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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 35) 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 71) page.

\(^1\) https://www.raspberrypi.org/downloads/raspbian/
\(^3\) https://www.raspberrypi.org/downloads/
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 35) 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 73) interface from GPIO Zero, it should be explicitly imported:

```python
from gpiozero import Button
```

Now `Button` (page 73) is available directly in your script:

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

Alternatively, the whole GPIO Zero library can be imported:

```python
import gpiozero
```

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

```python
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.

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
### GPIO Pinouts

#### 3V3 Power
- GPIO2: SDA I²C
- GPIO3: SCL I²C
- GPIO4: Ground
- GPIO17, GPIO27, GPIO22: 3V3 Power

#### 5V Power
- GPIO10: SPI MOSI
- GPIO9: SPI MISO
- GPIO11: SPI SCLK
- Ground
- GPIO14: UART0 TXD
- GPIO15: UART0 RXD

#### 3V3 Power (40-pin models only)
- GPIO10: SPI MOSI
- GPIO9: SPI MISO
- GPIO11: SPI SCLK
- Ground
- GPIO14: UART0 TXD
- GPIO15: UART0 RXD

#### USB Ports
- Ground

---

#### Diagram

[Diagram showing GPIO pinouts with 3V3 and 5V power, and various ground connections.]
2.3 LED

Turn an LED (page 87) on and off repeatedly:

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

red = LED(17)

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

Alternatively:

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

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()`\(^6\). See *How do I keep my script running?* (page 65) 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 88) using values between 0 and 1:

\(^6\) https://docs.python.org/3.5/library/signal.html#signal.pause
```python
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):

```python
from gpiozero import PWMLED
from signal import pause

led = PWMLED(17)

led.pulse()
pause()
```

### 2.5 Button

Check if a `Button` (page 73) is pressed:

```python
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:

```python
from gpiozero import Button

button = Button(2)

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

Run a function every time the button is pressed:

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

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 (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()
```
2.6 Button controlled LED

Turn on an LED (page 87) when a Button (page 73) is pressed:

```python
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:

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

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

led.source = button.values

pause()
```

2.7 Button controlled camera

Using the button press to trigger PiCamera\(^7\) to take a picture using `button.when_pressed = camera.capture()` would not work because the `camera.capture()`\(^8\) method requires an output parameter. However, this can be achieved using a custom function which requires no parameters:

\(^7\) https://picamera.readthedocs.io/en/latest/api_camera.html#picamera.PiCamera
\(^8\) https://picamera.readthedocs.io/en/latest/api_camera.html#picamera.PiCamera.capture
from gpiozero import Button
from picamera import PiCamera
from datetime import datetime
from signal import pause

button = Button(2)
camera = PiCamera()

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

button.when_pressed = capture
pause()

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

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

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 73) 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:

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 113):
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 113) with pwm=True allows each LED’s brightness to be controlled:

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 113) examples in the advanced LEDBoard recipes (page 27).

2.10 LEDBarGraph

A collection of LEDs can be treated like a bar graph using LEDBarGraph (page 116):

from gpiozero import LEDBarGraph
from time import sleep

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)
graph.value = 9/10  # (1, 1, 1, 1, 0.5)
sleep(1)
graph.value = 95/100 # (1, 1, 1, 1, 0.75)
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 116) with pwm=True allows more precise values using LED brightness:

from gpiozero import LEDBarGraph
from time import sleep

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

graph.value = 1/10  # (0.5, 0, 0, 0, 0)

(continues on next page)
A full traffic lights system.

Using a TrafficLights (page 120) kit like Pi-Stop:

```python
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)
```

(continues on next page)
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 87) 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:
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!")

See Push Button Stop Motion⁹ 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
from picamera import PiCamera

button = Button(2)
camera = PiCamera()
camera.start_preview()
frame = 1
while True:
    button.wait_for_press()
camera.capture('/home/pi/frame%d.jpg' % frame)
    frame += 1


break
if player_2.is_pressed:
    print("Player 2 wins!")
break

led.off()

See Quick Reaction Game\(^{10}\) for a full resource.

## 2.14 GPIO Music Box

Each button plays a different sound!

```python
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\(^{11}\) for a full resource.

## 2.15 All on when pressed

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

**FishDish** (page 134):

```python
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 135):

```python
from gpiozero import TrafficHat
from signal import pause

th = TrafficHat()
```

---

\(^{10}\) https://www.raspberrypi.org/learning/quick-reaction-game/

Using `LED` (page 87), `Buzzer` (page 92), and `Button` (page 73) components:

```python
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 90):
from gpiozero import RGBLED
from time import sleep

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 87) when a MotionSensor (page 76) detects motion:

```python
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

![Diagram of light sensor setup](image)

Have a LightSensor (page 78) detect light and dark:

```python
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:

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

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

sensor.when_dark = led.on

```

(continues on next page)
sensor.when_light = led.off
pause()

Or make a **PWMLED** (page 88) change brightness according to the detected light level:

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

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

led.source = sensor.values
pause()
```

## 2.19 Distance sensor

![Distance sensor image](image_url)

**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 sensor’s diagram obscuring most of the breadboard!)

Have a **DistanceSensor** (page 79) 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 93) 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 136) drive around in (roughly) a square:

```python
from gpiozero import Robot
from time import sleep

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

(continues on next page)```
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:

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

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:

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

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

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()
```

### 2.23 Keyboard controlled robot

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

```python
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)
        if next_key is None:
            key = window.getch()
        else:
            key = next_key
            next_key = None
        if key != -1:
            # KEY DOWN
            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 UP
            robot.stop()

curses.wrapper(main)

Note: This recipe uses the standard curses 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:

```python
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.issubset(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 down
            keypress_actions[event.code]()
        if event.value == 0:  # key up
            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:

```python
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:

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

robot = Robot(left=(4, 14), right=(17, 18))
pir = MotionSensor(5)
robot.source = zip(pir.values, pir.values)
pause()
```
2.25 Potentiometer

Continually print the value of a potentiometer (values between 0 and 1) connected to a MCP3008 (page 107) 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.values
pause()
```

2.26 Measure temperature with an ADC

Wire a TMP36 temperature sensor to the first channel of an MCP3008 (page 107) analog to digital converter:

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

(continues on next page)
def convert_temp(gen):
    for value in gen:
        yield (value * 3.3 - 0.5) * 100

ad = 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 162) property rather than a while loop:

from gpiozero import RGBLED, MCP3008
from signal import pause
led = RGBLED(2, 3, 4)
red_pot = MCP3008(0)
green_pot = MCP3008(1)
blue_pot = MCP3008(2)

led.source = zip(red_pot.values, green_pot.values, blue_pot.values)
pause()

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

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 to remotely control the lamp, and the TimeOfDay (page 155) 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.values
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 156) 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.values
green.source_delay = 60
red.source = negated(green.values)
pause()

2.30 CPU Temperature Bar Graph

You can read the Raspberry Pi’s own CPU temperature using the built-in CPUPortemperature (page 156) class, and display this on a “bar graph” of LEDs:

from gpiozero import LEDBarGraph, CPUPortemperature
from signal import pause

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

leds.source = cpu.values
pause()

2.31 More recipes

Continue to:

• Advanced Recipes (page 27)
• Remote GPIO Recipes (page 43)
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 113) object one-by-one:

```python
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 113) also supports indexing. This means you can access the individual LED (page 87) objects using `leds[i]` where `i` is an integer from 0 up to (not including) the number of LEDs:

```python
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:

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

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

leds[2:3].on()  # slice of 3rd and 4th LEDs on
sleep(1)
leds[-3:].off()  # last 3 LEDs off
sleep(1)
```
```python
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` objects can have their `LED` objects named upon construction. This means the individual LEDs can be accessed by their name:

```python
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` objects can also be nested within other `LEDBoard` objects:

```python
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.

```python
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.values
    leds.green.source_delay = 60
    leds.red.source = negated(leds.green.values)

pause()

Alternatively, using the STATUS Zero\(^{16}\) board:

```python
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.values
    leds.green.source_delay = 60
    leds.red.source = negated(leds.green.values)

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:

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

(continues on next page)

\(^{16}\) https://thepihut.com/status
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.values)
pause()

Note this recipe requires travispy\textsuperscript{17}. 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.

```python
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):
```

\textsuperscript{17} https://travispy.readthedocs.io/
3.5 Robot controlled by 2 potentiometers

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

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

robot = Robot(left=(4, 14), right=(17, 18))
left = MCP3008(0)
right = MCP3008(1)
robot.source = zip(left.values, right.values)
pause()
```

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

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

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

robot = Robot(left=(4, 14), right=(17, 18))
left = MCP3008(0)
right = MCP3008(1)
robot.source = zip(scaled(left.values, -1, 1), scaled(right.values, -1, 1))
pause()
```

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:

```python
from bluedot import BlueDot
from gpiozero import LED

bd = BlueDot()
led = LED(17)

while True:
    bd.wait_for_press()
    led.on()
```

---

18 [https://docs.python.org/3.5/library/functions.html#zip](https://docs.python.org/3.5/library/functions.html#zip)
bd.wait_for_release()
led.off()

Note this recipe requires bluedot and the associated Android app. See the BlueDot documentation\(^\text{19}\) 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:

```python
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:

```python
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)

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

(continues on next page)
```

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:

```python
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 3B the LEDs are controlled by a GPIO expander which is not accessible from gpiozero (yet).
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 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 177) documentation page.

One of the pin libraries supported, pigpio, 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 43) 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.

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:

---

20 https://pypi.python.org/pypi/RPi.GPIO
21 http://abyz.me.uk/rpi/pigpio/python.html
22 http://abyz.me.uk/rpi/pigpio/download.html
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:
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[^23]), 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 Python library on the PC.

4.2.1 Raspberry Pi

First, update your repositories list:

```bash
$ sudo apt update
```

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

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

or Python 2:

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

Alternatively, install with pip:

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

or for Python 2:

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

4.2.2 Linux

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

```bash
$ sudo apt update
```

Then install pip for Python 3:

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

or Python 2:

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


---

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.
(Alternatively, install pip with `get-pip`.)

Next, install GPIO Zero and pigpio for Python 3:

```
$ 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`.

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. 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` 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
```

If you are running this from a PC (not a Raspberry Pi) with gpiozero and the pigpio 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`. If `RPi.GPIO` is installed, this will be selected as the default pin factory, so either uninstall it, or use another environment variable to set it to `PiGPIOFactory`:

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

This usage will set the pin factory to `PiGPIOFactory` 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:

---

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 can be used, as pigpio 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 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)

while True:
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:

```python
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:

```python
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:

```python
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

while True:
```

(continues on next page)
Note that these examples use the `LED` (page 87) 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, `Device.pin_factory`, or the `pin_factory` keyword argument:

```python
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:

```python
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) on one Pi, and use remote pins to control another over the network:

```python
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:
    piri.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:

- Remote GPIO Recipes (page 43)
• *Pi Zero USB OTG* (page 47)
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 35).

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 on one Raspberry Pi control the LED of another:

```python
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.values

pause()
```

### 5.2 LED + 2 Buttons

The LED will come on when both buttons are pressed:

```python
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')
```

(continues on next page)
led = LED(17)
button_1 = Button(17, pin_factory=factory3)
button_2 = Button(17, pin_factory=factory4)
led.source = all_values(button_1.values, button_2.values)
pause()

5.3 Multi-room motion alert

Install a Raspberry Pi with a motion sensor in each room of your house, and have an LED indicator showing when there’s motion in each room:

```python
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]
leds = LEDBoard(2, 3, 4, 5)  # leds on this pi
sensors = [MotionSensor(17, pin_factory=r) for r in remotes]  # remote sensors
for led, sensor in zip(leds, sensors):
    led.source = sensor.values

pause()
```

5.4 Multi-room doorbell

Install a Raspberry Pi with a buzzer attached in each room you want to hear the doorbell, and use a push button as the doorbell:

```python
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.values

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, 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\(^{28}\) (not supported by GPIO Zero) includes temperature, humidity and pressure sensors, but no light sensor. Remote GPIO allows an external light sensor 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.

The Raspberry Pi Zero\(^{29}\) and Pi Zero W\(^{30}\) 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 35) 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\(^{31}\) 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:

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

---

6.1.3 Ubuntu setup

1. Add the Raspberry Pi PPA to your system:

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

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

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

3. Install the required packages from the PPA:

```bash
$ 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](image)

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 (be sure to use `ping6` as it’s IPv6 only) using the address `fe80::1%` followed by the connection string. You can look this up using `ifconfig`. 

Chapter 6. Pi Zero USB OTG
Set the `GPIOZERO_PIN_FACTORY` and `PIGPIO_ADDR` 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:

Alternatively, you can set the pin factory in-line, as explained in *Configuring Remote GPIO* (page 35).

Read more on the GPIO expander in blog posts on raspberrypi.org and bennuttall.com.

### 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 and learn.adafruit.com 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.

---

33 http://bennuttall.com/raspberry-pi-zero-gpio-expander/
34 http://blog.gbaman.info/?p=791
35 https://learn.adafruit.com/turning-your-raspberry-pi-zero-into-a-usb-gadget/ethernet-gadget
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
```
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:

```python
from gpiozero import LED, Button
from signal import pause
led = LED(17)
button = Button(2)
led.source = button.values
pause()
```

which is equivalent to:

```python
from gpiozero import LED, Button
from time import sleep
led = LED(17)
button = Button(2)

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

Every device has a `value` (page 161) property (the device’s current value). Input devices can only have their values read, but output devices can also have their value set to alter the state of the device:

```python
>>> led = PWMLED(17)
>>> led.value  # LED is initially off
0.0
>>> led.on()  # LED is now on
>>> led.value
1.0
>>> led.value = 0  # LED is now off
```

Every device also has a `values` (page 162) property (a generator continuously yielding the device’s current value). All output devices have a `source` (page 162) property which can be set to any iterator. The device will iterate over the values provided, setting the device’s value to each element at a rate specified in the `source_delay`
The most common use case for this is to set the source of an output device to the values of an input device, like the example above. A more interesting example would be a potentiometer controlling the brightness of an LED:

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

led = PWMLED(17)
pot = MCP3008()

led.source = pot.values

pause()
```

It is also possible to set an output device’s `source` to the `values` of another output device, to keep them matching:

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

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

red.source = button.values
green.source = red.values

pause()
```

The device’s values can also be processed before they are passed to the `source`:

For example:
from gpiozero import Button, LED
from signal import pause

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

led = LED(4)
btn = Button(17)
led.source = opposite(btn.values)
pause()

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

For example:

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

def rand():
    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 162) is changed or set to None.

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 = [1, 0, 1, 1, 1, 0, 0, 1, 0, 1]
pause()
7.1 Composite devices

Most devices have a value range between 0 and 1. Some have a range between -1 and 1 (e.g., Motor (page 93)). The value of a composite device is a namedtuple of such values. For example, the Robot (page 136) class:

```python
>>> 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)
>>> 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
```

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 165).

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

```python
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()
```

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

```python
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()
```

Some tools take a single source and process its values:
In this example, the LED is lit only when the button is not pressed:

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

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

led.source = negated(btn.values)
pause()
```

Some tools combine the values of multiple sources:

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

```python
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.values, button_b.values)
pause()
```

---

7.2. Source 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

For further information, please refer to https://pinout.xyz/
8.1.1 Synopsis

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

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 35)) 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 60)

-m, --monochrome
  Force monochrome output. See also --color (page 60)

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:

```
,--------------------------------.
| oooooooooooooooooooooooooooo J8 +====
| loooooooooooooooooooooooooooo | USB
| | +====
| Pi Model 3B V1.1 | I
| +------+ +====
| |D| |SoC | | USB
| |S| | | +====
| |I| +------+
| |C| +-------
| | | | 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
```

(continues on next page)
J8:

<table>
<thead>
<tr>
<th>Pin</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3V3</td>
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<td>2</td>
<td>(1)</td>
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<tr>
<td>3</td>
<td>(2)</td>
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<tr>
<td>4</td>
<td>5V</td>
</tr>
<tr>
<td>5</td>
<td>GPIO2</td>
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<td>6</td>
<td>(3)</td>
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<td>7</td>
<td>(4)</td>
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<td>8</td>
<td>5V</td>
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<tr>
<td>9</td>
<td>GPIO3</td>
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<td>10</td>
<td>(5)</td>
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<td>11</td>
<td>(6)</td>
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<td>12</td>
<td>GND</td>
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<td>GPIO4</td>
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<td>GPIO14</td>
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<td>GPIO27</td>
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<td>GPIO10</td>
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<td>GPIO24</td>
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<td>(26)</td>
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<td>51</td>
<td>GPIO07</td>
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<td>(28)</td>
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<td>GPIO12</td>
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<td>56</td>
<td>GND</td>
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<td>(29)</td>
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<td>(30)</td>
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<tr>
<td>59</td>
<td>GPIO06</td>
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<td>(31)</td>
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<td>(32)</td>
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<td>62</td>
<td>GPIO10</td>
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<td>63</td>
<td>GND</td>
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<td>(33)</td>
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<td>74</td>
<td>GPIO20</td>
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<td>75</td>
<td>GND</td>
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<tr>
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<td>(39)</td>
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<td>77</td>
<td>(40)</td>
</tr>
<tr>
<td>78</td>
<td>GPIO21</td>
</tr>
</tbody>
</table>

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 60):

```
$ pinout --monochrome
```

Or forced to be `--color` (page 60), 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 60). The tool understands both old-style revision codes\(^{37}\) (such as for the model B):

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

Or new-style revision codes\(^{38}\) (such as for the Pi Zero W):

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

\(^{37}\) [http://elinux.org/RPi_HardwareHistory](http://elinux.org/RPi_HardwareHistory)

\(^{38}\) [http://elinux.org/RPi_HardwareHistory](http://elinux.org/RPi_HardwareHistory)
You can also use the tool with `Configuring Remote GPIO` (page 35) to query remote Raspberry Pi’s:

```bash
$ 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.
9.1 How do I keep my script running?

The following script looks like it should turn an LED on:

```python
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()`\footnote{https://docs.python.org/3.5/library/signal.html#signal.pause} to keep the script alive:

```python
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:

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

def hello():
    print("Hello")

button = Button(2)
button.when_pressed = hello
pause()
```
9.2 My event handler isn’t being called?

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

```python
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`, the thing that is assigned is the *result of calling* the `pushed` function. Because `pushed` doesn’t explicitly return anything, the result is `None`. Hence this is equivalent to doing:

```python
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:

```python
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).

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 177)). 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 an environment variable. For example:

   ```bash
   $ GPIOZERO_PIN_FACTORY=pigpio python3
   ```

   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` will be raised.

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

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

   [40] https://docs.python.org/3.5/library/exceptions.html#ImportError
Refer to the `warnings` 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:

```python
>>> from pkg_resources import require
>>> require('gpiozero')
[gpiozero 1.4.0 (/usr/lib/python3/dist-packages)]
>>> require('gpiozero')[0].version
'1.4.0'
```

If you have multiple versions installed (e.g. from pip and apt) they will not show up in the list returned by the `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:

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

Alternatively, install pip with `get-pip`.

---

41 https://docs.python.org/3.5/library/warnings.html#module-warnings
Contributing

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

10.1 Suggestions

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

10.2 Bugs

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

10.3 Documentation

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

10.4 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.

43 https://github.com/RPi-Distro/python-gpiozero/issues
44 https://github.com/RPi-Distro/python-gpiozero/issues
45 https://github.com/RPi-Distro/python-gpiozero/tree/master/docs
10.5 Backwards compatibility

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

10.6 Python 2/3

The library is 100% compatible with both Python 2 and 3. We intend to drop Python 2 support in 2020 when Python 2 reaches end-of-life\textsuperscript{46}.

\textsuperscript{46} \url{http://legacy.python.org/dev/peps/pep-0373/}
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 87) and follow its heritage backward to DigitalOutputDevice (page 99). Follow that back to OutputDevice (page 102) 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).

11.1 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
$ 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 largely experimental at this stage and not very useful):

```
(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):

```
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
```

### 11.2 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
```

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 docs/_build/html while the PDF output goes to docs/_build/latex.

### 11.3 Test suite

If you wish to run the GPIO Zero test suite, follow the instructions in Development installation (page 71) above and then make the “test” target within the sandbox:

```
$ workon python-gpiozero
(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 330Ω 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!).
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. See the *Basic Recipes* (page 3) page for more information.

### 12.1 Button

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

Extends *DigitalInputDevice* (page 82) 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` in the *Button* (page 73) constructor.

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

```python
from gpiozero import Button

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

**Parameters**

- **pin** *(int)* – The GPIO pin which the button is attached to. See *Pin Numbering* (page 3) for valid pin numbers.

- **pull_up** *(bool)* – If `True` (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`, the GPIO pin will be pulled low by default. In this case, connect the other side of the button to 3V3.

---

47 https://docs.python.org/3.5/library/functions.html#int
48 https://docs.python.org/3.5/library/functions.html#bool
• **bounce_time** *(float)* – If None (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)* – The length of time (in seconds) to wait after the button is pushed, until executing the when_held (page 74) handler. Defaults to 1.

• **hold_repeat** *(bool)* – If True, the when_held (page 74) handler will be repeatedly executed as long as the device remains active, every hold_time seconds. If False (the default) the when_held (page 74) handler will be only be executed once per hold.

• **pin_factory** *(Factory)* – See API - Pins (page 177) for more information (this is an advanced feature which most users can ignore).

```python
wait_for_press(timeout=None)
```

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

**Parameters**

**timeout** *(float)* – Number of seconds to wait before proceeding. If this is None (the default), then wait indefinitely until the device is active.

```python
wait_for_release(timeout=None)
```

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

**Parameters**

**timeout** *(float)* – Number of seconds to wait before proceeding. If this is None (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 execution of the when_held (page 74) event rather than when the device activated, in contrast to active_time (page 163). If the device is not currently held, this is None.

**hold_repeat**

If True, when_held (page 74) will be executed repeatedly with hold_time (page 74) 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 74) handler. If hold_repeat (page 74) is True, this is also the length of time between invocations of when_held (page 74).

**is_held**

When True, the device has been active for at least hold_time (page 74) seconds.

**is_pressed**

Returns True if the device is currently active and False otherwise. This property is usually derived from value. Unlike value, this is always a boolean.

**pin**

The Pin (page 181) that the device is connected to. This will be None if the device has been closed (see the close() 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, the device uses a pull-up resistor to set the GPIO pin “high” by default.

**when_held**

The function to run when the device has remained active for hold_time (page 74) seconds.

---

49 https://docs.python.org/3.5/library/functions.html#float  
50 https://docs.python.org/3.5/library/functions.html#float  
51 https://docs.python.org/3.5/library/functions.html#bool  
52 https://docs.python.org/3.5/library/functions.html#float  
53 https://docs.python.org/3.5/library/functions.html#float
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 (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 (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 (the default) to disable the event.

12.2 Line Sensor (TRCT5000)

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

Extends SmoothedInputDevice (page 82) and represents a single pin line sensor like the TCRT5000 infra-red proximity sensor found in the CamJam #3 EduKit54.

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:

```python
from gpiozero import LineSensor
from signal import pause

threshold = 0.5

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

Parameters

- **pin (int)** – The GPIO pin which the sensor is attached to. See Pin Numbering (page 3) for valid pin numbers.

- **queue_len (int)** – The length of the queue used to store values read from the sensor. This defaults to 5.

- **sample_rate (float)** – The number of values to read from the device (and append to the internal queue) per second. Defaults to 100.

---

54 http://camjam.me/?page_id=1035
55 https://docs.python.org/3.5/library/functions.html#int
56 https://docs.python.org/3.5/library/functions.html#int
57 https://docs.python.org/3.5/library/functions.html#float
• **threshold** (*float*) – Defaults to 0.5. When the mean of all values in the internal queue rises above this value, the sensor will be considered “active” by the `is_active` (page 84) property, and all appropriate events will be fired.

• **partial** (*bool*) – When `False` (the default), the object will not return a value for `is_active` (page 84) until the internal queue has filled with values. Only set this to `True` if you require values immediately after object construction.

• **pin_factory** (*Factory* (page 180)) – See **API - Pins** (page 177) for more information (this is an advanced feature which most users can ignore).

**wait_for_line** (*timeout=None*)

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

**Parameters**

- **timeout** (*float*) – Number of seconds to wait before proceeding. If this is `None` (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*) – Number of seconds to wait before proceeding. If this is `None` (the default), then wait indefinitely until the device is active.

**pin**

The `Pin` (page 181) that the device is connected to. This will be `None` if the device has been closed (see the `close()` method). When dealing with GPIO pins, query `pin.number` to discover the GPIO pin (in BCM numbering) that the device is connected to.

**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` (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` (the default) to disable the event.

### 12.3 Motion Sensor (D-SUN PIR)

**class** `gpiozero.MotionSensor` (*pin, *, queue_len=1, sample_rate=10, threshold=0.5, partial=False, pin_factory=None*)

Extends **SmoothedInputDevice** (page 82) and represents a passive infra-red (PIR) motion sensor like the sort found in the CamJam #2 EduKit.

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:

---

58 https://docs.python.org/3.5/library/functions.html#float  
59 https://docs.python.org/3.5/library/functions.html#bool  
60 https://docs.python.org/3.5/library/functions.html#float  
61 https://docs.python.org/3.5/library/functions.html#float  
62 http://camjam.me/?page_id=623
from gpiozero import MotionSensor
pir = MotionSensor(4)
pir.wait_for_motion()
print("Motion detected!")

Parameters

- **pin** (*int*[^63]) – The GPIO pin which the sensor is attached to. See *Pin Numbering* (page 3) for valid pin numbers.
- **queue_len** (*int*[^64]) – 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*[^65]) – The number of values to read from the device (and append to the internal queue) per second. Defaults to 100.
- **threshold** (*float*[^66]) – Defaults to 0.5. When the mean of all values in the internal queue rises above this value, the sensor will be considered “active” by the *is_active* (page 84) property, and all appropriate events will be fired.
- **partial** (*bool*[^67]) – When False (the default), the object will not return a value for *is_active* (page 84) until the internal queue has filled with values. Only set this to True if you require values immediately after object construction.
- **pull_up** (*bool*[^68]) – If False (the default), the GPIO pin will be pulled low by default. If True, the GPIO pin will be pulled high by the sensor.
- **pin_factory** (*Factory*[^180]) – See *API - Pins* (page 177) 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*[^69]) – Number of seconds to wait before proceeding. If this is None (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*[^70]) – Number of seconds to wait before proceeding. If this is None (the default), then wait indefinitely until the device is inactive.

**motion_detected**

Returns *True* if the device is currently active and *False* otherwise.

**pin**

The *Pin* (page 181) that the device is connected to. This will be *None* if the device has been closed (see the *close()* method). When dealing with GPIO pins, query *pin.number* to discover the GPIO pin (in BCM numbering) that the device is connected to.

**when_motion**

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

---

[^63]: https://docs.python.org/3.5/library/functions.html#int
[^64]: https://docs.python.org/3.5/library/functions.html#int
[^65]: https://docs.python.org/3.5/library/functions.html#float
[^66]: https://docs.python.org/3.5/library/functions.html#float
[^67]: https://docs.python.org/3.5/library/functions.html#bool
[^68]: https://docs.python.org/3.5/library/functions.html#bool
[^69]: https://docs.python.org/3.5/library/functions.html#float
[^70]: https://docs.python.org/3.5/library/functions.html#float
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 (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 (the default) to disable the event.

12.4 Light Sensor (LDR)

class gpiozero.LightSensor(pin, *, queue_len=5, charge_time_limit=0.01, threshold=0.1, partial=False, pin_factory=None)

Extends SmoothedInputDevice (page 82) 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:

```python
from gpiozero import LightSensor

ldr = LightSensor(18)
ldr.wait_for_light()
print("Light detected!")
```

Parameters

- **pin (int)** – The GPIO pin which the sensor is attached to. See Pin Numbering (page 3) for valid pin numbers.
- **queue_len (int)** – The length of the queue used to store values read from the circuit. This defaults to 5.
- **charge_time_limit (float)** – 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.
  You may need to adjust this value for different valued capacitors or LDRs.
- **threshold (float)** – Defaults to 0.1. When the mean 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)** – When False (the default), the object will not return a value for is_active (page 84) until the internal queue has filled with values. Only set this to True if you require values immediately after object construction.
- **pin_factory (Factory)** – See API - Pins (page 177) 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 (float77) – Number of seconds to wait before proceeding. If this
is None (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 (float78) – Number of seconds to wait before proceeding. If this
is None (the default), then wait indefinitely until the device is active.

light_detected

Returns True if the device is currently active and False otherwise.

pin

The Pin (page 181) that the device is connected to. This will be None if the device has been closed
(see the close() method). When dealing with GPIO pins, query pin.number to discover the
GPIO pin (in BCM numbering) that the device is connected to.

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.

Set this property to None (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 (the default) to disable the event.

12.5 Distance Sensor (HC-SR04)

class gpiozero.DistanceSensor (echo, trigger, *, queue_len=30, max_distance=1, thresh-
old_distance=0.3, partial=False, pin_factory=None)

Extends SmoothedInputDevice (page 82) and represents an HC-SR04 ultrasonic distance sensor, as
found in the CamJam #3 EduKit79.

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 divider80.
6. Finally, connect the VCC pin of the sensor to a 5V pin on the Pi.

77 https://docs.python.org/3.5/library/functions.html#float
78 https://docs.python.org/3.5/library/functions.html#float
79 http://camjam.me/?page_id=1035
80 https://en.wikipedia.org/wiki/Voltage_divider
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 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:

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

sensor = DistanceSensor(echo=18, trigger=17)

while True:
    print('Distance: ', sensor.distance * 100)
    sleep(1)
```

Parameters

- `echo` (int) – The GPIO pin which the ECHO pin is attached to. See Pin Numbering (page 3) for valid pin numbers.
- `trigger` (int) – The GPIO pin which the TRIG pin is attached to. See Pin Numbering (page 3) for valid pin numbers.
- `queue_len` (int) – The length of the queue used to store values read from the sensor. This defaults to 30.
- `max_distance` (float) – The value 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) – 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) – When False (the default), the object will not return a value for is_active (page 84) until the internal queue has filled with values. Only set this to True if you require values immediately after object construction.

wait_for_in_range (timeout=None)

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

Parameters

- `timeout` (float) – Number of seconds to wait before proceeding. If this is None (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) – Number of seconds to wait before proceeding. If this is None (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 81).

echo
Returns the Pin (page 181) that the sensor’s echo is connected to. This is simply an alias for the usual pin attribute.

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 attribute. When distance (page 80) is equal to max_distance (page 81), value will be 1.

threshold_distance
The distance, measured in meters, that will trigger the when_in_range (page 81) and when_out_of_range (page 81) events when crossed. This is simply a meter-scaled variant of the usual threshold attribute.

trigger
Returns the Pin (page 181) that the sensor’s trigger is connected to.

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 (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 (the default) to disable the event.

12.6 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.

### 12.7 DigitalInputDevice

```python
class gpiozero.DigitalInputDevice(pin, *, pull_up=False, bounce_time=None, pin_factory=None)
```

Represents a generic input device with typical on/off behaviour.

This class extends `InputDevice` (page 84) 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**

- `bounce_time` (`float`) – Specifies the length of time (in seconds) that the component will ignore changes in state after an initial change. This defaults to `None` which indicates that no bounce compensation will be performed.

- `pin_factory` (`Factory` (page 180)) – See `API - Pins` (page 177) for more information (this is an advanced feature which most users can ignore).

### 12.8 SmoothedInputDevice

```python
class gpiozero.SmoothedInputDevice(pin, *, pull_up=False, 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 84) 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 the queue is compared to a threshold which is used to determine the state of the `is_active` (page 84) 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.

---

90 https://docs.python.org/3.5/library/functions.html#float
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**

- **threshold** *(float)* – The value above which the device will be considered “on”.
- **queue_len** *(int)* – The length of the internal queue which is filled by the background thread.
- **sample_wait** *(float)* – 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)* – If False (the default), attempts to read the state of the device (from the `is_active` property) will block until the queue has filled. If True, 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()` which a good selection for discarding outliers from jittery sensors. The function specific must accept a sequence of numbers and return a single number.
- **pin_factory** *(Factory)* – See [API - Pins](page 177) for more information (this is an advanced feature which most users can ignore).

**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:

```python
>>> from gpiozero import *
>>> bz = Buzzer(16)
>>> bz.on()
>>> bz.off()
>>> bz.close()
>>> led = LED(16)
>>> led.blink()
```

`Device` (page 161) descendents can also be used as context managers using the `with` statement. For example:

```python
>>> from gpiozero import *
>>> with Buzzer(16) as bz:
...    bz.on()
...    ...
>>> with LED(16) as led:
...    ...
```

(continues on next page)
is_active
  Returns True if the device is currently active and False otherwise.

partial
  If False (the default), attempts to read the value (page 84) or is_active (page 84) 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 84) exceeds this amount, then is_active (page 84) will return True.

value
  Returns the mean of the values in the internal queue. This is compared to threshold (page 84) to
determine whether is_active (page 84) is True.

12.9 InputDevice

class gpiozero.InputDevice (pin, *, pull_up=False, pin_factory=None)
  Represents a generic GPIO input device.

  This class extends GPIODevice (page 84) 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 property is adjusted accordingly so that True still means active regardless of the pull_up
  (page 84) setting.

  Parameters

  • pin (int97) – The GPIO pin (in Broadcom numbering) that the device is connected to.
    If this is None a GPIODeviceError (page 192) will be raised.

  • pull_up (bool98) – If True, the pin will be pulled high with an internal resistor. If
    False (the default), the pin will be pulled low.

  • pin_factory (Factory (page 180)) – See API - Pins (page 177) for more information
    (this is an advanced feature which most users can ignore).

pull_up
  If True, the device uses a pull-up resistor to set the GPIO pin “high” by default.

12.10 GPIODevice

class gpiozero.GPIODevice (pin, pin_factory=None)
  Extends Device (page 161). 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 85)).

  Parameters pin (int99) – The GPIO pin (in BCM numbering) that the device is connected to.
    If this is None, GPIOPinMissing (page 192) will be raised. If the pin is already in use
    by another device, GPIOPinInUse (page 192) 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:

```python
>>> from gpiozero import *
>>> bz = Buzzer(16)
>>> bz.on()
>>> bz.off()
>>> bz.close()
>>> led = LED(16)
>>> led.blink()
```

Device (page 161) descendents can also be used as context managers using the with statement. For example:

```python
>>> from gpiozero import *
>>> with Buzzer(16) as bz:
...    bz.on()
... with LED(16) as led:
...    led.on()
```

closed
Returns True if the device is closed (see the close() (page 84) 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 181) that the device is connected to. This will be None if the device has been closed
(see the close() (page 84) method). When dealing with GPIO pins, query pin.number to dis-
cover 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.

---

100 https://docs.python.org/3.5/reference/compound_stmts.html#with
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. See the Basic Recipes (page 3) page for more information.

### 13.1 LED

#### class `gpiozero.LED(pin, *, active_high=True, initial_value=False, pin_factory=None)`

Extends DigitalOutputDevice (page 99) 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:

```python
from gpiozero import LED
led = LED(17)
led.on()
```

**Parameters**

- `pin (int)` – The GPIO pin which the LED is attached to. See Pin Numbering (page 3) for valid pin numbers.

- `active_high (bool)` – If True (the default), the LED will operate normally with the circuit described above. If False you should wire the cathode to the GPIO pin, and the anode to a 3V3 pin (via a limiting resistor).

---

101. [https://docs.python.org/3.5/library/functions.html#int](https://docs.python.org/3.5/library/functions.html#int)
102. [https://docs.python.org/3.5/library/functions.html#bool](https://docs.python.org/3.5/library/functions.html#bool)
• initial_value (bool) – If False (the default), the LED will be off initially. If None, the LED will be left in whatever state the pin is found in when configured for output (warning: this can be on). If True, the LED will be switched on initially.

• pin_factory (Factory (page 180)) – See API - Pins (page 177) 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) – Number of seconds on. Defaults to 1 second.

• off_time (float) – Number of seconds off. Defaults to 1 second.

• n (int) – Number of times to blink; None (the default) means forever.

• background (bool) – If True (the default), start a background thread to continue blinking and return immediately. If False, 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 if the device is currently active and False otherwise. This property is usually derived from value. Unlike value, this is always a boolean.

`pin`

The Pin (page 181) that the device is connected to. This will be None if the device has been closed (see the close() method). When dealing with GPIO pins, query pin.number to discover the GPIO pin (in BCM numbering) that the device is connected to.

### 13.2 PWMLED

`class gpiozero.PWMLED (pin, *, active_high=True, initial_value=0, frequency=100, pin_factory=None)`

Extends PWMOutputDevice (page 100) 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) – The GPIO pin which the LED is attached to. See Pin Numbering (page 3) for valid pin numbers.

• active_high (bool) – If True (the default), the on() (page 89) method will set the GPIO to HIGH. If False, the on() (page 89) method will set the GPIO to LOW (the off() (page 89) method always does the opposite).

---

103 https://docs.python.org/3.5/library/functions.html#bool
104 https://docs.python.org/3.5/library/functions.html#float
105 https://docs.python.org/3.5/library/functions.html#float
106 https://docs.python.org/3.5/library/functions.html#int
107 https://docs.python.org/3.5/library/functions.html#bool
108 https://docs.python.org/3.5/library/functions.html#int
109 https://docs.python.org/3.5/library/functions.html#bool
• **initial_value** (*float*) – 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` 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*) – The frequency (in Hz) of pulses emitted to drive the LED. Defaults to 100Hz.

• **pin_factory** (*Factory* (page 180)) – See *API - Pins* (page 177) for more information (this is an advanced feature which most users can ignore).

```python
def 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*) – Number of seconds on. Defaults to 1 second.
- **off_time** (*float*) – Number of seconds off. Defaults to 1 second.
- **fade_in_time** (*float*) – Number of seconds to spend fading in. Defaults to 0.
- **fade_out_time** (*float*) – Number of seconds to spend fading out. Defaults to 0.
- **n** (*int*) – Number of times to blink; `None` (the default) means forever.
- **background** (*bool*) – If `True` (the default), start a background thread to continue blinking and return immediately. If `False`, only return when the blink is finished (warning: the default value of `n` will result in this method never returning).

```python
def off():
    Turns the device off.
```

```python
def on():
    Turns the device on.
```

```python
def 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*) – Number of seconds to spend fading in. Defaults to 1.
- **fade_out_time** (*float*) – Number of seconds to spend fading out. Defaults to 1.
- **n** (*int*) – Number of times to pulse; `None` (the default) means forever.
- **background** (*bool*) – If `True` (the default), start a background thread to continue pulsing and return immediately. If `False`, only return when the pulse is finished (warning: the default value of `n` will result in this method never returning).

```python
def toggle():
    Toggle the state of the device. If the device is currently off (*value* (page 90) is 0.0), this changes it to “fully” on (*value* (page 90) is 1.0). If the device has a duty cycle (*value* (page 90)) of 0.1, this will toggle it to 0.9, and so on.
```
is_lit
Returns True if the device is currently active (value (page 90) is non-zero) and False otherwise.

pin
The pin (page 181) that the device is connected to. This will be None if the device has been closed (see the close() 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.

13.3 RGBLED
class gpiozero.RGBLED (red, green, blue, *, active_high=True, initial_value=(0, 0, 0), pwm=True, pin_factory=None)
Extends Device (page 161) 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 can either use three limiting resistors (one per anode) or a single limiting resistor on the cathode.

The following code will make the LED purple:

```python
from gpiozero import RGBLED
led = RGBLED(2, 3, 4)
led.color = (1, 0, 1)
```

Parameters

- red (int\(^{122}\)) – The GPIO pin that controls the red component of the RGB LED.
- green (int\(^{123}\)) – The GPIO pin that controls the green component of the RGB LED.
- blue (int\(^{124}\)) – The GPIO pin that controls the blue component of the RGB LED.
- active_high (bool\(^{125}\)) – Set to True (the default) for common cathode RGB LEDs. If you are using a common anode RGB LED, set this to False.
- initial_value (tuple\(^{126}\)) – The initial color for the RGB LED. Defaults to black (0, 0, 0).
- pwm (bool\(^{127}\)) – If True (the default), construct PWMLED (page 88) instances for each component of the RGBLED. If False, construct regular LED (page 87) instances, which prevents smooth color graduations.
- pin_factory (Factory (page 180)) – See API - Pins (page 177) 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, on_color=(1, 1, 1), off_color=(0, 0, 0), n=None, background=True)
Make the device turn on and off repeatedly.

Parameters

\(^{122}\) https://docs.python.org/3.5/library/functions.html#int
\(^{123}\) https://docs.python.org/3.5/library/functions.html#int
\(^{124}\) https://docs.python.org/3.5/library/functions.html#int
\(^{125}\) https://docs.python.org/3.5/library/functions.html#bool
\(^{126}\) https://docs.python.org/3.5/library/stdtypes.html#tuple
\(^{127}\) https://docs.python.org/3.5/library/functions.html#bool
• **on_time** *(float)* – Number of seconds on. Defaults to 1 second.

• **off_time** *(float)* – Number of seconds off. Defaults to 1 second.

• **fade_in_time** *(float)* – Number of seconds to spend fading in. Defaults to 0. Must be 0 if `pwm` was `False` when the class was constructed (`ValueError` will be raised if not).

• **fade_out_time** *(float)* – Number of seconds to spend fading out. Defaults to 0. Must be 0 if `pwm` was `False` when the class was constructed (`ValueError` will be raised if not).

• **on_color** *(tuple)* – The color to use when the LED is “on”. Defaults to white.

• **off_color** *(tuple)* – The color to use when the LED is “off”. Defaults to black.

• **n** *(int)* – Number of times to blink; `None` (the default) means forever.

• **background** *(bool)* – If `True` (the default), start a background thread to continue blinking and return immediately. If `False`, 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)* – Number of seconds to spend fading in. Defaults to 1.

• **fade_out_time** *(float)* – Number of seconds to spend fading out. Defaults to 1.

• **on_color** *(tuple)* – The color to use when the LED is “on”. Defaults to white.

• **off_color** *(tuple)* – The color to use when the LED is “off”. Defaults to black.

• **n** *(int)* – Number of times to pulse; `None` (the default) means forever.

• **background** *(bool)* – If `True` (the default), start a background thread to continue pulsing and return immediately. If `False`, 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` is (0, 0, 0)), this changes it to “fully” on (`value` is (1, 1, 1)). If the device has a specific color, this method inverts the color.

---

128 https://docs.python.org/3.5/library/functions.html#float
129 https://docs.python.org/3.5/library/functions.html#float
130 https://docs.python.org/3.5/library/functions.html#float
131 https://docs.python.org/3.5/library/exceptions.html#ValueError
132 https://docs.python.org/3.5/library/functions.html#float
133 https://docs.python.org/3.5/library/exceptions.html#ValueError
134 https://docs.python.org/3.5/library/stdtypes.html#tuple
135 https://docs.python.org/3.5/library/stdtypes.html#tuple
136 https://docs.python.org/3.5/library/functions.html#int
137 https://docs.python.org/3.5/library/functions.html#bool
138 https://docs.python.org/3.5/library/functions.html#float
139 https://docs.python.org/3.5/library/functions.html#float
140 https://docs.python.org/3.5/library/stdtypes.html#tuple
141 https://docs.python.org/3.5/library/stdtypes.html#tuple
142 https://docs.python.org/3.5/library/functions.html#int
143 https://docs.python.org/3.5/library/functions.html#bool
color
Represents the color of the LED as an RGB 3-tuple of \((\text{red}, \text{green}, \text{blue})\) where each value is between 0 and 1 if \(\text{pwm}\) was \(\text{True}\) when the class was constructed (and only 0 or 1 if not).

For example, purple would be \((1, 0, 1)\) and yellow would be \((1, 1, 0)\), while orange would be \((1, 0.5, 0)\).

is_lit
Returns \text{True} if the LED is currently active (not black) and \text{False} otherwise.

13.4 Buzzer

class \text{gpiozero.Buzzer}(\text{pin, *}, \text{active\_high=} \text{True}, \text{initial\_value=} \text{False}, \text{pin\_factory=} \text{None})

Extends \text{DigitalOutputDevice} (page 99) and represents a digital buzzer component.

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

- \text{pin (int)} \text{144} – The GPIO pin which the buzzer is attached to. See Pin Numbering (page 3) for valid pin numbers.
- \text{active\_high (bool)} \text{145} – If \text{True} (the default), the buzzer will operate normally with the circuit described above. If \text{False} you should wire the cathode to the GPIO pin, and the anode to a 3V3 pin.
- \text{initial\_value (bool)} \text{146} – If \text{False} (the default), the buzzer will be silent initially. If \text{None}, the buzzer will be left in whatever state the pin is found in when configured for output (warning: this can be on). If \text{True}, the buzzer will be switched on initially.
- \text{pin\_factory (Factory) (page 180)} – See API - Pins (page 177) for more information (this is an advanced feature which most users can ignore).

\text{beep (on\_time=}1, \text{off\_time=}1, \text{n=}None, \text{background=} \text{True})
Make the device turn on and off repeatedly.

Parameters

- \text{on\_time (float)} \text{147} – Number of seconds on. Defaults to 1 second.
- \text{off\_time (float)} \text{148} – Number of seconds off. Defaults to 1 second.
- \text{n (int)} \text{149} – Number of times to blink; \text{None} (the default) means forever.
- \text{background (bool)} \text{150} – If \text{True} (the default), start a background thread to continue blinking and return immediately. If \text{False}, only return when the blink is finished (warning: the default value of \text{n} will result in this method never returning).

\text{144} https://docs.python.org/3.5/library/functions.html\#int
\text{145} https://docs.python.org/3.5/library/functions.html\#bool
\text{146} https://docs.python.org/3.5/library/functions.html\#bool
\text{147} https://docs.python.org/3.5/library/functions.html\#float
\text{148} https://docs.python.org/3.5/library/functions.html\#float
\text{149} https://docs.python.org/3.5/library/functions.html\#int
\text{150} https://docs.python.org/3.5/library/functions.html\#bool
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_active
    Returns True if the device is currently active and False otherwise. This property is usually derived
    from value. Unlike value, this is always a boolean.

pin
    The Pin (page 181) that the device is connected to. This will be None if the device has been closed
    (see the close() method). When dealing with GPIO pins, query pin.number to discover the
    GPIO pin (in BCM numbering) that the device is connected to.

13.5 Motor

class gpiozero.Motor(forward, backward, *, pwm=True, pin_factory=None)
Extends CompositeDevice (page 153) and represents a generic motor connected to a bi-directional
motor driver circuit (i.e. an H-bridge\[151\]).

Attach an H-bridge\[152\] 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”:

```python
from gpiozero import Motor
motor = Motor(17, 18)
motor.forward()
```

Parameters

- **forward** (int\[153\]) – The GPIO pin that the forward input of the motor driver chip is
  connected to.

- **backward** (int\[154\]) – The GPIO pin that the backward input of the motor driver chip
  is connected to.

- **pwm** (bool\[155\]) – If True (the default), construct PWMOutputDevice (page 100)
  instances for the motor controller pins, allowing both direction and variable speed con-
  trol. If False, construct DigitalOutputDevice (page 99) instances, allowing
  only direction control.

- **pin_factory** (Factory (page 180)) – See API - Pins (page 177) for more informa-
  tion (this is an advanced feature which most users can ignore).

backward(speed=1)

Drive the motor backwards.

Parameters **speed** (float\[156\]) – 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 when
the class was constructed (and only 0 or 1 if not).

---

151 https://en.wikipedia.org/wiki/H_bridge
152 https://en.wikipedia.org/wiki/H_bridge
153 https://docs.python.org/3.5/library/functions.html#int
154 https://docs.python.org/3.5/library/functions.html#int
155 https://docs.python.org/3.5/library/functions.html#bool
156 https://docs.python.org/3.5/library/functions.html#float
forward(speed=1)
    Drive the motor forwards.

    Parameters speed (float) – 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 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.

13.6 PhaseEnableMotor

class gpiozero.PhaseEnableMotor(phase, enable, *, pwm=True, pin_factory=None)
    Extends CompositeDevice (page 153) 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) – The GPIO pin that the phase (direction) input of the motor driver chip is connected to.
- **enable** (int) – The GPIO pin that the enable (speed) input of the motor driver chip is connected to.
- **pwm** (bool) – If True (the default), construct PWMOutputDevice (page 100) instances for the motor controller pins, allowing both direction and variable speed control. If False, construct DigitalOutputDevice (page 99) instances, allowing only direction control.
- **pin_factory** (Factory) – See API - Pins (page 177) for more information (this is an advanced feature which most users can ignore).

backward(speed=1)
    Drive the motor backwards.

    Parameters speed (float) – 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) – 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.

13.7 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 153) 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)** – The GPIO pin which the device is attached to. See Pin Numbering (page 3) for valid pin numbers.
- **initial_value (float)** – 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 means to start the servo un-controlled (see value (page 96)).
- **min_pulse_width (float)** – The pulse width corresponding to the servo’s minimum position. This defaults to 1ms.
- **max_pulse_width (float)** – The pulse width corresponding to the servo’s maximum position. This defaults to 2ms.
- **frame_width (float)** – 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) – See API - Pins (page 177) for more information (this is an advanced feature which most users can ignore).

detach()
Temporarily disable control of the servo. This is equivalent to setting value (page 96) to None.
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.

closed
Returns True if the device is closed (see the close() method). Once a device is closed you can no longer use any other methods or properties to control or query the device.

frame_width
The time between control pulses, measured in seconds.

is_active
Returns True if the device is currently active and False otherwise. This property is usually derived from value (page 96). Unlike value (page 96), this is always a boolean.

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.

source
The iterable to use as a source of values for value (page 96).

source_delay
The delay (measured in seconds) in the loop used to read values from source (page 96). Defaults to 0.01 seconds which is generally sufficient to keep CPU usage to a minimum while providing adequate responsiveness.

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 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.

values
An infinite iterator of values read from value.

13.8 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 95) 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 95) 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 96) instance with the correct bounds:

```python
>>> from gpiozero import AngularServo
>>> s = AngularServo(17, min_angle=-42, max_angle=44)
>>> s.angle = 0.0
>>> s.angle
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`): The GPIO pin which the device is attached to. See Pin Numbering (page 3) for valid pin numbers.

- **initial_angle** (`float`): 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 means to start the servo un-controlled (see value (page 98)).

- **min_angle** (`float`): 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`): 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`): The pulse width corresponding to the servo’s minimum position. This defaults to 1ms.

- **max_pulse_width** (`float`): The pulse width corresponding to the servo’s maximum position. This defaults to 2ms.

- **frame_width** (`float`): 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`): See API - Pins (page 177) for more information (this is an advanced feature which most users can ignore).

### detach()

Temporarily disable control of the servo. This is equivalent to setting value (page 98) to None.

### 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 and max_angle have been set appropriately in the constructor.

This can also be the special value None 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.

closed
Returns True if the device is closed (see the close() method). Once a device is closed you can no longer use any other methods or properties to control or query the device.

frame_width
The time between control pulses, measured in seconds.

is_active
Returns True if the device is currently active and False otherwise. This property is usually derived from value (page 98). Unlike value (page 98), this is always a boolean.

max_angle
The maximum angle that the servo will rotate to when max() (page 97) is called.

max_pulse_width
The control pulse width corresponding to the servo’s maximum position, measured in seconds.

min_angle
The minimum angle that the servo will rotate to when min() (page 98) is called.

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.

source
The iterable to use as a source of values for value (page 98).

source_delay
The delay (measured in seconds) in the loop used to read values from source (page 98). Defaults to 0.01 seconds which is generally sufficient to keep CPU usage to a minimum while providing adequate responsiveness.

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 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.

values
An infinite iterator of values read from value.

13.9 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.

### 13.10 DigitalOutputDevice

```python
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 102) with a `blink()` (page 99) method which uses an optional background thread to handle toggling the device state without further interaction.

```python
blink(on_time=1, off_time=1, n=None, background=True)
```

Make the device turn on and off repeatedly.

**Parameters**

- `on_time` *(float)* — Number of seconds on. Defaults to 1 second.
- `off_time` *(float)* — Number of seconds off. Defaults to 1 second.
- `n` *(int)* — Number of times to blink; `None` (the default) means forever.
- `background` *(bool)* — If `True` (the default), start a background thread to continue blinking and return immediately. If `False`, only return when the blink is finished (warning: the default value of `n` will result in this method never returning).

```python
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)
```

(continues on next page)
Gpiozero Documentation, Release 1.4.1

>>> bz.on()
>>> bz.off()
>>> bz.close()
>>> led = LED(16)
>>> led.blink()

Device (page 161) descendents can also be used as context managers using the `with` statement. For example:

```python
>>> from gpiozero import *
>>> with Buzzer(16) as bz:
...    bz.on()
...    ...
>>> with LED(16) as led:
...    led.on()
...    ...
```

- **off()**
  Turns the device off.

- **on()**
  Turns the device on.

- **value**
  Returns `True` if the device is currently active and `False` otherwise. Setting this property changes the state of the device.

## 13.11 PWMOutputDevice

```python
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`) — The GPIO pin which the device is attached to. See Pin Numbering (page 3) for valid pin numbers.

- **active_high** (`bool`) — If `True` (the default), the `on()` (page 101) method will set the GPIO to HIGH. If `False`, the `on()` (page 101) method will set the GPIO to LOW (the `off()` (page 101) method always does the opposite).

- **initial_value** (`float`) — 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` 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`) — The frequency (in Hz) of pulses emitted to drive the device. Defaults to 100Hz.

- **pin_factory** (`Factory`) — See API - Pins (page 177) for more information (this is an advanced feature which most users can ignore).

```python
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

179 https://docs.python.org/3.5/reference/compound_stmts.html#with
180 https://docs.python.org/3.5/library/functions.html#int
181 https://docs.python.org/3.5/library/functions.html#bool
182 https://docs.python.org/3.5/library/functions.html#float
183 https://docs.python.org/3.5/library/functions.html#int
• **on_time** (*float*¹⁸⁴) – Number of seconds on. Defaults to 1 second.

• **off_time** (*float*¹⁸⁵) – Number of seconds off. Defaults to 1 second.

• **fade_in_time** (*float*¹⁸⁶) – Number of seconds to spend fading in. Defaults to 0.

• **fade_out_time** (*float*¹⁸⁷) – Number of seconds to spend fading out. Defaults to 0.

• **n** (*int*¹⁸⁸) – Number of times to blink; None (the default) means forever.

• **background** (*bool*¹⁸⁹) – If True (the default), start a background thread to continue blinking and return immediately. If False, only return when the blink is finished (warning: the default value of n will result in this method never returning).

**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:

```python
>>> from gpiozero import *
>>> bz = Buzzer(16)
>>> bz.on()
>>> bz.off()
>>> bz.close()
>>> led = LED(16)
>>> led.blink()
```

Device (page 161) descendents can also be used as context managers using the **with** statement.

For example:

```python
>>> from gpiozero import *
>>> with Buzzer(16) as bz:
...     bz.on()
...     ...
>>> with LED(16) as led:
...     led.on()
...     ...
```

**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**

---

¹⁸⁴ [https://docs.python.org/3.5/library/functions.html#float](https://docs.python.org/3.5/library/functions.html#float)
¹⁸⁵ [https://docs.python.org/3.5/library/functions.html#float](https://docs.python.org/3.5/library/functions.html#float)
¹⁸⁶ [https://docs.python.org/3.5/library/functions.html#float](https://docs.python.org/3.5/library/functions.html#float)
¹⁸⁷ [https://docs.python.org/3.5/library/functions.html#float](https://docs.python.org/3.5/library/functions.html#float)
¹⁸⁸ [https://docs.python.org/3.5/library/functions.html#int](https://docs.python.org/3.5/library/functions.html#int)
¹⁸⁹ [https://docs.python.org/3.5/library/functions.html#bool](https://docs.python.org/3.5/library/functions.html#bool)
¹⁹⁰ [https://docs.python.org/3.5/reference/compound_stmts.html#with](https://docs.python.org/3.5/reference/compound_stmts.html#with)
• **fade_in_time** (*float*<sup>191</sup>) – Number of seconds to spend fading in. Defaults to 1.

• **fade_out_time** (*float*<sup>192</sup>) – Number of seconds to spend fading out. Defaults to 1.

• **n** (*int*<sup>193</sup>) – Number of times to pulse; *None* (the default) means forever.

• **background** (*bool*<sup>194</sup>) – If *True* (the default), start a background thread to continue pulsing and return immediately. If *False*, only return when the pulse is finished (warning: the default value of *n* will result in this method never returning).

`toggle()`

Toggles the state of the device. If the device is currently off (*value* (page 102) is 0.0), this changes it to “fully” on (*value* (page 102) is 1.0). If the device has a duty cycle (*value* (page 102)) 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* if the device is currently active (*value* (page 102) is non-zero) and *False* 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.

### 13.12 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 84) to add facilities common to GPIO output devices: an `on()` (page 102) method to switch the device on, a corresponding `off()` (page 102) method, and a `toggle()` (page 102) method.

**Parameters**

• **pin** (*int*<sup>195</sup>) – The GPIO pin (in BCM numbering) that the device is connected to. If this is *None* a `GPIOPinMissing` (page 192) will be raised.

• **active_high** (*bool*<sup>196</sup>) – If *True* (the default), the `on()` (page 102) method will set the GPIO to HIGH. If *False*, the `on()` (page 102) method will set the GPIO to LOW (the `off()` (page 102) method always does the opposite).

• **initial_value** (*bool*<sup>197</sup>) – If *False* (the default), the device will be off initially. If *None*, the device will be left in whatever state the pin is found in when configured for output (warning: this can be on). If *True*, the device will be switched on initially.

• **pin_factory** (*Factory* (page 180)) – See *API - Pins* (page 177) for more information (this is an advanced feature which most users can ignore).

`off()`

Turns the device off.

`on()`

Turns the device on.

---

<sup>191</sup> https://docs.python.org/3.5/library/functions.html#float  
<sup>192</sup> https://docs.python.org/3.5/library/functions.html#float  
<sup>193</sup> https://docs.python.org/3.5/library/functions.html#int  
<sup>194</sup> https://docs.python.org/3.5/library/functions.html#bool  
<sup>195</sup> https://docs.python.org/3.5/library/functions.html#int  
<sup>196</sup> https://docs.python.org/3.5/library/functions.html#int  
<sup>197</sup> https://docs.python.org/3.5/library/functions.html#bool
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, the value (page 103) property is True when the device’s pin is high. When False
the value (page 103) property is True 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 103)
(i.e. changing this property doesn’t change the device’s pin state - it just changes how that state is
interpreted).

value
Returns True if the device is currently active and False otherwise. Setting this property changes
the state of the device.

13.13 GPIODevice

class gpiozero.GPIODevice (pin, *, pin_factory=None)
Extends Device (page 161). 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 85)).

Parameters pin (int) – The GPIO pin (in BCM numbering) that the device is connected
to. If this is None, GPIOPinMissing (page 192) will be raised. If the pin is already in
use by another device, GPIOPinInUse (page 192) 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:

```python
>>> from gpiozero import *
>>> bz = Buzzer(16)
>>> bz.on()
>>> bz.off()
>>> bz.close()
>>> led = LED(16)
>>> led.blink()
```

Device (page 161) descendents can also be used as context managers using the with199 statement.
For example:

```python
>>> from gpiozero import *
... with Buzzer(16) as bz:
...     bz.on()
...
... with LED(16) as led:
...     led.on()
...
```

198 https://docs.python.org/3.5/library/functions.html#int
199 https://docs.python.org/3.5/reference/compound_stmts.html#with
closed

Returns `True` if the device is closed (see the `close()` (page 84) 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 181) that the device is connected to. This will be `None` if the device has been closed (see the `close()` (page 84) 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.
SPI stands for Serial Peripheral Interface\textsuperscript{200} 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.

### 14.1 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 \texttt{SPIBadArgs} (page 192) being raised. However, you can omit any arguments from either scheme. The defaults are:

\textsuperscript{200} 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 177) for more information).

Hence the following constructors are all equivalent:

```python
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.

14.2 Analog to Digital Converters (ADC)

```python
class gpiozero.MCP3001(max_voltage=3.3, **spi_args)
```

The MCP3001\(^{201}\) 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-.

```python
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).

```python
class gpiozero.MCP3002(channel=0, differential=False, max_voltage=3.3, **spi_args)
```

The MCP3002\(^{202}\) is a 10-bit analog to digital converter with 2 channels (0-1).

```python
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.

```python
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 107) in differential mode, channel 0 is read relative to channel 1).

```python
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).

```python
class gpiozero.MCP3004(channel=0, differential=False, max_voltage=3.3, **spi_args)
```

The MCP3004\(^{203}\) is a 10-bit analog to digital converter with 4 channels (0-3).

```python
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.

\(^{201}\) http://www.farnell.com/datasheets/630400.pdf
\(^{203}\) http://www.farnell.com/datasheets/808965.pdf
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 107) in differential mode, channel 0 is read relative to channel 1).

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).

```python
class gpiozero.MCP3008(channel=0, differential=False, max_voltage=3.3, **spi_args)
```

The `MCP3008` is a 10-bit analog to digital converter with 8 channels (0-7).

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.

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 107) in differential mode, channel 0 is read relative to channel 1).

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).

```python
class gpiozero.MCP3201(max_voltage=3.3, **spi_args)
```

The `MCP3201` 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-.

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.

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 107) in differential mode, channel 0 is read relative to channel 1).

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).

```python
class gpiozero.MCP3202(channel=0, differential=False, max_voltage=3.3, **spi_args)
```

The `MCP3202` is a 12-bit analog to digital converter with 2 channels (0-1).

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.

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 107) in differential mode, channel 0 is read relative to channel 1).

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).

```python
class gpiozero.MCP3204(channel=0, differential=False, max_voltage=3.3, **spi_args)
```

The `MCP3204` is a 12-bit analog to digital converter with 4 channels (0-3).

---

204 http://www.farnell.com/datasheets/808965.pdf

14.2. Analog to Digital Converters (ADC)
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 107) 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).

class gpiozero.MCP3208 (channel=0, differential=False, max_voltage=3.3, **spi_args)
The MCP3208\(^{208}\) 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).
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 107) 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).

class gpiozero.MCP3301 (max_voltage=3.3, **spi_args)
The MCP3301\(^{209}\) 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).

class gpiozero.MCP3302 (channel=0, differential=False, max_voltage=3.3, **spi_args)
The MCP3302\(^{210}\) 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 109) 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).

class gpiozero.MCP3304(channel=0, differential=False, max_voltage=3.3, **spi_args)
The MCP3304\(^{211}\) 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.

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 109) 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).

14.3 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):

\(^{211}\) [http://www.farnell.com/datasheets/1486116.pdf]
The following sections document these base classes for advanced users that wish to construct classes for their own devices.

14.4 AnalogInputDevice

```python
from gpiozero import MCP3008
```

Represents an analog input device connected to SPI (serial interface).

Typical analog input devices are analog to digital converters\(^{212}\) (ADCs). Several classes are provided for specific ADC chips, including `MCP3004` (page 106), `MCP3008` (page 107), `MCP3204` (page 107), and `MCP3208` (page 108).

The following code demonstrates reading the first channel of an MCP3008 chip attached to the Pi’s SPI pins:

```
from gpiozero import MCP3008
```

\(^{212}\) https://en.wikipedia.org/wiki/Analog-to-digital_converter
The `value` 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` like so:

```python
from gpiozero import MCP3008, PWMLED
pot = MCP3008(0)
led = PWMLED(17)
led.source = pot.values
```

The `voltage` 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.

### 14.5 SPIDevice

```python
class gpiozero.SPIDevice(**spi_args)
```

Extends `Device` (page 161). Represents a device that communicates via the SPI protocol.

See `SPI keyword args` (page 105) 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.

  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:

```python
>>> from gpiozero import *
>>> bz = Buzzer(16)
>>> bz.on()
>>> bz.off()
>>> bz.close()
```
Device (page 161) descendents can also be used as context managers using the with statement. For example:

```python
>>> from gpiozero import *
>>> with Buzzer(16) as bz:
...    bz.on()
...    ...
>>> with LED(16) as led:
...    led.on()
...    ...
```

**closed**

Returns `True` if the device is closed (see the `close()` (page 111) method). Once a device is closed you can no longer use any other methods or properties to control or query the device.

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213 https://docs.python.org/3.5/reference/compound_stmts.html#with
CHAPTER 15

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 73) and API - Output Devices (page 87) provided by GPIO Zero. See those pages for more information on using components individually.

Note: All GPIO pin numbers use Broadcom (BCM) numbering. See the Basic Recipes (page 3) page for more information.

15.1 LEDBoard

class gpiozero.LEDBoard(*pins, pwm=False, active_high=True, initial_value=False, pin_factory=None, **named_pins)

Extends LEDCollection (page 152) 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:

```python
from gpiozero import LEDBoard

colors = LEDBoard(2, 3, 4, 5, 6)
colors.on()
```

Parameters

- **pins** (int\(^{214}\)) – Specify the GPIO pins that the LEDs of the board are attached to. You can designate as many pins as necessary. You can also specify LEDBoard (page 113) instances to create trees of LEDs.

- **pwm** (bool\(^ {215}\)) – If True, construct PWMLED (page 88) instances for each pin. If False (the default), construct regular LED (page 87) instances. This parameter can only be specified as a keyword parameter.

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\(^{214}\) https://docs.python.org/3.5/library/functions.html#int

\(^{215}\) https://docs.python.org/3.5/library/functions.html#bool
• **active_high** (bool) – If True (the default), the on() (page 115) method will set all the associated pins to HIGH. If False, the on() (page 115) method will set all pins to LOW (the off() (page 115) method always does the opposite). This parameter can only be specified as a keyword parameter.

• **initial_value** (bool) – If False (the default), all LEDs will be off initially. If None, each device will be left in whatever state the pin is found in when configured for output (warning: this can be on). If True, the device will be switched on initially. This parameter can only be specified as a keyword parameter.

• **pin_factory** (Factory (page 180)) – See API - Pins (page 177) 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 113) 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) – Number of seconds on. Defaults to 1 second.

• **off_time** (float) – Number of seconds off. Defaults to 1 second.

• **fade_in_time** (float) – Number of seconds to spend fading in. Defaults to 0. Must be 0 if pwm was False when the class was constructed (ValueError will be raised if not).

• **fade_out_time** (float) – Number of seconds to spend fading out. Defaults to 0. Must be 0 if pwm was False when the class was constructed (ValueError will be raised if not).

• **n** (int) – Number of times to blink; None (the default) means forever.

• **background** (bool) – If True, start a background thread to continue blinking and return immediately. If False, only return when the blink is finished (warning: the default value of n will result in this method never returning).

`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:

https://docs.python.org/3.5/library/functions.html#bool
https://docs.python.org/3.5/library/functions.html#bool
https://docs.python.org/3.5/library/functions.html#float
https://docs.python.org/3.5/library/functions.html#float
https://docs.python.org/3.5/library/functions.html#float
https://docs.python.org/3.5/library/exceptions.html#ValueError
https://docs.python.org/3.5/library/functions.html#float
https://docs.python.org/3.5/library/exceptions.html#ValueError
https://docs.python.org/3.5/library/functions.html#int
https://docs.python.org/3.5/library/functions.html#bool
>>> from gpiozero import *
>>> bz = Buzzer(16)
>>> bz.on()
>>> bz.off()
>>> bz.close()
>>> led = LED(16)
>>> led.blink()

Device (page 161) descendents can also be used as context managers using the with statement. For example:

```python
>>> from gpiozero import *
>>> with Buzzer(16) as bz:
...    bz.on()
...    bz.off()
>>> with LED(16) as led:
...    led.on()
```

off (*args)
- Turn all the output devices off.

on (*args)
- Turn all the output devices 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) – Number of seconds to spend fading in. Defaults to 1.
- **fade_out_time** (float) – Number of seconds to spend fading out. Defaults to 1.
- **n** (int) – Number of times to blink; None (the default) means forever.
- **background** (bool) – If True (the default), start a background thread to continue blinking and return immediately. If False, only return when the blink is finished (warning: the default value of n will result in this method never returning).

toggle (*args)
- Toggle all the output devices. For each device, if it’s on, turn it off; if it’s off, turn it on.

closed
- Returns True if the device is closed (see the close() (page 114) 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 if the device is currently active and False otherwise. This property is usually derived from value (page 116). Unlike value (page 116), this is always a boolean.

leds
- A flat tuple of all LEDs contained in this collection (and all sub-collections).

source
- The iterable to use as a source of values for value (page 116).

source_delay
- The delay (measured in seconds) in the loop used to read values from source (page 115). Defaults to

---

226 https://docs.python.org/3.5/reference/compound_stmts.html#with
227 https://docs.python.org/3.5/library/functions.html#float
228 https://docs.python.org/3.5/library/functions.html#float
229 https://docs.python.org/3.5/library/functions.html#int
230 https://docs.python.org/3.5/library/functions.html#bool

---

15.1. LEDBoard 115
0.01 seconds which is generally sufficient to keep CPU usage to a minimum while providing adequate responsiveness.

**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.

**values**
An infinite iterator of values read from `value`.

## 15.2 LEDBarGraph

```python
class gpiozero.LEDBarGraph(*pins, pwm=False, active_high=True, initial_value=0, pin_factory=None)
```

Extends `LEDCollection` (page 152) 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:

```python
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 other output devices, `source` (page 117) and `values` (page 117) are supported:

```python
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.values
pause()
```

**Parameters**

- **pins** (int) – Specify the GPIO pins that the LEDs of the bar graph are attached to. You can designate as many pins as necessary.

- **pwm** (bool) – If True, construct `PWMLED` (page 88) instances for each pin. If False (the default), construct regular `LED` (page 87) instances. This parameter can only be specified as a keyword parameter.

- **active_high** (bool) – If True (the default), the `on()` (page 117) method will set all the associated pins to HIGH. If False, the `on()` (page 117) method will set all pins to LOW (the `off()` (page 117) method always does the opposite). This parameter can only be specified as a keyword parameter.

- **initial_value** (float) – The initial value (page 117) 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.

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231 https://docs.python.org/3.5/library/functions.html#int
232 https://docs.python.org/3.5/library/functions.html#bool
233 https://docs.python.org/3.5/library/functions.html#bool
234 https://docs.python.org/3.5/library/functions.html#float
• **pin_factory** *(Factory (page 180)) – See API - Pins (page 177) for more information (this is an advanced feature which most users can ignore).

**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.

**closed**
Returns True if the device is closed (see the close() 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 if the device is currently active and False otherwise. This property is usually derived from value (page 117). Unlike value (page 117), this is always a boolean.

**leds**
A flat tuple of all LEDs contained in this collection (and all sub-collections).

**lit_count**
The number of LEDs on the bar graph actually lit up. Note that just like value, 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 117).

**source_delay**
The delay (measured in seconds) in the loop used to read values from source (page 117). Defaults to 0.01 seconds which is generally sufficient to keep CPU usage to a minimum while providing adequate responsiveness.

**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:

```python
from gpiozero import LEDBarGraph
graph = LEDBarGraph(12, 16, 19)
graph.value = 1/3
```

**values**
An infinite iterator of values read from value.

### 15.3 ButtonBoard

**class gpiozero.ButtonBoard(*pins, pull_up=True, bounce_time=None, hold_time=1, hold_repeat=False, pin_factory=None, **named_pins)**

Extends `CompositeDevice` (page 153) and represents a generic button board or collection of buttons.
Parameters

- **pins (int)** – Specify the GPIO pins that the buttons of the board are attached to. You can designate as many pins as necessary.

- **pull_up (bool)** – If True (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, the GPIO pins will be pulled low by default. In this case, connect the other side of the buttons to 3V3. This parameter can only be specified as a keyword parameter.

- **bounce_time (float)** – If None (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. This parameter can only be specified as a keyword parameter.

- **hold_time (float)** – The length of time (in seconds) to wait after any button is pushed, until executing the *when_held* (page 119) handler. Defaults to 1. This parameter can only be specified as a keyword parameter.

- **hold_repeat (bool)** – If True, the *when_held* (page 119) handler will be repeatedly executed as long as any buttons remain held, every hold_time seconds. If False (the default) the *when_held* (page 119) handler will be only be executed once per hold. This parameter can only be specified as a keyword parameter.

- **pin_factory (Factory)** – See API - Pins (page 177) 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_active *(timeout=None)*
Pause the script until the device is activated, or the timeout is reached.

Parameters timeout (float) – Number of seconds to wait before proceeding. If this is None (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) – Number of seconds to wait before proceeding. If this is None (the default), then wait indefinitely until the device is inactive.

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

Parameters timeout (float) – Number of seconds to wait before proceeding. If this is None (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) – Number of seconds to wait before proceeding. If this is None (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.

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235 https://docs.python.org/3.5/library/functions.html#int
236 https://docs.python.org/3.5/library/functions.html#bool
237 https://docs.python.org/3.5/library/functions.html#float
238 https://docs.python.org/3.5/library/functions.html#float
239 https://docs.python.org/3.5/library/functions.html#float
240 https://docs.python.org/3.5/library/functions.html#float
241 https://docs.python.org/3.5/library/functions.html#float
242 https://docs.python.org/3.5/library/functions.html#float
243 https://docs.python.org/3.5/library/functions.html#float
closed
Returns True if the device is closed (see the close() method). Once a device is closed you can no
longer use any other methods or properties to control or query the device.

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 119) event rather than when the device activated, in contrast to
active_time (page 163). If the device is not currently held, this is None.

hold_repeat
If True, when_held (page 119) will be executed repeatedly with hold_time (page 119) 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 119) handler. If hold_repeat (page 119) is True, this is also the length of time between
invocations of when_held (page 119).

inactive_time
The length of time (in seconds) that the device has been inactive for. When the device is active, this is
None.

is_active
Returns True if the device is currently active and False otherwise. This property is usually derived
from value (page 119). Unlike value (page 119), this is always a boolean.

is_held
When True, the device has been active for at least hold_time (page 119) seconds.

is_pressed
Returns True if the device is currently active and False otherwise. This property is usually derived
from value (page 119). Unlike value (page 119), this is always a boolean.

pressed_time
The length of time (in seconds) that the device has been active for. When the device is inactive, this is
None.

pull_up
If True, 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.

values
An infinite iterator of values read from value.

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 (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 (the default) to disable the event.
when_held

The function to run when the device has remained active for `hold_time` (page 119) 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` (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` (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` (the default) to disable the event.

15.4 TrafficLights

class gpiozero.TrafficLights(red=None, amber=None, green=None, pwm=False, initial_value=False, yellow=None, pin_factory=None)

Extends LEDBoard (page 113) 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:

```python
from gpiozero import TrafficLights

traffic = TrafficLights(2, 3, 4)
traffic.amber.on()
```

Parameters

- **red**(int) – The GPIO pin that the red LED is attached to.
- **amber**(int) – The GPIO pin that the amber LED is attached to.
- **green**(int) – The GPIO pin that the green LED is attached to.
- **pwm**(bool) – If True, construct PWMLED (page 88) instances to represent each LED. If False (the default), construct regular LED (page 87) instances.
- **initial_value**(bool) – If False (the default), all LEDs will be off initially. If None, each device will be left in whatever state the pin is found in when configured for output (warning: this can be on). If True, the device will be switched on initially.
- **yellow**(int) – 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`. 

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244 https://docs.python.org/3.5/library/functions.html#int
245 https://docs.python.org/3.5/library/functions.html#int
246 https://docs.python.org/3.5/library/functions.html#int
247 https://docs.python.org/3.5/library/functions.html#bool
248 https://docs.python.org/3.5/library/functions.html#bool
249 https://docs.python.org/3.5/library/functions.html#int
• pin_factory (Factory (page 180)) – See API - Pins (page 177) 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 all the LEDs turn on and off repeatedly.

**Parameters**

- **on_time** (*float* 250) – Number of seconds on. Defaults to 1 second.
- **off_time** (*float* 251) – Number of seconds off. Defaults to 1 second.
- **fade_in_time** (*float* 252) – Number of seconds to spend fading in. Defaults to 0. Must be 0 if `pwm` was `False` when the class was constructed (`ValueError` 253 will be raised if not).
- **fade_out_time** (*float* 254) – Number of seconds to spend fading out. Defaults to 0. Must be 0 if `pwm` was `False` when the class was constructed (`ValueError` 255 will be raised if not).
- **n** (*int* 256) – Number of times to blink; `None` (the default) means forever.
- **background** (*bool* 257) – If `True`, start a background thread to continue blinking and return immediately. If `False`, only return when the blink is finished (warning: the default value of `n` will result in this method never returning).

**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:

```python
>>> from gpiozero import *
>>> bz = Buzzer(16)
>>> bz.on()
>>> bz.off()
>>> bz.close()
>>> led = LED(16)
>>> led.blink()
```

*Device* (page 161) descendents can also be used as context managers using the `with` 258 statement. For example:

```python
>>> from gpiozero import *
>>> with Buzzer(16) as bz:
...     bz.on()
...```

(continues on next page)

250 https://docs.python.org/3.5/library/functions.html#float
251 https://docs.python.org/3.5/library/functions.html#float
252 https://docs.python.org/3.5/library/functions.html#float
253 https://docs.python.org/3.5/library/exceptions.html#ValueError
254 https://docs.python.org/3.5/library/functions.html#float
255 https://docs.python.org/3.5/library/exceptions.html#ValueError
256 https://docs.python.org/3.5/library/functions.html#int
257 https://docs.python.org/3.5/library/functions.html#bool
258 https://docs.python.org/3.5/reference/compound_stmts.html#with
>>> with LED(16) as led:
...    led.on()
...

off(*args)
Turn all the output devices off.

on(*args)
Turn all the output devices on.

pulse(*args)
Make the device fade in and out repeatedly.

Parameters

• **fade_in_time** (**float**) – Number of seconds to spend fading in. Defaults to 1.
• **fade_out_time** (**float**) – Number of seconds to spend fading out. Defaults to 1.
• **n** (**int**) – Number of times to blink; None (the default) means forever.
• **background** (**bool**) – If True (the default), start a background thread to continue blinking and return immediately. If False, only return when the blink is finished (warning: the default value of n will result in this method never returning).

toggle(*args)
Toggle all the output devices. For each device, if it’s on, turn it off; if it’s off, turn it on.

closed
Returns True if the device is closed (see the close() (page 121) 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 if the device is currently active and False otherwise. This property is usually derived from value (page 122). Unlike value (page 122), this is always a boolean.

leds
A flat tuple of all LEDs contained in this collection (and all sub-collections).

source
The iterable to use as a source of values for value (page 122).

source_delay
The delay (measured in seconds) in the loop used to read values from source (page 122). Defaults to 0.01 seconds which is generally sufficient to keep CPU usage to a minimum while providing adequate responsiveness.

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.

values
An infinite iterator of values read from value.

---

259 https://docs.python.org/3.5/library/functions.html#float
260 https://docs.python.org/3.5/library/functions.html#float
261 https://docs.python.org/3.5/library/functions.html#float
262 https://docs.python.org/3.5/library/functions.html#bool
15.5 LedBorg

class gpiozero.LedBorg(initial_value=(0, 0, 0), pwm=True, pin_factory=None)

Extends RGBLED (page 90) for the PiBorg LedBorg\(^{263}\): 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** (tuple\(^{264}\)) – The initial color for the LedBorg. Defaults to black (0, 0, 0).
- **pwm** (bool\(^{265}\)) – If True (the default), construct PWMLED (page 88) instances for each component of the LedBorg. If False, construct regular LED (page 87) instances, which prevents smooth color graduations.
- **pin_factory** (Factory (page 180)) – See API - Pins (page 177) 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, 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\(^{266}\)) – Number of seconds on. Defaults to 1 second.
- **off_time** (float\(^{267}\)) – Number of seconds off. Defaults to 1 second.
- **fade_in_time** (float\(^{268}\)) – Number of seconds to spend fading in. Defaults to 0. Must be 0 if pwm was False when the class was constructed (ValueError\(^{269}\) will be raised if not).
- **fade_out_time** (float\(^{270}\)) – Number of seconds to spend fading out. Defaults to 0. Must be 0 if pwm was False when the class was constructed (ValueError\(^{271}\) will be raised if not).
- **on_color** (tuple\(^{272}\)) – The color to use when the LED is “on”. Defaults to white.
- **off_color** (tuple\(^{273}\)) – The color to use when the LED is “off”. Defaults to black.
- **n** (int\(^{274}\)) – Number of times to blink; None (the default) means forever.
- **background** (bool\(^{275}\)) – If True (the default), start a background thread to continue blinking and return immediately. If False, only return when the blink is finished (warning: the default value of n will result in this method never returning).

---

263 https://www.piborg.org/ledborg
264 https://docs.python.org/3.5/library/stdtypes.html#tuple
265 https://docs.python.org/3.5/library/functions.html#bool
266 https://docs.python.org/3.5/library/functions.html#float
267 https://docs.python.org/3.5/library/functions.html#float
268 https://docs.python.org/3.5/library/functions.html#float
269 https://docs.python.org/3.5/library/exceptions.html#ValueError
270 https://docs.python.org/3.5/library/functions.html#float
271 https://docs.python.org/3.5/library/exceptions.html#ValueError
272 https://docs.python.org/3.5/library/stdtypes.html#tuple
273 https://docs.python.org/3.5/library/stdtypes.html#tuple
274 https://docs.python.org/3.5/library/functions.html#int
275 https://docs.python.org/3.5/library/functions.html#bool
**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:

```python
>>> from gpiozero import *

>>> bz = Buzzer(16)

>>> bz.on()

>>> bz.off()

>>> bz.close()

>>> led = LED(16)

>>> led.blink()
```

**Device (page 161)** descendents can also be used as context managers using the `with` statement. For example:

```python
>>> from gpiozero import *

>>> with Buzzer(16) as bz:
...     bz.on()
...     ...

>>> with LED(16) as led:
...     led.on()
...     ...
```

**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) – Number of seconds to spend fading in. Defaults to 1.
- **fade_out_time**(float) – Number of seconds to spend fading out. Defaults to 1.
- **on_color**(tuple) – The color to use when the LED is “on”. Defaults to white.
- **off_color**(tuple) – The color to use when the LED is “off”. Defaults to black.
- **n**(int) – Number of times to pulse; None (the default) means forever.
- **background**(bool) – If True (the default), start a background thread to continue pulsing and return immediately. If False, only return when the pulse is finished (warning: the default value of n will result in this method never returning).

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276 https://docs.python.org/3.5/reference/compound_stmts.html#with
277 https://docs.python.org/3.5/library/functions.html#float
278 https://docs.python.org/3.5/library/functions.html#float
279 https://docs.python.org/3.5/library/stdtypes.html#tuple
280 https://docs.python.org/3.5/library/stdtypes.html#tuple
281 https://docs.python.org/3.5/library/functions.html#int
282 https://docs.python.org/3.5/library/functions.html#bool
**toggle()**

Toggles the state of the device. If the device is currently off (value (page 125) is (0, 0, 0)), this changes it to “fully” on (value (page 125) is (1, 1, 1)). If the device has a specific color, this method inverts the color.

**closed**

Returns True if the device is closed (see the close() (page 123) method). Once a device is closed you can no longer use any other methods or properties to control or query the device.

**color**

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 when the class was constructed (and only 0 or 1 if not).

For example, purple would be (1, 0, 1) and yellow would be (1, 1, 0), while orange would be (1, 0.5, 0).

**is_active**

Returns True if the LED is currently active (not black) and False otherwise.

**is_lit**

Returns True if the LED is currently active (not black) and False otherwise.

**source**

The iterable to use as a source of values for value (page 125).

**source_delay**

The delay (measured in seconds) in the loop used to read values from source (page 125). Defaults to 0.01 seconds which is generally sufficient to keep CPU usage to a minimum while providing adequate responsiveness.

**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 when the class was constructed (and only 0 or 1 if not).

For example, purple would be (1, 0, 1) and yellow would be (1, 1, 0), while orange would be (1, 0.5, 0).

**values**

An infinite iterator of values read from value.

## 15.6 PiLITEr

**class** `gpiozero.PiLiter (pwm=False, initial_value=False, pin_factory=None)`

Extends LEDBoard (page 113) for the Ciseco Pi-LITEr\(^\text{283}\): a strip of 8 very bright LEDs.

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:

```python
from gpiozero import PiLiter
lite = PiLiter()
lite.on()
```

**Parameters**

- **pwm (bool\(^\text{284}\))** - If True, construct PWMLED (page 88) instances for each pin. If False (the default), construct regular LED (page 87) instances.

\(^{283}\) [http://shop.ciseco.co.uk/pi-liter-8-led-strip-for-the-raspberry-pi/](http://shop.ciseco.co.uk/pi-liter-8-led-strip-for-the-raspberry-pi/)

\(^{284}\) [https://docs.python.org/3.5/library/functions.html#bool](https://docs.python.org/3.5/library/functions.html#bool)
• **initial_value** (*bool*) – If **False** (the default), all LEDs will be off initially. If **None**, each device will be left in whatever state the pin is found in when configured for output (warning: this can be on). If **True**, the device will be switched on initially.

• **pin_factory** (*Factory*) – See **API - Pins** (page 177) 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 all the LEDs turn on and off repeatedly.

**Parameters**

• **on_time** (*float*) – Number of seconds on. Defaults to 1 second.

• **off_time** (*float*) – Number of seconds off. Defaults to 1 second.

• **fade_in_time** (*float*) – Number of seconds to spend fading in. Defaults to 0. Must be 0 if **pwm** was **False** when the class was constructed (**ValueError** will be raised if not).

• **fade_out_time** (*float*) – Number of seconds to spend fading out. Defaults to 0. Must be 0 if **pwm** was **False** when the class was constructed (**ValueError** will be raised if not).

• **n** (*int*) – Number of times to blink; **None** (the default) means forever.

• **background** (*bool*) – If **True**, start a background thread to continue blinking and return immediately. If **False**, only return when the blink is finished (warning: the default value of **n** will result in this method never returning).

**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:

```python
>>> from gpiozero import *
>>> bz = Buzzer(16)
>>> bz.on()
>>> bz.off()
>>> bz.close()
>>> led = LED(16)
>>> led.blink()
```

**Device** (page 161) descendants can also be used as context managers using the **with** statement. For example:

```python
285 https://docs.python.org/3.5/library/functions.html#bool
286 https://docs.python.org/3.5/library/functions.html#float
287 https://docs.python.org/3.5/library/functions.html#float
288 https://docs.python.org/3.5/library/functions.html#float
289 https://docs.python.org/3.5/library/exceptions.html#ValueError
290 https://docs.python.org/3.5/library/functions.html#float
291 https://docs.python.org/3.5/library/exceptions.html#ValueError
292 https://docs.python.org/3.5/library/functions.html#int
293 https://docs.python.org/3.5/library/functions.html#bool
294 https://docs.python.org/3.5/reference/compound_stmts.html#with

126 Chapter 15. API - Boards and Accessories
off(*args)
   Turn all the output devices off.

on(*args)
   Turn all the output devices 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) – Number of seconds to spend fading in. Defaults to 1.
   • fade_out_time(float) – Number of seconds to spend fading out. Defaults to 1.
   • n(int) – Number of times to blink; None (the default) means forever.
   • background(bool) – If True (the default), start a background thread to continue blinking and return immediately. If False, only return when the blink is finished (warning: the default value of n will result in this method never returning).

toggle(*args)
   Toggle all the output devices. For each device, if it’s on, turn it off; if it’s off, turn it on.

closed
   Returns True if the device is closed (see the close() (page 126) 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 if the device is currently active and False otherwise. This property is usually derived from value (page 127). Unlike value (page 127), this is always a boolean.

leds
   A flat tuple of all LEDs contained in this collection (and all sub-collections).

source
   The iterable to use as a source of values for value (page 127).

source_delay
   The delay (measured in seconds) in the loop used to read values from source (page 127). Defaults to 0.01 seconds which is generally sufficient to keep CPU usage to a minimum while providing adequate responsiveness.

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.

values
   An infinite iterator of values read from value.

---
295 https://docs.python.org/3.5/library/functions.html#float
296 https://docs.python.org/3.5/library/functions.html#float
297 https://docs.python.org/3.5/library/functions.html#int
298 https://docs.python.org/3.5/library/functions.html#bool
15.7 PiLITEr Bar Graph

class gpiozero.PiLiterBarGraph (pwm=False, initial_value=0.0, pin_factory=None)

Extends LEDBarGraph (page 116) to treat the Ciseco Pi-LITEr 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:

```python
from gpiozero import PiLiterBarGraph

graph = PiLiterBarGraph()
graph.value = 0.5
```

**Parameters**

- **pwm** (bool) – If True, construct PWMLED (page 88) instances for each pin. If False (the default), construct regular LED (page 87) instances.
- **initial_value** (float) – The initial value (page 128) of the graph given as a float between -1 and +1. Defaults to 0.0.
- **pin_factory** (Factory) – See API - Pins (page 177) for more information (this is an advanced feature which most users can ignore).

**Methods**

- **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.

- **closed**
  Returns True if the device is closed (see the close() 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 if the device is currently active and False otherwise. This property is usually derived from value (page 128). Unlike value (page 128), this is always a boolean.

- **leds**
  A flat tuple of all LEDs contained in this collection (and all sub-collections).

- **lit_count**
  The number of LEDs on the bar graph actually lit up. Note that just like value, 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 128).

- **source_delay**
  The delay (measured in seconds) in the loop used to read values from source (page 128). Defaults to 0.01 seconds which is generally sufficient to keep CPU usage to a minimum while providing adequate responsiveness.

- **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.

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299 [http://shop.ciseco.co.uk/pi-liter-8-led-strip-for-the-raspberry-pi/](http://shop.ciseco.co.uk/pi-liter-8-led-strip-for-the-raspberry-pi/)

300 [https://docs.python.org/3.5/library/functions.html#bool](https://docs.python.org/3.5/library/functions.html#bool)

301 [https://docs.python.org/3.5/library/functions.html#float](https://docs.python.org/3.5/library/functions.html#float)
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:

```python
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 128) is effectively -1 < value <= 1.

values
An infinite iterator of values read from value.

### 15.8 PI-TRAFFIC

**class gpiozero.PiTraffic** *(pwm=False, initial_value=False, pin_factory=None)*

Extends `TrafficLights` (page 120) for the Low Voltage Labs PI-TRAFFIC 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:

```python
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 120).

**Parameters**

- `pwm` *(bool)* – If True, construct `PWMLED` (page 88) instances to represent each LED. If False (the default), construct regular `LED` (page 87) instances.
- `initial_value` *(bool)* – If False (the default), all LEDs will be off initially. If None, each device will be left in whatever state the pin is found in when configured for output (warning: this can be on). If True, the device will be switched on initially.
- `pin_factory` *(Factory)* – See API - Pins (page 180) 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 all the LEDs turn on and off repeatedly.

**Parameters**

- `on_time` *(float)* – Number of seconds on. Defaults to 1 second.
- `off_time` *(float)* – Number of seconds off. Defaults to 1 second.

---

303 [https://docs.python.org/3.5/library/functions.html#bool](https://docs.python.org/3.5/library/functions.html#bool)
304 [https://docs.python.org/3.5/library/functions.html#bool](https://docs.python.org/3.5/library/functions.html#bool)
305 [https://docs.python.org/3.5/library/functions.html#float](https://docs.python.org/3.5/library/functions.html#float)
306 [https://docs.python.org/3.5/library/functions.html#float](https://docs.python.org/3.5/library/functions.html#float)
• **fade_in_time** (*float*) – Number of seconds to spend fading in. Defaults to 0. Must be 0 if `pwm` was `False` when the class was constructed (`ValueError` will be raised if not).

• **fade_out_time** (*float*) – Number of seconds to spend fading out. Defaults to 0. Must be 0 if `pwm` was `False` when the class was constructed (`ValueError` will be raised if not).

• **n** (*int*) – Number of times to blink; `None` (the default) means forever.

• **background** (*bool*) – If `True`, start a background thread to continue blinking and return immediately. If `False`, only return when the blink is finished (warning: the default value of `n` will result in this method never returning).

**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:

```python
>>> from gpiozero import *
>>> bz = Buzzer(16)
>>> bz.on()
>>> bz.off()
>>> bz.close()
>>> led = LED(16)
>>> led.blink()
```

**Device** (page 161) descendents can also be used as context managers using the `with` statement. For example:

```python
>>> from gpiozero import *
>>> with Buzzer(16) as bz:
...    bz.on()
...    ...
>>> with LED(16) as led:
...    led.on()
...    ...
```

**off** (*args*)

Turn all the output devices off.

**on** (*args*)

Turn all the output devices on.

**pulse** (*fade_in_time=1, fade_out_time=1, n=None, background=True*)

Make the device fade in and out repeatedly.

**Parameters**

307 https://docs.python.org/3.5/library/functions.html#float
308 https://docs.python.org/3.5/library/exceptions.html#ValueError
309 https://docs.python.org/3.5/library/functions.html#float
310 https://docs.python.org/3.5/library/exceptions.html#ValueError
311 https://docs.python.org/3.5/library/exceptions.html#ValueError
312 https://docs.python.org/3.5/library/functions.html#bool
313 https://docs.python.org/3.5/reference/compound_stmts.html#with
• *fade_in_time* (*float*) – Number of seconds to spend fading in. Defaults to 1.
• *fade_out_time* (*float*) – Number of seconds to spend fading out. Defaults to 1.
• *n* (*int*) – Number of times to blink; None (the default) means forever.
• *background* (*bool*) – If True (the default), start a background thread to continue blinking and return immediately. If False, only return when the blink is finished (warning: the default value of *n* will result in this method never returning).

toggle(*args*)
Toggles all the output devices. For each device, if it’s on, turn it off; if it’s off, turn it on.

closed
Returns True if the device is closed (see the close() (page 130) 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 if the device is currently active and False otherwise. This property is usually derived from value (page 131). Unlike value (page 131), this is always a boolean.

leds
A flat tuple of all LEDs contained in this collection (and all sub-collections).

source
The iterable to use as a source of values for value (page 131).

source_delay
The delay (measured in seconds) in the loop used to read values from source (page 131). Defaults to 0.01 seconds which is generally sufficient to keep CPU usage to a minimum while providing adequate responsiveness.

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.

values
An infinite iterator of values read from value.

15.9 Pi-Stop

class gpiozero.PiStop(*location=None, pwm=False, initial_value=False, pin_factory=None*)
Extends TrafficLights (page 120) for the PiHardware Pi-Stop: a vertical traffic lights board.

The following example turns on the amber LED on a Pi-Stop connected to location A+:

```python
from gpiozero import PiStop

traffic = PiStop('A+')
traffic.amber.on()
```

Parameters

• *location* (*str*) – The location on the GPIO header to which the Pi-Stop is connected. Must be one of: A, A+, B, B+, C, D.

---

314 https://docs.python.org/3.5/library/functions.html#float
315 https://docs.python.org/3.5/library/functions.html#float
316 https://docs.python.org/3.5/library/functions.html#float
317 https://docs.python.org/3.5/library/functions.html#bool
318 https://pihw.wordpress.com/meltwaters-pi-hardware-kits/pi-stop/
319 https://docs.python.org/3.5/library/stdtypes.html#str
320 https://github.com/PiHw/Pi-Stop/blob/master/markdown_source/markdown/Discover-PiStop.md
• **pwm** *(bool)* – If True, construct `PWMLED` (page 88) instances to represent each LED. If False (the default), construct regular `LED` (page 87) instances.

• **initial_value** *(bool)* – If False (the default), all LEDs will be off initially. If None, each device will be left in whatever state the pin is found in when configured for output (warning: this can be on). If True, the device will be switched on initially.

• **pin_factory** *(Factory)* – See `API - Pins` (page 177) 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 all the LEDs turn on and off repeatedly.

**Parameters**

• **on_time** *(float)* – Number of seconds on. Defaults to 1 second.

• **off_time** *(float)* – Number of seconds off. Defaults to 1 second.

• **fade_in_time** *(float)* – Number of seconds to spend fading in. Defaults to 0. Must be 0 if `pwm` was False when the class was constructed (`ValueError` will be raised if not).

• **fade_out_time** *(float)* – Number of seconds to spend fading out. Defaults to 0. Must be 0 if `pwm` was False when the class was constructed (`ValueError` will be raised if not).

• **n** *(int)* – Number of times to blink; None (the default) means forever.

• **background** *(bool)* – If True, start a background thread to continue blinking and return immediately. If False, only return when the blink is finished (warning: the default value of n will result in this method never returning).

**`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:

```python
>>> from gpiozero import *
>>> bz = Buzzer(16)
>>> bz.on()
>>> bz.off()
>>> bz.close()
>>> led = LED(16)
>>> led.blink()
```

---

321 https://docs.python.org/3.5/library/functions.html#bool
322 https://docs.python.org/3.5/library/functions.html#bool
323 https://docs.python.org/3.5/library/functions.html#float
324 https://docs.python.org/3.5/library/functions.html#float
325 https://docs.python.org/3.5/library/functions.html#float
326 https://docs.python.org/3.5/library/exceptions.html#ValueError
327 https://docs.python.org/3.5/library/functions.html#float
328 https://docs.python.org/3.5/library/exceptions.html#ValueError
329 https://docs.python.org/3.5/library/functions.html#int
330 https://docs.python.org/3.5/library/functions.html#bool
Device (page 161) descendents can also be used as context managers using the with\(^{331}\) statement. For example:

```python
>>> from gpiozero import *
>>> with Buzzer(16) as bz:
    ...
    bz.on()
    ...
>>> with LED(16) as led:
    ...
    led.on()
    ...
```

`off (*args)`
Turn all the output devices off.

`on (*args)`
Turn all the output devices 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)\(^{332}\)` – Number of seconds to spend fading in. Defaults to 1.
- `fade_out_time (float)\(^{333}\)` – Number of seconds to spend fading out. Defaults to 1.
- `n (int)\(^{334}\)` – Number of times to blink; None (the default) means forever.
- `background (bool)\(^{335}\)` – If True (the default), start a background thread to continue blinking and return immediately. If False, only return when the blink is finished (warning: the default value of n will result in this method never returning).

`toggle (*args)`
Toggle all the output devices. For each device, if it’s on, turn it off; if it’s off, turn it on.

`closed`
Returns True if the device is closed (see the close() (page 132) 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 if the device is currently active and False otherwise. This property is usually derived from value (page 133). Unlike value (page 133), this is always a boolean.

`leds`
A flat tuple of all LEDs contained in this collection (and all sub-collections).

`source`
The iterable to use as a source of values for value (page 133).

`source_delay`
The delay (measured in seconds) in the loop used to read values from source (page 133). Defaults to 0.01 seconds which is generally sufficient to keep CPU usage to a minimum while providing adequate responsiveness.

`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.

`values`
An infinite iterator of values read from value.

\(^{331}\) https://docs.python.org/3.5/reference/compound_stmts.html#with
\(^{332}\) https://docs.python.org/3.5/library/functions.html#float
\(^{333}\) https://docs.python.org/3.5/library/functions.html#float
\(^{334}\) https://docs.python.org/3.5/library/functions.html#int
\(^{335}\) https://docs.python.org/3.5/library/functions.html#bool

15.9. Pi-Stop 133
15.10 TrafficLightsBuzzer

class gpiozero.TrafficLightsBuzzer (lights, buzzer, button, pin_factory=None)

Extends CompositeOutputDevice (page 152) and is a generic class for HATs with traffic lights, a button and a buzzer.

Parameters

- **lights** (TrafficLights (page 120)) – An instance of TrafficLights (page 120) representing the traffic lights of the HAT.
- **buzzer** (Buzzer (page 92)) – An instance of Buzzer (page 92) representing the buzzer on the HAT.
- **button** (Button (page 73)) – An instance of Button (page 73) representing the button on the HAT.
- **pin_factory** (Factory (page 180)) – See API - Pins (page 177) for more information (this is an advanced feature which most users can ignore).

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.

closed

Returns True if the device is closed (see the close() 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 if the device is currently active and False otherwise. This property is usually derived from value (page 134). Unlike value (page 134), this is always a boolean.

source

The iterable to use as a source of values for value (page 134).

source_delay

The delay (measured in seconds) in the loop used to read values from source (page 134). Defaults to 0.01 seconds which is generally sufficient to keep CPU usage to a minimum while providing adequate responsiveness.

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.

values

An infinite iterator of values read from value.

15.11 Fish Dish

class gpiozero.FishDish (pwm=False, pin_factory=None)

Extends TrafficLightsBuzzer (page 134) for the Pi Supply FishDish\(^{336}\): 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:

\(^{336}\)https://www.pi-supply.com/product/fish-dish-raspberry-pi-led-buzzer-board/
from gpiozero import FishDish

fish = FishDish()
fish.button.wait_for_press()
fish.lights.on()

Parameters

- **pwm** *(bool)* – If True, construct **PWMLED** (page 88) instances to represent each LED. If False (the default), construct regular **LED** (page 87) instances.

- **pin_factory** *(Factory)* – See **API - Pins** (page 177) for more information (this is an advanced feature which most users can ignore).

**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.

**closed**

Returns **True** if the device is closed (see the **close()** 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** if the device is currently active and **False** otherwise. This property is usually derived from **value** (page 135). Unlike **value** (page 135), this is **always** a boolean.

**source**

The iterable to use as a source of values for **value** (page 135).

**source_delay**

The delay (measured in seconds) in the loop used to read values from **source** (page 135). Defaults to 0.01 seconds which is generally sufficient to keep CPU usage to a minimum while providing adequate responsiveness.

**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.

**values**

An infinite iterator of values read from **value**.

### 15.12 Traffic HAT

**class** gpiozero.TrafficHat *(pwm=False, pin_factory=None)*

Extends **TrafficLightsBuzzer** (page 134) for the Ryanteck Traffic HAT\(^{338}\): 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:

```python
from gpiozero import TrafficHat

hat = TrafficHat()
```

\(^{337}\) [https://docs.python.org/3.5/library/functions.html#bool](https://docs.python.org/3.5/library/functions.html#bool)

\(^{338}\) [https://ryanteck.uk/hats/1-trafficchat-0635648607122.html](https://ryanteck.uk/hats/1-trafficchat-0635648607122.html)
hat.button.wait_for_press()
hat.lights.on()

Parameters

- `pwm` (bool) – If True, construct PWMLED (page 88) instances to represent each LED. If False (the default), construct regular LED (page 87) instances.

- `pin_factory` (Factory (page 180)) – See API - Pins (page 177) for more information (this is an advanced feature which most users can ignore).

`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.

`closed`
Returns True if the device is closed (see the close() 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 if the device is currently active and False otherwise. This property is usually derived from value (page 136). Unlike value (page 136), this is always a boolean.

`source`
The iterable to use as a source of values for value (page 136).

`source_delay`
The delay (measured in seconds) in the loop used to read values from source (page 136). Defaults to 0.01 seconds which is generally sufficient to keep CPU usage to a minimum while providing adequate responsiveness.

`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.

`values`
An infinite iterator of values read from value.

15.13 Robot

class gpiozero.Robot (left=None, right=None, pin_factory=None)
Extends CompositeDevice (page 153) 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:

```python
from gpiozero import Robot

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

Parameters

https://docs.python.org/3.5/library/functions.html#bool
• **left** (*tuple*[^340]) – A tuple of two GPIO pins representing the forward and backward inputs of the left motor’s controller.

• **right** (*tuple*[^341]) – A tuple of two GPIO pins representing the forward and backward inputs of the right motor’s controller.

• **pin_factory** (*Factory*[^180]) – See *API - Pins* (page 177) for more information (this is an advanced feature which most users can ignore).

**backward** (*speed=1, **kwargs*)

Drive the robot backward by running both motors backward.

**Parameters**

• **speed** (*float*[^342]) – Speed at which to drive the motors, as a value between 0 (stopped) and 1 (full speed). The default is 1.

• **curve_left** (*float*[^343]) – 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*[^344]) – 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*.

**forward** (*speed=1, **kwargs*)

Drive the robot forward by running both motors forward.

**Parameters**

• **speed** (*float*[^345]) – Speed at which to drive the motors, as a value between 0 (stopped) and 1 (full speed). The default is 1.

• **curve_left** (*float*[^346]) – 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*[^347]) – 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*[^348]) – 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.

[^340]: https://docs.python.org/3.5/library/stdtypes.html#tuple
[^341]: https://docs.python.org/3.5/library/stdtypes.html#tuple
[^342]: https://docs.python.org/3.5/library/functions.html#float
[^343]: https://docs.python.org/3.5/library/functions.html#float
[^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/functions.html#float
[^348]: https://docs.python.org/3.5/library/functions.html#float
Parameters

- **speed** (*float*[^349]) – 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.

- **closed**
  - Returns *True* if the device is closed (see the `close()` 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* if the device is currently active and *False* otherwise. This property is usually derived from `value` (page 138). Unlike `value` (page 138), this is always a boolean.

- **source**
  - The iterable to use as a source of values for `value` (page 138).

- **source_delay**
  - The delay (measured in seconds) in the loop used to read values from `source` (page 138). Defaults to 0.01 seconds which is generally sufficient to keep CPU usage to a minimum while providing adequate responsiveness.

- **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.

- **values**
  - An infinite iterator of values read from `value`.

### 15.14 PhaseEnableRobot

**class** `gpiozero.PhaseEnableRobot` *(left=None, right=None, pin_factory=None)*

Extends `CompositeDevice` (page 153) 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()
```

**Parameters**

- **left** (*tuple*[^350]) – A tuple of two GPIO pins representing the phase and enable inputs of the left motor’s controller.

- **right** (*tuple*[^351]) – A tuple of two GPIO pins representing the phase and enable inputs of the right motor’s controller.

- **pin_factory** (*Factory* (page 180)) – See `API - Pins` (page 177) for more information (this is an advanced feature which most users can ignore).

**backward** *(speed=1)*

- Drive the robot backward by running both motors backward.

[^349]: https://docs.python.org/3.5/library/functions.html#float
[^350]: https://docs.python.org/3.5/library/stdtypes.html#tuple
[^351]: https://docs.python.org/3.5/library/stdtypes.html#tuple
Parameters **speed** (*float*) – 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*) – 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*) – 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*) – 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.

**closed**
Returns **True** if the device is closed (see the **close()** 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** if the device is currently active and **False** otherwise. This property is usually derived from **value** (page 139). Unlike **value** (page 139), this is always a boolean.

**source**
The iterable to use as a source of values for **value** (page 139).

**source_delay**
The delay (measured in seconds) in the loop used to read values from **source** (page 139). Defaults to 0.01 seconds which is generally sufficient to keep CPU usage to a minimum while providing adequate responsiveness.

**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.

**values**
An infinite iterator of values read from **value**.

### 15.15 Ryanteck MCB Robot

**class** `gpiozero.RyanteckRobot` (*pin_factory=None*)

Extends **Robot** (page 136) for the Ryanteck motor controller board356.

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:

352 https://docs.python.org/3.5/library/functions.html#float
353 https://docs.python.org/3.5/library/functions.html#float
354 https://docs.python.org/3.5/library/functions.html#float
355 https://docs.python.org/3.5/library/functions.html#float
from gpiozero import RyanteckRobot
robot = RyanteckRobot()
robot.forward()

Parameters **pin_factory** *(Factory (page 180)) – See API - Pins (page 177) for more information (this is an advanced feature which most users can ignore).*

**backward** *(speed=1, **kwargs)*

Drive the robot backward by running both motors backward.

Parameters

- **speed** *(float)* – Speed at which to drive the motors, as a value between 0 (stopped) and 1 (full speed). The default is 1.
- **curve_left** *(float)* – 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)* – 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.

**forward** *(speed=1, **kwargs)*

Drive the robot forward by running both motors forward.

Parameters

- **speed** *(float)* – Speed at which to drive the motors, as a value between 0 (stopped) and 1 (full speed). The default is 1.
- **curve_left** *(float)* – 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)* – 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)* – 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.

**357** https://docs.python.org/3.5/library/functions.html#float
**358** https://docs.python.org/3.5/library/functions.html#float
**359** https://docs.python.org/3.5/library/functions.html#float
**360** https://docs.python.org/3.5/library/functions.html#float
**361** https://docs.python.org/3.5/library/functions.html#float
**362** https://docs.python.org/3.5/library/functions.html#float
**363** https://docs.python.org/3.5/library/functions.html#float
Parameters  **speed** (*float*[^364]) – 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.

**closed**
Returns `True` if the device is closed (see the `close()` 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` if the device is currently active and `False` otherwise. This property is usually derived from `value` (page 141). Unlike `value` (page 141), this is always a boolean.

**source**
The iterable to use as a source of values for `value` (page 141).

**source_delay**
The delay (measured in seconds) in the loop used to read values from `source` (page 141). Defaults to 0.01 seconds which is generally sufficient to keep CPU usage to a minimum while providing adequate responsiveness.

**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.

**values**
An infinite iterator of values read from `value`.

### 15.16 CamJam #3 Kit Robot

**class** `gpiozero.CamJamKitRobot` (*pin_factory=None*)

Extends `Robot` (page 136) for the CamJam #3 EduKit[^365] 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:

```python
from gpiozero import CamJamKitRobot
robot = CamJamKitRobot()
robot.forward()
```

**Parameters**

**pin_factory** (*Factory*[^366]) – See API - Pins (page 177) for more information (this is an advanced feature which most users can ignore).

**backward** (*speed=1, **kwargs*)
Drive the robot backward by running both motors backward.

**Parameters**

- **speed** (*float*[^366]) – Speed at which to drive the motors, as a value between 0 (stopped) and 1 (full speed). The default is 1.
- **curve_left** (*float*[^367]) – 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`.

[^364]: https://docs.python.org/3.5/library/functions.html#float
[^365]: http://camjam.me/?page_id=1035
[^366]: https://docs.python.org/3.5/library/functions.html#float
[^367]: https://docs.python.org/3.5/library/functions.html#float
• **curve_right** *(float)* – 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.

**forward(speed=1, **kwargs)**

Drive the robot forward by running both motors forward.

**Parameters**

- **speed** *(float)* – Speed at which to drive the motors, as a value between 0 (stopped) and 1 (full speed). The default is 1.

- **curve_left** *(float)* – 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)* – 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)* – 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)* – 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.

**closed**

Returns True if the device is closed (see the close() 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 if the device is currently active and False otherwise. This property is usually derived from value (page 142). Unlike value (page 142), this is always a boolean.

**source**

The iterable to use as a source of values for value (page 142).

**source_delay**

The delay (measured in seconds) in the loop used to read values from source (page 142). Defaults to 0.01 seconds which is generally sufficient to keep CPU usage to a minimum while providing adequate responsiveness.

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368 https://docs.python.org/3.5/library/functions.html#float
369 https://docs.python.org/3.5/library/functions.html#float
370 https://docs.python.org/3.5/library/functions.html#float
371 https://docs.python.org/3.5/library/functions.html#float
372 https://docs.python.org/3.5/library/functions.html#float
373 https://docs.python.org/3.5/library/functions.html#float
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.

values
An infinite iterator of values read from value.

15.17 Pololu DRV8835 Robot

class gpiozero.PololuDRV8835Robot (pin_factory=None)
Extends PhaseEnableRobot (page 138) for the Pololu DRV8835 Dual Motor Driver Kit.

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:

```python
from gpiozero import PololuDRV8835Robot
robot = PololuDRV8835Robot()
robot.forward()
```

Parameters pin_factory (Factory (page 180)) – See API - Pins (page 177) for more information (this is an advanced feature which most users can ignore).

backward (speed=1)
Drive the robot backward by running both motors backward.

Parameters speed (float) – 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) – 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) – 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) – 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.

374 https://www.pololu.com/product/2753
375 https://docs.python.org/3.5/library/functions.html#float
376 https://docs.python.org/3.5/library/functions.html#float
377 https://docs.python.org/3.5/library/functions.html#float
378 https://docs.python.org/3.5/library/functions.html#float
closed
   Returns True if the device is closed (see the close() 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 if the device is currently active and False otherwise. This property is usually derived from value (page 144). Unlike value (page 144), this is always a boolean.

source
   The iterable to use as a source of values for value (page 144).

source_delay
   The delay (measured in seconds) in the loop used to read values from source (page 144). Defaults to 0.01 seconds which is generally sufficient to keep CPU usage to a minimum while providing adequate responsiveness.

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.

values
   An infinite iterator of values read from value.

15.18 Energenie

class gpiozero.Energenie(socket=None, initial_value=False, pin_factory=None)
   Extends Device (page 161) to represent an Energenie socket\(^\text{379}\) controller.

   This class is constructed with a socket number and an optional initial state (defaults to False, meaning off). Instances of this class can be used to switch peripherals on and off. For example:

   ```python
   from gpiozero import Energenie
   lamp = Energenie(1)
   lamp.on()
   ```

Parameters

- **socket** (\texttt{int}\(^\text{380}\)) – Which socket this instance should control. This is an integer number between 1 and 4.
- **initial_value** (\texttt{bool}\(^\text{381}\)) – 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 which will switch the socket off.
- **pin_factory** (\texttt{Factory} (page 180)) – See \textit{API - Pins} (page 177) for more information (this is an advanced feature which most users can ignore).

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

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\(^{379}\) https://energenie4u.co.uk/index.php/catalogue/product/ENER002-2PI

\(^{380}\) https://docs.python.org/3.5/library/functions.html#int

\(^{381}\) https://docs.python.org/3.5/library/functions.html#bool
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:

```python
>>> from gpiozero import *
>>> bz = Buzzer(16)
>>> bz.on()
>>> bz.off()
>>> bz.close()
>>> led = LED(16)
>>> led.blink()
```

Device (page 161) descendents can also be used as context managers using the with statement. For example:

```python
>>> from gpiozero import *
>>> with Buzzer(16) as bz:
...    bz.on()
...    ...
>>> with LED(16) as led:
...    led.on()
...    ...
```

closed
Returns `True` if the device is closed (see the close() (page 144) 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` if the device is currently active and `False` otherwise. This property is usually derived from `value` (page 145). Unlike `value` (page 145), this is always a boolean.

source
The iterable to use as a source of values for `value` (page 145).

source_delay
The delay (measured in seconds) in the loop used to read values from `source` (page 145). Defaults to 0.01 seconds which is generally sufficient to keep CPU usage to a minimum while providing adequate responsiveness.

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.

values
An infinite iterator of values read from `value`.

15.19 StatusZero

class gpiozero.StatusZero(*labels, pwm=False, active_high=True, initial_value=False, pin_factory=None)
Extends LEDBoard (page 113) for The Pi Hut’s STATUS Zero: 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:

---

382 https://docs.python.org/3.5/reference/compound_stmts.html#with

383 https://thepihut.com/statuszero
from gpiozero import StatusZero
status = StatusZero('wifi', 'raining')
status.wifi.green.on()
status.raining.red.on()

Parameters

• **labels** (*str*) – 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 180)) – See API - Pins (page 177) 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 all the LEDs turn on and off repeatedly.

Parameters

• **on_time** (*float*) – Number of seconds on. Defaults to 1 second.

• **off_time** (*float*) – Number of seconds off. Defaults to 1 second.

• **fade_in_time** (*float*) – Number of seconds to spend fading in. Defaults to 0. Must be 0 if **pwm** was False when the class was constructed (**ValueError** will be raised if not).

• **fade_out_time** (*float*) – Number of seconds to spend fading out. Defaults to 0. Must be 0 if **pwm** was False when the class was constructed (**ValueError** will be raised if not).

• **n** (*int*) – Number of times to blink; None (the default) means forever.

• **background** (*bool*) – If True, start a background thread to continue blinking and return immediately. If False, only return when the blink is finished (warning: the default value of **n** will result in this method never returning).

**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:

384 https://docs.python.org/3.5/library/stdtypes.html#str
385 https://docs.python.org/3.5/library/functions.html#float
386 https://docs.python.org/3.5/library/functions.html#float
387 https://docs.python.org/3.5/library/functions.html#float
388 https://docs.python.org/3.5/library/exceptions.html#ValueError
389 https://docs.python.org/3.5/library/functions.html#float
390 https://docs.python.org/3.5/library/exceptions.html#ValueError
391 https://docs.python.org/3.5/library/functions.html#int
392 https://docs.python.org/3.5/library/functions.html#bool
```python
>>> from gpiozero import *

>>> bz = Buzzer(16)
>>> bz.on()
>>> bz.off()
>>> bz.close()

>>> led = LED(16)
>>> led.blink()
```

Device (page 161) descendents can also be used as context managers using the `with` statement. For example:

```python
>>> from gpiozero import *

>>> with Buzzer(16) as bz:
...    bz.on()
...

>>> with LED(16) as led:
...    led.on()
...
```

- **off** (*args*)
  - Turn all the output devices off.

- **on** (*args*)
  - Turn all the output devices 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*) – Number of seconds to spend fading in. Defaults to 1.
  - `fade_out_time` (*float*) – Number of seconds to spend fading out. Defaults to 1.
  - `n` (*int*) – Number of times to blink; `None` (the default) means forever.
  - `background` (*bool*) – If True (the default), start a background thread to continue blinking and return immediately. If False, only return when the blink is finished (warning: the default value of `n` will result in this method never returning).

- **toggle** (*args*)
  - Toggle all the output devices. For each device, if it’s on, turn it off; if it’s off, turn it on.

- **closed**
  - Returns True if the device is closed (see the `close()` (page 146) 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 if the device is currently active and False otherwise. This property is usually derived from `value` (page 148). Unlike `value` (page 148), this is always a boolean.

- **leds**
  - A flat tuple of all LEDs contained in this collection (and all sub-collections).

- **source**
  - The iterable to use as a source of values for `value` (page 148).

- **source_delay**
  - The delay (measured in seconds) in the loop used to read values from `source` (page 147). Defaults to

---

393 https://docs.python.org/3.5/reference/compound_stmts.html#with
394 https://docs.python.org/3.5/library/functions.html#float
395 https://docs.python.org/3.5/library/functions.html#float
396 https://docs.python.org/3.5/library/functions.html#int
397 https://docs.python.org/3.5/library/functions.html#bool
0.01 seconds which is generally sufficient to keep CPU usage to a minimum while providing adequate responsiveness.

**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.

**values**
An infinite iterator of values read from **value**.

### 15.20 StatusBoard

**class** `gpiozero.StatusBoard` (*labels*, `pwm=False`, `active_high=True`, `initial_value=False`, `pin_factory=None`)

Extends `CompositeOutputDevice` (page 152) for The Pi Hut’s STATUS 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')
status.wifi.lights.green.on()
status.wifi.button.when_pressed = status.wifi.lights.toggle
```

**Parameters**

- **labels** (`str`)
  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 180))
  See API - Pins (page 177) for more information (this is an advanced feature which most users can ignore).

**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.

**closed**
Returns True if the device is closed (see the close() 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 if the device is currently active and False otherwise. This property is usually derived from **value** (page 148). Unlike **value** (page 148), this is always a boolean.

**source**
The iterable to use as a source of values for **value** (page 148).

**source_delay**
The delay (measured in seconds) in the loop used to read values from **source** (page 148). Defaults to 0.01 seconds which is generally sufficient to keep CPU usage to a minimum while providing adequate responsiveness.

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398 [https://thepihut.com/status](https://thepihut.com/status)
399 [https://docs.python.org/3.5/library/stdtypes.html#str](https://docs.python.org/3.5/library/stdtypes.html#str)
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.

values
An infinite iterator of values read from value.

15.21 SnowPi

class gpiozero.SnowPi (pwm=False, initial_value=False, pin_factory=None)
Extends LEDBoard (page 113) for the Ryanteck SnowPi 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:

```python
from gpiozero import SnowPi

snowman = SnowPi(pwm=True)
snowman.eyes.on()
snowman.nose.pulse()
snowman.arms.blink()
```

Parameters

- **pwm** (bool) – If True, construct PWMLED (page 88) instances to represent each
  LED. If False (the default), construct regular LED (page 87) instances.
- **initial_value** (bool) – If False (the default), all LEDs will be off initially. If
  None, each device will be left in whatever state the pin is found in when configured for output (warning: this can be on). If True, the device will be switched on initially.
- **pin_factory** (Factory) – See API - Pins (page 177) 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 all the LEDs turn on and off repeatedly.

Parameters

- **on_time** (float) – Number of seconds on. Defaults to 1 second.
- **off_time** (float) – Number of seconds off. Defaults to 1 second.
- **fade_in_time** (float) – Number of seconds to spend fading in. Defaults to 0. Must be 0 if pwm was False when the class was constructed (ValueError will be raised if not).
- **fade_out_time** (float) – Number of seconds to spend fading out. Defaults to 0. Must be 0 if pwm was False when the class was constructed (ValueError will be raised if not).
- **n** (int) – Number of times to blink; None (the default) means forever.

---

401 https://docs.python.org/3.5/library/functions.html#bool
402 https://docs.python.org/3.5/library/functions.html#bool
403 https://docs.python.org/3.5/library/functions.html#float
404 https://docs.python.org/3.5/library/functions.html#float
405 https://docs.python.org/3.5/library/functions.html#float
406 https://docs.python.org/3.5/library/exceptions.html#ValueError
407 https://docs.python.org/3.5/library/functions.html#float
408 https://docs.python.org/3.5/library/exceptions.html#ValueError
409 https://docs.python.org/3.5/library/functions.html#int
• **background** (bool[^10]) – If True, start a background thread to continue blinking and return immediately. If False, only return when the blink is finished (warning: the default value of \( n \) will result in this method never returning).

**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:

```python
>>> from gpiozero import *
>>> bz = Buzzer(16)
>>> bz.on()
>>> bz.off()
>>> bz.close()
>>> led = LED(16)
>>> led.blink()
```

Device (page 161) descendents can also be used as context managers using the **with**[^11] statement. For example:

```python
>>> from gpiozero import *
>>> with Buzzer(16) as bz:
...    bz.on()
...    ...
>>> with LED(16) as led:
...    led.on()
...    ...
```

**off(**args**)
Turn all the output devices off.

**on(**args**)
Turn all the output devices on.

**pulse** (\( \text{fade\_in\_time}=1, \text{fade\_out\_time}=1, n=\text{None}, \text{background}=\text{True} \))
Make the device fade in and out repeatedly.

**Parameters**

• **fade\_in\_time** (float[^12]) – Number of seconds to spend fading in. Defaults to 1.

• **fade\_out\_time** (float[^13]) – Number of seconds to spend fading out. Defaults to 1.

• \( n \) (int[^14]) – Number of times to blink; None (the default) means forever.

• **background** (bool[^15]) – If True (the default), start a background thread to continue blinking and return immediately. If False, only return when the blink is finished (warning: the default value of \( n \) will result in this method never returning).

[^10]: https://docs.python.org/3.5/library/functions.html#bool
[^11]: https://docs.python.org/3.5/reference/compound_stmts.html#with
[^12]: https://docs.python.org/3.5/library/functions.html#float
[^13]: https://docs.python.org/3.5/library/functions.html#float
[^14]: https://docs.python.org/3.5/library/functions.html#int
[^15]: https://docs.python.org/3.5/library/functions.html#bool
**toggle** (*args*)

Toggles all the output devices. For each device, if it’s on, turn it off; if it’s off, turn it on.

**closed**

Returns `True` if the device is closed (see the `close()` (page 150) 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` if the device is currently active and `False` otherwise. This property is usually derived from `value` (page 151). Unlike `value` (page 151), this is *always* a boolean.

**leds**

A flat tuple of all LEDs contained in this collection (and all sub-collections).

**source**

The iterable to use as a source of values for `value` (page 151).

**source_delay**

The delay (measured in seconds) in the loop used to read values from `source` (page 151). Defaults to 0.01 seconds which is generally sufficient to keep CPU usage to a minimum while providing adequate responsiveness.

**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.

**values**

An infinite iterator of values read from `value`.

## 15.22 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.

### 15.23 LEDCollection

```python
class gpiozero.LEDCollection(*pins, pwm=False, active_high=True, initial_value=False, pin_factory=None, **named_pins)
```

Extends `CompositeOutputDevice` (page 152). Abstract base class for `LEDBoard` (page 113) and `LEDBarGraph` (page 116).

**leds**

A flat tuple of all LEDs contained in this collection (and all sub-collections).

### 15.24 CompositeOutputDevice

```python
class gpiozero.CompositeOutputDevice(*args, _order=None, pin_factory=None, **kwargs)
```

Extends `CompositeDevice` (page 153) with `on()` (page 152), `off()` (page 152), and `toggle()` (page 152) methods for controlling subordinate output devices. Also extends `value` (page 152) to be writeable.

**Parameters**

- `_order` (`list`[^1]) – If specified, this is the order of named items specified by keyword arguments (to ensure that the `value` (page 152) 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 180)) – See `API - Pins` (page 177) for more information (this is an advanced feature which most users can ignore).

**Methods**

- `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.

[^1]: https://docs.python.org/3.5/library/stdtypes.html#list
**15.25 CompositeDevice**

```python
class gpiozero.CompositeDevice(*args, _order=None, pin_factory=None, **kwargs)
```

Extends `Device` (page 161). Represents a device composed of multiple devices like simple HATs, H-bridge motor controllers, robots composed of multiple motors, etc.

The constructor accepts subordinate devices as positional or keyword arguments. Positional arguments form unnamed devices accessed via the `all` attribute, while keyword arguments are added to the device as named (read-only) attributes.

**Parameters**

- `_order` (`list`)[417]: If specified, this is the order of named items specified by keyword arguments (to ensure that the `value` (page 153) 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.

**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:

```python
>>> from gpiozero import *
>>> bz = Buzzer(16)
>>> bz.on()
>>> bz.off()
>>> bz.close()
>>> led = LED(16)
>>> led.blink()
```

`Device` (page 161) descendents can also be used as context managers using the `with`[418] statement. For example:

```python
>>> from gpiozero import *
>>> with Buzzer(16) as bz:
...    bz.on()
...    ...
>>> with LED(16) as led:
...    led.on()
...    ...
```

**closed**

Returns `True` if the device is closed (see the `close()` (page 153) 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` if the device is currently active and `False` otherwise. This property is usually derived from `value` (page 153). Unlike `value` (page 153), this is always a boolean.

**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.

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[417] https://docs.python.org/3.5/library/stdtypes.html#list
[418] https://docs.python.org/3.5/reference/compound_stmts.html#with
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!

### 16.1 TimeOfDay

**class gpiozero.TimeOfDay** *(start_time, end_time, utc=True)*

Extends *InternalDevice* (page 157) 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* instances.

The following example turns on a lamp attached to an *Energenie* (page 144) plug between 7 and 8 AM:

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

lamp = Energenie(0)
morning = TimeOfDay(time(7), time(8))

lamp.source = morning.values

pause()
```

**Parameters**

- **start_time** *(time)* – The time from which the device will be considered active.
- **end_time** *(time)* – The time after which the device will be considered inactive.

---

419. https://docs.python.org/3.5/library/datetime.html#datetime.time
420. https://docs.python.org/3.5/library/datetime.html#datetime.time
421. https://docs.python.org/3.5/library/datetime.html#datetime.time
• **utc** (*bool^[422]*) – If True (the default), a naive UTC time will be used for the comparison rather than a local time-zone reading.

### 16.2 PingServer

```python
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.values
pause()
```

**Parameters**

- **host** (*str^[423]*) – The hostname or IP address to attempt to ping.

### 16.3 CPUTemperature

```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: {:.1f}°C'.format(cpu.temperature))
graph = LEDBarGraph(5, 6, 13, 19, 25, pwm=True)
graph.source = cpu.values
pause()
```

**Parameters**

- **sensor_file** (*str^[424]*) – 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 millidegrees celsius.

---

[422]: https://docs.python.org/3.5/library/functions.html#bool
[423]: https://docs.python.org/3.5/library/stdtypes.html#str
[424]: https://docs.python.org/3.5/library/stdtypes.html#str
• `min_temp(float)` – The temperature at which value will read 0.0. This defaults to 0.0.

• `max_temp(float)` – The temperature at which value will read 1.0. This defaults to 100.0.

• `threshold(float)` – The temperature above which the device will be considered “active”. This defaults to 80.0.

`is_active`

Returns `True` when the CPU `temperature` (page 157) exceeds the `threshold`.

`temperature`

Returns the current CPU temperature in degrees celsius.

### 16.4 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.

#### 16.5 InternalDevice

**class `gpiozero.InternalDevice`**

Extends `Device` (page 161) 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.

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425 https://docs.python.org/3.5/library/functions.html#float
426 https://docs.python.org/3.5/library/functions.html#float
427 https://docs.python.org/3.5/library/functions.html#float
The GPIO Zero class hierarchy is quite extensive. It contains several base classes (most of which are documented in their corresponding chapters):

- **Device** (page 161) is the root of the hierarchy, implementing base functionality like `close()` (page 161) and context manager handlers.
- **GPIODevice** (page 84) represents individual devices that attach to a single GPIO pin.
- **SPIDevice** (page 111) represents devices that communicate over an SPI interface (implemented as four GPIO pins).
- **InternalDevice** (page 157) represents devices that are entirely internal to the Pi (usually operating system related services).
- **CompositeDevice** (page 153) represents devices composed of multiple other devices like HATs.

There are also several mixin classes\(^\text{428}\) 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):

\(^{428}\) https://en.wikipedia.org/wiki/Mixin
17.1 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 161) property, the `value` (page 161) property, and the `close()` (page 161) method).

```python
>>> from gpiozero import *
>>> bz = Buzzer(16)
>>> bz.on()
>>> bz.off()
>>> bz.close()
>>> led = LED(16)
>>> led.blink()
```

`Device` (page 161) descendents can also be used as context managers using the `with` statement. For example:

```python
>>> from gpiozero import *
>>> with Buzzer(16) as bz:
...    bz.on()
...    ...
>>> with LED(16) as led:
...    led.on()
...    ...
```

closed

Returns `True` if the device is closed (see the `close()` (page 161) 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` if the device is currently active and `False` otherwise. This property is usually derived from `value` (page 161). Unlike `value` (page 161), this is always a boolean.

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.

17.2 ValuesMixin

class gpiozero.ValuesMixin(...)

Adds a `values` (page 162) property to the class which returns an infinite generator of readings from the

---

429 https://docs.python.org/3.5/reference/compound_stmts.html#with
value 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.

### 17.3 SourceMixin

class gpiozero.SourceMixin(...)

Adds a source (page 162) property to the class which, given an iterable, sets value 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 162). Defaults to 0.01 seconds which is generally sufficient to keep CPU usage to a minimum while providing adequate responsiveness.

### 17.4 SharedMixin

class gpiozero.SharedMixin(...)

This mixin marks a class as “shared”. In this case, the meta-class (GPIOMeta) will use _shared_key() (page 162) 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() 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.

### 17.5 EventsMixin

class gpiozero.EventsMixin(...)

Adds edge-detected when_activated() (page 163) and when_deactivated() (page 163) events to a device based on changes to the is_active (page 161) property common to all devices. Also adds wait_for_active() (page 162) and wait_for_inactive() (page 163) 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*<sup>430</sup>) — Number of seconds to wait before proceeding. If this is *None* (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*<sup>431</sup>) — Number of seconds to wait before proceeding. If this is *None* (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*.

**inactive_time**
The length of time (in seconds) that the device has been inactive for. When the device is active, this is *None*.

**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* (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* (the default) to disable the event.

### 17.6 HoldMixin

class gpiozero.HoldMixin(...)

Extends *EventsMixin* (page 162) to add the *when_held* (page 163) event and the machinery to fire that event repeatedly (when *hold_repeat* (page 163) is *True*) at internals defined by *hold_time* (page 163).

**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 163) event rather than when the device activated, in contrast to *active_time* (page 163). If the device is not currently held, this is *None*.

**hold_repeat**
If *True*, *when_held* (page 163) will be executed repeatedly with *hold_time* (page 163) 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 163) handler. If *hold_repeat* (page 163) is *True*, this is also the length of time between invocations of *when_held* (page 163).

<sup>430</sup> https://docs.python.org/3.5/library/functions.html#float

<sup>431</sup> https://docs.python.org/3.5/library/functions.html#float
is_held
When True, the device has been active for at least hold_time (page 163) seconds.

when_held
The function to run when the device has remained active for hold_time (page 163) 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 (the default) to disable the event.
GPIO Zero includes several utility routines which are intended to be used with the Source/Values 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:

```python
from gpiozero.tools import scaled, negated, all_values
```

Given that source and values deal with infinite iterators, another excellent source of utilities is the itertools module in the standard library.

**Warning:** While the devices API is now considered stable and won’t change in backwards incompatible ways, the tools API is not yet considered stable. It is potentially subject to change in future versions. We welcome any comments from testers!

### 18.1 Single source conversions

**gpiozero.tools.absoluted(values)**

Returns values with all negative elements negated (so that they’re positive). For example:

```python
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.values, -1, 1)
led.source = absoluted(motor.values)
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

432 https://docs.python.org/3.5/library/itertools.html#module-itertools
can optionally be used to add hysteresis 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 1/4 and 3/4 of its full range:

```python
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.values, 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:

```python
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.values, 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:

```python
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.values)
pause()
```

gpiozero.tools.negated(values)
Returns the negation of the supplied values (True becomes False, and False becomes True). For example:

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

led = LED(4)
btn = Button(17)
led.source = negated(btn.values)
pause()
```

gpiozero.tools.post_delayed(values, delay)
Waits for delay seconds after returning each item from values.

---

433 https://en.wikipedia.org/wiki/Hysteresis
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 167), repeat_after can’t be 0. For example, to block every tenth item read from an ADC:

```python
from gpiozero import MCP3008
from gpiozero.tools import post_periodic_filtered
adc = MCP3008(channel=0)
for value in post_periodic_filtered(adc.values, 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:

```python
from gpiozero import MCP3008
from gpiozero.tools import pre_periodic_filtered
adc = MCP3008(channel=0)
for value in pre_periodic_filtered(adc.values, 50, 0):
    print(value)
```

Or to only display every even item read from an ADC:

```python
from gpiozero import MCP3008
from gpiozero.tools import pre_periodic_filtered
adc = MCP3008(channel=0)
for value in pre_periodic_filtered(adc.values, 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):

```python
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.values, 4)
pause()
```

gpiozero.toolsqueued(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:

```python
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].values, 5)
    leds[i].source_delay = 0.01

leds[4].source = btn.values
pause()

```python
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:

```python
from gpiozero import MCP3008
from gpiozero.tools import smoothed

adc = MCP3008(channel=0)

for value in smoothed(adc.values, 5):
    print(value)
```

```python
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):

```python
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.values, -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).

### 18.2 Combining sources

```python
gpiozero.tools.all_values(*values)
```
Returns the logical conjunction\(^{434}\) of all supplied values (the result is only True if and only if all input values are simultaneously True). One or more `values` can be specified. For example, to light an LED only when both buttons are pressed:

```python
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.values, btn2.values)
pause()

gpiozero.tools.any_values(*values)
Returns the logical disjunction\(^{435}\) of all supplied values (the result is True if any of the input values are currently True). One or more values can be specified. For example, to light an LED when any button is pressed:

```python
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.values, btn2.values)
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 as the average of several potentiometers connected to an MCP3008 ADC:

```python
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.values, pot2.values, pot3.values)
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 as the product (i.e. multiplication) of several potentiometers connected to an MCP3008 ADC:

```python
from gpiozero import MCP3008, PWMLED
from gpiozero.tools import multiplied
from signal import pause

pot1 = MCP3008(channel=0)
pot2 = MCP3008(channel=1)
pot3 = MCP3008(channel=2)
led = PWMLED(4)

led.source = multiplied(pot1.values, pot2.values, pot3.values)
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 as the (scaled) sum of several potentiometers connected to an MCP3008 ADC:

```python
from gpiozero import MCP3008, PWMLED
from gpiozero.tools import summed, scaled

pot1 = MCP3008(channel=0)
pot2 = MCP3008(channel=1)
pot3 = MCP3008(channel=2)
led = PWMLED(4)

led.source = summed(scaled(pot1.values, pot2.values, pot3.values))
pause()
```

\(^{435}\) https://en.wikipedia.org/wiki/Logical_disjunction

18.2. Combining sources
from signal import pause

pot1 = MCP3008(channel=0)
pot2 = MCP3008(channel=1)
pot3 = MCP3008(channel=2)
led = PWMLED(4)

led.source = scaled(summed(pot1.values, pot2.values, pot3.values), 0, 1, 0, 3)
pause()

18.3 Artificial sources

gpiozero.tools.alternating_values (initial_value=False)
Provides an infinite source of values alternating between True and False, starting with initial_value (which defaults to False). For example, to produce a flashing LED:

from gpiozero import LED
from gpiozero.tools import alternating_values
from signal import pause

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.values)
pause()

If you require a different range than -1 to +1, see scaled() (page 168).

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)

(continues on next page)
red.source_delay = 0.01
red.source = ramping_values(100)
pause()

If you require a wider range than 0 to 1, see `scaled()` (page 168).

**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:

```python
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 168).

**gpiozero.tools.sin_values(\( \text{period}=360 \))**

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:

```python
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.values)
pause()
```

If you require a different range than -1 to +1, see `scaled()` (page 168).
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:

```python
gpiozero.pi_info(revision=None)
```

Returns a `PiBoardInfo` (page 173) instance containing information about a revision of the Raspberry Pi.

**Parameters**

- `revision` *(str)* – The revision of the Pi to return information about. If this is omitted or `None` (the default), then the library will attempt to determine the model of Pi it is running on and return information about that.

**class gpiozero.PiBoardInfo**

This class is a `namedtuple()` 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:

```python
from gpiozero import *

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. If neither is specified, ANSI codes will only be used if stdout is detected to be a tty:

```python
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 193). If multiple pins support the desired function,
**PinMultiplePins** (page 193) will be raised (use `physical_pins()` (page 174) if you expect multiple pins in the result, such as for electrical ground).

**Parameters function** *(str)* – 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` which is not indexable. Use `physical_pin()` (page 173) if you are expecting a single return value.

**Parameters function** *(str)* – 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` (the default), the diagram will include ANSI color codes if stdout is a color-capable terminal. Otherwise `color` can be set to `True` or `False` 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 193) or `PinMultiplePins` (page 193) may be raised if the function is not associated with a single pin.

**Parameters function** *(str)* – The pin function you wish to determine pull-up for. Usually this is something like “GPIO9” for Broadcom GPIO pin 9.

**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) 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.

---

439 https://docs.python.org/3.5/library/stdtypes.html#str
440 https://docs.python.org/3.5/library/stdtypes.html#set
441 https://docs.python.org/3.5/library/stdtypes.html#str
442 https://docs.python.org/3.5/library/stdtypes.html#str
443 https://en.wikipedia.org/wiki/System_on_a_chip
**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 175) 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]`.

A rendered version of this data can be obtained by using the `PiBoardInfo` (page 173) object in a format string:

```python
from gpiozero import *
p = pi_info()
print(p[0:headers].format(p[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 173) object in a format string. For example:

```python
from gpiozero import *
p = pi_info()
print(p[0:board].format(pi_info()))
```

**class gpiozero.HeaderInfo**
This class is a `namedtuple()` 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:

```python
from gpiozero import *
p = pi_info()
p[0:headers].format(p[0:headers].format(pi_info()))
p[0:full].format(p[0:headers].format(pi_info()))
p[0:col2].format(p[0:headers].format(pi_info()))
p[0:row1].format(p[0:headers].format(pi_info()))
```

---

444 https://docs.python.org/3.5/library/collections.html#collections.namedtuple
'color' and 'mono' can be prefixed to format specifications to force the use of ANSI color codes\(^{445}\). If neither is specified, ANSI codes will only be used if stdout is detected to be a tty:

```python
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` (the default, the diagram will include ANSI color codes if stdout is a color-capable terminal). Otherwise *color* can be set to `True` or `False` 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 176) tuples.

**class gpiozero.PinInfo**
- This class is a `collections.namedtuple()`\(^{446}\) 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` but GPIO2 and GPIO3 are usually `True`). 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)


\(^{446}\) [https://docs.python.org/3.5/library/collections.html#collections.namedtuple](https://docs.python.org/3.5/library/collections.html#collections.namedtuple)
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 180) which turns it into a Pin (page 181) implementation. The default factory can be queried (and changed) with Device.pin_factory, i.e. the pin_factory attribute of the Device (page 161) class. However, all classes 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 later in the Configuring Remote GPIO (page 35) 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` will be raised.

## 20.1 Changing the pin factory

The default pin factory can be replaced by specifying a value for the `GPIOZERO_PIN_FACTORY` 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` 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>
```

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 180) and `Pin` (page 181) classes are listed in the table below. Factories are listed in the order that they are tried by default.

<table>
<thead>
<tr>
<th>Name</th>
<th>Factory class</th>
<th>Pin class</th>
</tr>
</thead>
<tbody>
<tr>
<td>rpigpio</td>
<td><code>gpiozero.pins.rpigpio.RPiGPIOFactory</code></td>
<td><code>gpiozero.pins.rpigpio.RPiGPIOPin</code></td>
</tr>
<tr>
<td>rpio</td>
<td><code>gpiozero.pins.rpio.RPIOFactory</code></td>
<td><code>gpiozero.pins.rpio.RPIOPin</code></td>
</tr>
<tr>
<td>pigpio</td>
<td><code>gpiozero.pins.pigpio.PiGPIOFactory</code></td>
<td><code>gpiozero.pins.pigpio.PiGPIOPin</code></td>
</tr>
<tr>
<td>native</td>
<td><code>gpiozero.pins.native.NativeFactory</code></td>
<td><code>gpiozero.pins.native.NativePin</code></td>
</tr>
</tbody>
</table>

If you need to change the default pin factory from within a script, either set `Device.pin_factory` to the new factory instance to use:

---

447 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 189) on a remote pi called remote-pi you can set the PIGPIO_ADDR environment variable when running your script:

$ GPIOZERO_PIN_FACTORY=pigpio PIGPIO_ADDR=remote-pi python3 my_script.py

Like the GPIOZERO_PIN_FACTORY 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 for one pin, and NativeFactory 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 35).

## 20.2 Mock pins

There’s also a gpiozero.pins.mock.MockFactory (page 190) 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.values

(continues on next 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.

## 20.3 Base classes

**class gpiozero.Factory**

Generates pins and SPI interfaces for devices. This is an abstract base class for pin factories. Descendents may override the following methods, if applicable:

- `close()` (page 180)
- `reserve_pins()` (page 180)
- `release_pins()` (page 180)
- `release_all()` (page 180)
- `pin()` (page 180)
- `spi()` (page 181)
- `_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 181) descendent representing the specified pin.

**Warning:** Descendants must ensure that pin instances representing the same hardware are identical; i.e. two separate invocations of `pin()` (page 180) 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 180) for further information.

**release_pins(reserver, *pins)**

Releases the reservation of `reserver` against `pins`. This is typically called during `Device.close()` (page 161) 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 180).

spi (**spi_args)
Returns an instance of an SPI (page 183) 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 192).

pi_info
Returns a PiBoardInfo (page 173) 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.

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 181)
• output_with_state() (page 182)
• input_with_pull() (page 181)
• _set_state()
• _get_frequency()
• _set_frequency()
• _get_pull()
• _set_pull()
• _get_bounce()
• _set_bounce()
• _get_edges()
• _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 181) 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:

```python
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:

```python
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`.

For example, if `edges` (page 182) is currently “rising”, `bounce` (page 182) is currently 5/1000 (5ms), then the waveform below will only fire `when_changed` (page 183) 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 ----------- |             |

If the pin does not support edge detection, attempts to set this property will raise `PinEdgeDetectUnsupported` (page 193). 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 183). This can be one of the strings “both” (the default), “rising”, “falling”, or “none”:

```
HIGH - - - > ----------
|       |
|       |
LOW -------------`-----------------
```

If the pin does not support edge detection, attempts to set this property will raise `PinEdgeDetectUnsupported` (page 193).

**frequency**
The frequency (in Hz) for the pin’s PWM implementation, or `None` if PWM is not currently in use. This value always defaults to `None` and may be changed with certain pin types to activate or deactivate PWM.

If the pin does not support PWM, `PinPWMUnsupported` (page 193) will be raised when attempting to set this to a value other than `None`. 
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 193) 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 193). If the specified value is not supported by the underlying hardware, PinInvalidPull (page 193) 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 183) 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 182) is not None) 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 193) will be raised. If an invalid value is specified for this attribute, PinInvalidState (page 193) 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 182) is detected on the pin). The function or bound method must take no parameters.

If the pin does not support edge detection, attempts to set this property will raise PinEdgeDetectUnsupported (page 193).

class gpiozero.SPI
Abstract interface for Serial Peripheral Interface (SPI) implementations. Descendents must override the following methods:

- transfer() (page 184)
- _get_clock_mode()

Descendents may override the following methods, if applicable:

- read() (page 184)
- write() (page 184)
- _set_clock_mode()
- _get_lsb_first()
- _set_lsb_first()
- _get_select_high()
- _set_select_high()
- _get_bits_per_word()

---

20.3. Base classes
**_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 184) of the interface.

This method is typically used with read-only devices that feature half-duplex communication. See `transfer()` (page 184) 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 184) 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 184) 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 184) 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 184) 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.

**clock_mode**

Presents a value representing the `clock_polarity` (page 185) and `clock_phase` (page 184) attributes combined according to the following table:

<table>
<thead>
<tr>
<th>mode</th>
<th>polarity (CPOL)</th>
<th>phase (CPHA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>False</td>
<td>False</td>
</tr>
<tr>
<td>1</td>
<td>False</td>
<td>True</td>
</tr>
<tr>
<td>2</td>
<td>True</td>
<td>False</td>
</tr>
<tr>
<td>3</td>
<td>True</td>
<td>True</td>
</tr>
</tbody>
</table>

Adjusting this value adjusts both the `clock_polarity` (page 185) and `clock_phase` (page 184) attributes simultaneously.

**clock_phase**

The phase of the SPI clock pin. If this is **False** (the default), data will be read from the MISO pin when the clock pin activates. Setting this to **True** 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 185) attribute (corresponding to CPOL).

The following diagram indicates when data is read when `clock_polarity` (page 185) is **False**, and `clock_phase` (page 184) is **False** (the default), equivalent to CPHA 0:

(continues on next page)
The following diagram indicates when data is read when `clock_polarity` (page 185) is False, but `clock_phase` (page 184) is True, equivalent to CPHA 1:

```
+---+---+---+---+---+---+---+---+
|   |   |   |   |   |   |   |   |
+---+---+---+---+---+---+---+---+
```

### `clock_polarity`

The polarity of the SPI clock pin. If this is False (the default), the clock pin will idle low, and pulse high. Setting this to True will cause the clock pin to idle high, and pulse low. On many data sheets this is documented as the CPOL value.

The following diagram illustrates the waveform when `clock_polarity` (page 185) is False (the default), equivalent to CPOL 0:

```
+---+---+---+---+---+---+---+---+
| on| 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 indicating that words are read and written in MSB (Most Significant Bit first) order. Effectively, this controls the Bit endianness of the connection.

The following diagram shows the a word containing the number 5 (binary 0101) transmitted on MISO with `bits_per_word` (page 184) set to 4, and `clock_mode` (page 184) set to 0, when `lsb_first` (page 185) is False (the default):

```
+---+---+---+---+---+---+---+---+
|   |   |   |   |   |   |   |   |
+---+---+---+---+---+---+---+---+
```

---

449 https://en.wikipedia.org/wiki/Endianness#Bit_endianness
And now with `lsb_first` (page 185) set to True (and all other parameters the same):

```
   ,---. ,---. ,---. ,---.
  CLK | | | | | | | |
  | | | | | | | |
----' `---' `---' `---' `---' `---' `---' `---'

MISO: | : | : | : | :
| : | : | : | :
--' : `-------' : `-----------
LSB  MSB
```

**select_high**

If False (the default), the chip select line is considered active when it is pulled low. When set to True, 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 185) is False, and `select_high` (page 186) is False (the default):

```
>---. ,------.
  CS | chip is selected, and will react to clock | idle
    '-----------------------------------------------------'

   ,---. ,---. ,---. ,---. ,---. ,---. ,---. ,---. ,---.
  CLK | | | | | | | | | | | | | |
  | | | | | | | | | | | | | |
----' `---' `---' `---' `---' `---' `---' `---' `---'. `------
```

And when `select_high` (page 186) is True:

```
>---. ,------.
  CS | chip is selected, and will react to clock | idle
    '-----------------------------------------------------'

   ,---. ,---. ,---. ,---. ,---. ,---. ,---. ,---. ,---.
  CLK | | | | | | | | | | | | | |
  | | | | | | | | | | | | | |
----' `---' `---' `---' `---' `---' `---' `---' `---'. `------
```

class `gpiozero.pins.pi.PiFactory`

Abstract base class representing hardware attached to a Raspberry Pi. This forms the base of `LocalPiFactory` (page 187).

**close()**

Closes the pin factory. This is expected to clean up all resources manipulated by the factory. It is 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 186) for the same pin specification must return the same object.
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.

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 SPIHardwareInterface instance will be returned. Otherwise, a SPISoftwareInterface 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)

Abstract base class representing a multi-function GPIO pin attached to a Raspberry Pi. This overrides several methods in the abstract base Pin (page 181). 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

Abstract base class representing pins attached locally to a Pi. This forms the base class for local-only pin interfaces (RPiGPIOPin (page 188), RPIOPin (page 188), and NativePin (page 189)).

class gpiozero.pins.local.LocalPiPin(factory, number)

Abstract base class representing a multi-function GPIO pin attached to the local Raspberry Pi.

20.4 RPi.GPIO

class gpiozero.pins.rpigpio.RPiGPIOFactory

Uses the RPi.GPIO\[^450\] library to interface to the Pi’s GPIO pins. This is the default pin implementation if

\[^450\] https://pypi.python.org/pypi/RPi.GPIO

20.4. RPi.GPIO
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.:

```python
from gpiozero import LED
led = LED(12)
```

However, you can also construct RPi.GPIO pins manually if you wish:

```python
from gpiozero.pins.rpigpio import RPiGPIOFactory
from gpiozero import LED
factory = RPiGPIOFactory()
led = LED(12, pin_factory=factory)
```

```python
class gpiozero.pins.rpigpio.RPiGPIOPin(factory, number)
Pin implementation for the RPi.GPIO library. See RPiGPIOFactory (page 187) for more information.
```

20.5 RPIO

```python
class gpiozero.pins.rpio.RPIOFactory
Uses the RPIO 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:

```python
from gpiozero.pins.rpio import RPIOFactory
from gpiozero import LED
factory = RPIOFactory()
led = LED(12, pin_factory=factory)
```

```python
class gpiozero.pins.rpio.RPIOPin(factory, number)
Pin implementation for the RPIO library. See RPIOFactory (page 188) for more information.
```

20.6 PiGPIO

```python
class gpiozero.pins.pigpio.PiGPIOFactor (host='localhost', port=8888)
Uses the pigpio 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 client library installed on it)

---

451 https://pypi.python.org/pypi/RPi.GPIO
452 https://pythonhosted.org/RPIO/
453 https://pythonhosted.org/RPIO/
454 http://abyz.co.uk/rpi/pigpio/
455 http://abyz.co.uk/rpi/pigpio/
• 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:

```python
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:

```python
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.

```python
class gpiozero.pins.pigpio.PiGPIOPin (factory, number)
Pin implementation for the pigpio library. See PiGPIOFactory (page 188) for more information.
```

## 20.7 Native

```python
class gpiozero.pins.native.NativeFactory
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. This implementation is also experimental; we make no guarantees it will not eat your Pi for breakfast!

You can construct native pin instances manually like so:

```python
from gpiozero.pins.native import NativeFactory
from gpiozero import LED

factory = NativeFactory()
led = LED(12, pin_factory=factory)
```

```python
class gpiozero.pins.native.NativePin (factory, number)
Native pin implementation. See NativeFactory (page 189) for more information.
```

456 http://abyz.co.uk/rpi/pigpio/
## 20.8 Mock

```python
class gpiozero.pins.mock.MockFactory(revision='a02082', pin_class=gpiozero.pins.mock.MockPin)
```

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` 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()` method by default. This can be changed after construction by modifying the `pin_class` attribute.

```python
pin(spec, pin_class=None, **kwargs)
```

The pin method for `MockFactory` additionally takes a `pin_class` attribute which can be used to override the class’ `pin_class` attribute. Any additional keyword arguments will be passed along to the pin constructor (useful with things like `MockConnectedPin` which expect to be constructed with another pin).

```python
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.

```python
class gpiozero.pins.mock.MockPin(factory, number)
```

A mock pin used primarily for testing. This class does not support PWM.

```python
close()
```

Cleans up the resources allocated to the pin. After this method is called, this Pin instance may no longer be used to query or control the pin’s state.

```python
class gpiozero.pins.mock.MockPWMPin(factory, number)
```

This derivative of `MockPin` adds PWM support.

```python
class gpiozero.pins.mock.MockConnectedPin(factory, number, input_pin=None)
```

This derivative of `MockPin` 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.

```python
class gpiozero.pins.mock.MockChargingPin(factory, number, charge_time=0.01)
```

This derivative of `MockPin` 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).

```python
class gpiozero.pins.mock.MockTriggerPin(factory, number, echo_pin=None, echo_time=0.04)
```

This derivative of `MockPin` is intended to be used with another `MockPin` 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.
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:

```python
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 191), 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 103) you would expect a `ValueError` to be raised. In fact, a `OutputDeviceBadValue` (page 192) error will be raised. However, note that this descends from both `GPIOZeroError` (page 191) (indirectly) and from `ValueError` so you can still do:

```python
from gpiozero import *
led = PWMLED(17)
try:
    led.value = 2
except ValueError:
    print('Bad value specified')
```

### 21.1 Errors

**exception** `gpiozero.GPIOZeroError`

Base class for all exceptions in GPIO Zero

**exception** `gpiozero.DeviceClosed`

Error raised when an operation is attempted on a closed device

---

457 https://docs.python.org/3.5/library/exceptions.html#ValueError

458 https://docs.python.org/3.5/library/exceptions.html#ValueError
exception gpiozero.BadEventHandler
    Error raised when an event handler with an incompatible prototype is specified

exception gpiozero.BadQueueLen
    Error raised when non-positive queue length is specified

exception gpiozero.BadWaitTime
    Error raised when an invalid wait time is specified

exception gpiozero.CompositeDeviceError
    Base class for errors specific to the CompositeDevice hierarchy

exception gpiozero.CompositeDeviceBadName
    Error raised when a composite device is constructed with a reserved name

exception gpiozero.EnergenieSocketMissing
    Error raised when socket number is not specified

exception gpiozero.EnergenieBadSocket
    Error raised when an invalid socket number is passed to Energenie (page 144)

exception gpiozero.SPIError
    Base class for errors related to the SPI implementation

exception gpiozero.SPIBadArgs
    Error raised when invalid arguments are given while constructing SPIDevice (page 111)

exception gpiozero.SPIBadChannel
    Error raised when an invalid channel is given to an AnalogInputDevice (page 110)

exception gpiozero.SPIFixedClockMode
    Error raised when the SPI clock mode cannot be changed

exception gpiozero.SPIInvalidClockMode
    Error raised when an invalid clock mode is given to an SPI implementation

exception gpiozero.SPIFixedBitOrder
    Error raised when the SPI bit-endianness cannot be changed

exception gpiozero.SPIFixedSelect
    Error raised when the SPI select polarity cannot be changed

exception gpiozero.SPIFixedWordSize
    Error raised when the number of bits per word cannot be changed

exception gpiozero.SPIInvalidWordSize
    Error raised when an invalid (out of range) number of bits per word is specified

exception gpiozero.GPIODeviceError
    Base class for errors specific to the GPIODevice hierarchy

exception gpiozero.GPIODeviceClosed
    Deprecated descendent of DeviceClosed (page 191)

exception gpiozero.GPIOPinInUse
    Error raised when attempting to use a pin already in use by another device

exception gpiozero.GPIOPinMissing
    Error raised when a pin specification is not given

exception gpiozero.InputDeviceError
    Base class for errors specific to the InputDevice hierarchy

exception gpiozero.OutputDeviceError
    Base class for errors specified to the OutputDevice hierarchy

exception gpiozero.OutputDeviceBadValue
    Error raised when value is set to an invalid value
exception gpiozero.PinError
   Base class for errors related to pin implementations

exception gpiozero.PinInvalidFunction
   Error raised when attempting to change the function of a pin to an invalid value

exception gpiozero.PinInvalidState
   Error raised when attempting to assign an invalid state to a pin

exception gpiozero.PinInvalidPull
   Error raised when attempting to assign an invalid pull-up to a pin

exception gpiozero.PinInvalidEdges
   Error raised when attempting to assign an invalid edge detection to a pin

exception gpiozero.PinInvalidBounce
   Error raised when attempting to assign an invalid bounce time to a pin

exception gpiozero.PinSetInput
   Error raised when attempting to set a read-only pin

exception gpiozero.PinFixedPull
   Error raised when attempting to set the pull of a pin with fixed pull-up

exception gpiozero.PinEdgeDetectUnsupported
   Error raised when attempting to use edge detection on unsupported pins

exception gpiozero.PinUnsupported
   Error raised when attempting to obtain a pin interface on unsupported pins

exception gpiozero.PinSPIUnsupported
   Error raised when attempting to obtain an SPI interface on unsupported pins

exception gpiozero.PinPWMError
   Base class for errors related to PWM implementations

exception gpiozero.PinPWMUnsupported
   Error raised when attempting to activate PWM on unsupported pins

exception gpiozero.PinPWMFixedValue
   Error raised when attempting to initialize PWM on an input pin

exception gpiozero.PinUnknownPi
   Error raised when gpiozero doesn’t recognize a revision of the Pi

exception gpiozero.PinMultiplePins
   Error raised when multiple pins support the requested function

exception gpiozero.PinNoPins
   Error raised when no pins support the requested function

exception gpiozero.PinInvalidPin
   Error raised when an invalid pin specification is provided

21.2 Warnings

exception gpiozero.GPIOZeroWarning
   Base class for all warnings in GPIO Zero

exception gpiozero.SPIWarning
   Base class for warnings related to the SPI implementation

exception gpiozero.SPISoftwareFallback
   Warning raised when falling back to the software implementation
exception gpiozero.PinFactoryFallback
   Warning raised when a default pin factory fails to load and a fallback is tried

exception gpiozero.PinNonPhysical
   Warning raised when a non-physical pin is specified in a constructor
22.1 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 137) and `Robot.backward()` (page 137) (#306\textsuperscript{469} and #619\textsuperscript{466})

• Fixed `DistanceSensor` (page 79) returning incorrect readings after a long pause, and added a lock to ensure multiple distance sensors can operate simultaneously in a single project (#584\textsuperscript{461}, #595\textsuperscript{462}, #617\textsuperscript{463}, #618\textsuperscript{464})

• Added support for phase/enable motor drivers with `PhaseEnableMotor` (page 94), `PhaseEnableRobot` (page 138), and descendants, thanks to Ian Harcombe! (#386\textsuperscript{465})

• A variety of other minor enhancements, largely thanks to Andrew Scheller! (#479\textsuperscript{466}, #489\textsuperscript{467}, #491\textsuperscript{468}, #492\textsuperscript{469})

22.2 Release 1.4.0 (2017-07-26)

• Pin factory is now configurable from device constructors (page 178) 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\textsuperscript{470})
• Major work on SPI, primarily to support remote hardware SPI (#421, #459, #465, #468, #575)
• Pin reservation now works properly between GPIO and SPI devices (#459, #468)
• Lots of work on the documentation: source/values chapter (page 51), better charts, more recipes, remote GPIO configuration (page 35), mock pins, better PDF output (#484, #469, #523, #520, #434, #565, #576)
• Support for StatusZero (page 145) and StatusBoard (page 148) HATs (#558)
• Added pinout command line tool to provide a simple reference to the GPIO layout and information about the associated Pi (#497, #504) thanks to Stewart Adcock for the initial work
• pi_info() (page 173) made more lenient for new (unknown) Pi models (#529)
• Fixed a variety of packaging issues (#535, #518, #519)
• Improved text in factory fallback warnings (#572)

22.3 Release 1.3.2 (2017-03-03)

• Added new Pi models to stop pi_info() (page 173) breaking
• Fix issue with pi_info() (page 173) breaking on unknown Pi models

22.4 Release 1.3.1 (2016-08-31 . . . later)

• Fixed hardware SPI support which Dave broke in 1.3.0. Sorry!
• Some minor docs changes

22.5 Release 1.3.0 (2016-08-31)

• Added ButtonBoard (page 117) for reading multiple buttons in a single class (#340)
• Added Servo (page 95) and AngularServo (page 96) classes for controlling simple servo motors (#248)

471 https://github.com/RPi-Distro/python-gpiozero/issues/421
472 https://github.com/RPi-Distro/python-gpiozero/issues/459
473 https://github.com/RPi-Distro/python-gpiozero/issues/465
474 https://github.com/RPi-Distro/python-gpiozero/issues/468
475 https://github.com/RPi-Distro/python-gpiozero/issues/575
476 https://github.com/RPi-Distro/python-gpiozero/issues/459
477 https://github.com/RPi-Distro/python-gpiozero/issues/468
478 https://github.com/RPi-Distro/python-gpiozero/issues/484
479 https://github.com/RPi-Distro/python-gpiozero/issues/469
480 https://github.com/RPi-Distro/python-gpiozero/issues/523
481 https://github.com/RPi-Distro/python-gpiozero/issues/520
482 https://github.com/RPi-Distro/python-gpiozero/issues/434
483 https://github.com/RPi-Distro/python-gpiozero/issues/565
484 https://github.com/RPi-Distro/python-gpiozero/issues/576
485 https://github.com/RPi-Distro/python-gpiozero/issues/558
486 https://github.com/RPi-Distro/python-gpiozero/issues/497
487 https://github.com/RPi-Distro/python-gpiozero/issues/504
488 https://github.com/RPi-Distro/python-gpiozero/issues/529
489 https://github.com/RPi-Distro/python-gpiozero/issues/353
490 https://github.com/RPi-Distro/python-gpiozero/issues/518
491 https://github.com/RPi-Distro/python-gpiozero/issues/519
492 https://github.com/RPi-Distro/python-gpiozero/issues/572
493 https://github.com/RPi-Distro/python-gpiozero/issues/340
494 https://github.com/RPi-Distro/python-gpiozero/issues/248
Lots of work on supporting easier use of internal and third-party pin implementations (#359495)

*Robot* (page 136) now has a proper value (page 138) attribute (#305496)

*Added CPUTemperature* (page 156) as another demo of “internal” devices (#294497)

A temporary work-around for an issue with *DistanceSensor* (page 79) was included but a full fix is in the works (#385498)

More work on the documentation (#320499, #295500, #289501, 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!

### 22.6 Release 1.2.0 (2016-04-10)

- Added *Energenie* (page 144) class for controlling Energenie plugs (#69502)
- Added *LineSensor* (page 75) class for single line-sensors (#109503)
- Added *DistanceSensor* (page 79) class for HC-SR04 ultra-sonic sensors (#114504)
- Added *SnowPi* (page 149) class for the Ryanteck Snow-pi board (#130505)
- Added *when_held* (and related properties) to *Button* (page 73) (#115506)
- Fixed issues with installing GPIO Zero for python 3 on Raspbian Wheezy releases (#140507)
- Added support for lots of ADC chips (MCP3xxx family) (#162508) - many thanks to pcopa and lurch!
- Added support for pigpio as a pin implementation with *PiGPIOPin* (page 189) (#180509)
- Many refinements to the base classes mean more consistency in composite devices and several bugs squashed (#164510, #175511, #182512, #189513, #193514, #220515)
- GPIO Zero is now aware of what sort of Pi it’s running on via *pi_info()* (page 173) 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) (#222516)
- The source/values system was enhanced to ensure normal usage doesn’t stress the CPU and lots of utilities were added (#181517, #251518)
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!

### 22.7 Release 1.1.0 (2016-02-08)

- Documentation converted to reST and expanded to include generic classes and several more recipes (#80, #82, #101, #119, #135, #168)
- New `CamJamKitRobot` (page 141) class with the pre-defined motor pins for the new CamJam EduKit
- New `LEDBarGraph` (page 116) class (many thanks to Martin O’Hanlon!) (#126, #176)
- New `Pin` (page 181) implementation abstracts out the concept of a GPIO pin paving the way for alternate library support and IO extenders in future (#141)
- New `LEDBoard.blink()` (page 114) method which works properly even when background is set to False (#94, #161)
- New `RGBLED.blink()` (page 90) method which implements (rudimentary) color fading too! (#135, #174)
- New `initial_value` attribute on `OutputDevice` (page 102) ensures consistent behaviour on construction (#118)
- New `active_high` attribute on `PWMOutputDevice` (page 100) and `RGBLED` (page 90) allows use of common anode devices (#143, #154)
- Loads of new ADC chips supported (many thanks to GitHub user pcopa!) (#150)

### 22.8 Release 1.0.0 (2015-11-16)

- Debian packaging added (#44)
- `PWMLED` (page 88) class added (#58)
- `TemperatureSensor` removed pending further work (#93)

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519 https://github.com/RPi-Distro/python-gpiozero/issues/80
520 https://github.com/RPi-Distro/python-gpiozero/issues/82
521 https://github.com/RPi-Distro/python-gpiozero/issues/101
522 https://github.com/RPi-Distro/python-gpiozero/issues/119
523 https://github.com/RPi-Distro/python-gpiozero/issues/135
524 https://github.com/RPi-Distro/python-gpiozero/issues/168
525 https://github.com/RPi-Distro/python-gpiozero/issues/126
526 https://github.com/RPi-Distro/python-gpiozero/issues/176
527 https://github.com/RPi-Distro/python-gpiozero/issues/141
528 https://github.com/RPi-Distro/python-gpiozero/issues/94
529 https://github.com/RPi-Distro/python-gpiozero/issues/161
530 https://github.com/RPi-Distro/python-gpiozero/issues/135
531 https://github.com/RPi-Distro/python-gpiozero/issues/174
532 https://github.com/RPi-Distro/python-gpiozero/issues/118
533 https://github.com/RPi-Distro/python-gpiozero/issues/143
534 https://github.com/RPi-Distro/python-gpiozero/issues/154
535 https://github.com/RPi-Distro/python-gpiozero/issues/150
536 https://github.com/RPi-Distro/python-gpiozero/issues/44
537 https://github.com/RPi-Distro/python-gpiozero/issues/58
538 https://github.com/RPi-Distro/python-gpiozero/issues/93
• *Buzzer.beep()* (page 92) alias method added (#75539)
• *Motor* (page 93) PWM devices exposed, and *Robot* (page 136) motor devices exposed (#107540)

22.9 Release 0.9.0 (2015-10-25)

Fourth public beta

• Added source and values properties to all relevant classes (#76541)
• Fix names of parameters in *Motor* (page 93) constructor (#79542)
• Added wrappers for LED groups on add-on boards (#81543)

22.10 Release 0.8.0 (2015-10-16)

Third public beta

• Added generic *AnalogInputDevice* (page 110) class along with specific classes for the *MCP3008* (page 107) and *MCP3004* (page 106) (#41544)
• Fixed *DigitalOutputDevice.blink()* (page 99) (#57545)

22.11 Release 0.7.0 (2015-10-09)

Second public beta

22.12 Release 0.6.0 (2015-09-28)

First public beta

22.13 Release 0.5.0 (2015-09-24)

22.14 Release 0.4.0 (2015-09-23)

22.15 Release 0.3.0 (2015-09-22)

22.16 Release 0.2.0 (2015-09-21)

Initial release

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539 https://github.com/RPi-Distro/python-gpiozero/issues/75
540 https://github.com/RPi-Distro/python-gpiozero/issues/107
541 https://github.com/RPi-Distro/python-gpiozero/issues/76
542 https://github.com/RPi-Distro/python-gpiozero/issues/79
543 https://github.com/RPi-Distro/python-gpiozero/issues/81
544 https://github.com/RPi-Distro/python-gpiozero/issues/41
545 https://github.com/RPi-Distro/python-gpiozero/issues/37
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\textsuperscript{546} https://www.raspberrypi.org/
Symbols
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