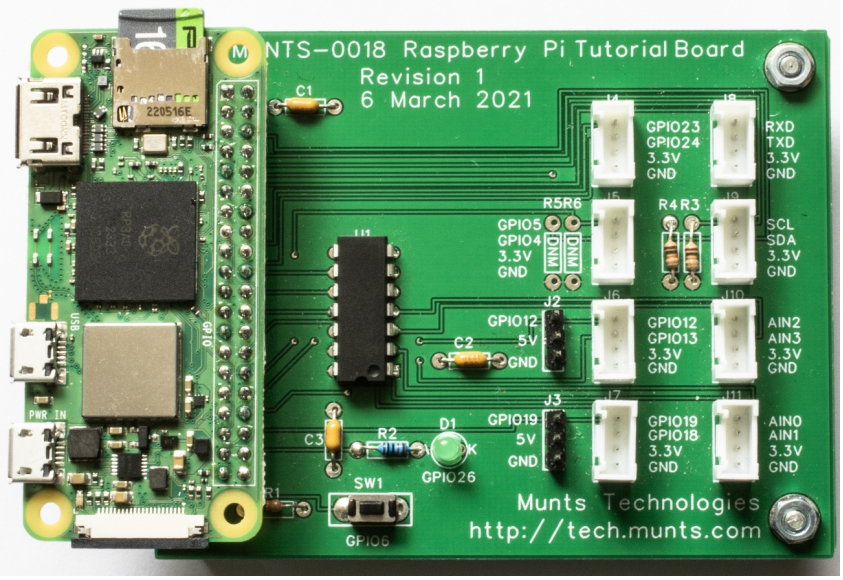
MUNTS-0019 Raspberry Pi Tutorial Kit User Guide



Revision 2
1 April 2025

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https://tech.munts.com

Introduction

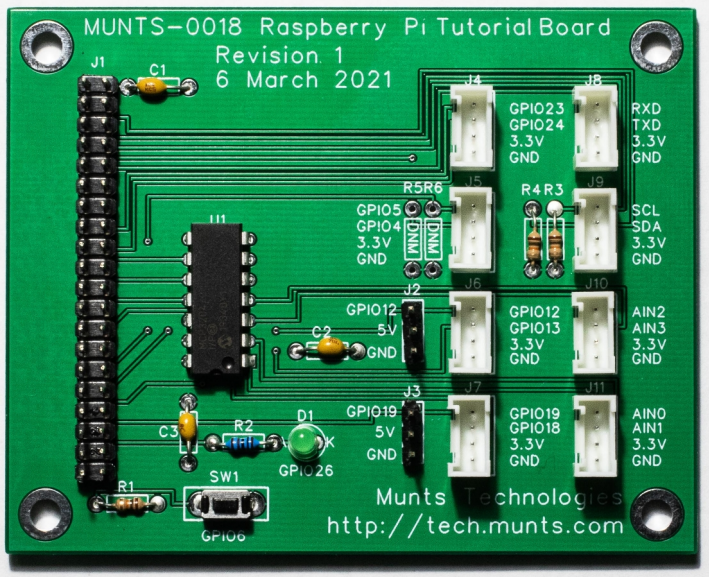
The ***MUNTS-0019 Raspberry Pi Tutorial Kit*** consists of a ***Orange Pi Zero 2W*** or ***Raspberry Pi Zero 2 W*** microcomputer mated to a ***MUNTS-0018 Raspberry Pi Tutorial I/O Board***, along with some ***Grove System*** compatible I/O devices.

The microcomputer supplied in the tutorial kit comes with ***MuntsOS Embedded Linux*** firmware already installed. ***MuntsOS*** is a very small Linux distribution for resource constrained microcomputers like the Raspberry Pi. It boots from a micro-SD card, but thereafter runs entirely from RAM.

MUNTS-0019 Raspberry Pi Tutorial Kits always come with firmware that enables the microcomputer to act as a ***USB Ethernet Gadget***. The microcomputer's USB interface hardware is placed into slave device mode. When plugged into a host computer, from which it receives power, the Raspberry Pi enumerates as a USB Ethernet device. This works on Chromebook, Linux, MacOS and Windows host computers.

The firmware even runs a DHCP server that causes the host operating system to configure its USB Ethernet interface such that the Raspberry Pi is accessible at the IPv4 address `10.254.254.252` or the domain name `usbgadget.munts.net.`

MUNTS-0018 Raspberry Pi Tutorial I/O Board User Guide



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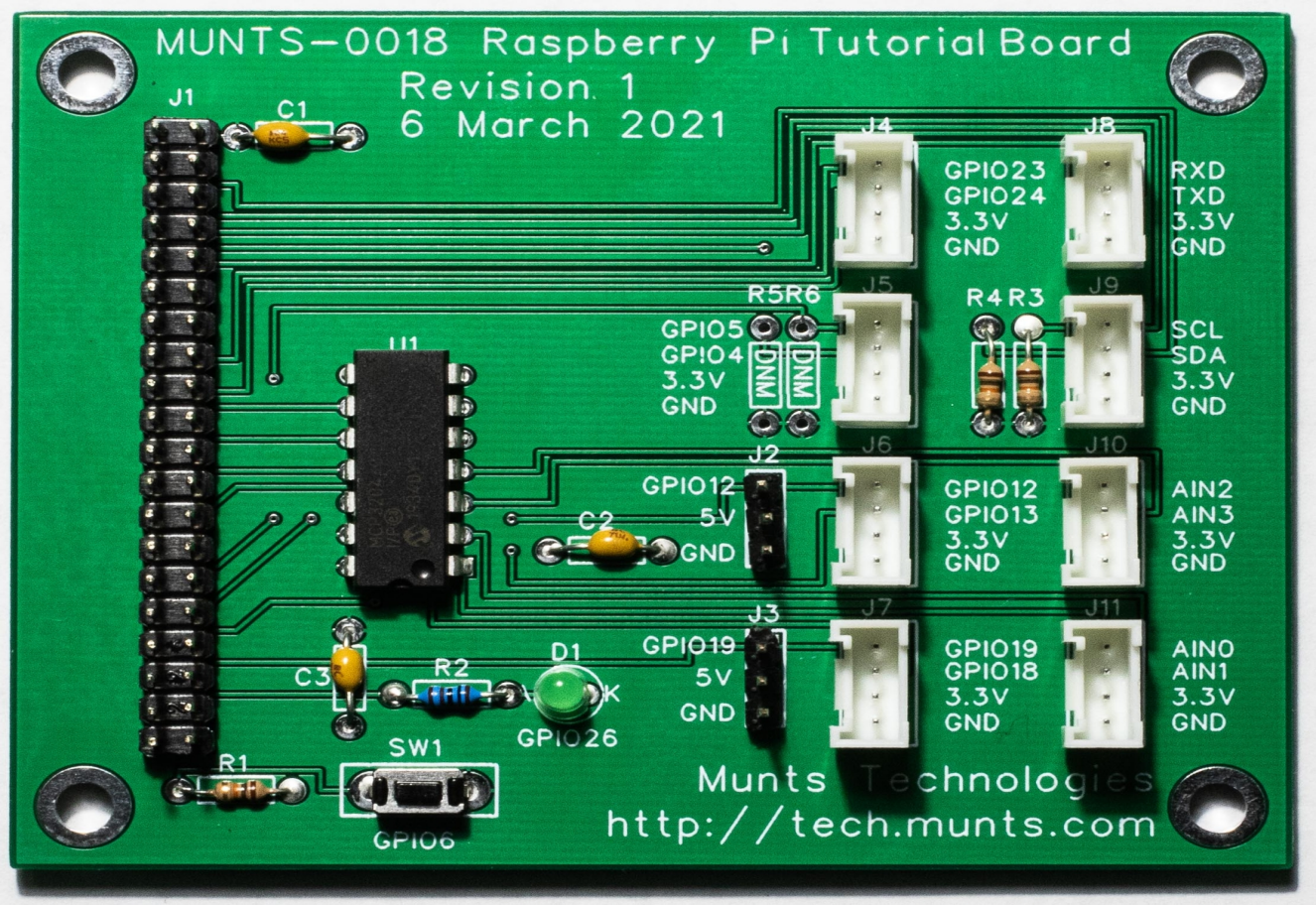
Introduction

The ***MUNTS-0018 Raspberry Pi Tutorial I/O Board*** is a breakout board for the 40-pin Raspberry Pi expansion bus.



It contains an on-board A/D converter, an LED, a momentary switch, two 3-pin 5V servo headers, and 8 Grove System connectors:

- 2 Grove GPIO connectors (providing four 3.3V GPIO pins).
- 2 Grove PWM output connectors (for controlling two DC motors).
- 1 Grove Serial Port connector.
- 1 Grove I^2C Bus connector.
- 2 Grove ADC input connectors (providing four 12-bit 3.3V analog inputs).

Button

The momentary switch button **SW1** is connected to **GPIO6**. When the button is pressed, reading **GPIO6** yields a 1/High/True value. When the button is released, reading **GPIO6** yields a 0/Low/False value.

LED

Light Emitting Diode (LED) **D1** is connected to **GPIO26**. Writing a 1/High/True value to **GPIO26** turns on the LED and writing a 0/Low/False value to **GPIO26** turns off the LED.

Analog Inputs

An MCP3204 Analog to Digital Converter provides 4 analog inputs that are connected to Grove Connectors **J10** and **J11**. Each analog input channel has a resolution of 12 bits (values 0 to 4095 inclusive) and a full scale range of 0.0 to 3.3V. The absolute accuracy of the analog inputs will depend on the accuracy of the interface computer's 3.3V regulator, which is connected to the MCP3204 voltage reference input.

Pin Mapping

J10 Pin 1	**AIN2**	**/sys/bus/iio/devices/iio:device0/in_voltage2_raw**
J10 Pin 2	**AIN3**	**/sys/bus/iio/devices/iio:device0/in_voltage3_raw**
J11 Pin 1	**AIN0**	**/sys/bus/iio/devices/iio:device0/in_voltage0_raw**
J11 Pin 2	**AIN1**	**/sys/bus/iio/devices/iio:device0/in_voltage1_raw**

Pulse Width Modulated DC Motor Driver Outputs

The Raspberry Pi expansion bus supports two hardware PWM outputs: `PWM0` and `PWM1`, each of which can be mapped to several GPIO pins. They routed to Grove connectors `J6` and `J7`, which are are configured for controlling DC motors.

Pin Mapping

`J6` Pin 1	`PWM0`	Motor Speed PWM Output
`J6` Pin 2	`GPIO13`	Motor Direction GPIO Output
`J7` Pin 1	`PWM1`	Motor Speed PWM Output
`J7` Pin 2	`GPIO18`	Motor Direction GPIO Output

RC Servo Outputs

Headers `J2` and `J3` are configured for controlling 5V RC servos. They share the `PWM0` and `PWM1` outputs with Grove Connectors `J6` and `J7`.

Both the PWM pulse frequency and duty cycle must be constrained to limited ranges when driving a servo. Standard RC servos require a PWM pulse frequency of 50 Hz and a PWM pulse width from 1.0 to 2.0 milliseconds.

When `J2` is used for a servo, `J6` cannot be used for a motor driver, and `J2` cannot be used for a servo when `J6` is used for a motor driver.

Likewise, when `J3` is used for a servo, `J7` cannot be used for a motor driver, and `J3` cannot be used for a servo when `J7` is used for a motor driver.

Pin Mapping

`J2` Pin 1	`PWM0`	Servo Position PWM Output
`J3` Pin 1	`PWM1`	Servo Position PWM Output

Serial Port

The Raspberry Pi expansion bus serial port is connected to Grove Connector **J8**.

The processor chip on the Raspberry Pi board has two different hardware serial ports, either of which can be mapped to the expansion bus. The boot configuration file **/boot/config.txt** must contain the following to map the primary full-feature serial port **/dev/ttyAMA0** to the expansion bus and on to **J8**:

```
dtoverlay=disable-bt
```

Pin Mapping

J8 Pin 1	**RXD**	Receive Data Input
J8 Pin 2	**TXD**	Transmit Data Output

Raspberry Pi 4 Extra Serial Port

Unlike any of its predecessors, the Raspberry Pi 4 has additional hardware serial ports available on the expansion bus. One of these extra hardware serial ports, **UART3**, can be mapped to Grove Connector **J5** by appending the following device tree overlay command to **/boot/config.txt**:

```
dtoverlay=uart3
```

This maps Linux serial port device **/dev/ttyAMA1** to Grove Connector **J5**.

Pin Mapping

J5 Pin 1	**RXD**	Receive Data Input
J5 Pin 2	**TXD**	Transmit Data Output

*Note: All serial port connectors on this board provide 3.3V TTL line level signals. They are **not** RS-232, RS-422, or RS-423 compatible.*

I²C Bus Controller

The Raspberry Pi expansion bus I²C bus controller device **/dev/i2c-1** is connected to Grove Connector **J9**.

The I²C bus controller is configured for the standard 100 kHz clock rate. It can be configured for a different clock rate with a device tree overlay command:

```
dtparam=i2c_baudrate=400000
```

The **MUNTS-0018** board has 10 kilohm I²C bus pullup resistors **R3** and **R4** already installed.

Pin Mapping

J9 Pin 1	**SCL1**	I²C Clock Signal
J9 Pin 2	**SDA1**	I²C Data Signal

Raspberry Pi 4 Extra I²C Bus Controller

Unlike any of its predecessors, the Raspberry Pi 4 has additional I²C bus controllers available on its expansion bus. One of these extra hardware I²C bus controllers, **I2C3**, can be mapped to Grove Connector **J5** by appending the following device tree overlay command to **/boot/config.txt**:

```
dtoverlay=i2c3
```

This maps Linux I²C bus controller device **/dev/i2c-3** to Grove Connector **J5**.

You may need to install 10 kilohm I²C bus pullup resistors at positions **R5** and **R6**. If at least one I²C slave device on the bus has pullup resistors, you will not need **R5** and **R6**.

Pin Mapping

J5 Pin 1	**SCL3**	I²C Clock Signal
J5 Pin 2	**SDA3**	I²C Data Signal

Device Tree Overlays

Very often, I/O devices on Linux microcomputer boards must be configured with device tree overlays. The **Raspberry Pi Zero 2 W** or **Orange Pi Zero 2 W** that will be mated to this board each require a special device tree overlay to enable all of the I/O resources on the MUNTS-0018 board..

Raspberry Pi Zero 2 W

The following must be added to `/boot/config.txt`:

```
dtoverlay=MUNTS-0018
```

You will also need to add the following to `/etc/pinmux.conf`:

```
12      a0      # PWM0
19      a3      # PWM1
```

Orange Pi Zero 2 W

The following must be added to `/boot/config.txt`:

```
overlays=MUNTS-0018
```

Since the designers of the **Orange Pi Zero 2W** board did not route any of its four PWM outputs to `GPIO18` or `GPIO19`, servo header `J3` and PWM socket `J7` can only be used for GPIO. Since they did route `PWM1` to `GPIO12` and `PWM2` to `GPIO13`, both connected to PWM socket `J6`, you can connect a motor driver requiring two PWM signals (clockwise and counterclockwise), such a DRV8871.

Additional Online Documentation

Device Tree Overlays

https://github.com/raspberrypi/documentation/blob/develop/documentation/asciidoc/computers/configuration/device-tree.adoc

Grove System

https://wiki.seeedstudio.com/Grove_System

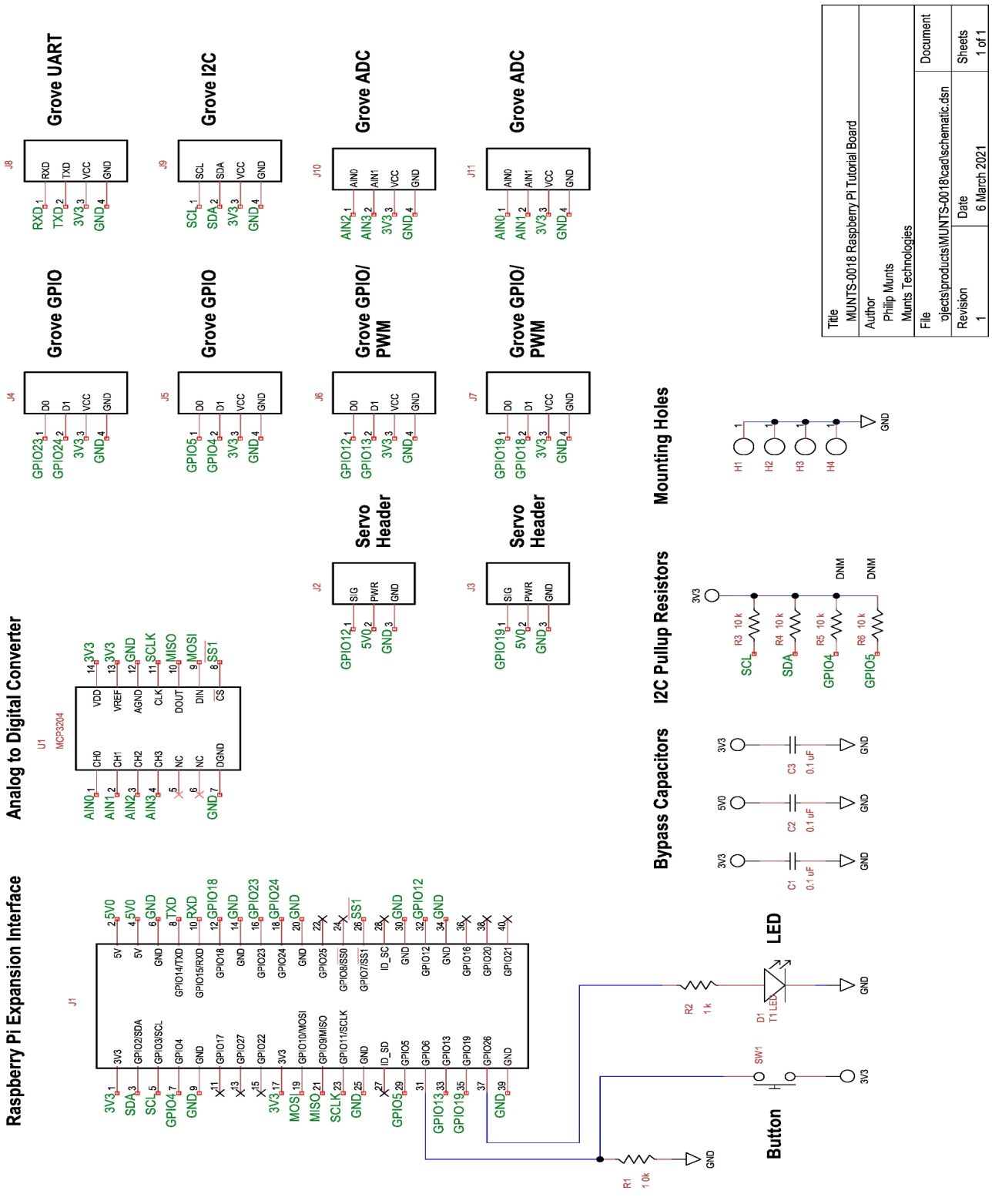
MCP3204 Analog to Digital Converter

https://www.microchip.com/wwwproducts/en/MCP3204

Raspberry Pi GPIO (General Purpose Input/Output)

https://www.raspberrypi.org/documentation/usage/gpio

Schematic Diagram



Revision History

Board

Revision 1	6 March 2021– First revision.

User Guide

Revision 1	23 December 2021 – First revision.
Revision 2	28 December 2021 – Fixed some minor formatting errors.
Revision 3	2 November 2023 – Removed most discussion of device tree overlays. Other cleanups and rewrites.
Revision 4	8 December 2023 – Added new section about device tree overlays.
Revision 5	26 January 2024 – Added note about adding entries to `/etc/pinmux.conf`.
Revision 6	28 December 2024 – Updated the Device Tree section to reflect the current settings for both the Raspberry Pi Zero 2 W and the similar Orange Pi Zero 2W microcomputer boards.
Revision 7	1 April 2025 – Added serial port pin mappings. Fixed some cosmetic formatting errors.