python-ev3dev Documentation

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Contents

A Python3 library implementing an interface for ev3dev devices, letting you control motors, sensors, hardware buttons, LCD displays and more from Python code.

If you haven't written code in Python before, you'll need to learn the language before you can use this library.

CHAPTER 1

Getting Started

This library runs on ev3dev. Before continuing, make sure that you have set up your EV3 or other ev3dev device as explained in the ev3dev Getting Started guide. Make sure that you have a kernel version that includes `-10-ev3dev` or higher (a larger number). You can check the kernel version by selecting "About" in Brickman and scrolling down to the "kernel version". If you don't have a compatible version, upgrade the kernel before continuing. Also note that if the ev3dev image you downloaded was created before September 2016, you probably don't have the most recent version of this library installed: see *Upgrading this Library* to upgrade it.

Once you have booted ev3dev and connected to your EV3 (or Raspberry Pi / BeagleBone) via SSH, you should be ready to start using ev3dev with Python: this library is included out-of-the-box. If you want to go through some basic usage examples, check out the *Usage Examples* section to try out motors, sensors and LEDs. Then look at *Writing Python Programs for Ev3dev* to see how you can save your Python code to a file.

Make sure that you look at the *User Resources* section as well for links to documentation and larger examples.

CHAPTER 2

Usage Examples

To run these minimal examples, run the Python3 interpreter from the terminal using the `python3` command:

```
$ python3
Python 3.4.2 (default, Oct  8 2014, 14:47:30)
[GCC 4.9.1] on linux
Type "help", "copyright", "credits" or "license" for more information.
>>>
```

The >>> characters are the default prompt for Python. In the examples below, we have removed these characters so it's easier to cut and paste the code into your session.

2.1 Required: Import the library

If you are using an EV3 brick (which is the case for most users), add the following to the top of your file:

```
import ev3dev.ev3 as ev3
```

If you are using a BrickPi, use this line:

```
import ev3dev.brickpi as ev3
```

2.2 Controlling the LEDs with a touch sensor

This code will turn the left LED red whenever the touch sensor is pressed, and back to green when it's released. Plug a touch sensor into any sensor port and then paste in this code - you'll need to hit `Enter` after pasting to complete the loop and start the program. Hit `Ctrl-C` to exit the loop.

```
ts = ev3.TouchSensor()
while True:
    ev3.Leds.set_color(ev3.Leds.LEFT, (ev3.Leds.GREEN, ev3.Leds.RED)[ts.value()])
```

2.3 Running a motor

Now plug a motor into the `A` port and paste this code into the Python prompt. This little program will run the motor at 500 ticks per second, which on the EV3 "large" motors equates to around 1.4 rotations per second, for three seconds (3000 milliseconds).

```
m = ev3.LargeMotor('outA')
m.run_timed(time_sp=3000, speed_sp=500)
```

The units for `speed_sp` that you see above are in "tacho ticks" per second. On the large EV3 motor, these equate to one tick per degree, so this is 500 degress per second.

2.4 Using text-to-speech

If you want to make your robot speak, you can use the *Sound.speak* method:

```
ev3.Sound.speak('Welcome to the E V 3 dev project!').wait()
```

To quit the Python REPL, just type `exit()` **or press** `Ctrl-D` **.**

Make sure to check out the *User Resources* section for more detailed information on these features and many others.

CHAPTER 3

Writing Python Programs for Ev3dev

Every Python program should have a few basic parts. Use this template to get started:

```
#!/usr/bin/env python3
from ev3dev.ev3 import *

# TODO: Add code here
```

The first two lines should be included in every Python program you write for ev3dev. The first allows you to run this program from Brickman, while the second imports this library.

When saving Python files, it is best to use the `.py` extension, e.g. `my-file.py`. To be able to run your Python code, **your program must be executable**. To mark a program as executable run `chmod +x my-file.py`. You can then run `my-file.py` via the Brickman File Browser or you can run it from the command line via `$ ./my-file.py`

CHAPTER 4

User Resources

Library Documentation Class documentation for this library can be found on our Read the Docs page **.** You can always go there to get information on how you can use this library's functionality.

ev3python.com One of our community members, @ndward, has put together a great website with detailed guides on using this library which are targeted at beginners. If you are just getting started with programming, we highly recommend that you check it out at ev3python.com!

Frequently-Asked Questions Experiencing an odd error or unsure of how to do something that seems simple? Check our our FAQ to see if there's an existing answer.

ev3dev.org ev3dev.org is a great resource for finding guides and tutorials on using ev3dev, straight from the maintainers.

Support If you are having trouble using this library, please open an issue at our Issues tracker so that we can help you. When opening an issue, make sure to include as much information as possible about what you are trying to do and what you have tried. The issue template is in place to guide you through this process.

Demo Code There are several demo programs that you can run to get acquainted with this language binding. The programs are available at https://github.com/ev3dev/ev3dev-lang-python-demo

CHAPTER 5

Upgrading this Library

You can upgrade this library from the command line as follows. Make sure to type the password (the default is `maker`) when prompted.

```
sudo apt-get update
sudo apt-get install --only-upgrade python3-ev3dev
```

CHAPTER 6

Developer Resources

Python Package Index The Python language has a package repository where you can find libraries that others have written, including the latest version of this package.

The ev3dev Binding Specification Like all of the language bindings for ev3dev supported hardware, the Python binding follows the minimal API that must be provided per this document.

The ev3dev-lang Project on GitHub The source repository for the generic API and the scripts to automatically generate the binding. Only developers of the ev3dev-lang-python binding would normally need to access this information.

CHAPTER 7

Python 2.x and Python 3.x Compatibility

Some versions of the ev3dev distribution come with both Python 2.x and Python 3.x installed but this library is compatible only with Python 3.

As of the 2016-10-17 ev3dev image, the version of this library which is included runs on Python 3 and this is the only version that will be supported from here forward.

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7.1 API reference

Each class in ev3dev module inherits from the base `Device` class.

class `ev3dev.`**`Device`**(*class_name*, *name_pattern='*'*, *name_exact=False*, ***kwargs*)

The ev3dev device base class

`ev3dev.`**`list_device_names`**(*class_path*, *name_pattern*, ***kwargs*)

This is a generator function that lists names of all devices matching the provided parameters.

Parameters:

class_path: class path of the device, a subdirectory of /sys/class. For example, '/sys/class/tacho-motor'.

name_pattern: pattern that device name should match. For example, 'sensor*' or 'motor*'. Default value: '*'.

keyword arguments: used for matching the corresponding device attributes. For example, address='outA', or driver_name=['lego-ev3-us', 'lego-nxt-us']. When argument value is a list, then a match against any entry of the list is enough.

`ev3dev.`**`list_devices`**(*class_name*, *name_pattern*, ***kwargs*)

This is a generator function that takes same arguments as *Device* class and enumerates all devices present in the system that match the provided arguments.

Parameters:

class_name: class name of the device, a subdirectory of /sys/class. For example, 'tacho-motor'.

name_pattern: pattern that device name should match. For example, 'sensor*' or 'motor*'. Default value: '*'.

keyword arguments: used for matching the corresponding device attributes. For example, address='outA', or driver_name=['lego-ev3-us', 'lego-nxt-us']. When argument value is a list, then a match against any entry of the list is enough.

`ev3dev.motor.list_motors(name_pattern='*', **kwargs)`

This is a generator function that enumerates all tacho motors that match the provided arguments.

Parameters:

name_pattern: pattern that device name should match. For example, 'motor*'. Default value: '*'.

keyword arguments: used for matching the corresponding device attributes. For example, driver_name='lego-ev3-l-motor', or address=['outB', 'outC']. When argument value is a list, then a match against any entry of the list is enough.

`ev3dev.sensor.list_sensors(name_pattern='sensor*', **kwargs)`

This is a generator function that enumerates all sensors that match the provided arguments.

Parameters:

name_pattern: pattern that device name should match. For example, 'sensor*'. Default value: '*'.

keyword arguments: used for matching the corresponding device attributes. For example, driver_name='lego-ev3-touch', or address=['in1', 'in3']. When argument value is a list, then a match against any entry of the list is enough.

Contents:

7.1.1 Motor classes

Tacho motor

`class ev3dev.motor.Motor(address=None, name_pattern='*', name_exact=False, **kwargs)`

The motor class provides a uniform interface for using motors with positional and directional feedback such as the EV3 and NXT motors. This feedback allows for precise control of the motors. This is the most common type of motor, so we just call it *motor*.

The way to configure a motor is to set the '_sp' attributes when calling a command or before. Only in 'run_direct' mode attribute changes are processed immediately, in the other modes they only take place when a new command is issued.

`COMMAND_RESET = 'reset'`

Reset all of the motor parameter attributes to their default value. This will also have the effect of stopping the motor.

`COMMAND_RUN_DIRECT = 'run-direct'`

Run the motor at the duty cycle specified by *duty_cycle_sp*. Unlike other run commands, changing *duty_cycle_sp* while running *will* take effect immediately.

`COMMAND_RUN_FOREVER = 'run-forever'`

Run the motor until another command is sent.

`COMMAND_RUN_TIMED = 'run-timed'`

Run the motor for the amount of time specified in *time_sp* and then stop the motor using the action specified by *stop_action*.

COMMAND_RUN_TO_ABS_POS = 'run-to-abs-pos'
Run to an absolute position specified by *position_sp* and then stop using the action specified in *stop_action*.

COMMAND_RUN_TO_REL_POS = 'run-to-rel-pos'
Run to a position relative to the current *position* value. The new position will be current *position* + *position_sp*. When the new position is reached, the motor will stop using the action specified by *stop_action*.

COMMAND_STOP = 'stop'
Stop any of the run commands before they are complete using the action specified by *stop_action*.

ENCODER_POLARITY_INVERSED = 'inversed'
Sets the inversed polarity of the rotary encoder.

ENCODER_POLARITY_NORMAL = 'normal'
Sets the normal polarity of the rotary encoder.

POLARITY_INVERSED = 'inversed'
With *inversed* polarity, a positive duty cycle will cause the motor to rotate counter-clockwise.

POLARITY_NORMAL = 'normal'
With *normal* polarity, a positive duty cycle will cause the motor to rotate clockwise.

STATE_HOLDING = 'holding'
The motor is not turning, but rather attempting to hold a fixed position.

STATE_OVERLOADED = 'overloaded'
The motor is turning, but cannot reach its *speed_sp*.

STATE_RAMPING = 'ramping'
The motor is ramping up or down and has not yet reached a constant output level.

STATE_RUNNING = 'running'
Power is being sent to the motor.

STATE_STALLED = 'stalled'
The motor is not turning when it should be.

STOP_ACTION_BRAKE = 'brake'
Power will be removed from the motor and a passive electrical load will be placed on the motor. This is usually done by shorting the motor terminals together. This load will absorb the energy from the rotation of the motors and cause the motor to stop more quickly than coasting.

STOP_ACTION_COAST = 'coast'
Power will be removed from the motor and it will freely coast to a stop.

STOP_ACTION_HOLD = 'hold'
Does not remove power from the motor. Instead it actively try to hold the motor at the current position. If an external force tries to turn the motor, the motor will *push back* to maintain its position.

address
Returns the name of the port that this motor is connected to.

command
Sends a command to the motor controller. See *commands* for a list of possible values.

commands
Returns a list of commands that are supported by the motor controller. Possible values are *run-forever*, *run-to-abs-pos*, *run-to-rel-pos*, *run-timed*, *run-direct*, *stop* and *reset*. Not all commands may be supported.

- *run-forever* will cause the motor to run until another command is sent.
- *run-to-abs-pos* will run to an absolute position specified by *position_sp* and then stop using the action specified in *stop_action*.

- *run-to-rel-pos* will run to a position relative to the current *position* value. The new position will be current *position* + *position_sp*. When the new position is reached, the motor will stop using the action specified by *stop_action*.
- *run-timed* will run the motor for the amount of time specified in *time_sp* and then stop the motor using the action specified by *stop_action*.
- *run-direct* will run the motor at the duty cycle specified by *duty_cycle_sp*. Unlike other run commands, changing *duty_cycle_sp* while running *will* take effect immediately.
- *stop* will stop any of the run commands before they are complete using the action specified by *stop_action*.
- *reset* will reset all of the motor parameter attributes to their default value. This will also have the effect of stopping the motor.

count_per_m
Returns the number of tacho counts in one meter of travel of the motor. Tacho counts are used by the position and speed attributes, so you can use this value to convert from distance to tacho counts. (linear motors only)

count_per_rot
Returns the number of tacho counts in one rotation of the motor. Tacho counts are used by the position and speed attributes, so you can use this value to convert rotations or degrees to tacho counts. (rotation motors only)

driver_name
Returns the name of the driver that provides this tacho motor device.

duty_cycle
Returns the current duty cycle of the motor. Units are percent. Values are -100 to 100.

duty_cycle_sp
Writing sets the duty cycle setpoint. Reading returns the current value. Units are in percent. Valid values are -100 to 100. A negative value causes the motor to rotate in reverse.

full_travel_count
Returns the number of tacho counts in the full travel of the motor. When combined with the *count_per_m* atribute, you can use this value to calculate the maximum travel distance of the motor. (linear motors only)

is_holding
The motor is not turning, but rather attempting to hold a fixed position.

is_overloaded
The motor is turning, but cannot reach its *speed_sp*.

is_ramping
The motor is ramping up or down and has not yet reached a constant output level.

is_running
Power is being sent to the motor.

is_stalled
The motor is not turning when it should be.

max_speed
Returns the maximum value that is accepted by the *speed_sp* attribute. This may be slightly different than the maximum speed that a particular motor can reach - it's the maximum theoretical speed.

on (*speed_pct*, *brake=True*, *block=False*)
Rotate the motor at 'speed_pct' for forever

'speed_pct' can be an integer or a SpeedInteger object which will be converted to an actual speed percentage in _speed_pct()

Note that *block* is False by default, this is different from the other *on_for_XYZ* methods

on_for_degrees (*speed_pct*, *degrees*, *brake=True*, *block=True*)
Rotate the motor at 'speed_pct' for 'degrees'

'speed_pct' can be an integer or a SpeedInteger object which will be converted to an actual speed percentage in _speed_pct()

on_for_rotations (*speed_pct*, *rotations*, *brake=True*, *block=True*)
Rotate the motor at 'speed_pct' for 'rotations'

'speed_pct' can be an integer or a SpeedInteger object which will be converted to an actual speed percentage in _speed_pct()

on_for_seconds (*speed_pct*, *seconds*, *brake=True*, *block=True*)
Rotate the motor at 'speed_pct' for 'seconds'

'speed_pct' can be an integer or a SpeedInteger object which will be converted to an actual speed percentage in _speed_pct()

on_to_position (*speed_pct*, *position*, *brake=True*, *block=True*)
Rotate the motor at 'speed_pct' to 'position'

'speed_pct' can be an integer or a SpeedInteger object which will be converted to an actual speed percentage in _speed_pct()

polarity
Sets the polarity of the motor. With *normal* polarity, a positive duty cycle will cause the motor to rotate clockwise. With *inversed* polarity, a positive duty cycle will cause the motor to rotate counter-clockwise. Valid values are *normal* and *inversed*.

position
Returns the current position of the motor in pulses of the rotary encoder. When the motor rotates clockwise, the position will increase. Likewise, rotating counter-clockwise causes the position to decrease. Writing will set the position to that value.

position_d
The derivative constant for the position PID.

position_i
The integral constant for the position PID.

position_p
The proportional constant for the position PID.

position_sp
Writing specifies the target position for the *run-to-abs-pos* and *run-to-rel-pos* commands. Reading returns the current value. Units are in tacho counts. You can use the value returned by *count_per_rot* to convert tacho counts to/from rotations or degrees.

ramp_down_sp
Writing sets the ramp down setpoint. Reading returns the current value. Units are in milliseconds and must be positive. When set to a non-zero value, the motor speed will decrease from 0 to 100% of *max_speed* over the span of this setpoint. The actual ramp time is the ratio of the difference between the *speed_sp* and the current *speed* and max_speed multiplied by *ramp_down_sp*.

ramp_up_sp
Writing sets the ramp up setpoint. Reading returns the current value. Units are in milliseconds and must be positive. When set to a non-zero value, the motor speed will increase from 0 to 100% of *max_speed*

over the span of this setpoint. The actual ramp time is the ratio of the difference between the *speed_sp* and the current *speed* and max_speed multiplied by *ramp_up_sp*.

reset(***kwargs*)
Reset all of the motor parameter attributes to their default value. This will also have the effect of stopping the motor.

run_direct(***kwargs*)
Run the motor at the duty cycle specified by *duty_cycle_sp*. Unlike other run commands, changing *duty_cycle_sp* while running *will* take effect immediately.

run_forever(***kwargs*)
Run the motor until another command is sent.

run_timed(***kwargs*)
Run the motor for the amount of time specified in *time_sp* and then stop the motor using the action specified by *stop_action*.

run_to_abs_pos(***kwargs*)
Run to an absolute position specified by *position_sp* and then stop using the action specified in *stop_action*.

run_to_rel_pos(***kwargs*)
Run to a position relative to the current *position* value. The new position will be current *position* + *position_sp*. When the new position is reached, the motor will stop using the action specified by *stop_action*.

speed
Returns the current motor speed in tacho counts per second. Note, this is not necessarily degrees (although it is for LEGO motors). Use the *count_per_rot* attribute to convert this value to RPM or deg/sec.

speed_d
The derivative constant for the speed regulation PID.

speed_i
The integral constant for the speed regulation PID.

speed_p
The proportional constant for the speed regulation PID.

speed_sp
Writing sets the target speed in tacho counts per second used for all *run-** commands except *run-direct*. Reading returns the current value. A negative value causes the motor to rotate in reverse with the exception of *run-to-*-pos* commands where the sign is ignored. Use the *count_per_rot* attribute to convert RPM or deg/sec to tacho counts per second. Use the *count_per_m* attribute to convert m/s to tacho counts per second.

state
Reading returns a list of state flags. Possible flags are *running*, *ramping*, *holding*, *overloaded* and *stalled*.

stop(***kwargs*)
Stop any of the run commands before they are complete using the action specified by *stop_action*.

stop_action
Reading returns the current stop action. Writing sets the stop action. The value determines the motors behavior when *command* is set to *stop*. Also, it determines the motors behavior when a run command completes. See *stop_actions* for a list of possible values.

stop_actions
Returns a list of stop actions supported by the motor controller. Possible values are *coast*, *brake* and *hold*. *coast* means that power will be removed from the motor and it will freely coast to a stop. *brake* means that power will be removed from the motor and a passive electrical load will be placed on the motor. This is usually done by shorting the motor terminals together. This load will absorb the energy from the rotation

of the motors and cause the motor to stop more quickly than coasting. *hold* does not remove power from the motor. Instead it actively tries to hold the motor at the current position. If an external force tries to turn the motor, the motor will 'push back' to maintain its position.

time_sp
Writing specifies the amount of time the motor will run when using the *run-timed* command. Reading returns the current value. Units are in milliseconds.

wait (*cond*, *timeout=None*)
Blocks until `cond(self.state)` is `True`. The condition is checked when there is an I/O event related to the `state` attribute. Exits early when `timeout` (in milliseconds) is reached.

Returns `True` if the condition is met, and `False` if the timeout is reached.

wait_until (*s*, *timeout=None*)
Blocks until `s` is in `self.state`. The condition is checked when there is an I/O event related to the `state` attribute. Exits early when `timeout` (in milliseconds) is reached.

Returns `True` if the condition is met, and `False` if the timeout is reached.

Example:

```
m.wait_until('stalled')
```

wait_until_not_moving (*timeout=None*)
Blocks until `running` is not in `self.state` or `stalled` is in `self.state`. The condition is checked when there is an I/O event related to the `state` attribute. Exits early when `timeout` (in milliseconds) is reached.

Returns `True` if the condition is met, and `False` if the timeout is reached.

Example:

```
m.wait_until_not_moving()
```

wait_while (*s*, *timeout=None*)
Blocks until `s` is not in `self.state`. The condition is checked when there is an I/O event related to the `state` attribute. Exits early when `timeout` (in milliseconds) is reached.

Returns `True` if the condition is met, and `False` if the timeout is reached.

Example:

```
m.wait_while('running')
```

Large EV3 Motor

class ev3dev.motor.**LargeMotor** (*address=None*, *name_pattern='*'*, *name_exact=False*, ***kwargs*)
Bases: *ev3dev.motor.Motor*

EV3/NXT large servo motor

Medium EV3 Motor

class ev3dev.motor.**MediumMotor** (*address=None*, *name_pattern='*'*, *name_exact=False*, ***kwargs*)
Bases: *ev3dev.motor.Motor*

EV3 medium servo motor

DC Motor

class ev3dev.motor.**DcMotor**(*address=None*, *name_pattern='motor*'*, *name_exact=False*, ***kwargs*)

The DC motor class provides a uniform interface for using regular DC motors with no fancy controls or feedback. This includes LEGO MINDSTORMS RCX motors and LEGO Power Functions motors.

COMMAND_RUN_DIRECT = 'run-direct'
Run the motor at the duty cycle specified by *duty_cycle_sp*. Unlike other run commands, changing *duty_cycle_sp* while running *will* take effect immediately.

COMMAND_RUN_FOREVER = 'run-forever'
Run the motor until another command is sent.

COMMAND_RUN_TIMED = 'run-timed'
Run the motor for the amount of time specified in *time_sp* and then stop the motor using the action specified by *stop_action*.

COMMAND_STOP = 'stop'
Stop any of the run commands before they are complete using the action specified by *stop_action*.

POLARITY_INVERSED = 'inversed'
With *inversed* polarity, a positive duty cycle will cause the motor to rotate counter-clockwise.

POLARITY_NORMAL = 'normal'
With *normal* polarity, a positive duty cycle will cause the motor to rotate clockwise.

STOP_ACTION_BRAKE = 'brake'
Power will be removed from the motor and a passive electrical load will be placed on the motor. This is usually done by shorting the motor terminals together. This load will absorb the energy from the rotation of the motors and cause the motor to stop more quickly than coasting.

STOP_ACTION_COAST = 'coast'
Power will be removed from the motor and it will freely coast to a stop.

address
Returns the name of the port that this motor is connected to.

command
Sets the command for the motor. Possible values are *run-forever*, *run-timed* and *stop*. Not all commands may be supported, so be sure to check the contents of the *commands* attribute.

commands
Returns a list of commands supported by the motor controller.

driver_name
Returns the name of the motor driver that loaded this device. See the list of [supported devices] for a list of drivers.

duty_cycle
Shows the current duty cycle of the PWM signal sent to the motor. Values are -100 to 100 (-100% to 100%).

duty_cycle_sp
Writing sets the duty cycle setpoint of the PWM signal sent to the motor. Valid values are -100 to 100 (-100% to 100%). Reading returns the current setpoint.

polarity
Sets the polarity of the motor. Valid values are *normal* and *inversed*.

ramp_down_sp
Sets the time in milliseconds that it take the motor to ramp down from 100% to 0%. Valid values are 0 to 10000 (10 seconds). Default is 0.

ramp_up_sp
Sets the time in milliseconds that it take the motor to up ramp from 0% to 100%. Valid values are 0 to 10000 (10 seconds). Default is 0.

run_direct(***kwargs*)
Run the motor at the duty cycle specified by *duty_cycle_sp*. Unlike other run commands, changing *duty_cycle_sp* while running *will* take effect immediately.

run_forever(***kwargs*)
Run the motor until another command is sent.

run_timed(***kwargs*)
Run the motor for the amount of time specified in *time_sp* and then stop the motor using the action specified by *stop_action*.

state
Gets a list of flags indicating the motor status. Possible flags are *running* and *ramping*. *running* indicates that the motor is powered. *ramping* indicates that the motor has not yet reached the *duty_cycle_sp*.

stop(***kwargs*)
Stop any of the run commands before they are complete using the action specified by *stop_action*.

stop_action
Sets the stop action that will be used when the motor stops. Read *stop_actions* to get the list of valid values.

stop_actions
Gets a list of stop actions. Valid values are *coast* and *brake*.

time_sp
Writing specifies the amount of time the motor will run when using the *run-timed* command. Reading returns the current value. Units are in milliseconds.

Servo Motor

class ev3dev.motor.**ServoMotor**(*address=None*, *name_pattern='motor*'*, *name_exact=False*, ***kwargs*)
The servo motor class provides a uniform interface for using hobby type servo motors.

COMMAND_FLOAT = 'float'
Remove power from the motor.

COMMAND_RUN = 'run'
Drive servo to the position set in the *position_sp* attribute.

POLARITY_INVERSED = 'inversed'
With *inversed* polarity, a positive duty cycle will cause the motor to rotate counter-clockwise.

POLARITY_NORMAL = 'normal'
With *normal* polarity, a positive duty cycle will cause the motor to rotate clockwise.

address
Returns the name of the port that this motor is connected to.

command
Sets the command for the servo. Valid values are *run* and *float*. Setting to *run* will cause the servo to be driven to the position_sp set in the *position_sp* attribute. Setting to *float* will remove power from the motor.

driver_name
Returns the name of the motor driver that loaded this device. See the list of [supported devices] for a list of drivers.

float (***kwargs*)
Remove power from the motor.

max_pulse_sp
Used to set the pulse size in milliseconds for the signal that tells the servo to drive to the maximum (clockwise) position_sp. Default value is 2400. Valid values are 2300 to 2700. You must write to the position_sp attribute for changes to this attribute to take effect.

mid_pulse_sp
Used to set the pulse size in milliseconds for the signal that tells the servo to drive to the mid position_sp. Default value is 1500. Valid values are 1300 to 1700. For example, on a 180 degree servo, this would be 90 degrees. On continuous rotation servo, this is the 'neutral' position_sp where the motor does not turn. You must write to the position_sp attribute for changes to this attribute to take effect.

min_pulse_sp
Used to set the pulse size in milliseconds for the signal that tells the servo to drive to the miniumum (counter-clockwise) position_sp. Default value is 600. Valid values are 300 to 700. You must write to the position_sp attribute for changes to this attribute to take effect.

polarity
Sets the polarity of the servo. Valid values are *normal* and *inversed*. Setting the value to *inversed* will cause the position_sp value to be inversed. i.e *-100* will correspond to *max_pulse_sp*, and *100* will correspond to *min_pulse_sp*.

position_sp
Reading returns the current position_sp of the servo. Writing instructs the servo to move to the specified position_sp. Units are percent. Valid values are -100 to 100 (-100% to 100%) where *-100* corresponds to *min_pulse_sp*, *0* corresponds to *mid_pulse_sp* and *100* corresponds to *max_pulse_sp*.

rate_sp
Sets the rate_sp at which the servo travels from 0 to 100.0% (half of the full range of the servo). Units are in milliseconds. Example: Setting the rate_sp to 1000 means that it will take a 180 degree servo 2 second to move from 0 to 180 degrees. Note: Some servo controllers may not support this in which case reading and writing will fail with *-EOPNOTSUPP*. In continuous rotation servos, this value will affect the rate_sp at which the speed ramps up or down.

run (***kwargs*)
Drive servo to the position set in the *position_sp* attribute.

state
Returns a list of flags indicating the state of the servo. Possible values are: * *running*: Indicates that the motor is powered.

7.1.2 Sensor classes

Sensor

This is the base class all the other sensor classes are derived from.

class ev3dev.sensor.**Sensor**(*address=None*, *name_pattern='sensor*'*, *name_exact=False*, ***kwargs*)
The sensor class provides a uniform interface for using most of the sensors available for the EV3. The various underlying device drivers will create a *lego-sensor* device for interacting with the sensors.

Sensors are primarily controlled by setting the *mode* and monitored by reading the *value<N>* attributes. Values can be converted to floating point if needed by *value<N>* / 10.0 ^ *decimals*.

Since the name of the *sensor<N>* device node does not correspond to the port that a sensor is plugged in to, you must look at the *address* attribute if you need to know which port a sensor is plugged in to. However, if you don't have more than one sensor of each type, you can just look for a matching *driver_name*. Then it will not matter which port a sensor is plugged in to - your program will still work.

address
Returns the name of the port that the sensor is connected to, e.g. *ev3:in1*. I2C sensors also include the I2C address (decimal), e.g. *ev3:in1:i2c8*.

bin_data (*fmt=None*)
Returns the unscaled raw values in the *value<N>* attributes as raw byte array. Use *bin_data_format*, *num_values* and the individual sensor documentation to determine how to interpret the data.

Use *fmt* to unpack the raw bytes into a struct.

Example:

```
>>> from ev3dev import *
>>> ir = InfraredSensor()
>>> ir.value()
28
>>> ir.bin_data('<b')
(28,)
```

bin_data_format
Returns the format of the values in *bin_data* for the current mode. Possible values are:

- *u8*: Unsigned 8-bit integer (byte)
- *s8*: Signed 8-bit integer (sbyte)
- *u16*: Unsigned 16-bit integer (ushort)
- *s16*: Signed 16-bit integer (short)
- *s16_be*: Signed 16-bit integer, big endian
- *s32*: Signed 32-bit integer (int)
- *float*: IEEE 754 32-bit floating point (float)

command
Sends a command to the sensor.

commands
Returns a list of the valid commands for the sensor. Returns -EOPNOTSUPP if no commands are supported.

decimals
Returns the number of decimal places for the values in the *value<N>* attributes of the current mode.

driver_name
Returns the name of the sensor device/driver. See the list of [supported sensors] for a complete list of drivers.

mode
Returns the current mode. Writing one of the values returned by *modes* sets the sensor to that mode.

modes
Returns a list of the valid modes for the sensor.

num_values
Returns the number of *value<N>* attributes that will return a valid value for the current mode.

units
Returns the units of the measured value for the current mode. May return empty string

value(*n=0*)
Returns the value or values measured by the sensor. Check num_values to see how many values there are. Values with N >= num_values will return an error. The values are fixed point numbers, so check decimals to see if you need to divide to get the actual value.

Special sensor classes

The classes derive from `Sensor` and provide helper functions specific to the corresponding sensor type. Each of the functions makes sure the sensor is in the required mode and then returns the specified value.

Touch Sensor

class ev3dev.sensor.lego.**TouchSensor**(*address=None*, *name_pattern='sensor*'*, *name_exact=False*, ***kwargs*)
Bases: *ev3dev.sensor.Sensor*

Touch Sensor

MODE_TOUCH = 'TOUCH'
Button state

is_pressed
A boolean indicating whether the current touch sensor is being pressed.

wait_for_bump(*timeout_ms=None*, *sleep_ms=10*)
Wait for the touch sensor to be pressed down and then released. Both actions must happen within timeout_ms.

Color Sensor

class ev3dev.sensor.lego.**ColorSensor**(*address=None*, *name_pattern='sensor*'*, *name_exact=False*, ***kwargs*)
Bases: *ev3dev.sensor.Sensor*

LEGO EV3 color sensor.

COLOR_BLACK = 1
Black color.

COLOR_BLUE = 2
Blue color.

COLOR_BROWN = 7
Brown color.

COLOR_GREEN = 3
Green color.

COLOR_NOCOLOR = 0
No color.

COLOR_RED = 5
Red color.

COLOR_WHITE = 6
White color.

COLOR_YELLOW = 4
Yellow color.

MODE_COL_AMBIENT = 'COL-AMBIENT'
Ambient light. Blue LEDs on.

MODE_COL_COLOR = 'COL-COLOR'
Color. All LEDs rapidly cycling, appears white.

MODE_COL_REFLECT = 'COL-REFLECT'
Reflected light. Red LED on.

MODE_REF_RAW = 'REF-RAW'
Raw reflected. Red LED on

MODE_RGB_RAW = 'RGB-RAW'
Raw Color Components. All LEDs rapidly cycling, appears white.

ambient_light_intensity
Ambient light intensity. Light on sensor is dimly lit blue.

blue
Blue component of the detected color, in the range 0-1020.

calibrate_white()
The RGB raw values are on a scale of 0-1020 but you never see a value anywhere close to 1020. This function is designed to be called when the sensor is placed over a white object in order to figure out what are the maximum RGB values the robot can expect to see. We will use these maximum values to scale future raw values to a 0-255 range in rgb().

If you never call this function red_max, green_max, and blue_max will use a default value of 300. This default was selected by measuring the RGB values of a white sheet of paper in a well lit room.

Note that there are several variables that influence the maximum RGB values detected by the color sensor - the distance of the color sensor to the white object - the amount of light in the room - shadows that the robot casts on the sensor

color

Color detected by the sensor, categorized by overall value.

- 0: No color
- 1: Black
- 2: Blue
- 3: Green
- 4: Yellow
- 5: Red
- 6: White
- 7: Brown

color_name
Returns NoColor, Black, Blue, etc

green
Green component of the detected color, in the range 0-1020.

hls
HLS: Hue, Luminance, Saturation H: position in the spectrum L: color lightness S: color saturation

hsv
HSV: Hue, Saturation, Value H: position in the spectrum S: color saturation ("purity") V: color brightness

lab
Return colors in Lab color space

raw
Red, green, and blue components of the detected color, officially in the range 0-1020 but the values returned will never be that high. We do not yet know why the values returned are low, but pointing the color sensor at a well lit sheet of white paper will return values in the 250-400 range.

If this is an issue, check out the rgb() and calibrate_white() methods.

red
Red component of the detected color, in the range 0-1020.

reflected_light_intensity
Reflected light intensity as a percentage. Light on sensor is red.

rgb
Same as raw() but RGB values are scaled to 0-255

Ultrasonic Sensor

class ev3dev.sensor.lego.**UltrasonicSensor**(*address=None*, *name_pattern='sensor*'*, *name_exact=False*, ***kwargs*)

Bases: *ev3dev.sensor.Sensor*

LEGO EV3 ultrasonic sensor.

MODE_US_DIST_CM = 'US-DIST-CM'
Continuous measurement in centimeters.

MODE_US_DIST_IN = 'US-DIST-IN'
Continuous measurement in inches.

MODE_US_LISTEN = 'US-LISTEN'
Listen.

MODE_US_SI_CM = 'US-SI-CM'
Single measurement in centimeters.

MODE_US_SI_IN = 'US-SI-IN'
Single measurement in inches.

distance_centimeters
Measurement of the distance detected by the sensor, in centimeters.

distance_inches
Measurement of the distance detected by the sensor, in inches.

other_sensor_present
Value indicating whether another ultrasonic sensor could be heard nearby.

Gyro Sensor

class ev3dev.sensor.lego.**GyroSensor**(*address=None*, *name_pattern='sensor*'*, *name_exact=False*, ***kwargs*)

Bases: *ev3dev.sensor.Sensor*

LEGO EV3 gyro sensor.

MODE_GYRO_ANG = 'GYRO-ANG'
Angle

MODE_GYRO_CAL = 'GYRO-CAL'
Calibration ???

MODE_GYRO_FAS = 'GYRO-FAS'
Raw sensor value

MODE_GYRO_G_A = 'GYRO-G&A'
Angle and rotational speed

MODE_GYRO_RATE = 'GYRO-RATE'
Rotational speed

angle
The number of degrees that the sensor has been rotated since it was put into this mode.

rate
The rate at which the sensor is rotating, in degrees/second.

rate_and_angle
Angle (degrees) and Rotational Speed (degrees/second).

wait_until_angle_changed_by(*delta*)
Wait until angle has changed by specified amount.

Infrared Sensor

class ev3dev.sensor.lego.**InfraredSensor**(*address=None*, *name_pattern='sensor*'*, *name_exact=False*, ***kwargs*)

Bases: *ev3dev.sensor.Sensor*, ev3dev.button.ButtonBase

LEGO EV3 infrared sensor.

MODE_IR_CAL = 'IR-CAL'
Calibration ???

MODE_IR_PROX = 'IR-PROX'
Proximity

MODE_IR_REMOTE = 'IR-REMOTE'
IR Remote Control

MODE_IR_REM_A = 'IR-REM-A'
IR Remote Control. State of the buttons is coded in binary

MODE_IR_SEEK = 'IR-SEEK'
IR Seeker

beacon(*channel=1*)
Checks if *beacon* button is pressed.

bottom_left(*channel=1*)
Checks if *bottom_left* button is pressed.

buttons_pressed(*channel=1*)
Returns list of currently pressed buttons.

bottom_right(*channel=1*)
Checks if *bottom_right* button is pressed.

distance(*channel=1*)
Returns distance (0, 100) to the beacon on the given channel. Returns None when beacon is not found.

heading(*channel=1*)
Returns heading (-25, 25) to the beacon on the given channel.

heading_and_distance(*channel=1*)
Returns heading and distance to the beacon on the given channel as a tuple.

on_channel1_top_left = None
Handles `Red Up`, etc events on channel 1

on_channel2_top_left = None
Handles `Red Up`, etc events on channel 2

on_channel3_top_left = None
Handles `Red Up`, etc events on channel 3

on_channel4_top_left = None
Handles `Red Up`, etc events on channel 4

process()
Check for currenly pressed buttons. If the new state differs from the old state, call the appropriate button event handlers.

To use the on_channel1_top_left, etc handlers your program would do something like:

def top_left_channel_1_action(state): print("top left on channel 1: %s" % state)

def bottom_right_channel_4_action(state): print("bottom right on channel 4: %s" % state)

ir = InfraredSensor() ir.on_channel1_top_left = top_left_channel_1_action ir.on_channel4_bottom_right = bottom_right_channel_4_action

while True: ir.process() time.sleep(0.01)

proximity
A measurement of the distance between the sensor and the remote, as a percentage. 100% is approximately 70cm/27in.

top_left(*channel=1*)
Checks if *top_left* button is pressed.

top_right(*channel=1*)
Checks if *top_right* button is pressed.

Sound Sensor

class ev3dev.sensor.lego.**SoundSensor**(*address=None*, *name_pattern='sensor*'*, *name_exact=False*, ***kwargs*)
Bases: *ev3dev.sensor.Sensor*

LEGO NXT Sound Sensor

MODE_DB = 'DB'
Sound pressure level. Flat weighting

MODE_DBA = 'DBA'
Sound pressure level. A weighting

sound_pressure
A measurement of the measured sound pressure level, as a percent. Uses a flat weighting.

sound_pressure_low
A measurement of the measured sound pressure level, as a percent. Uses A-weighting, which focuses on levels up to 55 dB.

Light Sensor

class ev3dev.sensor.lego.**LightSensor**(*address=None*, *name_pattern='sensor*'*, *name_exact=False*, ***kwargs*)
Bases: *ev3dev.sensor.Sensor*

LEGO NXT Light Sensor

MODE_AMBIENT = 'AMBIENT'
Ambient light. LED off

MODE_REFLECT = 'REFLECT'
Reflected light. LED on

ambient_light_intensity
A measurement of the ambient light intensity, as a percentage.

reflected_light_intensity
A measurement of the reflected light intensity, as a percentage.

7.1.3 Other classes

Button

class ev3dev.button.**Button**
EVB Buttons

Event handlers

These will be called when state of the corresponding button is changed:

on_up

on_down

on_left

on_right

on_enter

on_backspace

Member functions and properties

any()
Checks if any button is pressed.

backspace
Check if 'backspace' button is pressed.

buttons_pressed
Returns list of names of pressed buttons.

check_buttons(*buttons=[]*)
Check if currently pressed buttons exactly match the given list.

down
Check if 'down' button is pressed.

enter
Check if 'enter' button is pressed.

evdev_device
Return our corresponding evdev device object

evdev_device_name = None
These handlers are called by *process()* whenever state of 'up', 'down', etc buttons have changed since last *process()* call

left
Check if 'left' button is pressed.

on_change(*changed_buttons*)
This handler is called by *process()* whenever state of any button has changed since last *process()* call. *changed_buttons* is a list of tuples of changed button names and their states.

process(*new_state=None*)
Check for currenly pressed buttons. If the new state differs from the old state, call the appropriate button event handlers.

right
Check if 'right' button is pressed.

up
Check if 'up' button is pressed.

wait_for_bump(*buttons*, *timeout_ms=None*)
Wait for the button to be pressed down and then released. Both actions must happen within timeout_ms.

Leds

class ev3dev.led.**Led**(*address=None*, *name_pattern='*'*, *name_exact=False*, *desc='LED'*, ***kwargs*)
Any device controlled by the generic LED driver. See https://www.kernel.org/doc/Documentation/leds/leds-class.txt for more details.

brightness
Sets the brightness level. Possible values are from 0 to *max_brightness*.

brightness_pct
Returns led brightness as a fraction of max_brightness

delay_off
The *timer* trigger will periodically change the LED brightness between 0 and the current brightness setting. The *off* time can be specified via *delay_off* attribute in milliseconds.

delay_on
The *timer* trigger will periodically change the LED brightness between 0 and the current brightness setting. The *on* time can be specified via *delay_on* attribute in milliseconds.

max_brightness
Returns the maximum allowable brightness value.

trigger
Sets the led trigger. A trigger is a kernel based source of led events. Triggers can either be simple or complex. A simple trigger isn't configurable and is designed to slot into existing subsystems with minimal additional code. Examples are the *ide-disk* and *nand-disk* triggers.

Complex triggers whilst available to all LEDs have LED specific parameters and work on a per LED basis. The *timer* trigger is an example. The *timer* trigger will periodically change the LED brightness between 0 and the current brightness setting. The *on* and *off* time can be specified via *delay_{on,off}* attributes in milliseconds. You can change the brightness value of a LED independently of the timer trigger. However, if you set the brightness value to 0 it will also disable the *timer* trigger.

triggers
Returns a list of available triggers.

class ev3dev.led.**Leds**

EV3 platform

Led groups:

LEFT

RIGHT

Colors:

RED

GREEN

AMBER

ORANGE

YELLOW

BrickPI platform

Led groups:

LED1

LED2

Colors:

BLUE

all_off()
Turn all leds off

set (*group*, ***kwargs*)
Set attributes for each led in group.

Example:: my_leds = Leds() my_leds.set_color('LEFT', brightness_pct=0.5, trigger='timer')

set_color (*group*, *color*, *pct=1*)
Sets brigthness of leds in the given group to the values specified in color tuple. When percentage is specified, brightness of each led is reduced proportionally.

Example:: my_leds = Leds() my_leds.set_color('LEFT', 'AMBER')

Power Supply

class ev3dev.power.**PowerSupply** (*address=None*, *name_pattern='*'*, *name_exact=False*, ***kwargs*)
A generic interface to read data from the system's power_supply class. Uses the built-in legoev3-battery if none is specified.

max_voltage

measured_amps
The measured current that the battery is supplying (in amps)

measured_current
The measured current that the battery is supplying (in microamps)

measured_voltage
The measured voltage that the battery is supplying (in microvolts)

measured_volts
The measured voltage that the battery is supplying (in volts)

min_voltage

technology

type

Sound

class ev3dev.sound.**Sound**
Support beep, play wav files, or convert text to speech.

Note that all methods of the class spawn system processes and return subprocess.Popen objects. The methods are asynchronous (they return immediately after child process was spawned, without waiting for its completion), but you can call wait() on the returned result.

Examples:

```
# Play 'bark.wav', return immediately:
Sound.play('bark.wav')

# Introduce yourself, wait for completion:
Sound.speak('Hello, I am Robot').wait()

# Play a small song
Sound.play_song((
    ('D4', 'e3'),
    ('D4', 'e3'),
    ('D4', 'e3'),
```

```
    ('G4', 'h'),
    ('D5', 'h')
))
```

In order to mimic EV3-G API parameters, durations used in methods exposed as EV3-G blocks for sound related operations are expressed as a float number of seconds.

beep(*args=''*)

Call beep command with the provided arguments (if any). See beep man page and google linux beep music for inspiration.

get_volume(*channel=None*)

Gets the current sound volume by parsing the output of `amixer get <channel>`. If the channel is not specified, it tries to determine the default one by running `amixer scontrols`. If that fails as well, it uses the `Playback` channel, as that is the only channel on the EV3.

play(*wav_file*, *play_type=0*)

Play a sound file (wav format).

Args: wav_file (str): the sound file path play_type (int): one off Sound.PLAY_xxx play types (wait, no wait, loop)

Returns: subprocess.Popen: the spawn subprocess when no wait play type is selected, None otherwise

play_file(*wav_file*, *volume=100*, *play_type=0*)

Play a sound file (wav format) at a given volume.

Args: wav_file (str): the sound file path volume (int) the play volume, in percent of maximum volume play_type (int): one off Sound.PLAY_xxx play types (wait, no wait, loop)

Returns: subprocess.Popen: the spawn subprocess when no wait play type is selected, None otherwise

play_note(*note*, *duration*, *volume=100*, *play_type=0*)

Plays a note, given by its name as defined in `_NOTE_FREQUENCIES`.

Args: note (str) the note symbol with its octave number duration (float): tone duration, in seconds volume (int) the play volume, in percent of maximum volume play_type (int) the type of play (wait, no wait, loop), as defined by the `PLAY_xxx` constants

Returns: the PID of the underlying beep command if no wait play type, None otherwise

Raises: ValueError: is invalid parameter (note, duration,...)

play_song(*song*, *tempo=120*, *delay=0.05*)

Plays a song provided as a list of tuples containing the note name and its value using music conventional notation instead of numerical values for frequency and duration.

It supports symbolic notes (e.g. `A4`, `D#3`, `Gb5`) and durations (e.g. `q`, `h`).

For an exhaustive list of accepted note symbols and values, have a look at the `_NOTE_FREQUENCIES` and `_NOTE_VALUES` private dictionaries in the source code.

The value can be suffixed by modifiers:

- a *divider* introduced by a `/` to obtain triplets for instance (e.g. `q/3` for a triplet of eight note)
- a *multiplier* introduced by `*` (e.g. `*1.5` is a dotted note).

Shortcuts exist for common modifiers:

- `3` produces a triplet member note. For instance *e3* gives a triplet of eight notes, i.e. 3 eight notes in the duration of a single quarter. You must ensure that 3 triplets notes are defined in sequence to match the count, otherwise the result will not be the expected one.

- `.` produces a dotted note, i.e. which duration is one and a half the base one. Double dots are not currently supported.

Example:

```
>>> # A long time ago in a galaxy far,
>>> # far away...
>>> Sound.play_song((
>>>     ('D4', 'e3'),      # intro anacrouse
>>>     ('D4', 'e3'),
>>>     ('D4', 'e3'),
>>>     ('G4', 'h'),       # meas 1
>>>     ('D5', 'h'),
>>>     ('C5', 'e3'),      # meas 2
>>>     ('B4', 'e3'),
>>>     ('A4', 'e3'),
>>>     ('G5', 'h'),
>>>     ('D5', 'q'),
>>>     ('C5', 'e3'),      # meas 3
>>>     ('B4', 'e3'),
>>>     ('A4', 'e3'),
>>>     ('G5', 'h'),
>>>     ('D5', 'q'),
>>>     ('C5', 'e3'),      # meas 4
>>>     ('B4', 'e3'),
>>>     ('C5', 'e3'),
>>>     ('A4', 'h.'),
>>> ))
```

Important: Only 4/4 signature songs are supported with respect to note durations.

Args: song (iterable[tuple(str, str)]): the song tempo (int): the song tempo, given in quarters per minute delay (float): delay between notes (in seconds)

Returns: subprocess.Popen: the spawn subprocess

Raises: ValueError: if invalid note in song or invalid play parameters

play_tone (*frequency*, *duration*, *delay=0.0*, *volume=100*, *play_type=0*)
Play a single tone, specified by its frequency, duration, volume and final delay.

Args: frequency (int): the tone frequency, in Hertz duration (float): tone duration, in seconds delay (float): delay after tone, in seconds (can be useful when chaining calls to `play_tone`) volume (int): sound volume in percent (between 0 and 100) play_type (int): one off Sound.PLAY_xxx play types (wait, no wait, loop)

Returns: the sound playing subprocess PID when no wait play type is selected, None otherwise

Raises: ValueError: if invalid value for parameter(s)

set_volume (*pct*, *channel=None*)
Sets the sound volume to the given percentage [0-100] by calling `amixer -q set <channel> <pct>%`. If the channel is not specified, it tries to determine the default one by running `amixer scontrols`. If that fails as well, it uses the `Playback` channel, as that is the only channel on the EV3.

speak (*text*, *espeak_opts='-a 200 -s 130'*, *volume=100*, *play_type=0*)
Speak the given text aloud.

Uses the `espeak` external command.

Args: text (str): the text to speak espeak_opts (str): espeak command options volume (int) the play volume, in percent of maximum volume play_type (int): one off Sound.PLAY_xxx play types (wait, no wait, loop)

Returns: subprocess.Popen: the spawn subprocess when no wait play type is selected, None otherwise

tone (**args*)

tone(tone_sequence)

Play tone sequence. The tone_sequence parameter is a list of tuples, where each tuple contains up to three numbers. The first number is frequency in Hz, the second is duration in milliseconds, and the third is delay in milliseconds between this and the next tone in the sequence.

Here is a cheerful example:

```
Sound.tone([
    (392, 350, 100), (392, 350, 100), (392, 350, 100), (311.1, 250, 100),
    (466.2, 25, 100), (392, 350, 100), (311.1, 250, 100), (466.2, 25, 100),
    (392, 700, 100), (587.32, 350, 100), (587.32, 350, 100),
    (587.32, 350, 100), (622.26, 250, 100), (466.2, 25, 100),
    (369.99, 350, 100), (311.1, 250, 100), (466.2, 25, 100), (392, 700, 100),
    (784, 350, 100), (392, 250, 100), (392, 25, 100), (784, 350, 100),
    (739.98, 250, 100), (698.46, 25, 100), (659.26, 25, 100),
    (622.26, 25, 100), (659.26, 50, 400), (415.3, 25, 200), (554.36, 350,␣
↪100),
    (523.25, 250, 100), (493.88, 25, 100), (466.16, 25, 100), (440, 25, 100),
    (466.16, 50, 400), (311.13, 25, 200), (369.99, 350, 100),
    (311.13, 250, 100), (392, 25, 100), (466.16, 350, 100), (392, 250, 100),
    (466.16, 25, 100), (587.32, 700, 100), (784, 350, 100), (392, 250, 100),
    (392, 25, 100), (784, 350, 100), (739.98, 250, 100), (698.46, 25, 100),
    (659.26, 25, 100), (622.26, 25, 100), (659.26, 50, 400), (415.3, 25, 200),
    (554.36, 350, 100), (523.25, 250, 100), (493.88, 25, 100),
    (466.16, 25, 100), (440, 25, 100), (466.16, 50, 400), (311.13, 25, 200),
    (392, 350, 100), (311.13, 250, 100), (466.16, 25, 100),
    (392.00, 300, 150), (311.13, 250, 100), (466.16, 25, 100), (392, 700)
    ]).wait()
```

Have also a look at `play_song()` for a more musician-friendly way of doing, which uses the conventional notation for notes and durations.

tone(frequency, duration)

Play single tone of given frequency (Hz) and duration (milliseconds).

Screen

class ev3dev.display.**Display** (*desc='Display'*)

Bases: `ev3dev.display.FbMem`

A convenience wrapper for the FbMem class. Provides drawing functions from the python imaging library (PIL).

circle (*clear_screen=True*, *x=50*, *y=50*, *radius=40*, *fill_color='black'*, *outline_color='black'*)
Draw a circle of 'radius' centered at (x, y)

clear ()
Clears the screen

draw
Returns a handle to PIL.ImageDraw.Draw class associated with the screen.

Example:

```
screen.draw.rectangle((10,10,60,20), fill='black')
```

image
Returns a handle to PIL.Image class that is backing the screen. This can be accessed for blitting images to the screen.

Example:

```
screen.image.paste(picture, (0, 0))
```

line (*clear_screen=True*, *x1=10*, *y1=10*, *x2=50*, *y2=50*, *line_color='black'*, *width=1*)
Draw a line from (x1, y1) to (x2, y2)

point (*clear_screen=True*, *x=10*, *y=10*, *point_color='black'*)
Draw a single pixel at (x, y)

rectangle (*clear_screen=True*, *x=10*, *y=10*, *width=80*, *height=40*, *fill_color='black'*, *outline_color='black'*)
Draw a rectangle 'width x height' where the top left corner is at (x, y)

shape
Dimensions of the screen.

text_grid (*text*, *clear_screen=True*, *x=0*, *y=0*, *text_color='black'*, *font=None*)
Display 'text' starting at grid (x, y)

The EV3 display can be broken down in a grid that is 22 columns wide and 12 rows tall. Each column is 8 pixels wide and each row is 10 pixels tall.

'text_color' : PIL says it supports "common HTML color names". There are 140 HTML color names listed here that are supported by all modern browsers. This is probably a good list to start with. https://www.w3schools.com/colors/colors_names.asp

'font' [can be any font displayed here] http://ev3dev-lang.readthedocs.io/projects/python-ev3dev/en/stable/other.html#bitmap-fonts

text_pixels (*text*, *clear_screen=True*, *x=0*, *y=0*, *text_color='black'*, *font=None*)
Display *text* starting at pixel (x, y).

The EV3 display is 178x128 pixels - (0, 0) would be the top left corner of the display - (89, 64) would be right in the middle of the display

'text_color' : PIL says it supports "common HTML color names". There are 140 HTML color names listed here that are supported by all modern browsers. This is probably a good list to start with. https://www.w3schools.com/colors/colors_names.asp

'font' [can be any font displayed here] http://ev3dev-lang.readthedocs.io/projects/python-ev3dev/en/stable/other.html#bitmap-fonts

update ()
Applies pending changes to the screen. Nothing will be drawn on the screen until this function is called.

xres
Horizontal screen resolution

yres
Vertical screen resolution

Bitmap fonts

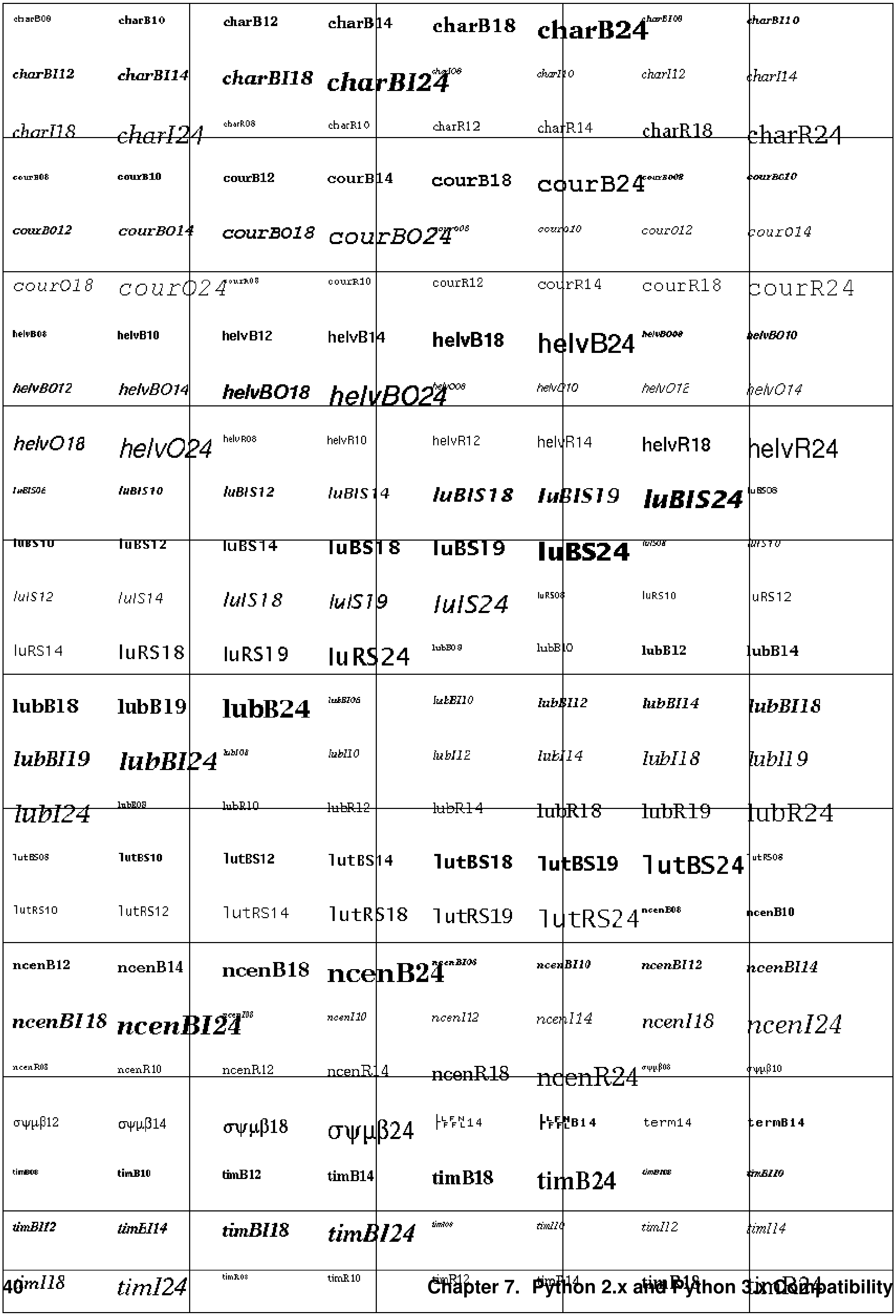
The `Display` class allows to write text on the LCD using python imaging library (PIL) interface (see description of the `text()` method here). The `ev3dev.fonts` module contains bitmap fonts in PIL format that should look good on a tiny EV3 screen:

```
import ev3dev.fonts as fonts
display.draw.text((10,10), 'Hello World!', font=fonts.load('luBS14'))
```

`ev3dev.fonts.`**`available`**`()`
Returns list of available font names.

`ev3dev.fonts.`**`load`**`(`*name*`)`
Loads the font specified by name and returns it as an instance of PIL.ImageFont class.

The following image lists all available fonts. The grid lines correspond to EV3 screen size:


charB08 charB10 charB12 charB14 charB18 charB24 charBI08 charBI10
charBI12 charBI14 charBI18 charBI24 charI08 charI10 charI12 charI14
charI18 charI24 charR08 charR10 charR12 charR14 charR18 charR24
courB08 courB10 courB12 courB14 courB18 courB24 courBO08 courBO10
courBO12 courBO14 courBO18 courBO24 courO08 courO10 courO12 courO14
courO18 courO24 courR08 courR10 courR12 courR14 courR18 courR24
helvB08 helvB10 helvB12 helvB14 helvB18 helvB24 helvBO08 helvBO10
helvBO12 helvBO14 helvBO18 helvBO24 helvO08 helvO10 helvO12 helvO14
helvO18 helvO24 helvR08 helvR10 helvR12 helvR14 helvR18 helvR24
luBIS08 luBIS10 luBIS12 luBIS14 luBIS18 luBIS19 luBIS24 luBS08
luBS10 luBS12 luBS14 luBS18 luBS19 luBS24 luIS08 luIS10
luIS12 luIS14 luIS18 luIS19 luIS24 luRS08 luRS10 luRS12
luRS14 luRS18 luRS19 luRS24 lubB08 lubB10 lubB12 lubB14
lubB18 lubB19 lubB24 lubBI08 lubBI10 lubBI12 lubBI14 lubBI18
lubBI19 lubBI24 lubI08 lubI10 lubI12 lubI14 lubI18 lubI19
lubI24 lubR08 lubR10 lubR12 lubR14 lubR18 lubR19 lubR24
lutBS08 lutBS10 lutBS12 lutBS14 lutBS18 lutBS19 lutBS24 lutRS08
lutRS10 lutRS12 lutRS14 lutRS18 lutRS19 lutRS24 ncenB08 ncenB10
ncenB12 ncenB14 ncenB18 ncenB24 ncenBI08 ncenBI10 ncenBI12 ncenBI14
ncenBI18 ncenBI24 ncenI08 ncenI10 ncenI12 ncenI14 ncenI18 ncenI24
ncenR08 ncenR10 ncenR12 ncenR14 ncenR18 ncenR24 σψμβ08 σψμβ10
σψμβ12 σψμβ14 σψμβ18 σψμβ24 term14 termB14
timB08 timB10 timB12 timB14 timB18 timB24 timBI08 timBI10
timBI12 timBI14 timBI18 timBI24 timI08 timI10 timI12 timI14
timI18 timI24 timR08 timR10 timR12 timR14 timR18 timR24

Lego Port

class ev3dev.port.**LegoPort**(*address=None*, *name_pattern='*'*, *name_exact=False*, ***kwargs*)

The *lego-port* class provides an interface for working with input and output ports that are compatible with LEGO MINDSTORMS RCX/NXT/EV3, LEGO WeDo and LEGO Power Functions sensors and motors. Supported devices include the LEGO MINDSTORMS EV3 Intelligent Brick, the LEGO WeDo USB hub and various sensor multiplexers from 3rd party manufacturers.

Some types of ports may have multiple modes of operation. For example, the input ports on the EV3 brick can communicate with sensors using UART, I2C or analog validate signals - but not all at the same time. Therefore there are multiple modes available to connect to the different types of sensors.

In most cases, ports are able to automatically detect what type of sensor or motor is connected. In some cases though, this must be manually specified using the *mode* and *set_device* attributes. The *mode* attribute affects how the port communicates with the connected device. For example the input ports on the EV3 brick can communicate using UART, I2C or analog voltages, but not all at the same time, so the mode must be set to the one that is appropriate for the connected sensor. The *set_device* attribute is used to specify the exact type of sensor that is connected. Note: the mode must be correctly set before setting the sensor type.

Ports can be found at */sys/class/lego-port/port<N>* where *<N>* is incremented each time a new port is registered. Note: The number is not related to the actual port at all - use the *address* attribute to find a specific port.

address
Returns the name of the port. See individual driver documentation for the name that will be returned.

driver_name
Returns the name of the driver that loaded this device. You can find the complete list of drivers in the [list of port drivers].

mode
Reading returns the currently selected mode. Writing sets the mode. Generally speaking when the mode changes any sensor or motor devices associated with the port will be removed new ones loaded, however this this will depend on the individual driver implementing this class.

modes
Returns a list of the available modes of the port.

set_device
For modes that support it, writing the name of a driver will cause a new device to be registered for that driver and attached to this port. For example, since NXT/Analog sensors cannot be auto-detected, you must use this attribute to load the correct driver. Returns -EOPNOTSUPP if setting a device is not supported.

status
In most cases, reading status will return the same value as *mode*. In cases where there is an *auto* mode additional values may be returned, such as *no-device* or *error*. See individual port driver documentation for the full list of possible values.

7.2 Working with ev3dev remotely using RPyC

RPyC (pronounced as are-pie-see), or Remote Python Call, is a transparent python library for symmetrical remote procedure calls, clustering and distributed-computing. RPyC makes use of object-proxying, a technique that employs python's dynamic nature, to overcome the physical boundaries between processes and computers, so that remote objects can be manipulated as if they were local. Here are simple steps you need to follow in order to install and use RPyC with ev3dev:

1. Install RPyC both on the EV3 and on your desktop PC. For the EV3, enter the following command at the command prompt (after you connect with SSH):

```
sudo easy_install3 rpyc
```

On the desktop PC, it really depends on your operating system. In case it is some flavor of linux, you should be able to do

```
sudo pip3 install rpyc
```

In case it is Windows, there is a win32 installer on the project's sourceforge page. Also, have a look at the Download and Install page on their site.

2. Create file `rpyc_server.sh` with the following contents on the EV3:

```
#!/bin/bash
python3 `which rpyc_classic.py`
```

and make the file executable:

```
chmod +x rpyc_server.sh
```

Launch the created file either from SSH session (with `./rpyc_server.sh` command), or from brickman. It should output something like

```
INFO:SLAVE/18812:server started on [0.0.0.0]:18812
```

and keep running.

3. Now you are ready to connect to the RPyC server from your desktop PC. The following python script should make a large motor connected to output port `A` spin for a second.

```
import rpyc
conn = rpyc.classic.connect('ev3dev') # host name or IP address of the EV3
ev3 = conn.modules['ev3dev.ev3']      # import ev3dev.ev3 remotely
m = ev3.LargeMotor('outA')
m.run_timed(time_sp=1000, speed_sp=600)
```

You can run scripts like this from any interactive python environment, like ipython shell/notebook, spyder, pycharm, etc.

Some *advantages* of using RPyC with ev3dev are:

- It uses much less resources than running ipython notebook on EV3; RPyC server is lightweight, and only requires an IP connection to the EV3 once set up (no ssh required).
- The scripts you are working with are actually stored and edited on your desktop PC, with your favorite editor/IDE.
- Some robots may need much more computational power than what EV3 can give you. A notable example is the Rubics cube solver: there is an algorithm that provides almost optimal solution (in terms of number of cube rotations), but it takes more RAM than is available on EV3. With RPYC, you could run the heavy-duty computations on your desktop.

The most obvious *disadvantage* is latency introduced by network connection. This may be a show stopper for robots where reaction speed is essential.

7.3 Frequently-Asked Questions

7.3.1 My script works when launched as `python3 script.py` but exits immediately or throws an error when launched from Brickman or as `./script.py`

This may occur if your file includes Windows-style line endings, which are often inserted by editors on Windows. To resolve this issue, open an SSH session and run the following command, replacing `<file>` with the name of the Python file you're using:

```
sed -i 's/\r//g' <file>
```

This will fix it for the copy of the file on the brick, but if you plan to edit it again from Windows you should configure your editor to use Unix-style endings. For PyCharm, you can find a guide on doing this here. Most other editors have similar options; there may be an option for it in the status bar at the bottom of the window or in the menu bar at the top.

CHAPTER 8

Indices and tables

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