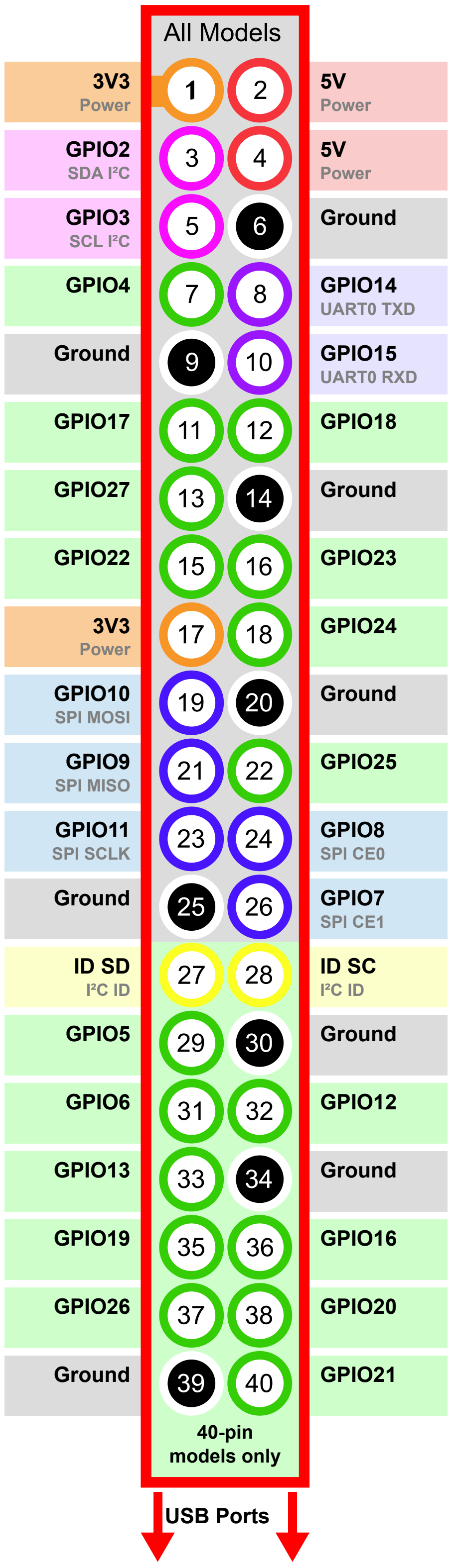
```
button = gpiozero.Button(2)
```

2.2 Pin Numbering

This library uses Broadcom (BCM) pin numbering for the GPIO pins, as opposed to physical (BOARD) numbering. Unlike in the RPi.GPIO[5] library, this is not configurable. However, translation from other schemes can be used by providing prefixes to pin numbers (see below).

Any pin marked "GPIO" in the diagram below can be used as a pin number. For example, if an LED was attached to "GPIO17" you would specify the pin number as 17 rather than 11:

[5] https://pypi.python.org/pypi/RPi.GPIO



If you wish to use physical (BOARD) numbering you can specify the pin number as “BOARD11”. If you are familiar with the wiringPi[6] pin numbers (another physical layout) you could use “WPI0” instead. Finally, you can specify pins as “header:number”, e.g. “J8:11” meaning physical pin 11 on header J8 (the GPIO header on modern Pis). Hence, the following lines are all equivalent:

```
>>> led = LED(17)
```

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[6] https://projects.drogon.net/raspberry-pi/wiringpi/pins/

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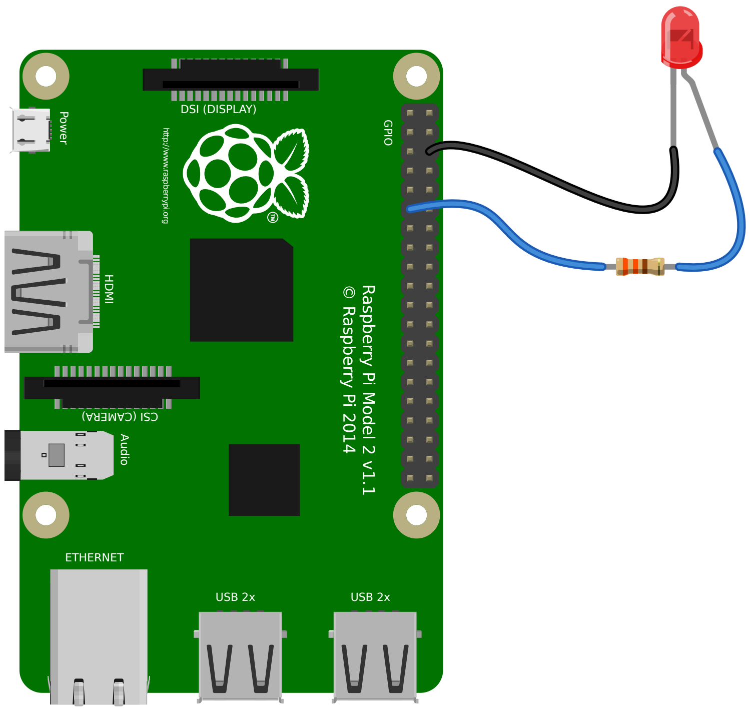
```
>>> led = LED("GPIO17")
>>> led = LED("BCM17")
>>> led = LED("BOARD11")
>>> led = LED("WPI0")
>>> led = LED("J8:11")
```

Note that these alternate schemes are merely translations. If you request the state of a device on the command line, the associated pin number will *always* be reported in the Broadcom (BCM) scheme:

```
>>> led = LED("BOARD11")
>>> led
<gpiozero.LED object on pin GPIO17, active_high=True, is_active=False>
```

Throughout this manual we will use the default integer pin numbers, in the Broadcom (BCM) layout shown above.

2.3 LED



Turn an *LED* (page 111) on and off repeatedly:

```
from gpiozero import LED
from time import sleep

red = LED(17)

while True:
    red.on()
    sleep(1)
    red.off()
    sleep(1)
```

Alternatively:

```
from gpiozero import LED
from signal import pause
```

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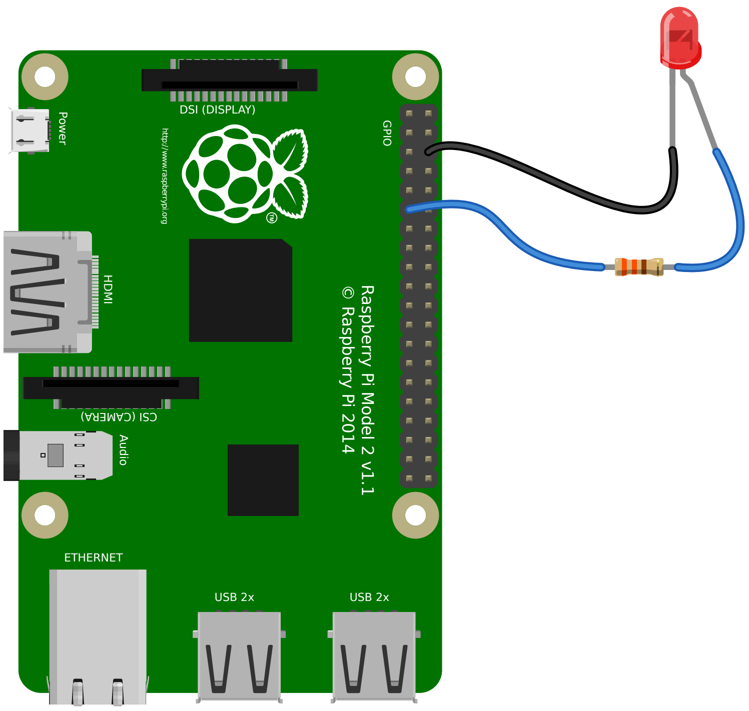
```
red = LED(17)

red.blink()

pause()
```

Note: Reaching the end of a Python script will terminate the process and GPIOs may be reset. Keep your script alive with `signal.pause()`[7]. See *How do I keep my script running?* (page 75) for more information.

2.4 LED with variable brightness



Any regular LED can have its brightness value set using PWM (pulse-width-modulation). In GPIO Zero, this can be achieved using *PWMLED* (page 113) using values between 0 and 1:

```
from gpiozero import PWMLED
from time import sleep

led = PWMLED(17)

while True:
    led.value = 0  # off
    sleep(1)
    led.value = 0.5  # half brightness
    sleep(1)
    led.value = 1  # full brightness
    sleep(1)
```

Similarly to blinking on and off continuously, a PWMLED can pulse (fade in and out continuously):

[7] https://docs.python.org/3.5/library/signal.html#signal.pause

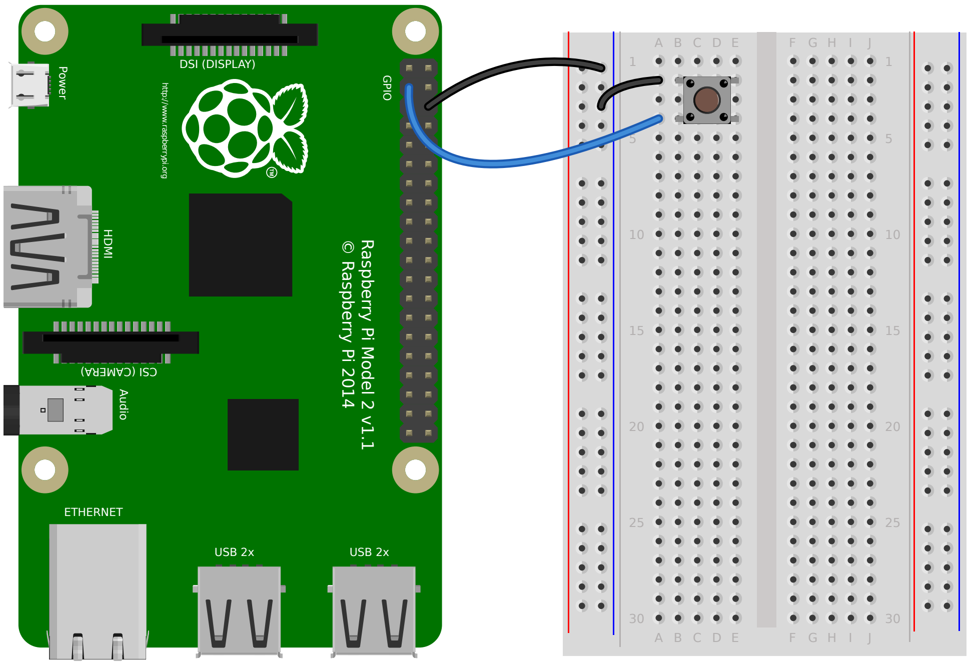
```
from gpiozero import PWMLED
from signal import pause

led = PWMLED(17)

led.pulse()

pause()
```

2.5 Button



Check if a `Button` (page 93) is pressed:

```
from gpiozero import Button

button = Button(2)

while True:
    if button.is_pressed:
        print("Button is pressed")
    else:
        print("Button is not pressed")
```

Wait for a button to be pressed before continuing:

```
from gpiozero import Button

button = Button(2)

button.wait_for_press()
print("Button was pressed")
```

Run a function every time the button is pressed:

```
from gpiozero import Button
from signal import pause
```

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```python

def say_hello():
    print("Hello!")

button = Button(2)

button.when_pressed = say_hello

pause()
```

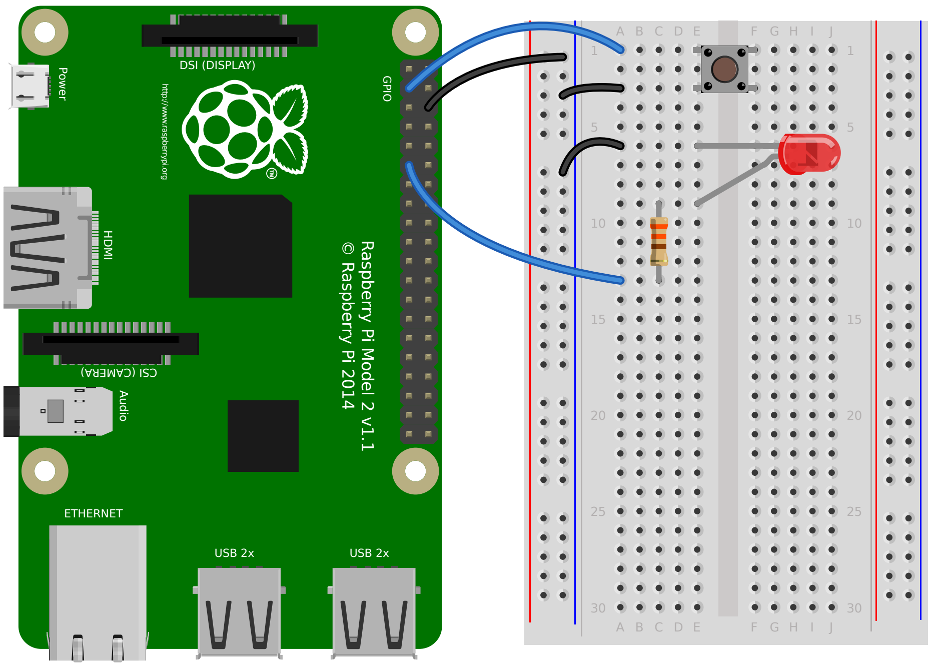
Note: Note that the line `button.when_pressed = say_hello` does not run the function `say_hello`, rather it creates a reference to the function to be called when the button is pressed. Accidental use of `button.when_pressed = say_hello()` would set the `when_pressed` action to `None`[8] (the return value of this function) which would mean nothing happens when the button is pressed.

Similarly, functions can be attached to button releases:

```python
from gpiozero import Button
from signal import pause

def say_hello():
    print("Hello!")

def say_goodbye():
    print("Goodbye!")

button = Button(2)

button.when_pressed = say_hello
button.when_released = say_goodbye

pause()
```

[8] https://docs.python.org/3.5/library/constants.html#None

2.6 Button controlled LED



Turn on an *LED* (page 111) when a *Button* (page 93) is pressed:

```
from gpiozero import LED, Button
from signal import pause

led = LED(17)
button = Button(2)

button.when_pressed = led.on
button.when_released = led.off

pause()
```

Alternatively:

```
from gpiozero import LED, Button
from signal import pause

led = LED(17)
button = Button(2)

led.source = button

pause()
```

2.7 Button controlled camera

Using the button press to trigger `PiCamera`[9] to take a picture using `button.when_pressed = camera.capture` would not work because the `capture()`[10] method requires an `output` parameter. However, this can be achieved using a custom function which requires no parameters:

[9] https://picamera.readthedocs.io/en/latest/api_camera.html#picamera.PiCamera
[10] https://picamera.readthedocs.io/en/latest/api_camera.html#picamera.PiCamera.capture

```python
from gpiozero import Button
from picamera import PiCamera
from datetime import datetime
from signal import pause

button = Button(2)
camera = PiCamera()

def capture():
    timestamp = datetime.now().isoformat()
    camera.capture('/home/pi/%s.jpg' % timestamp)

button.when_pressed = capture

pause()
```

Another example could use one button to start and stop the camera preview, and another to capture:

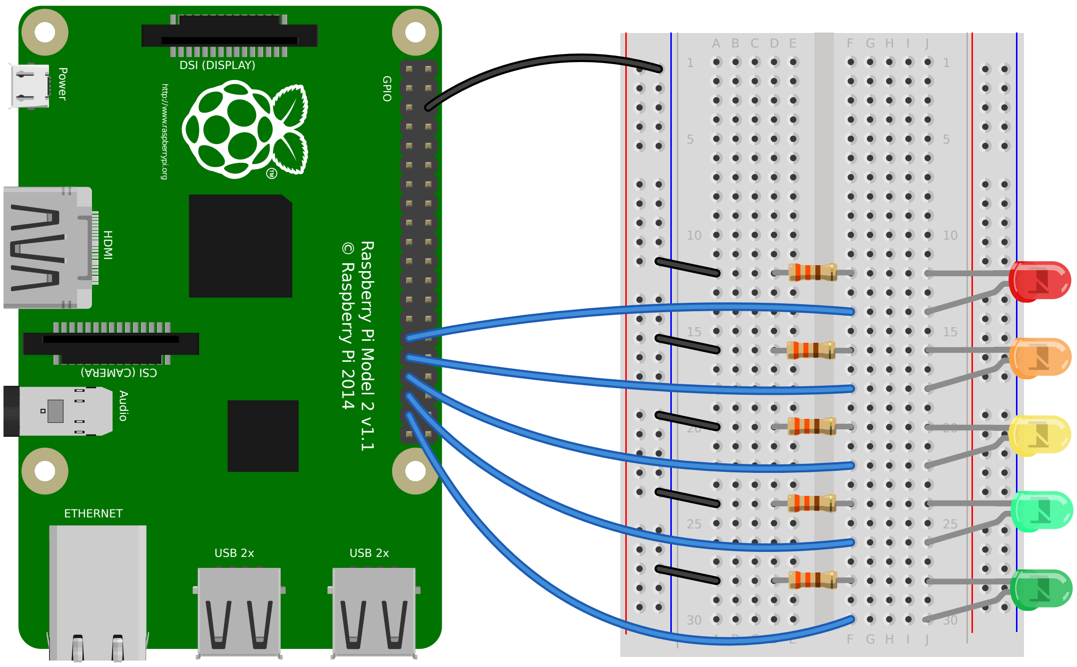
```python
from gpiozero import Button
from picamera import PiCamera
from datetime import datetime
from signal import pause

left_button = Button(2)
right_button = Button(3)
camera = PiCamera()

def capture():
    timestamp = datetime.now().isoformat()
    camera.capture('/home/pi/%s.jpg' % timestamp)

left_button.when_pressed = camera.start_preview
left_button.when_released = camera.stop_preview
right_button.when_pressed = capture

pause()
```

2.8 Shutdown button

The `Button` (page 93) class also provides the ability to run a function when the button has been held for a given length of time. This example will shut down the Raspberry Pi when the button is held for 2 seconds:

```python
from gpiozero import Button
from subprocess import check_call
from signal import pause

def shutdown():
    check_call(['sudo', 'poweroff'])

shutdown_btn = Button(17, hold_time=2)
shutdown_btn.when_held = shutdown

pause()
```

2.9 LEDBoard



A collection of LEDs can be accessed using *LEDBoard* (page 141):

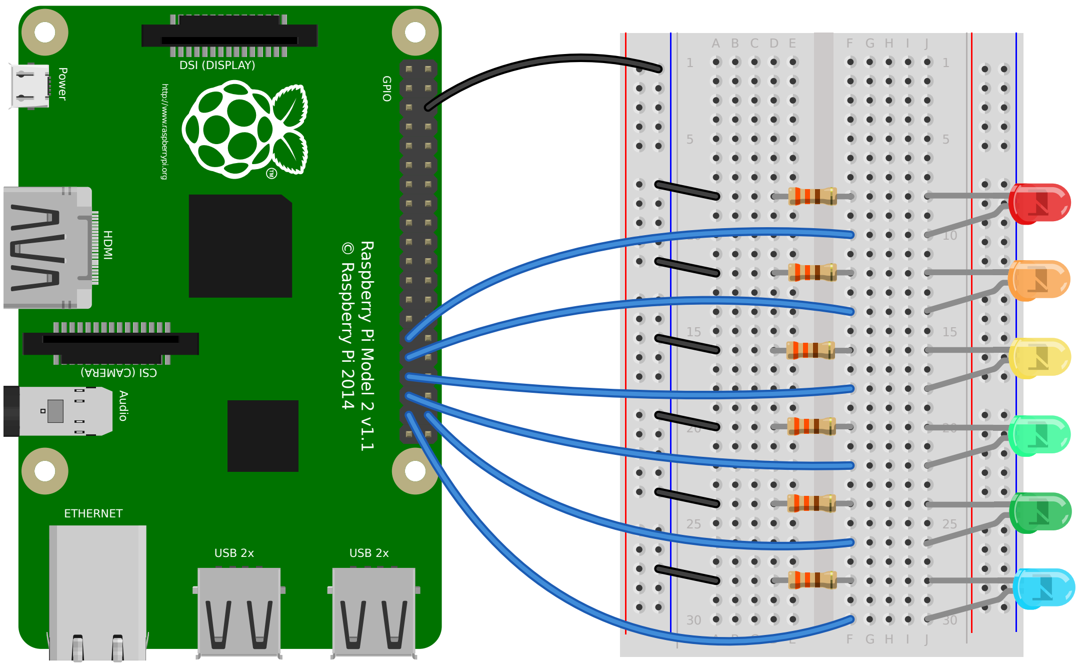
```python
from gpiozero import LEDBoard
from time import sleep
from signal import pause

leds = LEDBoard(5, 6, 13, 19, 26)

leds.on()
sleep(1)
leds.off()
sleep(1)
leds.value = (1, 0, 1, 0, 1)
sleep(1)
leds.blink()

pause()
```

Using *LEDBoard* (page 141) with `pwm=True` allows each LED's brightness to be controlled:

```python
from gpiozero import LEDBoard
from signal import pause

leds = LEDBoard(5, 6, 13, 19, 26, pwm=True)

leds.value = (0.2, 0.4, 0.6, 0.8, 1.0)

pause()
```

See more *LEDBoard* (page 141) examples in the *advanced LEDBoard recipes* (page 35).

2.10 LEDBarGraph



A collection of LEDs can be treated like a bar graph using *LEDBarGraph* (page 144):

```
from gpiozero import LEDBarGraph
from time import sleep
from __future__ import division  # required for python 2

graph = LEDBarGraph(5, 6, 13, 19, 26, 20)

graph.value = 1  # (1, 1, 1, 1, 1, 1)
sleep(1)
graph.value = 1/2  # (1, 1, 1, 0, 0, 0)
sleep(1)
graph.value = -1/2  # (0, 0, 0, 1, 1, 1)
sleep(1)
graph.value = 1/4  # (1, 0, 0, 0, 0, 0)
sleep(1)
graph.value = -1  # (1, 1, 1, 1, 1, 1)
sleep(1)
```

Note values are essentially rounded to account for the fact LEDs can only be on or off when `pwm=False` (the default).

However, using *LEDBarGraph* (page 144) with `pwm=True` allows more precise values using LED brightness:

```
from gpiozero import LEDBarGraph
from time import sleep
from __future__ import division  # required for python 2

graph = LEDBarGraph(5, 6, 13, 19, 26, pwm=True)

graph.value = 1/10  # (0.5, 0, 0, 0, 0)
sleep(1)
graph.value = 3/10  # (1, 0.5, 0, 0, 0)
sleep(1)
graph.value = -3/10  # (0, 0, 0, 0.5, 1)
sleep(1)
```

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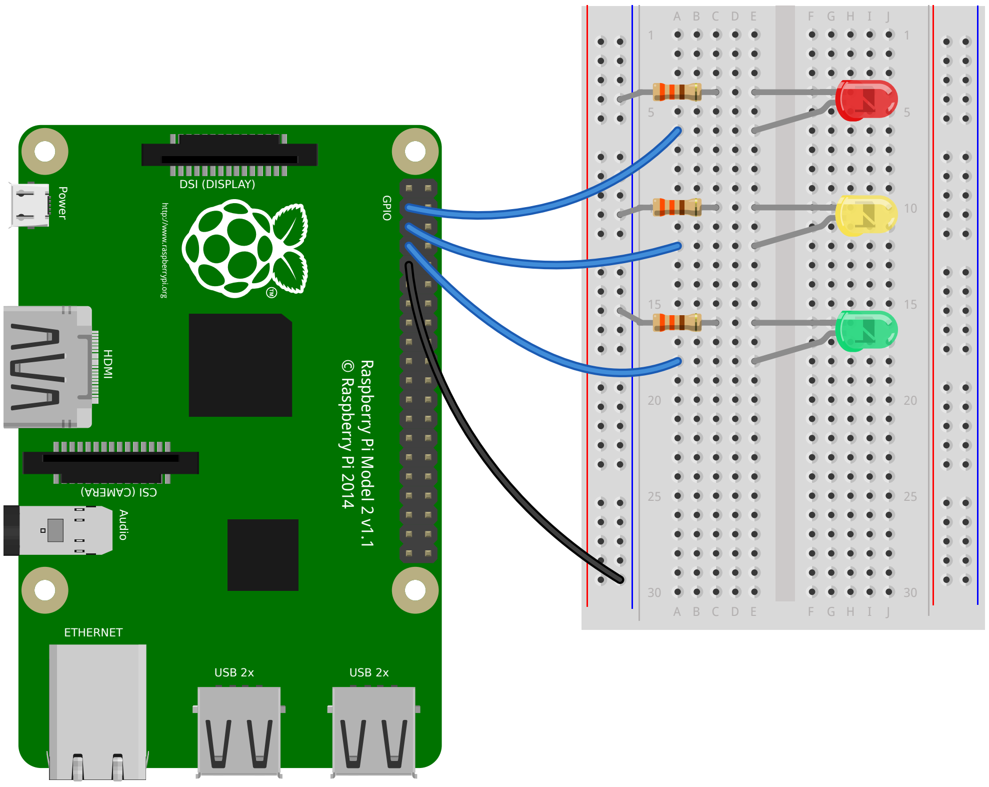
```
graph.value = 9/10  # (1, 1, 1, 1, 0.5)
sleep(1)
graph.value = 95/100  # (1, 1, 1, 1, 0.75)
sleep(1)
```

2.11 Traffic Lights



A full traffic lights system.

Using a `TrafficLights` (page 147) kit like Pi-Stop:

```
from gpiozero import TrafficLights
from time import sleep

lights = TrafficLights(2, 3, 4)

lights.green.on()

while True:
    sleep(10)
    lights.green.off()
    lights.amber.on()
    sleep(1)
    lights.amber.off()
    lights.red.on()
    sleep(10)
    lights.amber.on()
    sleep(1)
    lights.green.on()
    lights.amber.off()
    lights.red.off()
```

Alternatively:

```python
from gpiozero import TrafficLights
from time import sleep
from signal import pause

lights = TrafficLights(2, 3, 4)

def traffic_light_sequence():
    while True:
        yield (0, 0, 1) # green
        sleep(10)
        yield (0, 1, 0) # amber
        sleep(1)
        yield (1, 0, 0) # red
        sleep(10)
        yield (1, 1, 0) # red+amber
        sleep(1)

lights.source = traffic_light_sequence()

pause()
```

Using `LED` (page 111) components:

```python
from gpiozero import LED
from time import sleep

red = LED(2)
amber = LED(3)
green = LED(4)

green.on()
amber.off()
red.off()

while True:
    sleep(10)
    green.off()
    amber.on()
    sleep(1)
    amber.off()
    red.on()
    sleep(10)
    amber.on()
    sleep(1)
    green.on()
    amber.off()
    red.off()
```

2.12 Push button stop motion

Capture a picture with the camera module every time a button is pressed:

```python
from gpiozero import Button
from picamera import PiCamera

button = Button(2)
camera = PiCamera()

```

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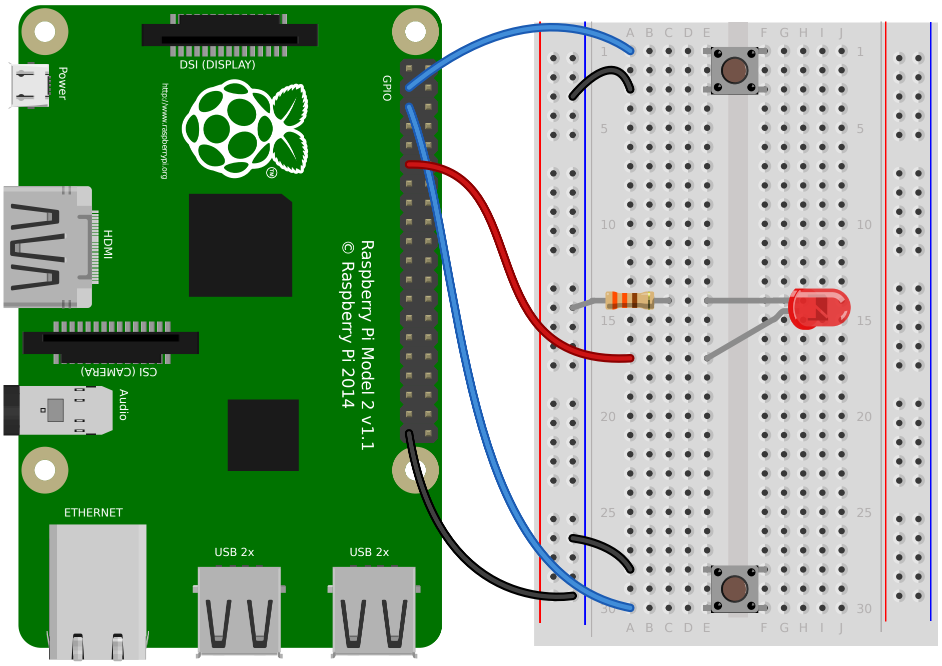
```
camera.start_preview()
frame = 1
while True:
    button.wait_for_press()
    camera.capture('/home/pi/frame%03d.jpg' % frame)
    frame += 1
```

See Push Button Stop Motion[11] for a full resource.

2.13 Reaction Game



When you see the light come on, the first person to press their button wins!

```
from gpiozero import Button, LED
from time import sleep
import random

led = LED(17)

player_1 = Button(2)
player_2 = Button(3)

time = random.uniform(5, 10)
sleep(time)
led.on()

while True:
    if player_1.is_pressed:
        print("Player 1 wins!")
        break
    if player_2.is_pressed:
        print("Player 2 wins!")
        break
```

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[11] https://www.raspberrypi.org/learning/quick-reaction-game/

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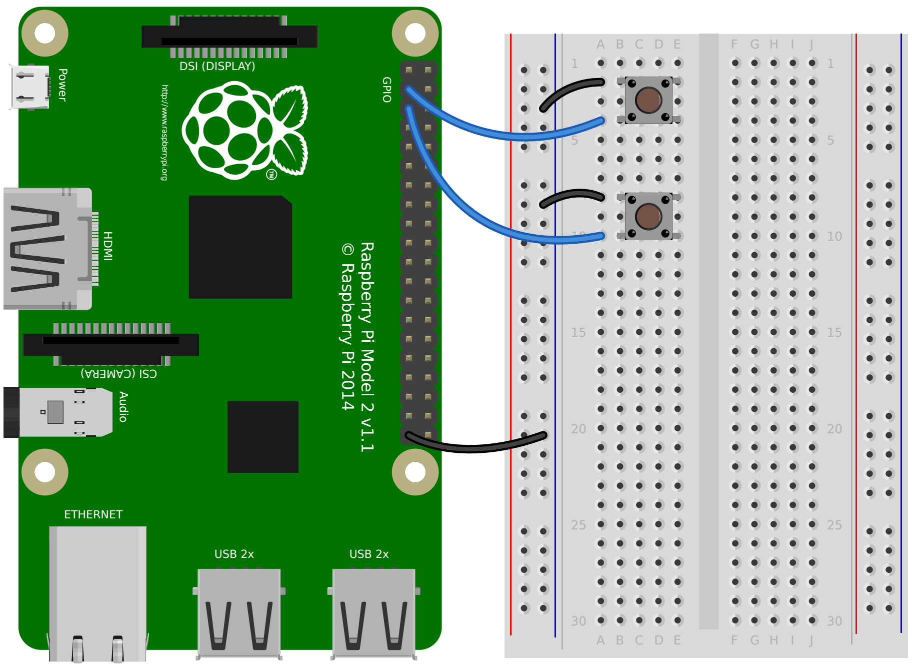
```
led.off()
```

See Quick Reaction Game[12] for a full resource.

2.14 GPIO Music Box



Each button plays a different sound!

```
from gpiozero import Button
import pygame.mixer
from pygame.mixer import Sound
from signal import pause

pygame.mixer.init()

button_sounds = {
    Button(2): Sound("samples/drum_tom_mid_hard.wav"),
    Button(3): Sound("samples/drum_cymbal_open.wav"),
}

for button, sound in button_sounds.items():
    button.when_pressed = sound.play

pause()
```

See GPIO Music Box[13] for a full resource.

2.15 All on when pressed

While the button is pressed down, the buzzer and all the lights come on.

[12] https://www.raspberrypi.org/learning/quick-reaction-game/
[13] https://www.raspberrypi.org/learning/gpio-music-box/

`FishDish` (page 153):

```
from gpiozero import FishDish
from signal import pause

fish = FishDish()

fish.button.when_pressed = fish.on
fish.button.when_released = fish.off

pause()
```

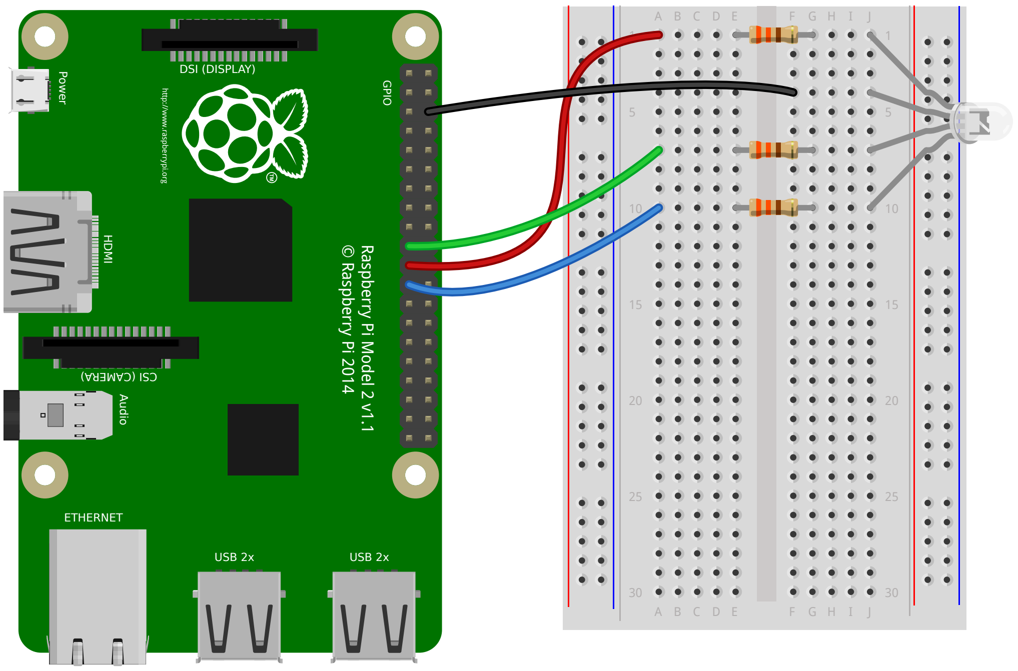
Ryanteck `TrafficHat` (page 153):

```
from gpiozero import TrafficHat
from signal import pause

th = TrafficHat()

th.button.when_pressed = th.on
th.button.when_released = th.off

pause()
```

Using `LED` (page 111), `Buzzer` (page 117), and `Button` (page 93) components:

```
from gpiozero import LED, Buzzer, Button
from signal import pause

button = Button(2)
buzzer = Buzzer(3)
red = LED(4)
amber = LED(5)
green = LED(6)

things = [red, amber, green, buzzer]

def things_on():
    for thing in things:
        thing.on()

def things_off():
    for thing in things:
        thing.off()

button.when_pressed = things_on
button.when_released = things_off

pause()
```

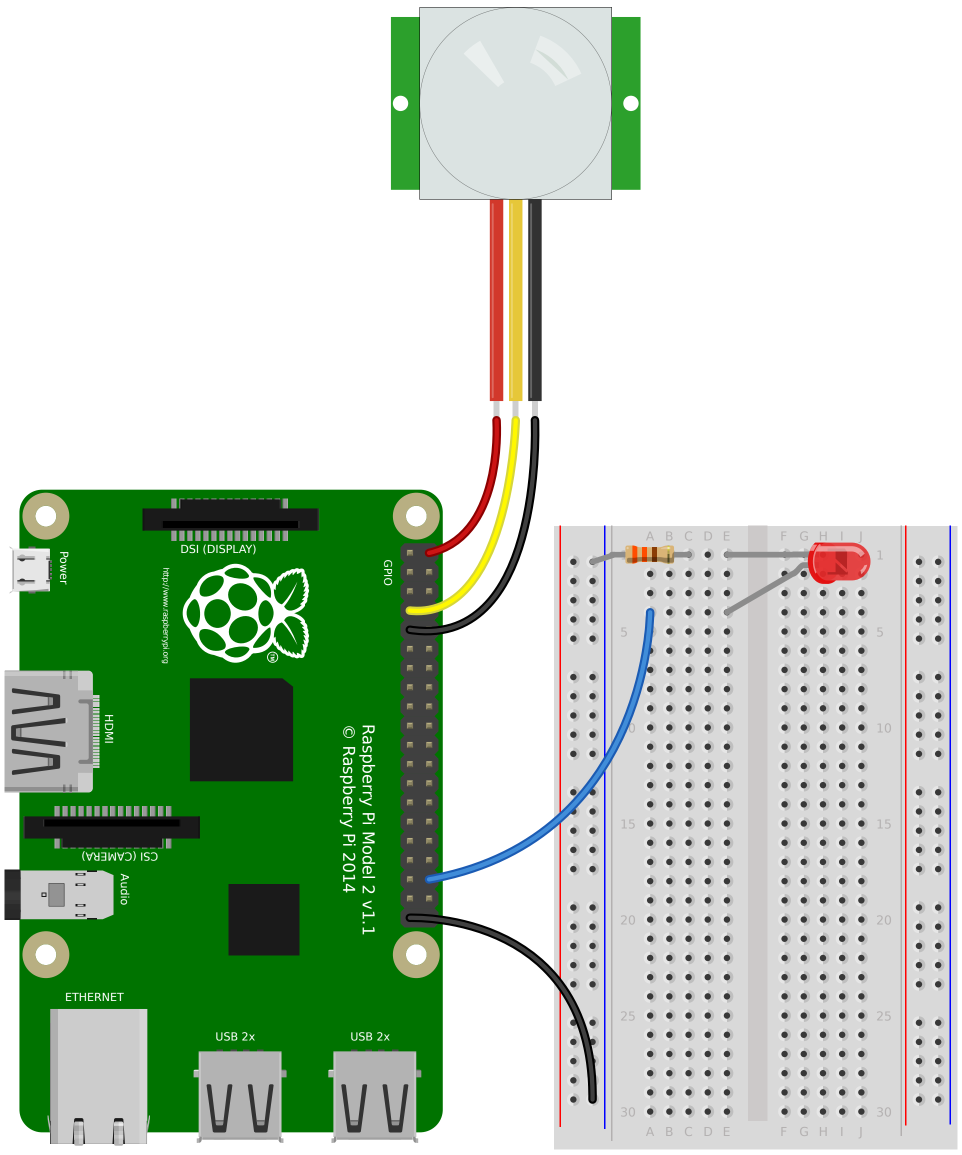
2.16 Full color LED



Making colours with an *RGBLED* (page 115):

```
from gpiozero import RGBLED
from time import sleep
from __future__ import division  # required for python 2

led = RGBLED(red=9, green=10, blue=11)

led.red = 1  # full red
sleep(1)
led.red = 0.5  # half red
sleep(1)

led.color = (0, 1, 0)  # full green
sleep(1)
led.color = (1, 0, 1)  # magenta
sleep(1)
led.color = (1, 1, 0)  # yellow
sleep(1)
led.color = (0, 1, 1)  # cyan
sleep(1)
led.color = (1, 1, 1)  # white
sleep(1)

led.color = (0, 0, 0)  # off
sleep(1)

# slowly increase intensity of blue
for n in range(100):
    led.blue = n/100
    sleep(0.1)
```

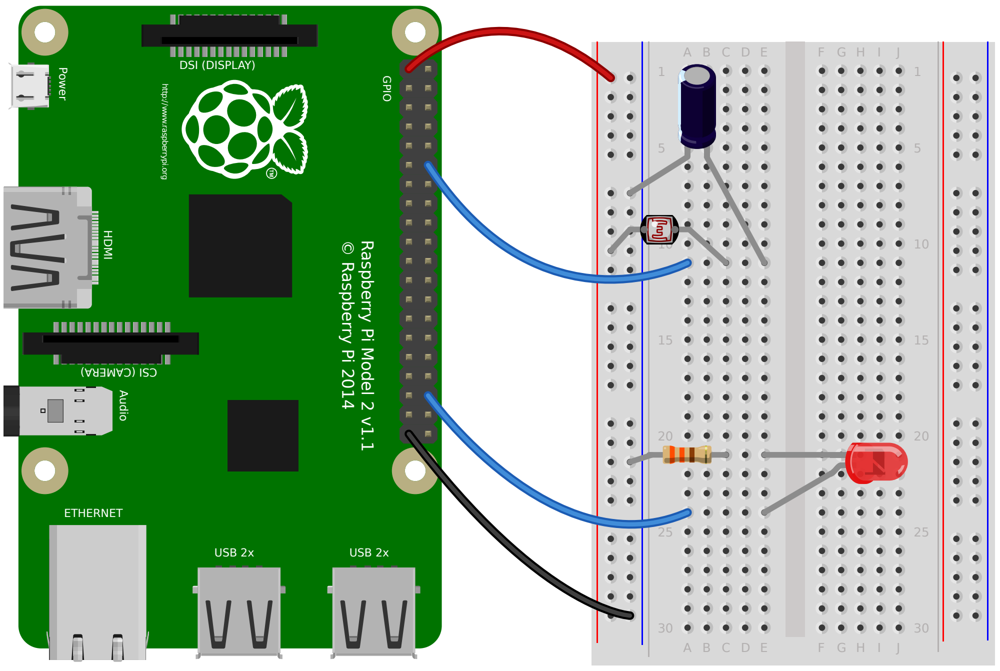
2.17 Motion sensor



Light an *LED* (page 111) when a *MotionSensor* (page 97) detects motion:

```
from gpiozero import MotionSensor, LED
from signal import pause

pir = MotionSensor(4)
led = LED(16)

pir.when_motion = led.on
pir.when_no_motion = led.off

pause()
```

2.18 Light sensor



Have a *LightSensor* (page 99) detect light and dark:

```
from gpiozero import LightSensor

sensor = LightSensor(18)

while True:
    sensor.wait_for_light()
    print("It's light! :)")
    sensor.wait_for_dark()
    print("It's dark :(")
```

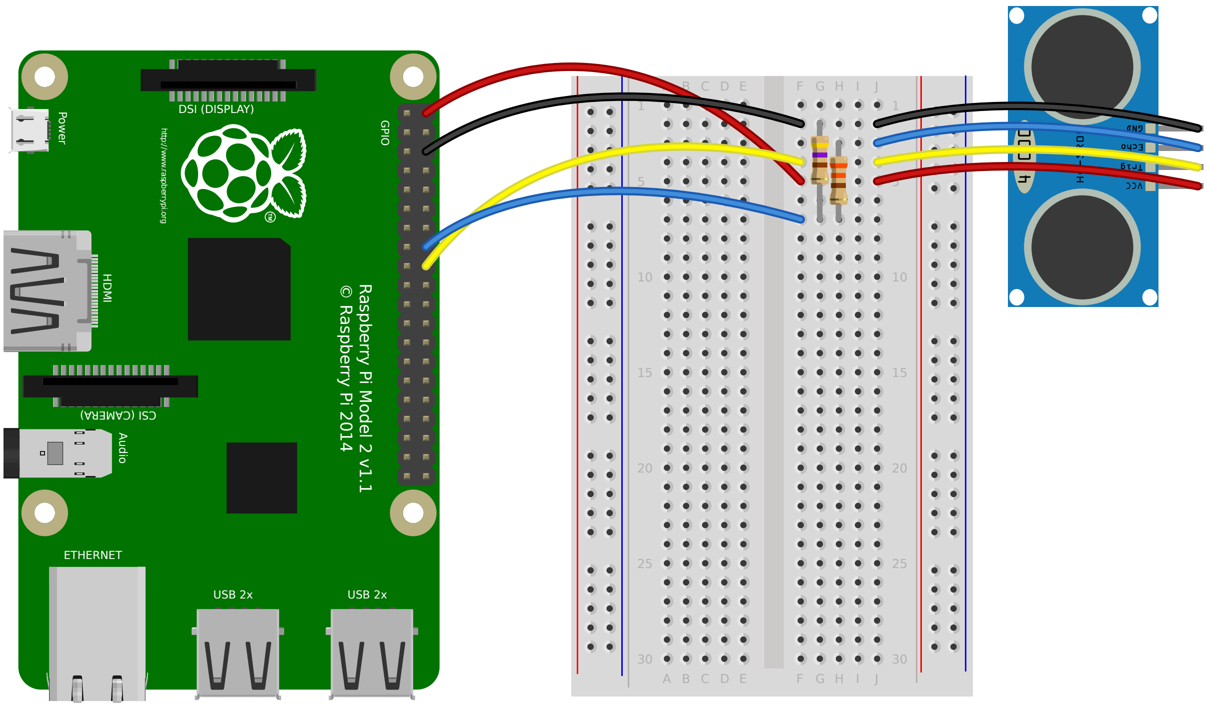
Run a function when the light changes:

```
from gpiozero import LightSensor, LED
from signal import pause

sensor = LightSensor(18)
led = LED(16)

sensor.when_dark = led.on
sensor.when_light = led.off

pause()
```

Or make a *PWMLED* (page 113) change brightness according to the detected light level:

```
from gpiozero import LightSensor, PWMLED
from signal import pause

sensor = LightSensor(18)
led = PWMLED(16)

led.source = sensor

pause()
```

2.19 Distance sensor



Note: In the diagram above, the wires leading from the sensor to the breadboard can be omitted; simply plug the sensor directly into the breadboard facing the edge (unfortunately this is difficult to illustrate in the diagram without the sensor's diagram obscuring most of the breadboard!)

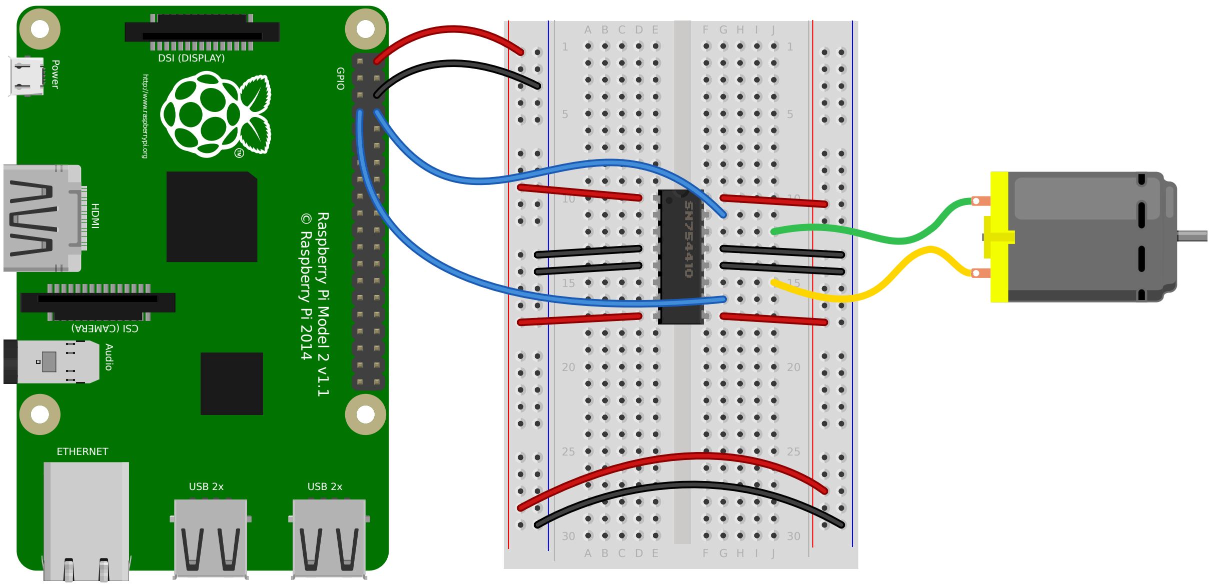
Have a *DistanceSensor* (page 101) detect the distance to the nearest object:

```python
from gpiozero import DistanceSensor
from time import sleep

sensor = DistanceSensor(23, 24)

while True:
    print('Distance to nearest object is', sensor.distance, 'm')
    sleep(1)
```

Run a function when something gets near the sensor:

```python
from gpiozero import DistanceSensor, LED
from signal import pause

sensor = DistanceSensor(23, 24, max_distance=1, threshold_distance=0.2)
led = LED(16)

sensor.when_in_range = led.on
sensor.when_out_of_range = led.off

pause()
```

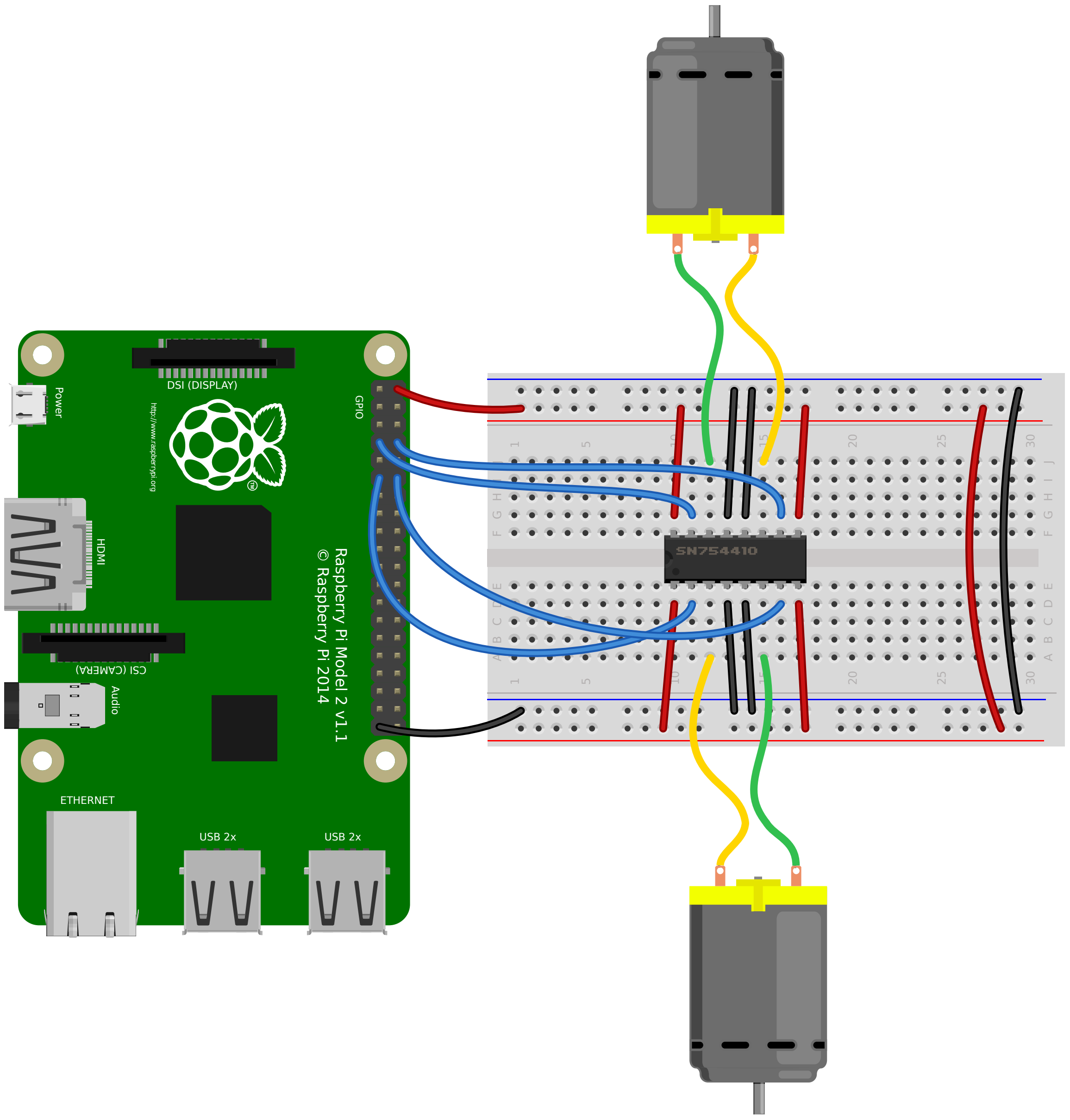
2.20 Motors



Spin a *Motor* (page 120) around forwards and backwards:

```python
from gpiozero import Motor
from time import sleep

motor = Motor(forward=4, backward=14)

while True:
    motor.forward()
    sleep(5)
    motor.backward()
    sleep(5)
```

2.21 Robot



Make a *Robot* (page 155) drive around in (roughly) a square:

```
from gpiozero import Robot
from time import sleep

robot = Robot(left=(4, 14), right=(17, 18))

for i in range(4):
    robot.forward()
    sleep(10)
    robot.right()
    sleep(1)
```

Make a robot with a distance sensor that runs away when things get within 20cm of it:

```
from gpiozero import Robot, DistanceSensor
from signal import pause

```

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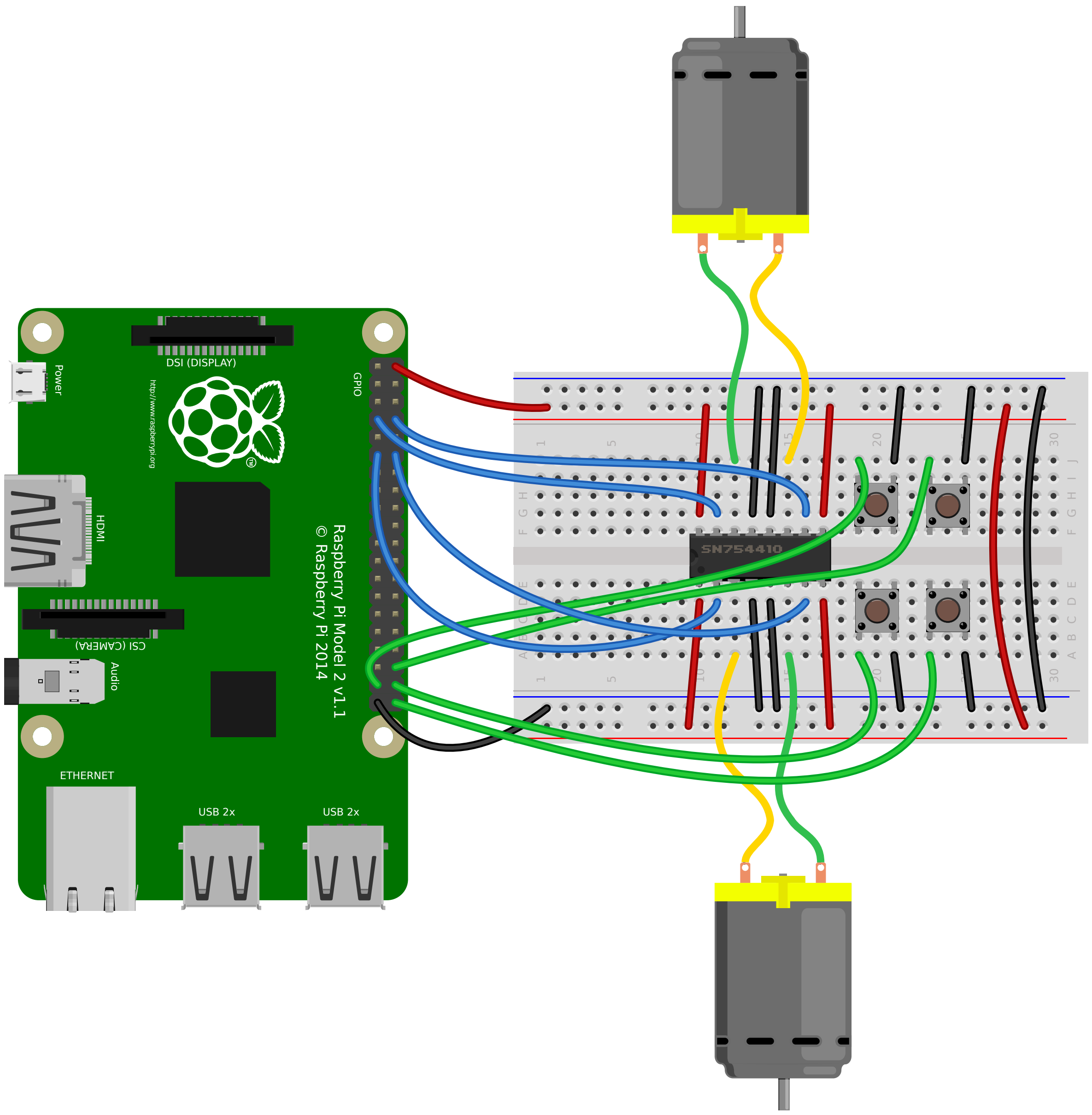
```
sensor = DistanceSensor(23, 24, max_distance=1, threshold_distance=0.2)
robot = Robot(left=(4, 14), right=(17, 18))

sensor.when_in_range = robot.backward
sensor.when_out_of_range = robot.stop
pause()
```

2.22 Button controlled robot



Use four GPIO buttons as forward/back/left/right controls for a robot:

```
from gpiozero import Robot, Button
from signal import pause

robot = Robot(left=(4, 14), right=(17, 18))

left = Button(26)
```

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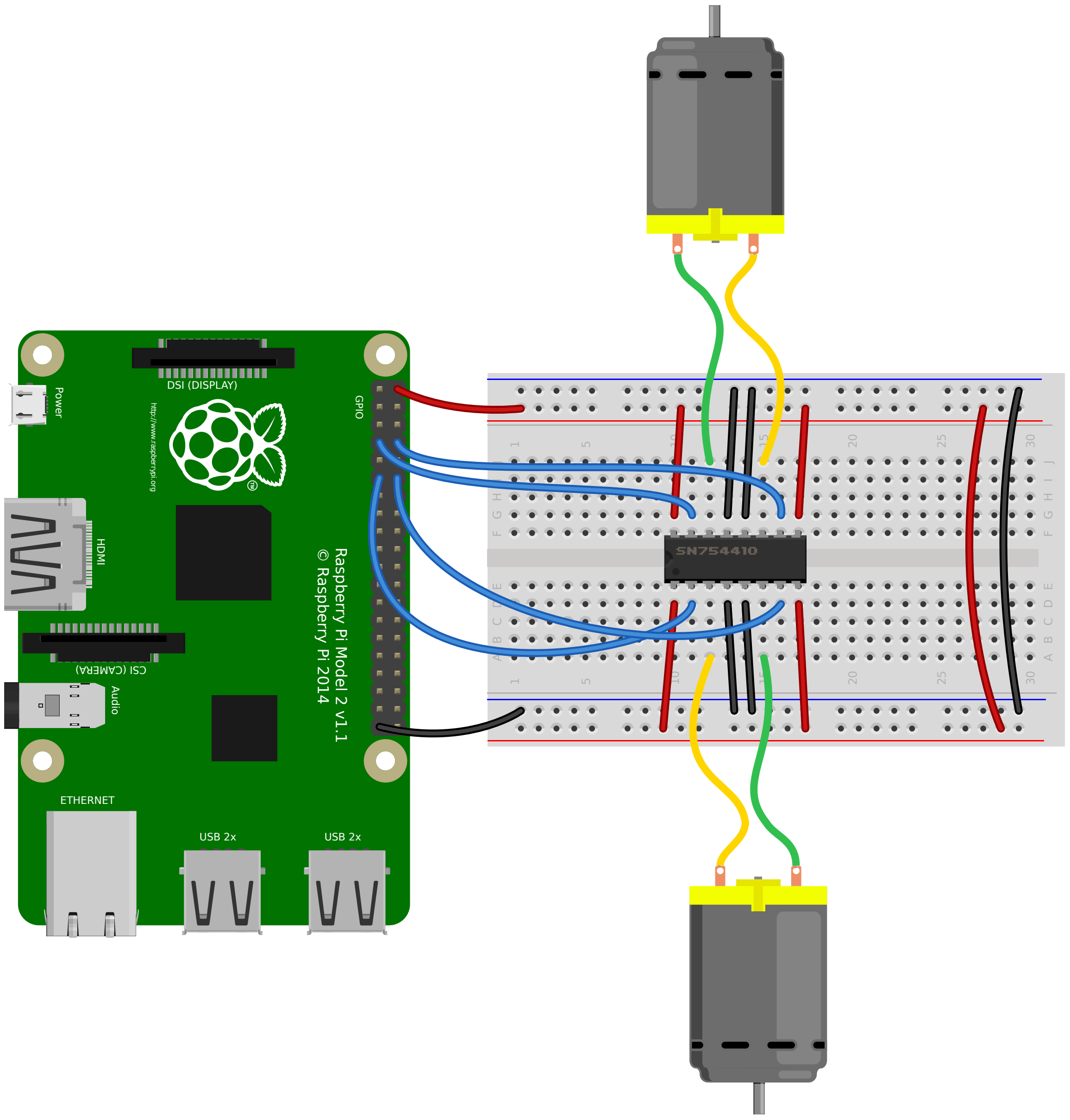
```
right = Button(16)
fw = Button(21)
bw = Button(20)

fw.when_pressed = robot.forward
fw.when_released = robot.stop

left.when_pressed = robot.left
left.when_released = robot.stop

right.when_pressed = robot.right
right.when_released = robot.stop

bw.when_pressed = robot.backward
bw.when_released = robot.stop

pause()
```

2.23 Keyboard controlled robot



Use up/down/left/right keys to control a robot:

```
import curses
from gpiozero import Robot

robot = Robot(left=(4, 14), right=(17, 18))

actions = {
    curses.KEY_UP:    robot.forward,
    curses.KEY_DOWN:  robot.backward,
    curses.KEY_LEFT:  robot.left,
    curses.KEY_RIGHT: robot.right,
}

def main(window):
    next_key = None
    while True:
        curses.halfdelay(1)
```

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```
        if next_key is None:
            key = window.getch()
        else:
            key = next_key
            next_key = None
        if key != -1:
            # KEY PRESSED
            curses.halfdelay(3)
            action = actions.get(key)
            if action is not None:
                action()
            next_key = key
            while next_key == key:
                next_key = window.getch()
            # KEY RELEASED
            robot.stop()

curses.wrapper(main)
```

Note: This recipe uses the standard `curses`[14] module. This module requires that Python is running in a terminal in order to work correctly, hence this recipe will *not* work in environments like IDLE.

If you prefer a version that works under IDLE, the following recipe should suffice:

```
from gpiozero import Robot
from evdev import InputDevice, list_devices, ecodes

robot = Robot(left=(4, 14), right=(17, 18))

# Get the list of available input devices
devices = [InputDevice(device) for device in list_devices()]
# Filter out everything that's not a keyboard. Keyboards are defined as any
# device which has keys, and which specifically has keys 1..31 (roughly Esc,
# the numeric keys, the first row of QWERTY plus a few more) and which does
# *not* have key 0 (reserved)
must_have = {i for i in range(1, 32)}
must_not_have = {0}
devices = [
    dev
    for dev in devices
    for keys in (set(dev.capabilities().get(ecodes.EV_KEY, [])),)
    if must_have.issubset(keys)
    and must_not_have.isdisjoint(keys)
]
# Pick the first keyboard
keyboard = devices[0]

keypress_actions = {
    ecodes.KEY_UP: robot.forward,
    ecodes.KEY_DOWN: robot.backward,
    ecodes.KEY_LEFT: robot.left,
    ecodes.KEY_RIGHT: robot.right,
}

for event in keyboard.read_loop():
    if event.type == ecodes.EV_KEY and event.code in keypress_actions:
        if event.value == 1:  # key pressed
            keypress_actions[event.code]()
```

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[14] https://docs.python.org/3.5/library/curses.html#module-curses

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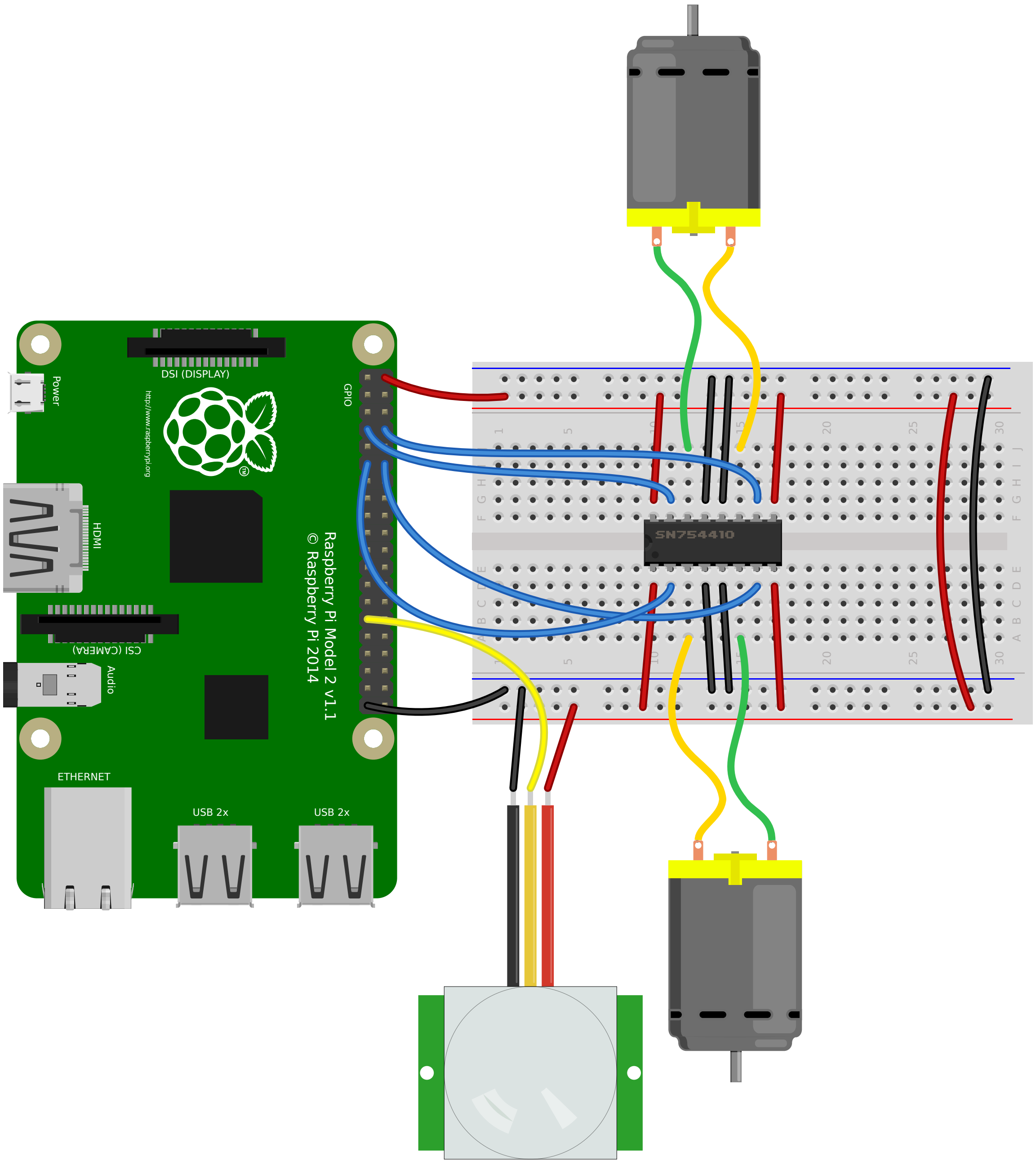
```
        if event.value == 0:  # key released
            robot.stop()
```

Note: This recipe uses the third-party `evdev` module. Install this library with `sudo pip3 install evdev` first. Be aware that `evdev` will only work with local input devices; this recipe will *not* work over SSH.

2.24 Motion sensor robot



Make a robot drive forward when it detects motion:

```
from gpiozero import Robot, MotionSensor
from signal import pause

robot = Robot(left=(4, 14), right=(17, 18))
pir = MotionSensor(5)

pir.when_motion = robot.forward
pir.when_no_motion = robot.stop

pause()
```

Alternatively:

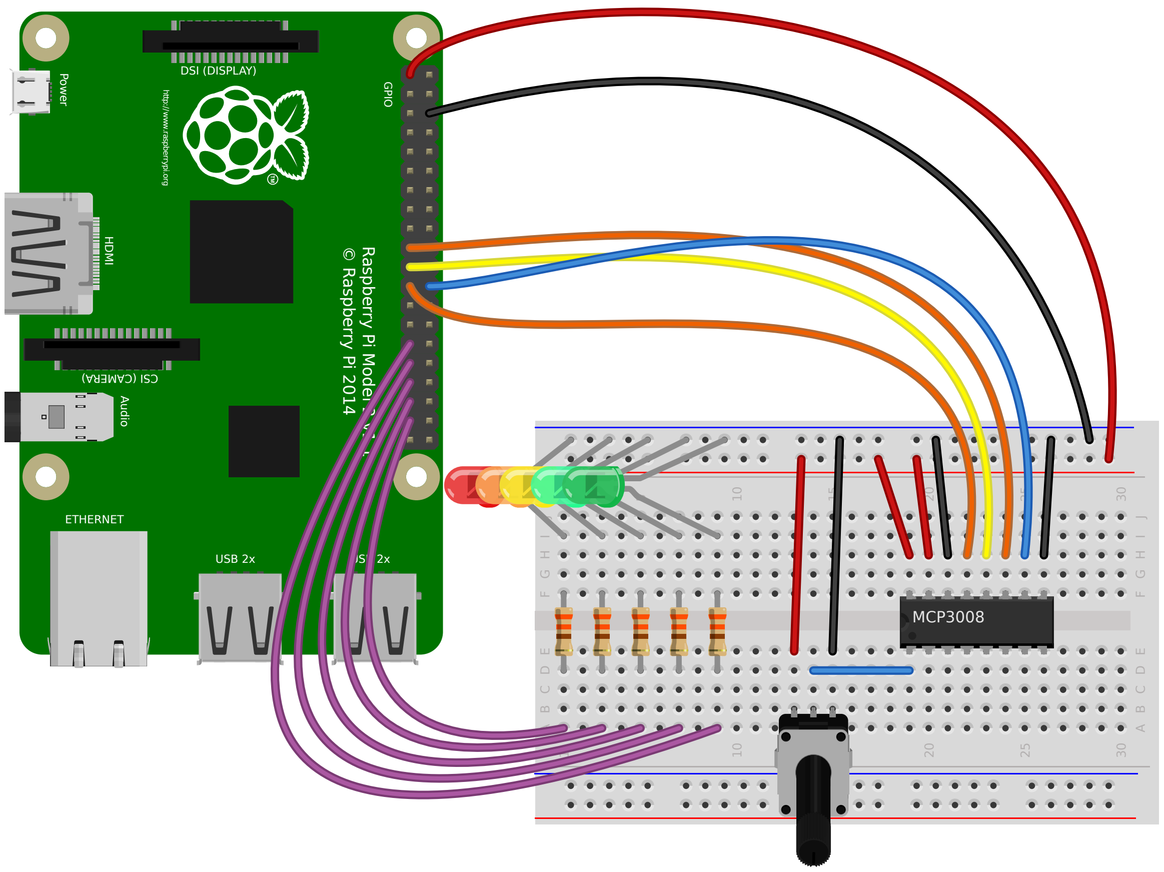
```
from gpiozero import Robot, MotionSensor
from gpiozero.tools import zip_values
from signal import pause

robot = Robot(left=(4, 14), right=(17, 18))
pir = MotionSensor(5)

robot.source = zip_values(pir, pir)

pause()
```

2.25 Potentiometer



Continually print the value of a potentiometer (values between 0 and 1) connected to a *MCP3008* (page 135) analog to digital converter:

```python
from gpiozero import MCP3008

pot = MCP3008(channel=0)

while True:
    print(pot.value)
```

Present the value of a potentiometer on an LED bar graph using PWM to represent states that won't "fill" an LED:

```python
from gpiozero import LEDBarGraph, MCP3008
from signal import pause

graph = LEDBarGraph(5, 6, 13, 19, 26, pwm=True)
pot = MCP3008(channel=0)

graph.source = pot

pause()
```

2.26 Measure temperature with an ADC

Wire a TMP36 temperature sensor to the first channel of an *MCP3008* (page 135) analog to digital converter:

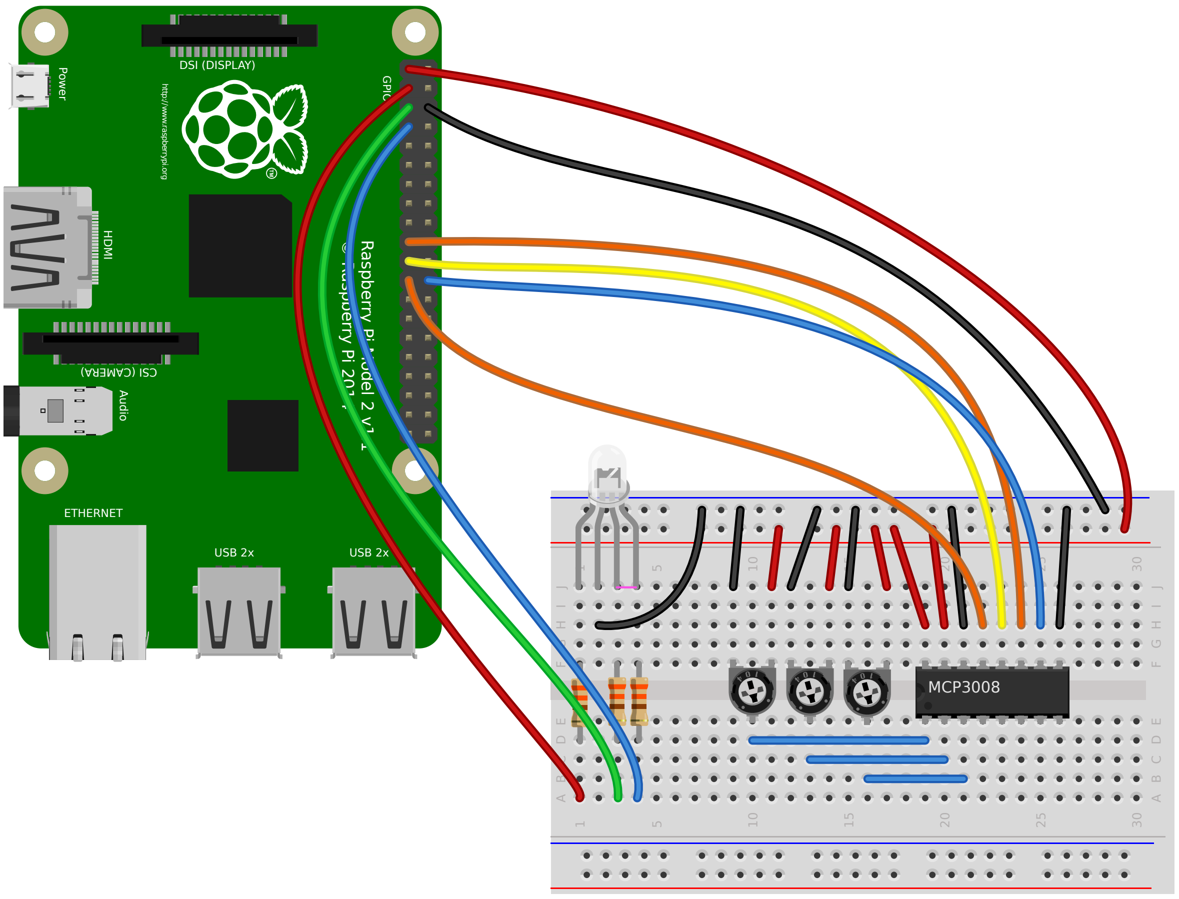
```python
from gpiozero import MCP3008
from time import sleep

def convert_temp(gen):
    for value in gen:
        yield (value * 3.3 - 0.5) * 100

adc = MCP3008(channel=0)

for temp in convert_temp(adc.values):
    print('The temperature is', temp, 'C')
    sleep(1)
```

2.27 Full color LED controlled by 3 potentiometers



Wire up three potentiometers (for red, green and blue) and use each of their values to make up the colour of the LED:

```
from gpiozero import RGBLED, MCP3008

led = RGBLED(red=2, green=3, blue=4)
red_pot = MCP3008(channel=0)
green_pot = MCP3008(channel=1)
blue_pot = MCP3008(channel=2)

while True:
    led.red = red_pot.value
    led.green = green_pot.value
    led.blue = blue_pot.value
```

Alternatively, the following example is identical, but uses the `source` (page 176) property rather than a `while`[15] loop:

```
from gpiozero import RGBLED, MCP3008
from gpiozero.tools import zip_values
from signal import pause

led = RGBLED(2, 3, 4)
red_pot = MCP3008(0)
green_pot = MCP3008(1)
blue_pot = MCP3008(2)
```

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[15] https://docs.python.org/3.5/reference/compound_stmts.html#while

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```
led.source = zip_values(red_pot, green_pot, blue_pot)

pause()
```

2.28 Timed heat lamp

If you have a pet (e.g. a tortoise) which requires a heat lamp to be switched on for a certain amount of time each day, you can use an Energenie Pi-mote[16] to remotely control the lamp, and the *TimeOfDay* (page 167) class to control the timing:

```
from gpiozero import Energenie, TimeOfDay
from datetime import time
from signal import pause

lamp = Energenie(1)
daytime = TimeOfDay(time(8), time(20))

lamp.source = daytime
lamp.source_delay = 60

pause()
```

2.29 Internet connection status indicator

You can use a pair of green and red LEDs to indicate whether or not your internet connection is working. Simply use the *PingServer* (page 168) class to identify whether a ping to *google.com* is successful. If successful, the green LED is lit, and if not, the red LED is lit:

```
from gpiozero import LED, PingServer
from gpiozero.tools import negated
from signal import pause

green = LED(17)
red = LED(18)

google = PingServer('google.com')

green.source = google
green.source_delay = 60
red.source = negated(green)

pause()
```

2.30 CPU Temperature Bar Graph

You can read the Raspberry Pi's own CPU temperature using the built-in *CPUTemperature* (page 169) class, and display this on a "bar graph" of LEDs:

```
from gpiozero import LEDBarGraph, CPUTemperature
from signal import pause
```

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[16] https://energenie4u.co.uk/catalogue/product/ENER002-2PI

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```
cpu = CPUTemperature(min_temp=50, max_temp=90)
leds = LEDBarGraph(2, 3, 4, 5, 6, 7, 8, pwm=True)

leds.source = cpu

pause()
```

2.31 More recipes

Continue to:

- *Advanced Recipes* (page 35)
- *Remote GPIO Recipes* (page 51)

CHAPTER 3

Advanced Recipes

The following recipes demonstrate some of the capabilities of the GPIO Zero library. Please note that all recipes are written assuming Python 3. Recipes *may* work under Python 2, but no guarantees!

3.1 LEDBoard

You can iterate over the LEDs in a *LEDBoard* (page 141) object one-by-one:

```
from gpiozero import LEDBoard
from time import sleep

leds = LEDBoard(5, 6, 13, 19, 26)

for led in leds:
    led.on()
    sleep(1)
    led.off()
```

LEDBoard (page 141) also supports indexing. This means you can access the individual *LED* (page 111) objects using `leds[i]` where `i` is an integer from 0 up to (not including) the number of LEDs:

```
from gpiozero import LEDBoard
from time import sleep

leds = LEDBoard(2, 3, 4, 5, 6, 7, 8, 9)

leds[0].on()   # first led on
sleep(1)
leds[7].on()   # last led on
sleep(1)
leds[-1].off()   # last led off
sleep(1)
```

This also means you can use slicing to access a subset of the LEDs:

```
from gpiozero import LEDBoard
from time import sleep
```

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```
leds = LEDBoard(2, 3, 4, 5, 6, 7, 8, 9)

for led in leds[3:]:  # leds 3 and onward
    led.on()
sleep(1)
leds.off()

for led in leds[:2]:  # leds 0 and 1
    led.on()
sleep(1)
leds.off()

for led in leds[::2]:  # even leds (0, 2, 4...)
    led.on()
sleep(1)
leds.off()

for led in leds[1::2]:  # odd leds (1, 3, 5...)
    led.on()
sleep(1)
leds.off()
```

LEDBoard (page 141) objects can have their *LED* objects named upon construction. This means the individual LEDs can be accessed by their name:

```
from gpiozero import LEDBoard
from time import sleep

leds = LEDBoard(red=2, green=3, blue=4)

leds.red.on()
sleep(1)
leds.green.on()
sleep(1)
leds.blue.on()
sleep(1)
```

LEDBoard (page 141) objects can also be nested within other *LEDBoard* (page 141) objects:

```
from gpiozero import LEDBoard
from time import sleep

leds = LEDBoard(red=LEDBoard(top=2, bottom=3), green=LEDBoard(top=4, bottom=5))

leds.red.on() ## both reds on
sleep(1)
leds.green.on()  # both greens on
sleep(1)
leds.off()  # all off
sleep(1)
leds.red.top.on()  # top red on
sleep(1)
leds.green.bottom.on()  # bottom green on
sleep(1)
```

3.2 Who's home indicator

Using a number of green-red LED pairs, you can show the status of who's home, according to which IP addresses you can ping successfully. Note that this assumes each person's mobile phone has a reserved IP address on the home router.

```
from gpiozero import PingServer, LEDBoard
from gpiozero.tools import negated
from signal import pause

status = LEDBoard(
    mum=LEDBoard(red=14, green=15),
    dad=LEDBoard(red=17, green=18),
    alice=LEDBoard(red=21, green=22)
)

statuses = {
    PingServer('192.168.1.5'): status.mum,
    PingServer('192.168.1.6'): status.dad,
    PingServer('192.168.1.7'): status.alice,
}

for server, leds in statuses.items():
    leds.green.source = server
    leds.green.source_delay = 60
    leds.red.source = negated(leds.green)

pause()
```

Alternatively, using the STATUS Zero[17] board:

```
from gpiozero import PingServer, StatusZero
from gpiozero.tools import negated
from signal import pause

status = StatusZero('mum', 'dad', 'alice')

statuses = {
    PingServer('192.168.1.5'): status.mum,
    PingServer('192.168.1.6'): status.dad,
    PingServer('192.168.1.7'): status.alice,
}

for server, leds in statuses.items():
    leds.green.source = server
    leds.green.source_delay = 60
    leds.red.source = negated(leds.green)

pause()
```

3.3 Travis build LED indicator

Use LEDs to indicate the status of a Travis build. A green light means the tests are passing, a red light means the build is broken:

```
from travispy import TravisPy
from gpiozero import LED
```

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[17] https://thepihut.com/status

(continued from previous page)

```
from gpiozero.tools import negated
from time import sleep
from signal import pause

def build_passed(repo):
    t = TravisPy()
    r = t.repo(repo)
    while True:
        yield r.last_build_state == 'passed'

red = LED(12)
green = LED(16)

green.source = build_passed('RPi-Distro/python-gpiozero')
green.source_delay = 60 * 5  # check every 5 minutes
red.source = negated(green)

pause()
```

Note this recipe requires travispy[18]. Install with `sudo pip3 install travispy`.

3.4 Button controlled robot

Alternatively to the examples in the simple recipes, you can use four buttons to program the directions and add a fifth button to process them in turn, like a Bee-Bot or Turtle robot.

```
from gpiozero import Button, Robot
from time import sleep
from signal import pause

robot = Robot((17, 18), (22, 23))

left = Button(2)
right = Button(3)
forward = Button(4)
backward = Button(5)
go = Button(6)

instructions = []

def add_instruction(btn):
    instructions.append({
        left:     (-1, 1),
        right:    (1, -1),
        forward:  (1, 1),
        backward: (-1, -1),
    }[btn])

def do_instructions():
    instructions.append((0, 0))
    robot.source_delay = 0.5
    robot.source = instructions
    sleep(robot.source_delay * len(instructions))
    del instructions[:]

go.when_pressed = do_instructions
for button in (left, right, forward, backward):
```

(continues on next page)

[18] https://travispy.readthedocs.io/

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```
    button.when_pressed = add_instruction

pause()
```

3.5 Robot controlled by 2 potentiometers

Use two potentiometers to control the left and right motor speed of a robot:

```
from gpiozero import Robot, MCP3008
from gpiozero.tools import zip_values
from signal import pause

robot = Robot(left=(4, 14), right=(17, 18))

left_pot = MCP3008(0)
right_pot = MCP3008(1)

robot.source = zip_values(left_pot, right_pot)

pause()
```

To include reverse direction, scale the potentiometer values from 0->1 to -1->1:

```
from gpiozero import Robot, MCP3008
from gpiozero.tools import scaled
from signal import pause

robot = Robot(left=(4, 14), right=(17, 18))

left_pot = MCP3008(0)
right_pot = MCP3008(1)

robot.source = zip(scaled(left_pot, -1, 1), scaled(right_pot, -1, 1))

pause()
```

Note: Please note the example above requires Python 3. In Python 2, `zip()` [19] doesn't support lazy evaluation so the script will simply hang.

3.6 BlueDot LED

BlueDot is a Python library an Android app which allows you to easily add Bluetooth control to your Raspberry Pi project. A simple example to control a LED using the BlueDot app:

```
from bluedot import BlueDot
from gpiozero import LED

bd = BlueDot()
led = LED(17)

while True:
    bd.wait_for_press()
```

(continues on next page)

[19] https://docs.python.org/3.5/library/functions.html#zip

(continued from previous page)

```
    led.on()
    bd.wait_for_release()
    led.off()
```

Note this recipe requires `bluedot` and the associated Android app. See the BlueDot documentation[20] for installation instructions.

3.7 BlueDot robot

You can create a Bluetooth controlled robot which moves forward when the dot is pressed and stops when it is released:

```
from bluedot import BlueDot
from gpiozero import Robot
from signal import pause

bd = BlueDot()
robot = Robot(left=(4, 14), right=(17, 18))

def move(pos):
    if pos.top:
        robot.forward(pos.distance)
    elif pos.bottom:
        robot.backward(pos.distance)
    elif pos.left:
        robot.left(pos.distance)
    elif pos.right:
        robot.right(pos.distance)

bd.when_pressed = move
bd.when_moved = move
bd.when_released = robot.stop

pause()
```

Or a more advanced example including controlling the robot's speed and precise direction:

```
from gpiozero import Robot
from bluedot import BlueDot
from signal import pause

def pos_to_values(x, y):
    left = y if x > 0 else y + x
    right = y if x < 0 else y - x
    return (clamped(left), clamped(right))

def clamped(v):
    return max(-1, min(1, v))

def drive():
    while True:
        if bd.is_pressed:
            x, y = bd.position.x, bd.position.y
            yield pos_to_values(x, y)
        else:
            yield (0, 0)
```

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[20] https://bluedot.readthedocs.io/en/latest/index.html

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```
robot = Robot(left=(4, 14), right=(17, 18))
bd = BlueDot()

robot.source = drive()

pause()
```

3.8 Controlling the Pi's own LEDs

On certain models of Pi (specifically the model A+, B+, and 2B) it's possible to control the power and activity LEDs. This can be useful for testing GPIO functionality without the need to wire up your own LEDs (also useful because the power and activity LEDs are "known good").

Firstly you need to disable the usual triggers for the built-in LEDs. This can be done from the terminal with the following commands:

```
$ echo none | sudo tee /sys/class/leds/led0/trigger
$ echo gpio | sudo tee /sys/class/leds/led1/trigger
```

Now you can control the LEDs with gpiozero like so:

```
from gpiozero import LED
from signal import pause

power = LED(35) # /sys/class/leds/led1
activity = LED(47) # /sys/class/leds/led0

activity.blink()
power.blink()
pause()
```

To revert the LEDs to their usual purpose you can either reboot your Pi or run the following commands:

```
$ echo mmc0 | sudo tee /sys/class/leds/led0/trigger
$ echo input | sudo tee /sys/class/leds/led1/trigger
```

Note: On the Pi Zero you can control the activity LED with this recipe, but there's no separate power LED to control (it's also worth noting the activity LED is active low, so set `active_high=False` when constructing your LED component).

On the original Pi 1 (model A or B), the activity LED can be controlled with GPIO16 (after disabling its trigger as above) but the power LED is hard-wired on.

On the Pi 3 the LEDs are controlled by a GPIO expander which is not accessible from gpiozero (yet).

CHAPTER 4

Configuring Remote GPIO

GPIO Zero supports a number of different pin implementations (low-level pin libraries which deal with the GPIO pins directly). By default, the RPi.GPIO[21] library is used (assuming it is installed on your system), but you can optionally specify one to use. For more information, see the *API - Pins* (page 195) documentation page.

One of the pin libraries supported, pigpio[22], provides the ability to control GPIO pins remotely over the network, which means you can use GPIO Zero to control devices connected to a Raspberry Pi on the network. You can do this from another Raspberry Pi, or even from a PC.

See the *Remote GPIO Recipes* (page 51) page for examples on how remote pins can be used.

4.1 Preparing the Raspberry Pi

If you're using Raspbian (desktop - not Raspbian Lite) then you have everything you need to use the remote GPIO feature. If you're using Raspbian Lite, or another distribution, you'll need to install pigpio:

```
$ sudo apt install pigpio
```

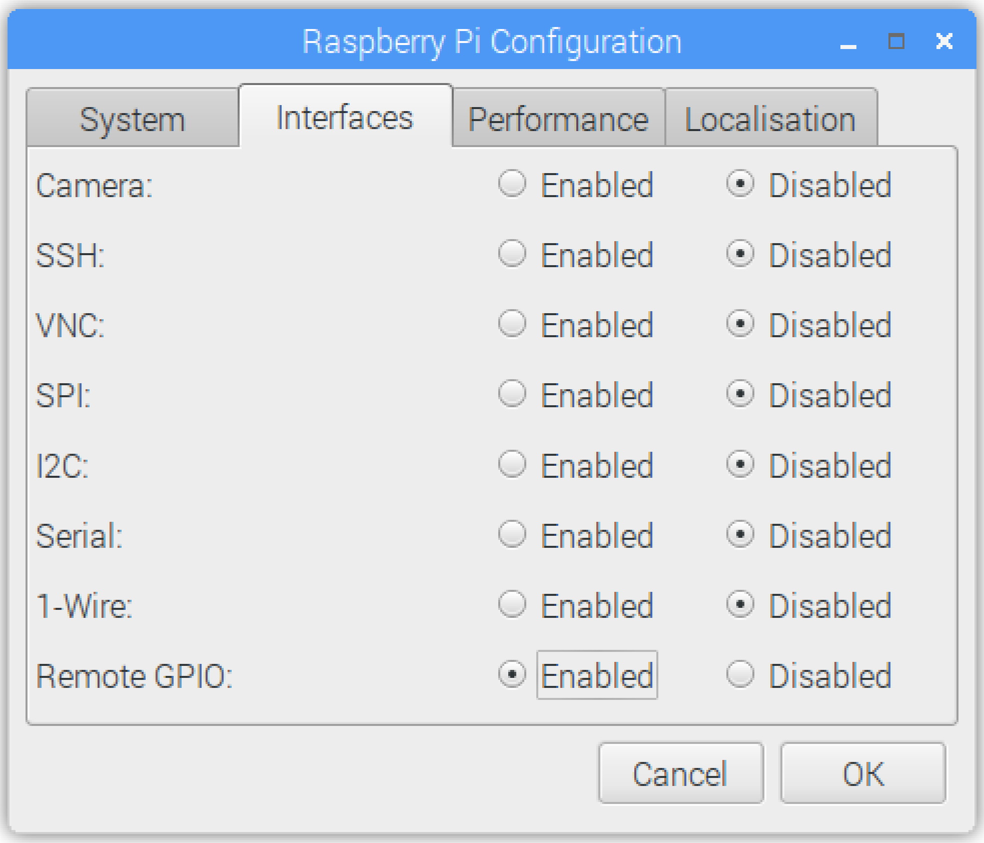
Alternatively, pigpio is available from abyz.me.uk[23].

You'll need to enable remote connections, and launch the pigpio daemon on the Raspberry Pi.

4.1.1 Enable remote connections

On the Raspbian desktop image, you can enable *Remote GPIO* in the Raspberry Pi configuration tool:

[21] https://pypi.python.org/pypi/RPi.GPIO
[22] http://abyz.me.uk/rpi/pigpio/python.html
[23] http://abyz.me.uk/rpi/pigpio/download.html


Raspberry Pi Configuration

System | Interfaces | Performance | Localisation

Camera: Enabled [✓ Disabled]

SSH: Enabled [✓ Disabled]

VNC: Enabled [✓ Disabled]

SPI: Enabled [✓ Disabled]

I2C: Enabled [✓ Disabled]

Serial: Enabled [✓ Disabled]

1-Wire: Enabled [✓ Disabled]

Remote GPIO: [✓ Enabled] Disabled

Cancel | OK

Alternatively, enter `sudo raspi-config` on the command line, and enable Remote GPIO. This is functionally equivalent to the desktop method.

This will allow remote connections (until disabled) when the pigpio daemon is launched using **`systemctl`** (see below). It will also launch the pigpio daemon for the current session. Therefore, nothing further is required for the current session, but after a reboot, a **`systemctl`** command will be required.

4.1.2 Command-line: systemctl

To automate running the daemon at boot time, run:

```
$ sudo systemctl enable pigpiod
```

To run the daemon once using **`systemctl`**, run:

```
$ sudo systemctl start pigpiod
```

4.1.3 Command-line: pigpiod

Another option is to launch the pigpio daemon manually:

```
$ sudo pigpiod
```

This is for single-session-use and will not persist after a reboot. However, this method can be used to allow connections from a specific IP address, using the `-n` flag. For example:

```
$ sudo pigpiod -n localhost # allow localhost only
$ sudo pigpiod -n 192.168.1.65 # allow 192.168.1.65 only
$ sudo pigpiod -n localhost -n 192.168.1.65 # allow localhost and 192.168.1.65 only
```

Note: Note that running `sudo pigpiod` will not honour the Remote GPIO configuration setting (i.e. without the `-n` flag it will allow remote connections even if the remote setting is disabled), but `sudo systemctl enable pigpiod` or `sudo systemctl start pigpiod` will not allow remote connections unless configured accordingly.

4.2 Preparing the control computer

If the control computer (the computer you're running your Python code from) is a Raspberry Pi running Raspbian (or a PC running Raspberry Pi Desktop x86[24]), then you have everything you need. If you're using another Linux distribution, Mac OS or Windows then you'll need to install the pigpio[25] Python library on the PC.

4.2.1 Raspberry Pi

First, update your repositories list:

```
$ sudo apt update
```

Then install GPIO Zero and the pigpio library for Python 3:

```
$ sudo apt install python3-gpiozero python3-pigpio
```

or Python 2:

```
$ sudo apt install python-gpiozero python-pigpio
```

Alternatively, install with pip:

```
$ sudo pip3 install gpiozero pigpio
```

or for Python 2:

```
$ sudo pip install gpiozero pigpio
```

4.2.2 Linux

First, update your distribution's repositories list. For example:

```
$ sudo apt update
```

Then install pip for Python 3:

```
$ sudo apt install python3-pip
```

or Python 2:

```
$ sudo apt install python-pip
```

(Alternatively, install pip with get-pip[26].)

Next, install GPIO Zero and pigpio for Python 3:

[24] https://www.raspberrypi.org/downloads/raspberry-pi-desktop/
[25] http://abyz.me.uk/rpi/pigpio/python.html
[26] https://pip.pypa.io/en/stable/installing/

```
$ sudo pip3 install gpiozero pigpio
```

or Python 2:

```
$ sudo pip install gpiozero pigpio
```

4.2.3 Mac OS

First, install pip. If you installed Python 3 using brew, you will already have pip. If not, install pip with get-pip[27].

Next, install GPIO Zero and pigpio with pip:

```
$ pip3 install gpiozero pigpio
```

Or for Python 2:

```
$ pip install gpiozero pigpio
```

4.2.4 Windows

First, install pip by following this guide[28]. Next, install GPIO Zero and pigpio with pip:

```
C:\Users\user1> pip install gpiozero pigpio
```

4.3 Environment variables

The simplest way to use devices with remote pins is to set the *PIGPIO_ADDR* (page 74) environment variable to the IP address of the desired Raspberry Pi. You must run your Python script or launch your development environment with the environment variable set using the command line. For example, one of the following:

```
$ PIGPIO_ADDR=192.168.1.3 python3 hello.py
$ PIGPIO_ADDR=192.168.1.3 python3
$ PIGPIO_ADDR=192.168.1.3 ipython3
$ PIGPIO_ADDR=192.168.1.3 idle3 &
```

If you are running this from a PC (not a Raspberry Pi) with gpiozero and the pigpio[29] Python library installed, this will work with no further configuration. However, if you are running this from a Raspberry Pi, you will also need to ensure the default pin factory is set to *PiGPIOFactory* (page 208). If RPi.GPIO[30] is installed, this will be selected as the default pin factory, so either uninstall it, or use the *GPIOZERO_PIN_FACTORY* (page 74) environment variable to override it:

```
$ GPIOZERO_PIN_FACTORY=pigpio PIGPIO_ADDR=192.168.1.3 python3 hello.py
```

This usage will set the pin factory to *PiGPIOFactory* (page 208) with a default host of `192.168.1.3`. The pin factory can be changed inline in the code, as seen in the following sections.

With this usage, you can write gpiozero code like you would on a Raspberry Pi, with no modifications needed. For example:

[27] https://pip.pypa.io/en/stable/installing/
[28] https://www.raspberrypi.org/learning/using-pip-on-windows/worksheet/
[29] http://abyz.me.uk/rpi/pigpio/python.html
[30] https://pypi.python.org/pypi/RPi.GPIO

```
from gpiozero import LED
from time import sleep

red = LED(17)

while True:
    red.on()
    sleep(1)
    red.off()
    sleep(1)
```

When run with:

```
$ PIGPIO_ADDR=192.168.1.3 python3 led.py
```

will flash the LED connected to pin 17 of the Raspberry Pi with the IP address `192.168.1.3`. And:

```
$ PIGPIO_ADDR=192.168.1.4 python3 led.py
```

will flash the LED connected to pin 17 of the Raspberry Pi with the IP address `192.168.1.4`, without any code changes, as long as the Raspberry Pi has the pigpio daemon running.

Note: When running code directly on a Raspberry Pi, any pin factory can be used (assuming the relevant library is installed), but when a device is used remotely, only *`PiGPIOFactory`* (page 208) can be used, as pigpio[31] is the only pin library which supports remote GPIO.

4.4 Pin factories

An alternative (or additional) method of configuring gpiozero objects to use remote pins is to create instances of *`PiGPIOFactory`* (page 208) objects, and use them when instantiating device objects. For example, with no environment variables set:

```
from gpiozero import LED
from gpiozero.pins.pigpio import PiGPIOFactory
from time import sleep

factory = PiGPIOFactory(host='192.168.1.3')
led = LED(17, pin_factory=factory)

while True:
    led.on()
    sleep(1)
    led.off()
    sleep(1)
```

This allows devices on multiple Raspberry Pis to be used in the same script:

```
from gpiozero import LED
from gpiozero.pins.pigpio import PiGPIOFactory
from time import sleep

factory3 = PiGPIOFactory(host='192.168.1.3')
factory4 = PiGPIOFactory(host='192.168.1.4')
led_1 = LED(17, pin_factory=factory3)
led_2 = LED(17, pin_factory=factory4)
```

(continues on next page)

[31] http://abyz.me.uk/rpi/pigpio/python.html

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```
while True:
    led_1.on()
    led_2.off()
    sleep(1)
    led_1.off()
    led_2.on()
    sleep(1)
```

You can, of course, continue to create gpiozero device objects as normal, and create others using remote pins. For example, if run on a Raspberry Pi, the following script will flash an LED on the controller Pi, and also on another Pi on the network:

```
from gpiozero import LED
from gpiozero.pins.pigpio import PiGPIOFactory
from time import sleep

remote_factory = PiGPIOFactory(host='192.168.1.3')
led_1 = LED(17)  # local pin
led_2 = LED(17, pin_factory=remote_factory)  # remote pin

while True:
    led_1.on()
    led_2.off()
    sleep(1)
    led_1.off()
    led_2.on()
    sleep(1)
```

Alternatively, when run with the environment variables `GPIOZERO_PIN_FACTORY=pigpio PIGPIO_ADDR=192.168.1.3` set, the following script will behave exactly the same as the previous one:

```
from gpiozero import LED
from gpiozero.pins.rpigpio import RPiGPIOFactory
from time import sleep

local_factory = RPiGPIOFactory()
led_1 = LED(17, pin_factory=local_factory)  # local pin
led_2 = LED(17)  # remote pin

while True:
    led_1.on()
    led_2.off()
    sleep(1)
    led_1.off()
    led_2.on()
    sleep(1)
```

Of course, multiple IP addresses can be used:

```
from gpiozero import LED
from gpiozero.pins.pigpio import PiGPIOFactory
from time import sleep

factory3 = PiGPIOFactory(host='192.168.1.3')
factory4 = PiGPIOFactory(host='192.168.1.4')

led_1 = LED(17)  # local pin
led_2 = LED(17, pin_factory=factory3)  # remote pin on one pi
led_3 = LED(17, pin_factory=factory4)  # remote pin on another pi

```

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```
while True:
    led_1.on()
    led_2.off()
    led_3.on()
    sleep(1)
    led_1.off()
    led_2.on()
    led_3.off()
    sleep(1)
```

Note that these examples use the *LED* (page 111) class, which takes a *pin* argument to initialise. Some classes, particularly those representing HATs and other add-on boards, do not require their pin numbers to be specified. However, it is still possible to use remote pins with these devices, either using environment variables, or the *pin_factory* keyword argument:

```
import gpiozero
from gpiozero import TrafficHat
from gpiozero.pins.pigpio import PiGPIOFactory
from time import sleep

gpiozero.Device.pin_factory = PiGPIOFactory(host='192.168.1.3')
th = TrafficHat()  # traffic hat on 192.168.1.3 using remote pins
```

This also allows you to swap between two IP addresses and create instances of multiple HATs connected to different Pis:

```
import gpiozero
from gpiozero import TrafficHat
from gpiozero.pins.pigpio import PiGPIOFactory
from time import sleep

remote_factory = PiGPIOFactory(host='192.168.1.3')

th_1 = TrafficHat()  # traffic hat using local pins
th_2 = TrafficHat(pin_factory=remote_factory)  # traffic hat on 192.168.1.3 using␣
↪remote pins
```

You could even use a HAT which is not supported by GPIO Zero (such as the Sense HAT[32]) on one Pi, and use remote pins to control another over the network:

```
from gpiozero import MotionSensor
from gpiozero.pins.pigpio import PiGPIOFactory
from sense_hat import SenseHat

remote_factory = PiGPIOFactory(host='192.198.1.4')
pir = MotionSensor(4, pin_factory=remote_factory)  # remote motion sensor
sense = SenseHat()  # local sense hat

while True:
    pir.wait_for_motion()
    sense.show_message(sense.temperature)
```

Note that in this case, the Sense HAT code must be run locally, and the GPIO remotely.

4.5 Remote GPIO usage

Continue to:

[32] https://www.raspberrypi.org/products/sense-hat/

- *Remote GPIO Recipes* (page 51)
- *Pi Zero USB OTG* (page 55)

CHAPTER 5

Remote GPIO Recipes

The following recipes demonstrate some of the capabilities of the remote GPIO feature of the GPIO Zero library. Before you start following these examples, please read up on preparing your Pi and your host PC to work with *Configuring Remote GPIO* (page 43).

Please note that all recipes are written assuming Python 3. Recipes *may* work under Python 2, but no guarantees!

5.1 LED + Button

Let a `Button` (page 93) on one Raspberry Pi control the `LED` (page 111) of another:

```
from gpiozero import LED
from gpiozero.pins.pigpio import PiGPIOFactory
from signal import pause

factory = PiGPIOFactory(host='192.168.1.3')

button = Button(2)
led = LED(17, pin_factory=factory)

led.source = button

pause()
```

5.2 LED + 2 Buttons

The `LED` (page 111) will come on when both buttons are pressed:

```
from gpiozero import LED
from gpiozero.pins.pigpio import PiGPIOFactory
from gpiozero.tools import all_values
from signal import pause

factory3 = PiGPIOFactory(host='192.168.1.3')
factory4 = PiGPIOFactory(host='192.168.1.4')
```

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```
led = LED(17)
button_1 = Button(17, pin_factory=factory3)
button_2 = Button(17, pin_factory=factory4)

led.source = all_values(button_1, button_2)

pause()
```

5.3 Multi-room motion alert

Install a Raspberry Pi with a `MotionSensor` (page 97) in each room of your house, and have an class:*LED* indicator showing when there's motion in each room:

```
from gpiozero import LEDBoard, MotionSensor
from gpiozero.pins.pigpio import PiGPIOFactory
from gpiozero.tools import zip_values
from signal import pause

ips = ['192.168.1.3', '192.168.1.4', '192.168.1.5', '192.168.1.6']
remotes = [PiGPIOFactory(host=ip) for ip in ips]

leds = LEDBoard(2, 3, 4, 5)  # leds on this pi
sensors = [MotionSensor(17, pin_factory=r) for r in remotes]  # remote sensors

leds.source = zip_values(*sensors)

pause()
```

5.4 Multi-room doorbell

Install a Raspberry Pi with a `Buzzer` (page 117) attached in each room you want to hear the doorbell, and use a push `Button` (page 93) as the doorbell:

```
from gpiozero import LEDBoard, MotionSensor
from gpiozero.pins.pigpio import PiGPIOFactory
from signal import pause

ips = ['192.168.1.3', '192.168.1.4', '192.168.1.5', '192.168.1.6']
remotes = [PiGPIOFactory(host=ip) for ip in ips]

button = Button(17)  # button on this pi
buzzers = [Buzzer(pin, pin_factory=r) for r in remotes]  # buzzers on remote pins

for buzzer in buzzers:
    buzzer.source = button

pause()
```

This could also be used as an internal doorbell (tell people it's time for dinner from the kitchen).

5.5 Remote button robot

Similarly to the simple recipe for the button controlled `Robot` (page 155), this example uses four buttons to control the direction of a robot. However, using remote pins for the robot means the control buttons can be separate from the robot:

```
from gpiozero import Button, Robot
from gpiozero.pins.pigpio import PiGPIOFactory
from signal import pause

factory = PiGPIOFactory(host='192.168.1.17')
robot = Robot(left=(4, 14), right=(17, 18), pin_factory=factory)  # remote pins

# local buttons
left = Button(26)
right = Button(16)
fw = Button(21)
bw = Button(20)

fw.when_pressed = robot.forward
fw.when_released = robot.stop

left.when_pressed = robot.left
left.when_released = robot.stop

right.when_pressed = robot.right
right.when_released = robot.stop

bw.when_pressed = robot.backward
bw.when_released = robot.stop

pause()
```

5.6 Light sensor + Sense HAT

The Sense HAT[33] (not supported by GPIO Zero) includes temperature, humidity and pressure sensors, but no light sensor. Remote GPIO allows an external `LightSensor` (page 99) to be used as well. The Sense HAT LED display can be used to show different colours according to the light levels:

```
from gpiozero import LightSensor
from gpiozero.pins.pigpio import PiGPIOFactory
from sense_hat import SenseHat

remote_factory = PiGPIOFactory(host='192.168.1.4')
light = LightSensor(4, pin_factory=remote_factory)  # remote motion sensor
sense = SenseHat()  # local sense hat

blue = (0, 0, 255)
yellow = (255, 255, 0)

while True:
    if light.value > 0.5:
        sense.clear(yellow)
    else:
        sense.clear(blue)
```

Note that in this case, the Sense HAT code must be run locally, and the GPIO remotely.

[33] https://www.raspberrypi.org/products/sense-hat/

CHAPTER 6

Pi Zero USB OTG

The Raspberry Pi Zero[34] and Pi Zero W[35] feature a USB OTG port, allowing users to configure the device as (amongst other things) an Ethernet device. In this mode, it is possible to control the Pi Zero's GPIO pins over USB from another computer using the *remote GPIO* (page 43) feature.

6.1 GPIO expander method - no SD card required

The GPIO expander method allows you to boot the Pi Zero over USB from the PC, without an SD card. Your PC sends the required boot firmware to the Pi over the USB cable, launching a mini version of Raspbian and booting it in RAM. The OS then starts the pigpio daemon, allowing "remote" access over the USB cable.

At the time of writing, this is only possible using either the Raspberry Pi Desktop x86 OS, or Ubuntu (or a derivative), or from another Raspberry Pi. Usage from Windows and Mac OS is not supported at present.

6.1.1 Raspberry Pi Desktop x86 setup

1. Download an ISO of the Raspberry Pi Desktop OS[36] from raspberrypi.org (this must be the Stretch release, not the older Jessie image).
2. Write the image to a USB stick or burn to a DVD.
3. Live boot your PC or Mac into the OS (select "Run with persistence" and your computer will be back to normal afterwards).

6.1.2 Raspberry Pi (Raspbian) setup

1. Update your package list and install the `usbbootgui` package:

```
$ sudo apt update
$ sudo apt install usbbootgui
```

[34] https://www.raspberrypi.org/products/raspberry-pi-zero/
[35] https://www.raspberrypi.org/products/raspberry-pi-zero-w/
[36] https://www.raspberrypi.org/downloads/raspberry-pi-desktop/

6.1.3 Ubuntu setup

1. Add the Raspberry Pi PPA to your system:

```
$ sudo add-apt-repository ppa:rpi-distro/ppa
```

2. If you have previously installed `gpiozero` or `pigpio` with pip, uninstall these first:

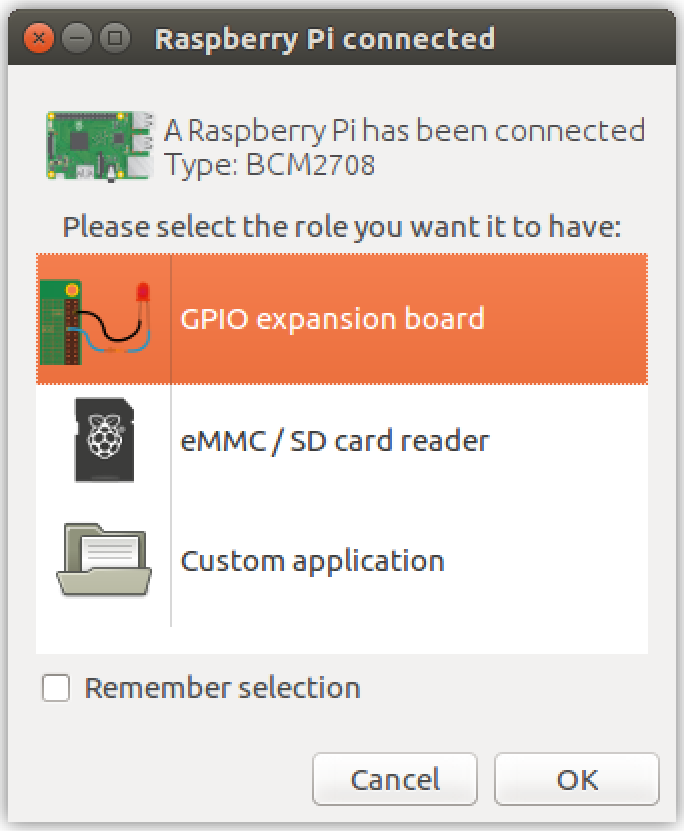
```
$ sudo pip3 uninstall gpiozero pigpio
```

3. Install the required packages from the PPA:

```
$ sudo apt install usbbootgui pigpio python3-gpiozero python3-pigpio
```

6.1.4 Access the GPIOs

Once your PC or Pi has the USB Boot GUI tool installed, connecting a Pi Zero will automatically launch a prompt to select a role for the device. Select "GPIO expansion board" and continue:


Raspberry Pi connected

A Raspberry Pi has been connected
Type: BCM2708

Please select the role you want it to have:

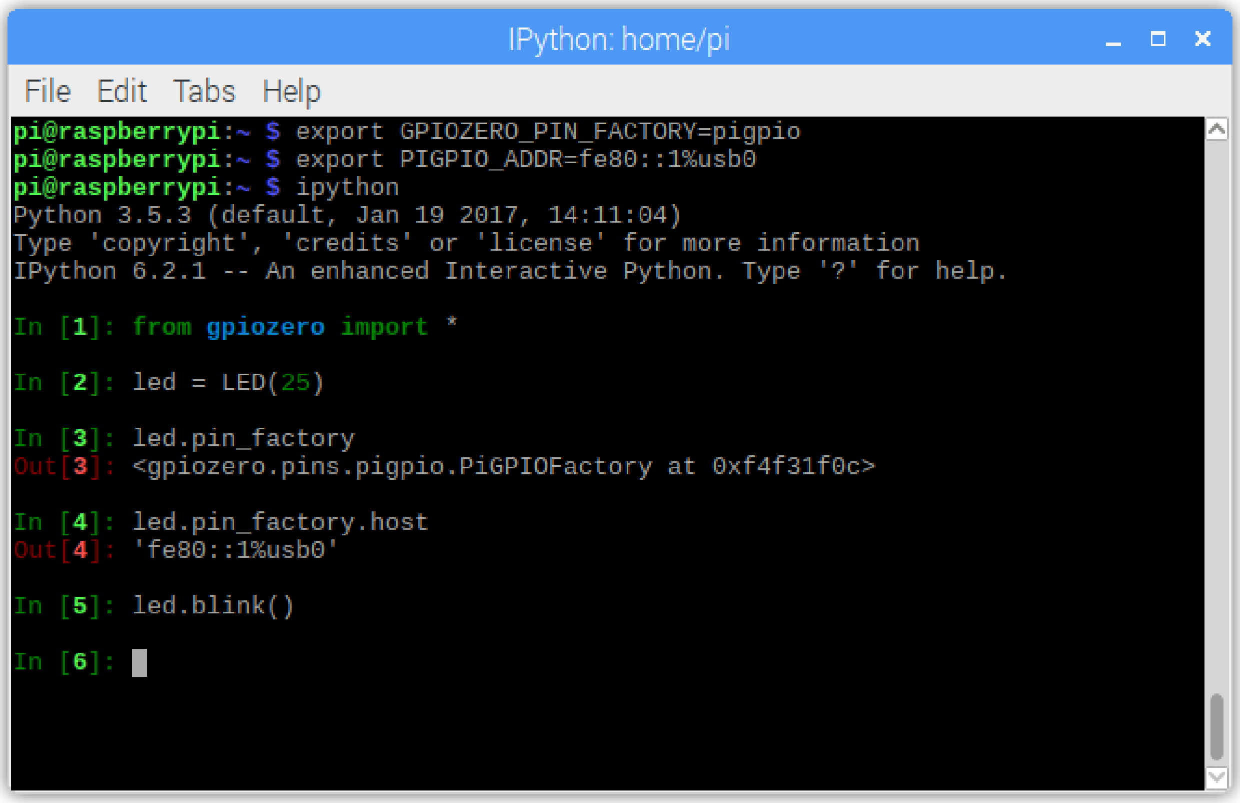
It will take 30 seconds or so to flash it, then the dialogue will disappear.

Raspberry Pi Desktop and Raspbian will name your Pi Zero connection `usb0`. On Ubuntu, this will likely be something else. You can ping it using the address `fe80::1%` followed by the connection string. You can look this up using `ifconfig`.

Set the *GPIOZERO_PIN_FACTORY* (page 74) and *PIGPIO_ADDR* (page 74) environment variables on your PC so GPIO Zero connects to the "remote" Pi Zero:

```
$ export GPIOZERO_PIN_FACTORY=pigpio
$ export PIGPIO_ADDR=fe80::1%usb0
```

Now any GPIO Zero code you run on the PC will use the GPIOs of the attached Pi Zero:



```
pi@raspberrypi:~ $ export GPIOZERO_PIN_FACTORY=pigpio
pi@raspberrypi:~ $ export PIGPIO_ADDR=fe80::1%usb0
pi@raspberrypi:~ $ ipython
Python 3.5.3 (default, Jan 19 2017, 14:11:04)
Type 'copyright', 'credits' or 'license' for more information
IPython 6.2.1 -- An enhanced Interactive Python. Type '?' for help.

In [1]: from gpiozero import *

In [2]: led = LED(25)

In [3]: led.pin_factory
Out[3]: <gpiozero.pins.pigpio.PiGPIOFactory at 0xf4f31f0c>

In [4]: led.pin_factory.host
Out[4]: 'fe80::1%usb0'

In [5]: led.blink()

In [6]:
```

Alternatively, you can set the pin factory in-line, as explained in *Configuring Remote GPIO* (page 43).

Read more on the GPIO expander in blog posts on raspberrypi.org[37] and bennuttall.com[38].

6.2 Legacy method - SD card required

The legacy method requires the Pi Zero to have a Raspbian SD card inserted.

Start by creating a Raspbian (desktop or lite) SD card, and then configure the boot partition like so:

1. Edit `config.txt` and add `dtoverlay=dwc2` on a new line, then save the file.
2. Create an empty file called `ssh` (no file extension) and save it in the boot partition.
3. Edit `cmdline.txt`` and insert `modules-load=dwc2,g_ether` after `rootwait`.

(See guides on blog.gbaman.info[39] and learn.adafruit.com[40] for more detailed instructions)

Then connect the Pi Zero to your computer using a micro USB cable (connecting it to the USB port, not the power port). You'll see the indicator LED flashing as the Pi Zero boots. When it's ready, you will be able to ping and SSH into it using the hostname `raspberrypi.local`. SSH into the Pi Zero, install pigpio and run the pigpio daemon.

Then, drop out of the SSH session and you can run Python code on your computer to control devices attached to the Pi Zero, referencing it by its hostname (or IP address if you know it), for example:

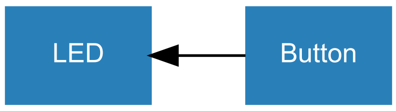
```
$ GPIOZERO_PIN_FACTORY=pigpio PIGPIO_ADDR=raspberrypi.local python3 led.py
```

[37] https://www.raspberrypi.org/blog/gpio-expander/
[38] http://bennuttall.com/raspberry-pi-zero-gpio-expander/
[39] http://blog.gbaman.info/?p=791
[40] https://learn.adafruit.com/turning-your-raspberry-pi-zero-into-a-usb-gadget/ethernet-gadget

CHAPTER 7

Source/Values

GPIO Zero provides a method of using the declarative programming paradigm to connect devices together: feeding the values of one device into another, for example the values of a button into an LED:



```
from gpiozero import LED, Button
from signal import pause

led = LED(17)
button = Button(2)

led.source = button

pause()
```

which is equivalent to:

```
from gpiozero import LED, Button
from time import sleep

led = LED(17)
button = Button(2)

while True:
    led.value = button.value
    sleep(0.01)
```

except that the former is updated in a background thread, which enables you to do other things at the same time.

Every device has a `value` (page 175) property (the device's current value). Input devices (like buttons) can only have their values read, but output devices (like LEDs) can also have their value set to alter the state of the device:

```
>>> led = PWMLED(17)
>>> led.value  # LED is initially off
0.0
>>> led.on()  # LED is now on
```

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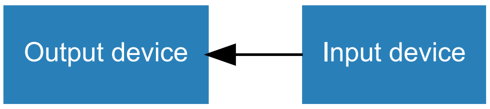
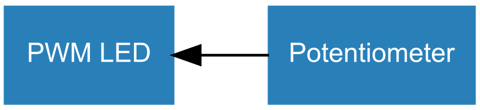
```
>>> led.value
1.0
>>> led.value = 0  # LED is now off
```

Every device also has a `values` (page 176) property (a generator[41] continuously yielding the device's current value). All output devices have a `source` (page 176) property which can be set to any iterator[42]. The device will iterate over the values of the device provided, setting the device's value to each element at a rate specified in the `source_delay` (page 176) property (the default is 0.01 seconds).



The most common use case for this is to set the source of an output device to match the values of an input device, like the example above. A more interesting example would be a potentiometer controlling the brightness of an LED:



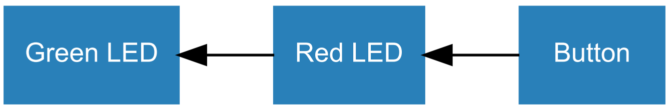
```
from gpiozero import PWMLED, MCP3008
from signal import pause

led = PWMLED(17)
pot = MCP3008()

led.source = pot

pause()
```

The way this works is that the input device's `values` (page 176) property is used to feed values into the output device. Prior to v1.5, the `source` (page 176) had to be set directly to a device's `values` (page 176) property:

```
from gpiozero import PWMLED, MCP3008
from signal import pause

led = PWMLED(17)
pot = MCP3008()

led.source = pot.values

pause()
```

Note: Although this method is still supported, the recommended way is now to set the `source` (page 176) to a device object.

It is also possible to set an output device's `source` (page 176) to another output device, to keep them matching. In this example, the red LED is set to match the button, and the green LED is set to match the red LED, so both LEDs will be on when the button is pressed:

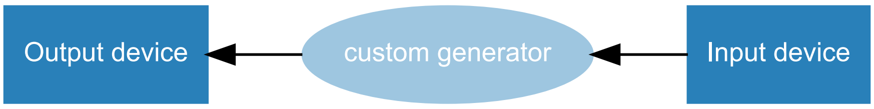


[41] https://wiki.python.org/moin/Generators
[42] https://wiki.python.org/moin/Iterator

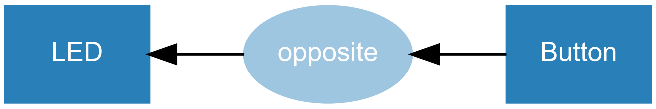
```
from gpiozero import LED, Button
from signal import pause

red = LED(14)
green = LED(15)
button = Button(17)

red.source = button
green.source = red

pause()
```

7.1 Processing values

The device's values can also be processed before they are passed to the `source` (page 176):

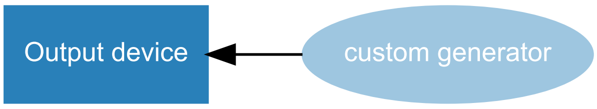


For example, writing a generator function to pass the opposite of the Button value into the LED:

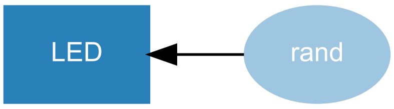


```
from gpiozero import Button, LED
from signal import pause

def opposite(device):
    for value in device.values:
        yield not value

led = LED(4)
btn = Button(17)

led.source = opposite(btn)

pause()
```

Alternatively, a custom generator can be used to provide values from an artificial source:



For example, writing a generator function to randomly yield 0 or 1:



```
from gpiozero import LED
from random import randint
from signal import pause

def rand():
```

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```
    while True:
        yield randint(0, 1)

led = LED(17)
led.source = rand()

pause()
```

If the iterator is infinite (i.e. an infinite generator), the elements will be processed until the *source* (page 176) is changed or set to None[43].

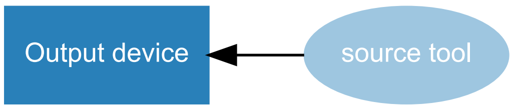
If the iterator is finite (e.g. a list), this will terminate once all elements are processed (leaving the device's value at the final element):

```
from gpiozero import LED
from signal import pause

led = LED(17)
led.source_delay = 1
led.source = [1, 0, 1, 1, 1, 0, 0, 1, 0, 1]

pause()
```

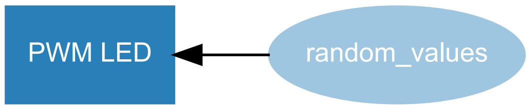
7.2 Source Tools

GPIO Zero provides a set of ready-made functions for dealing with source/values, called source tools. These are available by importing from *gpiozero.tools* (page 179).

Some of these source tools are artificial sources which require no input:



In this example, random values between 0 and 1 are passed to the LED, giving it a flickering candle effect:

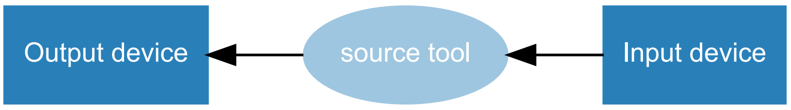


```
from gpiozero import PWMLED
from gpiozero.tools import random_values
from signal import pause

led = PWMLED(4)
led.source = random_values()
led.source_delay = 0.1

pause()
```

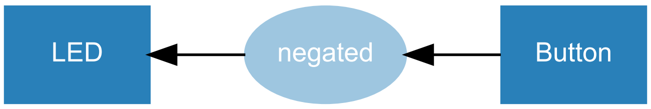
Note that in the above example, *source_delay* (page 176) is used to make the LED iterate over the random values slightly slower. *source_delay* (page 176) can be set to a larger number (e.g. 1 for a one second delay) or set to 0 to disable any delay.

Some tools take a single source and process its values:

[43] https://docs.python.org/3.5/library/constants.html#None



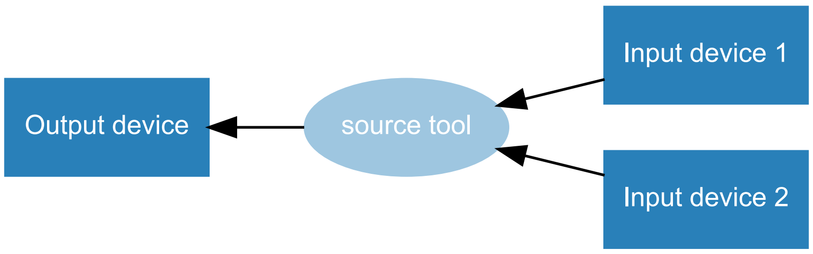
In this example, the LED is lit only when the button is not pressed:



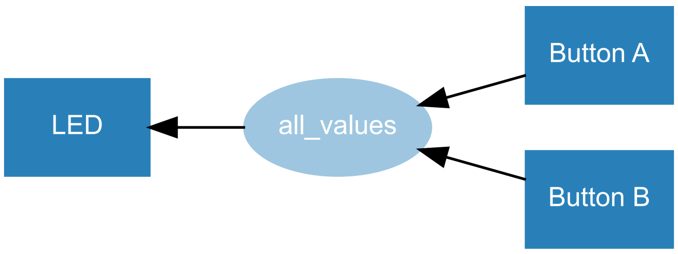
```
from gpiozero import Button, LED
from gpiozero.tools import negated
from signal import pause

led = LED(4)
btn = Button(17)

led.source = negated(btn)

pause()
```

Note: Note that source tools which take one or more `value` parameters support passing either *`ValuesMixin`* (page 176) derivatives, or iterators, including a device's *`values`* (page 176) property.

Some tools combine the values of multiple sources:



In this example, the LED is lit only if both buttons are pressed (like an AND[44] gate):

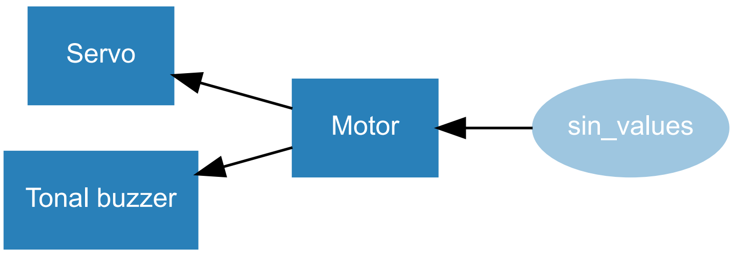


```
from gpiozero import Button, LED
from gpiozero.tools import all_values
from signal import pause

button_a = Button(2)
button_b = Button(3)
led = LED(17)

led.source = all_values(button_a, button_b)

pause()
```

[44] https://en.wikipedia.org/wiki/AND_gate

Similarly, `any_values()` (page 183) with two buttons would simulate an OR[45] gate.

While most devices have a `value` (page 175) range between 0 and 1, some have a range between -1 and 1 (e.g. `Motor` (page 120), `Servo` (page 123) and `TonalBuzzer` (page 119)). Some source tools output values between -1 and 1, which are ideal for these devices, for example passing `sin_values()` (page 185) in:

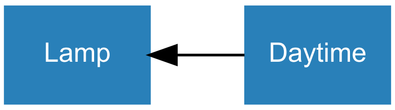


```
from gpiozero import Motor, Servo, TonalBuzzer
from gpiozero.tools import sin_values
from signal import pause

motor = Motor(2, 3)
servo = Servo(4)
buzzer = TonalBuzzer(5)

motor.source = sin_values()
servo.source = motor
buzzer.source = motor

pause()
```

In this example, all three devices are following the sine wave[46]. The motor value ramps up from 0 (stopped) to 1 (full speed forwards), then back down to 0 and on to -1 (full speed backwards) in a cycle. Similarly, the servo moves from its mid point to the right, then towards the left; and the buzzer starts with its mid tone, gradually raises its frequency, to its highest tone, then down towards its lowest tone. Note that setting `source_delay` (page 176) will alter the speed at which the device iterates through the values. Alternatively, the tool `cos_values()` (page 185) could be used to start from -1 and go up to 1, and so on.

7.3 Internal devices

GPIO Zero also provides several *internal devices* (page 167) which represent facilities provided by the operating system itself. These can be used to react to things like the time of day, or whether a server is available on the network. These classes include a `values` (page 176) property which can be used to feed values into a device's `source` (page 176). For example, a lamp connected to an `Energenie` (page 159) socket can be controlled by a `TimeOfDay` (page 167) object so that it is on between the hours of 8am and 8pm:



```
from gpiozero import Energenie, TimeOfDay
from datetime import time
from signal import pause

lamp = Energenie(1)
daytime = TimeOfDay(time(8), time(20))

lamp.source = daytime
```

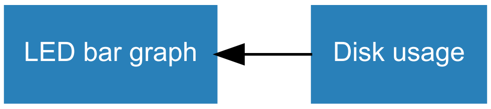
(continues on next page)

[45] https://en.wikipedia.org/wiki/OR_gate
[46] https://en.wikipedia.org/wiki/Sine_wave

(continued from previous page)

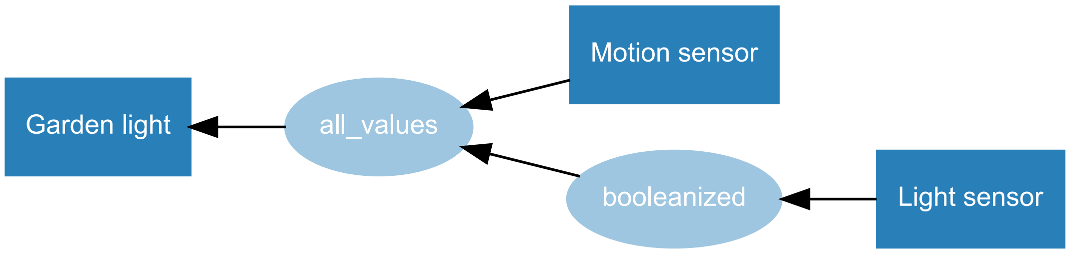
```
lamp.source_delay = 60

pause()
```

Using the `DiskUsage` (page 171) class with `LEDBarGraph` (page 144) can show your Pi's disk usage percentage on a bar graph:



```
from gpiozero import DiskUsage, LEDBarGraph
from signal import pause

disk = DiskUsage()
graph = LEDBarGraph(2, 3, 4, 5, 6, 7, 8)

graph.source = disk

pause()
```

Demonstrating a garden light system whereby the light comes on if it's dark and there's motion is simple enough, but it requires using the `booleanized()` (page 179) source tool to convert the light sensor from a float value into a boolean:



```
from gpiozero import LED, MotionSensor, LightSensor
from gpiozero.tools import booleanized, all_values
from signal import pause

garden = LED(2)
motion = MotionSensor(4)
light = LightSensor(5)

garden.source = all_values(booleanized(light, 0, 0.1), motion)

pause()
```

7.4 Composite devices

The `value` (page 175) of a composite device made up of the nested values of its devices. For example, the value of a `Robot` (page 155) object is a 2-tuple containing its left and right motor values:

```
>>> from gpiozero import Robot
>>> robot = Robot(left=(14, 15), right=(17, 18))
>>> robot.value
RobotValue(left_motor=0.0, right_motor=0.0)
>>> tuple(robot.value)
(0.0, 0.0)
```

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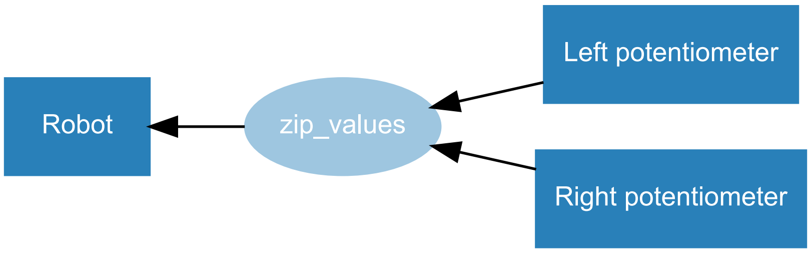
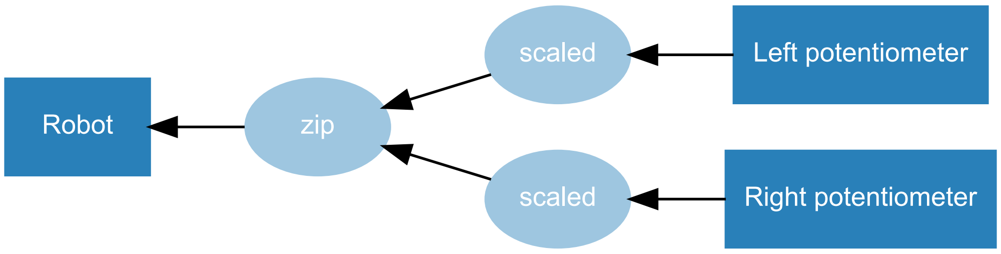
```
>>> robot.forward()
>>> tuple(robot.value)
(1.0, 1.0)
>>> robot.backward()
>>> tuple(robot.value)
(-1.0, -1.0)
>>> robot.value = (1, 1)  # robot is now driven forwards
```

Use two potentiometers to control the left and right motor speed of a robot:



```
from gpiozero import Robot, MCP3008
from gpiozero.tools import zip_values
from signal import pause

robot = Robot(left=(4, 14), right=(17, 18))

left_pot = MCP3008(0)
right_pot = MCP3008(1)

robot.source = zip_values(left_pot, right_pot)

pause()
```

To include reverse direction, scale the potentiometer values from 0->1 to -1->1:



```
from gpiozero import Robot, MCP3008
from gpiozero.tools import scaled
from signal import pause

robot = Robot(left=(4, 14), right=(17, 18))

left_pot = MCP3008(0)
right_pot = MCP3008(1)

robot.source = zip(scaled(left_pot, -1, 1), scaled(right_pot, -1, 1))

pause()
```

Note that this example uses the built-in `zip()`[47] rather than the tool *`zip_values()`* (page 184) as the *`scaled()`* (page 182) tool yields values which do not need converting, just zipping. Also note that this use

[47] https://docs.python.org/3.5/library/functions.html#zip

of `zip()`[48] will not work in Python 2, instead use izip[49].

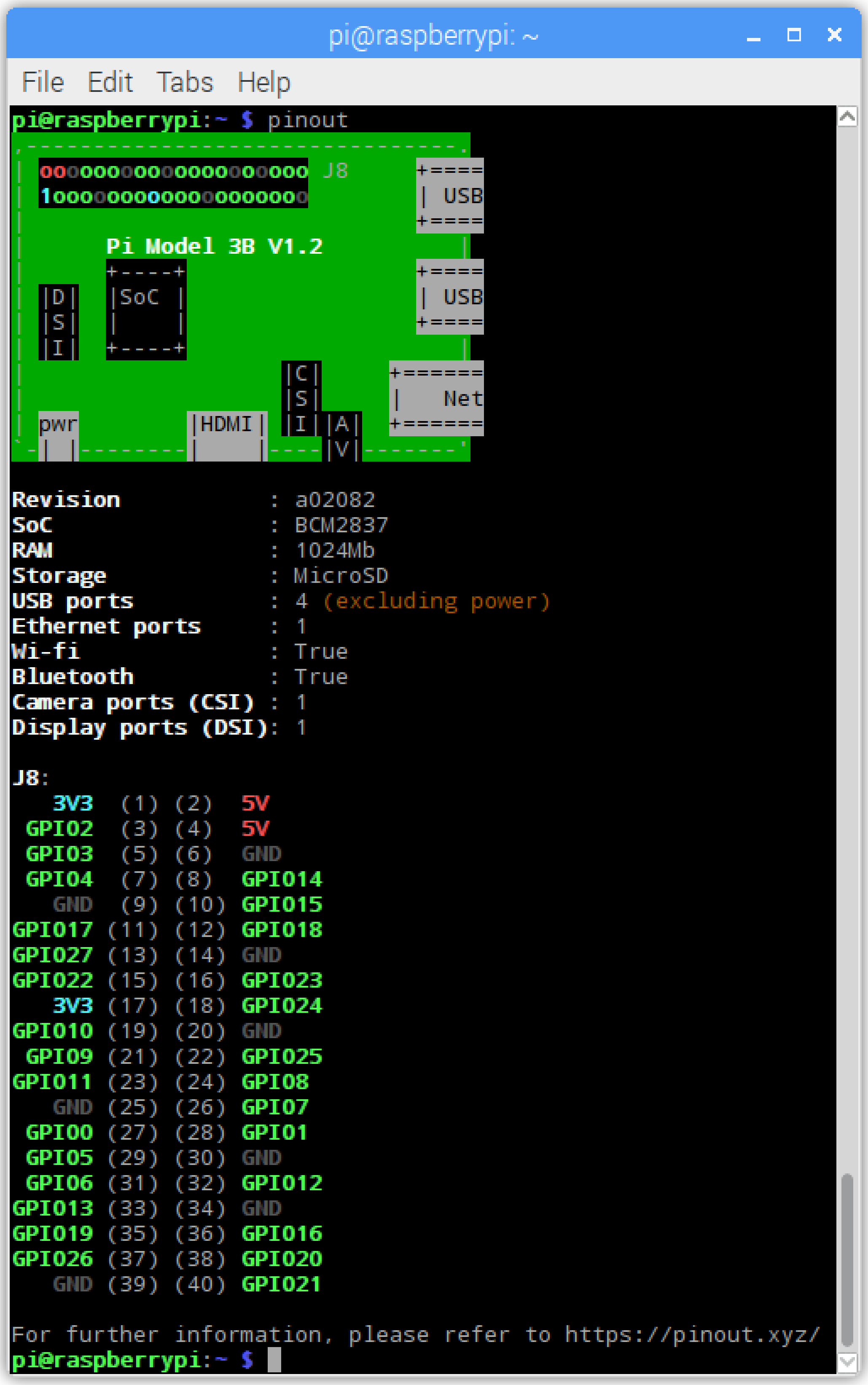
[48] https://docs.python.org/3.5/library/functions.html#zip
[49] https://docs.python.org/2/library/itertools.html#itertools.izip

CHAPTER 8

Command-line Tools

The gpiozero package contains a database of information about the various revisions of Raspberry Pi. This is queried by the **`pinout`** command-line tool to output details of the GPIO pins available.

8.1 pinout



```
pi@raspberrypi:~ $ pinout
,--------------------------------.
| oooooooooooooooooooo J8     +====
| 1ooooooooooooooooooo        | USB
|                             +====
|      Pi Model 3B V1.2          |
|      +----+                 +====
| |D|  |SoC |                 | USB
| |S|  |    |                 +====
| |I|  +----+                    |
|                   |C|     +======
|                   |S|     |   Net
| pwr        |HDMI| |I||A|  +======
`-| |--------|    |----|V|-------'

Revision           : a02082
SoC                : BCM2837
RAM                : 1024Mb
Storage            : MicroSD
USB ports          : 4 (excluding power)
Ethernet ports     : 1
Wi-fi              : True
Bluetooth          : True
Camera ports (CSI) : 1
Display ports (DSI): 1

J8:
   3V3  (1) (2)  5V
 GPIO2  (3) (4)  5V
 GPIO3  (5) (6)  GND
 GPIO4  (7) (8)  GPIO14
   GND  (9) (10) GPIO15
GPIO17 (11) (12) GPIO18
GPIO27 (13) (14) GND
GPIO22 (15) (16) GPIO23
   3V3 (17) (18) GPIO24
GPIO10 (19) (20) GND
 GPIO9 (21) (22) GPIO25
GPIO11 (23) (24) GPIO8
   GND (25) (26) GPIO7
 GPIO0 (27) (28) GPIO1
 GPIO5 (29) (30) GND
 GPIO6 (31) (32) GPIO12
GPIO13 (33) (34) GND
GPIO19 (35) (36) GPIO16
GPIO26 (37) (38) GPIO20
   GND (39) (40) GPIO21

For further information, please refer to https://pinout.xyz/
pi@raspberrypi:~ $
```

8.1.1 Synopsis

```
pinout [-h] [-r REVISION] [-c] [-m] [-x]
```

8.1.2 Description

A utility for querying Raspberry Pi GPIO pin-out information. Running **pinout** on its own will output a board diagram, and GPIO header diagram for the current Raspberry Pi. It is also possible to manually specify a revision of Pi, or (by *Configuring Remote GPIO* (page 43)) to output information about a remote Pi.

8.1.3 Options

-h, --help
show this help message and exit

-r REVISION**, --revision** REVISION
RPi revision. Default is to autodetect revision of current device

-c, --color
Force colored output (by default, the output will include ANSI color codes if run in a color-capable terminal). See also `--monochrome` (page 71)

-m, --monochrome
Force monochrome output. See also `--color` (page 71)

-x, --xyz
Open pinout.xyz[50] in the default web browser

8.1.4 Examples

To output information about the current Raspberry Pi:

```
$ pinout
```

For a Raspberry Pi model 3B, this will output something like the following:

```
,--------------------------------.
| oooooooooooooooooooo J8     +====
| 1ooooooooooooooooooo        | USB
|                             +====
|      Pi Model 3B V1.1          |
|      +----+                 +====
| |D|  |SoC |                 | USB
| |S|  |    |                 +====
| |I|  +----+                    |
|                   |C|     +======
|                   |S|     |   Net
| pwr        |HDMI| |I||A|  +======
`-| |--------|    |----|V|-------'

Revision           : a02082
SoC                : BCM2837
RAM                : 1024Mb
Storage            : MicroSD
USB ports          : 4 (excluding power)
Ethernet ports     : 1
Wi-fi              : True
```

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[50] https://pinout.xyz/

(continued from previous page)

```
Bluetooth           : True
Camera ports (CSI)  : 1
Display ports (DSI): 1

J8:
   3V3  (1)  (2)   5V
 GPIO2  (3)  (4)   5V
 GPIO3  (5)  (6)   GND
 GPIO4  (7)  (8)   GPIO14
   GND  (9)  (10)  GPIO15
GPIO17 (11)  (12)  GPIO18
GPIO27 (13)  (14)  GND
GPIO22 (15)  (16)  GPIO23
   3V3 (17)  (18)  GPIO24
GPIO10 (19)  (20)  GND
 GPIO9 (21)  (22)  GPIO25
GPIO11 (23)  (24)  GPIO8
   GND (25)  (26)  GPIO7
 GPIO0 (27)  (28)  GPIO1
 GPIO5 (29)  (30)  GND
 GPIO6 (31)  (32)  GPIO12
GPIO13 (33)  (34)  GND
GPIO19 (35)  (36)  GPIO16
GPIO26 (37)  (38)  GPIO20
   GND (39)  (40)  GPIO21
```

By default, if stdout is a console that supports color, ANSI codes will be used to produce color output. Output can be forced to be *--monochrome* (page 71):

```
$ pinout --monochrome
```

Or forced to be *--color* (page 71), in case you are redirecting to something capable of supporting ANSI codes:

```
$ pinout --color | less -SR
```

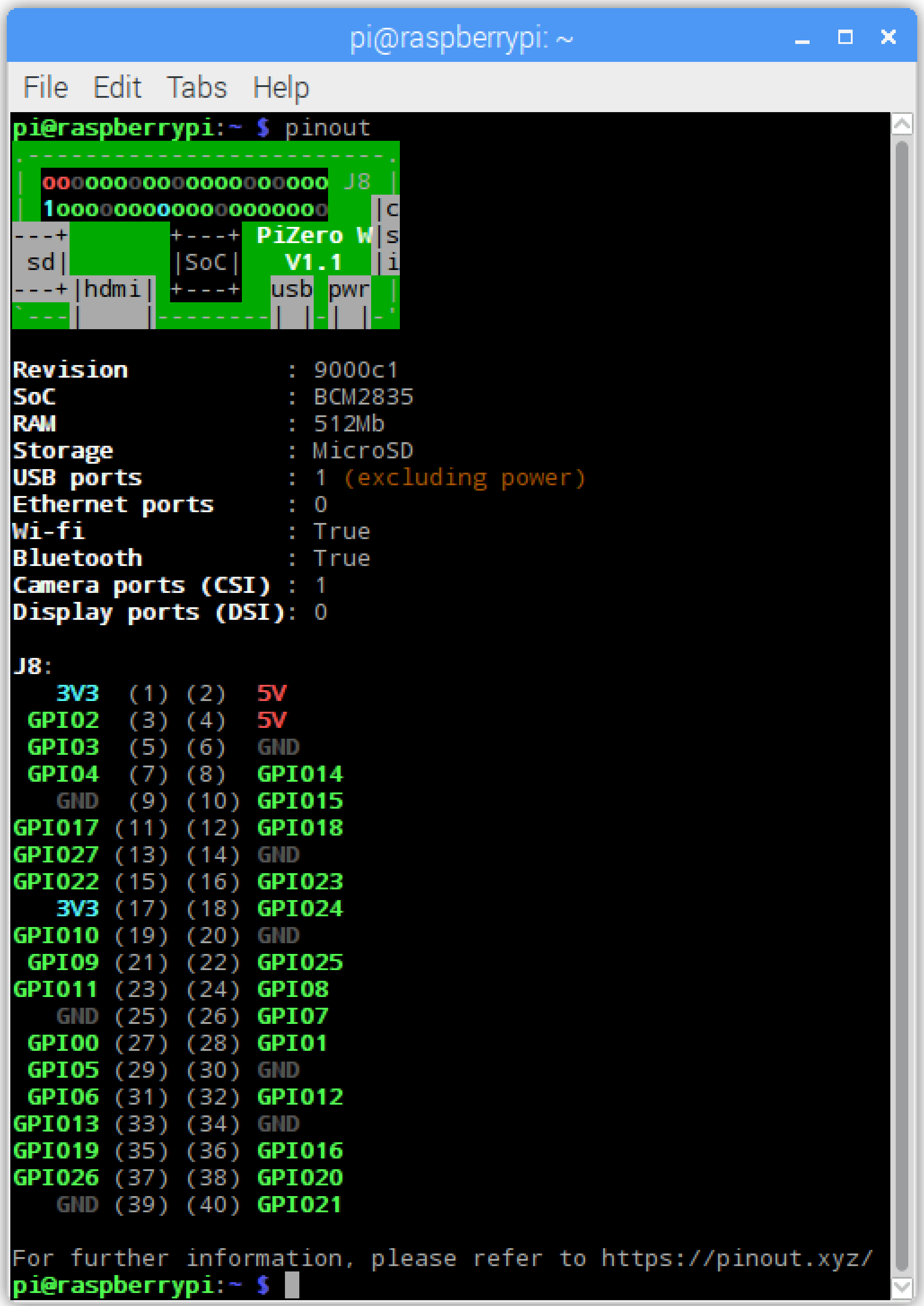
To manually specify the revision of Pi you want to query, use *--revision* (page 71). The tool understands both old-style revision codes[51] (such as for the model B):

```
$ pinout -r 000d
```

Or new-style revision codes[52] (such as for the Pi Zero W):

```
$ pinout -r 9000c1
```

[51] https://www.raspberrypi.org/documentation/hardware/raspberrypi/revision-codes/README.md
[52] https://www.raspberrypi.org/documentation/hardware/raspberrypi/revision-codes/README.md



```
pi@raspberrypi:~ $ pinout
.-------------------------.
| oooooooooooooooooooo J8 |
| 1ooooooooooooooooooo  |c
---+       +---+ PiZero W|s
 sd|       |SoC|   V1.1  |i
---+|hdmi| +---+  usb pwr |
`---|    |--------| |-| |-'

Revision           : 9000c1
SoC                : BCM2835
RAM                : 512Mb
Storage            : MicroSD
USB ports          : 1 (excluding power)
Ethernet ports     : 0
Wi-fi              : True
Bluetooth          : True
Camera ports (CSI) : 1
Display ports (DSI): 0

J8:
   3V3  (1) (2)  5V
 GPIO2  (3) (4)  5V
 GPIO3  (5) (6)  GND
 GPIO4  (7) (8)  GPIO14
   GND  (9) (10) GPIO15
GPIO17 (11) (12) GPIO18
GPIO27 (13) (14) GND
GPIO22 (15) (16) GPIO23
   3V3 (17) (18) GPIO24
GPIO10 (19) (20) GND
 GPIO9 (21) (22) GPIO25
GPIO11 (23) (24) GPIO8
   GND (25) (26) GPIO7
 GPIO0 (27) (28) GPIO1
 GPIO5 (29) (30) GND
 GPIO6 (31) (32) GPIO12
GPIO13 (33) (34) GND
GPIO19 (35) (36) GPIO16
GPIO26 (37) (38) GPIO20
   GND (39) (40) GPIO21

For further information, please refer to https://pinout.xyz/
pi@raspberrypi:~ $
```

You can also use the tool with *Configuring Remote GPIO* (page 43) to query remote Raspberry Pi's:

```
$ GPIOZERO_PIN_FACTORY=pigpio PIGPIO_ADDR=other_pi pinout
```

Or run the tool directly on a PC using the mock pin implementation (although in this case you'll almost certainly want to specify the Pi revision manually):

```
$ GPIOZERO_PIN_FACTORY=mock pinout -r a22042
```

8.1.5 Environment Variables

GPIOZERO_PIN_FACTORY
The library to use when communicating with the GPIO pins. Defaults to attempting to load RPi.GPIO, then RPIO, then pigpio, and finally uses a native Python implementation. Valid values include "rpigpio", "rpio", "pigpio", "native", and "mock". The latter is most useful on non-Pi platforms as it emulates a Raspberry Pi model 3B (by default).

PIGPIO_ADDR
The hostname of the Raspberry Pi the pigpio library should attempt to connect to (if the pigpio pin factory is being used). Defaults to `localhost`.

PIGPIO_PORT
The port number the pigpio library should attempt to connect to (if the pigpio pin factory is being used). Defaults to `8888`.

CHAPTER 9

Frequently Asked Questions

9.1 How do I keep my script running?

The following script looks like it should turn an *LED* (page 111) on:

```
from gpiozero import LED

led = LED(17)
led.on()
```

And it does, if you're using the Python (or IPython or IDLE) shell. However, if you saved this script as a Python file and ran it, it would flash on briefly, then the script would end and it would turn off.

The following file includes an intentional `pause()`[53] to keep the script alive:

```
from gpiozero import LED
from signal import pause

led = LED(17)
led.on()

pause()
```

Now the script will stay running, leaving the LED on, until it is terminated manually (e.g. by pressing Ctrl+C). Similarly, when setting up callbacks on button presses or other input devices, the script needs to be running for the events to be detected:

```
from gpiozero import Button
from signal import pause

def hello():
    print("Hello")

button = Button(2)
button.when_pressed = hello

pause()
```

[53] https://docs.python.org/3.5/library/signal.html#signal.pause

9.2 My event handler isn't being called

When assigning event handlers, don't call the function you're assigning. For example:

```
from gpiozero import Button

def pushed():
    print("Don't push the button!")

b = Button(17)
b.when_pressed = pushed()
```

In the case above, when assigning to *when_pressed* (page 95), the thing that is assigned is the *result of calling* the pushed function. Because pushed doesn't explicitly return anything, the result is None[54]. Hence this is equivalent to doing:

```
b.when_pressed = None
```

This doesn't raise an error because it's perfectly valid: it's what you assign when you don't want the event handler to do anything. Instead, you want to do the following:

```
b.when_pressed = pushed
```

This will assign the function to the event handler *without calling it*. This is the crucial difference between `my_function` (a reference to a function) and `my_function()` (the result of calling a function).

Note: Note that as of v1.5, setting a callback to None when it was previously None will raise a *CallbackSetToNone* (page 216) warning, with the intention of alerting users when callbacks are set to None accidentally. However, if this is intentional, the warning can be suppressed. See the warnings[55] module for reference.

9.3 Why do I get PinFactoryFallback warnings when I import gpiozero?

You are most likely working in a virtual Python environment and have forgotten to install a pin driver library like `RPi.GPIO`. GPIO Zero relies upon lower level pin drivers to handle interfacing to the GPIO pins on the Raspberry Pi, so you can eliminate the warning simply by installing GPIO Zero's first preference:

```
$ pip install rpi.gpio
```

When GPIO Zero is imported it attempts to find a pin driver by importing them in a preferred order (detailed in *API - Pins* (page 195)). If it fails to load its first preference (`RPi.GPIO`) it notifies you with a warning, then falls back to trying its second preference and so on. Eventually it will fall back all the way to the `native` implementation. This is a pure Python implementation built into GPIO Zero itself. While this will work for most things it's almost certainly not what you want (it doesn't support PWM, and it's quite slow at certain things).

If you want to use a pin driver other than the default, and you want to suppress the warnings you've got a couple of options:

1. Explicitly specify what pin driver you want via the *GPIOZERO_PIN_FACTORY* (page 74) environment variable. For example:

   ```
   $ GPIOZERO_PIN_FACTORY=pigpio python3
   ```

[54] https://docs.python.org/3.5/library/constants.html#None
[55] https://docs.python.org/3.5/library/warnings.html#module-warnings

In this case no warning is issued because there's no fallback; either the specified factory loads or it fails in which case an `ImportError`[56] will be raised.

2. Suppress the warnings and let the fallback mechanism work:

```
>>> import warnings
>>> warnings.simplefilter('ignore')
>>> import gpiozero
```

Refer to the `warnings`[57] module documentation for more refined ways to filter out specific warning classes.

9.4 How can I tell what version of gpiozero I have installed?

The gpiozero library relies on the setuptools package for installation services. You can use the setuptools `pkg_resources` API to query which version of gpiozero is available in your Python environment like so:

```
>>> from pkg_resources import require
>>> require('gpiozero')
[gpiozero 1.4.1 (/usr/lib/python3/dist-packages)]
>>> require('gpiozero')[0].version
'1.4.1'
```

If you have multiple versions installed (e.g. from **`pip`** and **`apt`**) they will not show up in the list returned by the `pkg_resources.require()` method. However, the first entry in the list will be the version that `import gpiozero` will import.

If you receive the error "No module named pkg_resources", you need to install **`pip`**. This can be done with the following command in Raspbian:

```
$ sudo apt install python3-pip
```

Alternatively, install pip with get-pip[58].

9.5 Why do I get "command not found" when running pinout?

The gpiozero library is available as a Debian package for Python 2 and Python 3, but the cli_pinout tool cannot be made available by both packages, so it's only included with the Python 3 version of the package. To make sure the cli_pinout tool is available, the "python3-gpiozero" package must be installed:

```
$ sudo apt install python3-gpiozero
```

Alternatively, installing gpiozero using **`pip`** will install the command line tool, regardless of Python version:

```
$ sudo pip3 install gpiozero
```

or:

```
$ sudo pip install gpiozero
```

[56] https://docs.python.org/3.5/library/exceptions.html#ImportError
[57] https://docs.python.org/3.5/library/warnings.html#module-warnings
[58] https://pip.pypa.io/en/stable/installing/

9.6 The pinout command line tool incorrectly identifies my Raspberry Pi model

If your Raspberry Pi model is new, it's possible it wasn't known about at the time of the gpiozero release you are using. Ensure you have the latest version installed (remember, the cli_pinout tool usually comes from the Python 3 version of the package as noted in the previous FAQ).

If the Pi model you are using isn't known to gpiozero, it may have been added since the last release. You can check the GitHub issues[59] to see if it's been reported before, or check the commits[60] on GitHub since the last release to see if it's been added. The model determination can be found in `gpiozero/pins/data.py`.

9.7 What's the gpiozero equivalent of GPIO.cleanup()?

Many people ask how to do the equivalent of the `cleanup` function from `RPi.GPIO`. In gpiozero, at the end of your script, cleanup is run automatically, restoring your GPIO pins to the state they were found.

To explicitly close a connection to a pin, you can manually call the *`close()`* (page 175) method on a device object:

```
>>> led = LED(2)
>>> led.on()
>>> led
<gpiozero.LED object on pin GPIO2, active_high=True, is_active=True>
>>> led.close()
>>> led
<gpiozero.LED object closed>
```

This means that you can reuse the pin for another device, and that despite turning the LED on (and hence, the pin high), after calling *`close()`* (page 175) it is restored to its previous state (LED off, pin low).

9.8 How do I use button.when_pressed and button.when_held together?

The *`Button`* (page 93) class provides a *`when_held`* (page 95) property which is used to set a callback for when the button is held down for a set amount of time (as determined by the *`hold_time`* (page 95) property). If you want to set *`when_held`* (page 95) as well as *`when_pressed`* (page 95), you'll notice that both callbacks will fire. Sometimes, this is acceptable, but often you'll want to only fire the *`when_pressed`* (page 95) callback when the button has not been held, only pressed.

The way to achieve this is to *not* set a callback on *`when_pressed`* (page 95), and instead use *`when_released`* (page 95) to work out whether it had been held or just pressed:

```
from gpiozero import Button

Button.was_held = False

def held(btn):
    btn.was_held = True
    print("button was held not just pressed")

def released(btn):
    if not btn.was_held:
        pressed()
```

(continues on next page)

[59] https://github.com/RPi-Distro/python-gpiozero/issues
[60] https://github.com/RPi-Distro/python-gpiozero/commits/master

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```
    btn.was_held = False

def pressed():
    print("button was pressed not held")

btn = Button(2)

btn.when_held = held
btn.when_released = released
```

9.9 Why do I get "ImportError: cannot import name" when trying to import from gpiozero?

It's common to see people name their first gpiozero script `gpiozero.py`. Unfortunately, this will cause your script to try to import itself, rather than the gpiozero library from the libraries path. You'll see an error like this:

```
Traceback (most recent call last):
  File "gpiozero.py", line 1, in <module>
    from gpiozero import LED
  File "/home/pi/gpiozero.py", line 1, in <module>
    from gpiozero import LED
ImportError: cannot import name 'LED'
```

Simply rename your script to something else, and run it again. Be sure not to name any of your scripts the same name as a Python module you may be importing, such as `picamera.py`.

9.10 Why do I get an AttributeError trying to set attributes on a device object?

If you try to add an attribute to a gpiozero device object after its initialization, you'll find you can't:

```
>>> from gpiozero import Button
>>> btn = Button(2)
>>> btn.label = 'alarm'
Traceback (most recent call last):
  File "<stdin>", line 1, in <module>
  File "/usr/lib/python3/dist-packages/gpiozero/devices.py", line 118, in __
↪setattr__
    self.__class__.__name__, name))
AttributeError: 'Button' object has no attribute 'label'
```

This is in order to prevent users accidentally setting new attributes by mistake. Because gpiozero provides functionality through setting attributes via properties, such as callbacks on buttons (and often there is no immediate feedback when setting a property), this could lead to bugs very difficult to find. Consider the following example:

```
from gpiozero import Button

def hello():
    print("hello")

btn = Button(2)

btn.pressed = hello
```

This is perfectly valid Python code, and no errors would occur, but the program would not behave as expected: pressing the button would do nothing, because the property for setting a callback is `when_pressed` not `pressed`. But without gpiozero preventing this non-existent attribute from being set, the user would likely struggle to see the mistake.

If you really want to set a new attribute on a device object, you need to create it in the class before initializing your object:

```
>>> from gpiozero import Button
>>> Button.label = ''
>>> btn = Button(2)
>>> btn.label = 'alarm'
>>> def press(btn):
...:    print(btn.label, "was pressed")
>>> btn.when_pressed = press
```

9.11 Why is it called GPIO Zero? Does it only work on Pi Zero?

gpiozero works on all Raspberry Pi models, not just the Pi Zero.

The "zero" is part of a naming convention for "zero-boilerplate" education friendly libraries, which started with Pygame Zero[61], and has been followed by NetworkZero[62], guizero[63] and more.

These libraries aim to remove barrier to entry and provide a smooth learning curve for beginners by making it easy to get started and easy to build up to more advanced projects.

[61] https://pygame-zero.readthedocs.io/en/stable/
[62] https://networkzero.readthedocs.io/en/latest/
[63] https://lawsie.github.io/guizero/

CHAPTER 10

Migrating from RPi.GPIO

If you are familiar with the RPi.GPIO[64] library, you will be used to writing code which deals with *pins* and the *state of pins*. You will see from the examples in this documentation that we generally refer to things like LEDs and Buttons rather than input pins and output pins.

GPIO Zero provides classes which represent *devices*, so instead of having a pin number and telling it to go high, you have an LED and you tell it to turn on, and instead of having a pin number and asking if it's high or low, you have a button and ask if it's pressed. There is also no boilerplate code to get started — you just import the parts you need.

GPIO Zero provides many device classes, each with specific methods and properties bespoke to that device. For example, the functionality for an HC-SR04 Distance Sensor can be found in the `DistanceSensor` (page 101) class.

As well as specific device classes, we provide base classes `InputDevice` (page 107) and `OutputDevice` (page 129). One main difference between these and the equivalents in RPi.GPIO is that they are classes, not functions, which means that you initialize one to begin, and provide its pin number, but then you never need to use the pin number again, as it's stored by the object.

GPIO Zero was originally just a layer on top of RPi.GPIO, but we later added support for various other underlying pin libraries. RPi.GPIO is currently the default pin library used. Read more about this in *Changing the pin factory* (page 196).

10.1 Output devices

Turning an LED on in RPi.GPIO[65]:

```
import RPi.GPIO as GPIO

GPIO.setmode(GPIO.BCM)
GPIO.setwarnings(False)

GPIO.setup(2, GPIO.OUT)

GPIO.output(2, GPIO.HIGH)
```

[64] https://pypi.org/project/RPi.GPIO/
[65] https://pypi.org/project/RPi.GPIO/

Turning an LED on in GPIO Zero:

```
from gpiozero import LED

led = LED(2)

led.on()
```

The `LED` (page 111) class also supports threaded blinking through the `blink()` (page 112) method.

`OutputDevice` (page 129) is the base class for output devices, and can be used in a similar way to output devices in RPi.GPIO.

See a full list of supported *output devices* (page 111). Other output devices have similar property and method names. There is commonality in naming at base level, such as `OutputDevice.is_active`, which is aliased in a device class, such as `LED.is_lit` (page 112).

10.2 Input devices

Reading a button press in RPi.GPIO[66]:

```
import RPi.GPIO as GPIO

GPIO.setmode(GPIO.BCM)
GPIO.setwarnings(False)

GPIO.setup(4, GPIO.IN, GPIO.PUD_UP)

if not GPIO.input(4):
    print("button is pressed")
```

Reading a button press in GPIO Zero:

```
from gpiozero import Button

btn = Button(4)

if btn.is_pressed:
    print("button is pressed")
```

Note that in the RPi.GPIO example, the button is set up with the option `GPIO.PUD_UP` which means "pull-up", and therefore when the button is not pressed, the pin is high. When the button is pressed, the pin goes low, so the condition requires negation (`if not`). If the button was configured as pull-down, the logic is reversed and the condition would become `if GPIO.input(4):`

```
import RPi.GPIO as GPIO

GPIO.setmode(GPIO.BCM)
GPIO.setwarnings(False)

GPIO.setup(4, GPIO.IN, GPIO.PUD_DOWN)

if GPIO.input(4):
    print("button is pressed")
```

In GPIO Zero, the default configuration for a button is pull-up, but this can be configured at initialization, and the rest of the code stays the same:

[66] https://pypi.org/project/RPi.GPIO/

```
from gpiozero import Button

btn = Button(4, pull_up=False)

if btn.is_pressed:
    print("button is pressed")
```

RPi.GPIO also supports blocking edge detection.

Wait for a pull-up button to be pressed in RPi.GPIO:

```
import RPi.GPIO as GPIO

GPIO.setmode(GPIO.BCM)
GPIO.setwarnings(False)

GPIO.setup(4, GPIO.IN, GPIO.PUD_UP)

GPIO.wait_for_edge(4, GPIO.FALLING):
print("button was pressed")
```

The equivalent in GPIO Zero:

```
from gpiozero import Buttons

btn = Button(4)

btn.wait_for_press()
print("button was pressed")
```

Again, if the button is pulled down, the logic is reversed. Instead of waiting for a falling edge, we're waiting for a rising edge:

```
import RPi.GPIO as GPIO

GPIO.setmode(GPIO.BCM)
GPIO.setwarnings(False)

GPIO.setup(4, GPIO.IN, GPIO.PUD_UP)

GPIO.wait_for_edge(4, GPIO.FALLING):
print("button was pressed")
```

Again, in GPIO Zero, the only difference is in the initialization:

```
from gpiozero import Buttons

btn = Button(4, pull_up=False)

btn.wait_for_press()
print("button was pressed")
```

RPi.GPIO has threaded callbacks. You create a function (which must take one argument), and pass it in to `add_event_detect`, along with the pin number and the edge direction:

```
import RPi.GPIO as GPIO

GPIO.setmode(GPIO.BCM)
GPIO.setwarnings(False)

def pressed(pin):
    print("button was pressed")
```

(continues on next page)

(continued from previous page)

```

def released(pin):
    print("button was released")

GPIO.setup(4, GPIO.IN, GPIO.PUD_UP)

GPIO.add_event_detect(4, GPIO.FALLING, pressed)
GPIO.add_event_detect(4, GPIO.RISING, released)
```

In GPIO Zero, you assign the *when_pressed* (page 95) and *when_released* (page 95) properties to set up callbacks on those actions:

```
from gpiozero import Buttons

def pressed():
    print("button was pressed")

def released():
    print("button was released")

btn = Button(4)

btn.when_pressed = pressed
btn.when_released = released
```

when_held (page 95) is also provided, where the length of time considered a "hold" is configurable.

The callback functions don't have to take any arguments, but if they take one, the button object is passed in, allowing you to determine which button called the function.

InputDevice (page 107) is the base class for input devices, and can be used in a similar way to input devices in RPi.GPIO.

See a full list of *input devices* (page 93). Other input devices have similar property and method names. There is commonality in naming at base level, such as *InputDevice.is_active* (page 108), which is aliased in a device class, such as *Button.is_pressed* (page 95) and *LightSensor.light_detected* (page 100).

10.3 Composite devices, boards and accessories

Some devices require connections to multiple pins, for example a distance sensor, a combination of LEDs or a HAT. Some GPIO Zero devices comprise multiple device connections within one object, such as *RGBLED* (page 115), *LEDBoard* (page 141), *DistanceSensor* (page 101), *Motor* (page 120) and *Robot* (page 155).

With RPi.GPIO, you would have one output pin for the trigger, and one input pin for the echo. You would time the echo and calculate the distance. With GPIO Zero, you create a single *DistanceSensor* (page 101) object, specifying the trigger and echo pins, and you would read the *DistanceSensor.distance* (page 102) property which automatically calculates the distance within the implementation of the class.

The *Motor* (page 120) class controls two output pins to drive the motor forwards or backwards. The *Robot* (page 155) class controls four output pins (two motors) in the right combination to drive a robot forwards or backwards, and turn left and right.

The *LEDBoard* (page 141) class takes an arbitrary number of pins, each controlling a single LED. The resulting *LEDBoard* (page 141) object can be used to control all LEDs together (all on / all off), or individually by index. Also the object can be iterated over to turn LEDs on in order. See examples of this (including slicing) in the *advanced recipes* (page 35).

10.4 PWM (Pulse-width modulation)

Both libraries support software PWM control on any pin. Depending on the pin library used, GPIO Zero can also support hardware PWM (using `RPIOPin` or `PiGPIOPin`).

A simple example of using PWM is to control the brightness of an LED.

In RPi.GPIO[67]:

```python
import RPi.GPIO as GPIO
from time import sleep

GPIO.setmode(GPIO.BCM)
GPIO.setwarnings(False)

GPIO.setup(2, GPIO.OUT)
pwm = GPIO.PWM(2, 100)
pwm.start(0)

for dc in range(100):
    pwm.changeDutyCycle(dc)
    sleep(0.01)
```

In GPIO Zero:

```python
from gpiozero import PWMLED
from time import sleep

led = PWMLED(2)

for b in range(100):
    led.value = b / 100
    sleep(0.01)
```

`PWMLED` (page 113) has a *`blink()`* (page 113) method which can be used the same was as *`LED`* (page 111)'s *`blink()`* (page 112) method, but its PWM capabilities allow for `fade_in` and `fade_out` options to be provided. There is also the *`pulse()`* (page 114) method which provides a neat way to have an LED fade in and out repeatedly.

Other devices can make use of PWM, such as motors (for variable speed) and servos. See the *`Motor`* (page 120), *`Servo`* (page 123) and *`AngularServo`* (page 124) classes for information on those. *`Motor`* (page 120) and *`Robot`* (page 155) default to using PWM, but it can be disabled with `pwm=False` at initialization. Servos cannot be used without PWM. Devices containing LEDs default to not using PWM, but `pwm=True` can be specified and any LED objects within the device will be initialized as *`PWMLED`* (page 113) objects.

10.5 Cleanup

Pin state cleanup is explicit in RPi.GPIO, and is done manually with `GPIO.cleanup()` but in GPIO Zero, cleanup is automatically performed on every pin used, at the end of the script. Manual cleanup is possible by use of the *`close()`* (page 175) method on the device.

Read more in the relevant FAQ: *What's the gpiozero equivalent of GPIO.cleanup()?* (page 78)

10.6 Pi Information

RPi.GPIO provides information about the Pi you're using. The equivalent in GPIO Zero is the function *`pi_info()`* (page 189):

[67] https://pypi.org/project/RPi.GPIO/

```
>>> from gpiozero import pi_info
>>> pi = pi_info()
>>> pi
PiBoardInfo(revision='a02082', model='3B', pcb_revision='1.2', released='2016Q1',␣
↪soc='BCM2837', manufacturer='Sony', memory=1024, storage='MicroSD', usb=4,␣
↪ethernet=1, wifi=True, bluetooth=True, csi=1, dsi=1, headers=..., board=...)
>>> pi.soc
'BCM2837'
>>> pi.wifi
True
```

Read more about what `PiBoardInfo` (page 189) provides.

10.7 More

GPIO Zero provides more than just GPIO device support, it includes some support for *SPI devices* (page 133) including a range of analog to digital converters.

Device classes which are compatible with other GPIO devices, but have no relation to GPIO pins, such as `CPUTemperature` (page 169), `TimeOfDay` (page 167), `PingServer` (page 168) and `LoadAverage` (page 170) are also provided.

GPIO Zero features support for multiple pin libraries. The default is to use `RPi.GPIO` to control the pins, but you can choose to use another library, such as `pigpio`, which supports network controlled GPIO. See *Changing the pin factory* (page 196) and *Configuring Remote GPIO* (page 43) for more information.

It is possible to run GPIO Zero on your PC, both for remote GPIO and for testing purposes, using *Mock pins* (page 197).

Another feature of this library is configuring devices to be connected together in a logical way, for example in one line you can say that an LED and button are “paired”, i.e. the button being pressed turns the LED on. Read about this in *Source/Values* (page 59).

10.8 FAQs

Note the following FAQs which may catch out users too familiar with RPi.GPIO:

- *How do I keep my script running?* (page 75)
- *Why do I get PinFactoryFallback warnings when I import gpiozero?* (page 76)
- *What’s the gpiozero equivalent of GPIO.cleanup()?* (page 78)

CHAPTER 11

Contributing

Contributions to the library are welcome! Here are some guidelines to follow.

11.1 Suggestions

Please make suggestions for additional components or enhancements to the codebase by opening an issue[68] explaining your reasoning clearly.

11.2 Bugs

Please submit bug reports by opening an issue[69] explaining the problem clearly using code examples.

11.3 Documentation

The documentation source lives in the docs[70] folder. Contributions to the documentation are welcome but should be easy to read and understand.

11.4 Commit messages and pull requests

Commit messages should be concise but descriptive, and in the form of a patch description, i.e. instructional not past tense ("Add LED example" not "Added LED example").

Commits which close (or intend to close) an issue should include the phrase "fix #123" or "close #123" where `#123` is the issue number, as well as include a short description, for example: "Add LED example, close #123", and pull requests should aim to match or closely match the corresponding issue title.

Copyrights on submissions are owned by their authors (we don't bother with copyright assignments), and we assume that authors are happy for their code to be released under the project's *license* (page 225). Do feel free

[68] https://github.com/RPi-Distro/python-gpiozero/issues
[69] https://github.com/RPi-Distro/python-gpiozero/issues
[70] https://github.com/RPi-Distro/python-gpiozero/tree/master/docs

to add your name to the list of contributors in `README.rst` at the top level of the project in your pull request! Don't worry about adding your name to the copyright headers in whatever files you touch; these are updated automatically from the git metadata before each release.

11.5 Backwards compatibility

Since this library reached v1.0 we aim to maintain backwards-compatibility thereafter. Changes which break backwards-compatibility will not be accepted.

11.6 Python 2/3

The library is 100% compatible with both Python 2.7 and Python 3 from version 3.2 onwards. We intend to drop Python 2 support in 2020 when Python 2 reaches end-of-life[71].

[71] http://legacy.python.org/dev/peps/pep-0373/

CHAPTER 12

Development

The main GitHub repository for the project can be found at:

> https://github.com/RPi-Distro/python-gpiozero

For anybody wishing to hack on the project, we recommend starting off by getting to grips with some simple device classes. Pick something like *LED* (page 111) and follow its heritage backward to *DigitalOutputDevice* (page 127). Follow that back to *OutputDevice* (page 129) and you should have a good understanding of simple output devices along with a grasp of how GPIO Zero relies fairly heavily upon inheritance to refine the functionality of devices. The same can be done for input devices, and eventually more complex devices (composites and SPI based).

12.1 Development installation

If you wish to develop GPIO Zero itself, we recommend obtaining the source by cloning the GitHub repository and then use the "develop" target of the Makefile which will install the package as a link to the cloned repository allowing in-place development (it also builds a tags file for use with vim/emacs with Exuberant's ctags utility). The following example demonstrates this method within a virtual Python environment:

```
$ sudo apt install lsb-release build-essential git git-core \
    exuberant-ctags virtualenvwrapper python-virtualenv python3-virtualenv \
    python-dev python3-dev
```

After installing `virtualenvwrapper` you'll need to restart your shell before commands like **`mkvirtualenv`** will operate correctly. Once you've restarted your shell, continue:

```
$ cd
$ mkvirtualenv -p /usr/bin/python3 python-gpiozero
$ workon python-gpiozero
(python-gpiozero) $ git clone https://github.com/RPi-Distro/python-gpiozero.git
(python-gpiozero) $ cd python-gpiozero
(python-gpiozero) $ make develop
```

You will likely wish to install one or more pin implementations within the virtual environment (if you don't, GPIO Zero will use the "native" pin implementation which is usable at this stage, but doesn't support facilities like PWM):

```
(python-gpiozero) $ pip install rpi.gpio pigpio
```

If you are working on SPI devices you may also wish to install the `spidev` package to provide hardware SPI capabilities (again, GPIO Zero will work without this, but a big-banging software SPI implementation will be used instead which limits bandwidth):

```
(python-gpiozero) $ pip install spidev
```

To pull the latest changes from git into your clone and update your installation:

```
$ workon python-gpiozero
(python-gpiozero) $ cd ~/python-gpiozero
(python-gpiozero) $ git pull
(python-gpiozero) $ make develop
```

To remove your installation, destroy the sandbox and the clone:

```
(python-gpiozero) $ deactivate
$ rmvirtualenv python-gpiozero
$ rm -fr ~/python-gpiozero
```

12.2 Building the docs

If you wish to build the docs, you'll need a few more dependencies. Inkscape is used for conversion of SVGs to other formats, Graphviz is used for rendering certain charts, and TeX Live is required for building PDF output. The following command should install all required dependencies:

```
$ sudo apt install texlive-latex-recommended texlive-latex-extra \
    texlive-fonts-recommended graphviz inkscape python-sphinx latexmk
```

Once these are installed, you can use the "doc" target to build the documentation:

```
$ workon python-gpiozero
(python-gpiozero) $ cd ~/python-gpiozero
(python-gpiozero) $ make doc
```

The HTML output is written to `build/html` while the PDF output goes to `build/latex`.

12.3 Test suite

If you wish to run the GPIO Zero test suite, follow the instructions in *Development installation* (page 89) above and then make the "test" target within the sandbox. You'll also need to install some pip packages:

```
$ workon python-gpiozero
(python-gpiozero) $ pip install coverage mock pytest
(python-gpiozero) $ cd ~/python-gpiozero
(python-gpiozero) $ make test
```

The test suite expects pins 22 and 27 (by default) to be wired together in order to run the "real" pin tests. The pins used by the test suite can be overridden with the environment variables `GPIOZERO_TEST_PIN` (defaults to 22) and `GPIOZERO_TEST_INPUT_PIN` (defaults to 27).

Warning: When wiring GPIOs together, ensure a load (like a 1KΩ resistor) is placed between them. Failure to do so may lead to blown GPIO pins (your humble author has a fried GPIO27 as a result of such laziness, although it did take *many* runs of the test suite before this occurred!).

The test suite is also setup for usage with the **tox** utility, in which case it will attempt to execute the test suite with all supported versions of Python. If you are developing under Ubuntu you may wish to look into the Dead Snakes PPA[72] in order to install old/new versions of Python; the tox setup *should* work with the version of tox shipped with Ubuntu Xenial, but more features (like parallel test execution) are available with later versions.

On the subject of parallel test execution, this is also supported in the tox setup, including the "real" pin tests (a file-system level lock is used to ensure different interpreters don't try to access the physical pins simultaneously).

For example, to execute the test suite under tox, skipping interpreter versions which are not installed:

```
$ tox -s
```

To execute the test suite under all installed interpreter versions in parallel, using as many parallel tasks as there are CPUs, then displaying a combined report of coverage from all environments:

```
$ tox -p auto -s
$ coverage combine --rcfile coverage.cfg
$ coverage report --rcfile coverage.cfg
```

[72] https://launchpad.net/~deadsnakes/%2Barchive/ubuntu/ppa

CHAPTER 13

API - Input Devices

These input device component interfaces have been provided for simple use of everyday components. Components must be wired up correctly before use in code.

Note: All GPIO pin numbers use Broadcom (BCM) numbering by default. See the *Pin Numbering* (page 3) section for more information.

13.1 Regular Classes

The following classes are intended for general use with the devices they represent. All classes in this section are concrete (not abstract).

13.1.1 Button

class gpiozero.**Button**(*pin*, ***, *pull_up=True*, *active_state=None*, *bounce_time=None*, *hold_time=1*, *hold_repeat=False*, *pin_factory=None*)

Extends `DigitalInputDevice` (page 104) and represents a simple push button or switch.

Connect one side of the button to a ground pin, and the other to any GPIO pin. Alternatively, connect one side of the button to the 3V3 pin, and the other to any GPIO pin, then set *pull_up* to `False`[73] in the `Button` (page 93) constructor.

The following example will print a line of text when the button is pushed:

```
from gpiozero import Button

button = Button(4)
button.wait_for_press()
print("The button was pressed!")
```

Parameters

[73] https://docs.python.org/3.5/library/constants.html#False

- **pin** (*int*[74] *or str*[75]) – The GPIO pin which the button is connected to. See *Pin Numbering* (page 3) for valid pin numbers. If this is `None`[76] a *GPIODeviceError* (page 213) will be raised.
- **pull_up** (*bool*[77] *or None*[78]) – If `True`[79] (the default), the GPIO pin will be pulled high by default. In this case, connect the other side of the button to ground. If `False`[80], the GPIO pin will be pulled low by default. In this case, connect the other side of the button to 3V3. If `None`[81], the pin will be floating, so it must be externally pulled up or down and the `active_state` parameter must be set accordingly.
- **active_state** (*bool*[82] *or None*[83]) – See description under *InputDevice* (page 107) for more information.
- **bounce_time** (*float*[84] *or None*[85]) – If `None`[86] (the default), no software bounce compensation will be performed. Otherwise, this is the length of time (in seconds) that the component will ignore changes in state after an initial change.
- **hold_time** (*float*[87]) – The length of time (in seconds) to wait after the button is pushed, until executing the *when_held* (page 95) handler. Defaults to `1`.
- **hold_repeat** (*bool*[88]) – If `True`[89], the *when_held* (page 95) handler will be repeatedly executed as long as the device remains active, every *hold_time* seconds. If `False`[90] (the default) the *when_held* (page 95) handler will be only be executed once per hold.
- **pin_factory** (`Factory` (page 198) *or None*[91]) – See *API - Pins* (page 195) for more information (this is an advanced feature which most users can ignore).

wait_for_press(*timeout=None*)

Pause the script until the device is activated, or the timeout is reached.

Parameters timeout (*float*[92] *or None*[93]) – Number of seconds to wait before proceeding. If this is `None`[94] (the default), then wait indefinitely until the device is active.

wait_for_release(*timeout=None*)

Pause the script until the device is deactivated, or the timeout is reached.

Parameters timeout (*float*[95] *or None*[96]) – Number of seconds to wait before proceeding. If this is `None`[97] (the default), then wait indefinitely until the device is inactive.

held_time

The length of time (in seconds) that the device has been held for. This is counted from the first

[74] https://docs.python.org/3.5/library/functions.html#int
[75] https://docs.python.org/3.5/library/stdtypes.html#str
[76] https://docs.python.org/3.5/library/constants.html#None
[77] https://docs.python.org/3.5/library/functions.html#bool
[78] https://docs.python.org/3.5/library/constants.html#None
[79] https://docs.python.org/3.5/library/constants.html#True
[80] https://docs.python.org/3.5/library/constants.html#False
[81] https://docs.python.org/3.5/library/constants.html#None
[82] https://docs.python.org/3.5/library/functions.html#bool
[83] https://docs.python.org/3.5/library/constants.html#None
[84] https://docs.python.org/3.5/library/functions.html#float
[85] https://docs.python.org/3.5/library/constants.html#None
[86] https://docs.python.org/3.5/library/constants.html#None
[87] https://docs.python.org/3.5/library/functions.html#float
[88] https://docs.python.org/3.5/library/functions.html#bool
[89] https://docs.python.org/3.5/library/constants.html#True
[90] https://docs.python.org/3.5/library/constants.html#False
[91] https://docs.python.org/3.5/library/constants.html#None
[92] https://docs.python.org/3.5/library/functions.html#float
[93] https://docs.python.org/3.5/library/constants.html#None
[94] https://docs.python.org/3.5/library/constants.html#None
[95] https://docs.python.org/3.5/library/functions.html#float
[96] https://docs.python.org/3.5/library/constants.html#None
[97] https://docs.python.org/3.5/library/constants.html#None

execution of the `when_held` (page 95) event rather than when the device activated, in contrast to `active_time` (page 177). If the device is not currently held, this is `None`[98].

`hold_repeat`
If `True`[99], `when_held` (page 95) will be executed repeatedly with `hold_time` (page 95) seconds between each invocation.

`hold_time`
The length of time (in seconds) to wait after the device is activated, until executing the `when_held` (page 95) handler. If `hold_repeat` (page 95) is True, this is also the length of time between invocations of `when_held` (page 95).

`is_held`
When `True`[100], the device has been active for at least `hold_time` (page 95) seconds.

`is_pressed`
Returns `True`[101] if the device is currently active and `False`[102] otherwise. This property is usually derived from `value` (page 95). Unlike `value` (page 95), this is *always* a boolean.

`pin`
The `Pin` (page 199) that the device is connected to. This will be `None`[103] if the device has been closed (see the `close()` (page 175) method). When dealing with GPIO pins, query `pin.number` to discover the GPIO pin (in BCM numbering) that the device is connected to.

`pull_up`
If `True`[104], the device uses a pull-up resistor to set the GPIO pin "high" by default.

`value`
Returns 1 if the button is currently pressed, and 0 if it is not.

`when_held`
The function to run when the device has remained active for `hold_time` (page 95) seconds.

This can be set to a function which accepts no (mandatory) parameters, or a Python function which accepts a single mandatory parameter (with as many optional parameters as you like). If the function accepts a single mandatory parameter, the device that activated will be passed as that parameter.

Set this property to `None`[105] (the default) to disable the event.

`when_pressed`
The function to run when the device changes state from inactive to active.

This can be set to a function which accepts no (mandatory) parameters, or a Python function which accepts a single mandatory parameter (with as many optional parameters as you like). If the function accepts a single mandatory parameter, the device that activated will be passed as that parameter.

Set this property to `None`[106] (the default) to disable the event.

`when_released`
The function to run when the device changes state from active to inactive.

This can be set to a function which accepts no (mandatory) parameters, or a Python function which accepts a single mandatory parameter (with as many optional parameters as you like). If the function accepts a single mandatory parameter, the device that deactivated will be passed as that parameter.

Set this property to `None`[107] (the default) to disable the event.

[98] https://docs.python.org/3.5/library/constants.html#None
[99] https://docs.python.org/3.5/library/constants.html#True
[100] https://docs.python.org/3.5/library/constants.html#True
[101] https://docs.python.org/3.5/library/constants.html#True
[102] https://docs.python.org/3.5/library/constants.html#False
[103] https://docs.python.org/3.5/library/constants.html#None
[104] https://docs.python.org/3.5/library/constants.html#True
[105] https://docs.python.org/3.5/library/constants.html#None
[106] https://docs.python.org/3.5/library/constants.html#None
[107] https://docs.python.org/3.5/library/constants.html#None

13.1.2 LineSensor (TRCT5000)

class gpiozero.**LineSensor**(*pin*, **, *queue_len=5*, *sample_rate=100*, *threshold=0.5*, *partial=False*, *pin_factory=None*)

Extends *SmoothedInputDevice* (page 105) and represents a single pin line sensor like the TCRT5000 infra-red proximity sensor found in the CamJam #3 EduKit[108].

A typical line sensor has a small circuit board with three pins: VCC, GND, and OUT. VCC should be connected to a 3V3 pin, GND to one of the ground pins, and finally OUT to the GPIO specified as the value of the *pin* parameter in the constructor.

The following code will print a line of text indicating when the sensor detects a line, or stops detecting a line:

```
from gpiozero import LineSensor
from signal import pause

sensor = LineSensor(4)
sensor.when_line = lambda: print('Line detected')
sensor.when_no_line = lambda: print('No line detected')
pause()
```

Parameters

- **pin** (*int*[109] *or str*[110]) – The GPIO pin which the sensor is connected to. See *Pin Numbering* (page 3) for valid pin numbers. If this is None[111] a *GPIODeviceError* (page 213) will be raised.
- **pull_up** (*bool*[112] *or None*[113]) – See descrpition under *InputDevice* (page 107) for more information.
- **active_state** (*bool*[114] *or None*[115]) – See description under *InputDevice* (page 107) for more information.
- **queue_len** (*int*[116]) – The length of the queue used to store values read from the sensor. This defaults to 5.
- **sample_rate** (*float*[117]) – The number of values to read from the device (and append to the internal queue) per second. Defaults to 100.
- **threshold** (*float*[118]) – Defaults to 0.5. When the average of all values in the internal queue rises above this value, the sensor will be considered "active" by the *is_active* (page 106) property, and all appropriate events will be fired.
- **partial** (*bool*[119]) – When False[120] (the default), the object will not return a value for *is_active* (page 106) until the internal queue has filled with values. Only set this to True[121] if you require values immediately after object construction.
- **pin_factory** (Factory (page 198) *or None*[122]) – See *API - Pins* (page 195) for more information (this is an advanced feature which most users can ignore).

[108] http://camjam.me/?page_id=1035
[109] https://docs.python.org/3.5/library/functions.html#int
[110] https://docs.python.org/3.5/library/stdtypes.html#str
[111] https://docs.python.org/3.5/library/constants.html#None
[112] https://docs.python.org/3.5/library/functions.html#bool
[113] https://docs.python.org/3.5/library/constants.html#None
[114] https://docs.python.org/3.5/library/functions.html#bool
[115] https://docs.python.org/3.5/library/constants.html#None
[116] https://docs.python.org/3.5/library/functions.html#int
[117] https://docs.python.org/3.5/library/functions.html#float
[118] https://docs.python.org/3.5/library/functions.html#float
[119] https://docs.python.org/3.5/library/functions.html#bool
[120] https://docs.python.org/3.5/library/constants.html#False
[121] https://docs.python.org/3.5/library/constants.html#True
[122] https://docs.python.org/3.5/library/constants.html#None

wait_for_line(*timeout=None*)
Pause the script until the device is deactivated, or the timeout is reached.

Parameters **timeout** (*float*[123] *or* *None*[124]) – Number of seconds to wait before proceeding. If this is `None`[125] (the default), then wait indefinitely until the device is inactive.

wait_for_no_line(*timeout=None*)
Pause the script until the device is activated, or the timeout is reached.

Parameters **timeout** (*float*[126] *or* *None*[127]) – Number of seconds to wait before proceeding. If this is `None`[128] (the default), then wait indefinitely until the device is active.

pin
The *Pin* (page 199) that the device is connected to. This will be `None`[129] if the device has been closed (see the *close()* (page 175) method). When dealing with GPIO pins, query `pin.number` to discover the GPIO pin (in BCM numbering) that the device is connected to.

value
Returns a value representing the average of the queued values. This is nearer 0 for black under the sensor, and nearer 1 for white under the sensor.

when_line
The function to run when the device changes state from active to inactive.

This can be set to a function which accepts no (mandatory) parameters, or a Python function which accepts a single mandatory parameter (with as many optional parameters as you like). If the function accepts a single mandatory parameter, the device that deactivated will be passed as that parameter.

Set this property to `None`[130] (the default) to disable the event.

when_no_line
The function to run when the device changes state from inactive to active.

This can be set to a function which accepts no (mandatory) parameters, or a Python function which accepts a single mandatory parameter (with as many optional parameters as you like). If the function accepts a single mandatory parameter, the device that activated will be passed as that parameter.

Set this property to `None`[131] (the default) to disable the event.

13.1.3 MotionSensor (D-SUN PIR)

class gpiozero.**MotionSensor**(*pin*, ***, *queue_len=1*, *sample_rate=10*, *threshold=0.5*, *partial=False*, *pin_factory=None*)
Extends *SmoothedInputDevice* (page 105) and represents a passive infra-red (PIR) motion sensor like the sort found in the CamJam #2 EduKit[132].

A typical PIR device has a small circuit board with three pins: VCC, OUT, and GND. VCC should be connected to a 5V pin, GND to one of the ground pins, and finally OUT to the GPIO specified as the value of the *pin* parameter in the constructor.

The following code will print a line of text when motion is detected:

```python
from gpiozero import MotionSensor

pir = MotionSensor(4)
```

(continues on next page)

[123] https://docs.python.org/3.5/library/functions.html#float
[124] https://docs.python.org/3.5/library/constants.html#None
[125] https://docs.python.org/3.5/library/constants.html#None
[126] https://docs.python.org/3.5/library/functions.html#float
[127] https://docs.python.org/3.5/library/constants.html#None
[128] https://docs.python.org/3.5/library/constants.html#None
[129] https://docs.python.org/3.5/library/constants.html#None
[130] https://docs.python.org/3.5/library/constants.html#None
[131] https://docs.python.org/3.5/library/constants.html#None
[132] http://camjam.me/?page_id=623

(continued from previous page)

```
pir.wait_for_motion()
print("Motion detected!")
```

Parameters

- **pin** (*int*[133] *or* *str*[134]) – The GPIO pin which the sensor is connected to. See *Pin Numbering* (page 3) for valid pin numbers. If this is `None`[135] a *GPIODeviceError* (page 213) will be raised.
- **pull_up** (*bool*[136] *or* *None*[137]) – See descrpition under *InputDevice* (page 107) for more information.
- **active_state** (*bool*[138] *or* *None*[139]) – See description under *InputDevice* (page 107) for more information.
- **queue_len** (*int*[140]) – The length of the queue used to store values read from the sensor. This defaults to 1 which effectively disables the queue. If your motion sensor is particularly "twitchy" you may wish to increase this value.
- **sample_rate** (*float*[141]) – The number of values to read from the device (and append to the internal queue) per second. Defaults to 100.
- **threshold** (*float*[142]) – Defaults to 0.5. When the average of all values in the internal queue rises above this value, the sensor will be considered "active" by the *is_active* (page 106) property, and all appropriate events will be fired.
- **partial** (*bool*[143]) – When `False`[144] (the default), the object will not return a value for *is_active* (page 106) until the internal queue has filled with values. Only set this to `True`[145] if you require values immediately after object construction.
- **pin_factory** (`Factory` (page 198) *or* *None*[146]) – See *API - Pins* (page 195) for more information (this is an advanced feature which most users can ignore).

wait_for_motion(*timeout=None*)
Pause the script until the device is activated, or the timeout is reached.

Parameters **timeout** (*float*[147] *or* *None*[148]) – Number of seconds to wait before proceeding. If this is `None`[149] (the default), then wait indefinitely until the device is active.

wait_for_no_motion(*timeout=None*)
Pause the script until the device is deactivated, or the timeout is reached.

Parameters **timeout** (*float*[150] *or* *None*[151]) – Number of seconds to wait before proceeding. If this is `None`[152] (the default), then wait indefinitely until the device is inactive.

133 https://docs.python.org/3.5/library/functions.html#int
134 https://docs.python.org/3.5/library/stdtypes.html#str
135 https://docs.python.org/3.5/library/constants.html#None
136 https://docs.python.org/3.5/library/functions.html#bool
137 https://docs.python.org/3.5/library/constants.html#None
138 https://docs.python.org/3.5/library/functions.html#bool
139 https://docs.python.org/3.5/library/constants.html#None
140 https://docs.python.org/3.5/library/functions.html#int
141 https://docs.python.org/3.5/library/functions.html#float
142 https://docs.python.org/3.5/library/functions.html#float
143 https://docs.python.org/3.5/library/functions.html#bool
144 https://docs.python.org/3.5/library/constants.html#False
145 https://docs.python.org/3.5/library/constants.html#True
146 https://docs.python.org/3.5/library/constants.html#None
147 https://docs.python.org/3.5/library/functions.html#float
148 https://docs.python.org/3.5/library/constants.html#None
149 https://docs.python.org/3.5/library/constants.html#None
150 https://docs.python.org/3.5/library/functions.html#float
151 https://docs.python.org/3.5/library/constants.html#None
152 https://docs.python.org/3.5/library/constants.html#None

motion_detected
Returns True[153] if the *value* (page 107) currently exceeds *threshold* (page 107) and False[154] otherwise.

pin
The *Pin* (page 199) that the device is connected to. This will be None[155] if the device has been closed (see the *close()* (page 175) method). When dealing with GPIO pins, query `pin.number` to discover the GPIO pin (in BCM numbering) that the device is connected to.

value
With the default *queue_len* of 1, this is effectively boolean where 0 means no motion detected and 1 means motion detected. If you specify a *queue_len* greater than 1, this will be an averaged value where values closer to 1 imply motion detection.

when_motion
The function to run when the device changes state from inactive to active.

This can be set to a function which accepts no (mandatory) parameters, or a Python function which accepts a single mandatory parameter (with as many optional parameters as you like). If the function accepts a single mandatory parameter, the device that activated will be passed as that parameter.

Set this property to None[156] (the default) to disable the event.

when_no_motion
The function to run when the device changes state from active to inactive.

This can be set to a function which accepts no (mandatory) parameters, or a Python function which accepts a single mandatory parameter (with as many optional parameters as you like). If the function accepts a single mandatory parameter, the device that deactivated will be passed as that parameter.

Set this property to None[157] (the default) to disable the event.

13.1.4 LightSensor (LDR)

class gpiozero.**LightSensor**(*pin*, ***, *queue_len=5*, *charge_time_limit=0.01*, *threshold=0.1*, *partial=False*, *pin_factory=None*)
Extends *SmoothedInputDevice* (page 105) and represents a light dependent resistor (LDR).

Connect one leg of the LDR to the 3V3 pin; connect one leg of a 1µF capacitor to a ground pin; connect the other leg of the LDR and the other leg of the capacitor to the same GPIO pin. This class repeatedly discharges the capacitor, then times the duration it takes to charge (which will vary according to the light falling on the LDR).

The following code will print a line of text when light is detected:

```
from gpiozero import LightSensor

ldr = LightSensor(18)
ldr.wait_for_light()
print("Light detected!")
```

Parameters

- **pin** (*int*[158] *or str*[159]) – The GPIO pin which the sensor is attached to. See *Pin Numbering* (page 3) for valid pin numbers. If this is None[160] a *GPIODeviceError* (page 213) will be raised.

[153] https://docs.python.org/3.5/library/constants.html#True
[154] https://docs.python.org/3.5/library/constants.html#False
[155] https://docs.python.org/3.5/library/constants.html#None
[156] https://docs.python.org/3.5/library/constants.html#None
[157] https://docs.python.org/3.5/library/constants.html#None
[158] https://docs.python.org/3.5/library/functions.html#int
[159] https://docs.python.org/3.5/library/stdtypes.html#str
[160] https://docs.python.org/3.5/library/constants.html#None

- **queue_len** (*int*[161]) – The length of the queue used to store values read from the circuit. This defaults to 5.
- **charge_time_limit** (*float*[162]) – If the capacitor in the circuit takes longer than this length of time to charge, it is assumed to be dark. The default (0.01 seconds) is appropriate for a 1µF capacitor coupled with the LDR from the CamJam #2 EduKit[163]. You may need to adjust this value for different valued capacitors or LDRs.
- **threshold** (*float*[164]) – Defaults to 0.1. When the average of all values in the internal queue rises above this value, the area will be considered "light", and all appropriate events will be fired.
- **partial** (*bool*[165]) – When `False`[166] (the default), the object will not return a value for *is_active* (page 106) until the internal queue has filled with values. Only set this to `True`[167] if you require values immediately after object construction.
- **pin_factory** (`Factory` (page 198) *or* `None`[168]) – See *API - Pins* (page 195) for more information (this is an advanced feature which most users can ignore).

wait_for_dark (*timeout=None*)

Pause the script until the device is deactivated, or the timeout is reached.

Parameters **timeout** (*float*[169] *or* *None*[170]) – Number of seconds to wait before proceeding. If this is `None`[171] (the default), then wait indefinitely until the device is inactive.

wait_for_light (*timeout=None*)

Pause the script until the device is activated, or the timeout is reached.

Parameters **timeout** (*float*[172] *or* *None*[173]) – Number of seconds to wait before proceeding. If this is `None`[174] (the default), then wait indefinitely until the device is active.

light_detected

Returns `True`[175] if the *value* (page 107) currently exceeds *threshold* (page 107) and `False`[176] otherwise.

pin

The *Pin* (page 199) that the device is connected to. This will be `None`[177] if the device has been closed (see the *close()* (page 175) method). When dealing with GPIO pins, query `pin.number` to discover the GPIO pin (in BCM numbering) that the device is connected to.

value

Returns a value between 0 (dark) and 1 (light).

when_dark

The function to run when the device changes state from active to inactive.

This can be set to a function which accepts no (mandatory) parameters, or a Python function which accepts a single mandatory parameter (with as many optional parameters as you like). If the function accepts a single mandatory parameter, the device that deactivated will be passed as that parameter.

[161] https://docs.python.org/3.5/library/functions.html#int
[162] https://docs.python.org/3.5/library/functions.html#float
[163] http://camjam.me/?page_id=623
[164] https://docs.python.org/3.5/library/functions.html#float
[165] https://docs.python.org/3.5/library/functions.html#bool
[166] https://docs.python.org/3.5/library/constants.html#False
[167] https://docs.python.org/3.5/library/constants.html#True
[168] https://docs.python.org/3.5/library/constants.html#None
[169] https://docs.python.org/3.5/library/functions.html#float
[170] https://docs.python.org/3.5/library/constants.html#None
[171] https://docs.python.org/3.5/library/constants.html#None
[172] https://docs.python.org/3.5/library/functions.html#float
[173] https://docs.python.org/3.5/library/constants.html#None
[174] https://docs.python.org/3.5/library/constants.html#None
[175] https://docs.python.org/3.5/library/constants.html#True
[176] https://docs.python.org/3.5/library/constants.html#False
[177] https://docs.python.org/3.5/library/constants.html#None

Set this property to `None`[178] (the default) to disable the event.

`when_light`
The function to run when the device changes state from inactive to active.

This can be set to a function which accepts no (mandatory) parameters, or a Python function which accepts a single mandatory parameter (with as many optional parameters as you like). If the function accepts a single mandatory parameter, the device that activated will be passed as that parameter.

Set this property to `None`[179] (the default) to disable the event.

13.1.5 DistanceSensor (HC-SR04)

class gpiozero.**DistanceSensor**(*echo*, *trigger*, ***, *queue_len=30*, *max_distance=1*, *threshold_distance=0.3*, *partial=False*, *pin_factory=None*)

Extends *SmoothedInputDevice* (page 105) and represents an HC-SR04 ultrasonic distance sensor, as found in the CamJam #3 EduKit[180].

The distance sensor requires two GPIO pins: one for the *trigger* (marked TRIG on the sensor) and another for the *echo* (marked ECHO on the sensor). However, a voltage divider is required to ensure the 5V from the ECHO pin doesn't damage the Pi. Wire your sensor according to the following instructions:

1. Connect the GND pin of the sensor to a ground pin on the Pi.
2. Connect the TRIG pin of the sensor a GPIO pin.
3. Connect one end of a 330Ω resistor to the ECHO pin of the sensor.
4. Connect one end of a 470Ω resistor to the GND pin of the sensor.
5. Connect the free ends of both resistors to another GPIO pin. This forms the required voltage divider[181].
6. Finally, connect the VCC pin of the sensor to a 5V pin on the Pi.

Alternatively, 3V3 tolerant sensors (which no not require a voltage divider) are also available.

Note: If you do not have the precise values of resistor specified above, don't worry! What matters is the *ratio* of the resistors to each other.

You also don't need to be absolutely precise; the voltage divider[182] given above will actually output ~3V (rather than 3.3V). A simple 2:3 ratio will give 3.333V which implies you can take three resistors of equal value, use one of them instead of the 330Ω resistor, and two of them in series instead of the 470Ω resistor.

The following code will periodically report the distance measured by the sensor in cm assuming the TRIG pin is connected to GPIO17, and the ECHO pin to GPIO18:

```
from gpiozero import DistanceSensor
from time import sleep

sensor = DistanceSensor(echo=18, trigger=17)
while True:
    print('Distance: ', sensor.distance * 100)
    sleep(1)
```

Note: For improved accuracy, use the pigpio pin driver rather than the default RPi.GPIO driver (pigpio uses DMA sampling for much more precise edge timing). This is particularly relevant if you're using Pi 1 or Pi Zero. See *Changing the pin factory* (page 196) for further information.

[178] https://docs.python.org/3.5/library/constants.html#None
[179] https://docs.python.org/3.5/library/constants.html#None
[180] http://camjam.me/?page_id=1035
[181] https://en.wikipedia.org/wiki/Voltage_divider
[182] https://en.wikipedia.org/wiki/Voltage_divider

Parameters

- **echo** (*int*[183] *or str*[184]) – The GPIO pin which the ECHO pin is connected to. See *Pin Numbering* (page 3) for valid pin numbers. If this is `None`[185] a *GPIODeviceError* (page 213) will be raised.
- **trigger** (*int*[186] *or str*[187]) – The GPIO pin which the TRIG pin is connected to. See *Pin Numbering* (page 3) for valid pin numbers. If this is `None`[188] a *GPIODeviceError* (page 213) will be raised.
- **queue_len** (*int*[189]) – The length of the queue used to store values read from the sensor. This defaults to 30.
- **max_distance** (*float*[190]) – The *value* (page 103) attribute reports a normalized value between 0 (too close to measure) and 1 (maximum distance). This parameter specifies the maximum distance expected in meters. This defaults to 1.
- **threshold_distance** (*float*[191]) – Defaults to 0.3. This is the distance (in meters) that will trigger the `in_range` and `out_of_range` events when crossed.
- **partial** (*bool*[192]) – When `False`[193] (the default), the object will not return a value for *is_active* (page 106) until the internal queue has filled with values. Only set this to `True`[194] if you require values immediately after object construction.
- **pin_factory** (*Factory* (page 198) *or None*[195]) – See *API - Pins* (page 195) for more information (this is an advanced feature which most users can ignore).

wait_for_in_range(*timeout=None*)

Pause the script until the device is deactivated, or the timeout is reached.

Parameters **timeout** (*float*[196] *or None*[197]) – Number of seconds to wait before proceeding. If this is `None`[198] (the default), then wait indefinitely until the device is inactive.

wait_for_out_of_range(*timeout=None*)

Pause the script until the device is activated, or the timeout is reached.

Parameters **timeout** (*float*[199] *or None*[200]) – Number of seconds to wait before proceeding. If this is `None`[201] (the default), then wait indefinitely until the device is active.

distance

Returns the current distance measured by the sensor in meters. Note that this property will have a value between 0 and *max_distance* (page 102).

echo

Returns the *Pin* (page 199) that the sensor's echo is connected to. This is simply an alias for the usual *pin* (page 109) attribute.

[183] https://docs.python.org/3.5/library/functions.html#int
[184] https://docs.python.org/3.5/library/stdtypes.html#str
[185] https://docs.python.org/3.5/library/constants.html#None
[186] https://docs.python.org/3.5/library/functions.html#int
[187] https://docs.python.org/3.5/library/stdtypes.html#str
[188] https://docs.python.org/3.5/library/constants.html#None
[189] https://docs.python.org/3.5/library/functions.html#int
[190] https://docs.python.org/3.5/library/functions.html#float
[191] https://docs.python.org/3.5/library/functions.html#float
[192] https://docs.python.org/3.5/library/functions.html#bool
[193] https://docs.python.org/3.5/library/constants.html#False
[194] https://docs.python.org/3.5/library/constants.html#True
[195] https://docs.python.org/3.5/library/constants.html#None
[196] https://docs.python.org/3.5/library/functions.html#float
[197] https://docs.python.org/3.5/library/constants.html#None
[198] https://docs.python.org/3.5/library/constants.html#None
[199] https://docs.python.org/3.5/library/functions.html#float
[200] https://docs.python.org/3.5/library/constants.html#None
[201] https://docs.python.org/3.5/library/constants.html#None

max_distance
The maximum distance that the sensor will measure in meters. This value is specified in the constructor and is used to provide the scaling for the `value` (page 107) attribute. When `distance` (page 102) is equal to `max_distance` (page 102), `value` (page 107) will be 1.

threshold_distance
The distance, measured in meters, that will trigger the `when_in_range` (page 103) and `when_out_of_range` (page 103) events when crossed. This is simply a meter-scaled variant of the usual `threshold` (page 107) attribute.

trigger
Returns the `Pin` (page 199) that the sensor's trigger is connected to.

value
Returns a value between 0, indicating the reflector is either touching the sensor or is sufficiently near that the sensor can't tell the difference, and 1, indicating the reflector is at or beyond the specified *max_distance*.

when_in_range
The function to run when the device changes state from active to inactive.

This can be set to a function which accepts no (mandatory) parameters, or a Python function which accepts a single mandatory parameter (with as many optional parameters as you like). If the function accepts a single mandatory parameter, the device that deactivated will be passed as that parameter.

Set this property to `None`[202] (the default) to disable the event.

when_out_of_range
The function to run when the device changes state from inactive to active.

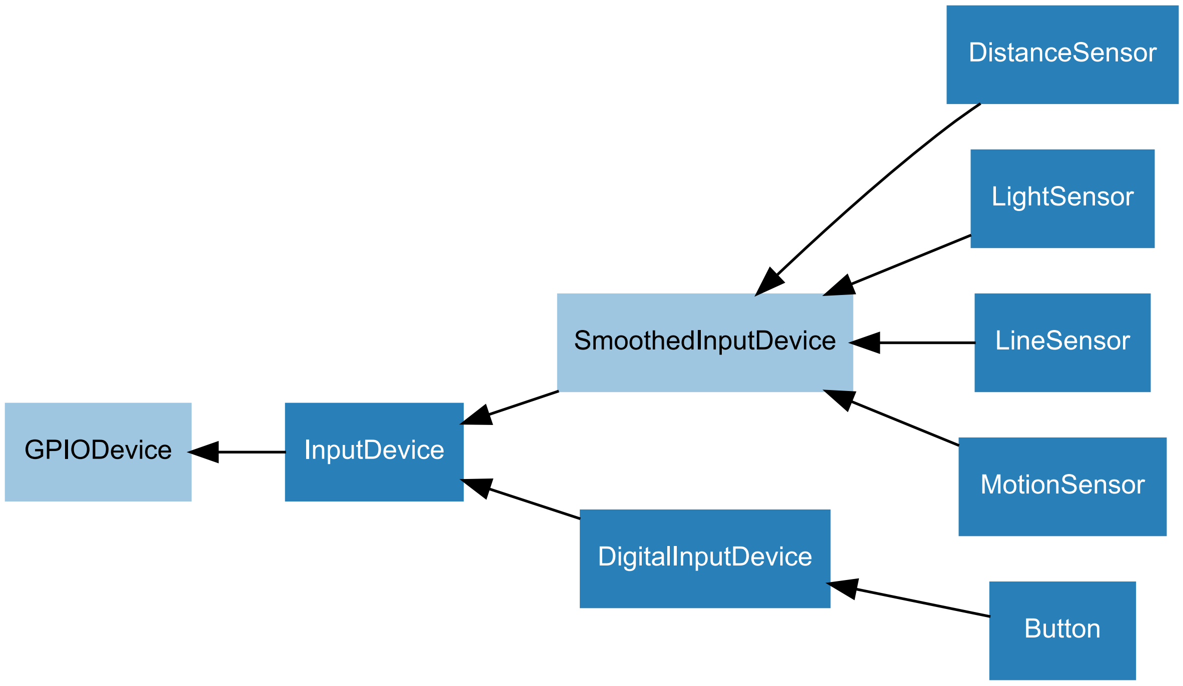
This can be set to a function which accepts no (mandatory) parameters, or a Python function which accepts a single mandatory parameter (with as many optional parameters as you like). If the function accepts a single mandatory parameter, the device that activated will be passed as that parameter.

Set this property to `None`[203] (the default) to disable the event.

13.2 Base Classes

The classes in the sections above are derived from a series of base classes, some of which are effectively abstract. The classes form the (partial) hierarchy displayed in the graph below (abstract classes are shaded lighter than concrete classes):

[202] https://docs.python.org/3.5/library/constants.html#None
[203] https://docs.python.org/3.5/library/constants.html#None



The following sections document these base classes for advanced users that wish to construct classes for their own devices.

13.2.1 DigitalInputDevice

class gpiozero.**DigitalInputDevice**(*pin*, ***, *pull_up=False*, *active_state=None*, *bounce_time=None*, *pin_factory=None*)

Represents a generic input device with typical on/off behaviour.

This class extends *InputDevice* (page 107) with machinery to fire the active and inactive events for devices that operate in a typical digital manner: straight forward on / off states with (reasonably) clean transitions between the two.

Parameters

- **pin** (*int*[204] *or str*[205]) – The GPIO pin that the device is connected to. See *Pin Numbering* (page 3) for valid pin numbers. If this is None[206] a *GPIODeviceError* (page 213) will be raised.
- **pull_up** (*bool*[207] *or None*[208]) – See descrpition under *InputDevice* (page 107) for more information.
- **active_state** (*bool*[209] *or None*[210]) – See description under *InputDevice* (page 107) for more information.
- **bounce_time** (*float*[211] *or None*[212]) – Specifies the length of time (in seconds) that the component will ignore changes in state after an initial change. This defaults to None[213] which indicates that no bounce compensation will be performed.

[204] https://docs.python.org/3.5/library/functions.html#int
[205] https://docs.python.org/3.5/library/stdtypes.html#str
[206] https://docs.python.org/3.5/library/constants.html#None
[207] https://docs.python.org/3.5/library/functions.html#bool
[208] https://docs.python.org/3.5/library/constants.html#None
[209] https://docs.python.org/3.5/library/functions.html#bool
[210] https://docs.python.org/3.5/library/constants.html#None
[211] https://docs.python.org/3.5/library/functions.html#float
[212] https://docs.python.org/3.5/library/constants.html#None
[213] https://docs.python.org/3.5/library/constants.html#None

- **pin_factory** (`Factory` (page 198) *or* `None`[214]) – See *API - Pins* (page 195) for more information (this is an advanced feature which most users can ignore).

wait_for_active (*timeout=None*)
Pause the script until the device is activated, or the timeout is reached.

Parameters timeout (*float*[215] *or* `None`[216]) – Number of seconds to wait before proceeding. If this is `None`[217] (the default), then wait indefinitely until the device is active.

wait_for_inactive (*timeout=None*)
Pause the script until the device is deactivated, or the timeout is reached.

Parameters timeout (*float*[218] *or* `None`[219]) – Number of seconds to wait before proceeding. If this is `None`[220] (the default), then wait indefinitely until the device is inactive.

active_time
The length of time (in seconds) that the device has been active for. When the device is inactive, this is `None`[221].

inactive_time
The length of time (in seconds) that the device has been inactive for. When the device is active, this is `None`[222].

value
Returns a value representing the device's state. Frequently, this is a boolean value, or a number between 0 and 1 but some devices use larger ranges (e.g. -1 to +1) and composite devices usually use tuples to return the states of all their subordinate components.

when_activated
The function to run when the device changes state from inactive to active.

This can be set to a function which accepts no (mandatory) parameters, or a Python function which accepts a single mandatory parameter (with as many optional parameters as you like). If the function accepts a single mandatory parameter, the device that activated will be passed as that parameter.

Set this property to `None`[223] (the default) to disable the event.

when_deactivated
The function to run when the device changes state from active to inactive.

This can be set to a function which accepts no (mandatory) parameters, or a Python function which accepts a single mandatory parameter (with as many optional parameters as you like). If the function accepts a single mandatory parameter, the device that deactivated will be passed as that parameter.

Set this property to `None`[224] (the default) to disable the event.

13.2.2 SmoothedInputDevice

class gpiozero.**SmoothedInputDevice** (*pin*, ***, *pull_up=False*, *active_state=None*, *threshold=0.5*, *queue_len=5*, *sample_wait=0.0*, *partial=False*, *pin_factory=None*)
Represents a generic input device which takes its value from the average of a queue of historical values.

This class extends *InputDevice* (page 107) with a queue which is filled by a background thread which continually polls the state of the underlying device. The average (a configurable function) of the values in

[214] https://docs.python.org/3.5/library/constants.html#None
[215] https://docs.python.org/3.5/library/functions.html#float
[216] https://docs.python.org/3.5/library/constants.html#None
[217] https://docs.python.org/3.5/library/constants.html#None
[218] https://docs.python.org/3.5/library/functions.html#float
[219] https://docs.python.org/3.5/library/constants.html#None
[220] https://docs.python.org/3.5/library/constants.html#None
[221] https://docs.python.org/3.5/library/constants.html#None
[222] https://docs.python.org/3.5/library/constants.html#None
[223] https://docs.python.org/3.5/library/constants.html#None
[224] https://docs.python.org/3.5/library/constants.html#None

the queue is compared to a threshold which is used to determine the state of the *is_active* (page 106) property.

Note: The background queue is not automatically started upon construction. This is to allow descendents to set up additional components before the queue starts reading values. Effectively this is an abstract base class.

This class is intended for use with devices which either exhibit analog behaviour (such as the charging time of a capacitor with an LDR), or those which exhibit "twitchy" behaviour (such as certain motion sensors).

Parameters

- **pin** (*int*[225] *or str*[226]) – The GPIO pin that the device is connected to. See *Pin Numbering* (page 3) for valid pin numbers. If this is `None`[227] a *GPIODeviceError* (page 213) will be raised.
- **pull_up** (*bool*[228] *or None*[229]) – See descrpition under *InputDevice* (page 107) for more information.
- **active_state** (*bool*[230] *or None*[231]) – See description under *InputDevice* (page 107) for more information.
- **threshold** (*float*[232]) – The value above which the device will be considered "on".
- **queue_len** (*int*[233]) – The length of the internal queue which is filled by the background thread.
- **sample_wait** (*float*[234]) – The length of time to wait between retrieving the state of the underlying device. Defaults to 0.0 indicating that values are retrieved as fast as possible.
- **partial** (*bool*[235]) – If `False`[236] (the default), attempts to read the state of the device (from the *is_active* (page 106) property) will block until the queue has filled. If `True`[237], a value will be returned immediately, but be aware that this value is likely to fluctuate excessively.
- **average** – The function used to average the values in the internal queue. This defaults to `statistics.median()`[238] which is a good selection for discarding outliers from jittery sensors. The function specified must accept a sequence of numbers and return a single number.
- **ignore** (*frozenset*[239] *or None*[240]) – The set of values which the queue should ignore, if returned from querying the device's value.
- **pin_factory** (`Factory` (page 198) *or None*[241]) – See *API - Pins* (page 195) for more information (this is an advanced feature which most users can ignore).

[225] https://docs.python.org/3.5/library/functions.html#int
[226] https://docs.python.org/3.5/library/stdtypes.html#str
[227] https://docs.python.org/3.5/library/constants.html#None
[228] https://docs.python.org/3.5/library/functions.html#bool
[229] https://docs.python.org/3.5/library/constants.html#None
[230] https://docs.python.org/3.5/library/functions.html#bool
[231] https://docs.python.org/3.5/library/constants.html#None
[232] https://docs.python.org/3.5/library/functions.html#float
[233] https://docs.python.org/3.5/library/functions.html#int
[234] https://docs.python.org/3.5/library/functions.html#float
[235] https://docs.python.org/3.5/library/functions.html#bool
[236] https://docs.python.org/3.5/library/constants.html#False
[237] https://docs.python.org/3.5/library/constants.html#True
[238] https://docs.python.org/3.5/library/statistics.html#statistics.median
[239] https://docs.python.org/3.5/library/stdtypes.html#frozenset
[240] https://docs.python.org/3.5/library/constants.html#None
[241] https://docs.python.org/3.5/library/constants.html#None

is_active
Returns `True`[242] if the *value* (page 107) currently exceeds *threshold* (page 107) and `False`[243] otherwise.

partial
If `False`[244] (the default), attempts to read the *value* (page 107) or *is_active* (page 106) properties will block until the queue has filled.

queue_len
The length of the internal queue of values which is averaged to determine the overall state of the device. This defaults to 5.

threshold
If *value* (page 107) exceeds this amount, then *is_active* (page 106) will return `True`[245].

value
Returns the average of the values in the internal queue. This is compared to *threshold* (page 107) to determine whether *is_active* (page 106) is `True`[246].

13.2.3 InputDevice

class gpiozero.**InputDevice**(*pin*, *, *pull_up=False*, *active_state=None*, *pin_factory=None*)
Represents a generic GPIO input device.

This class extends *GPIODevice* (page 108) to add facilities common to GPIO input devices. The constructor adds the optional *pull_up* parameter to specify how the pin should be pulled by the internal resistors. The *is_active* (page 108) property is adjusted accordingly so that `True`[247] still means active regardless of the *pull_up* setting.

Parameters

- **pin** (*int*[248] *or str*[249]) – The GPIO pin that the device is connected to. See *Pin Numbering* (page 3) for valid pin numbers. If this is `None`[250] a *GPIODeviceError* (page 213) will be raised.
- **pull_up** (*bool*[251] *or None*[252]) – If `True`[253], the pin will be pulled high with an internal resistor. If `False`[254] (the default), the pin will be pulled low. If `None`[255], the pin will be floating. As gpiozero cannot automatically guess the active state when not pulling the pin, the *active_state* parameter must be passed.
- **active_state** (*bool*[256] *or None*[257]) – If `True`[258], when the hardware pin state is `HIGH`, the software pin is `HIGH`. If `False`[259], the input polarity is reversed: when the hardware pin state is `HIGH`, the software pin state is `LOW`. Use this parameter to set the active state of the underlying pin when configuring it as not pulled (when *pull_up* is

[242] https://docs.python.org/3.5/library/constants.html#True
[243] https://docs.python.org/3.5/library/constants.html#False
[244] https://docs.python.org/3.5/library/constants.html#False
[245] https://docs.python.org/3.5/library/constants.html#True
[246] https://docs.python.org/3.5/library/constants.html#True
[247] https://docs.python.org/3.5/library/constants.html#True
[248] https://docs.python.org/3.5/library/functions.html#int
[249] https://docs.python.org/3.5/library/stdtypes.html#str
[250] https://docs.python.org/3.5/library/constants.html#None
[251] https://docs.python.org/3.5/library/functions.html#bool
[252] https://docs.python.org/3.5/library/constants.html#None
[253] https://docs.python.org/3.5/library/constants.html#True
[254] https://docs.python.org/3.5/library/constants.html#False
[255] https://docs.python.org/3.5/library/constants.html#None
[256] https://docs.python.org/3.5/library/functions.html#bool
[257] https://docs.python.org/3.5/library/constants.html#None
[258] https://docs.python.org/3.5/library/constants.html#True
[259] https://docs.python.org/3.5/library/constants.html#False

None[260]). When *pull_up* is True[261] or False[262], the active state is automatically set to the proper value.

- **pin_factory** (Factory (page 198) *or* None[263]) – See *API - Pins* (page 195) for more information (this is an advanced feature which most users can ignore).

is_active
Returns True[264] if the device is currently active and False[265] otherwise. This property is usually derived from *value* (page 108). Unlike *value* (page 108), this is *always* a boolean.

pull_up
If True[266], the device uses a pull-up resistor to set the GPIO pin "high" by default.

value
Returns a value representing the device's state. Frequently, this is a boolean value, or a number between 0 and 1 but some devices use larger ranges (e.g. -1 to +1) and composite devices usually use tuples to return the states of all their subordinate components.

13.2.4 GPIODevice

class gpiozero.**GPIODevice**(*pin*, *pin_factory=None*)
Extends *Device* (page 175). Represents a generic GPIO device and provides the services common to all single-pin GPIO devices (like ensuring two GPIO devices do no share a *pin* (page 109)).

Parameters pin (*int*[267] *or str*[268]) – The GPIO pin that the device is connected to. See *Pin Numbering* (page 3) for valid pin numbers. If this is None[269] a *GPIODeviceError* (page 213) will be raised. If the pin is already in use by another device, *GPIOPinInUse* (page 213) will be raised.

close()
Shut down the device and release all associated resources. This method can be called on an already closed device without raising an exception.

This method is primarily intended for interactive use at the command line. It disables the device and releases its pin(s) for use by another device.

You can attempt to do this simply by deleting an object, but unless you've cleaned up all references to the object this may not work (even if you've cleaned up all references, there's still no guarantee the garbage collector will actually delete the object at that point). By contrast, the close method provides a means of ensuring that the object is shut down.

For example, if you have a breadboard with a buzzer connected to pin 16, but then wish to attach an LED instead:

```
>>> from gpiozero import *
>>> bz = Buzzer(16)
>>> bz.on()
>>> bz.off()
>>> bz.close()
>>> led = LED(16)
>>> led.blink()
```

[260] https://docs.python.org/3.5/library/constants.html#None
[261] https://docs.python.org/3.5/library/constants.html#True
[262] https://docs.python.org/3.5/library/constants.html#False
[263] https://docs.python.org/3.5/library/constants.html#None
[264] https://docs.python.org/3.5/library/constants.html#True
[265] https://docs.python.org/3.5/library/constants.html#False
[266] https://docs.python.org/3.5/library/constants.html#True
[267] https://docs.python.org/3.5/library/functions.html#int
[268] https://docs.python.org/3.5/library/stdtypes.html#str
[269] https://docs.python.org/3.5/library/constants.html#None

`Device` (page 175) descendents can also be used as context managers using the `with`[270] statement. For example:

```
>>> from gpiozero import *
>>> with Buzzer(16) as bz:
...     bz.on()
...
>>> with LED(16) as led:
...     led.on()
...
```

closed

Returns `True`[271] if the device is closed (see the `close()` (page 108) method). Once a device is closed you can no longer use any other methods or properties to control or query the device.

pin

The `Pin` (page 199) that the device is connected to. This will be `None`[272] if the device has been closed (see the `close()` (page 175) method). When dealing with GPIO pins, query `pin.number` to discover the GPIO pin (in BCM numbering) that the device is connected to.

value

Returns a value representing the device's state. Frequently, this is a boolean value, or a number between 0 and 1 but some devices use larger ranges (e.g. -1 to +1) and composite devices usually use tuples to return the states of all their subordinate components.

[270] https://docs.python.org/3.5/reference/compound_stmts.html#with
[271] https://docs.python.org/3.5/library/constants.html#True
[272] https://docs.python.org/3.5/library/constants.html#None

CHAPTER 14

API - Output Devices

These output device component interfaces have been provided for simple use of everyday components. Components must be wired up correctly before use in code.

Note: All GPIO pin numbers use Broadcom (BCM) numbering by default. See the *Pin Numbering* (page 3) section for more information.

14.1 Regular Classes

The following classes are intended for general use with the devices they represent. All classes in this section are concrete (not abstract).

14.1.1 LED

class gpiozero.**LED**(*pin*, **, *active_high=True*, *initial_value=False*, *pin_factory=None*)

Extends `DigitalOutputDevice` (page 127) and represents a light emitting diode (LED).

Connect the cathode (short leg, flat side) of the LED to a ground pin; connect the anode (longer leg) to a limiting resistor; connect the other side of the limiting resistor to a GPIO pin (the limiting resistor can be placed either side of the LED).

The following example will light the LED:

```
from gpiozero import LED

led = LED(17)
led.on()
```

Parameters

- **pin** (`int`[273] `or` `str`[274]) – The GPIO pin which the LED is connected to. See *Pin Numbering* (page 3) for valid pin numbers. If this is `None`[275] a `GPIODeviceError`

[273] https://docs.python.org/3.5/library/functions.html#int
[274] https://docs.python.org/3.5/library/stdtypes.html#str
[275] https://docs.python.org/3.5/library/constants.html#None

(page 213) will be raised.

- **active_high** (*bool*[276]) – If True[277] (the default), the LED will operate normally with the circuit described above. If False[278] you should wire the cathode to the GPIO pin, and the anode to a 3V3 pin (via a limiting resistor).
- **initial_value** (*bool*[279] *or None*[280]) – If False[281] (the default), the LED will be off initially. If None[282], the LED will be left in whatever state the pin is found in when configured for output (warning: this can be on). If True[283], the LED will be switched on initially.
- **pin_factory** (Factory (page 198) *or None*[284]) – See *API - Pins* (page 195) for more information (this is an advanced feature which most users can ignore).

blink (*on_time=1*, *off_time=1*, *n=None*, *background=True*)
Make the device turn on and off repeatedly.

Parameters

- **on_time** (*float*[285]) – Number of seconds on. Defaults to 1 second.
- **off_time** (*float*[286]) – Number of seconds off. Defaults to 1 second.
- **n** (*int*[287] *or None*[288]) – Number of times to blink; None[289] (the default) means forever.
- **background** (*bool*[290]) – If True[291] (the default), start a background thread to continue blinking and return immediately. If False[292], only return when the blink is finished (warning: the default value of *n* will result in this method never returning).

off()
Turns the device off.

on()
Turns the device on.

toggle()
Reverse the state of the device. If it's on, turn it off; if it's off, turn it on.

is_lit
Returns True[293] if the device is currently active and False[294] otherwise. This property is usually derived from *value* (page 112). Unlike *value* (page 112), this is *always* a boolean.

pin
The *Pin* (page 199) that the device is connected to. This will be None[295] if the device has been closed (see the *close()* (page 175) method). When dealing with GPIO pins, query `pin.number` to discover the GPIO pin (in BCM numbering) that the device is connected to.

[276] https://docs.python.org/3.5/library/functions.html#bool
[277] https://docs.python.org/3.5/library/constants.html#True
[278] https://docs.python.org/3.5/library/constants.html#False
[279] https://docs.python.org/3.5/library/functions.html#bool
[280] https://docs.python.org/3.5/library/constants.html#None
[281] https://docs.python.org/3.5/library/constants.html#False
[282] https://docs.python.org/3.5/library/constants.html#None
[283] https://docs.python.org/3.5/library/constants.html#True
[284] https://docs.python.org/3.5/library/constants.html#None
[285] https://docs.python.org/3.5/library/functions.html#float
[286] https://docs.python.org/3.5/library/functions.html#float
[287] https://docs.python.org/3.5/library/functions.html#int
[288] https://docs.python.org/3.5/library/constants.html#None
[289] https://docs.python.org/3.5/library/constants.html#None
[290] https://docs.python.org/3.5/library/functions.html#bool
[291] https://docs.python.org/3.5/library/constants.html#True
[292] https://docs.python.org/3.5/library/constants.html#False
[293] https://docs.python.org/3.5/library/constants.html#True
[294] https://docs.python.org/3.5/library/constants.html#False
[295] https://docs.python.org/3.5/library/constants.html#None

value
Returns 1 if the device is currently active and 0 otherwise. Setting this property changes the state of the device.

14.1.2 PWMLED

class gpiozero.**PWMLED**(*pin*, ***, *active_high=True*, *initial_value=0*, *frequency=100*, *pin_factory=None*)
Extends *PWMOutputDevice* (page 128) and represents a light emitting diode (LED) with variable brightness.

A typical configuration of such a device is to connect a GPIO pin to the anode (long leg) of the LED, and the cathode (short leg) to ground, with an optional resistor to prevent the LED from burning out.

Parameters

- **pin** (*int*[296] *or str*[297]) – The GPIO pin which the LED is connected to. See *Pin Numbering* (page 3) for valid pin numbers. If this is None[298] a *GPIODeviceError* (page 213) will be raised.
- **active_high** (*bool*[299]) – If True[300] (the default), the *on()* (page 114) method will set the GPIO to HIGH. If False[301], the *on()* (page 114) method will set the GPIO to LOW (the *off()* (page 114) method always does the opposite).
- **initial_value** (*float*[302]) – If 0 (the default), the LED will be off initially. Other values between 0 and 1 can be specified as an initial brightness for the LED. Note that None[303] cannot be specified (unlike the parent class) as there is no way to tell PWM not to alter the state of the pin.
- **frequency** (*int*[304]) – The frequency (in Hz) of pulses emitted to drive the LED. Defaults to 100Hz.
- **pin_factory** (Factory (page 198) *or None*[305]) – See *API - Pins* (page 195) for more information (this is an advanced feature which most users can ignore).

blink(*on_time=1*, *off_time=1*, *fade_in_time=0*, *fade_out_time=0*, *n=None*, *background=True*)
Make the device turn on and off repeatedly.

Parameters

- **on_time** (*float*[306]) – Number of seconds on. Defaults to 1 second.
- **off_time** (*float*[307]) – Number of seconds off. Defaults to 1 second.
- **fade_in_time** (*float*[308]) – Number of seconds to spend fading in. Defaults to 0.
- **fade_out_time** (*float*[309]) – Number of seconds to spend fading out. Defaults to 0.

[296] https://docs.python.org/3.5/library/functions.html#int
[297] https://docs.python.org/3.5/library/stdtypes.html#str
[298] https://docs.python.org/3.5/library/constants.html#None
[299] https://docs.python.org/3.5/library/functions.html#bool
[300] https://docs.python.org/3.5/library/constants.html#True
[301] https://docs.python.org/3.5/library/constants.html#False
[302] https://docs.python.org/3.5/library/functions.html#float
[303] https://docs.python.org/3.5/library/constants.html#None
[304] https://docs.python.org/3.5/library/functions.html#int
[305] https://docs.python.org/3.5/library/constants.html#None
[306] https://docs.python.org/3.5/library/functions.html#float
[307] https://docs.python.org/3.5/library/functions.html#float
[308] https://docs.python.org/3.5/library/functions.html#float
[309] https://docs.python.org/3.5/library/functions.html#float

- **n** (*int*[310] *or None*[311]) – Number of times to blink; None[312] (the default) means forever.
- **background** (*bool*[313]) – If True[314] (the default), start a background thread to continue blinking and return immediately. If False[315], only return when the blink is finished (warning: the default value of *n* will result in this method never returning).

off()
Turns the device off.

on()
Turns the device on.

pulse(*fade_in_time=1*, *fade_out_time=1*, *n=None*, *background=True*)
Make the device fade in and out repeatedly.

Parameters

- **fade_in_time** (*float*[316]) – Number of seconds to spend fading in. Defaults to 1.
- **fade_out_time** (*float*[317]) – Number of seconds to spend fading out. Defaults to 1.
- **n** (*int*[318] *or None*[319]) – Number of times to pulse; None[320] (the default) means forever.
- **background** (*bool*[321]) – If True[322] (the default), start a background thread to continue pulsing and return immediately. If False[323], only return when the pulse is finished (warning: the default value of *n* will result in this method never returning).

toggle()
Toggle the state of the device. If the device is currently off (*value* (page 114) is 0.0), this changes it to "fully" on (*value* (page 114) is 1.0). If the device has a duty cycle (*value* (page 114)) of 0.1, this will toggle it to 0.9, and so on.

is_lit
Returns True[324] if the device is currently active (*value* (page 114) is non-zero) and False[325] otherwise.

pin
The *Pin* (page 199) that the device is connected to. This will be None[326] if the device has been closed (see the *close()* (page 175) method). When dealing with GPIO pins, query `pin.number` to discover the GPIO pin (in BCM numbering) that the device is connected to.

value
The duty cycle of the PWM device. 0.0 is off, 1.0 is fully on. Values in between may be specified for varying levels of power in the device.

[310] https://docs.python.org/3.5/library/functions.html#int
[311] https://docs.python.org/3.5/library/constants.html#None
[312] https://docs.python.org/3.5/library/constants.html#None
[313] https://docs.python.org/3.5/library/functions.html#bool
[314] https://docs.python.org/3.5/library/constants.html#True
[315] https://docs.python.org/3.5/library/constants.html#False
[316] https://docs.python.org/3.5/library/functions.html#float
[317] https://docs.python.org/3.5/library/functions.html#float
[318] https://docs.python.org/3.5/library/functions.html#int
[319] https://docs.python.org/3.5/library/constants.html#None
[320] https://docs.python.org/3.5/library/constants.html#None
[321] https://docs.python.org/3.5/library/functions.html#bool
[322] https://docs.python.org/3.5/library/constants.html#True
[323] https://docs.python.org/3.5/library/constants.html#False
[324] https://docs.python.org/3.5/library/constants.html#True
[325] https://docs.python.org/3.5/library/constants.html#False
[326] https://docs.python.org/3.5/library/constants.html#None

14.1.3 RGBLED

class gpiozero.**RGBLED**(*red*, *green*, *blue*, ***, *active_high=True*, *initial_value=(0, 0, 0)*, *pwm=True*, *pin_factory=None*)

Extends *Device* (page 175) and represents a full color LED component (composed of red, green, and blue LEDs).

Connect the common cathode (longest leg) to a ground pin; connect each of the other legs (representing the red, green, and blue anodes) to any GPIO pins. You should use three limiting resistors (one per anode).

The following code will make the LED yellow:

```
from gpiozero import RGBLED

led = RGBLED(2, 3, 4)
led.color = (1, 1, 0)
```

The colorzero[327] library is also supported:

```
from gpiozero import RGBLED
from colorzero import Color

led = RGBLED(2, 3, 4)
led.color = Color('yellow')
```

Parameters

- **red** (*int*[328] *or str*[329]) – The GPIO pin that controls the red component of the RGB LED. See *Pin Numbering* (page 3) for valid pin numbers. If this is None[330] a *GPIODeviceError* (page 213) will be raised.
- **green** (*int*[331] *or str*[332]) – The GPIO pin that controls the green component of the RGB LED.
- **blue** (*int*[333] *or str*[334]) – The GPIO pin that controls the blue component of the RGB LED.
- **active_high** (*bool*[335]) – Set to True[336] (the default) for common cathode RGB LEDs. If you are using a common anode RGB LED, set this to False[337].
- **initial_value** (*Color*[338] *or tuple*[339]) – The initial color for the RGB LED. Defaults to black (0, 0, 0).
- **pwm** (*bool*[340]) – If True[341] (the default), construct *PWMLED* (page 113) instances for each component of the RGBLED. If False[342], construct regular *LED* (page 111) instances, which prevents smooth color graduations.
- **pin_factory** (Factory (page 198) *or None*[343]) – See *API - Pins* (page 195) for more information (this is an advanced feature which most users can ignore).

[327] https://colorzero.readthedocs.io/
[328] https://docs.python.org/3.5/library/functions.html#int
[329] https://docs.python.org/3.5/library/stdtypes.html#str
[330] https://docs.python.org/3.5/library/constants.html#None
[331] https://docs.python.org/3.5/library/functions.html#int
[332] https://docs.python.org/3.5/library/stdtypes.html#str
[333] https://docs.python.org/3.5/library/functions.html#int
[334] https://docs.python.org/3.5/library/stdtypes.html#str
[335] https://docs.python.org/3.5/library/functions.html#bool
[336] https://docs.python.org/3.5/library/constants.html#True
[337] https://docs.python.org/3.5/library/constants.html#False
[338] https://colorzero.readthedocs.io/en/latest/api_color.html#colorzero.Color
[339] https://docs.python.org/3.5/library/stdtypes.html#tuple
[340] https://docs.python.org/3.5/library/functions.html#bool
[341] https://docs.python.org/3.5/library/constants.html#True
[342] https://docs.python.org/3.5/library/constants.html#False
[343] https://docs.python.org/3.5/library/constants.html#None

blink(*on_time=1*, *off_time=1*, *fade_in_time=0*, *fade_out_time=0*, *on_color=(1, 1, 1)*, *off_color=(0, 0, 0)*, *n=None*, *background=True*)
Make the device turn on and off repeatedly.

Parameters

- **on_time** (`float`[344]) – Number of seconds on. Defaults to 1 second.
- **off_time** (`float`[345]) – Number of seconds off. Defaults to 1 second.
- **fade_in_time** (`float`[346]) – Number of seconds to spend fading in. Defaults to 0. Must be 0 if *pwm* was `False`[347] when the class was constructed (`ValueError`[348] will be raised if not).
- **fade_out_time** (`float`[349]) – Number of seconds to spend fading out. Defaults to 0. Must be 0 if *pwm* was `False`[350] when the class was constructed (`ValueError`[351] will be raised if not).
- **on_color** (`Color`[352] `or` `tuple`[353]) – The color to use when the LED is "on". Defaults to white.
- **off_color** (`Color`[354] `or` `tuple`[355]) – The color to use when the LED is "off". Defaults to black.
- **n** (`int`[356] `or` `None`[357]) – Number of times to blink; `None`[358] (the default) means forever.
- **background** (`bool`[359]) – If `True`[360] (the default), start a background thread to continue blinking and return immediately. If `False`[361], only return when the blink is finished (warning: the default value of *n* will result in this method never returning).

off()
Turn the LED off. This is equivalent to setting the LED color to black `(0, 0, 0)`.

on()
Turn the LED on. This equivalent to setting the LED color to white `(1, 1, 1)`.

pulse(*fade_in_time=1*, *fade_out_time=1*, *on_color=(1, 1, 1)*, *off_color=(0, 0, 0)*, *n=None*, *background=True*)
Make the device fade in and out repeatedly.

Parameters

- **fade_in_time** (`float`[362]) – Number of seconds to spend fading in. Defaults to 1.
- **fade_out_time** (`float`[363]) – Number of seconds to spend fading out. Defaults to 1.

[344] https://docs.python.org/3.5/library/functions.html#float
[345] https://docs.python.org/3.5/library/functions.html#float
[346] https://docs.python.org/3.5/library/functions.html#float
[347] https://docs.python.org/3.5/library/constants.html#False
[348] https://docs.python.org/3.5/library/exceptions.html#ValueError
[349] https://docs.python.org/3.5/library/functions.html#float
[350] https://docs.python.org/3.5/library/constants.html#False
[351] https://docs.python.org/3.5/library/exceptions.html#ValueError
[352] https://colorzero.readthedocs.io/en/latest/api_color.html#colorzero.Color
[353] https://docs.python.org/3.5/library/stdtypes.html#tuple
[354] https://colorzero.readthedocs.io/en/latest/api_color.html#colorzero.Color
[355] https://docs.python.org/3.5/library/stdtypes.html#tuple
[356] https://docs.python.org/3.5/library/functions.html#int
[357] https://docs.python.org/3.5/library/constants.html#None
[358] https://docs.python.org/3.5/library/constants.html#None
[359] https://docs.python.org/3.5/library/functions.html#bool
[360] https://docs.python.org/3.5/library/constants.html#True
[361] https://docs.python.org/3.5/library/constants.html#False
[362] https://docs.python.org/3.5/library/functions.html#float
[363] https://docs.python.org/3.5/library/functions.html#float

- **on_color** (*Color*[364] *or tuple*[365]) – The color to use when the LED is "on". Defaults to white.
- **off_color** (*Color*[366] *or tuple*[367]) – The color to use when the LED is "off". Defaults to black.
- **n** (*int*[368] *or None*[369]) – Number of times to pulse; `None`[370] (the default) means forever.
- **background** (*bool*[371]) – If `True`[372] (the default), start a background thread to continue pulsing and return immediately. If `False`[373], only return when the pulse is finished (warning: the default value of *n* will result in this method never returning).

toggle()
Toggle the state of the device. If the device is currently off (*value* (page 117) is `(0, 0, 0)`), this changes it to "fully" on (*value* (page 117) is `(1, 1, 1)`). If the device has a specific color, this method inverts the color.

blue
Represents the blue element of the LED as a `Blue`[374] object.

color
Represents the color of the LED as a `Color`[375] object.

green
Represents the green element of the LED as a `Green`[376] object.

is_lit
Returns `True`[377] if the LED is currently active (not black) and `False`[378] otherwise.

red
Represents the red element of the LED as a `Red`[379] object.

value
Represents the color of the LED as an RGB 3-tuple of `(red, green, blue)` where each value is between 0 and 1 if *pwm* was `True`[380] when the class was constructed (and only 0 or 1 if not).

For example, red would be `(1, 0, 0)` and yellow would be `(1, 1, 0)`, while orange would be `(1, 0.5, 0)`.

14.1.4 Buzzer

class gpiozero.**Buzzer**(*pin*, ***, *active_high=True*, *initial_value=False*, *pin_factory=None*)
Extends *DigitalOutputDevice* (page 127) and represents a digital buzzer component.

Note: This interface is only capable of simple on/off commands, and is not capable of playing a variety of tones (see *TonalBuzzer* (page 119)).

[364] https://colorzero.readthedocs.io/en/latest/api_color.html#colorzero.Color
[365] https://docs.python.org/3.5/library/stdtypes.html#tuple
[366] https://colorzero.readthedocs.io/en/latest/api_color.html#colorzero.Color
[367] https://docs.python.org/3.5/library/stdtypes.html#tuple
[368] https://docs.python.org/3.5/library/functions.html#int
[369] https://docs.python.org/3.5/library/constants.html#None
[370] https://docs.python.org/3.5/library/constants.html#None
[371] https://docs.python.org/3.5/library/functions.html#bool
[372] https://docs.python.org/3.5/library/constants.html#True
[373] https://docs.python.org/3.5/library/constants.html#False
[374] https://colorzero.readthedocs.io/en/latest/api_color.html#colorzero.Blue
[375] https://colorzero.readthedocs.io/en/latest/api_color.html#colorzero.Color
[376] https://colorzero.readthedocs.io/en/latest/api_color.html#colorzero.Green
[377] https://docs.python.org/3.5/library/constants.html#True
[378] https://docs.python.org/3.5/library/constants.html#False
[379] https://colorzero.readthedocs.io/en/latest/api_color.html#colorzero.Red
[380] https://docs.python.org/3.5/library/constants.html#True

Connect the cathode (negative pin) of the buzzer to a ground pin; connect the other side to any GPIO pin.

The following example will sound the buzzer:

```
from gpiozero import Buzzer

bz = Buzzer(3)
bz.on()
```

Parameters

- **pin** (*int*[381] *or str*[382]) – The GPIO pin which the buzzer is connected to. See *Pin Numbering* (page 3) for valid pin numbers. If this is `None`[383] a *GPIODeviceError* (page 213) will be raised.
- **active_high** (*bool*[384]) – If `True`[385] (the default), the buzzer will operate normally with the circuit described above. If `False`[386] you should wire the cathode to the GPIO pin, and the anode to a 3V3 pin.
- **initial_value** (*bool*[387] *or None*[388]) – If `False`[389] (the default), the buzzer will be silent initially. If `None`[390], the buzzer will be left in whatever state the pin is found in when configured for output (warning: this can be on). If `True`[391], the buzzer will be switched on initially.
- **pin_factory** (`Factory` (page 198) *or None*[392]) – See *API - Pins* (page 195) for more information (this is an advanced feature which most users can ignore).

beep(*on_time=1*, *off_time=1*, *n=None*, *background=True*)
Make the device turn on and off repeatedly.

Parameters

- **on_time** (*float*[393]) – Number of seconds on. Defaults to 1 second.
- **off_time** (*float*[394]) – Number of seconds off. Defaults to 1 second.
- **n** (*int*[395] *or None*[396]) – Number of times to blink; `None`[397] (the default) means forever.
- **background** (*bool*[398]) – If `True`[399] (the default), start a background thread to continue blinking and return immediately. If `False`[400], only return when the blink is finished (warning: the default value of *n* will result in this method never returning).

off()
Turns the device off.

[381] https://docs.python.org/3.5/library/functions.html#int
[382] https://docs.python.org/3.5/library/stdtypes.html#str
[383] https://docs.python.org/3.5/library/constants.html#None
[384] https://docs.python.org/3.5/library/functions.html#bool
[385] https://docs.python.org/3.5/library/constants.html#True
[386] https://docs.python.org/3.5/library/constants.html#False
[387] https://docs.python.org/3.5/library/functions.html#bool
[388] https://docs.python.org/3.5/library/constants.html#None
[389] https://docs.python.org/3.5/library/constants.html#False
[390] https://docs.python.org/3.5/library/constants.html#None
[391] https://docs.python.org/3.5/library/constants.html#True
[392] https://docs.python.org/3.5/library/constants.html#None
[393] https://docs.python.org/3.5/library/functions.html#float
[394] https://docs.python.org/3.5/library/functions.html#float
[395] https://docs.python.org/3.5/library/functions.html#int
[396] https://docs.python.org/3.5/library/constants.html#None
[397] https://docs.python.org/3.5/library/constants.html#None
[398] https://docs.python.org/3.5/library/functions.html#bool
[399] https://docs.python.org/3.5/library/constants.html#True
[400] https://docs.python.org/3.5/library/constants.html#False

on()
Turns the device on.

toggle()
Reverse the state of the device. If it's on, turn it off; if it's off, turn it on.

is_active
Returns `True`[401] if the device is currently active and `False`[402] otherwise. This property is usually derived from *`value`* (page 119). Unlike *`value`* (page 119), this is *always* a boolean.

pin
The *`Pin`* (page 199) that the device is connected to. This will be `None`[403] if the device has been closed (see the *`close()`* (page 175) method). When dealing with GPIO pins, query `pin.number` to discover the GPIO pin (in BCM numbering) that the device is connected to.

value
Returns 1 if the device is currently active and 0 otherwise. Setting this property changes the state of the device.

14.1.5 TonalBuzzer

class gpiozero.**TonalBuzzer**(*pin*, ***, *initial_value=None*, *mid_tone=Tone('A4')*, *octaves=1*, *pin_factory=None*)
Extends *`CompositeDevice`* (page 164) and represents a tonal buzzer.

Parameters

- **pin** (*`int`*[404] *or* *`str`*[405]) – The GPIO pin which the buzzer is connected to. See *Pin Numbering* (page 3) for valid pin numbers. If this is `None`[406] a *`GPIODeviceError`* (page 213) will be raised.
- **initial_value** (*`float`*[407]) – If `None`[408] (the default), the buzzer will be off initially. Values between -1 and 1 can be specified as an initial value for the buzzer.
- **mid_tone** (*`int`*[409] *or* *`str`*[410]) – The tone which is represented the device's middle value (0). The default is "A4" (MIDI note 69).
- **octaves** (*`int`*[411]) – The number of octaves to allow away from the base note. The default is 1, meaning a value of -1 goes one octave below the base note, and one above, i.e. from A3 to A5 with the default base note of A4.
- **pin_factory** (`Factory` (page 198) *or* *`None`*[412]) – See *API - Pins* (page 195) for more information (this is an advanced feature which most users can ignore).

Note: Note that this class does not currently work with *`PiGPIOFactory`* (page 208).

play(*tone*)
Play the given *tone*. This can either be an instance of *`Tone`* (page 187) or can be anything that could be used to construct an instance of *`Tone`* (page 187).

For example:

401 https://docs.python.org/3.5/library/constants.html#True
402 https://docs.python.org/3.5/library/constants.html#False
403 https://docs.python.org/3.5/library/constants.html#None
404 https://docs.python.org/3.5/library/functions.html#int
405 https://docs.python.org/3.5/library/stdtypes.html#str
406 https://docs.python.org/3.5/library/constants.html#None
407 https://docs.python.org/3.5/library/functions.html#float
408 https://docs.python.org/3.5/library/constants.html#None
409 https://docs.python.org/3.5/library/functions.html#int
410 https://docs.python.org/3.5/library/stdtypes.html#str
411 https://docs.python.org/3.5/library/functions.html#int
412 https://docs.python.org/3.5/library/constants.html#None

```
>>> from gpiozero import TonalBuzzer
>>> from gpiozero.tones import Tone
>>> b = TonalBuzzer(17)
>>> b.play(Tone("A4"))
>>> b.play(Tone(220.0)) # Hz
>>> b.play(Tone(60)) # middle C in MIDI notation
>>> b.play("A4")
>>> b.play(220.0)
>>> b.play(60)
```

stop()
Turn the buzzer off. This is equivalent to setting *value* (page 120) to None[413].

is_active
Returns True[414] if the buzzer is currently playing, otherwise False[415].

max_tone
The highest tone that the buzzer can play, i.e. the tone played when *value* (page 120) is 1.

mid_tone
The middle tone available, i.e. the tone played when *value* (page 120) is 0.

min_tone
The lowest tone that the buzzer can play, i.e. the tone played when *value* (page 120) is -1.

octaves
The number of octaves available (above and below mid_tone).

tone
Returns the *Tone* (page 187) that the buzzer is currently playing, or None[416] if the buzzer is silent. This property can also be set to play the specified tone.

value
Represents the state of the buzzer as a value between -1 (representing the minimum tone) and 1 (representing the maximum tone). This can also be the special value None[417] indicating that the buzzer is currently silent.

14.1.6 Motor

class gpiozero.**Motor**(*forward*, *backward*, ***, *pwm=True*, *pin_factory=None*)
Extends *CompositeDevice* (page 164) and represents a generic motor connected to a bi-directional motor driver circuit (i.e. an H-bridge[418]).

Attach an H-bridge[419] motor controller to your Pi; connect a power source (e.g. a battery pack or the 5V pin) to the controller; connect the outputs of the controller board to the two terminals of the motor; connect the inputs of the controller board to two GPIO pins.

The following code will make the motor turn "forwards":

```
from gpiozero import Motor

motor = Motor(17, 18)
motor.forward()
```

Parameters

[413] https://docs.python.org/3.5/library/constants.html#None
[414] https://docs.python.org/3.5/library/constants.html#True
[415] https://docs.python.org/3.5/library/constants.html#False
[416] https://docs.python.org/3.5/library/constants.html#None
[417] https://docs.python.org/3.5/library/constants.html#None
[418] https://en.wikipedia.org/wiki/H_bridge
[419] https://en.wikipedia.org/wiki/H_bridge

- **forward** (*int*[420] *or* *str*[421]) – The GPIO pin that the forward input of the motor driver chip is connected to. See *Pin Numbering* (page 3) for valid pin numbers. If this is `None`[422] a *GPIODeviceError* (page 213) will be raised.
- **backward** (*int*[423] *or* *str*[424]) – The GPIO pin that the backward input of the motor driver chip is connected to. See *Pin Numbering* (page 3) for valid pin numbers. If this is `None`[425] a *GPIODeviceError* (page 213) will be raised.
- **enable** (*int*[426] *or* *str*[427] *or* *None*[428]) – The GPIO pin that enables the motor. Required for *some* motor controller boards. See *Pin Numbering* (page 3) for valid pin numbers.
- **pwm** (*bool*[429]) – If `True`[430] (the default), construct *PWMOutputDevice* (page 128) instances for the motor controller pins, allowing both direction and variable speed control. If `False`[431], construct *DigitalOutputDevice* (page 127) instances, allowing only direction control.
- **pin_factory** (`Factory` (page 198) *or* *None*[432]) – See *API - Pins* (page 195) for more information (this is an advanced feature which most users can ignore).

backward(*speed=1*)
Drive the motor backwards.

Parameters speed (*float*[433]) – The speed at which the motor should turn. Can be any value between 0 (stopped) and the default 1 (maximum speed) if *pwm* was `True`[434] when the class was constructed (and only 0 or 1 if not).

forward(*speed=1*)
Drive the motor forwards.

Parameters speed (*float*[435]) – The speed at which the motor should turn. Can be any value between 0 (stopped) and the default 1 (maximum speed) if *pwm* was `True`[436] when the class was constructed (and only 0 or 1 if not).

reverse()
Reverse the current direction of the motor. If the motor is currently idle this does nothing. Otherwise, the motor's direction will be reversed at the current speed.

stop()
Stop the motor.

is_active
Returns `True`[437] if the motor is currently running and `False`[438] otherwise.

value
Represents the speed of the motor as a floating point value between -1 (full speed backward) and 1 (full speed forward), with 0 representing stopped.

[420] https://docs.python.org/3.5/library/functions.html#int
[421] https://docs.python.org/3.5/library/stdtypes.html#str
[422] https://docs.python.org/3.5/library/constants.html#None
[423] https://docs.python.org/3.5/library/functions.html#int
[424] https://docs.python.org/3.5/library/stdtypes.html#str
[425] https://docs.python.org/3.5/library/constants.html#None
[426] https://docs.python.org/3.5/library/functions.html#int
[427] https://docs.python.org/3.5/library/stdtypes.html#str
[428] https://docs.python.org/3.5/library/constants.html#None
[429] https://docs.python.org/3.5/library/functions.html#bool
[430] https://docs.python.org/3.5/library/constants.html#True
[431] https://docs.python.org/3.5/library/constants.html#False
[432] https://docs.python.org/3.5/library/constants.html#None
[433] https://docs.python.org/3.5/library/functions.html#float
[434] https://docs.python.org/3.5/library/constants.html#True
[435] https://docs.python.org/3.5/library/functions.html#float
[436] https://docs.python.org/3.5/library/constants.html#True
[437] https://docs.python.org/3.5/library/constants.html#True
[438] https://docs.python.org/3.5/library/constants.html#False

14.1.7 PhaseEnableMotor

class gpiozero.**PhaseEnableMotor**(*phase*, *enable*, ***, *pwm=True*, *pin_factory=None*)

Extends `CompositeDevice` (page 164) and represents a generic motor connected to a Phase/Enable motor driver circuit; the phase of the driver controls whether the motor turns forwards or backwards, while enable controls the speed with PWM.

The following code will make the motor turn "forwards":

```python
from gpiozero import PhaseEnableMotor
motor = PhaseEnableMotor(12, 5)
motor.forward()
```

Parameters

- **phase** (*int*[439] *or* *str*[440]) – The GPIO pin that the phase (direction) input of the motor driver chip is connected to. See *Pin Numbering* (page 3) for valid pin numbers. If this is `None`[441] a `GPIODeviceError` (page 213) will be raised.
- **enable** (*int*[442] *or* *str*[443]) – The GPIO pin that the enable (speed) input of the motor driver chip is connected to. See *Pin Numbering* (page 3) for valid pin numbers. If this is `None`[444] a `GPIODeviceError` (page 213) will be raised.
- **pwm** (*bool*[445]) – If `True`[446] (the default), construct `PWMOutputDevice` (page 128) instances for the motor controller pins, allowing both direction and variable speed control. If `False`[447], construct `DigitalOutputDevice` (page 127) instances, allowing only direction control.
- **pin_factory** (`Factory` (page 198) *or* `None`[448]) – See *API - Pins* (page 195) for more information (this is an advanced feature which most users can ignore).

backward(*speed=1*)

Drive the motor backwards.

Parameters **speed** (*float*[449]) – The speed at which the motor should turn. Can be any value between 0 (stopped) and the default 1 (maximum speed).

forward(*speed=1*)

Drive the motor forwards.

Parameters **speed** (*float*[450]) – The speed at which the motor should turn. Can be any value between 0 (stopped) and the default 1 (maximum speed).

reverse()

Reverse the current direction of the motor. If the motor is currently idle this does nothing. Otherwise, the motor's direction will be reversed at the current speed.

stop()

Stop the motor.

is_active

Returns `True`[451] if the motor is currently running and `False`[452] otherwise.

[439] https://docs.python.org/3.5/library/functions.html#int
[440] https://docs.python.org/3.5/library/stdtypes.html#str
[441] https://docs.python.org/3.5/library/constants.html#None
[442] https://docs.python.org/3.5/library/functions.html#int
[443] https://docs.python.org/3.5/library/stdtypes.html#str
[444] https://docs.python.org/3.5/library/constants.html#None
[445] https://docs.python.org/3.5/library/functions.html#bool
[446] https://docs.python.org/3.5/library/constants.html#True
[447] https://docs.python.org/3.5/library/constants.html#False
[448] https://docs.python.org/3.5/library/constants.html#None
[449] https://docs.python.org/3.5/library/functions.html#float
[450] https://docs.python.org/3.5/library/functions.html#float
[451] https://docs.python.org/3.5/library/constants.html#True
[452] https://docs.python.org/3.5/library/constants.html#False

value
Represents the speed of the motor as a floating point value between -1 (full speed backward) and 1 (full speed forward).

14.1.8 Servo

class gpiozero.**Servo**(*pin*, ***, *initial_value=0*, *min_pulse_width=1/1000*, *max_pulse_width=2/1000*, *frame_width=20/1000*, *pin_factory=None*)

Extends `CompositeDevice` (page 164) and represents a PWM-controlled servo motor connected to a GPIO pin.

Connect a power source (e.g. a battery pack or the 5V pin) to the power cable of the servo (this is typically colored red); connect the ground cable of the servo (typically colored black or brown) to the negative of your battery pack, or a GND pin; connect the final cable (typically colored white or orange) to the GPIO pin you wish to use for controlling the servo.

The following code will make the servo move between its minimum, maximum, and mid-point positions with a pause between each:

```python
from gpiozero import Servo
from time import sleep

servo = Servo(17)
while True:
    servo.min()
    sleep(1)
    servo.mid()
    sleep(1)
    servo.max()
    sleep(1)
```

Parameters

- **pin** (*int*[453] *or str*[454]) – The GPIO pin that the servo is connected to. See *Pin Numbering* (page 3) for valid pin numbers. If this is `None`[455] a *GPIODeviceError* (page 213) will be raised.
- **initial_value** (*float*[456]) – If `0` (the default), the device's mid-point will be set initially. Other values between -1 and +1 can be specified as an initial position. `None`[457] means to start the servo un-controlled (see `value` (page 124)).
- **min_pulse_width** (*float*[458]) – The pulse width corresponding to the servo's minimum position. This defaults to 1ms.
- **max_pulse_width** (*float*[459]) – The pulse width corresponding to the servo's maximum position. This defaults to 2ms.
- **frame_width** (*float*[460]) – The length of time between servo control pulses measured in seconds. This defaults to 20ms which is a common value for servos.
- **pin_factory** (`Factory` (page 198) *or None*[461]) – See *API - Pins* (page 195) for more information (this is an advanced feature which most users can ignore).

[453] https://docs.python.org/3.5/library/functions.html#int
[454] https://docs.python.org/3.5/library/stdtypes.html#str
[455] https://docs.python.org/3.5/library/constants.html#None
[456] https://docs.python.org/3.5/library/functions.html#float
[457] https://docs.python.org/3.5/library/constants.html#None
[458] https://docs.python.org/3.5/library/functions.html#float
[459] https://docs.python.org/3.5/library/functions.html#float
[460] https://docs.python.org/3.5/library/functions.html#float
[461] https://docs.python.org/3.5/library/constants.html#None

detach()
: Temporarily disable control of the servo. This is equivalent to setting `value` (page 124) to `None`[462].

max()
: Set the servo to its maximum position.

mid()
: Set the servo to its mid-point position.

min()
: Set the servo to its minimum position.

frame_width
: The time between control pulses, measured in seconds.

is_active
: Composite devices are considered "active" if any of their constituent devices have a "truthy" value.

max_pulse_width
: The control pulse width corresponding to the servo's maximum position, measured in seconds.

min_pulse_width
: The control pulse width corresponding to the servo's minimum position, measured in seconds.

pulse_width
: Returns the current pulse width controlling the servo.

value
: Represents the position of the servo as a value between -1 (the minimum position) and +1 (the maximum position). This can also be the special value `None`[463] indicating that the servo is currently "uncontrolled", i.e. that no control signal is being sent. Typically this means the servo's position remains unchanged, but that it can be moved by hand.

14.1.9 AngularServo

class gpiozero.**AngularServo**(*pin*, **, *initial_angle=0*, *min_angle=-90*, *max_angle=90*, *min_pulse_width=1/1000*, *max_pulse_width=2/1000*, *frame_width=20/1000*, *pin_factory=None*)

Extends `Servo` (page 123) and represents a rotational PWM-controlled servo motor which can be set to particular angles (assuming valid minimum and maximum angles are provided to the constructor).

Connect a power source (e.g. a battery pack or the 5V pin) to the power cable of the servo (this is typically colored red); connect the ground cable of the servo (typically colored black or brown) to the negative of your battery pack, or a GND pin; connect the final cable (typically colored white or orange) to the GPIO pin you wish to use for controlling the servo.

Next, calibrate the angles that the servo can rotate to. In an interactive Python session, construct a `Servo` (page 123) instance. The servo should move to its mid-point by default. Set the servo to its minimum value, and measure the angle from the mid-point. Set the servo to its maximum value, and again measure the angle:

```
>>> from gpiozero import Servo
>>> s = Servo(17)
>>> s.min() # measure the angle
>>> s.max() # measure the angle
```

You should now be able to construct an `AngularServo` (page 124) instance with the correct bounds:

```
>>> from gpiozero import AngularServo
>>> s = AngularServo(17, min_angle=-42, max_angle=44)
>>> s.angle = 0.0
>>> s.angle
```

(continues on next page)

[462] https://docs.python.org/3.5/library/constants.html#None
[463] https://docs.python.org/3.5/library/constants.html#None

(continued from previous page)

```
0.0
>>> s.angle = 15
>>> s.angle
15.0
```

Note: You can set *min_angle* greater than *max_angle* if you wish to reverse the sense of the angles (e.g. `min_angle=45, max_angle=-45`). This can be useful with servos that rotate in the opposite direction to your expectations of minimum and maximum.

Parameters

- **pin** (*int*[464] *or str*[465]) – The GPIO pin that the servo is connected to. See *Pin Numbering* (page 3) for valid pin numbers. If this is `None`[466] a *GPIODeviceError* (page 213) will be raised.
- **initial_angle** (*float*[467]) – Sets the servo's initial angle to the specified value. The default is 0. The value specified must be between *min_angle* and *max_angle* inclusive. `None`[468] means to start the servo un-controlled (see *value* (page 126)).
- **min_angle** (*float*[469]) – Sets the minimum angle that the servo can rotate to. This defaults to -90, but should be set to whatever you measure from your servo during calibration.
- **max_angle** (*float*[470]) – Sets the maximum angle that the servo can rotate to. This defaults to 90, but should be set to whatever you measure from your servo during calibration.
- **min_pulse_width** (*float*[471]) – The pulse width corresponding to the servo's minimum position. This defaults to 1ms.
- **max_pulse_width** (*float*[472]) – The pulse width corresponding to the servo's maximum position. This defaults to 2ms.
- **frame_width** (*float*[473]) – The length of time between servo control pulses measured in seconds. This defaults to 20ms which is a common value for servos.
- **pin_factory** (`Factory` (page 198) *or None*[474]) – See *API - Pins* (page 195) for more information (this is an advanced feature which most users can ignore).

max()
Set the servo to its maximum position.

mid()
Set the servo to its mid-point position.

min()
Set the servo to its minimum position.

angle
The position of the servo as an angle measured in degrees. This will only be accurate if *min_angle* (page 126) and *max_angle* (page 126) have been set appropriately in the constructor.

464 https://docs.python.org/3.5/library/functions.html#int
465 https://docs.python.org/3.5/library/stdtypes.html#str
466 https://docs.python.org/3.5/library/constants.html#None
467 https://docs.python.org/3.5/library/functions.html#float
468 https://docs.python.org/3.5/library/constants.html#None
469 https://docs.python.org/3.5/library/functions.html#float
470 https://docs.python.org/3.5/library/functions.html#float
471 https://docs.python.org/3.5/library/functions.html#float
472 https://docs.python.org/3.5/library/functions.html#float
473 https://docs.python.org/3.5/library/functions.html#float
474 https://docs.python.org/3.5/library/constants.html#None

This can also be the special value `None`[475] indicating that the servo is currently "uncontrolled", i.e. that no control signal is being sent. Typically this means the servo's position remains unchanged, but that it can be moved by hand.

is_active
Composite devices are considered "active" if any of their constituent devices have a "truthy" value.

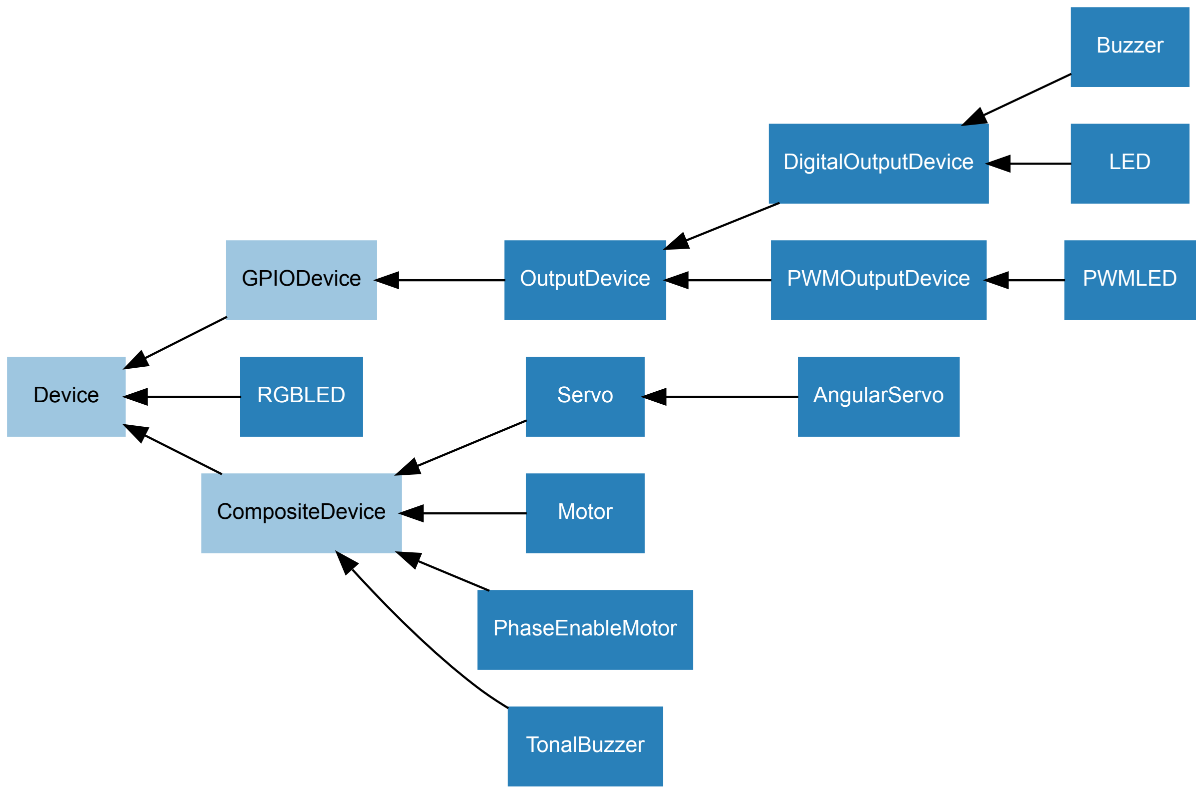
max_angle
The maximum angle that the servo will rotate to when *max()* (page 125) is called.

min_angle
The minimum angle that the servo will rotate to when *min()* (page 125) is called.

value
Represents the position of the servo as a value between -1 (the minimum position) and +1 (the maximum position). This can also be the special value `None`[476] indicating that the servo is currently "uncontrolled", i.e. that no control signal is being sent. Typically this means the servo's position remains unchanged, but that it can be moved by hand.

14.2 Base Classes

The classes in the sections above are derived from a series of base classes, some of which are effectively abstract. The classes form the (partial) hierarchy displayed in the graph below (abstract classes are shaded lighter than concrete classes):



The following sections document these base classes for advanced users that wish to construct classes for their own devices.

[475] https://docs.python.org/3.5/library/constants.html#None
[476] https://docs.python.org/3.5/library/constants.html#None

14.2.1 DigitalOutputDevice

class gpiozero.**DigitalOutputDevice**(*pin*, ***, *active_high=True*, *initial_value=False*, *pin_factory=None*)

Represents a generic output device with typical on/off behaviour.

This class extends `OutputDevice` (page 129) with a `blink()` (page 127) method which uses an optional background thread to handle toggling the device state without further interaction.

Parameters

- **pin** (`int`[477] `or str`[478]) – The GPIO pin that the device is connected to. See *Pin Numbering* (page 3) for valid pin numbers. If this is `None`[479] a `GPIODeviceError` (page 213) will be raised.
- **active_high** (`bool`[480]) – If `True`[481] (the default), the `on()` (page 127) method will set the GPIO to HIGH. If `False`[482], the `on()` (page 127) method will set the GPIO to LOW (the `off()` (page 127) method always does the opposite).
- **initial_value** (`bool`[483] `or None`[484]) – If `False`[485] (the default), the device will be off initially. If `None`[486], the device will be left in whatever state the pin is found in when configured for output (warning: this can be on). If `True`[487], the device will be switched on initially.
- **pin_factory** (`Factory` (page 198) `or None`[488]) – See *API - Pins* (page 195) for more information (this is an advanced feature which most users can ignore).

blink(*on_time=1*, *off_time=1*, *n=None*, *background=True*)

Make the device turn on and off repeatedly.

Parameters

- **on_time** (`float`[489]) – Number of seconds on. Defaults to 1 second.
- **off_time** (`float`[490]) – Number of seconds off. Defaults to 1 second.
- **n** (`int`[491] `or None`[492]) – Number of times to blink; `None`[493] (the default) means forever.
- **background** (`bool`[494]) – If `True`[495] (the default), start a background thread to continue blinking and return immediately. If `False`[496], only return when the blink is finished (warning: the default value of *n* will result in this method never returning).

off()

Turns the device off.

on()

Turns the device on.

[477] https://docs.python.org/3.5/library/functions.html#int
[478] https://docs.python.org/3.5/library/stdtypes.html#str
[479] https://docs.python.org/3.5/library/constants.html#None
[480] https://docs.python.org/3.5/library/functions.html#bool
[481] https://docs.python.org/3.5/library/constants.html#True
[482] https://docs.python.org/3.5/library/constants.html#False
[483] https://docs.python.org/3.5/library/functions.html#bool
[484] https://docs.python.org/3.5/library/constants.html#None
[485] https://docs.python.org/3.5/library/constants.html#False
[486] https://docs.python.org/3.5/library/constants.html#None
[487] https://docs.python.org/3.5/library/constants.html#True
[488] https://docs.python.org/3.5/library/constants.html#None
[489] https://docs.python.org/3.5/library/functions.html#float
[490] https://docs.python.org/3.5/library/functions.html#float
[491] https://docs.python.org/3.5/library/functions.html#int
[492] https://docs.python.org/3.5/library/constants.html#None
[493] https://docs.python.org/3.5/library/constants.html#None
[494] https://docs.python.org/3.5/library/functions.html#bool
[495] https://docs.python.org/3.5/library/constants.html#True
[496] https://docs.python.org/3.5/library/constants.html#False

value
Returns 1 if the device is currently active and 0 otherwise. Setting this property changes the state of the device.

14.2.2 PWMOutputDevice

class gpiozero.**PWMOutputDevice**(*pin*, ***, *active_high=True*, *initial_value=0*, *frequency=100*, *pin_factory=None*)
Generic output device configured for pulse-width modulation (PWM).

Parameters

- **pin** (*int*[497] *or str*[498]) – The GPIO pin that the device is connected to. See *Pin Numbering* (page 3) for valid pin numbers. If this is `None`[499] a *GPIODeviceError* (page 213) will be raised.
- **active_high** (*bool*[500]) – If `True`[501] (the default), the *on()* (page 129) method will set the GPIO to HIGH. If `False`[502], the *on()* (page 129) method will set the GPIO to LOW (the *off()* (page 129) method always does the opposite).
- **initial_value** (*float*[503]) – If 0 (the default), the device's duty cycle will be 0 initially. Other values between 0 and 1 can be specified as an initial duty cycle. Note that `None`[504] cannot be specified (unlike the parent class) as there is no way to tell PWM not to alter the state of the pin.
- **frequency** (*int*[505]) – The frequency (in Hz) of pulses emitted to drive the device. Defaults to 100Hz.
- **pin_factory** (`Factory` (page 198) *or None*[506]) – See *API - Pins* (page 195) for more information (this is an advanced feature which most users can ignore).

blink(*on_time=1*, *off_time=1*, *fade_in_time=0*, *fade_out_time=0*, *n=None*, *background=True*)
Make the device turn on and off repeatedly.

Parameters

- **on_time** (*float*[507]) – Number of seconds on. Defaults to 1 second.
- **off_time** (*float*[508]) – Number of seconds off. Defaults to 1 second.
- **fade_in_time** (*float*[509]) – Number of seconds to spend fading in. Defaults to 0.
- **fade_out_time** (*float*[510]) – Number of seconds to spend fading out. Defaults to 0.
- **n** (*int*[511] *or None*[512]) – Number of times to blink; `None`[513] (the default) means forever.

[497] https://docs.python.org/3.5/library/functions.html#int
[498] https://docs.python.org/3.5/library/stdtypes.html#str
[499] https://docs.python.org/3.5/library/constants.html#None
[500] https://docs.python.org/3.5/library/functions.html#bool
[501] https://docs.python.org/3.5/library/constants.html#True
[502] https://docs.python.org/3.5/library/constants.html#False
[503] https://docs.python.org/3.5/library/functions.html#float
[504] https://docs.python.org/3.5/library/constants.html#None
[505] https://docs.python.org/3.5/library/functions.html#int
[506] https://docs.python.org/3.5/library/constants.html#None
[507] https://docs.python.org/3.5/library/functions.html#float
[508] https://docs.python.org/3.5/library/functions.html#float
[509] https://docs.python.org/3.5/library/functions.html#float
[510] https://docs.python.org/3.5/library/functions.html#float
[511] https://docs.python.org/3.5/library/functions.html#int
[512] https://docs.python.org/3.5/library/constants.html#None
[513] https://docs.python.org/3.5/library/constants.html#None

- **background** (*bool*[514]) – If True[515] (the default), start a background thread to continue blinking and return immediately. If False[516], only return when the blink is finished (warning: the default value of *n* will result in this method never returning).

off()
Turns the device off.

on()
Turns the device on.

pulse(*fade_in_time=1*, *fade_out_time=1*, *n=None*, *background=True*)
Make the device fade in and out repeatedly.

Parameters

- **fade_in_time** (*float*[517]) – Number of seconds to spend fading in. Defaults to 1.
- **fade_out_time** (*float*[518]) – Number of seconds to spend fading out. Defaults to 1.
- **n** (*int*[519] *or None*[520]) – Number of times to pulse; None[521] (the default) means forever.
- **background** (*bool*[522]) – If True[523] (the default), start a background thread to continue pulsing and return immediately. If False[524], only return when the pulse is finished (warning: the default value of *n* will result in this method never returning).

toggle()
Toggle the state of the device. If the device is currently off (*value* (page 129) is 0.0), this changes it to "fully" on (*value* (page 129) is 1.0). If the device has a duty cycle (*value* (page 129)) of 0.1, this will toggle it to 0.9, and so on.

frequency
The frequency of the pulses used with the PWM device, in Hz. The default is 100Hz.

is_active
Returns True[525] if the device is currently active (*value* (page 129) is non-zero) and False[526] otherwise.

value
The duty cycle of the PWM device. 0.0 is off, 1.0 is fully on. Values in between may be specified for varying levels of power in the device.

14.2.3 OutputDevice

class gpiozero.**OutputDevice**(*pin*, ***, *active_high=True*, *initial_value=False*, *pin_factory=None*)
Represents a generic GPIO output device.

This class extends *GPIODevice* (page 108) to add facilities common to GPIO output devices: an *on()* (page 130) method to switch the device on, a corresponding *off()* (page 130) method, and a *toggle()* (page 130) method.

[514] https://docs.python.org/3.5/library/functions.html#bool
[515] https://docs.python.org/3.5/library/constants.html#True
[516] https://docs.python.org/3.5/library/constants.html#False
[517] https://docs.python.org/3.5/library/functions.html#float
[518] https://docs.python.org/3.5/library/functions.html#float
[519] https://docs.python.org/3.5/library/functions.html#int
[520] https://docs.python.org/3.5/library/constants.html#None
[521] https://docs.python.org/3.5/library/constants.html#None
[522] https://docs.python.org/3.5/library/functions.html#bool
[523] https://docs.python.org/3.5/library/constants.html#True
[524] https://docs.python.org/3.5/library/constants.html#False
[525] https://docs.python.org/3.5/library/constants.html#True
[526] https://docs.python.org/3.5/library/constants.html#False

Parameters

- **pin** (*int*[527] *or str*[528]) – The GPIO pin that the device is connected to. See *Pin Numbering* (page 3) for valid pin numbers. If this is `None`[529] a *GPIODeviceError* (page 213) will be raised.
- **active_high** (*bool*[530]) – If `True`[531] (the default), the *on()* (page 130) method will set the GPIO to HIGH. If `False`[532], the *on()* (page 130) method will set the GPIO to LOW (the *off()* (page 130) method always does the opposite).
- **initial_value** (*bool*[533] *or None*[534]) – If `False`[535] (the default), the device will be off initially. If `None`[536], the device will be left in whatever state the pin is found in when configured for output (warning: this can be on). If `True`[537], the device will be switched on initially.
- **pin_factory** (`Factory` (page 198) *or None*[538]) – See *API - Pins* (page 195) for more information (this is an advanced feature which most users can ignore).

off()
Turns the device off.

on()
Turns the device on.

toggle()
Reverse the state of the device. If it's on, turn it off; if it's off, turn it on.

active_high
When `True`[539], the *value* (page 130) property is `True`[540] when the device's *pin* (page 109) is high. When `False`[541] the *value* (page 130) property is `True`[542] when the device's pin is low (i.e. the value is inverted).

This property can be set after construction; be warned that changing it will invert *value* (page 130) (i.e. changing this property doesn't change the device's pin state - it just changes how that state is interpreted).

value
Returns 1 if the device is currently active and 0 otherwise. Setting this property changes the state of the device.

14.2.4 GPIODevice

class gpiozero.**GPIODevice**(*pin*, *, *pin_factory=None*)
Extends *Device* (page 175). Represents a generic GPIO device and provides the services common to all single-pin GPIO devices (like ensuring two GPIO devices do no share a *pin* (page 109)).

Parameters **pin** (*int*[543] *or str*[544]) – The GPIO pin that the device is connected to. See

[527] https://docs.python.org/3.5/library/functions.html#int
[528] https://docs.python.org/3.5/library/stdtypes.html#str
[529] https://docs.python.org/3.5/library/constants.html#None
[530] https://docs.python.org/3.5/library/functions.html#bool
[531] https://docs.python.org/3.5/library/constants.html#True
[532] https://docs.python.org/3.5/library/constants.html#False
[533] https://docs.python.org/3.5/library/functions.html#bool
[534] https://docs.python.org/3.5/library/constants.html#None
[535] https://docs.python.org/3.5/library/constants.html#False
[536] https://docs.python.org/3.5/library/constants.html#None
[537] https://docs.python.org/3.5/library/constants.html#True
[538] https://docs.python.org/3.5/library/constants.html#None
[539] https://docs.python.org/3.5/library/constants.html#True
[540] https://docs.python.org/3.5/library/constants.html#True
[541] https://docs.python.org/3.5/library/constants.html#False
[542] https://docs.python.org/3.5/library/constants.html#True
[543] https://docs.python.org/3.5/library/functions.html#int
[544] https://docs.python.org/3.5/library/stdtypes.html#str

Pin Numbering (page 3) for valid pin numbers. If this is `None`[545] a *GPIODeviceError* (page 213) will be raised. If the pin is already in use by another device, *GPIOPinInUse* (page 213) will be raised.

close()

Shut down the device and release all associated resources. This method can be called on an already closed device without raising an exception.

This method is primarily intended for interactive use at the command line. It disables the device and releases its pin(s) for use by another device.

You can attempt to do this simply by deleting an object, but unless you've cleaned up all references to the object this may not work (even if you've cleaned up all references, there's still no guarantee the garbage collector will actually delete the object at that point). By contrast, the close method provides a means of ensuring that the object is shut down.

For example, if you have a breadboard with a buzzer connected to pin 16, but then wish to attach an LED instead:

```
>>> from gpiozero import *
>>> bz = Buzzer(16)
>>> bz.on()
>>> bz.off()
>>> bz.close()
>>> led = LED(16)
>>> led.blink()
```

Device (page 175) descendents can also be used as context managers using the `with`[546] statement. For example:

```
>>> from gpiozero import *
>>> with Buzzer(16) as bz:
...     bz.on()
...
>>> with LED(16) as led:
...     led.on()
...
```

closed

Returns `True`[547] if the device is closed (see the *close()* (page 108) method). Once a device is closed you can no longer use any other methods or properties to control or query the device.

pin

The *Pin* (page 199) that the device is connected to. This will be `None`[548] if the device has been closed (see the *close()* (page 175) method). When dealing with GPIO pins, query `pin.number` to discover the GPIO pin (in BCM numbering) that the device is connected to.

value

Returns a value representing the device's state. Frequently, this is a boolean value, or a number between 0 and 1 but some devices use larger ranges (e.g. -1 to +1) and composite devices usually use tuples to return the states of all their subordinate components.

[545] https://docs.python.org/3.5/library/constants.html#None
[546] https://docs.python.org/3.5/reference/compound_stmts.html#with
[547] https://docs.python.org/3.5/library/constants.html#True
[548] https://docs.python.org/3.5/library/constants.html#None

CHAPTER 15

API - SPI Devices

SPI stands for Serial Peripheral Interface[549] and is a mechanism allowing compatible devices to communicate with the Pi. SPI is a four-wire protocol meaning it usually requires four pins to operate:

- A "clock" pin which provides timing information.
- A "MOSI" pin (Master Out, Slave In) which the Pi uses to send information to the device.
- A "MISO" pin (Master In, Slave Out) which the Pi uses to receive information from the device.
- A "select" pin which the Pi uses to indicate which device it's talking to. This last pin is necessary because multiple devices can share the clock, MOSI, and MISO pins, but only one device can be connected to each select pin.

The gpiozero library provides two SPI implementations:

- A software based implementation. This is always available, can use any four GPIO pins for SPI communication, but is rather slow and won't work with all devices.
- A hardware based implementation. This is only available when the SPI kernel module is loaded, and the Python spidev library is available. It can only use specific pins for SPI communication (GPIO11=clock, GPIO10=MOSI, GPIO9=MISO, while GPIO8 is select for device 0 and GPIO7 is select for device 1). However, it is extremely fast and works with all devices.

15.1 SPI keyword args

When constructing an SPI device there are two schemes for specifying which pins it is connected to:

- You can specify *port* and *device* keyword arguments. The *port* parameter must be 0 (there is only one user-accessible hardware SPI interface on the Pi using GPIO11 as the clock pin, GPIO10 as the MOSI pin, and GPIO9 as the MISO pin), while the *device* parameter must be 0 or 1. If *device* is 0, the select pin will be GPIO8. If *device* is 1, the select pin will be GPIO7.
- Alternatively you can specify *clock_pin*, *mosi_pin*, *miso_pin*, and *select_pin* keyword arguments. In this case the pins can be any 4 GPIO pins (remember that SPI devices can share clock, MOSI, and MISO pins, but not select pins - the gpiozero library will enforce this restriction).

You cannot mix these two schemes, i.e. attempting to specify *port* and *clock_pin* will result in `SPIBadArgs` (page 213) being raised. However, you can omit any arguments from either scheme. The defaults are:

[549] https://en.wikipedia.org/wiki/Serial_Peripheral_Interface_Bus

- *port* and *device* both default to 0.
- *clock_pin* defaults to 11, *mosi_pin* defaults to 10, *miso_pin* defaults to 9, and *select_pin* defaults to 8.
- As with other GPIO based devices you can optionally specify a *pin_factory* argument overriding the default pin factory (see *API - Pins* (page 195) for more information).

Hence the following constructors are all equivalent:

```
from gpiozero import MCP3008

MCP3008(channel=0)
MCP3008(channel=0, device=0)
MCP3008(channel=0, port=0, device=0)
MCP3008(channel=0, select_pin=8)
MCP3008(channel=0, clock_pin=11, mosi_pin=10, miso_pin=9, select_pin=8)
```

Note that the defaults describe equivalent sets of pins and that these pins are compatible with the hardware implementation. Regardless of which scheme you use, gpiozero will attempt to use the hardware implementation if it is available and if the selected pins are compatible, falling back to the software implementation if not.

15.2 Analog to Digital Converters (ADC)

The following classes are intended for general use with the integrated circuits they are named after. All classes in this section are concrete (not abstract).

15.2.1 MCP3001

class gpiozero.**MCP3001**(*max_voltage=3.3*, ***spi_args*)

The MCP3001[550] is a 10-bit analog to digital converter with 1 channel. Please note that the MCP3001 always operates in differential mode, measuring the value of IN+ relative to IN-.

value

The current value read from the device, scaled to a value between 0 and 1 (or -1 to +1 for certain devices operating in differential mode).

15.2.2 MCP3002

class gpiozero.**MCP3002**(*channel=0*, *differential=False*, *max_voltage=3.3*, ***spi_args*)

The MCP3002[551] is a 10-bit analog to digital converter with 2 channels (0-1).

channel

The channel to read data from. The MCP3008/3208/3304 have 8 channels (0-7), while the MCP3004/3204/3302 have 4 channels (0-3), the MCP3002/3202 have 2 channels (0-1), and the MCP3001/3201/3301 only have 1 channel.

differential

If `True`, the device is operated in differential mode. In this mode one channel (specified by the channel attribute) is read relative to the value of a second channel (implied by the chip's design).

Please refer to the device data-sheet to determine which channel is used as the relative base value (for example, when using an *MCP3008* (page 135) in differential mode, channel 0 is read relative to channel 1).

value

The current value read from the device, scaled to a value between 0 and 1 (or -1 to +1 for certain devices operating in differential mode).

[550] http://www.farnell.com/datasheets/630400.pdf
[551] http://www.farnell.com/datasheets/1599363.pdf

15.2.3 MCP3004

class gpiozero.**MCP3004**(*channel=0*, *differential=False*, *max_voltage=3.3*, ***spi_args*)

The MCP3004[552] is a 10-bit analog to digital converter with 4 channels (0-3).

channel

The channel to read data from. The MCP3008/3208/3304 have 8 channels (0-7), while the MCP3004/3204/3302 have 4 channels (0-3), the MCP3002/3202 have 2 channels (0-1), and the MCP3001/3201/3301 only have 1 channel.

differential

If `True`, the device is operated in differential mode. In this mode one channel (specified by the channel attribute) is read relative to the value of a second channel (implied by the chip's design).

Please refer to the device data-sheet to determine which channel is used as the relative base value (for example, when using an *MCP3008* (page 135) in differential mode, channel 0 is read relative to channel 1).

value

The current value read from the device, scaled to a value between 0 and 1 (or -1 to +1 for certain devices operating in differential mode).

15.2.4 MCP3008

class gpiozero.**MCP3008**(*channel=0*, *differential=False*, *max_voltage=3.3*, ***spi_args*)

The MCP3008[553] is a 10-bit analog to digital converter with 8 channels (0-7).

channel

The channel to read data from. The MCP3008/3208/3304 have 8 channels (0-7), while the MCP3004/3204/3302 have 4 channels (0-3), the MCP3002/3202 have 2 channels (0-1), and the MCP3001/3201/3301 only have 1 channel.

differential

If `True`, the device is operated in differential mode. In this mode one channel (specified by the channel attribute) is read relative to the value of a second channel (implied by the chip's design).

Please refer to the device data-sheet to determine which channel is used as the relative base value (for example, when using an *MCP3008* (page 135) in differential mode, channel 0 is read relative to channel 1).

value

The current value read from the device, scaled to a value between 0 and 1 (or -1 to +1 for certain devices operating in differential mode).

15.2.5 MCP3201

class gpiozero.**MCP3201**(*max_voltage=3.3*, ***spi_args*)

The MCP3201[554] is a 12-bit analog to digital converter with 1 channel. Please note that the MCP3201 always operates in differential mode, measuring the value of IN+ relative to IN-.

value

The current value read from the device, scaled to a value between 0 and 1 (or -1 to +1 for certain devices operating in differential mode).

[552] http://www.farnell.com/datasheets/808965.pdf
[553] http://www.farnell.com/datasheets/808965.pdf
[554] http://www.farnell.com/datasheets/1669366.pdf

15.2.6 MCP3202

class gpiozero.**MCP3202**(*channel=0*, *differential=False*, *max_voltage=3.3*, ***spi_args*)

The MCP3202[555] is a 12-bit analog to digital converter with 2 channels (0-1).

channel

The channel to read data from. The MCP3008/3208/3304 have 8 channels (0-7), while the MCP3004/3204/3302 have 4 channels (0-3), the MCP3002/3202 have 2 channels (0-1), and the MCP3001/3201/3301 only have 1 channel.

differential

If `True`, the device is operated in differential mode. In this mode one channel (specified by the channel attribute) is read relative to the value of a second channel (implied by the chip's design).

Please refer to the device data-sheet to determine which channel is used as the relative base value (for example, when using an *MCP3008* (page 135) in differential mode, channel 0 is read relative to channel 1).

value

The current value read from the device, scaled to a value between 0 and 1 (or -1 to +1 for certain devices operating in differential mode).

15.2.7 MCP3204

class gpiozero.**MCP3204**(*channel=0*, *differential=False*, *max_voltage=3.3*, ***spi_args*)

The MCP3204[556] is a 12-bit analog to digital converter with 4 channels (0-3).

channel

The channel to read data from. The MCP3008/3208/3304 have 8 channels (0-7), while the MCP3004/3204/3302 have 4 channels (0-3), the MCP3002/3202 have 2 channels (0-1), and the MCP3001/3201/3301 only have 1 channel.

differential

If `True`, the device is operated in differential mode. In this mode one channel (specified by the channel attribute) is read relative to the value of a second channel (implied by the chip's design).

Please refer to the device data-sheet to determine which channel is used as the relative base value (for example, when using an *MCP3008* (page 135) in differential mode, channel 0 is read relative to channel 1).

value

The current value read from the device, scaled to a value between 0 and 1 (or -1 to +1 for certain devices operating in differential mode).

15.2.8 MCP3208

class gpiozero.**MCP3208**(*channel=0*, *differential=False*, *max_voltage=3.3*, ***spi_args*)

The MCP3208[557] is a 12-bit analog to digital converter with 8 channels (0-7).

channel

The channel to read data from. The MCP3008/3208/3304 have 8 channels (0-7), while the MCP3004/3204/3302 have 4 channels (0-3), the MCP3002/3202 have 2 channels (0-1), and the MCP3001/3201/3301 only have 1 channel.

differential

If `True`, the device is operated in differential mode. In this mode one channel (specified by the channel attribute) is read relative to the value of a second channel (implied by the chip's design).

[555] http://www.farnell.com/datasheets/1669376.pdf
[556] http://www.farnell.com/datasheets/808967.pdf
[557] http://www.farnell.com/datasheets/808967.pdf

Please refer to the device data-sheet to determine which channel is used as the relative base value (for example, when using an `MCP3008` (page 135) in differential mode, channel 0 is read relative to channel 1).

`value`
The current value read from the device, scaled to a value between 0 and 1 (or -1 to +1 for certain devices operating in differential mode).

15.2.9 MCP3301

class `gpiozero.`**`MCP3301`**(*max_voltage=3.3*, ***spi_args*)
The MCP3301[558] is a signed 13-bit analog to digital converter. Please note that the MCP3301 always operates in differential mode measuring the difference between IN+ and IN-. Its output value is scaled from -1 to +1.

`value`
The current value read from the device, scaled to a value between 0 and 1 (or -1 to +1 for devices operating in differential mode).

15.2.10 MCP3302

class `gpiozero.`**`MCP3302`**(*channel=0*, *differential=False*, *max_voltage=3.3*, ***spi_args*)
The MCP3302[559] is a 12/13-bit analog to digital converter with 4 channels (0-3). When operated in differential mode, the device outputs a signed 13-bit value which is scaled from -1 to +1. When operated in single-ended mode (the default), the device outputs an unsigned 12-bit value scaled from 0 to 1.

`channel`
The channel to read data from. The MCP3008/3208/3304 have 8 channels (0-7), while the MCP3004/3204/3302 have 4 channels (0-3), the MCP3002/3202 have 2 channels (0-1), and the MCP3001/3201/3301 only have 1 channel.

`differential`
If `True`, the device is operated in differential mode. In this mode one channel (specified by the channel attribute) is read relative to the value of a second channel (implied by the chip's design).

Please refer to the device data-sheet to determine which channel is used as the relative base value (for example, when using an `MCP3304` (page 137) in differential mode, channel 0 is read relative to channel 1).

`value`
The current value read from the device, scaled to a value between 0 and 1 (or -1 to +1 for devices operating in differential mode).

15.2.11 MCP3304

class `gpiozero.`**`MCP3304`**(*channel=0*, *differential=False*, *max_voltage=3.3*, ***spi_args*)
The MCP3304[560] is a 12/13-bit analog to digital converter with 8 channels (0-7). When operated in differential mode, the device outputs a signed 13-bit value which is scaled from -1 to +1. When operated in single-ended mode (the default), the device outputs an unsigned 12-bit value scaled from 0 to 1.

`channel`
The channel to read data from. The MCP3008/3208/3304 have 8 channels (0-7), while the MCP3004/3204/3302 have 4 channels (0-3), the MCP3002/3202 have 2 channels (0-1), and the MCP3001/3201/3301 only have 1 channel.

[558] http://www.farnell.com/datasheets/1669397.pdf
[559] http://www.farnell.com/datasheets/1486116.pdf
[560] http://www.farnell.com/datasheets/1486116.pdf

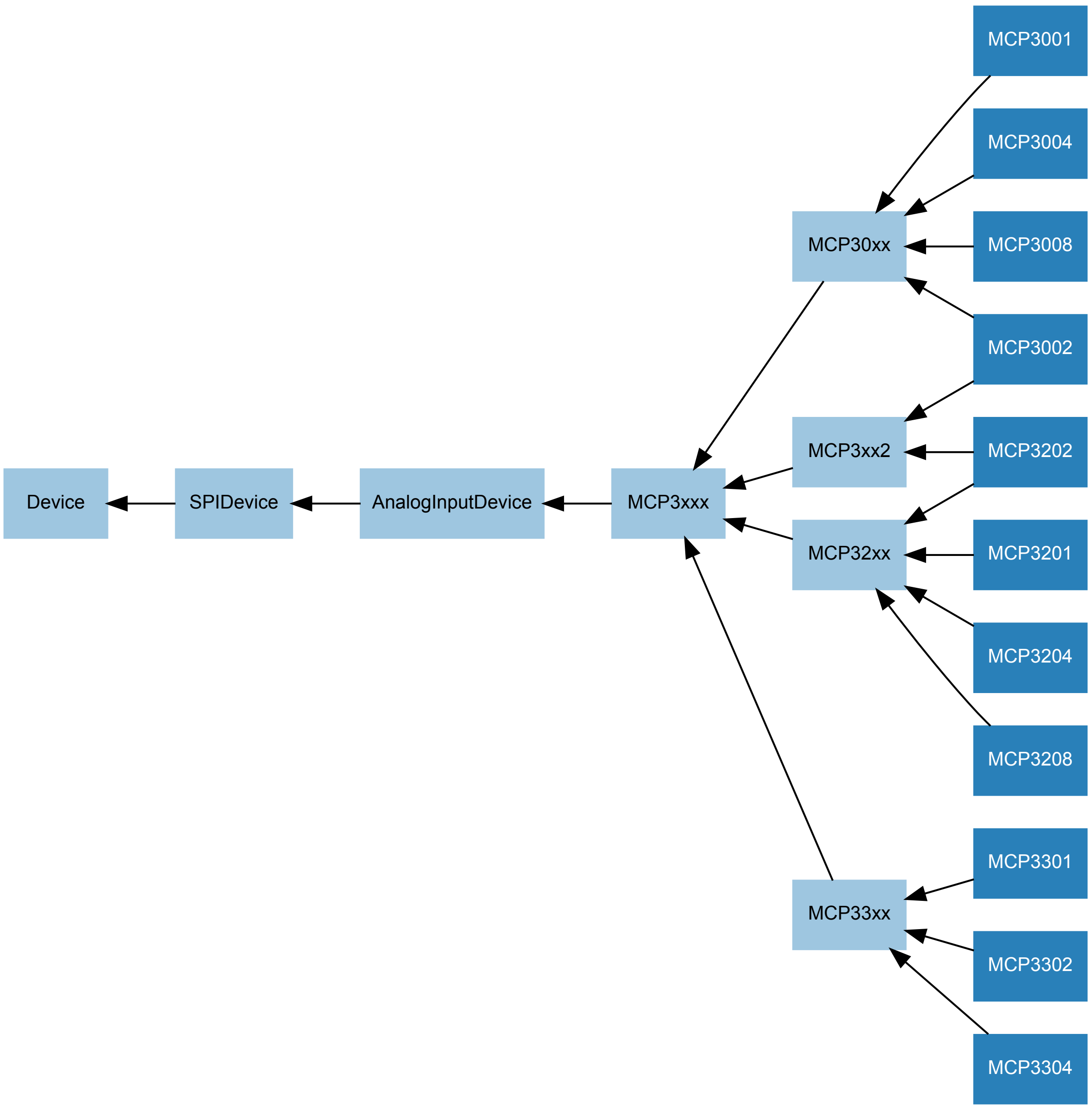
differential
If `True`, the device is operated in differential mode. In this mode one channel (specified by the channel attribute) is read relative to the value of a second channel (implied by the chip's design).

Please refer to the device data-sheet to determine which channel is used as the relative base value (for example, when using an *MCP3304* (page 137) in differential mode, channel 0 is read relative to channel 1).

value
The current value read from the device, scaled to a value between 0 and 1 (or -1 to +1 for devices operating in differential mode).

15.3 Base Classes

The classes in the sections above are derived from a series of base classes, some of which are effectively abstract. The classes form the (partial) hierarchy displayed in the graph below (abstract classes are shaded lighter than concrete classes):



The following sections document these base classes for advanced users that wish to construct classes for their own devices.

15.3.1 AnalogInputDevice

class gpiozero.**AnalogInputDevice**(*bits*, *max_voltage=3.3*, ***spi_args*)

Represents an analog input device connected to SPI (serial interface).

Typical analog input devices are analog to digital converters[561] (ADCs). Several classes are provided for specific ADC chips, including *MCP3004* (page 135), *MCP3008* (page 135), *MCP3204* (page 136), and *MCP3208* (page 136).

The following code demonstrates reading the first channel of an MCP3008 chip attached to the Pi's SPI pins:

```
from gpiozero import MCP3008

pot = MCP3008(0)
print(pot.value)
```

The *value* (page 139) attribute is normalized such that its value is always between 0.0 and 1.0 (or in special cases, such as differential sampling, -1 to +1). Hence, you can use an analog input to control the brightness of a *PWMLED* (page 113) like so:

```
from gpiozero import MCP3008, PWMLED

pot = MCP3008(0)
led = PWMLED(17)
led.source = pot
```

The *voltage* (page 139) attribute reports values between 0.0 and *max_voltage* (which defaults to 3.3, the logic level of the GPIO pins).

bits
The bit-resolution of the device/channel.

max_voltage
The voltage required to set the device's value to 1.

raw_value
The raw value as read from the device.

value
The current value read from the device, scaled to a value between 0 and 1 (or -1 to +1 for certain devices operating in differential mode).

voltage
The current voltage read from the device. This will be a value between 0 and the *max_voltage* parameter specified in the constructor.

15.3.2 SPIDevice

class gpiozero.**SPIDevice**(***spi_args*)

Extends *Device* (page 175). Represents a device that communicates via the SPI protocol.

See *SPI keyword args* (page 133) for information on the keyword arguments that can be specified with the constructor.

close()
Shut down the device and release all associated resources. This method can be called on an already closed device without raising an exception.

[561] https://en.wikipedia.org/wiki/Analog-to-digital_converter

This method is primarily intended for interactive use at the command line. It disables the device and releases its pin(s) for use by another device.

You can attempt to do this simply by deleting an object, but unless you've cleaned up all references to the object this may not work (even if you've cleaned up all references, there's still no guarantee the garbage collector will actually delete the object at that point). By contrast, the close method provides a means of ensuring that the object is shut down.

For example, if you have a breadboard with a buzzer connected to pin 16, but then wish to attach an LED instead:

```
>>> from gpiozero import *
>>> bz = Buzzer(16)
>>> bz.on()
>>> bz.off()
>>> bz.close()
>>> led = LED(16)
>>> led.blink()
```

`Device` (page 175) descendents can also be used as context managers using the `with`[562] statement. For example:

```
>>> from gpiozero import *
>>> with Buzzer(16) as bz:
...     bz.on()
...
>>> with LED(16) as led:
...     led.on()
...
```

`closed`

Returns `True`[563] if the device is closed (see the `close()` (page 139) method). Once a device is closed you can no longer use any other methods or properties to control or query the device.

[562] https://docs.python.org/3.5/reference/compound_stmts.html#with
[563] https://docs.python.org/3.5/library/constants.html#True

CHAPTER 16

API - Boards and Accessories

These additional interfaces are provided to group collections of components together for ease of use, and as examples. They are composites made up of components from the various *API - Input Devices* (page 93) and *API - Output Devices* (page 111) provided by GPIO Zero. See those pages for more information on using components individually.

Note: All GPIO pin numbers use Broadcom (BCM) numbering by default. See the *Pin Numbering* (page 3) section for more information.

16.1 Regular Classes

The following classes are intended for general use with the devices they are named after. All classes in this section are concrete (not abstract).

16.1.1 LEDBoard

class gpiozero.**LEDBoard**(**pins*, *pwm=False*, *active_high=True*, *initial_value=False*, *pin_factory=None*, ***named_pins*)

Extends `LEDCollection` (page 164) and represents a generic LED board or collection of LEDs.

The following example turns on all the LEDs on a board containing 5 LEDs attached to GPIO pins 2 through 6:

```
from gpiozero import LEDBoard

leds = LEDBoard(2, 3, 4, 5, 6)
leds.on()
```

Parameters

- ***pins** – Specify the GPIO pins that the LEDs of the board are attached to. See *Pin Numbering* (page 3) for valid pin numbers. You can designate as many pins as necessary. You can also specify `LEDBoard` (page 141) instances to create trees of LEDs.

- **pwm** (*bool*[564]) – If True[565], construct *PWMLED* (page 113) instances for each pin. If False[566] (the default), construct regular *LED* (page 111) instances.
- **active_high** (*bool*[567]) – If True[568] (the default), the *on()* (page 143) method will set all the associated pins to HIGH. If False[569], the *on()* (page 143) method will set all pins to LOW (the *off()* (page 143) method always does the opposite).
- **initial_value** (*bool*[570] *or None*[571]) – If False[572] (the default), all LEDs will be off initially. If None[573], each device will be left in whatever state the pin is found in when configured for output (warning: this can be on). If True[574], the device will be switched on initially.
- **pin_factory** (Factory (page 198) *or None*[575]) – See *API - Pins* (page 195) for more information (this is an advanced feature which most users can ignore).
- ****named_pins** – Specify GPIO pins that LEDs of the board are attached to, associating each LED with a property name. You can designate as many pins as necessary and use any names, provided they're not already in use by something else. You can also specify *LEDBoard* (page 141) instances to create trees of LEDs.

blink(*on_time=1*, *off_time=1*, *fade_in_time=0*, *fade_out_time=0*, *n=None*, *background=True*)
Make all the LEDs turn on and off repeatedly.

Parameters

- **on_time** (*float*[576]) – Number of seconds on. Defaults to 1 second.
- **off_time** (*float*[577]) – Number of seconds off. Defaults to 1 second.
- **fade_in_time** (*float*[578]) – Number of seconds to spend fading in. Defaults to 0. Must be 0 if pwm was False[579] when the class was constructed (ValueError[580] will be raised if not).
- **fade_out_time** (*float*[581]) – Number of seconds to spend fading out. Defaults to 0. Must be 0 if pwm was False[582] when the class was constructed (ValueError[583] will be raised if not).
- **n** (*int*[584] *or None*[585]) – Number of times to blink; None[586] (the default) means forever.
- **background** (*bool*[587]) – If True[588], start a background thread to continue blinking and return immediately. If False[589], only return when the blink is finished (warning:

[564] https://docs.python.org/3.5/library/functions.html#bool
[565] https://docs.python.org/3.5/library/constants.html#True
[566] https://docs.python.org/3.5/library/constants.html#False
[567] https://docs.python.org/3.5/library/functions.html#bool
[568] https://docs.python.org/3.5/library/constants.html#True
[569] https://docs.python.org/3.5/library/constants.html#False
[570] https://docs.python.org/3.5/library/functions.html#bool
[571] https://docs.python.org/3.5/library/constants.html#None
[572] https://docs.python.org/3.5/library/constants.html#False
[573] https://docs.python.org/3.5/library/constants.html#None
[574] https://docs.python.org/3.5/library/constants.html#True
[575] https://docs.python.org/3.5/library/constants.html#None
[576] https://docs.python.org/3.5/library/functions.html#float
[577] https://docs.python.org/3.5/library/functions.html#float
[578] https://docs.python.org/3.5/library/functions.html#float
[579] https://docs.python.org/3.5/library/constants.html#False
[580] https://docs.python.org/3.5/library/exceptions.html#ValueError
[581] https://docs.python.org/3.5/library/functions.html#float
[582] https://docs.python.org/3.5/library/constants.html#False
[583] https://docs.python.org/3.5/library/exceptions.html#ValueError
[584] https://docs.python.org/3.5/library/functions.html#int
[585] https://docs.python.org/3.5/library/constants.html#None
[586] https://docs.python.org/3.5/library/constants.html#None
[587] https://docs.python.org/3.5/library/functions.html#bool
[588] https://docs.python.org/3.5/library/constants.html#True
[589] https://docs.python.org/3.5/library/constants.html#False

the default value of *n* will result in this method never returning).

off (**args*)

If no arguments are specified, turn all the LEDs off. If arguments are specified, they must be the indexes of the LEDs you wish to turn off. For example:

```
from gpiozero import LEDBoard

leds = LEDBoard(2, 3, 4, 5)
leds.on()       # turn on all LEDs
leds.off(0)     # turn off the first LED (pin 2)
leds.off(-1)    # turn off the last LED (pin 5)
leds.off(1, 2) # turn off the middle LEDs (pins 3 and 4)
leds.on()       # turn on all LEDs
```

If `blink()` (page 142) is currently active, it will be stopped first.

Parameters **args** (`int`[590]) – The index(es) of the LED(s) to turn off. If no indexes are specified turn off all LEDs.

on (**args*)

If no arguments are specified, turn all the LEDs on. If arguments are specified, they must be the indexes of the LEDs you wish to turn on. For example:

```
from gpiozero import LEDBoard

leds = LEDBoard(2, 3, 4, 5)
leds.on(0)     # turn on the first LED (pin 2)
leds.on(-1)    # turn on the last LED (pin 5)
leds.on(1, 2) # turn on the middle LEDs (pins 3 and 4)
leds.off()     # turn off all LEDs
leds.on()      # turn on all LEDs
```

If `blink()` (page 142) is currently active, it will be stopped first.

Parameters **args** (`int`[591]) – The index(es) of the LED(s) to turn on. If no indexes are specified turn on all LEDs.

pulse (*fade_in_time=1*, *fade_out_time=1*, *n=None*, *background=True*)

Make all LEDs fade in and out repeatedly. Note that this method will only work if the *pwm* parameter was `True`[592] at construction time.

Parameters

- **fade_in_time** (`float`[593]) – Number of seconds to spend fading in. Defaults to 1.
- **fade_out_time** (`float`[594]) – Number of seconds to spend fading out. Defaults to 1.
- **n** (`int`[595] *or* `None`[596]) – Number of times to blink; `None`[597] (the default) means forever.
- **background** (`bool`[598]) – If `True`[599] (the default), start a background thread to continue blinking and return immediately. If `False`[600], only return when the blink is finished (warning: the default value of *n* will result in this method never returning).

[590] https://docs.python.org/3.5/library/functions.html#int
[591] https://docs.python.org/3.5/library/functions.html#int
[592] https://docs.python.org/3.5/library/constants.html#True
[593] https://docs.python.org/3.5/library/functions.html#float
[594] https://docs.python.org/3.5/library/functions.html#float
[595] https://docs.python.org/3.5/library/functions.html#int
[596] https://docs.python.org/3.5/library/constants.html#None
[597] https://docs.python.org/3.5/library/constants.html#None
[598] https://docs.python.org/3.5/library/functions.html#bool
[599] https://docs.python.org/3.5/library/constants.html#True
[600] https://docs.python.org/3.5/library/constants.html#False

toggle(**args*)

If no arguments are specified, toggle the state of all LEDs. If arguments are specified, they must be the indexes of the LEDs you wish to toggle. For example:

```
from gpiozero import LEDBoard

leds = LEDBoard(2, 3, 4, 5)
leds.toggle(0)   # turn on the first LED (pin 2)
leds.toggle(-1)  # turn on the last LED (pin 5)
leds.toggle()    # turn the first and last LED off, and the
                 # middle pair on
```

If `blink()` (page 142) is currently active, it will be stopped first.

Parameters **args** (`int`[601]) – The index(es) of the LED(s) to toggle. If no indexes are specified toggle the state of all LEDs.

16.1.2 LEDBarGraph

class gpiozero.**LEDBarGraph**(**pins, pwm=False, active_high=True, initial_value=0, pin_factory=None*)

Extends `LEDCollection` (page 164) to control a line of LEDs representing a bar graph. Positive values (0 to 1) light the LEDs from first to last. Negative values (-1 to 0) light the LEDs from last to first.

The following example demonstrates turning on the first two and last two LEDs in a board containing five LEDs attached to GPIOs 2 through 6:

```
from gpiozero import LEDBarGraph
from time import sleep

graph = LEDBarGraph(2, 3, 4, 5, 6)
graph.value = 2/5  # Light the first two LEDs only
sleep(1)
graph.value = -2/5 # Light the last two LEDs only
sleep(1)
graph.off()
```

As with all other output devices, `source` (page 145) and `values` (page 145) are supported:

```
from gpiozero import LEDBarGraph, MCP3008
from signal import pause

graph = LEDBarGraph(2, 3, 4, 5, 6, pwm=True)
pot = MCP3008(channel=0)

graph.source = pot

pause()
```

Parameters

- ***pins** – Specify the GPIO pins that the LEDs of the bar graph are attached to. See *Pin Numbering* (page 3) for valid pin numbers. You can designate as many pins as necessary.
- **pwm** (`bool`[602]) – If `True`[603], construct `PWMLED` (page 113) instances for each pin. If `False`[604] (the default), construct regular `LED` (page 111) instances. This parameter can only be specified as a keyword parameter.

[601] https://docs.python.org/3.5/library/functions.html#int
[602] https://docs.python.org/3.5/library/functions.html#bool
[603] https://docs.python.org/3.5/library/constants.html#True
[604] https://docs.python.org/3.5/library/constants.html#False

- **active_high** (*bool*[605]) – If True[606] (the default), the on() method will set all the associated pins to HIGH. If False[607], the on() method will set all pins to LOW (the off() method always does the opposite). This parameter can only be specified as a keyword parameter.
- **initial_value** (*float*[608]) – The initial *value* (page 145) of the graph given as a float between -1 and +1. Defaults to 0.0. This parameter can only be specified as a keyword parameter.
- **pin_factory** (Factory (page 198) *or None*[609]) – See *API - Pins* (page 195) for more information (this is an advanced feature which most users can ignore).

lit_count
The number of LEDs on the bar graph actually lit up. Note that just like *value* (page 145), this can be negative if the LEDs are lit from last to first.

source
The iterable to use as a source of values for *value* (page 145).

value
The value of the LED bar graph. When no LEDs are lit, the value is 0. When all LEDs are lit, the value is 1. Values between 0 and 1 light LEDs linearly from first to last. Values between 0 and -1 light LEDs linearly from last to first.

To light a particular number of LEDs, simply divide that number by the number of LEDs. For example, if your graph contains 3 LEDs, the following will light the first:

```
from gpiozero import LEDBarGraph

graph = LEDBarGraph(12, 16, 19)
graph.value = 1/3
```

Note: Setting value to -1 will light all LEDs. However, querying it subsequently will return 1 as both representations are the same in hardware. The readable range of *value* (page 145) is effectively -1 < value <= 1.

values
An infinite iterator of values read from *value* (page 145).

16.1.3 ButtonBoard

class gpiozero.**ButtonBoard**(**pins, pull_up=True, active_state=None, bounce_time=None, hold_time=1, hold_repeat=False, pin_factory=None, **named_pins*)

Extends *CompositeDevice* (page 164) and represents a generic button board or collection of buttons. The *value* (page 147) of the button board is a tuple of all the buttons states. This can be used to control all the LEDs in a *LEDBoard* (page 141) with a *ButtonBoard* (page 145):

```
from gpiozero import LEDBoard, ButtonBoard
from signal import pause

leds = LEDBoard(2, 3, 4, 5)
btns = ButtonBoard(6, 7, 8, 9)
leds.source = btns.values
pause()
```

[605] https://docs.python.org/3.5/library/functions.html#bool
[606] https://docs.python.org/3.5/library/constants.html#True
[607] https://docs.python.org/3.5/library/constants.html#False
[608] https://docs.python.org/3.5/library/functions.html#float
[609] https://docs.python.org/3.5/library/constants.html#None

Alternatively you could represent the number of pressed buttons with an *LEDBarGraph* (page 144):

```
from gpiozero import LEDBarGraph, ButtonBoard
from signal import pause

graph = LEDBarGraph(2, 3, 4, 5)
btns = ButtonBoard(6, 7, 8, 9)
graph.source = (sum(value) for value in btn.values)
pause()
```

Parameters

- ***pins** – Specify the GPIO pins that the buttons of the board are attached to. See *Pin Numbering* (page 3) for valid pin numbers. You can designate as many pins as necessary.
- **pull_up** (*bool*[610] *or None*[611]) – If True[612] (the default), the GPIO pins will be pulled high by default. In this case, connect the other side of the buttons to ground. If False[613], the GPIO pins will be pulled low by default. In this case, connect the other side of the buttons to 3V3. If None[614], the pin will be floating, so it must be externally pulled up or down and the active_state parameter must be set accordingly.
- **active_state** (*bool*[615] *or None*[616]) – See description under *InputDevice* (page 107) for more information.
- **bounce_time** (*float*[617]) – If None[618] (the default), no software bounce compensation will be performed. Otherwise, this is the length of time (in seconds) that the buttons will ignore changes in state after an initial change.
- **hold_time** (*float*[619]) – The length of time (in seconds) to wait after any button is pushed, until executing the when_held handler. Defaults to 1.
- **hold_repeat** (*bool*[620]) – If True[621], the when_held handler will be repeatedly executed as long as any buttons remain held, every *hold_time* seconds. If False[622] (the default) the when_held handler will be only be executed once per hold.
- **pin_factory** (Factory (page 198) *or None*[623]) – See *API - Pins* (page 195) for more information (this is an advanced feature which most users can ignore).
- ****named_pins** – Specify GPIO pins that buttons of the board are attached to, associating each button with a property name. You can designate as many pins as necessary and use any names, provided they're not already in use by something else.

wait_for_press (*timeout=None*)

Pause the script until the device is activated, or the timeout is reached.

Parameters timeout (*float*[624] *or None*[625]) – Number of seconds to wait before proceeding. If this is None[626] (the default), then wait indefinitely until the device is active.

[610] https://docs.python.org/3.5/library/functions.html#bool
[611] https://docs.python.org/3.5/library/constants.html#None
[612] https://docs.python.org/3.5/library/constants.html#True
[613] https://docs.python.org/3.5/library/constants.html#False
[614] https://docs.python.org/3.5/library/constants.html#None
[615] https://docs.python.org/3.5/library/functions.html#bool
[616] https://docs.python.org/3.5/library/constants.html#None
[617] https://docs.python.org/3.5/library/functions.html#float
[618] https://docs.python.org/3.5/library/constants.html#None
[619] https://docs.python.org/3.5/library/functions.html#float
[620] https://docs.python.org/3.5/library/functions.html#bool
[621] https://docs.python.org/3.5/library/constants.html#True
[622] https://docs.python.org/3.5/library/constants.html#False
[623] https://docs.python.org/3.5/library/constants.html#None
[624] https://docs.python.org/3.5/library/functions.html#float
[625] https://docs.python.org/3.5/library/constants.html#None
[626] https://docs.python.org/3.5/library/constants.html#None

wait_for_release(*timeout=None*)
Pause the script until the device is deactivated, or the timeout is reached.

Parameters **timeout** (*float*[627] *or None*[628]) – Number of seconds to wait before proceeding. If this is None[629] (the default), then wait indefinitely until the device is inactive.

is_pressed
Composite devices are considered "active" if any of their constituent devices have a "truthy" value.

pressed_time
The length of time (in seconds) that the device has been active for. When the device is inactive, this is None[630].

value
A namedtuple()[631] containing a value for each subordinate device. Devices with names will be represented as named elements. Unnamed devices will have a unique name generated for them, and they will appear in the position they appeared in the constructor.

when_pressed
The function to run when the device changes state from inactive to active.

This can be set to a function which accepts no (mandatory) parameters, or a Python function which accepts a single mandatory parameter (with as many optional parameters as you like). If the function accepts a single mandatory parameter, the device that activated will be passed as that parameter.

Set this property to None[632] (the default) to disable the event.

when_released
The function to run when the device changes state from active to inactive.

This can be set to a function which accepts no (mandatory) parameters, or a Python function which accepts a single mandatory parameter (with as many optional parameters as you like). If the function accepts a single mandatory parameter, the device that deactivated will be passed as that parameter.

Set this property to None[633] (the default) to disable the event.

16.1.4 TrafficLights

class gpiozero.**TrafficLights**(*red, amber, green, *, yellow=None, pwm=False, initial_value=False, pin_factory=None*)
Extends *LEDBoard* (page 141) for devices containing red, yellow, and green LEDs.

The following example initializes a device connected to GPIO pins 2, 3, and 4, then lights the amber (yellow) LED attached to GPIO 3:

```
from gpiozero import TrafficLights

traffic = TrafficLights(2, 3, 4)
traffic.amber.on()
```

Parameters

- **red** (*int*[634] *or str*[635]) – The GPIO pin that the red LED is attached to. See *Pin Numbering* (page 3) for valid pin numbers.

[627] https://docs.python.org/3.5/library/functions.html#float
[628] https://docs.python.org/3.5/library/constants.html#None
[629] https://docs.python.org/3.5/library/constants.html#None
[630] https://docs.python.org/3.5/library/constants.html#None
[631] https://docs.python.org/3.5/library/collections.html#collections.namedtuple
[632] https://docs.python.org/3.5/library/constants.html#None
[633] https://docs.python.org/3.5/library/constants.html#None
[634] https://docs.python.org/3.5/library/functions.html#int
[635] https://docs.python.org/3.5/library/stdtypes.html#str

- **amber** (*int*[636] *or* *str*[637] *or* *None*[638]) – The GPIO pin that the amber LED is attached to. See *Pin Numbering* (page 3) for valid pin numbers.
- **yellow** (*int*[639] *or* *str*[640] *or* *None*[641]) – The GPIO pin that the yellow LED is attached to. This is merely an alias for the `amber` parameter; you can't specify both `amber` and `yellow`. See *Pin Numbering* (page 3) for valid pin numbers.
- **green** (*int*[642] *or* *str*[643]) – The GPIO pin that the green LED is attached to. See *Pin Numbering* (page 3) for valid pin numbers.
- **pwm** (*bool*[644]) – If `True`[645], construct *PWMLED* (page 113) instances to represent each LED. If `False`[646] (the default), construct regular *LED* (page 111) instances.
- **initial_value** (*bool*[647] *or* *None*[648]) – If `False`[649] (the default), all LEDs will be off initially. If `None`[650], each device will be left in whatever state the pin is found in when configured for output (warning: this can be on). If `True`[651], the device will be switched on initially.
- **pin_factory** (`Factory` (page 198) *or* *None*[652]) – See *API - Pins* (page 195) for more information (this is an advanced feature which most users can ignore).

red
The red *LED* (page 111) or *PWMLED* (page 113).

amber
The amber *LED* (page 111) or *PWMLED* (page 113). Note that this attribute will not be present when the instance is constructed with the *yellow* keyword parameter.

yellow
The yellow *LED* (page 111) or *PWMLED* (page 113). Note that this attribute will only be present when the instance is constructed with the *yellow* keyword parameter.

green
The green *LED* (page 111) or *PWMLED* (page 113).

16.1.5 TrafficLightsBuzzer

class gpiozero.**TrafficLightsBuzzer**(*lights*, *buzzer*, *button*, ***, *pin_factory=None*)
Extends *CompositeOutputDevice* (page 164) and is a generic class for HATs with traffic lights, a button and a buzzer.

Parameters

- **lights** (`TrafficLights` (page 147)) – An instance of *TrafficLights* (page 147) representing the traffic lights of the HAT.
- **buzzer** (`Buzzer` (page 117)) – An instance of *Buzzer* (page 117) representing the buzzer on the HAT.

636 https://docs.python.org/3.5/library/functions.html#int
637 https://docs.python.org/3.5/library/stdtypes.html#str
638 https://docs.python.org/3.5/library/constants.html#None
639 https://docs.python.org/3.5/library/functions.html#int
640 https://docs.python.org/3.5/library/stdtypes.html#str
641 https://docs.python.org/3.5/library/constants.html#None
642 https://docs.python.org/3.5/library/functions.html#int
643 https://docs.python.org/3.5/library/stdtypes.html#str
644 https://docs.python.org/3.5/library/functions.html#bool
645 https://docs.python.org/3.5/library/constants.html#True
646 https://docs.python.org/3.5/library/constants.html#False
647 https://docs.python.org/3.5/library/functions.html#bool
648 https://docs.python.org/3.5/library/constants.html#None
649 https://docs.python.org/3.5/library/constants.html#False
650 https://docs.python.org/3.5/library/constants.html#None
651 https://docs.python.org/3.5/library/constants.html#True
652 https://docs.python.org/3.5/library/constants.html#None

- **button** (`Button` (page 93)) – An instance of *`Button`* (page 93) representing the button on the HAT.
- **pin_factory** (`Factory` (page 198) *or* `None`[653]) – See *API - Pins* (page 195) for more information (this is an advanced feature which most users can ignore).

lights
The *`TrafficLights`* (page 147) instance passed as the *lights* parameter.

buzzer
The *`Buzzer`* (page 117) instance passed as the *buzzer* parameter.

button
The *`Button`* (page 93) instance passed as the *button* parameter.

16.1.6 PiHutXmasTree

class gpiozero.**PiHutXmasTree**(**, pwm=False, initial_value=False, pin_factory=None*)
Extends *`LEDBoard`* (page 141) for The Pi Hut's Xmas board[654]: a 3D Christmas tree board with 24 red LEDs and a white LED as a star on top.

The 24 red LEDs can be accessed through the attributes led0, led1, led2, and so on. The white star LED is accessed through the *`star`* (page 150) attribute. Alternatively, as with all descendents of *`LEDBoard`* (page 141), you can treat the instance as a sequence of LEDs (the first element is the *`star`* (page 150)).

The Xmas Tree board pins are fixed and therefore there's no need to specify them when constructing this class. The following example turns all the LEDs on one at a time:

```
from gpiozero import PiHutXmasTree
from time import sleep

tree = PiHutXmasTree()

for light in tree:
    light.on()
    sleep(1)
```

The following example turns the star LED on and sets all the red LEDs to flicker randomly:

```
from gpiozero import PiHutXmasTree
from gpiozero.tools import random_values
from signal import pause

tree = PiHutXmasTree(pwm=True)

tree.star.on()

for led in tree[1:]:
    led.source_delay = 0.1
    led.source = random_values()

pause()
```

Parameters

- **pwm** (`bool`[655]) – If `True`[656], construct *`PWMLED`* (page 113) instances for each pin. If `False`[657] (the default), construct regular *`LED`* (page 111) instances.

[653] https://docs.python.org/3.5/library/constants.html#None
[654] https://thepihut.com/xmas
[655] https://docs.python.org/3.5/library/functions.html#bool
[656] https://docs.python.org/3.5/library/constants.html#True
[657] https://docs.python.org/3.5/library/constants.html#False

- **initial_value** (*bool*[658] *or None*[659]) – If False[660] (the default), all LEDs will be off initially. If None[661], each device will be left in whatever state the pin is found in when configured for output (warning: this can be on). If True[662], the device will be switched on initially.
- **pin_factory** (Factory (page 198) *or None*[663]) – See *API - Pins* (page 195) for more information (this is an advanced feature which most users can ignore).

star

Returns the *LED* (page 111) or *PWMLED* (page 113) representing the white star on top of the tree.

led0, led1, led2, ...

Returns the *LED* (page 111) or *PWMLED* (page 113) representing one of the red LEDs. There are actually 24 of these properties named led0, led1, and so on but for the sake of brevity we represent all 24 under this section.

16.1.7 LedBorg

class gpiozero.**LedBorg**(*, *pwm=True*, *initial_value=(0, 0, 0)*, *pin_factory=None*)

Extends *RGBLED* (page 115) for the PiBorg LedBorg[664]: an add-on board containing a very bright RGB LED.

The LedBorg pins are fixed and therefore there's no need to specify them when constructing this class. The following example turns the LedBorg purple:

```python
from gpiozero import LedBorg

led = LedBorg()
led.color = (1, 0, 1)
```

Parameters

- **initial_value** (*Color*[665] *or tuple*[666]) – The initial color for the LedBorg. Defaults to black (0, 0, 0).
- **pwm** (*bool*[667]) – If True[668] (the default), construct *PWMLED* (page 113) instances for each component of the LedBorg. If False[669], construct regular *LED* (page 111) instances, which prevents smooth color graduations.
- **pin_factory** (Factory (page 198) *or None*[670]) – See *API - Pins* (page 195) for more information (this is an advanced feature which most users can ignore).

16.1.8 PiLiter

class gpiozero.**PiLiter**(*, *pwm=False*, *initial_value=False*, *pin_factory=None*)

Extends *LEDBoard* (page 141) for the Ciseco Pi-LITEr[671]: a strip of 8 very bright LEDs.

[658] https://docs.python.org/3.5/library/functions.html#bool
[659] https://docs.python.org/3.5/library/constants.html#None
[660] https://docs.python.org/3.5/library/constants.html#False
[661] https://docs.python.org/3.5/library/constants.html#None
[662] https://docs.python.org/3.5/library/constants.html#True
[663] https://docs.python.org/3.5/library/constants.html#None
[664] https://www.piborg.org/ledborg
[665] https://colorzero.readthedocs.io/en/latest/api_color.html#colorzero.Color
[666] https://docs.python.org/3.5/library/stdtypes.html#tuple
[667] https://docs.python.org/3.5/library/functions.html#bool
[668] https://docs.python.org/3.5/library/constants.html#True
[669] https://docs.python.org/3.5/library/constants.html#False
[670] https://docs.python.org/3.5/library/constants.html#None
[671] http://shop.ciseco.co.uk/pi-liter-8-led-strip-for-the-raspberry-pi/

The Pi-LITEr pins are fixed and therefore there's no need to specify them when constructing this class. The following example turns on all the LEDs of the Pi-LITEr:

```
from gpiozero import PiLiter

lite = PiLiter()
lite.on()
```

Parameters

- **pwm** (*bool*[672]) – If True[673], construct *PWMLED* (page 113) instances for each pin. If False[674] (the default), construct regular *LED* (page 111) instances.
- **initial_value** (*bool*[675] *or None*[676]) – If False[677] (the default), all LEDs will be off initially. If None[678], each LED will be left in whatever state the pin is found in when configured for output (warning: this can be on). If True[679], the each LED will be switched on initially.
- **pin_factory** (Factory (page 198) *or None*[680]) – See *API - Pins* (page 195) for more information (this is an advanced feature which most users can ignore).

16.1.9 PiLiterBarGraph

class gpiozero.**PiLiterBarGraph**(**, pwm=False, initial_value=False, pin_factory=None*)

Extends *LEDBarGraph* (page 144) to treat the Ciseco Pi-LITEr[681] as an 8-segment bar graph.

The Pi-LITEr pins are fixed and therefore there's no need to specify them when constructing this class. The following example sets the graph value to 0.5:

```
from gpiozero import PiLiterBarGraph

graph = PiLiterBarGraph()
graph.value = 0.5
```

Parameters

- **pwm** (*bool*[682]) – If True[683], construct *PWMLED* (page 113) instances for each pin. If False[684] (the default), construct regular *LED* (page 111) instances.
- **initial_value** (*float*[685]) – The initial value of the graph given as a float between -1 and +1. Defaults to 0.0.
- **pin_factory** (Factory (page 198) *or None*[686]) – See *API - Pins* (page 195) for more information (this is an advanced feature which most users can ignore).

[672] https://docs.python.org/3.5/library/functions.html#bool
[673] https://docs.python.org/3.5/library/constants.html#True
[674] https://docs.python.org/3.5/library/constants.html#False
[675] https://docs.python.org/3.5/library/functions.html#bool
[676] https://docs.python.org/3.5/library/constants.html#None
[677] https://docs.python.org/3.5/library/constants.html#False
[678] https://docs.python.org/3.5/library/constants.html#None
[679] https://docs.python.org/3.5/library/constants.html#True
[680] https://docs.python.org/3.5/library/constants.html#None
[681] http://shop.ciseco.co.uk/pi-liter-8-led-strip-for-the-raspberry-pi/
[682] https://docs.python.org/3.5/library/functions.html#bool
[683] https://docs.python.org/3.5/library/constants.html#True
[684] https://docs.python.org/3.5/library/constants.html#False
[685] https://docs.python.org/3.5/library/functions.html#float
[686] https://docs.python.org/3.5/library/constants.html#None

16.1.10 PiTraffic

class gpiozero.**PiTraffic**(**, pwm=False, initial_value=False, pin_factory=None*)

Extends `TrafficLights` (page 147) for the Low Voltage Labs PI-TRAFFIC[687] vertical traffic lights board when attached to GPIO pins 9, 10, and 11.

There's no need to specify the pins if the PI-TRAFFIC is connected to the default pins (9, 10, 11). The following example turns on the amber LED on the PI-TRAFFIC:

```
from gpiozero import PiTraffic

traffic = PiTraffic()
traffic.amber.on()
```

To use the PI-TRAFFIC board when attached to a non-standard set of pins, simply use the parent class, `TrafficLights` (page 147).

Parameters

- **pwm** (`bool`[688]) – If `True`[689], construct `PWMLED` (page 113) instances to represent each LED. If `False`[690] (the default), construct regular `LED` (page 111) instances.
- **initial_value** (`bool`[691]) – If `False`[692] (the default), all LEDs will be off initially. If `None`[693], each device will be left in whatever state the pin is found in when configured for output (warning: this can be on). If `True`[694], the device will be switched on initially.
- **pin_factory** (`Factory` (page 198) *or* `None`[695]) – See *API - Pins* (page 195) for more information (this is an advanced feature which most users can ignore).

16.1.11 PiStop

class gpiozero.**PiStop**(*location, *, pwm=False, initial_value=False, pin_factory=None*)

Extends `TrafficLights` (page 147) for the PiHardware Pi-Stop[696]: a vertical traffic lights board.

The following example turns on the amber LED on a Pi-Stop connected to location `A+`:

```
from gpiozero import PiStop

traffic = PiStop('A+')
traffic.amber.on()
```

Parameters

- **location** (`str`[697]) – The location[698] on the GPIO header to which the Pi-Stop is connected. Must be one of: `A`, `A+`, `B`, `B+`, `C`, `D`.
- **pwm** (`bool`[699]) – If `True`[700], construct `PWMLED` (page 113) instances to represent each LED. If `False`[701] (the default), construct regular `LED` (page 111) instances.

[687] http://lowvoltagelabs.com/products/pi-traffic/
[688] https://docs.python.org/3.5/library/functions.html#bool
[689] https://docs.python.org/3.5/library/constants.html#True
[690] https://docs.python.org/3.5/library/constants.html#False
[691] https://docs.python.org/3.5/library/functions.html#bool
[692] https://docs.python.org/3.5/library/constants.html#False
[693] https://docs.python.org/3.5/library/constants.html#None
[694] https://docs.python.org/3.5/library/constants.html#True
[695] https://docs.python.org/3.5/library/constants.html#None
[696] https://pihw.wordpress.com/meltwaters-pi-hardware-kits/pi-stop/
[697] https://docs.python.org/3.5/library/stdtypes.html#str
[698] https://github.com/PiHw/Pi-Stop/blob/master/markdown_source/markdown/Discover-PiStop.md
[699] https://docs.python.org/3.5/library/functions.html#bool
[700] https://docs.python.org/3.5/library/constants.html#True
[701] https://docs.python.org/3.5/library/constants.html#False

- **initial_value** (*bool*[702]) – If False[703] (the default), all LEDs will be off initially. If None[704], each device will be left in whatever state the pin is found in when configured for output (warning: this can be on). If True[705], the device will be switched on initially.
- **pin_factory** (*Factory* (page 198) *or None*[706]) – See *API - Pins* (page 195) for more information (this is an advanced feature which most users can ignore).

16.1.12 FishDish

class gpiozero.**FishDish**(**, pwm=False, pin_factory=None*)

Extends *TrafficLightsBuzzer* (page 148) for the Pi Supply FishDish[707]: traffic light LEDs, a button and a buzzer.

The FishDish pins are fixed and therefore there's no need to specify them when constructing this class. The following example waits for the button to be pressed on the FishDish, then turns on all the LEDs:

```
from gpiozero import FishDish

fish = FishDish()
fish.button.wait_for_press()
fish.lights.on()
```

Parameters

- **pwm** (*bool*[708]) – If True[709], construct *PWMLED* (page 113) instances to represent each LED. If False[710] (the default), construct regular *LED* (page 111) instances.
- **pin_factory** (*Factory* (page 198) *or None*[711]) – See *API - Pins* (page 195) for more information (this is an advanced feature which most users can ignore).

16.1.13 TrafficHat

class gpiozero.**TrafficHat**(**, pwm=False, pin_factory=None*)

Extends *TrafficLightsBuzzer* (page 148) for the Ryanteck Traffic HAT[712]: traffic light LEDs, a button and a buzzer.

The Traffic HAT pins are fixed and therefore there's no need to specify them when constructing this class. The following example waits for the button to be pressed on the Traffic HAT, then turns on all the LEDs:

```
from gpiozero import TrafficHat

hat = TrafficHat()
hat.button.wait_for_press()
hat.lights.on()
```

Parameters

[702] https://docs.python.org/3.5/library/functions.html#bool
[703] https://docs.python.org/3.5/library/constants.html#False
[704] https://docs.python.org/3.5/library/constants.html#None
[705] https://docs.python.org/3.5/library/constants.html#True
[706] https://docs.python.org/3.5/library/constants.html#None
[707] https://www.pi-supply.com/product/fish-dish-raspberry-pi-led-buzzer-board/
[708] https://docs.python.org/3.5/library/functions.html#bool
[709] https://docs.python.org/3.5/library/constants.html#True
[710] https://docs.python.org/3.5/library/constants.html#False
[711] https://docs.python.org/3.5/library/constants.html#None
[712] https://ryanteck.uk/hats/1-traffichat-0635648607122.html

- **pwm** (*bool*[713]) – If True[714], construct *PWMLED* (page 113) instances to represent each LED. If False[715] (the default), construct regular *LED* (page 111) instances.
- **pin_factory** (Factory (page 198) *or* None[716]) – See *API - Pins* (page 195) for more information (this is an advanced feature which most users can ignore).

16.1.14 JamHat

class gpiozero.**JamHat**(**, pwm=False, pin_factory=None*)

Extends *CompositeOutputDevice* (page 164) for the ModMyPi JamHat[717] board.

There are 6 LEDs, two buttons and a tonal buzzer. The pins are fixed. Usage:

```
from gpiozero import JamHat

hat = JamHat()

hat.button_1.wait_for_press()
hat.lights_1.on()
hat.buzzer.play('C4')
hat.button_2.wait_for_press()
hat.off()
```

Parameters

- **pwm** (*bool*[718]) – If True[719], construct :class: PWMLED instances to represent each LED on the board. If False[720] (the default), construct regular *LED* (page 111) instances.
- **pin_factory** (Factory (page 198) *or* None[721]) – See *API - Pins* (page 195) for more information (this is an advanced feature which most users can ignore).

lights_1, lights_2

Two *LEDBoard* (page 141) instances representing the top (lights_1) and bottom (lights_2) rows of LEDs on the JamHat.

red, yellow, green

LED (page 111) or *PWMLED* (page 113) instances representing the red, yellow, and green LEDs along the top row.

button_1, button_2

The left (button_1) and right (button_2) *Button* (page 93) objects on the JamHat.

buzzer

The *Buzzer* (page 117) at the bottom right of the JamHat.

off()

Turns all the LEDs off and stops the buzzer.

on()

Turns all the LEDs on and makes the buzzer play its mid tone.

[713] https://docs.python.org/3.5/library/functions.html#bool
[714] https://docs.python.org/3.5/library/constants.html#True
[715] https://docs.python.org/3.5/library/constants.html#False
[716] https://docs.python.org/3.5/library/constants.html#None
[717] https://www.modmypi.com/jam-hat
[718] https://docs.python.org/3.5/library/functions.html#bool
[719] https://docs.python.org/3.5/library/constants.html#True
[720] https://docs.python.org/3.5/library/constants.html#False
[721] https://docs.python.org/3.5/library/constants.html#None

16.1.15 Robot

class gpiozero.**Robot**(*left*, *right*, ***, *pwm=True*, *pin_factory=None*)

Extends *CompositeDevice* (page 164) to represent a generic dual-motor robot.

This class is constructed with two tuples representing the forward and backward pins of the left and right controllers respectively. For example, if the left motor's controller is connected to GPIOs 4 and 14, while the right motor's controller is connected to GPIOs 17 and 18 then the following example will drive the robot forward:

```
from gpiozero import Robot

robot = Robot(left=(4, 14), right=(17, 18))
robot.forward()
```

Parameters

- **left** (*tuple*[722]) – A tuple of two (or three) GPIO pins representing the forward and backward inputs of the left motor's controller. Use three pins if your motor controller requires an enable pin.
- **right** (*tuple*[723]) – A tuple of two (or three) GPIO pins representing the forward and backward inputs of the right motor's controller. Use three pins if your motor controller requires an enable pin.
- **pwm** (*bool*[724]) – If True[725] (the default), construct *PWMOutputDevice* (page 128) instances for the motor controller pins, allowing both direction and variable speed control. If False[726], construct *DigitalOutputDevice* (page 127) instances, allowing only direction control.
- **pin_factory** (Factory (page 198) *or* None[727]) – See *API - Pins* (page 195) for more information (this is an advanced feature which most users can ignore).

left_motor

The *Motor* (page 120) on the left of the robot.

right_motor

The *Motor* (page 120) on the right of the robot.

backward(*speed=1*, ***kwargs*)

Drive the robot backward by running both motors backward.

Parameters

- **speed** (*float*[728]) – Speed at which to drive the motors, as a value between 0 (stopped) and 1 (full speed). The default is 1.
- **curve_left** (*float*[729]) – The amount to curve left while moving backwards, by driving the left motor at a slower speed. Maximum *curve_left* is 1, the default is 0 (no curve). This parameter can only be specified as a keyword parameter, and is mutually exclusive with *curve_right*.
- **curve_right** (*float*[730]) – The amount to curve right while moving backwards, by driving the right motor at a slower speed. Maximum *curve_right* is 1, the default is 0 (no curve). This parameter can only be specified as a keyword parameter, and is mutually exclusive with *curve_left*.

[722] https://docs.python.org/3.5/library/stdtypes.html#tuple
[723] https://docs.python.org/3.5/library/stdtypes.html#tuple
[724] https://docs.python.org/3.5/library/functions.html#bool
[725] https://docs.python.org/3.5/library/constants.html#True
[726] https://docs.python.org/3.5/library/constants.html#False
[727] https://docs.python.org/3.5/library/constants.html#None
[728] https://docs.python.org/3.5/library/functions.html#float
[729] https://docs.python.org/3.5/library/functions.html#float
[730] https://docs.python.org/3.5/library/functions.html#float

forward(*speed=1*, ***kwargs*)
Drive the robot forward by running both motors forward.

Parameters

- **speed** (*float*[731]) – Speed at which to drive the motors, as a value between 0 (stopped) and 1 (full speed). The default is 1.
- **curve_left** (*float*[732]) – The amount to curve left while moving forwards, by driving the left motor at a slower speed. Maximum *curve_left* is 1, the default is 0 (no curve). This parameter can only be specified as a keyword parameter, and is mutually exclusive with *curve_right*.
- **curve_right** (*float*[733]) – The amount to curve right while moving forwards, by driving the right motor at a slower speed. Maximum *curve_right* is 1, the default is 0 (no curve). This parameter can only be specified as a keyword parameter, and is mutually exclusive with *curve_left*.

left(*speed=1*)
Make the robot turn left by running the right motor forward and left motor backward.

Parameters **speed** (*float*[734]) – Speed at which to drive the motors, as a value between 0 (stopped) and 1 (full speed). The default is 1.

reverse()
Reverse the robot's current motor directions. If the robot is currently running full speed forward, it will run full speed backward. If the robot is turning left at half-speed, it will turn right at half-speed. If the robot is currently stopped it will remain stopped.

right(*speed=1*)
Make the robot turn right by running the left motor forward and right motor backward.

Parameters **speed** (*float*[735]) – Speed at which to drive the motors, as a value between 0 (stopped) and 1 (full speed). The default is 1.

stop()
Stop the robot.

value
Represents the motion of the robot as a tuple of (left_motor_speed, right_motor_speed) with `(-1, -1)` representing full speed backwards, `(1, 1)` representing full speed forwards, and `(0, 0)` representing stopped.

16.1.16 PhaseEnableRobot

class gpiozero.**PhaseEnableRobot**(*left*, *right*, ***, *pwm=True*, *pin_factory=None*)
Extends `CompositeDevice` (page 164) to represent a dual-motor robot based around a Phase/Enable motor board.

This class is constructed with two tuples representing the phase (direction) and enable (speed) pins of the left and right controllers respectively. For example, if the left motor's controller is connected to GPIOs 12 and 5, while the right motor's controller is connected to GPIOs 13 and 6 so the following example will drive the robot forward:

```python
from gpiozero import PhaseEnableRobot

robot = PhaseEnableRobot(left=(5, 12), right=(6, 13))
robot.forward()
```

[731] https://docs.python.org/3.5/library/functions.html#float
[732] https://docs.python.org/3.5/library/functions.html#float
[733] https://docs.python.org/3.5/library/functions.html#float
[734] https://docs.python.org/3.5/library/functions.html#float
[735] https://docs.python.org/3.5/library/functions.html#float

Parameters

- **left** (*tuple*[736]) – A tuple of two GPIO pins representing the phase and enable inputs of the left motor's controller.
- **right** (*tuple*[737]) – A tuple of two GPIO pins representing the phase and enable inputs of the right motor's controller.
- **pwm** (*bool*[738]) – If `True`[739] (the default), construct *PWMOutputDevice* (page 128) instances for the motor controller's enable pins, allowing both direction and variable speed control. If `False`[740], construct *DigitalOutputDevice* (page 127) instances, allowing only direction control.
- **pin_factory** (`Factory` (page 198) *or* `None`[741]) – See *API - Pins* (page 195) for more information (this is an advanced feature which most users can ignore).

left_motor
The *PhaseEnableMotor* (page 122) on the left of the robot.

right_motor
The *PhaseEnableMotor* (page 122) on the right of the robot.

backward(*speed=1*)
Drive the robot backward by running both motors backward.

Parameters **speed** (*float*[742]) – Speed at which to drive the motors, as a value between 0 (stopped) and 1 (full speed). The default is 1.

forward(*speed=1*)
Drive the robot forward by running both motors forward.

Parameters **speed** (*float*[743]) – Speed at which to drive the motors, as a value between 0 (stopped) and 1 (full speed). The default is 1.

left(*speed=1*)
Make the robot turn left by running the right motor forward and left motor backward.

Parameters **speed** (*float*[744]) – Speed at which to drive the motors, as a value between 0 (stopped) and 1 (full speed). The default is 1.

reverse()
Reverse the robot's current motor directions. If the robot is currently running full speed forward, it will run full speed backward. If the robot is turning left at half-speed, it will turn right at half-speed. If the robot is currently stopped it will remain stopped.

right(*speed=1*)
Make the robot turn right by running the left motor forward and right motor backward.

Parameters **speed** (*float*[745]) – Speed at which to drive the motors, as a value between 0 (stopped) and 1 (full speed). The default is 1.

stop()
Stop the robot.

value
Returns a tuple of two floating point values (-1 to 1) representing the speeds of the robot's two motors (left and right). This property can also be set to alter the speed of both motors.

[736] https://docs.python.org/3.5/library/stdtypes.html#tuple
[737] https://docs.python.org/3.5/library/stdtypes.html#tuple
[738] https://docs.python.org/3.5/library/functions.html#bool
[739] https://docs.python.org/3.5/library/constants.html#True
[740] https://docs.python.org/3.5/library/constants.html#False
[741] https://docs.python.org/3.5/library/constants.html#None
[742] https://docs.python.org/3.5/library/functions.html#float
[743] https://docs.python.org/3.5/library/functions.html#float
[744] https://docs.python.org/3.5/library/functions.html#float
[745] https://docs.python.org/3.5/library/functions.html#float

16.1.17 RyanteckRobot

class gpiozero.**RyanteckRobot**(**, pwm=True, pin_factory=None*)

Extends *Robot* (page 155) for the Ryanteck motor controller board[746].

The Ryanteck MCB pins are fixed and therefore there's no need to specify them when constructing this class. The following example drives the robot forward:

```
from gpiozero import RyanteckRobot

robot = RyanteckRobot()
robot.forward()
```

Parameters

- **pwm** (*bool*[747]) – If True[748] (the default), construct *PWMOutputDevice* (page 128) instances for the motor controller pins, allowing both direction and variable speed control. If False[749], construct *DigitalOutputDevice* (page 127) instances, allowing only direction control.
- **pin_factory** (Factory (page 198) *or* None[750]) – See *API - Pins* (page 195) for more information (this is an advanced feature which most users can ignore).

16.1.18 CamJamKitRobot

class gpiozero.**CamJamKitRobot**(**, pwm=True, pin_factory=None*)

Extends *Robot* (page 155) for the CamJam #3 EduKit[751] motor controller board.

The CamJam robot controller pins are fixed and therefore there's no need to specify them when constructing this class. The following example drives the robot forward:

```
from gpiozero import CamJamKitRobot

robot = CamJamKitRobot()
robot.forward()
```

Parameters

- **pwm** (*bool*[752]) – If True[753] (the default), construct *PWMOutputDevice* (page 128) instances for the motor controller pins, allowing both direction and variable speed control. If False[754], construct *DigitalOutputDevice* (page 127) instances, allowing only direction control.
- **pin_factory** (Factory (page 198) *or* None[755]) – See *API - Pins* (page 195) for more information (this is an advanced feature which most users can ignore).

16.1.19 PololuDRV8835Robot

class gpiozero.**PololuDRV8835Robot**(**, pwm=True, pin_factory=None*)

Extends *PhaseEnableRobot* (page 156) for the Pololu DRV8835 Dual Motor Driver Kit[756].

[746] https://ryanteck.uk/add-ons/6-ryanteck-rpi-motor-controller-board-0635648607160.html
[747] https://docs.python.org/3.5/library/functions.html#bool
[748] https://docs.python.org/3.5/library/constants.html#True
[749] https://docs.python.org/3.5/library/constants.html#False
[750] https://docs.python.org/3.5/library/constants.html#None
[751] http://camjam.me/?page_id=1035
[752] https://docs.python.org/3.5/library/functions.html#bool
[753] https://docs.python.org/3.5/library/constants.html#True
[754] https://docs.python.org/3.5/library/constants.html#False
[755] https://docs.python.org/3.5/library/constants.html#None
[756] https://www.pololu.com/product/2753

The Pololu DRV8835 pins are fixed and therefore there's no need to specify them when constructing this class. The following example drives the robot forward:

```
from gpiozero import PololuDRV8835Robot

robot = PololuDRV8835Robot()
robot.forward()
```

Parameters

- **pwm** (*bool*[757]) – If True[758] (the default), construct *PWMOutputDevice* (page 128) instances for the motor controller's enable pins, allowing both direction and variable speed control. If False[759], construct *DigitalOutputDevice* (page 127) instances, allowing only direction control.
- **pin_factory** (Factory (page 198) *or* None[760]) – See *API - Pins* (page 195) for more information (this is an advanced feature which most users can ignore).

16.1.20 Energenie

class gpiozero.**Energenie**(*socket*, ***, *initial_value=False*, *pin_factory=None*)

Extends *Device* (page 175) to represent an Energenie socket[761] controller.

This class is constructed with a socket number and an optional initial state (defaults to False[762], meaning off). Instances of this class can be used to switch peripherals on and off. For example:

```
from gpiozero import Energenie

lamp = Energenie(1)
lamp.on()
```

Parameters

- **socket** (*int*[763]) – Which socket this instance should control. This is an integer number between 1 and 4.
- **initial_value** (*bool*[764]) – The initial state of the socket. As Energenie sockets provide no means of reading their state, you must provide an initial state for the socket, which will be set upon construction. This defaults to False[765] which will switch the socket off.
- **pin_factory** (Factory (page 198) *or* None[766]) – See *API - Pins* (page 195) for more information (this is an advanced feature which most users can ignore).

off()

Turns the socket off.

on()

Turns the socket on.

socket

Returns the socket number.

[757] https://docs.python.org/3.5/library/functions.html#bool
[758] https://docs.python.org/3.5/library/constants.html#True
[759] https://docs.python.org/3.5/library/constants.html#False
[760] https://docs.python.org/3.5/library/constants.html#None
[761] https://energenie4u.co.uk/index.php/catalogue/product/ENER002-2PI
[762] https://docs.python.org/3.5/library/constants.html#False
[763] https://docs.python.org/3.5/library/functions.html#int
[764] https://docs.python.org/3.5/library/functions.html#bool
[765] https://docs.python.org/3.5/library/constants.html#False
[766] https://docs.python.org/3.5/library/constants.html#None

value
Returns `True`[767] if the socket is on and `False`[768] if the socket is off. Setting this property changes the state of the socket.

16.1.21 StatusZero

class gpiozero.**StatusZero**(**labels, pwm=False, active_high=True, initial_value=False, pin_factory=None*)
Extends *LEDBoard* (page 141) for The Pi Hut's STATUS Zero[769]: a Pi Zero sized add-on board with three sets of red/green LEDs to provide a status indicator.

The following example designates the first strip the label "wifi" and the second "raining", and turns them green and red respectfully:

```python
from gpiozero import StatusZero

status = StatusZero('wifi', 'raining')
status.wifi.green.on()
status.raining.red.on()
```

Each designated label will contain two *LED* (page 111) objects named "red" and "green".

Parameters

- ***labels** (*str*[770]) – Specify the names of the labels you wish to designate the strips to. You can list up to three labels. If no labels are given, three strips will be initialised with names 'one', 'two', and 'three'. If some, but not all strips are given labels, any remaining strips will not be initialised.
- **pin_factory** (`Factory` (page 198) *or* `None`[771]) – See *API - Pins* (page 195) for more information (this is an advanced feature which most users can ignore).

your-label-here, your-label-here, ...
This entry represents one of the three labelled attributes supported on the STATUS Zero board. It is an *LEDBoard* (page 141) which contains:

red
The *LED* (page 111) or *PWMLED* (page 113) representing the red LED next to the label.

green
The *LED* (page 111) or *PWMLED* (page 113) representing the green LED next to the label.

16.1.22 StatusBoard

class gpiozero.**StatusBoard**(**labels, pwm=False, active_high=True, initial_value=False, pin_factory=None*)
Extends *CompositeOutputDevice* (page 164) for The Pi Hut's STATUS[772] board: a HAT sized add-on board with five sets of red/green LEDs and buttons to provide a status indicator with additional input.

The following example designates the first strip the label "wifi" and the second "raining", turns the wifi green and then activates the button to toggle its lights when pressed:

```python
from gpiozero import StatusBoard

status = StatusBoard('wifi', 'raining')
```

(continues on next page)

[767] https://docs.python.org/3.5/library/constants.html#True
[768] https://docs.python.org/3.5/library/constants.html#False
[769] https://thepihut.com/statuszero
[770] https://docs.python.org/3.5/library/stdtypes.html#str
[771] https://docs.python.org/3.5/library/constants.html#None
[772] https://thepihut.com/status

(continued from previous page)

```
status.wifi.lights.green.on()
status.wifi.button.when_pressed = status.wifi.lights.toggle
```

Each designated label will contain a "lights" `LEDBoard` (page 141) containing two `LED` (page 111) objects named "red" and "green", and a `Button` (page 93) object named "button".

Parameters

- **`*labels`** (`str`[773]) – Specify the names of the labels you wish to designate the strips to. You can list up to five labels. If no labels are given, five strips will be initialised with names 'one' to 'five'. If some, but not all strips are given labels, any remaining strips will not be initialised.
- **`pin_factory`** (`Factory` (page 198) *or* `None`[774]) – See *API - Pins* (page 195) for more information (this is an advanced feature which most users can ignore).

`your-label-here, your-label-here, ...`

This entry represents one of the five labelled attributes supported on the STATUS board. It is an `CompositeOutputDevice` (page 164) which contains:

`lights`

A `LEDBoard` (page 141) representing the lights next to the label. It contains:

`red`

The `LED` (page 111) or `PWMLED` (page 113) representing the red LED next to the label.

`green`

The `LED` (page 111) or `PWMLED` (page 113) representing the green LED next to the label.

`button`

A `Button` (page 93) representing the button next to the label.

16.1.23 SnowPi

class gpiozero.**SnowPi**(**, pwm=False, initial_value=False, pin_factory=None*)

Extends `LEDBoard` (page 141) for the Ryanteck SnowPi[775] board.

The SnowPi pins are fixed and therefore there's no need to specify them when constructing this class. The following example turns on the eyes, sets the nose pulsing, and the arms blinking:

```
from gpiozero import SnowPi

snowman = SnowPi(pwm=True)
snowman.eyes.on()
snowman.nose.pulse()
snowman.arms.blink()
```

Parameters

- **`pwm`** (`bool`[776]) – If `True`[777], construct `PWMLED` (page 113) instances to represent each LED. If `False`[778] (the default), construct regular `LED` (page 111) instances.
- **`initial_value`** (`bool`[779]) – If `False`[780] (the default), all LEDs will be off initially. If `None`[781], each device will be left in whatever state the pin is found in when configured

[773] https://docs.python.org/3.5/library/stdtypes.html#str
[774] https://docs.python.org/3.5/library/constants.html#None
[775] https://ryanteck.uk/raspberry-pi/114-snowpi-the-gpio-snowman-for-raspberry-pi-0635648608303.html
[776] https://docs.python.org/3.5/library/functions.html#bool
[777] https://docs.python.org/3.5/library/constants.html#True
[778] https://docs.python.org/3.5/library/constants.html#False
[779] https://docs.python.org/3.5/library/functions.html#bool
[780] https://docs.python.org/3.5/library/constants.html#False
[781] https://docs.python.org/3.5/library/constants.html#None

for output (warning: this can be on). If `True`[782], the device will be switched on initially.

- **pin_factory** (`Factory` (page 198) *or* `None`[783]) – See *API - Pins* (page 195) for more information (this is an advanced feature which most users can ignore).

arms

A `LEDBoard` (page 141) representing the arms of the snow man. It contains the following attributes:

left, right

Two `LEDBoard` (page 141) objects representing the left and right arms of the snow-man. They contain:

top, middle, bottom

The `LED` (page 111) or `PWMLED` (page 113) down the snow-man's arms.

eyes

A `LEDBoard` (page 141) representing the eyes of the snow-man. It contains:

left, right

The `LED` (page 111) or `PWMLED` (page 113) for the snow-man's eyes.

nose

The `LED` (page 111) or `PWMLED` (page 113) for the snow-man's nose.

16.1.24 PumpkinPi

class gpiozero.**PumpkinPi**(**, pwm=False, initial_value=False, pin_factory=None*)

Extends `LEDBoard` (page 141) for the ModMyPi PumpkinPi[784] board.

There are twelve LEDs connected up to individual pins, so for the PumpkinPi the pins are fixed. For example:

```
from gpiozero import PumpkinPi

pumpkin = PumpkinPi(pwm=True)
pumpkin.sides.pulse()
pumpkin.off()
```

Parameters

- **pwm** (`bool`[785]) – If `True`[786], construct `PWMLED` (page 113) instances to represent each LED. If `False`[787] (the default), construct regular `LED` (page 111) instances
- **initial_value** (`bool`[788] *or* `None`[789]) – If `False`[790] (the default), all LEDs will be off initially. If `None`[791], each device will be left in whatever state the pin is found in when configured for output (warning: this can be on). If `True`[792], the device will be switched on initially.
- **pin_factory** (`Factory` (page 198) *or* `None`[793]) – See *API - Pins* (page 195) for more information (this is an advanced feature which most users can ignore).

[782] https://docs.python.org/3.5/library/constants.html#True
[783] https://docs.python.org/3.5/library/constants.html#None
[784] https://www.modmypi.com/halloween-pumpkin-programmable-kit
[785] https://docs.python.org/3.5/library/functions.html#bool
[786] https://docs.python.org/3.5/library/constants.html#True
[787] https://docs.python.org/3.5/library/constants.html#False
[788] https://docs.python.org/3.5/library/functions.html#bool
[789] https://docs.python.org/3.5/library/constants.html#None
[790] https://docs.python.org/3.5/library/constants.html#False
[791] https://docs.python.org/3.5/library/constants.html#None
[792] https://docs.python.org/3.5/library/constants.html#True
[793] https://docs.python.org/3.5/library/constants.html#None

sides
A *LEDBoard* (page 141) representing the LEDs around the edge of the pumpkin. It contains:

left, right
Two *LEDBoard* (page 141) instances representing the LEDs on the left and right sides of the pumpkin. They each contain:

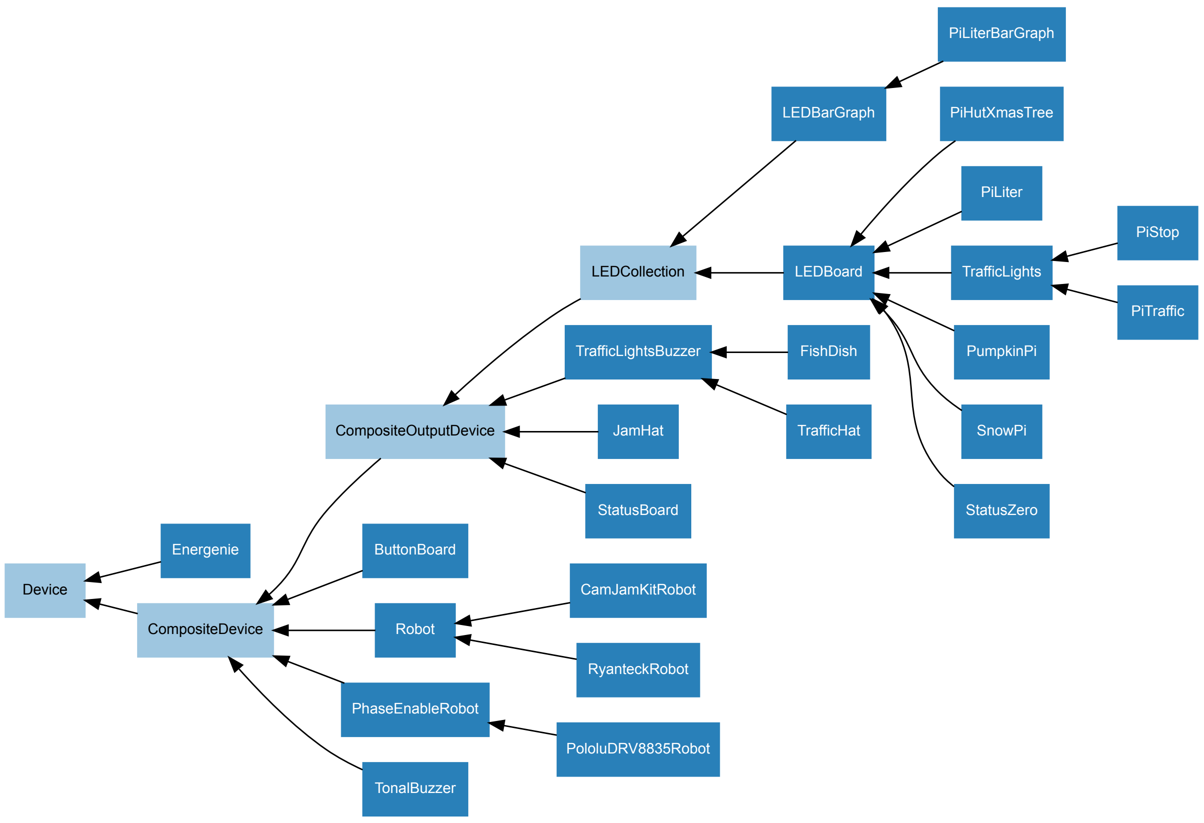
top, midtop, middle, midbottom, bottom
Each *LED* (page 111) or *PWMLED* (page 113) around the specified side of the pumpkin.

eyes
A *LEDBoard* (page 141) representing the eyes of the pumpkin. It contains:

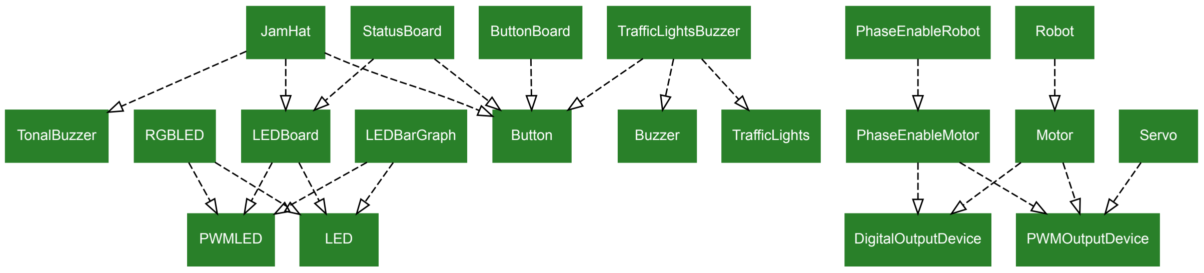
left, right
The *LED* (page 111) or *PWMLED* (page 113) for each of the pumpkin's eyes.

16.2 Base Classes

The classes in the sections above are derived from a series of base classes, some of which are effectively abstract. The classes form the (partial) hierarchy displayed in the graph below:



For composite devices, the following chart shows which devices are composed of which other devices:



The following sections document these base classes for advanced users that wish to construct classes for their own devices.

16.2.1 LEDCollection

class gpiozero.**LEDCollection**(**pins*, *pwm=False*, *active_high=True*, *initial_value=False*, *pin_factory=None*, ***named_pins*)

Extends `CompositeOutputDevice` (page 164). Abstract base class for `LEDBoard` (page 141) and `LEDBarGraph` (page 144).

leds

A flat tuple of all LEDs contained in this collection (and all sub-collections).

16.2.2 CompositeOutputDevice

class gpiozero.**CompositeOutputDevice**(**args*, *_order=None*, *pin_factory=None*, ***kwargs*)

Extends `CompositeDevice` (page 164) with `on()` (page 164), `off()` (page 164), and `toggle()` (page 164) methods for controlling subordinate output devices. Also extends `value` (page 164) to be writeable.

Parameters

- ***args** (`Device` (page 175)) – The un-named devices that belong to the composite device. The `value` (page 175) attributes of these devices will be represented within the composite device's tuple `value` (page 164) in the order specified here.
- **_order** (`list`[794] `or None`[795]) – If specified, this is the order of named items specified by keyword arguments (to ensure that the `value` (page 164) tuple is constructed with a specific order). All keyword arguments *must* be included in the collection. If omitted, an alphabetically sorted order will be selected for keyword arguments.
- **pin_factory** (`Factory` (page 198) `or None`[796]) – See *API - Pins* (page 195) for more information (this is an advanced feature which most users can ignore).
- ****kwargs** (`Device` (page 175)) – The named devices that belong to the composite device. These devices will be accessible as named attributes on the resulting device, and their `value` (page 164) attributes will be accessible as named elements of the composite device's tuple `value` (page 164).

off()

Turn all the output devices off.

on()

Turn all the output devices on.

toggle()

Toggle all the output devices. For each device, if it's on, turn it off; if it's off, turn it on.

value

A tuple containing a value for each subordinate device. This property can also be set to update the state of all subordinate output devices.

16.2.3 CompositeDevice

class gpiozero.**CompositeDevice**(**args*, *_order=None*, *pin_factory=None*, ***kwargs*)

Extends `Device` (page 175). Represents a device composed of multiple devices like simple HATs, H-bridge motor controllers, robots composed of multiple motors, etc.

[794] https://docs.python.org/3.5/library/stdtypes.html#list
[795] https://docs.python.org/3.5/library/constants.html#None
[796] https://docs.python.org/3.5/library/constants.html#None

The constructor accepts subordinate devices as positional or keyword arguments. Positional arguments form unnamed devices accessed by treating the composite device as a container, while keyword arguments are added to the device as named (read-only) attributes.

For example:

```
>>> from gpiozero import *
>>> d = CompositeDevice(LED(2), LED(3), LED(4), btn=Button(17))
>>> d[0]
<gpiozero.LED object on pin GPIO2, active_high=True, is_active=False>
>>> d[1]
<gpiozero.LED object on pin GPIO3, active_high=True, is_active=False>
>>> d[2]
<gpiozero.LED object on pin GPIO4, active_high=True, is_active=False>
>>> d.btn
<gpiozero.Button object on pin GPIO17, pull_up=True, is_active=False>
>>> d.value
CompositeDeviceValue(device_0=False, device_1=False, device_2=False, btn=False)
```

Parameters

- **`*args`** (`Device` (page 175)) – The un-named devices that belong to the composite device. The *`value`* (page 166) attributes of these devices will be represented within the composite device's tuple *`value`* (page 166) in the order specified here.
- **`_order`** (*`list`*[797] *or* *`None`*[798]) – If specified, this is the order of named items specified by keyword arguments (to ensure that the *`value`* (page 166) tuple is constructed with a specific order). All keyword arguments *must* be included in the collection. If omitted, an alphabetically sorted order will be selected for keyword arguments.
- **`pin_factory`** (`Factory` (page 198) *or* *`None`*[799]) – See *API - Pins* (page 195) for more information (this is an advanced feature which most users can ignore).
- **`**kwargs`** (`Device` (page 175)) – The named devices that belong to the composite device. These devices will be accessible as named attributes on the resulting device, and their *`value`* (page 166) attributes will be accessible as named elements of the composite device's tuple *`value`* (page 166).

`close`()

Shut down the device and release all associated resources. This method can be called on an already closed device without raising an exception.

This method is primarily intended for interactive use at the command line. It disables the device and releases its pin(s) for use by another device.

You can attempt to do this simply by deleting an object, but unless you've cleaned up all references to the object this may not work (even if you've cleaned up all references, there's still no guarantee the garbage collector will actually delete the object at that point). By contrast, the close method provides a means of ensuring that the object is shut down.

For example, if you have a breadboard with a buzzer connected to pin 16, but then wish to attach an LED instead:

```
>>> from gpiozero import *
>>> bz = Buzzer(16)
>>> bz.on()
>>> bz.off()
>>> bz.close()
>>> led = LED(16)
>>> led.blink()
```

[797] https://docs.python.org/3.5/library/stdtypes.html#list
[798] https://docs.python.org/3.5/library/constants.html#None
[799] https://docs.python.org/3.5/library/constants.html#None

`Device` (page 175) descendents can also be used as context managers using the `with`[800] statement. For example:

```
>>> from gpiozero import *
>>> with Buzzer(16) as bz:
...     bz.on()
...
>>> with LED(16) as led:
...     led.on()
...
```

closed
Returns `True`[801] if the device is closed (see the `close()` (page 165) method). Once a device is closed you can no longer use any other methods or properties to control or query the device.

is_active
Composite devices are considered "active" if any of their constituent devices have a "truthy" value.

namedtuple
The `namedtuple()`[802] type constructed to represent the value of the composite device. The `value` (page 166) attribute returns values of this type.

value
A `namedtuple()`[803] containing a value for each subordinate device. Devices with names will be represented as named elements. Unnamed devices will have a unique name generated for them, and they will appear in the position they appeared in the constructor.

[800] https://docs.python.org/3.5/reference/compound_stmts.html#with
[801] https://docs.python.org/3.5/library/constants.html#True
[802] https://docs.python.org/3.5/library/collections.html#collections.namedtuple
[803] https://docs.python.org/3.5/library/collections.html#collections.namedtuple

CHAPTER 17

API - Internal Devices

GPIO Zero also provides several "internal" devices which represent facilities provided by the operating system itself. These can be used to react to things like the time of day, or whether a server is available on the network.

Warning: These devices are experimental and their API is not yet considered stable. We welcome any comments from testers, especially regarding new "internal devices" that you'd find useful!

17.1 Regular Classes

The following classes are intended for general use with the devices they are named after. All classes in this section are concrete (not abstract).

17.1.1 TimeOfDay

class gpiozero.**TimeOfDay**(*start_time*, *end_time*, ***, *utc=True*, *pin_factory=None*)

Extends `InternalDevice` (page 172) to provide a device which is active when the computer's clock indicates that the current time is between *start_time* and *end_time* (inclusive) which are `time`[804] instances.

The following example turns on a lamp attached to an `Energenie` (page 159) plug between 7 and 8 AM:

```
from gpiozero import TimeOfDay, Energenie
from datetime import time
from signal import pause

lamp = Energenie(1)
morning = TimeOfDay(time(7), time(8))

lamp.source = morning

pause()
```

Note that *start_time* may be greater than *end_time*, indicating a time period which crosses midnight.

Parameters

[804] https://docs.python.org/3.5/library/datetime.html#datetime.time

- **start_time** (*time*[805]) – The time from which the device will be considered active.
- **end_time** (*time*[806]) – The time after which the device will be considered inactive.
- **utc** (*bool*[807]) – If True[808] (the default), a naive UTC time will be used for the comparison rather than a local time-zone reading.
- **pin_factory** (Factory (page 198) *or* None[809]) – See *API - Pins* (page 195) for more information (this is an advanced feature which most users can ignore).

end_time
The time of day after which the device will be considered inactive.

start_time
The time of day after which the device will be considered active.

utc
If True[810], use a naive UTC time reading for comparison instead of a local timezone reading.

value
Returns True[811] when the system clock reads between *start_time* (page 168) and *end_time* (page 168), and False[812] otherwise. If *start_time* (page 168) is greater than *end_time* (page 168) (indicating a period that crosses midnight), then this returns True[813] when the current time is greater than *start_time* (page 168) or less than *end_time* (page 168).

17.1.2 PingServer

class gpiozero.**PingServer**(*host*, ***, *pin_factory=None*)
Extends *InternalDevice* (page 172) to provide a device which is active when a *host* on the network can be pinged.

The following example lights an LED while a server is reachable (note the use of *source_delay* (page 176) to ensure the server is not flooded with pings):

```
from gpiozero import PingServer, LED
from signal import pause

google = PingServer('google.com')
led = LED(4)

led.source_delay = 60  # check once per minute
led.source = google

pause()
```

Parameters

- **host** (*str*[814]) – The hostname or IP address to attempt to ping.
- **pin_factory** (Factory (page 198) *or* None[815]) – See *API - Pins* (page 195) for more information (this is an advanced feature which most users can ignore).

[805] https://docs.python.org/3.5/library/datetime.html#datetime.time
[806] https://docs.python.org/3.5/library/datetime.html#datetime.time
[807] https://docs.python.org/3.5/library/functions.html#bool
[808] https://docs.python.org/3.5/library/constants.html#True
[809] https://docs.python.org/3.5/library/constants.html#None
[810] https://docs.python.org/3.5/library/constants.html#True
[811] https://docs.python.org/3.5/library/constants.html#True
[812] https://docs.python.org/3.5/library/constants.html#False
[813] https://docs.python.org/3.5/library/constants.html#True
[814] https://docs.python.org/3.5/library/stdtypes.html#str
[815] https://docs.python.org/3.5/library/constants.html#None

host
The hostname or IP address to test whenever `value` (page 169) is queried.

value
Returns `True`[816] if the host returned a single ping, and `False`[817] otherwise.

17.1.3 CPUTemperature

class gpiozero.**CPUTemperature**(*sensor_file='/sys/class/thermal/thermal_zone0/temp'*, ***, *min_temp=0.0*, *max_temp=100.0*, *threshold=80.0*, *pin_factory=None*)

Extends `InternalDevice` (page 172) to provide a device which is active when the CPU temperature exceeds the *threshold* value.

The following example plots the CPU's temperature on an LED bar graph:

```python
from gpiozero import LEDBarGraph, CPUTemperature
from signal import pause

# Use minimums and maximums that are closer to "normal" usage so the
# bar graph is a bit more "lively"
cpu = CPUTemperature(min_temp=50, max_temp=90)

print('Initial temperature: {}C'.format(cpu.temperature))

graph = LEDBarGraph(5, 6, 13, 19, 25, pwm=True)
graph.source = cpu

pause()
```

Parameters

- **sensor_file** (`str`[818]) – The file from which to read the temperature. This defaults to the sysfs file `/sys/class/thermal/thermal_zone0/temp`. Whatever file is specified is expected to contain a single line containing the temperature in milli-degrees celsius.
- **min_temp** (`float`[819]) – The temperature at which `value` (page 169) will read 0.0. This defaults to 0.0.
- **max_temp** (`float`[820]) – The temperature at which `value` (page 169) will read 1.0. This defaults to 100.0.
- **threshold** (`float`[821]) – The temperature above which the device will be considered "active". (see `is_active` (page 169)). This defaults to 80.0.
- **pin_factory** (`Factory` (page 198) *or* `None`[822]) – See *API - Pins* (page 195) for more information (this is an advanced feature which most users can ignore).

is_active
Returns `True`[823] when the CPU `temperature` (page 169) exceeds the *threshold*.

temperature
Returns the current CPU temperature in degrees celsius.

816 https://docs.python.org/3.5/library/constants.html#True
817 https://docs.python.org/3.5/library/constants.html#False
818 https://docs.python.org/3.5/library/stdtypes.html#str
819 https://docs.python.org/3.5/library/functions.html#float
820 https://docs.python.org/3.5/library/functions.html#float
821 https://docs.python.org/3.5/library/functions.html#float
822 https://docs.python.org/3.5/library/constants.html#None
823 https://docs.python.org/3.5/library/constants.html#True

value
Returns the current CPU temperature as a value between 0.0 (representing the *min_temp* value) and 1.0 (representing the *max_temp* value). These default to 0.0 and 100.0 respectively, hence `value` (page 169) is `temperature` (page 169) divided by 100 by default.

17.1.4 LoadAverage

class gpiozero.**LoadAverage**(*load_average_file='/proc/loadavg'*, *, *min_load_average=0.0*, *max_load_average=1.0*, *threshold=0.8*, *minutes=5*, *pin_factory=None*)

Extends `InternalDevice` (page 172) to provide a device which is active when the CPU load average exceeds the *threshold* value.

The following example plots the load average on an LED bar graph:

```
from gpiozero import LEDBarGraph, LoadAverage
from signal import pause

la = LoadAverage(min_load_average=0, max_load_average=2)
graph = LEDBarGraph(5, 6, 13, 19, 25, pwm=True)

graph.source = la

pause()
```

Parameters

- **load_average_file** (*str*[824]) – The file from which to read the load average. This defaults to the proc file `/proc/loadavg`. Whatever file is specified is expected to contain three space-separated load averages at the beginning of the file, representing 1 minute, 5 minute and 15 minute averages respectively.
- **min_load_average** (*float*[825]) – The load average at which `value` (page 170) will read 0.0. This defaults to 0.0.
- **max_load_average** (*float*[826]) – The load average at which `value` (page 170) will read 1.0. This defaults to 1.0.
- **threshold** (*float*[827]) – The load average above which the device will be considered "active". (see `is_active` (page 170)). This defaults to 0.8.
- **minutes** (*int*[828]) – The number of minutes over which to average the load. Must be 1, 5 or 15. This defaults to 5.
- **pin_factory** (`Factory` (page 198) *or* `None`[829]) – See *API - Pins* (page 195) for more information (this is an advanced feature which most users can ignore).

is_active
Returns `True`[830] when the `load_average` (page 170) exceeds the *threshold*.

load_average
Returns the current load average.

value
Returns the current load average as a value between 0.0 (representing the *min_load_average* value) and 1.0 (representing the *max_load_average* value). These default to 0.0 and 1.0 respectively.

[824] https://docs.python.org/3.5/library/stdtypes.html#str
[825] https://docs.python.org/3.5/library/functions.html#float
[826] https://docs.python.org/3.5/library/functions.html#float
[827] https://docs.python.org/3.5/library/functions.html#float
[828] https://docs.python.org/3.5/library/functions.html#int
[829] https://docs.python.org/3.5/library/constants.html#None
[830] https://docs.python.org/3.5/library/constants.html#True

17.1.5 DiskUsage

class gpiozero.**DiskUsage**(*filesystem='/'*, ***, *threshold=90.0*, *pin_factory=None*)

Extends `InternalDevice` (page 172) to provide a device which is active when the disk space used exceeds the *threshold* value.

The following example plots the disk usage on an LED bar graph:

```
from gpiozero import LEDBarGraph, DiskUsage
from signal import pause

disk = DiskUsage()

print('Current disk usage: {}%'.format(disk.usage))

graph = LEDBarGraph(5, 6, 13, 19, 25, pwm=True)
graph.source = disk

pause()
```

Parameters

- **filesystem** (*str*[831]) – A path within the filesystem for which the disk usage needs to be computed. This defaults to `/`, which is the root filesystem.
- **threshold** (*float*[832]) – The disk usage percentage above which the device will be considered "active" (see `is_active` (page 171)). This defaults to 90.0.
- **pin_factory** (`Factory` (page 198) *or* `None`[833]) – See *API - Pins* (page 195) for more information (this is an advanced feature which most users can ignore).

is_active

Returns `True`[834] when the disk `usage` (page 171) exceeds the *threshold*.

usage

Returns the current disk usage in percentage.

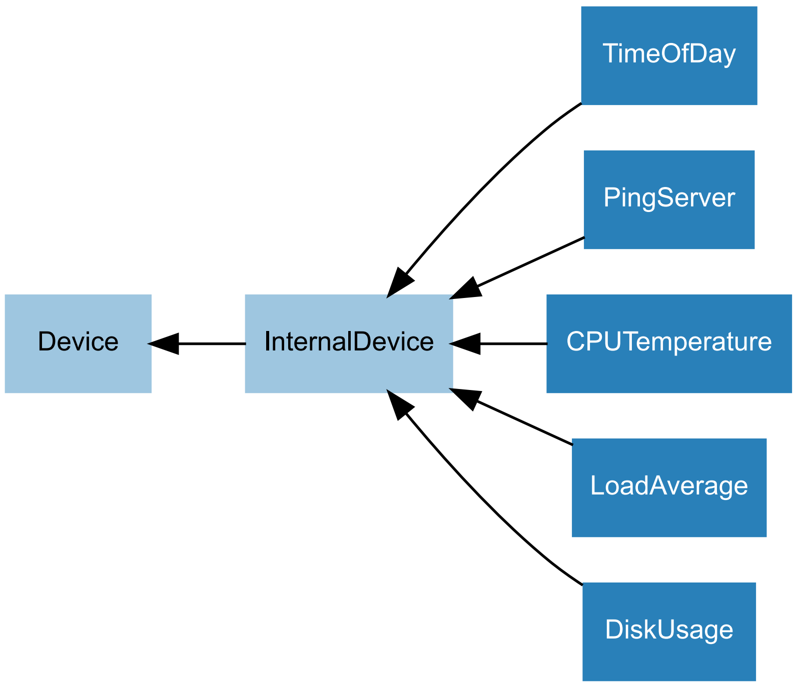
value

Returns the current disk usage as a value between 0.0 and 1.0 by dividing `usage` (page 171) by 100.

17.2 Base Classes

The classes in the sections above are derived from a series of base classes, some of which are effectively abstract. The classes form the (partial) hierarchy displayed in the graph below (abstract classes are shaded lighter than concrete classes):

[831] https://docs.python.org/3.5/library/stdtypes.html#str
[832] https://docs.python.org/3.5/library/functions.html#float
[833] https://docs.python.org/3.5/library/constants.html#None
[834] https://docs.python.org/3.5/library/constants.html#True



The following sections document these base classes for advanced users that wish to construct classes for their own devices.

17.2.1 InternalDevice

class gpiozero.**InternalDevice**(*, *pin_factory=None*)

Extends `Device` (page 175) to provide a basis for devices which have no specific hardware representation. These are effectively pseudo-devices and usually represent operating system services like the internal clock, file systems or network facilities.

CHAPTER 18

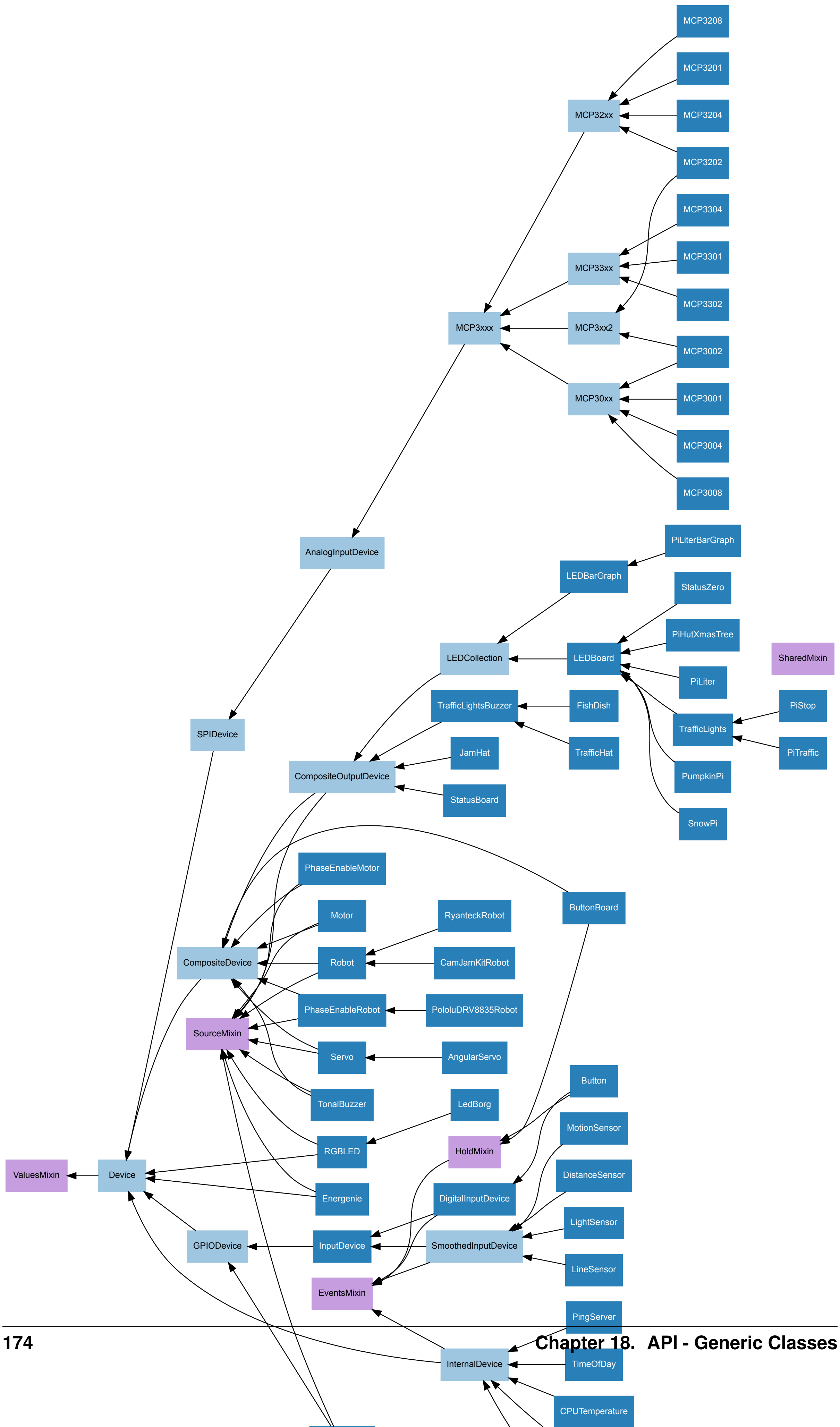
API - Generic Classes

The GPIO Zero class hierarchy is quite extensive. It contains several base classes (most of which are documented in their corresponding chapters):

- `Device` (page 175) is the root of the hierarchy, implementing base functionality like `close()` (page 175) and context manager handlers.
- `GPIODevice` (page 108) represents individual devices that attach to a single GPIO pin
- `SPIDevice` (page 139) represents devices that communicate over an SPI interface (implemented as four GPIO pins)
- `InternalDevice` (page 172) represents devices that are entirely internal to the Pi (usually operating system related services)
- `CompositeDevice` (page 164) represents devices composed of multiple other devices like HATs

There are also several mixin classes[835] for adding important functionality at numerous points in the hierarchy, which is illustrated below (mixin classes are represented in purple, while abstract classes are shaded lighter):

[835] https://en.wikipedia.org/wiki/Mixin


MCP3208
MCP3201
MCP32xx
MCP3204
MCP3202
MCP3304
MCP33xx
MCP3301
MCP3302
MCP3xxx
MCP3xx2
MCP3002
MCP30xx
MCP3001
MCP3004
MCP3008
AnalogInputDevice
PiLiterBarGraph
LEDBarGraph
StatusZero
PiHutXmasTree
SharedMixin
LEDCollection
LEDBoard
PiLiter
TrafficLightsBuzzer
FishDish
PiStop
SPIDevice
TrafficLights
JamHat
TrafficHat
PiTraffic
CompositeOutputDevice
PumpkinPi
StatusBoard
SnowPi
PhaseEnableMotor
ButtonBoard
Motor
RyanteckRobot
CompositeDevice
Robot
CamJamKitRobot
PhaseEnableRobot
PololuDRV8835Robot
SourceMixin
Servo
AngularServo
Button
TonalBuzzer
LedBorg
MotionSensor
RGBLED
HoldMixin
ValuesMixin
Device
DistanceSensor
Energenie
DigitalInputDevice
LightSensor
GPIODevice
InputDevice
SmoothedInputDevice
LineSensor
EventsMixin
PingServer
InternalDevice
TimeOfDay
CPUTemperature

18.1 Device

class gpiozero.**Device**(*, *pin_factory=None*)

Represents a single device of any type; GPIO-based, SPI-based, I2C-based, etc. This is the base class of the device hierarchy. It defines the basic services applicable to all devices (specifically the `is_active` (page 175) property, the `value` (page 175) property, and the `close()` (page 175) method).

pin_factory

This attribute exists at both a class level (representing the default pin factory used to construct devices when no *pin_factory* parameter is specified), and at an instance level (representing the pin factory that the device was constructed with).

The pin factory provides various facilities to the device including allocating pins, providing low level interfaces (e.g. SPI), and clock facilities (querying and calculating elapsed times).

close()

Shut down the device and release all associated resources. This method can be called on an already closed device without raising an exception.

This method is primarily intended for interactive use at the command line. It disables the device and releases its pin(s) for use by another device.

You can attempt to do this simply by deleting an object, but unless you've cleaned up all references to the object this may not work (even if you've cleaned up all references, there's still no guarantee the garbage collector will actually delete the object at that point). By contrast, the close method provides a means of ensuring that the object is shut down.

For example, if you have a breadboard with a buzzer connected to pin 16, but then wish to attach an LED instead:

```
>>> from gpiozero import *
>>> bz = Buzzer(16)
>>> bz.on()
>>> bz.off()
>>> bz.close()
>>> led = LED(16)
>>> led.blink()
```

`Device` (page 175) descendents can also be used as context managers using the `with`[836] statement. For example:

```
>>> from gpiozero import *
>>> with Buzzer(16) as bz:
...     bz.on()
...
>>> with LED(16) as led:
...     led.on()
...
```

closed

Returns `True`[837] if the device is closed (see the `close()` (page 175) method). Once a device is closed you can no longer use any other methods or properties to control or query the device.

is_active

Returns `True`[838] if the device is currently active and `False`[839] otherwise. This property is usually derived from `value` (page 175). Unlike `value` (page 175), this is *always* a boolean.

value

Returns a value representing the device's state. Frequently, this is a boolean value, or a number

[836] https://docs.python.org/3.5/reference/compound_stmts.html#with
[837] https://docs.python.org/3.5/library/constants.html#True
[838] https://docs.python.org/3.5/library/constants.html#True
[839] https://docs.python.org/3.5/library/constants.html#False

between 0 and 1 but some devices use larger ranges (e.g. -1 to +1) and composite devices usually use tuples to return the states of all their subordinate components.

18.2 ValuesMixin

class `gpiozero.`**`ValuesMixin`**`(...)`

Adds a `values` (page 176) property to the class which returns an infinite generator of readings from the `value` (page 175) property. There is rarely a need to use this mixin directly as all base classes in GPIO Zero include it.

Note: Use this mixin *first* in the parent class list.

`values`

An infinite iterator of values read from `value`.

18.3 SourceMixin

class `gpiozero.`**`SourceMixin`**`(...)`

Adds a `source` (page 176) property to the class which, given an iterable or a `ValuesMixin` (page 176) descendent, sets `value` (page 175) to each member of that iterable until it is exhausted. This mixin is generally included in novel output devices to allow their state to be driven from another device.

Note: Use this mixin *first* in the parent class list.

`source`

The iterable to use as a source of values for `value`.

`source_delay`

The delay (measured in seconds) in the loop used to read values from `source` (page 176). Defaults to 0.01 seconds which is generally sufficient to keep CPU usage to a minimum while providing adequate responsiveness.

18.4 SharedMixin

class `gpiozero.`**`SharedMixin`**`(...)`

This mixin marks a class as "shared". In this case, the meta-class (GPIOMeta) will use `_shared_key()` (page 176) to convert the constructor arguments to an immutable key, and will check whether any existing instances match that key. If they do, they will be returned by the constructor instead of a new instance. An internal reference counter is used to determine how many times an instance has been "constructed" in this way.

When `close()` (page 175) is called, an internal reference counter will be decremented and the instance will only close when it reaches zero.

classmethod `_shared_key``(*args, **kwargs)`

Given the constructor arguments, returns an immutable key representing the instance. The default simply assumes all positional arguments are immutable.

18.5 EventsMixin

class gpiozero.**EventsMixin**(...)

Adds edge-detected *when_activated()* (page 177) and *when_deactivated()* (page 177) events to a device based on changes to the *is_active* (page 175) property common to all devices. Also adds *wait_for_active()* (page 177) and *wait_for_inactive()* (page 177) methods for level-waiting.

Note: Note that this mixin provides no means of actually firing its events; call `_fire_events()` in sub-classes when device state changes to trigger the events. This should also be called once at the end of initialization to set initial states.

wait_for_active(*timeout=None*)

Pause the script until the device is activated, or the timeout is reached.

Parameters timeout (*float*[840] *or None*[841]) – Number of seconds to wait before proceeding. If this is None[842] (the default), then wait indefinitely until the device is active.

wait_for_inactive(*timeout=None*)

Pause the script until the device is deactivated, or the timeout is reached.

Parameters timeout (*float*[843] *or None*[844]) – Number of seconds to wait before proceeding. If this is None[845] (the default), then wait indefinitely until the device is inactive.

active_time

The length of time (in seconds) that the device has been active for. When the device is inactive, this is None[846].

inactive_time

The length of time (in seconds) that the device has been inactive for. When the device is active, this is None[847].

when_activated

The function to run when the device changes state from inactive to active.

This can be set to a function which accepts no (mandatory) parameters, or a Python function which accepts a single mandatory parameter (with as many optional parameters as you like). If the function accepts a single mandatory parameter, the device that activated will be passed as that parameter.

Set this property to None[848] (the default) to disable the event.

when_deactivated

The function to run when the device changes state from active to inactive.

This can be set to a function which accepts no (mandatory) parameters, or a Python function which accepts a single mandatory parameter (with as many optional parameters as you like). If the function accepts a single mandatory parameter, the device that deactivated will be passed as that parameter.

Set this property to None[849] (the default) to disable the event.

[840] https://docs.python.org/3.5/library/functions.html#float
[841] https://docs.python.org/3.5/library/constants.html#None
[842] https://docs.python.org/3.5/library/constants.html#None
[843] https://docs.python.org/3.5/library/functions.html#float
[844] https://docs.python.org/3.5/library/constants.html#None
[845] https://docs.python.org/3.5/library/constants.html#None
[846] https://docs.python.org/3.5/library/constants.html#None
[847] https://docs.python.org/3.5/library/constants.html#None
[848] https://docs.python.org/3.5/library/constants.html#None
[849] https://docs.python.org/3.5/library/constants.html#None

18.6 HoldMixin

class gpiozero.**HoldMixin**(...)

Extends *EventsMixin* (page 177) to add the *when_held* (page 178) event and the machinery to fire that event repeatedly (when *hold_repeat* (page 178) is True[850]) at internals defined by *hold_time* (page 178).

held_time

The length of time (in seconds) that the device has been held for. This is counted from the first execution of the *when_held* (page 178) event rather than when the device activated, in contrast to *active_time* (page 177). If the device is not currently held, this is None[851].

hold_repeat

If True[852], *when_held* (page 178) will be executed repeatedly with *hold_time* (page 178) seconds between each invocation.

hold_time

The length of time (in seconds) to wait after the device is activated, until executing the *when_held* (page 178) handler. If *hold_repeat* (page 178) is True, this is also the length of time between invocations of *when_held* (page 178).

is_held

When True[853], the device has been active for at least *hold_time* (page 178) seconds.

when_held

The function to run when the device has remained active for *hold_time* (page 178) seconds.

This can be set to a function which accepts no (mandatory) parameters, or a Python function which accepts a single mandatory parameter (with as many optional parameters as you like). If the function accepts a single mandatory parameter, the device that activated will be passed as that parameter.

Set this property to None[854] (the default) to disable the event.

[850] https://docs.python.org/3.5/library/constants.html#True
[851] https://docs.python.org/3.5/library/constants.html#None
[852] https://docs.python.org/3.5/library/constants.html#True
[853] https://docs.python.org/3.5/library/constants.html#True
[854] https://docs.python.org/3.5/library/constants.html#None

CHAPTER 19

API - Device Source Tools

GPIO Zero includes several utility routines which are intended to be used with the *Source/Values* (page 59) attributes common to most devices in the library. These utility routines are in the `tools` module of GPIO Zero and are typically imported as follows:

```
from gpiozero.tools import scaled, negated, all_values
```

Given that `source` (page 176) and `values` (page 176) deal with infinite iterators, another excellent source of utilities is the `itertools`[855] module in the standard library.

19.1 Single source conversions

`gpiozero.tools.`**`absoluted`**`(`*values*`)`

Returns *values* with all negative elements negated (so that they're positive). For example:

```
from gpiozero import PWMLED, Motor, MCP3008
from gpiozero.tools import absoluted, scaled
from signal import pause

led = PWMLED(4)
motor = Motor(22, 27)
pot = MCP3008(channel=0)

motor.source = scaled(pot, -1, 1)
led.source = absoluted(motor)

pause()
```

`gpiozero.tools.`**`booleanized`**`(`*values*, *min_value*, *max_value*, *hysteresis=0*`)`

Returns True for each item in *values* between *min_value* and *max_value*, and False otherwise. *hysteresis* can optionally be used to add hysteresis[856] which prevents the output value rapidly flipping when the input value is fluctuating near the *min_value* or *max_value* thresholds. For example, to light an LED only when a potentiometer is between ¼ and ¾ of its full range:

[855] https://docs.python.org/3.5/library/itertools.html#module-itertools
[856] https://en.wikipedia.org/wiki/Hysteresis

```
from gpiozero import LED, MCP3008
from gpiozero.tools import booleanized
from signal import pause

led = LED(4)
pot = MCP3008(channel=0)

led.source = booleanized(pot, 0.25, 0.75)

pause()
```

gpiozero.tools.**clamped**(*values*, *output_min=0*, *output_max=1*)

Returns *values* clamped from *output_min* to *output_max*, i.e. any items less than *output_min* will be returned as *output_min* and any items larger than *output_max* will be returned as *output_max* (these default to 0 and 1 respectively). For example:

```
from gpiozero import PWMLED, MCP3008
from gpiozero.tools import clamped
from signal import pause

led = PWMLED(4)
pot = MCP3008(channel=0)

led.source = clamped(pot, 0.5, 1.0)

pause()
```

gpiozero.tools.**inverted**(*values*, *input_min=0*, *input_max=1*)

Returns the inversion of the supplied values (*input_min* becomes *input_max*, *input_max* becomes *input_min*, *input_min + 0.1* becomes *input_max - 0.1*, etc.). All items in *values* are assumed to be between *input_min* and *input_max* (which default to 0 and 1 respectively), and the output will be in the same range. For example:

```
from gpiozero import MCP3008, PWMLED
from gpiozero.tools import inverted
from signal import pause

led = PWMLED(4)
pot = MCP3008(channel=0)

led.source = inverted(pot)

pause()
```

gpiozero.tools.**negated**(*values*)

Returns the negation of the supplied values (`True`[857] becomes `False`[858], and `False`[859] becomes `True`[860]). For example:

```
from gpiozero import Button, LED
from gpiozero.tools import negated
from signal import pause

led = LED(4)
btn = Button(17)

led.source = negated(btn)
```

(continues on next page)

[857] https://docs.python.org/3.5/library/constants.html#True
[858] https://docs.python.org/3.5/library/constants.html#False
[859] https://docs.python.org/3.5/library/constants.html#False
[860] https://docs.python.org/3.5/library/constants.html#True

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```
pause()
```

gpiozero.tools.**post_delayed**(*values*, *delay*)

Waits for *delay* seconds after returning each item from *values*.

gpiozero.tools.**post_periodic_filtered**(*values*, *repeat_after*, *block*)

After every *repeat_after* items, blocks the next *block* items from *values*. Note that unlike *pre_periodic_filtered()* (page 181), *repeat_after* can't be 0. For example, to block every tenth item read from an ADC:

```
from gpiozero import MCP3008
from gpiozero.tools import post_periodic_filtered

adc = MCP3008(channel=0)

for value in post_periodic_filtered(adc, 9, 1):
    print(value)
```

gpiozero.tools.**pre_delayed**(*values*, *delay*)

Waits for *delay* seconds before returning each item from *values*.

gpiozero.tools.**pre_periodic_filtered**(*values*, *block*, *repeat_after*)

Blocks the first *block* items from *values*, repeating the block after every *repeat_after* items, if *repeat_after* is non-zero. For example, to discard the first 50 values read from an ADC:

```
from gpiozero import MCP3008
from gpiozero.tools import pre_periodic_filtered

adc = MCP3008(channel=0)

for value in pre_periodic_filtered(adc, 50, 0):
    print(value)
```

Or to only display every even item read from an ADC:

```
from gpiozero import MCP3008
from gpiozero.tools import pre_periodic_filtered

adc = MCP3008(channel=0)

for value in pre_periodic_filtered(adc, 1, 1):
    print(value)
```

gpiozero.tools.**quantized**(*values*, *steps*, *input_min=0*, *input_max=1*)

Returns *values* quantized to *steps* increments. All items in *values* are assumed to be between *input_min* and *input_max* (which default to 0 and 1 respectively), and the output will be in the same range.

For example, to quantize values between 0 and 1 to 5 "steps" (0.0, 0.25, 0.5, 0.75, 1.0):

```
from gpiozero import PWMLED, MCP3008
from gpiozero.tools import quantized
from signal import pause

led = PWMLED(4)
pot = MCP3008(channel=0)

led.source = quantized(pot, 4)

pause()
```

`gpiozero.tools.`**`queued`**`(`*values*, *qsize*`)`

Queues up readings from *values* (the number of readings queued is determined by *qsize*) and begins yielding values only when the queue is full. For example, to "cascade" values along a sequence of LEDs:

```
from gpiozero import LEDBoard, Button
from gpiozero.tools import queued
from signal import pause

leds = LEDBoard(5, 6, 13, 19, 26)
btn = Button(17)

for i in range(4):
    leds[i].source = queued(leds[i + 1], 5)
    leds[i].source_delay = 0.01

leds[4].source = btn

pause()
```

`gpiozero.tools.`**`smoothed`**`(`*values*, *qsize*, *average=<function mean>*`)`

Queues up readings from *values* (the number of readings queued is determined by *qsize*) and begins yielding the *average* of the last *qsize* values when the queue is full. The larger the *qsize*, the more the values are smoothed. For example, to smooth the analog values read from an ADC:

```
from gpiozero import MCP3008
from gpiozero.tools import smoothed

adc = MCP3008(channel=0)

for value in smoothed(adc, 5):
    print(value)
```

`gpiozero.tools.`**`scaled`**`(`*values*, *output_min*, *output_max*, *input_min=0*, *input_max=1*`)`

Returns *values* scaled from *output_min* to *output_max*, assuming that all items in *values* lie between *input_min* and *input_max* (which default to 0 and 1 respectively). For example, to control the direction of a motor (which is represented as a value between -1 and 1) using a potentiometer (which typically provides values between 0 and 1):

```
from gpiozero import Motor, MCP3008
from gpiozero.tools import scaled
from signal import pause

motor = Motor(20, 21)
pot = MCP3008(channel=0)

motor.source = scaled(pot, -1, 1)

pause()
```

Warning: If *values* contains elements that lie outside *input_min* to *input_max* (inclusive) then the function will not produce values that lie within *output_min* to *output_max* (inclusive).

19.2 Combining sources

`gpiozero.tools.`**`all_values`**`(`**values*`)`

Returns the logical conjunction[861] of all supplied values (the result is only `True`[862] if and only if all input

[861] https://en.wikipedia.org/wiki/Logical_conjunction
[862] https://docs.python.org/3.5/library/constants.html#True

values are simultaneously `True`[863]). One or more *values* can be specified. For example, to light an *LED* (page 111) only when *both* buttons are pressed:

```
from gpiozero import LED, Button
from gpiozero.tools import all_values
from signal import pause

led = LED(4)
btn1 = Button(20)
btn2 = Button(21)

led.source = all_values(btn1, btn2)

pause()
```

`gpiozero.tools.`**`any_values`**`(*values)`

Returns the logical disjunction[864] of all supplied values (the result is `True`[865] if any of the input values are currently `True`[866]). One or more *values* can be specified. For example, to light an *LED* (page 111) when *any* button is pressed:

```
from gpiozero import LED, Button
from gpiozero.tools import any_values
from signal import pause

led = LED(4)
btn1 = Button(20)
btn2 = Button(21)

led.source = any_values(btn1, btn2)

pause()
```

`gpiozero.tools.`**`averaged`**`(*values)`

Returns the mean of all supplied values. One or more *values* can be specified. For example, to light a *PWMLED* (page 113) as the average of several potentiometers connected to an *MCP3008* (page 135) ADC:

```
from gpiozero import MCP3008, PWMLED
from gpiozero.tools import averaged
from signal import pause

pot1 = MCP3008(channel=0)
pot2 = MCP3008(channel=1)
pot3 = MCP3008(channel=2)
led = PWMLED(4)

led.source = averaged(pot1, pot2, pot3)

pause()
```

`gpiozero.tools.`**`multiplied`**`(*values)`

Returns the product of all supplied values. One or more *values* can be specified. For example, to light a *PWMLED* (page 113) as the product (i.e. multiplication) of several potentiometers connected to an *MCP3008* (page 135) ADC:

```
from gpiozero import MCP3008, PWMLED
from gpiozero.tools import multiplied
from signal import pause
```

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[863] https://docs.python.org/3.5/library/constants.html#True
[864] https://en.wikipedia.org/wiki/Logical_disjunction
[865] https://docs.python.org/3.5/library/constants.html#True
[866] https://docs.python.org/3.5/library/constants.html#True

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```
pot1 = MCP3008(channel=0)
pot2 = MCP3008(channel=1)
pot3 = MCP3008(channel=2)
led = PWMLED(4)

led.source = multiplied(pot1, pot2, pot3)

pause()
```

`gpiozero.tools.`**`summed`**`(`**values*`)`

Returns the sum of all supplied values. One or more *values* can be specified. For example, to light a *PWMLED* (page 113) as the (scaled) sum of several potentiometers connected to an *MCP3008* (page 135) ADC:

```
from gpiozero import MCP3008, PWMLED
from gpiozero.tools import summed, scaled
from signal import pause

pot1 = MCP3008(channel=0)
pot2 = MCP3008(channel=1)
pot3 = MCP3008(channel=2)
led = PWMLED(4)

led.source = scaled(summed(pot1, pot2, pot3), 0, 1, 0, 3)

pause()
```

`gpiozero.tools.`**`zip_values`**`(`**devices*`)`

Provides a source constructed from the values of each item, for example:

```
from gpiozero import MCP3008, Robot
from gpiozero.tools import zip_values
from signal import pause

robot = Robot(left=(4, 14), right=(17, 18))

left = MCP3008(0)
right = MCP3008(1)

robot.source = zip_values(left, right)

pause()
```

`zip_values(left, right)` is equivalent to `zip(left.values, right.values)`.

19.3 Artificial sources

`gpiozero.tools.`**`alternating_values`**`(`*initial_value=False*`)`

Provides an infinite source of values alternating between `True`[867] and `False`[868], starting wth *initial_value* (which defaults to `False`[869]). For example, to produce a flashing LED:

```
from gpiozero import LED
from gpiozero.tools import alternating_values
from signal import pause
```

(continues on next page)

[867] https://docs.python.org/3.5/library/constants.html#True
[868] https://docs.python.org/3.5/library/constants.html#False
[869] https://docs.python.org/3.5/library/constants.html#False

(continued from previous page)

```
red = LED(2)

red.source_delay = 0.5
red.source = alternating_values()

pause()
```

gpiozero.tools.**cos_values**(*period=360*)

Provides an infinite source of values representing a cosine wave (from -1 to +1) which repeats every *period* values. For example, to produce a "siren" effect with a couple of LEDs that repeats once a second:

```
from gpiozero import PWMLED
from gpiozero.tools import cos_values, scaled, inverted
from signal import pause

red = PWMLED(2)
blue = PWMLED(3)

red.source_delay = 0.01
blue.source_delay = red.source_delay
red.source = scaled(cos_values(100), 0, 1, -1, 1)
blue.source = inverted(red)

pause()
```

If you require a different range than -1 to +1, see `scaled()` (page 182).

gpiozero.tools.**ramping_values**(*period=360*)

Provides an infinite source of values representing a triangle wave (from 0 to 1 and back again) which repeats every *period* values. For example, to pulse an LED once a second:

```
from gpiozero import PWMLED
from gpiozero.tools import ramping_values
from signal import pause

red = PWMLED(2)

red.source_delay = 0.01
red.source = ramping_values(100)

pause()
```

If you require a wider range than 0 to 1, see `scaled()` (page 182).

gpiozero.tools.**random_values**()

Provides an infinite source of random values between 0 and 1. For example, to produce a "flickering candle" effect with an LED:

```
from gpiozero import PWMLED
from gpiozero.tools import random_values
from signal import pause

led = PWMLED(4)

led.source = random_values()

pause()
```

If you require a wider range than 0 to 1, see `scaled()` (page 182).

gpiozero.tools.**sin_values**(*period=360*)

Provides an infinite source of values representing a sine wave (from -1 to +1) which repeats every *period* values. For example, to produce a “siren” effect with a couple of LEDs that repeats once a second:

```
from gpiozero import PWMLED
from gpiozero.tools import sin_values, scaled, inverted
from signal import pause

red = PWMLED(2)
blue = PWMLED(3)

red.source_delay = 0.01
blue.source_delay = red.source_delay
red.source = scaled(sin_values(100), 0, 1, -1, 1)
blue.source = inverted(red)

pause()
```

If you require a different range than -1 to +1, see `scaled()` (page 182).

CHAPTER 20

API - Tones

GPIO Zero includes a *Tone* (page 187) class intended for use with the *TonalBuzzer* (page 119). This class is in the `tones` module of GPIO Zero and is typically imported as follows:

```
from gpiozero.tones import Tone
```

20.1 Tone

class gpiozero.tones.**Tone**

Represents a frequency of sound in a variety of musical notations.

Tone (page 187) class can be used with the *TonalBuzzer* (page 119) class to easily represent musical tones. The class can be constructed in a variety of ways. For example as a straight frequency in Hz[870] (which is the internal storage format), as an integer MIDI note, or as a string representation of a musical note.

All the following constructors are equivalent ways to construct the typical tuning note, concert A[871] at 440Hz, which is MIDI note #69:

```
>>> from gpiozero.tones import Tone
>>> Tone(440.0)
>>> Tone(69)
>>> Tone('A4')
```

If you do not want the constructor to guess which format you are using (there is some ambiguity between frequencies and MIDI notes at the bottom end of the frequencies, from 128Hz down), you can use one of the explicit constructors, *from_frequency()* (page 188), *from_midi()* (page 188), or *from_note()* (page 188), or you can specify a keyword argument when constructing:

```
>>> Tone.from_frequency(440)
>>> Tone.from_midi(69)
>>> Tone.from_note('A4')
>>> Tone(frequency=440)
>>> Tone(midi=69)
>>> Tone(note='A4')
```

[870] https://en.wikipedia.org/wiki/Hertz
[871] https://en.wikipedia.org/wiki/Concert_pitch

Several attributes are provided to permit conversion to any of the supported construction formats: `frequency` (page 188), `midi` (page 188), and `note` (page 188). Methods are provided to step `up()` (page 188) or `down()` (page 188) to adjacent MIDI notes.

> **Warning:** Currently `Tone` (page 187) derives from `float`[872] and can be used as a floating point number in most circumstances (addition, subtraction, etc). This part of the API is not yet considered "stable"; i.e. we may decide to enhance / change this behaviour in future versions.

down (*n=1*)
Return the `Tone` (page 187) *n* semi-tones below this frequency (*n* defaults to 1).

classmethod from_frequency (*freq*)
Construct a `Tone` (page 187) from a frequency specified in Hz[873] which must be a positive floating-point value in the range 0 < freq <= 20000.

classmethod from_midi (*midi_note*)
Construct a `Tone` (page 187) from a MIDI note, which must be an integer in the range 0 to 127. For reference, A4 (concert A[874] typically used for tuning) is MIDI note #69.

classmethod from_note (*note*)
Construct a `Tone` (page 187) from a musical note which must consist of a capital letter A through G, followed by an optional semi-tone modifier ("b" for flat, "#" for sharp, or their Unicode equivalents), followed by an octave number (0 through 9).

For example concert A[875], the typical tuning note at 440Hz, would be represented as "A4". One semi-tone above this would be "A#4" or alternatively "Bb4". Unicode representations of sharp and flat are also accepted.

up (*n=1*)
Return the `Tone` (page 187) *n* semi-tones above this frequency (*n* defaults to 1).

frequency
Return the frequency of the tone in Hz[876].

midi
Return the (nearest) MIDI note to the tone's frequency. This will be an integer number in the range 0 to 127. If the frequency is outside the range represented by MIDI notes (which is approximately 8Hz to 12.5KHz) `ValueError`[877] exception will be raised.

note
Return the (nearest) note to the tone's frequency. This will be a string in the form accepted by `from_note()` (page 188). If the frequency is outside the range represented by this format ("A0" is approximately 27.5Hz, and "G9" is approximately 12.5Khz) a `ValueError`[878] exception will be raised.

[872] https://docs.python.org/3.5/library/functions.html#float
[873] https://en.wikipedia.org/wiki/Hertz
[874] https://en.wikipedia.org/wiki/Concert_pitch
[875] https://en.wikipedia.org/wiki/Concert_pitch
[876] https://en.wikipedia.org/wiki/Hertz
[877] https://docs.python.org/3.5/library/exceptions.html#ValueError
[878] https://docs.python.org/3.5/library/exceptions.html#ValueError

CHAPTER 21

API - Pi Information

The GPIO Zero library also contains a database of information about the various revisions of the Raspberry Pi computer. This is used internally to raise warnings when non-physical pins are used, or to raise exceptions when pull-downs are requested on pins with physical pull-up resistors attached. The following functions and classes can be used to query this database:

21.1 pi_info

`gpiozero.`**`pi_info`**`(`*revision=None*`)`

Returns a `PiBoardInfo` (page 189) instance containing information about a *revision* of the Raspberry Pi.

Parameters **`revision`** (`str`[879]) – The revision of the Pi to return information about. If this is omitted or `None`[880] (the default), then the library will attempt to determine the model of Pi it is running on and return information about that.

21.2 PiBoardInfo

`class` `gpiozero.`**`PiBoardInfo`**

This class is a `namedtuple()`[881] derivative used to represent information about a particular model of Raspberry Pi. While it is a tuple, it is strongly recommended that you use the following named attributes to access the data contained within. The object can be used in format strings with various custom format specifications:

```
from gpiozero import *

print('{0}'.format(pi_info()))
print('{0:full}'.format(pi_info()))
print('{0:board}'.format(pi_info()))
print('{0:specs}'.format(pi_info()))
print('{0:headers}'.format(pi_info()))
```

"color" and "mono" can be prefixed to format specifications to force the use of ANSI color codes[882]. If

[879] https://docs.python.org/3.5/library/stdtypes.html#str
[880] https://docs.python.org/3.5/library/constants.html#None
[881] https://docs.python.org/3.5/library/collections.html#collections.namedtuple
[882] https://en.wikipedia.org/wiki/ANSI_escape_code

neither is specified, ANSI codes will only be used if stdout is detected to be a tty:

```
print('{0:color board}'.format(pi_info())) # force use of ANSI codes
print('{0:mono board}'.format(pi_info())) # force plain ASCII
```

physical_pin (*function*)
Return the physical pin supporting the specified *function*. If no pins support the desired *function*, this function raises `PinNoPins` (page 215). If multiple pins support the desired *function*, `PinMultiplePins` (page 215) will be raised (use `physical_pins()` (page 190) if you expect multiple pins in the result, such as for electrical ground).

Parameters **function** (`str`[883]) – The pin function you wish to search for. Usually this is something like "GPIO9" for Broadcom GPIO pin 9.

physical_pins (*function*)
Return the physical pins supporting the specified *function* as tuples of `(header, pin_number)` where *header* is a string specifying the header containing the *pin_number*. Note that the return value is a `set`[884] which is not indexable. Use `physical_pin()` (page 190) if you are expecting a single return value.

Parameters **function** (`str`[885]) – The pin function you wish to search for. Usually this is something like "GPIO9" for Broadcom GPIO pin 9, or "GND" for all the pins connecting to electrical ground.

pprint (*color=None*)
Pretty-print a representation of the board along with header diagrams.

If *color* is `None`[886] (the default), the diagram will include ANSI color codes if stdout is a color-capable terminal. Otherwise *color* can be set to `True`[887] or `False`[888] to force color or monochrome output.

pulled_up (*function*)
Returns a bool indicating whether a physical pull-up is attached to the pin supporting the specified *function*. Either `PinNoPins` (page 215) or `PinMultiplePins` (page 215) may be raised if the function is not associated with a single pin.

Parameters **function** (`str`[889]) – The pin function you wish to determine pull-up for. Usually this is something like "GPIO9" for Broadcom GPIO pin 9.

to_gpio (*spec*)
Parses a pin *spec*, returning the equivalent Broadcom GPIO port number or raising a `ValueError`[890] exception if the spec does not represent a GPIO port.

The *spec* may be given in any of the following forms:

- An integer, which will be accepted as a GPIO number
- 'GPIOn' where n is the GPIO number
- 'WPIn' where n is the wiringPi[891] pin number
- 'BCMn' where n is the GPIO number (alias of GPIOn)
- 'BOARDn' where n is the physical pin number on the main header
- 'h:n' where h is the header name and n is the physical pin number (for example J8:5 is physical pin 5 on header J8, which is the main header on modern Raspberry Pis)

[883] https://docs.python.org/3.5/library/stdtypes.html#str
[884] https://docs.python.org/3.5/library/stdtypes.html#set
[885] https://docs.python.org/3.5/library/stdtypes.html#str
[886] https://docs.python.org/3.5/library/constants.html#None
[887] https://docs.python.org/3.5/library/constants.html#True
[888] https://docs.python.org/3.5/library/constants.html#False
[889] https://docs.python.org/3.5/library/stdtypes.html#str
[890] https://docs.python.org/3.5/library/exceptions.html#ValueError
[891] http://wiringpi.com/pins/

revision
A string indicating the revision of the Pi. This is unique to each revision and can be considered the "key" from which all other attributes are derived. However, in itself the string is fairly meaningless.

model
A string containing the model of the Pi (for example, "B", "B+", "A+", "2B", "CM" (for the Compute Module), or "Zero").

pcb_revision
A string containing the PCB revision number which is silk-screened onto the Pi (on some models).

Note: This is primarily useful to distinguish between the model B revision 1.0 and 2.0 (not to be confused with the model 2B) which had slightly different pinouts on their 26-pin GPIO headers.

released
A string containing an approximate release date for this revision of the Pi (formatted as yyyyQq, e.g. 2012Q1 means the first quarter of 2012).

soc
A string indicating the SoC (system on a chip[892]) that this revision of the Pi is based upon.

manufacturer
A string indicating the name of the manufacturer (usually "Sony" but a few others exist).

memory
An integer indicating the amount of memory (in Mb) connected to the SoC.

Note: This can differ substantially from the amount of RAM available to the operating system as the GPU's memory is shared with the CPU. When the camera module is activated, at least 128Mb of RAM is typically reserved for the GPU.

storage
A string indicating the type of bootable storage used with this revision of Pi, e.g. "SD", "MicroSD", or "eMMC" (for the Compute Module).

usb
An integer indicating how many USB ports are physically present on this revision of the Pi.

Note: This does *not* include the micro-USB port used to power the Pi.

ethernet
An integer indicating how many Ethernet ports are physically present on this revision of the Pi.

wifi
A bool indicating whether this revision of the Pi has wifi built-in.

bluetooth
A bool indicating whether this revision of the Pi has bluetooth built-in.

csi
An integer indicating the number of CSI (camera) ports available on this revision of the Pi.

dsi
An integer indicating the number of DSI (display) ports available on this revision of the Pi.

headers
A dictionary which maps header labels to *HeaderInfo* (page 192) tuples. For example, to obtain information about header P1 you would query `headers['P1']`. To obtain information about pin 12 on header J8 you would query `headers['J8'].pins[12]`.

[892] https://en.wikipedia.org/wiki/System_on_a_chip

A rendered version of this data can be obtained by using the *PiBoardInfo* (page 189) object in a format string:

```
from gpiozero import *
print('{0:headers}'.format(pi_info()))
```

board
An ASCII art rendition of the board, primarily intended for console pretty-print usage. A more usefully rendered version of this data can be obtained by using the *PiBoardInfo* (page 189) object in a format string. For example:

```
from gpiozero import *
print('{0:board}'.format(pi_info()))
```

21.3 HeaderInfo

class gpiozero.**HeaderInfo**
This class is a `namedtuple()`[893] derivative used to represent information about a pin header on a board. The object can be used in a format string with various custom specifications:

```
from gpiozero import *

print('{0}'.format(pi_info().headers['J8']))
print('{0:full}'.format(pi_info().headers['J8']))
print('{0:col2}'.format(pi_info().headers['P1']))
print('{0:row1}'.format(pi_info().headers['P1']))
```

"color" and "mono" can be prefixed to format specifications to force the use of ANSI color codes[894]. If neither is specified, ANSI codes will only be used if stdout is detected to be a tty:

```
print('{0:color row2}'.format(pi_info().headers['J8'])) # force use of ANSI␣
↪codes
print('{0:mono row2}'.format(pi_info().headers['P1'])) # force plain ASCII
```

The following attributes are defined:

pprint(*color=None*)
Pretty-print a diagram of the header pins.

If *color* is `None`[895] (the default, the diagram will include ANSI color codes if stdout is a color-capable terminal). Otherwise *color* can be set to `True`[896] or `False`[897] to force color or monochrome output.

name
The name of the header, typically as it appears silk-screened on the board (e.g. "P1" or "J8").

rows
The number of rows on the header.

columns
The number of columns on the header.

pins
A dictionary mapping physical pin numbers to *PinInfo* (page 193) tuples.

[893] https://docs.python.org/3.5/library/collections.html#collections.namedtuple
[894] https://en.wikipedia.org/wiki/ANSI_escape_code
[895] https://docs.python.org/3.5/library/constants.html#None
[896] https://docs.python.org/3.5/library/constants.html#True
[897] https://docs.python.org/3.5/library/constants.html#False

21.4 PinInfo

class gpiozero.**PinInfo**

This class is a `namedtuple()`[898] derivative used to represent information about a pin present on a GPIO header. The following attributes are defined:

number

An integer containing the physical pin number on the header (starting from 1 in accordance with convention).

function

A string describing the function of the pin. Some common examples include "GND" (for pins connecting to ground), "3V3" (for pins which output 3.3 volts), "GPIO9" (for GPIO9 in the Broadcom numbering scheme), etc.

pull_up

A bool indicating whether the pin has a physical pull-up resistor permanently attached (this is usually `False`[899] but GPIO2 and GPIO3 are *usually* `True`[900]). This is used internally by gpiozero to raise errors when pull-down is requested on a pin with a physical pull-up resistor.

row

An integer indicating on which row the pin is physically located in the header (1-based)

col

An integer indicating in which column the pin is physically located in the header (1-based)

[898] https://docs.python.org/3.5/library/collections.html#collections.namedtuple
[899] https://docs.python.org/3.5/library/constants.html#False
[900] https://docs.python.org/3.5/library/constants.html#True

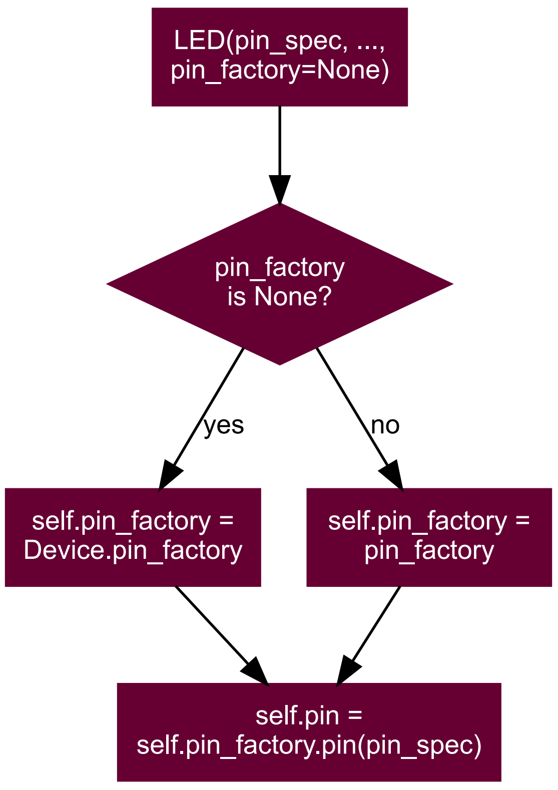
CHAPTER 22

API - Pins

As of release 1.1, the GPIO Zero library can be roughly divided into two things: pins and the devices that are connected to them. The majority of the documentation focuses on devices as pins are below the level that most users are concerned with. However, some users may wish to take advantage of the capabilities of alternative GPIO implementations or (in future) use GPIO extender chips. This is the purpose of the pins portion of the library.

When you construct a device, you pass in a pin specification. This is passed to a pin `Factory` (page 198) which turns it into a `Pin` (page 199) implementation. The default factory can be queried (and changed) with `Device.pin_factory` (page 175). However, all classes (even internal devices) accept a *pin_factory* keyword argument to their constructors permitting the factory to be overridden on a per-device basis (the reason for allowing per-device factories is made apparent in the *Configuring Remote GPIO* (page 43) chapter).

This is illustrated in the following flow-chart:



The default factory is constructed when GPIO Zero is first imported; if no default factory can be constructed (e.g. because no GPIO implementations are installed, or all of them fail to load for whatever reason), an `ImportError`[901] will be raised.

22.1 Changing the pin factory

The default pin factory can be replaced by specifying a value for the *GPIOZERO_PIN_FACTORY* (page 74) environment variable. For example:

```
$ GPIOZERO_PIN_FACTORY=native python
Python 3.4.2 (default, Oct 19 2014, 13:31:11)
[GCC 4.9.1] on linux
Type "help", "copyright", "credits" or "license" for more information.
>>> import gpiozero
>>> gpiozero.Device.pin_factory
<gpiozero.pins.native.NativeFactory object at 0x762c26b0>
```

To set the *GPIOZERO_PIN_FACTORY* (page 74) for the rest of your session you can **export** this value:

```
$ export GPIOZERO_PIN_FACTORY=native
$ python
Python 3.4.2 (default, Oct 19 2014, 13:31:11)
[GCC 4.9.1] on linux
Type "help", "copyright", "credits" or "license" for more information.
>>> import gpiozero
>>> gpiozero.Device.pin_factory
<gpiozero.pins.native.NativeFactory object at 0x762c26b0>
>>> quit()
$ python
Python 3.4.2 (default, Oct 19 2014, 13:31:11)
[GCC 4.9.1] on linux
Type "help", "copyright", "credits" or "license" for more information.
>>> import gpiozero
>>> gpiozero.Device.pin_factory
<gpiozero.pins.native.NativeFactory object at 0x76401330>
```

If you add the **export** command to your `~/.bashrc` file, you'll set the default pin factory for all future sessions too.

The following values, and the corresponding *Factory* (page 198) and *Pin* (page 199) classes are listed in the table below. Factories are listed in the order that they are tried by default.

Name	Factory class	Pin class
rpig-pio	*gpiozero.pins.rpigpio.RPiGPIOFactory* (page 207)	*gpiozero.pins.rpigpio.RPiGPIOPin* (page 207)
rpio	*gpiozero.pins.rpio.RPIOFactory* (page 207)	*gpiozero.pins.rpio.RPIOPin* (page 207)
pig-pio	*gpiozero.pins.pigpio.PiGPIOFactory* (page 208)	*gpiozero.pins.pigpio.PiGPIOPin* (page 208)
na-tive	*gpiozero.pins.native.NativeFactory* (page 208)	*gpiozero.pins.native.NativePin* (page 209)

If you need to change the default pin factory from within a script, either set *Device.pin_factory* (page 175) to the new factory instance to use:

[901] https://docs.python.org/3.5/library/exceptions.html#ImportError

```
from gpiozero.pins.native import NativeFactory
from gpiozero import Device, LED

Device.pin_factory = NativeFactory()

# These will now implicitly use NativePin instead of
# RPiGPIOPin
led1 = LED(16)
led2 = LED(17)
```

Or use the *pin_factory* keyword parameter mentioned above:

```
from gpiozero.pins.native import NativeFactory
from gpiozero import LED

my_factory = NativeFactory()

# This will use NativePin instead of RPiGPIOPin for led1
# but led2 will continue to use RPiGPIOPin
led1 = LED(16, pin_factory=my_factory)
led2 = LED(17)
```

Certain factories may take default information from additional sources. For example, to default to creating pins with `gpiozero.pins.pigpio.PiGPIOPin` (page 208) on a remote pi called "remote-pi" you can set the `PIGPIO_ADDR` (page 74) environment variable when running your script:

```
$ GPIOZERO_PIN_FACTORY=pigpio PIGPIO_ADDR=remote-pi python3 my_script.py
```

Like the `GPIOZERO_PIN_FACTORY` (page 74) value, these can be exported from your `~/.bashrc` script too.

Warning: The astute and mischievous reader may note that it is possible to mix factories, e.g. using `RPiGPIOFactory` (page 207) for one pin, and `NativeFactory` (page 208) for another. This is unsupported, and if it results in your script crashing, your components failing, or your Raspberry Pi turning into an actual raspberry pie, you have only yourself to blame.

Sensible uses of multiple pin factories are given in *Configuring Remote GPIO* (page 43).

22.2 Mock pins

There's also a `gpiozero.pins.mock.MockFactory` (page 209) which generates entirely fake pins. This was originally intended for GPIO Zero developers who wish to write tests for devices without having to have the physical device wired in to their Pi. However, they have also proven relatively useful in developing GPIO Zero scripts without having a Pi to hand. This pin factory will never be loaded by default; it must be explicitly specified. For example:

```
from gpiozero.pins.mock import MockFactory
from gpiozero import Device, Button, LED
from time import sleep

# Set the default pin factory to a mock factory
Device.pin_factory = MockFactory()

# Construct a couple of devices attached to mock pins 16 and 17, and link the
# devices
led = LED(17)
btn = Button(16)
led.source = btn
```

(continues on next page)

(continued from previous page)

```
# Here the button isn't "pushed" so the LED's value should be False
print(led.value)

# Get a reference to mock pin 16 (used by the button)
btn_pin = Device.pin_factory.pin(16)

# Drive the pin low (this is what would happen electrically when the button is
# pushed)
btn_pin.drive_low()
sleep(0.1) # give source some time to re-read the button state
print(led.value)

btn_pin.drive_high()
sleep(0.1)
print(led.value)
```

Several sub-classes of mock pins exist for emulating various other things (pins that do/don't support PWM, pins that are connected together, pins that drive high after a delay, etc). Interested users are invited to read the GPIO Zero test suite for further examples of usage.

22.3 Base classes

class gpiozero.**Factory**

Generates pins and SPI interfaces for devices. This is an abstract base class for pin factories. Descendents *must* override the following methods:

- `ticks()` (page 199)
- `ticks_diff()` (page 199)

Descendents *may* override the following methods, if applicable:

- `close()` (page 198)
- `reserve_pins()` (page 199)
- `release_pins()` (page 198)
- `release_all()` (page 198)
- `pin()` (page 198)
- `spi()` (page 199)
- `_get_pi_info()`

close()

Closes the pin factory. This is expected to clean up all resources manipulated by the factory. It it typically called at script termination.

pin(*spec*)

Creates an instance of a `Pin` (page 199) descendent representing the specified pin.

Warning: Descendents must ensure that pin instances representing the same hardware are identical; i.e. two separate invocations of `pin()` (page 198) for the same pin specification must return the same object.

release_all(*reserver*)

Releases all pin reservations taken out by *reserver*. See `release_pins()` (page 198) for further information).

release_pins(*reserver*, **pins*)
Releases the reservation of *reserver* against *pins*. This is typically called during `close()` (page 175) to clean up reservations taken during construction. Releasing a reservation that is not currently held will be silently ignored (to permit clean-up after failed / partial construction).

reserve_pins(*requester*, **pins*)
Called to indicate that the device reserves the right to use the specified *pins*. This should be done during device construction. If pins are reserved, you must ensure that the reservation is released by eventually called `release_pins()` (page 198).

spi(***spi_args*)
Returns an instance of an `SPI` (page 202) interface, for the specified SPI *port* and *device*, or for the specified pins (*clock_pin*, *mosi_pin*, *miso_pin*, and *select_pin*). Only one of the schemes can be used; attempting to mix *port* and *device* with pin numbers will raise `SPIBadArgs` (page 213).

ticks()
Return the current ticks, according to the factory. The reference point is undefined and thus the result of this method is only meaningful when compared to another value returned by this method.

The format of the time is also arbitrary, as is whether the time wraps after a certain duration. Ticks should only be compared using the `ticks_diff()` (page 199) method.

ticks_diff(*later*, *earlier*)
Return the time in seconds between two `ticks()` (page 199) results. The arguments are specified in the same order as they would be in the formula *later* - *earlier* but the result is guaranteed to be in seconds, and to be positive even if the ticks "wrapped" between calls to `ticks()` (page 199).

pi_info
Returns a `PiBoardInfo` (page 189) instance representing the Pi that instances generated by this factory will be attached to.

If the pins represented by this class are not *directly* attached to a Pi (e.g. the pin is attached to a board attached to the Pi, or the pins are not on a Pi at all), this may return `None`[902].

class gpiozero.**Pin**
Abstract base class representing a pin attached to some form of controller, be it GPIO, SPI, ADC, etc.

Descendents should override property getters and setters to accurately represent the capabilities of pins. Descendents *must* override the following methods:

- `_get_function()`
- `_set_function()`
- `_get_state()`

Descendents *may* additionally override the following methods, if applicable:

- `close()` (page 200)
- `output_with_state()` (page 200)
- `input_with_pull()` (page 200)
- `_set_state()`
- `_get_frequency()`
- `_set_frequency()`
- `_get_pull()`
- `_set_pull()`
- `_get_bounce()`
- `_set_bounce()`
- `_get_edges()`

[902] https://docs.python.org/3.5/library/constants.html#None

- `_set_edges()`
- `_get_when_changed()`
- `_set_when_changed()`

close()

Cleans up the resources allocated to the pin. After this method is called, this *Pin* (page 199) instance may no longer be used to query or control the pin's state.

input_with_pull(*pull*)

Sets the pin's function to "input" and specifies an initial pull-up for the pin. By default this is equivalent to performing:

```
pin.function = 'input'
pin.pull = pull
```

However, descendents may override this order to provide the smallest possible delay between configuring the pin for input and pulling the pin up/down (which can be important for avoiding "blips" in some configurations).

output_with_state(*state*)

Sets the pin's function to "output" and specifies an initial state for the pin. By default this is equivalent to performing:

```
pin.function = 'output'
pin.state = state
```

However, descendents may override this in order to provide the smallest possible delay between configuring the pin for output and specifying an initial value (which can be important for avoiding "blips" in active-low configurations).

bounce

The amount of bounce detection (elimination) currently in use by edge detection, measured in seconds. If bounce detection is not currently in use, this is `None`[903].

For example, if *edges* (page 200) is currently "rising", *bounce* (page 200) is currently 5/1000 (5ms), then the waveform below will only fire *when_changed* (page 201) on two occasions despite there being three rising edges:

```
TIME 0...1...2...3...4...5...6...7...8...9...10..11..12 ms

bounce elimination   |===================| |==============

HIGH - - - - >       ,--. ,--------------. ,--.
                     |  | |              | |  |
                     |  | |              | |  |
LOW  ----------------'  `-'              `-'  `-----------
                     :                     :
                     :                     :
               when_changed          when_changed
                   fires                 fires
```

If the pin does not support edge detection, attempts to set this property will raise *PinEdgeDetectUnsupported* (page 214). If the pin supports edge detection, the class must implement bounce detection, even if only in software.

edges

The edge that will trigger execution of the function or bound method assigned to *when_changed* (page 201). This can be one of the strings "both" (the default), "rising", "falling", or "none":

[903] https://docs.python.org/3.5/library/constants.html#None

```
HIGH - - - - >           ,--------------.
                         |              |
                         |              |
LOW  --------------------'              `--------------
                         :              :
                         :              :
Fires when_changed     "both"         "both"
when edges is ...     "rising"       "falling"
```

If the pin does not support edge detection, attempts to set this property will raise `PinEdgeDetectUnsupported` (page 214).

frequency
The frequency (in Hz) for the pin's PWM implementation, or `None`[904] if PWM is not currently in use. This value always defaults to `None`[905] and may be changed with certain pin types to activate or deactivate PWM.

If the pin does not support PWM, `PinPWMUnsupported` (page 215) will be raised when attempting to set this to a value other than `None`[906].

function
The function of the pin. This property is a string indicating the current function or purpose of the pin. Typically this is the string "input" or "output". However, in some circumstances it can be other strings indicating non-GPIO related functionality.

With certain pin types (e.g. GPIO pins), this attribute can be changed to configure the function of a pin. If an invalid function is specified, for this attribute, `PinInvalidFunction` (page 214) will be raised.

pull
The pull-up state of the pin represented as a string. This is typically one of the strings "up", "down", or "floating" but additional values may be supported by the underlying hardware.

If the pin does not support changing pull-up state (for example because of a fixed pull-up resistor), attempts to set this property will raise `PinFixedPull` (page 214). If the specified value is not supported by the underlying hardware, `PinInvalidPull` (page 214) is raised.

state
The state of the pin. This is 0 for low, and 1 for high. As a low level view of the pin, no swapping is performed in the case of pull ups (see `pull` (page 201) for more information):

```
HIGH - - - - >       ,----------------------
                     |
                     |
LOW  ----------------'
```

Descendents which implement analog, or analog-like capabilities can return values between 0 and 1. For example, pins implementing PWM (where `frequency` (page 201) is not `None`[907]) return a value between 0.0 and 1.0 representing the current PWM duty cycle.

If a pin is currently configured for input, and an attempt is made to set this attribute, `PinSetInput` (page 214) will be raised. If an invalid value is specified for this attribute, `PinInvalidState` (page 214) will be raised.

when_changed
A function or bound method to be called when the pin's state changes (more specifically when the edge specified by `edges` (page 200) is detected on the pin). The function or bound method must accept two parameters: the first will report the ticks (from `Factory.ticks()` (page 199)) when the pin's state changed, and the second will report the pin's current state.

[904] https://docs.python.org/3.5/library/constants.html#None
[905] https://docs.python.org/3.5/library/constants.html#None
[906] https://docs.python.org/3.5/library/constants.html#None
[907] https://docs.python.org/3.5/library/constants.html#None

> **Warning:** Depending on hardware support, the state is *not guaranteed to be accurate*. For instance, many GPIO implementations will provide an interrupt indicating when a pin's state changed but not what it changed to. In this case the pin driver simply reads the pin's current state to supply this parameter, but the pin's state may have changed *since* the interrupt. Exercise appropriate caution when relying upon this parameter.

If the pin does not support edge detection, attempts to set this property will raise `PinEdgeDetectUnsupported` (page 214).

class `gpiozero.`**`SPI`**

Abstract interface for Serial Peripheral Interface[908] (SPI) implementations. Descendents *must* override the following methods:

- `transfer()` (page 202)
- `_get_clock_mode()`

Descendents *may* override the following methods, if applicable:

- `read()` (page 202)
- `write()` (page 202)
- `_set_clock_mode()`
- `_get_lsb_first()`
- `_set_lsb_first()`
- `_get_select_high()`
- `_set_select_high()`
- `_get_bits_per_word()`
- `_set_bits_per_word()`

`read`(*n*)

Read *n* words of data from the SPI interface, returning them as a sequence of unsigned ints, each no larger than the configured `bits_per_word` (page 202) of the interface.

This method is typically used with read-only devices that feature half-duplex communication. See `transfer()` (page 202) for full duplex communication.

`transfer`(*data*)

Write *data* to the SPI interface. *data* must be a sequence of unsigned integer words each of which will fit within the configured `bits_per_word` (page 202) of the interface. The method returns the sequence of words read from the interface while writing occurred (full duplex communication).

The length of the sequence returned dictates the number of words of *data* written to the interface. Each word in the returned sequence will be an unsigned integer no larger than the configured `bits_per_word` (page 202) of the interface.

`write`(*data*)

Write *data* to the SPI interface. *data* must be a sequence of unsigned integer words each of which will fit within the configured `bits_per_word` (page 202) of the interface. The method returns the number of words written to the interface (which may be less than or equal to the length of *data*).

This method is typically used with write-only devices that feature half-duplex communication. See `transfer()` (page 202) for full duplex communication.

`bits_per_word`

Controls the number of bits that make up a word, and thus where the word boundaries appear in the data stream, and the maximum value of a word. Defaults to 8 meaning that words are effectively bytes.

Several implementations do not support non-byte-sized words.

[908] https://en.wikipedia.org/wiki/Serial_Peripheral_Interface_Bus

clock_mode

Presents a value representing the *clock_polarity* (page 203) and *clock_phase* (page 203) attributes combined according to the following table:

mode	polarity (CPOL)	phase (CPHA)
0	False	False
1	False	True
2	True	False
3	True	True

Adjusting this value adjusts both the *clock_polarity* (page 203) and *clock_phase* (page 203) attributes simultaneously.

clock_phase

The phase of the SPI clock pin. If this is False[909] (the default), data will be read from the MISO pin when the clock pin activates. Setting this to True[910] will cause data to be read from the MISO pin when the clock pin deactivates. On many data sheets this is documented as the CPHA value. Whether the clock edge is rising or falling when the clock is considered activated is controlled by the *clock_polarity* (page 203) attribute (corresponding to CPOL).

The following diagram indicates when data is read when *clock_polarity* (page 203) is False[911], and *clock_phase* (page 203) is False[912] (the default), equivalent to CPHA 0:

```
    ,---.   ,---.   ,---.   ,---.   ,---.   ,---.   ,---.
CLK |   |   |   |   |   |   |   |   |   |   |   |   |   |
    |   |   |   |   |   |   |   |   |   |   |   |   |   |
----'   `---'   `---'   `---'   `---'   `---'   `---'   `-------

    :       :       :       :       :       :       :
MISO---.   ,---.   ,---.   ,---.   ,---.   ,---.   ,---.
  /     \ /     \ /     \ /     \ /     \ /     \ /     \
-{  Bit  X  Bit  X  Bit  X  Bit  X  Bit  X  Bit  X  Bit  }------
  \     / \     / \     / \     / \     / \     / \     /
   `---'   `---'   `---'   `---'   `---'   `---'   `---'
```

The following diagram indicates when data is read when *clock_polarity* (page 203) is False[913], but *clock_phase* (page 203) is True[914], equivalent to CPHA 1:

```
    ,---.   ,---.   ,---.   ,---.   ,---.   ,---.   ,---.
CLK |   |   |   |   |   |   |   |   |   |   |   |   |   |
    |   |   |   |   |   |   |   |   |   |   |   |   |   |
----'   `---'   `---'   `---'   `---'   `---'   `---'   `-------

        :       :       :       :       :       :       :
MISO   ,---.   ,---.   ,---.   ,---.   ,---.   ,---.   ,---.
      /     \ /     \ /     \ /     \ /     \ /     \ /     \
-----{  Bit  X  Bit  X  Bit  X  Bit  X  Bit  X  Bit  X  Bit  }--
      \     / \     / \     / \     / \     / \     / \     /
       `---'   `---'   `---'   `---'   `---'   `---'   `---'
```

clock_polarity

The polarity of the SPI clock pin. If this is False[915] (the default), the clock pin will idle low, and pulse high. Setting this to True[916] will cause the clock pin to idle high, and pulse low. On many data sheets this is documented as the CPOL value.

[909] https://docs.python.org/3.5/library/constants.html#False
[910] https://docs.python.org/3.5/library/constants.html#True
[911] https://docs.python.org/3.5/library/constants.html#False
[912] https://docs.python.org/3.5/library/constants.html#False
[913] https://docs.python.org/3.5/library/constants.html#False
[914] https://docs.python.org/3.5/library/constants.html#True
[915] https://docs.python.org/3.5/library/constants.html#False
[916] https://docs.python.org/3.5/library/constants.html#True

The following diagram illustrates the waveform when `clock_polarity` (page 203) is `False`[917] (the default), equivalent to CPOL 0:

```
       on      on      on      on      on      on      on
      ,---.   ,---.   ,---.   ,---.   ,---.   ,---.   ,---.
CLK   |   |   |   |   |   |   |   |   |   |   |   |   |   |
      |   |   |   |   |   |   |   |   |   |   |   |   |   |
------'   `---'   `---'   `---'   `---'   `---'   `---'   `------
idle       off     off     off     off     off     off       idle
```

The following diagram illustrates the waveform when `clock_polarity` (page 203) is `True`[918], equivalent to CPOL 1:

```
idle       off     off     off     off     off     off       idle
------.   ,---.   ,---.   ,---.   ,---.   ,---.   ,---.   ,------
      |   |   |   |   |   |   |   |   |   |   |   |   |   |
CLK   |   |   |   |   |   |   |   |   |   |   |   |   |   |
      `---'   `---'   `---'   `---'   `---'   `---'   `---'
       on      on      on      on      on      on      on
```

lsb_first

Controls whether words are read and written LSB in (Least Significant Bit first) order. The default is `False`[919] indicating that words are read and written in MSB (Most Significant Bit first) order. Effectively, this controls the Bit endianness[920] of the connection.

The following diagram shows the a word containing the number 5 (binary 0101) transmitted on MISO with `bits_per_word` (page 202) set to 4, and `clock_mode` (page 203) set to 0, when `lsb_first` (page 204) is `False`[921] (the default):

```
    ,---.   ,---.   ,---.   ,---.
CLK |   |   |   |   |   |   |   |
    |   |   |   |   |   |   |   |
----'   `---'   `---'   `---'   `-----
    :     ,-------. :     ,-------.
MISO:     | :     | :     | :     |
    :     | :     | :     | :     |
----------' :     `-------' :     `----
    :       :       :       :
   MSB                     LSB
```

And now with `lsb_first` (page 204) set to `True`[922] (and all other parameters the same):

```
    ,---.   ,---.   ,---.   ,---.
CLK |   |   |   |   |   |   |   |
    |   |   |   |   |   |   |   |
----'   `---'   `---'   `---'   `-----
  ,-------. :     ,-------. :
MISO:     | :     | :     | :
  | :     | :     | :     | :
--' :     `-------' :     `-----------
    :       :       :       :
   LSB                     MSB
```

select_high

If `False`[923] (the default), the chip select line is considered active when it is pulled low. When set to

[917] https://docs.python.org/3.5/library/constants.html#False
[918] https://docs.python.org/3.5/library/constants.html#True
[919] https://docs.python.org/3.5/library/constants.html#False
[920] https://en.wikipedia.org/wiki/Endianness#Bit_endianness
[921] https://docs.python.org/3.5/library/constants.html#False
[922] https://docs.python.org/3.5/library/constants.html#True
[923] https://docs.python.org/3.5/library/constants.html#False

True[924], the chip select line is considered active when it is driven high.

The following diagram shows the waveform of the chip select line, and the clock when *clock_polarity* (page 203) is False[925], and *select_high* (page 204) is False[926] (the default):

```
---.                                                     ,------
__ |                                                     |
CS |      chip is selected, and will react to clock      |  idle
   `-----------------------------------------------------'

    ,---.   ,---.   ,---.   ,---.   ,---.   ,---.   ,---.
CLK |   |   |   |   |   |   |   |   |   |   |   |   |   |
    |   |   |   |   |   |   |   |   |   |   |   |   |   |
----'   `---'   `---'   `---'   `---'   `---'   `---'   `-------
```

And when *select_high* (page 204) is True[927]:

```
   ,-----------------------------------------------------.
CS |      chip is selected, and will react to clock      |  idle
   |                                                     |
---'                                                     `------

    ,---.   ,---.   ,---.   ,---.   ,---.   ,---.   ,---.
CLK |   |   |   |   |   |   |   |   |   |   |   |   |   |
    |   |   |   |   |   |   |   |   |   |   |   |   |   |
----'   `---'   `---'   `---'   `---'   `---'   `---'   `-------
```

class gpiozero.pins.pi.**PiFactory**

Extends *Factory* (page 198). Abstract base class representing hardware attached to a Raspberry Pi. This forms the base of *LocalPiFactory* (page 206).

close()

Closes the pin factory. This is expected to clean up all resources manipulated by the factory. It it typically called at script termination.

pin(*spec*)

Creates an instance of a Pin descendent representing the specified pin.

> **Warning:** Descendents must ensure that pin instances representing the same hardware are identical; i.e. two separate invocations of *pin()* (page 205) for the same pin specification must return the same object.

release_pins(*reserver*, **pins*)

Releases the reservation of *reserver* against *pins*. This is typically called during *close()* (page 175) to clean up reservations taken during construction. Releasing a reservation that is not currently held will be silently ignored (to permit clean-up after failed / partial construction).

reserve_pins(*requester*, **pins*)

Called to indicate that the device reserves the right to use the specified *pins*. This should be done during device construction. If pins are reserved, you must ensure that the reservation is released by eventually called *release_pins()* (page 205).

spi(***spi_args*)

Returns an SPI interface, for the specified SPI *port* and *device*, or for the specified pins (*clock_pin*, *mosi_pin*, *miso_pin*, and *select_pin*). Only one of the schemes can be used; attempting to mix *port* and *device* with pin numbers will raise *SPIBadArgs* (page 213).

[924] https://docs.python.org/3.5/library/constants.html#True
[925] https://docs.python.org/3.5/library/constants.html#False
[926] https://docs.python.org/3.5/library/constants.html#False
[927] https://docs.python.org/3.5/library/constants.html#True

If the pins specified match the hardware SPI pins (clock on GPIO11, MOSI on GPIO10, MISO on GPIO9, and chip select on GPIO8 or GPIO7), and the spidev module can be imported, a hardware based interface (using spidev) will be returned. Otherwise, a software based interface will be returned which will use simple bit-banging to communicate.

Both interfaces have the same API, support clock polarity and phase attributes, and can handle half and full duplex communications, but the hardware interface is significantly faster (though for many things this doesn't matter).

class `gpiozero.pins.pi.`**`PiPin`**(*factory*, *number*)

Extends *`Pin`* (page 199). Abstract base class representing a multi-function GPIO pin attached to a Raspberry Pi. Descendents *must* override the following methods:

- `_get_function()`
- `_set_function()`
- `_get_state()`
- `_call_when_changed()`
- `_enable_event_detect()`
- `_disable_event_detect()`

Descendents *may* additionally override the following methods, if applicable:

- `close()`
- `output_with_state()`
- `input_with_pull()`
- `_set_state()`
- `_get_frequency()`
- `_set_frequency()`
- `_get_pull()`
- `_set_pull()`
- `_get_bounce()`
- `_set_bounce()`
- `_get_edges()`
- `_set_edges()`

class `gpiozero.pins.local.`**`LocalPiFactory`**

Extends *`PiFactory`* (page 205). Abstract base class representing pins attached locally to a Pi. This forms the base class for local-only pin interfaces (*`RPiGPIOPin`* (page 207), *`RPIOPin`* (page 207), and *`NativePin`* (page 209)).

static ticks()

Return the current ticks, according to the factory. The reference point is undefined and thus the result of this method is only meaningful when compared to another value returned by this method.

The format of the time is also arbitrary, as is whether the time wraps after a certain duration. Ticks should only be compared using the *`ticks_diff()`* (page 206) method.

static ticks_diff(*later*, *earlier*)

Return the time in seconds between two *`ticks()`* (page 206) results. The arguments are specified in the same order as they would be in the formula *later* - *earlier* but the result is guaranteed to be in seconds, and to be positive even if the ticks "wrapped" between calls to *`ticks()`* (page 206).

class `gpiozero.pins.local.`**`LocalPiPin`**(*factory*, *number*)

Extends *`PiPin`* (page 206). Abstract base class representing a multi-function GPIO pin attached to the local Raspberry Pi.

22.4 RPi.GPIO

class gpiozero.pins.rpigpio.**RPiGPIOFactory**

Extends *LocalPiFactory* (page 206). Uses the RPi.GPIO[928] library to interface to the Pi's GPIO pins. This is the default pin implementation if the RPi.GPIO library is installed. Supports all features including PWM (via software).

Because this is the default pin implementation you can use it simply by specifying an integer number for the pin in most operations, e.g.:

```
from gpiozero import LED

led = LED(12)
```

However, you can also construct RPi.GPIO pins manually if you wish:

```
from gpiozero.pins.rpigpio import RPiGPIOFactory
from gpiozero import LED

factory = RPiGPIOFactory()
led = LED(12, pin_factory=factory)
```

class gpiozero.pins.rpigpio.**RPiGPIOPin**(*factory*, *number*)

Extends *LocalPiPin* (page 206). Pin implementation for the RPi.GPIO[929] library. See *RPiGPIOFactory* (page 207) for more information.

22.5 RPIO

class gpiozero.pins.rpio.**RPIOFactory**

Extends *LocalPiFactory* (page 206). Uses the RPIO[930] library to interface to the Pi's GPIO pins. This is the default pin implementation if the RPi.GPIO library is not installed, but RPIO is. Supports all features including PWM (hardware via DMA).

Note: Please note that at the time of writing, RPIO is only compatible with Pi 1's; the Raspberry Pi 2 Model B is *not* supported. Also note that root access is required so scripts must typically be run with `sudo`.

You can construct RPIO pins manually like so:

```
from gpiozero.pins.rpio import RPIOFactory
from gpiozero import LED

factory = RPIOFactory()
led = LED(12, pin_factory=factory)
```

class gpiozero.pins.rpio.**RPIOPin**(*factory*, *number*)

Extends *LocalPiPin* (page 206). Pin implementation for the RPIO[931] library. See *RPIOFactory* (page 207) for more information.

[928] https://pypi.python.org/pypi/RPi.GPIO
[929] https://pypi.python.org/pypi/RPi.GPIO
[930] https://pythonhosted.org/RPIO/
[931] https://pythonhosted.org/RPIO/

22.6 PiGPIO

class gpiozero.pins.pigpio.**PiGPIOFactory**(*host=None*, *port=None*)

Extends *PiFactory* (page 205). Uses the pigpio[932] library to interface to the Pi's GPIO pins. The pigpio library relies on a daemon (**pigpiod**) to be running as root to provide access to the GPIO pins, and communicates with this daemon over a network socket.

While this does mean only the daemon itself should control the pins, the architecture does have several advantages:

- Pins can be remote controlled from another machine (the other machine doesn't even have to be a Raspberry Pi; it simply needs the pigpio[933] client library installed on it)
- The daemon supports hardware PWM via the DMA controller
- Your script itself doesn't require root privileges; it just needs to be able to communicate with the daemon

You can construct pigpio pins manually like so:

```
from gpiozero.pins.pigpio import PiGPIOFactory
from gpiozero import LED

factory = PiGPIOFactory()
led = LED(12, pin_factory=factory)
```

This is particularly useful for controlling pins on a remote machine. To accomplish this simply specify the host (and optionally port) when constructing the pin:

```
from gpiozero.pins.pigpio import PiGPIOFactory
from gpiozero import LED

factory = PiGPIOFactory(host='192.168.0.2')
led = LED(12, pin_factory=factory)
```

Note: In some circumstances, especially when playing with PWM, it does appear to be possible to get the daemon into "unusual" states. We would be most interested to hear any bug reports relating to this (it may be a bug in our pin implementation). A workaround for now is simply to restart the **pigpiod** daemon.

class gpiozero.pins.pigpio.**PiGPIOPin**(*factory*, *number*)

Extends *PiPin* (page 206). Pin implementation for the pigpio[934] library. See *PiGPIOFactory* (page 208) for more information.

22.7 Native

class gpiozero.pins.native.**NativeFactory**

Extends *LocalPiFactory* (page 206). Uses a built-in pure Python implementation to interface to the Pi's GPIO pins. This is the default pin implementation if no third-party libraries are discovered.

Warning: This implementation does *not* currently support PWM. Attempting to use any class which requests PWM will raise an exception.

You can construct native pin instances manually like so:

[932] http://abyz.co.uk/rpi/pigpio/
[933] http://abyz.co.uk/rpi/pigpio/
[934] http://abyz.co.uk/rpi/pigpio/

```
from gpiozero.pins.native import NativeFactory
from gpiozero import LED

factory = NativeFactory()
led = LED(12, pin_factory=factory)
```

class gpiozero.pins.native.**NativePin**(*factory*, *number*)
Extends `LocalPiPin` (page 206). Native pin implementation. See `NativeFactory` (page 208) for more information.

22.8 Mock

class gpiozero.pins.mock.**MockFactory**(*revision=None*, *pin_class=None*)
Factory for generating mock pins. The *revision* parameter specifies what revision of Pi the mock factory pretends to be (this affects the result of the `pi_info` (page 199) attribute as well as where pull-ups are assumed to be). The *pin_class* attribute specifies which mock pin class will be generated by the `pin()` (page 209) method by default. This can be changed after construction by modifying the `pin_class` (page 209) attribute.

pin_class
This attribute stores the `MockPin` (page 209) class (or descendent) that will be used when constructing pins with the `pin()` (page 209) method (if no *pin_class* parameter is used to override it). It defaults on construction to the value of the *pin_class* parameter in the constructor, or `MockPin` (page 209) if that is unspecified.

pin(*spec*, *pin_class=None*, ***kwargs*)
The pin method for `MockFactory` (page 209) additionally takes a *pin_class* attribute which can be used to override the class' `pin_class` (page 209) attribute. Any additional keyword arguments will be passed along to the pin constructor (useful with things like `MockConnectedPin` (page 209) which expect to be constructed with another pin).

reset()
Clears the pins and reservations sets. This is primarily useful in test suites to ensure the pin factory is back in a "clean" state before the next set of tests are run.

class gpiozero.pins.mock.**MockPin**(*factory*, *number*)
A mock pin used primarily for testing. This class does *not* support PWM.

class gpiozero.pins.mock.**MockPWMPin**(*factory*, *number*)
This derivative of `MockPin` (page 209) adds PWM support.

class gpiozero.pins.mock.**MockConnectedPin**(*factory*, *number*, *input_pin=None*)
This derivative of `MockPin` (page 209) emulates a pin connected to another mock pin. This is used in the "real pins" portion of the test suite to check that one pin can influence another.

class gpiozero.pins.mock.**MockChargingPin**(*factory*, *number*, *charge_time=0.01*)
This derivative of `MockPin` (page 209) emulates a pin which, when set to input, waits a predetermined length of time and then drives itself high (as if attached to, e.g. a typical circuit using an LDR and a capacitor to time the charging rate).

class gpiozero.pins.mock.**MockTriggerPin**(*factory*, *number*, *echo_pin=None*, *echo_time=0.04*)
This derivative of `MockPin` (page 209) is intended to be used with another `MockPin` (page 209) to emulate a distance sensor. Set *echo_pin* to the corresponding pin instance. When this pin is driven high it will trigger the echo pin to drive high for the echo time.

CHAPTER 23

API - Exceptions

The following exceptions are defined by GPIO Zero. Please note that multiple inheritance is heavily used in the exception hierarchy to make testing for exceptions easier. For example, to capture any exception generated by GPIO Zero's code:

```
from gpiozero import *

led = PWMLED(17)
try:
    led.value = 2
except GPIOZeroError:
    print('A GPIO Zero error occurred')
```

Since all GPIO Zero's exceptions descend from *GPIOZeroError* (page 211), this will work. However, certain specific errors have multiple parents. For example, in the case that an out of range value is passed to *OutputDevice.value* (page 130) you would expect a `ValueError`[935] to be raised. In fact, a *OutputDeviceBadValue* (page 214) error will be raised. However, note that this descends from both *GPIOZeroError* (page 211) (indirectly) and from `ValueError`[936] so you can still do the obvious:

```
from gpiozero import *

led = PWMLED(17)
try:
    led.value = 2
except ValueError:
    print('Bad value specified')
```

23.1 Errors

exception gpiozero.**GPIOZeroError**

Bases: `Exception`[937]

Base class for all exceptions in GPIO Zero

[935] https://docs.python.org/3.5/library/exceptions.html#ValueError
[936] https://docs.python.org/3.5/library/exceptions.html#ValueError
[937] https://docs.python.org/3.5/library/exceptions.html#Exception

exception gpiozero.**DeviceClosed**
Bases: `gpiozero.exc.GPIOZeroError`

Error raised when an operation is attempted on a closed device

exception gpiozero.**BadEventHandler**
Bases: `gpiozero.exc.GPIOZeroError`, `ValueError`[938]

Error raised when an event handler with an incompatible prototype is specified

exception gpiozero.**BadWaitTime**
Bases: `gpiozero.exc.GPIOZeroError`, `ValueError`[939]

Error raised when an invalid wait time is specified

exception gpiozero.**BadQueueLen**
Bases: `gpiozero.exc.GPIOZeroError`, `ValueError`[940]

Error raised when non-positive queue length is specified

exception gpiozero.**BadPinFactory**
Bases: `gpiozero.exc.GPIOZeroError`, `ImportError`[941]

Error raised when an unknown pin factory name is specified

exception gpiozero.**ZombieThread**
Bases: `gpiozero.exc.GPIOZeroError`, `RuntimeError`[942]

Error raised when a thread fails to die within a given timeout

exception gpiozero.**CompositeDeviceError**
Bases: `gpiozero.exc.GPIOZeroError`

Base class for errors specific to the CompositeDevice hierarchy

exception gpiozero.**CompositeDeviceBadName**
Bases: `gpiozero.exc.CompositeDeviceError`, `ValueError`[943]

Error raised when a composite device is constructed with a reserved name

exception gpiozero.**CompositeDeviceBadOrder**
Bases: `gpiozero.exc.CompositeDeviceError`, `ValueError`[944]

Error raised when a composite device is constructed with an incomplete order

exception gpiozero.**CompositeDeviceBadDevice**
Bases: `gpiozero.exc.CompositeDeviceError`, `ValueError`[945]

Error raised when a composite device is constructed with an object that doesn't inherit from *`Device`* (page 175)

exception gpiozero.**EnergenieSocketMissing**
Bases: `gpiozero.exc.CompositeDeviceError`, `ValueError`[946]

Error raised when socket number is not specified

exception gpiozero.**EnergenieBadSocket**
Bases: `gpiozero.exc.CompositeDeviceError`, `ValueError`[947]

Error raised when an invalid socket number is passed to *`Energenie`* (page 159)

[938] https://docs.python.org/3.5/library/exceptions.html#ValueError
[939] https://docs.python.org/3.5/library/exceptions.html#ValueError
[940] https://docs.python.org/3.5/library/exceptions.html#ValueError
[941] https://docs.python.org/3.5/library/exceptions.html#ImportError
[942] https://docs.python.org/3.5/library/exceptions.html#RuntimeError
[943] https://docs.python.org/3.5/library/exceptions.html#ValueError
[944] https://docs.python.org/3.5/library/exceptions.html#ValueError
[945] https://docs.python.org/3.5/library/exceptions.html#ValueError
[946] https://docs.python.org/3.5/library/exceptions.html#ValueError
[947] https://docs.python.org/3.5/library/exceptions.html#ValueError

exception gpiozero.**SPIError**
Bases: `gpiozero.exc.GPIOZeroError`

Base class for errors related to the SPI implementation

exception gpiozero.**SPIBadArgs**
Bases: `gpiozero.exc.SPIError`, `ValueError`[948]

Error raised when invalid arguments are given while constructing *`SPIDevice`* (page 139)

exception gpiozero.**SPIBadChannel**
Bases: `gpiozero.exc.SPIError`, `ValueError`[949]

Error raised when an invalid channel is given to an *`AnalogInputDevice`* (page 139)

exception gpiozero.**SPIFixedClockMode**
Bases: `gpiozero.exc.SPIError`, `AttributeError`[950]

Error raised when the SPI clock mode cannot be changed

exception gpiozero.**SPIInvalidClockMode**
Bases: `gpiozero.exc.SPIError`, `ValueError`[951]

Error raised when an invalid clock mode is given to an SPI implementation

exception gpiozero.**SPIFixedBitOrder**
Bases: `gpiozero.exc.SPIError`, `AttributeError`[952]

Error raised when the SPI bit-endianness cannot be changed

exception gpiozero.**SPIFixedSelect**
Bases: `gpiozero.exc.SPIError`, `AttributeError`[953]

Error raised when the SPI select polarity cannot be changed

exception gpiozero.**SPIFixedWordSize**
Bases: `gpiozero.exc.SPIError`, `AttributeError`[954]

Error raised when the number of bits per word cannot be changed

exception gpiozero.**SPIInvalidWordSize**
Bases: `gpiozero.exc.SPIError`, `ValueError`[955]

Error raised when an invalid (out of range) number of bits per word is specified

exception gpiozero.**GPIODeviceError**
Bases: `gpiozero.exc.GPIOZeroError`

Base class for errors specific to the GPIODevice hierarchy

exception gpiozero.**GPIODeviceClosed**
Bases: `gpiozero.exc.GPIODeviceError`, `gpiozero.exc.DeviceClosed`

Deprecated descendent of *`DeviceClosed`* (page 211)

exception gpiozero.**GPIOPinInUse**
Bases: `gpiozero.exc.GPIODeviceError`

Error raised when attempting to use a pin already in use by another device

exception gpiozero.**GPIOPinMissing**
Bases: `gpiozero.exc.GPIODeviceError`, `ValueError`[956]

[948] https://docs.python.org/3.5/library/exceptions.html#ValueError
[949] https://docs.python.org/3.5/library/exceptions.html#ValueError
[950] https://docs.python.org/3.5/library/exceptions.html#AttributeError
[951] https://docs.python.org/3.5/library/exceptions.html#ValueError
[952] https://docs.python.org/3.5/library/exceptions.html#AttributeError
[953] https://docs.python.org/3.5/library/exceptions.html#AttributeError
[954] https://docs.python.org/3.5/library/exceptions.html#AttributeError
[955] https://docs.python.org/3.5/library/exceptions.html#ValueError
[956] https://docs.python.org/3.5/library/exceptions.html#ValueError

Error raised when a pin specification is not given

exception gpiozero.**InputDeviceError**
Bases: `gpiozero.exc.GPIODeviceError`

Base class for errors specific to the InputDevice hierarchy

exception gpiozero.**OutputDeviceError**
Bases: `gpiozero.exc.GPIODeviceError`

Base class for errors specified to the OutputDevice hierarchy

exception gpiozero.**OutputDeviceBadValue**
Bases: `gpiozero.exc.OutputDeviceError`, `ValueError`[957]

Error raised when `value` is set to an invalid value

exception gpiozero.**PinError**
Bases: `gpiozero.exc.GPIOZeroError`

Base class for errors related to pin implementations

exception gpiozero.**PinInvalidFunction**
Bases: `gpiozero.exc.PinError`, `ValueError`[958]

Error raised when attempting to change the function of a pin to an invalid value

exception gpiozero.**PinInvalidState**
Bases: `gpiozero.exc.PinError`, `ValueError`[959]

Error raised when attempting to assign an invalid state to a pin

exception gpiozero.**PinInvalidPull**
Bases: `gpiozero.exc.PinError`, `ValueError`[960]

Error raised when attempting to assign an invalid pull-up to a pin

exception gpiozero.**PinInvalidEdges**
Bases: `gpiozero.exc.PinError`, `ValueError`[961]

Error raised when attempting to assign an invalid edge detection to a pin

exception gpiozero.**PinInvalidBounce**
Bases: `gpiozero.exc.PinError`, `ValueError`[962]

Error raised when attempting to assign an invalid bounce time to a pin

exception gpiozero.**PinSetInput**
Bases: `gpiozero.exc.PinError`, `AttributeError`[963]

Error raised when attempting to set a read-only pin

exception gpiozero.**PinFixedPull**
Bases: `gpiozero.exc.PinError`, `AttributeError`[964]

Error raised when attempting to set the pull of a pin with fixed pull-up

exception gpiozero.**PinEdgeDetectUnsupported**
Bases: `gpiozero.exc.PinError`, `AttributeError`[965]

Error raised when attempting to use edge detection on unsupported pins

[957] https://docs.python.org/3.5/library/exceptions.html#ValueError
[958] https://docs.python.org/3.5/library/exceptions.html#ValueError
[959] https://docs.python.org/3.5/library/exceptions.html#ValueError
[960] https://docs.python.org/3.5/library/exceptions.html#ValueError
[961] https://docs.python.org/3.5/library/exceptions.html#ValueError
[962] https://docs.python.org/3.5/library/exceptions.html#ValueError
[963] https://docs.python.org/3.5/library/exceptions.html#AttributeError
[964] https://docs.python.org/3.5/library/exceptions.html#AttributeError
[965] https://docs.python.org/3.5/library/exceptions.html#AttributeError

exception gpiozero.**PinUnsupported**
Bases: gpiozero.exc.PinError, NotImplementedError[966]

Error raised when attempting to obtain a pin interface on unsupported pins

exception gpiozero.**PinSPIUnsupported**
Bases: gpiozero.exc.PinError, NotImplementedError[967]

Error raised when attempting to obtain an SPI interface on unsupported pins

exception gpiozero.**PinPWMError**
Bases: gpiozero.exc.PinError

Base class for errors related to PWM implementations

exception gpiozero.**PinPWMUnsupported**
Bases: gpiozero.exc.PinPWMError, AttributeError[968]

Error raised when attempting to activate PWM on unsupported pins

exception gpiozero.**PinPWMFixedValue**
Bases: gpiozero.exc.PinPWMError, AttributeError[969]

Error raised when attempting to initialize PWM on an input pin

exception gpiozero.**PinUnknownPi**
Bases: gpiozero.exc.PinError, RuntimeError[970]

Error raised when gpiozero doesn't recognize a revision of the Pi

exception gpiozero.**PinMultiplePins**
Bases: gpiozero.exc.PinError, RuntimeError[971]

Error raised when multiple pins support the requested function

exception gpiozero.**PinNoPins**
Bases: gpiozero.exc.PinError, RuntimeError[972]

Error raised when no pins support the requested function

exception gpiozero.**PinInvalidPin**
Bases: gpiozero.exc.PinError, ValueError[973]

Error raised when an invalid pin specification is provided

23.2 Warnings

exception gpiozero.**GPIOZeroWarning**
Bases: Warning[974]

Base class for all warnings in GPIO Zero

exception gpiozero.**DistanceSensorNoEcho**
Bases: gpiozero.exc.GPIOZeroWarning

Warning raised when the distance sensor sees no echo at all

[966] https://docs.python.org/3.5/library/exceptions.html#NotImplementedError
[967] https://docs.python.org/3.5/library/exceptions.html#NotImplementedError
[968] https://docs.python.org/3.5/library/exceptions.html#AttributeError
[969] https://docs.python.org/3.5/library/exceptions.html#AttributeError
[970] https://docs.python.org/3.5/library/exceptions.html#RuntimeError
[971] https://docs.python.org/3.5/library/exceptions.html#RuntimeError
[972] https://docs.python.org/3.5/library/exceptions.html#RuntimeError
[973] https://docs.python.org/3.5/library/exceptions.html#ValueError
[974] https://docs.python.org/3.5/library/exceptions.html#Warning

exception gpiozero.**SPIWarning**
Bases: `gpiozero.exc.GPIOZeroWarning`

Base class for warnings related to the SPI implementation

exception gpiozero.**SPISoftwareFallback**
Bases: `gpiozero.exc.SPIWarning`

Warning raised when falling back to the software implementation

exception gpiozero.**PinWarning**
Bases: `gpiozero.exc.GPIOZeroWarning`

Base class for warnings related to pin implementations

exception gpiozero.**PinFactoryFallback**
Bases: `gpiozero.exc.PinWarning`

Warning raised when a default pin factory fails to load and a fallback is tried

exception gpiozero.**PinNonPhysical**
Bases: `gpiozero.exc.PinWarning`

Warning raised when a non-physical pin is specified in a constructor

exception gpiozero.**ThresholdOutOfRange**
Bases: `gpiozero.exc.GPIOZeroWarning`

Warning raised when a threshold is out of range specified by min and max values

exception gpiozero.**CallbackSetToNone**
Bases: `gpiozero.exc.GPIOZeroWarning`

Warning raised when a callback is set to None when its previous value was None

CHAPTER 24

Changelog

24.1 Release 1.5.0 (2019-02-12)

- Introduced pin event timing to increase accuracy of certain devices such as the HC-SR04 `DistanceSensor` (page 101). (#664[975], #665[976])
- Further improvements to `DistanceSensor` (page 101) (ignoring missed edges). (#719[977])
- Allow `source` to take a device object as well as `values` or other `values`. See *Source/Values* (page 59). (#640[978])
- Added internal device classes `LoadAverage` (page 170) and `DiskUsage` (page 171) (thanks to Jeevan M R for the latter). (#532[979], #714[980])
- Added support for colorzero[981] with `RGBLED` (page 115) (this adds a new dependency). (#655[982])
- Added `TonalBuzzer` (page 119) with `Tone` (page 187) API for specifying frequencies raw or via MIDI or musical notes. (#681[983], #717[984])
- Added `PiHutXmasTree` (page 149). (#502[985])
- Added `PumpkinPi` (page 162) and `JamHat` (page 154) (thanks to Claire Pollard). (#680[986], #681[987], #717[988])
- Ensured gpiozero can be imported without a valid pin factory set. (#591[989], #713[990])

[975] https://github.com/RPi-Distro/python-gpiozero/issues/664
[976] https://github.com/RPi-Distro/python-gpiozero/issues/665
[977] https://github.com/RPi-Distro/python-gpiozero/issues/719
[978] https://github.com/RPi-Distro/python-gpiozero/issues/640
[979] https://github.com/RPi-Distro/python-gpiozero/issues/532
[980] https://github.com/RPi-Distro/python-gpiozero/issues/714
[981] https://colorzero.readthedocs.io/en/stable
[982] https://github.com/RPi-Distro/python-gpiozero/issues/655
[983] https://github.com/RPi-Distro/python-gpiozero/issues/681
[984] https://github.com/RPi-Distro/python-gpiozero/issues/717
[985] https://github.com/RPi-Distro/python-gpiozero/issues/502
[986] https://github.com/RPi-Distro/python-gpiozero/issues/680
[987] https://github.com/RPi-Distro/python-gpiozero/issues/681
[988] https://github.com/RPi-Distro/python-gpiozero/issues/717
[989] https://github.com/RPi-Distro/python-gpiozero/issues/591
[990] https://github.com/RPi-Distro/python-gpiozero/issues/713

- Reduced import time by not computing default pin factory at the point of import. (#675[991], #722[992])
- Added support for various pin numbering mechanisms. (#470[993])
- `Motor` (page 120) instances now use `DigitalOutputDevice` (page 127) for non-PWM pins.
- Allow non-PWM use of `Robot` (page 155). (#481[994])
- Added optional `enable` init param to `Motor` (page 120). (#366[995])
- Added `--xyz` option to **`pinout`** command line tool to open pinout.xyz[996] in a web browser. (#604[997])
- Added 3B+, 3A+ and CM3+ to Pi model data. (#627[998], #704[999])
- Minor improvements to `Energenie` (page 159), thanks to Steve Amor. (#629[1000], #634[1001])
- Allow `SmoothedInputDevice` (page 105), `LightSensor` (page 99) and `MotionSensor` (page 97) to have pull-up configured. (#652[1002])
- Allow input devices to be pulled up or down externally, thanks to Philippe Muller. (#593[1003], #658[1004])
- Minor changes to support Python 3.7, thanks to Russel Winder and Rick Ansell. (#666[1005], #668[1006], #669[1007], #671[1008], #673[1009])
- Added `zip_values()` (page 184) source tool.
- Correct row/col numbering logic in `PinInfo` (page 193). (#674[1010])
- Many additional tests, and other improvements to the test suite.
- Many documentation corrections, additions and clarifications.
- Automatic documentation class hierarchy diagram generation.
- Automatic copyright attribution in source files.

24.2 Release 1.4.1 (2018-02-20)

This release is mostly bug-fixes, but a few enhancements have made it in too:

- Added `curve_left` and `curve_right` parameters to `Robot.forward()` (page 156) and `Robot.backward()` (page 155). (#306[1011] and #619[1012])

[991] https://github.com/RPi-Distro/python-gpiozero/issues/675
[992] https://github.com/RPi-Distro/python-gpiozero/issues/722
[993] https://github.com/RPi-Distro/python-gpiozero/issues/470
[994] https://github.com/RPi-Distro/python-gpiozero/issues/481
[995] https://github.com/RPi-Distro/python-gpiozero/issues/366
[996] https://pinout.xyz
[997] https://github.com/RPi-Distro/python-gpiozero/issues/604
[998] https://github.com/RPi-Distro/python-gpiozero/issues/627
[999] https://github.com/RPi-Distro/python-gpiozero/issues/704
[1000] https://github.com/RPi-Distro/python-gpiozero/issues/629
[1001] https://github.com/RPi-Distro/python-gpiozero/issues/634
[1002] https://github.com/RPi-Distro/python-gpiozero/issues/652
[1003] https://github.com/RPi-Distro/python-gpiozero/issues/593
[1004] https://github.com/RPi-Distro/python-gpiozero/issues/658
[1005] https://github.com/RPi-Distro/python-gpiozero/issues/666
[1006] https://github.com/RPi-Distro/python-gpiozero/issues/668
[1007] https://github.com/RPi-Distro/python-gpiozero/issues/669
[1008] https://github.com/RPi-Distro/python-gpiozero/issues/671
[1009] https://github.com/RPi-Distro/python-gpiozero/issues/673
[1010] https://github.com/RPi-Distro/python-gpiozero/issues/674
[1011] https://github.com/RPi-Distro/python-gpiozero/issues/306
[1012] https://github.com/RPi-Distro/python-gpiozero/issues/619

- Fixed `DistanceSensor` (page 101) returning incorrect readings after a long pause, and added a lock to ensure multiple distance sensors can operate simultaneously in a single project. (#584[1013], #595[1014], #617[1015], #618[1016])
- Added support for phase/enable motor drivers with `PhaseEnableMotor` (page 122), `PhaseEnableRobot` (page 156), and descendants, thanks to Ian Harcombe! (#386[1017])
- A variety of other minor enhancements, largely thanks to Andrew Scheller! (#479[1018], #489[1019], #491[1020], #492[1021])

24.3 Release 1.4.0 (2017-07-26)

- Pin factory is now *configurable from device constructors* (page 196) as well as command line. NOTE: this is a backwards incompatible change for manual pin construction but it's hoped this is (currently) a sufficiently rare use case that this won't affect too many people and the benefits of the new system warrant such a change, i.e. the ability to use remote pin factories with HAT classes that don't accept pin assignations (#279[1022])
- Major work on SPI, primarily to support remote hardware SPI (#421[1023], #459[1024], #465[1025], #468[1026], #575[1027])
- Pin reservation now works properly between GPIO and SPI devices (#459[1028], #468[1029])
- Lots of work on the documentation: *source/values chapter* (page 59), better charts, more recipes, *remote GPIO configuration* (page 43), mock pins, better PDF output (#484[1030], #469[1031], #523[1032], #520[1033], #434[1034], #565[1035], #576[1036])
- Support for `StatusZero` (page 160) and `StatusBoard` (page 160) HATs (#558[1037])
- Added **`pinout`** command line tool to provide a simple reference to the GPIO layout and information about the associated Pi (#497[1038], #504[1039]) thanks to Stewart Adcock for the initial work
- `pi_info()` (page 189) made more lenient for new (unknown) Pi models (#529[1040])
- Fixed a variety of packaging issues (#535[1041], #518[1042], #519[1043])

[1013] https://github.com/RPi-Distro/python-gpiozero/issues/584
[1014] https://github.com/RPi-Distro/python-gpiozero/issues/595
[1015] https://github.com/RPi-Distro/python-gpiozero/issues/617
[1016] https://github.com/RPi-Distro/python-gpiozero/issues/618
[1017] https://github.com/RPi-Distro/python-gpiozero/issues/386
[1018] https://github.com/RPi-Distro/python-gpiozero/issues/479
[1019] https://github.com/RPi-Distro/python-gpiozero/issues/489
[1020] https://github.com/RPi-Distro/python-gpiozero/issues/491
[1021] https://github.com/RPi-Distro/python-gpiozero/issues/492
[1022] https://github.com/RPi-Distro/python-gpiozero/issues/279
[1023] https://github.com/RPi-Distro/python-gpiozero/issues/421
[1024] https://github.com/RPi-Distro/python-gpiozero/issues/459
[1025] https://github.com/RPi-Distro/python-gpiozero/issues/465
[1026] https://github.com/RPi-Distro/python-gpiozero/issues/468
[1027] https://github.com/RPi-Distro/python-gpiozero/issues/575
[1028] https://github.com/RPi-Distro/python-gpiozero/issues/459
[1029] https://github.com/RPi-Distro/python-gpiozero/issues/468
[1030] https://github.com/RPi-Distro/python-gpiozero/issues/484
[1031] https://github.com/RPi-Distro/python-gpiozero/issues/469
[1032] https://github.com/RPi-Distro/python-gpiozero/issues/523
[1033] https://github.com/RPi-Distro/python-gpiozero/issues/520
[1034] https://github.com/RPi-Distro/python-gpiozero/issues/434
[1035] https://github.com/RPi-Distro/python-gpiozero/issues/565
[1036] https://github.com/RPi-Distro/python-gpiozero/issues/576
[1037] https://github.com/RPi-Distro/python-gpiozero/issues/558
[1038] https://github.com/RPi-Distro/python-gpiozero/issues/497
[1039] https://github.com/RPi-Distro/python-gpiozero/issues/504
[1040] https://github.com/RPi-Distro/python-gpiozero/issues/529
[1041] https://github.com/RPi-Distro/python-gpiozero/issues/535
[1042] https://github.com/RPi-Distro/python-gpiozero/issues/518
[1043] https://github.com/RPi-Distro/python-gpiozero/issues/519

- Improved text in factory fallback warnings (#572[1044])

24.4 Release 1.3.2 (2017-03-03)

- Added new Pi models to stop `pi_info()` (page 189) breaking
- Fix issue with `pi_info()` (page 189) breaking on unknown Pi models

24.5 Release 1.3.1 (2016-08-31 . . . later)

- Fixed hardware SPI support which Dave broke in 1.3.0. Sorry!
- Some minor docs changes

24.6 Release 1.3.0 (2016-08-31)

- Added `ButtonBoard` (page 145) for reading multiple buttons in a single class (#340[1045])
- Added `Servo` (page 123) and `AngularServo` (page 124) classes for controlling simple servo motors (#248[1046])
- Lots of work on supporting easier use of internal and third-party pin implementations (#359[1047])
- `Robot` (page 155) now has a proper `value` (page 156) attribute (#305[1048])
- Added `CPUTemperature` (page 169) as another demo of "internal" devices (#294[1049])
- A temporary work-around for an issue with `DistanceSensor` (page 101) was included but a full fix is in the works (#385[1050])
- More work on the documentation (#320[1051], #295[1052], #289[1053], etc.)

Not quite as much as we'd hoped to get done this time, but we're rushing to make a Raspbian freeze. As always, thanks to the community - your suggestions and PRs have been brilliant and even if we don't take stuff exactly as is, it's always great to see your ideas. Onto 1.4!

24.7 Release 1.2.0 (2016-04-10)

- Added `Energenie` (page 159) class for controlling Energenie plugs (#69[1054])
- Added `LineSensor` (page 96) class for single line-sensors (#109[1055])
- Added `DistanceSensor` (page 101) class for HC-SR04 ultra-sonic sensors (#114[1056])
- Added `SnowPi` (page 161) class for the Ryanteck Snow-pi board (#130[1057])

[1044] https://github.com/RPi-Distro/python-gpiozero/issues/572
[1045] https://github.com/RPi-Distro/python-gpiozero/issues/340
[1046] https://github.com/RPi-Distro/python-gpiozero/issues/248
[1047] https://github.com/RPi-Distro/python-gpiozero/issues/359
[1048] https://github.com/RPi-Distro/python-gpiozero/issues/305
[1049] https://github.com/RPi-Distro/python-gpiozero/issues/294
[1050] https://github.com/RPi-Distro/python-gpiozero/issues/385
[1051] https://github.com/RPi-Distro/python-gpiozero/issues/320
[1052] https://github.com/RPi-Distro/python-gpiozero/issues/295
[1053] https://github.com/RPi-Distro/python-gpiozero/issues/289
[1054] https://github.com/RPi-Distro/python-gpiozero/issues/69
[1055] https://github.com/RPi-Distro/python-gpiozero/issues/109
[1056] https://github.com/RPi-Distro/python-gpiozero/issues/114
[1057] https://github.com/RPi-Distro/python-gpiozero/issues/130

- Added `when_held` (page 95) (and related properties) to `Button` (page 93) (#115[1058])
- Fixed issues with installing GPIO Zero for python 3 on Raspbian Wheezy releases (#140[1059])
- Added support for lots of ADC chips (MCP3xxx family) (#162[1060]) - many thanks to pcopa and lurch!
- Added support for pigpiod as a pin implementation with `PiGPIOPin` (page 208) (#180[1061])
- Many refinements to the base classes mean more consistency in composite devices and several bugs squashed (#164[1062], #175[1063], #182[1064], #189[1065], #193[1066], #229[1067])
- GPIO Zero is now aware of what sort of Pi it's running on via `pi_info()` (page 189) and has a fairly extensive database of Pi information which it uses to determine when users request impossible things (like pull-down on a pin with a physical pull-up resistor) (#222[1068])
- The source/values system was enhanced to ensure normal usage doesn't stress the CPU and lots of utilities were added (#181[1069], #251[1070])

And I'll just add a note of thanks to the many people in the community who contributed to this release: we've had some great PRs, suggestions, and bug reports in this version. Of particular note:

- Schelto van Doorn was instrumental in adding support for numerous ADC chips
- Alex Eames generously donated a RasPiO Analog board which was extremely useful in developing the software SPI interface (and testing the ADC support)
- Andrew Scheller squashed several dozen bugs (usually a day or so after Dave had introduced them ;)

As always, many thanks to the whole community - we look forward to hearing from you more in 1.3!

24.8 Release 1.1.0 (2016-02-08)

- Documentation converted to reST and expanded to include generic classes and several more recipes (#80[1071], #82[1072], #101[1073], #119[1074], #135[1075], #168[1076])
- New `CamJamKitRobot` (page 158) class with the pre-defined motor pins for the new CamJam EduKit
- New `LEDBarGraph` (page 144) class (many thanks to Martin O'Hanlon!) (#126[1077], #176[1078])
- New `Pin` (page 199) implementation abstracts out the concept of a GPIO pin paving the way for alternate library support and IO extenders in future (#141[1079])
- New `LEDBoard.blink()` (page 142) method which works properly even when background is set to `False` (#94[1080], #161[1081])

[1058] https://github.com/RPi-Distro/python-gpiozero/issues/115
[1059] https://github.com/RPi-Distro/python-gpiozero/issues/140
[1060] https://github.com/RPi-Distro/python-gpiozero/issues/162
[1061] https://github.com/RPi-Distro/python-gpiozero/issues/180
[1062] https://github.com/RPi-Distro/python-gpiozero/issues/164
[1063] https://github.com/RPi-Distro/python-gpiozero/issues/175
[1064] https://github.com/RPi-Distro/python-gpiozero/issues/182
[1065] https://github.com/RPi-Distro/python-gpiozero/issues/189
[1066] https://github.com/RPi-Distro/python-gpiozero/issues/193
[1067] https://github.com/RPi-Distro/python-gpiozero/issues/229
[1068] https://github.com/RPi-Distro/python-gpiozero/issues/222
[1069] https://github.com/RPi-Distro/python-gpiozero/issues/181
[1070] https://github.com/RPi-Distro/python-gpiozero/issues/251
[1071] https://github.com/RPi-Distro/python-gpiozero/issues/80
[1072] https://github.com/RPi-Distro/python-gpiozero/issues/82
[1073] https://github.com/RPi-Distro/python-gpiozero/issues/101
[1074] https://github.com/RPi-Distro/python-gpiozero/issues/119
[1075] https://github.com/RPi-Distro/python-gpiozero/issues/135
[1076] https://github.com/RPi-Distro/python-gpiozero/issues/168
[1077] https://github.com/RPi-Distro/python-gpiozero/issues/126
[1078] https://github.com/RPi-Distro/python-gpiozero/issues/176
[1079] https://github.com/RPi-Distro/python-gpiozero/issues/141
[1080] https://github.com/RPi-Distro/python-gpiozero/issues/94
[1081] https://github.com/RPi-Distro/python-gpiozero/issues/161

- New `RGBLED.blink()` (page 116) method which implements (rudimentary) color fading too! (#135[1082], #174[1083])
- New `initial_value` attribute on `OutputDevice` (page 129) ensures consistent behaviour on construction (#118[1084])
- New `active_high` attribute on `PWMOutputDevice` (page 128) and `RGBLED` (page 115) allows use of common anode devices (#143[1085], #154[1086])
- Loads of new ADC chips supported (many thanks to GitHub user pcopa!) (#150[1087])

24.9 Release 1.0.0 (2015-11-16)

- Debian packaging added (#44[1088])
- `PWMLED` (page 113) class added (#58[1089])
- `TemperatureSensor` removed pending further work (#93[1090])
- `Buzzer.beep()` (page 118) alias method added (#75[1091])
- `Motor` (page 120) PWM devices exposed, and `Robot` (page 155) motor devices exposed (#107[1092])

24.10 Release 0.9.0 (2015-10-25)

Fourth public beta

- Added source and values properties to all relevant classes (#76[1093])
- Fix names of parameters in `Motor` (page 120) constructor (#79[1094])
- Added wrappers for LED groups on add-on boards (#81[1095])

24.11 Release 0.8.0 (2015-10-16)

Third public beta

- Added generic `AnalogInputDevice` (page 139) class along with specific classes for the `MCP3008` (page 135) and `MCP3004` (page 135) (#41[1096])
- Fixed `DigitalOutputDevice.blink()` (page 127) (#57[1097])

[1082] https://github.com/RPi-Distro/python-gpiozero/issues/135
[1083] https://github.com/RPi-Distro/python-gpiozero/issues/174
[1084] https://github.com/RPi-Distro/python-gpiozero/issues/118
[1085] https://github.com/RPi-Distro/python-gpiozero/issues/143
[1086] https://github.com/RPi-Distro/python-gpiozero/issues/154
[1087] https://github.com/RPi-Distro/python-gpiozero/issues/150
[1088] https://github.com/RPi-Distro/python-gpiozero/issues/44
[1089] https://github.com/RPi-Distro/python-gpiozero/issues/58
[1090] https://github.com/RPi-Distro/python-gpiozero/issues/93
[1091] https://github.com/RPi-Distro/python-gpiozero/issues/75
[1092] https://github.com/RPi-Distro/python-gpiozero/issues/107
[1093] https://github.com/RPi-Distro/python-gpiozero/issues/76
[1094] https://github.com/RPi-Distro/python-gpiozero/issues/79
[1095] https://github.com/RPi-Distro/python-gpiozero/issues/81
[1096] https://github.com/RPi-Distro/python-gpiozero/issues/41
[1097] https://github.com/RPi-Distro/python-gpiozero/issues/57

24.12 Release 0.7.0 (2015-10-09)

Second public beta

24.13 Release 0.6.0 (2015-09-28)

First public beta

24.14 Release 0.5.0 (2015-09-24)

24.15 Release 0.4.0 (2015-09-23)

24.16 Release 0.3.0 (2015-09-22)

24.17 Release 0.2.0 (2015-09-21)

Initial release

CHAPTER 25

License

Python Module Index

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