

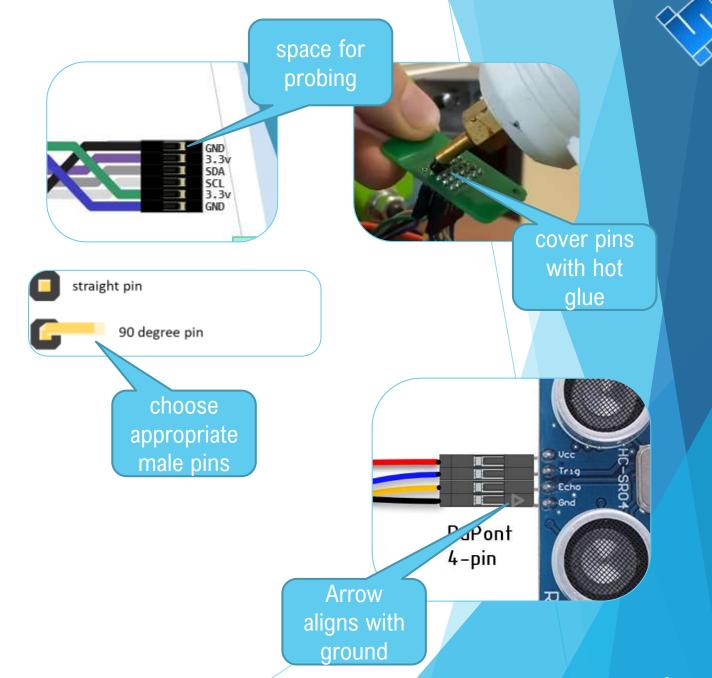
SCUTTLE Robot Wiring Guide

Revision 2022.04.24

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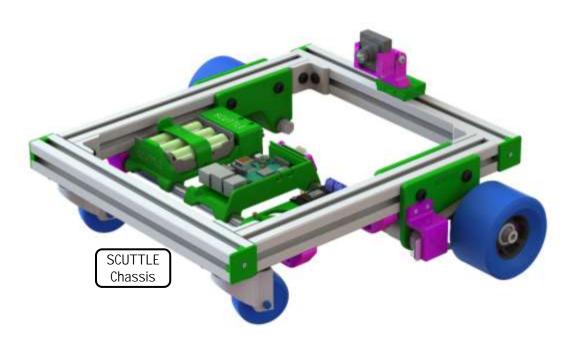
Good Practices

- Keep Wire sets bonded together.
- Use colors which are found in the common sequence
 - makes it easy for others to repeat your trials
 - makes it easy to document
- Eliminate individual pins
 - replace them with multi-position housings
- Use black colored wire for ground
 - whenever possible
- Dupont Housings: align the arrow to ground pin
 - whenever possible
- ▶ Use 90-degree headers where appropriate
- Hot glue backs of through-hole pins
 - reduce chance of short circuit
 - hot glue is removable if necessary



SCUTTLE Supports various CPUs







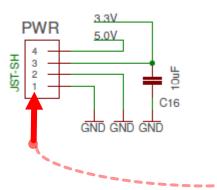
Before You Begin:

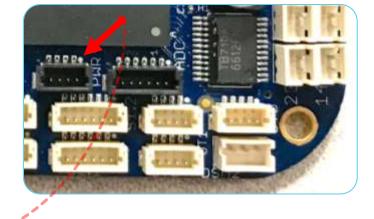


Important Info:

To match the beaglebone pins to the pin numbers on the diagram: The tiny white circle on the silkscreen at each connector indicates "pin1"

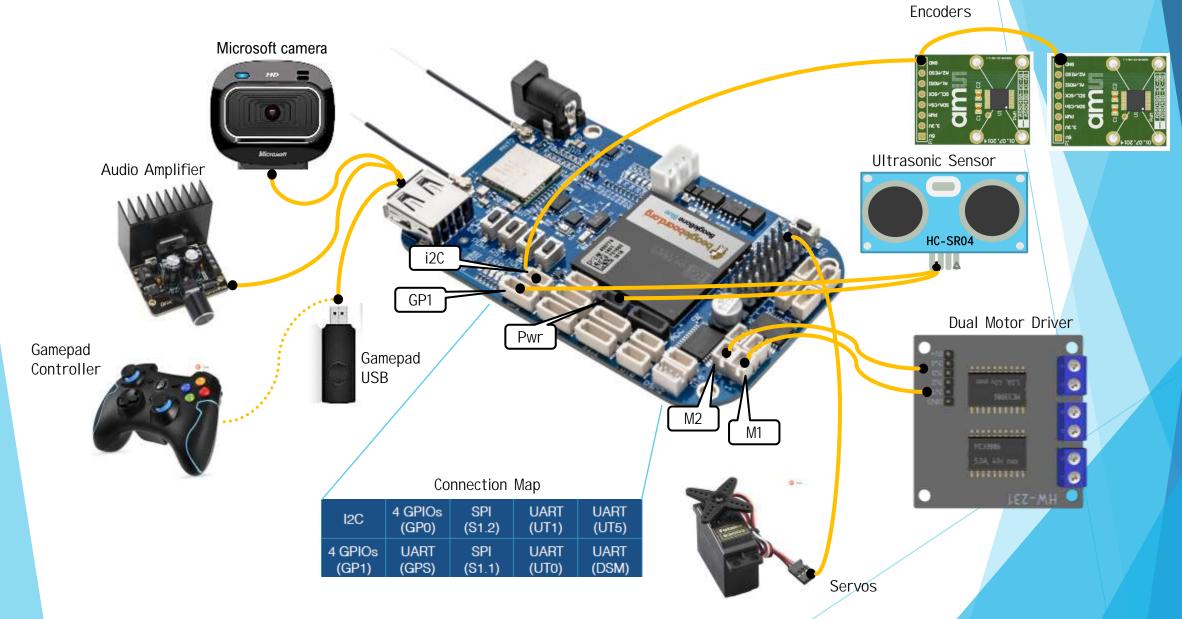
images of this style are copied directly from the beaglebone schematic





Validated Sensors & Actuators

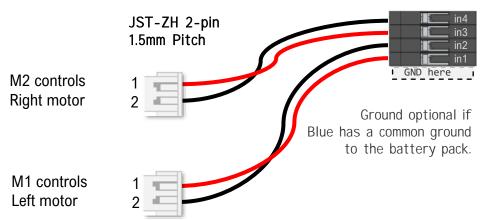


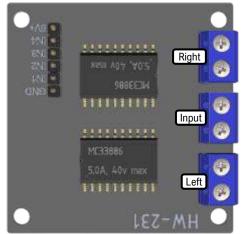


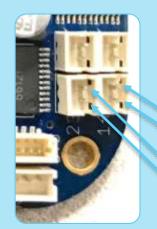
Motor Driver Signal Wires



Motor Driver Top View HW-231 Motor Driver





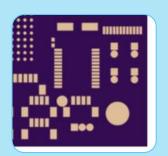


Pin 1 should be HIGH when motor is driven FORWARD

> Motor1 Pin1 Motor1 Pin2

Motor2 Pin1

Hardware design convention:
Pin 1 uses the square solder pac

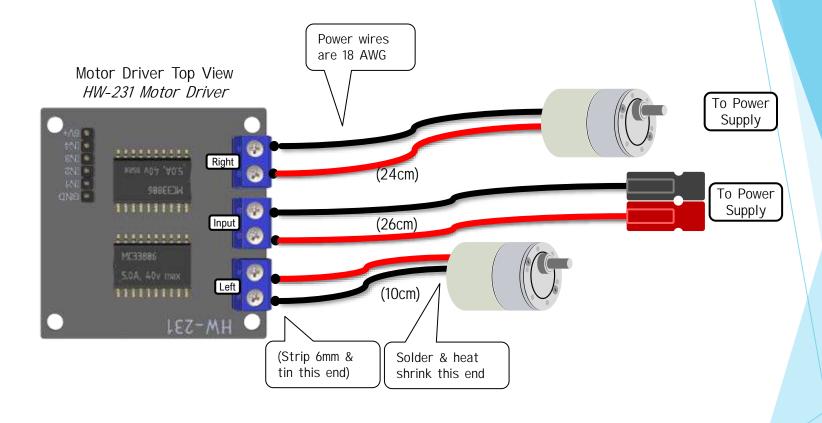


Motor Direction:

Left-hand: Drives CCW on positive command. Right-hand: Drives CW on positive command

Motor Driver Power Wires





Motor Direction:

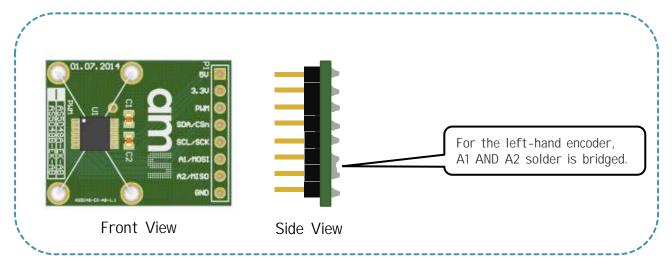
Left-hand: Drives CCW on positive command. Right-hand: Drives CW on positive command

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Encoder Details







The i2c address is determined by the signals on A1 and A2 pins.

Left Hand Encoder A1 is pulled **down** to GND. I2C address is 0x40

Right Hand Encoder pin A1 is pulled **up** to 3.3v. I2C address is 0x41

	Pin A1	Pin A2	Resulting i2c address
Left Encoder	LOW	LOW	0x40
Right Encoder	LOW	HIGH	0x41

R

H-Bridge L298N (optional)

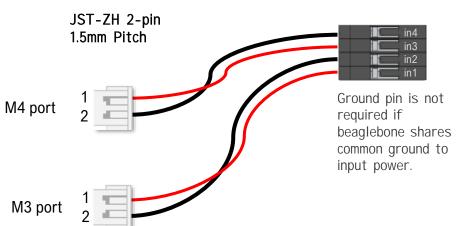


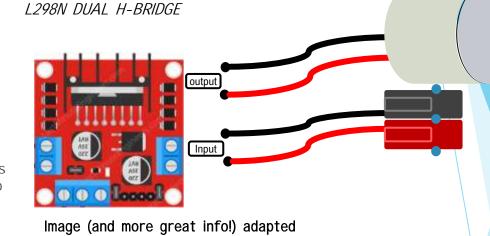
To Power Supply

A versatile and cheap device for delivering variable voltage to low-powered DC actuators.

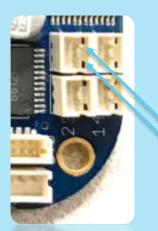
(below 2A)

Connect any actuator





from <u>LastMinutEngineers.com</u>



Pin 1 should be HIGH when motor is driven FORWARD

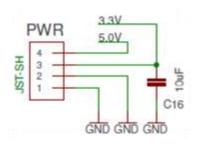


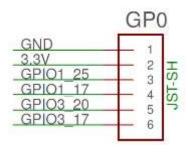


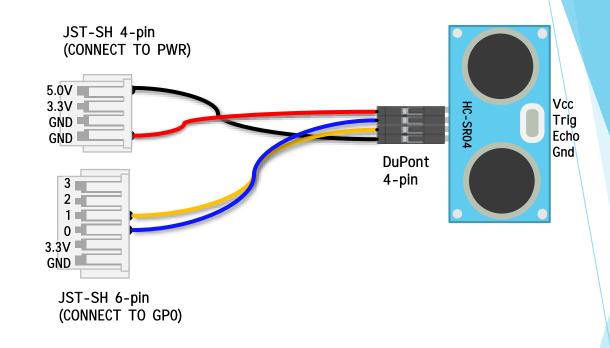
More information about the 5v regulator Found on the datasheet (L78M05)

Ultrasonic Distance Sensor (GPIO)







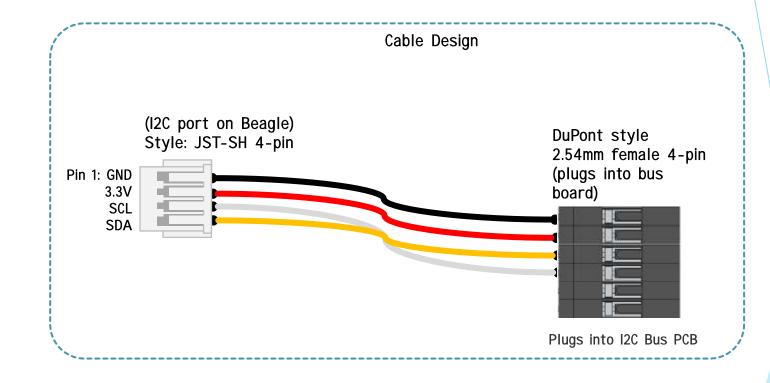


NOTE: For JST connectors out-of-box, the colors are not in the correct order. You need to rearrange them.



Beaglebone to I2C bus cable



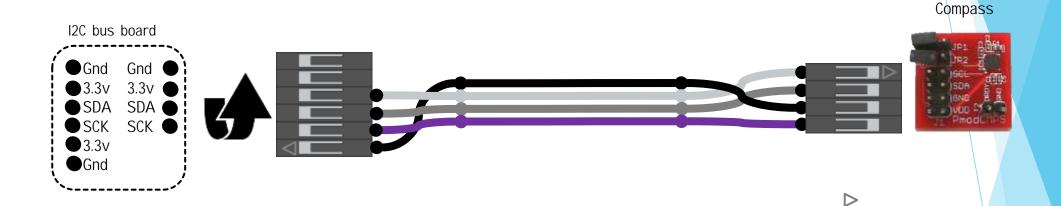


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Compass CMPS or CMPS2 (I2C)







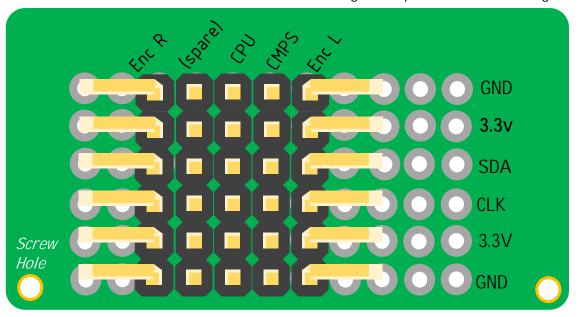
This compass is not necessary since you can access the compass on the beaglebone blue. Be sure to calibrate the compass on the blue since it lies within close proximity of magnetic hardware on the robot.

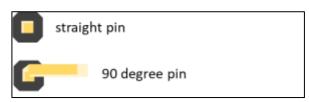
12C Bus Board

Option A: solder a perfboard / breadboard

The board is made from a breadboard and soldered manually. The board can be cut between rows J & K.

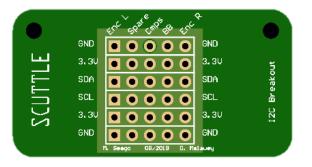
The solder bridges all pins from left to right.





Option B: Order the custom PCB

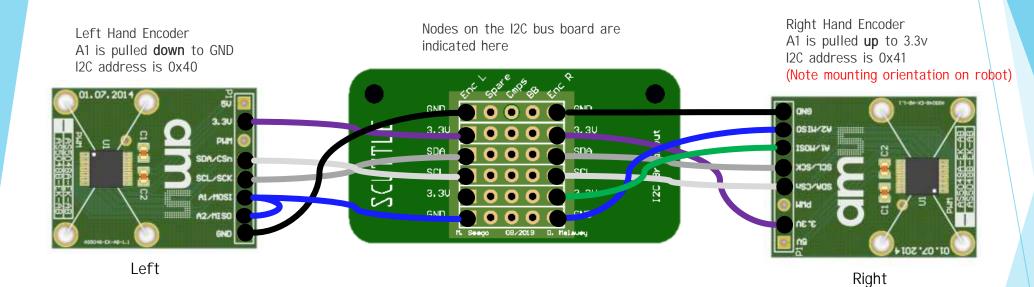
You can order the custom PCB from JLCPCB.com or any other service. We have posted the design files on our github under <u>electronics hardware</u>.





Encoder AMS AS5048 (I2C)

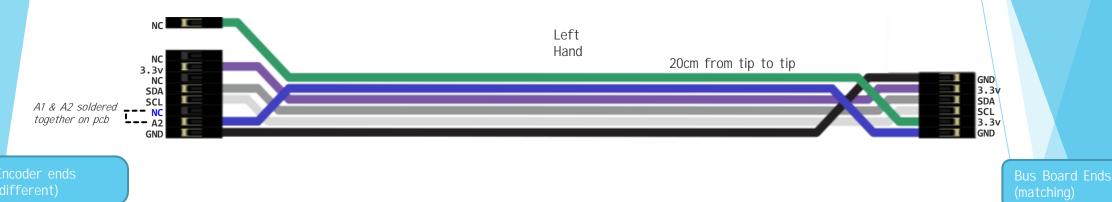




Also see: Encoder Details Slide

Cables modified as of 2020.12 SDA = GREY SCL= WHITE





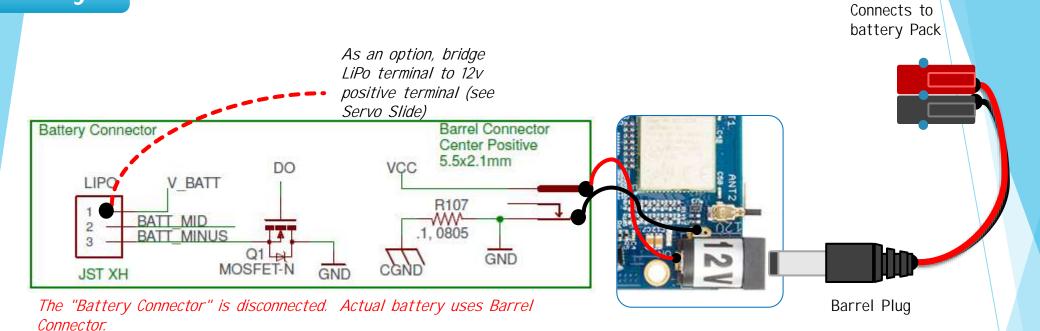
Right
Hand

SDA
SCL
A1
A2

Right
Hand

Battery

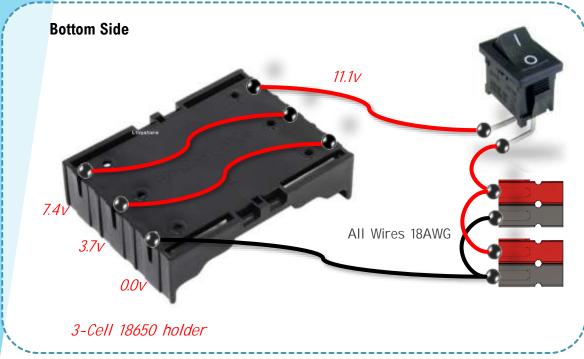




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Battery Pack (version1 configuration)





Switch PN:SRB22A2FBBNN Carries 10A max

Two pairs of Anderson connectors are attached here.

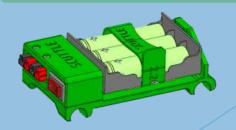
This battery pack was used through 2020.09. The wires are appropriate for the CAD designs posted prior to version 2.1.

You may build a battery pack without a Battery Management System (BMS) as shown here, or copy our latest design which includes BMS. See next slide.

Pack version 1 BMS: does not fit Model on GrabCAD



Pack version 2 BMS: optional Model on GrabCAD



Battery Pack (v2, enhanced with BMS)

The BMS adds several functions to the battery pack. Look out for a Youtube video covering the SCUTTLE BMS soon (-DM 2020.11)



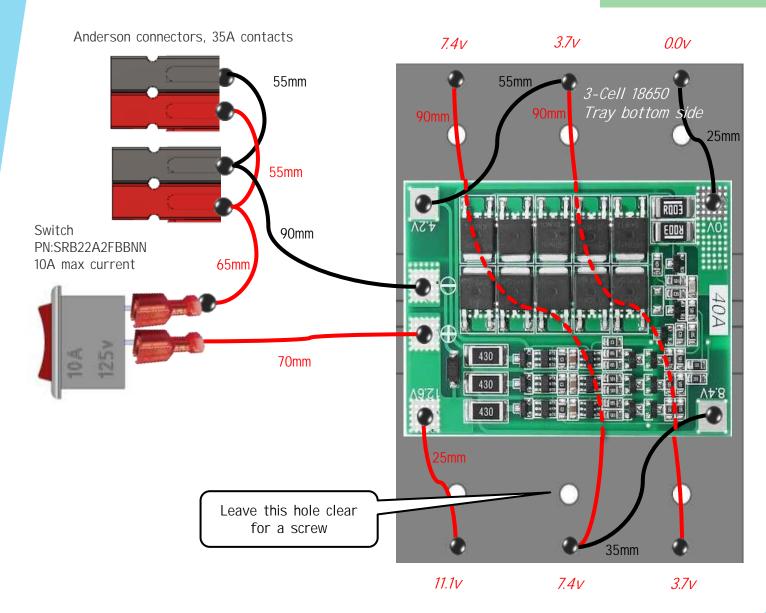


Table of wires to cut (11 total)

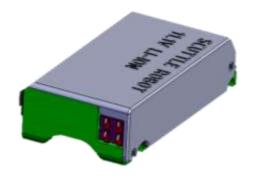
to cut (11 total)		
Length (mm)		
<mark>25</mark> , 25		
35, 35		
<mark>55</mark> , 55		
65		
70		
90, 90, 90		

Battery Pack Styles



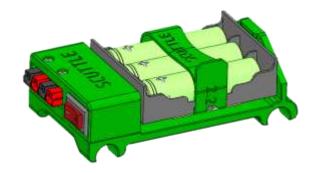
Pack version 1

- BMS: does not fit
- Model on <u>GrabCAD</u>
- Access CAD model from within SCUTTLE assembly



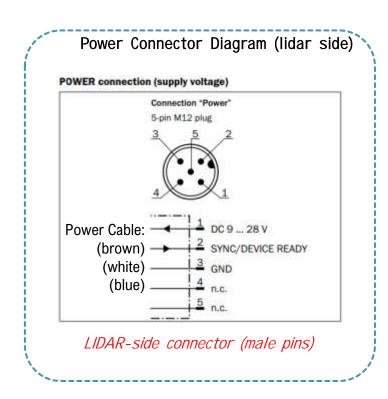
Pack version 2

- BMS: optional
- Model on <u>GrabCAD</u>
- Access the model as a standalone assembly



LIDAR







Typical Lidar power consumption: 2.1w

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GamePad





Button Behavior:

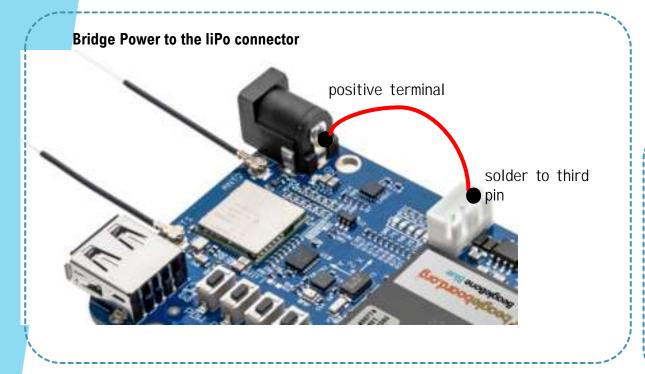
- not pressed: 0
- Pressed: 1

Axis behavior:

- Right returns positive values
- down returns positive values
- Outputs:
- Analog axes return values between -1 and 1
- These axes reach their limits before the hard-stop.
- To discover the behavior graphically, visit the html graphical test page here

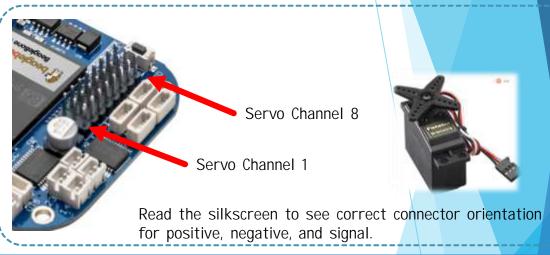
2

Servos



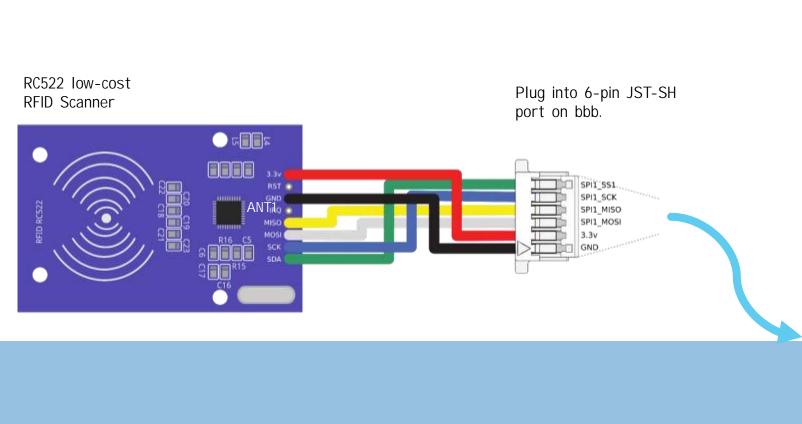
Without a power source available at the positive (third pin) input of the liPo connector, the board has insufficient current available to the servos to drive servos at full torque or to drive multiple servos.

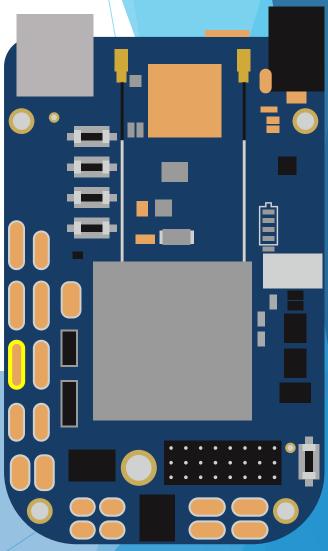
A safe fix is to solder the positive terminal of the DC jack to the third pin of the connector shown. When a battery is connected, the pins correspond to 0.0v, 3.7v, and 7.2v terminals of a 2-cell lipo.



22

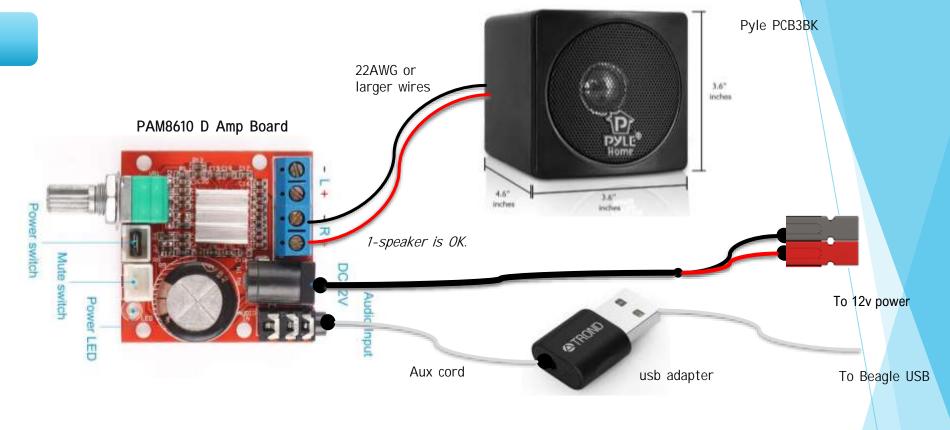
RFID reader











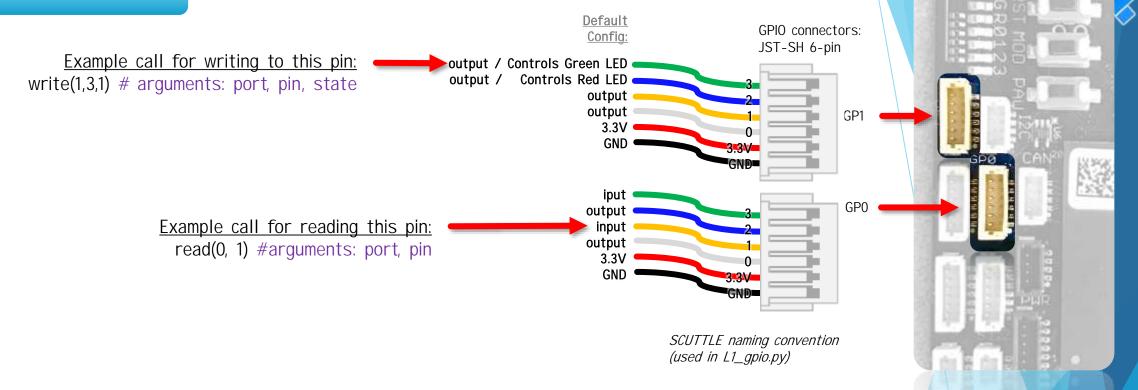
Alternative:

The above setup will support at least 10 watts (this is actually quite loud — easy to hear in a crowded room).

It is also possible to find a speaker which receives BOTH power AND signal over USB. These will be more compact but less powerful. (The speaker shown is 3w max)



GPIO Connections



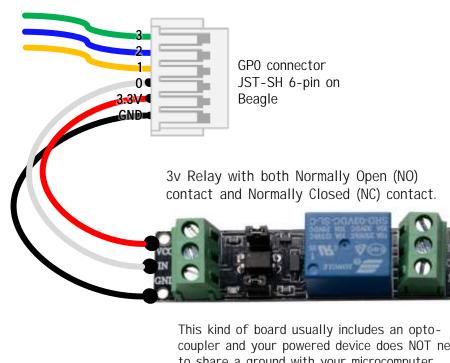
Connector vector image preserved for later use.



Note: JST wires don't come with the proper color sequence. They must be rearranged.

GPIO Example - Relay





Heavy Duty Pump Relays are appropriate for switching of high powered devices. For heavy pumps, motors, fans, or floodlights, it may be best to add a dedicated power source such as an ancilliary battery. Then, control the power to the device using logic-level signals and a relay or solid-state relay.

A great detailed writeup is here.

Heavy Duty Power Supply

coupler and your powered device does NOT need to share a ground with your microcomputer. There are two circuits here, isolated from each other.



Twin Relays (tested)

Successfully tested setup 2020.10.10

- · Jumper pin is removed from Vcc pins
- Send GND and 5v to the device from Beaglebone PWR
- In our test, the 3.3v from Beagle was insufficient to drive the relays
- · Our device was found to be active low although advertised as active high

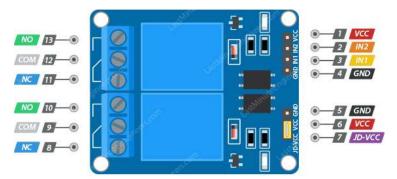
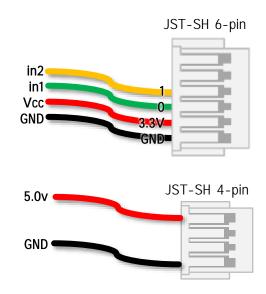


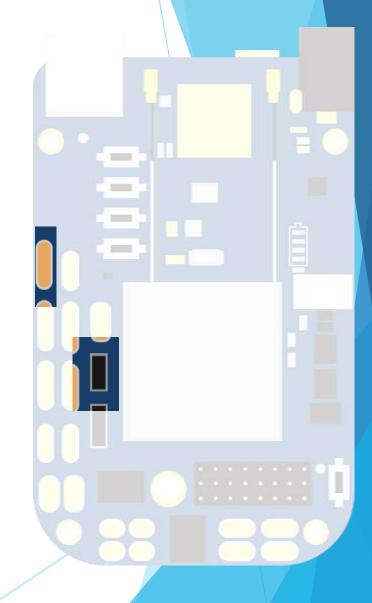
Image credit: Last Minute Engineers (visit)

The problem with active-low relays:

If you have an actuator which must not be actuated until the right moment, (such as a car horn we tested indoors) an active-low device may cause you trouble.

Unless the coil power is provided at the exact moment that the signal pin is driven high, there will be an actuation during startup. Consider this when you shop for a relay.

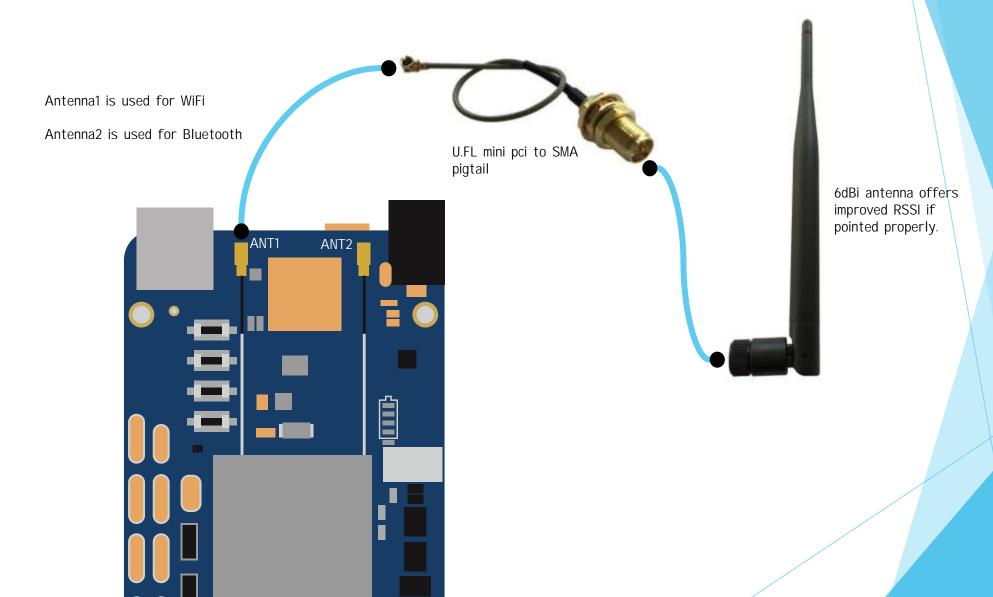


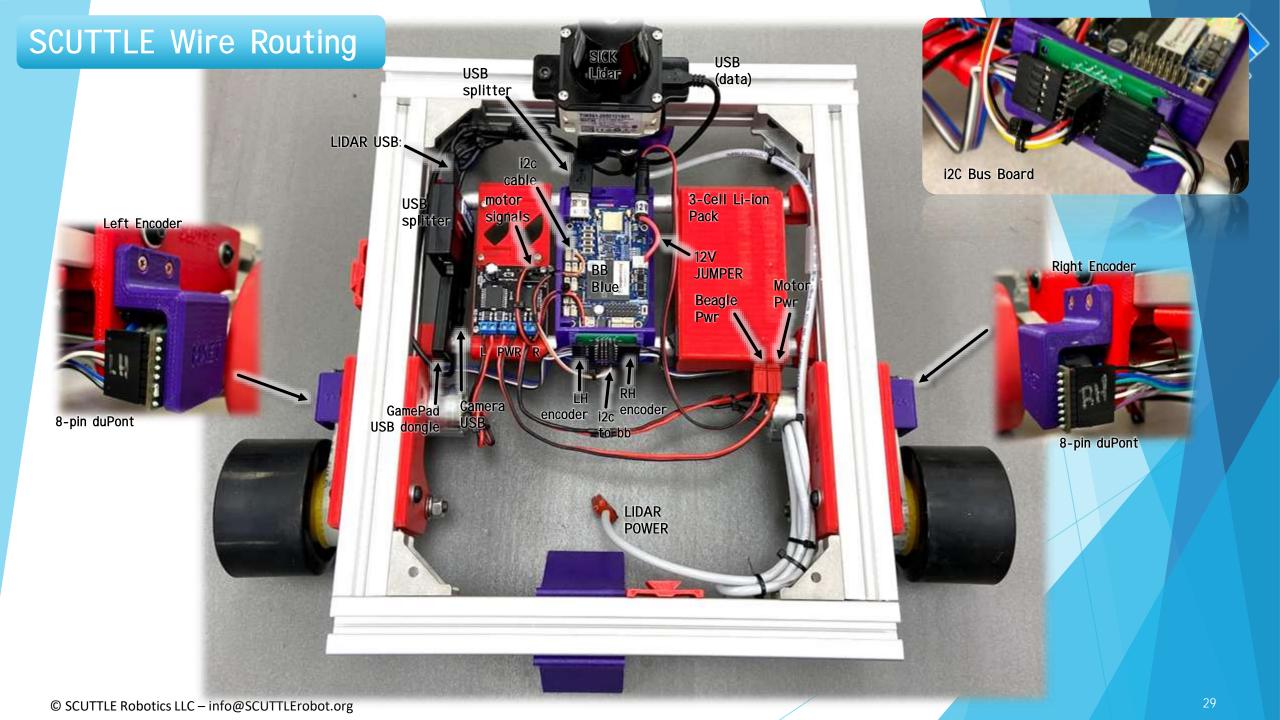


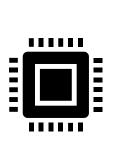
Wifi Antenna

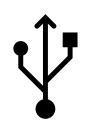
Users can replace the small onboard antenna with their own selected antenna.













Wiring Guide Section 2

[Raspberry Pi] [Jetson Nano] [Edge Al]



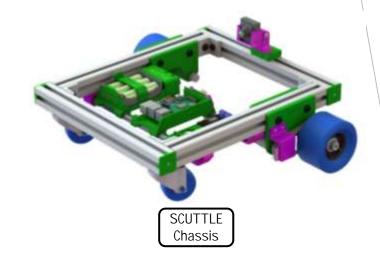
Pi Wiring Guide

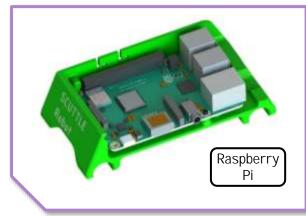


Contents:

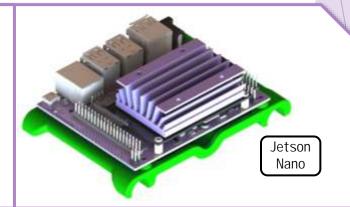
This section covers single board computers (SBCs) that conform to the 40-pin header design from Raspberry Pi

Note: Raspberry Pi was integrated after Beaglebone Blue. For wiring elements corresponding purely to the chassis, see Part 1.





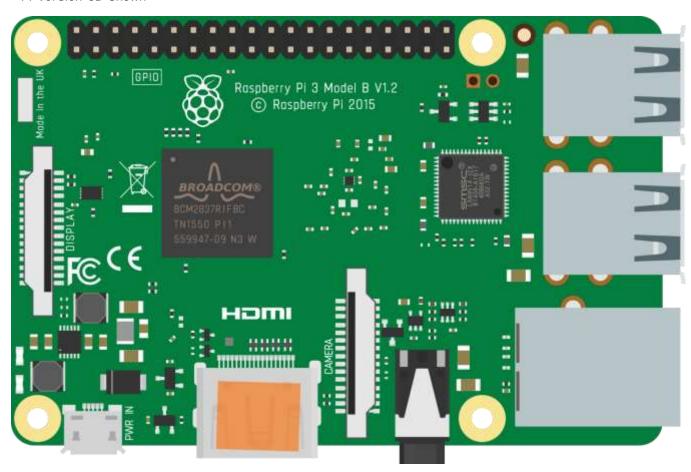




SCUTTLE Wiring Guide Pt2



Pi version 3B shown



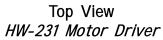
Pin Number Convention



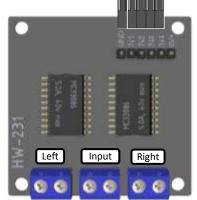
Pi - Motor Driver Signals

Keep the wires bonded to each other, if possible.

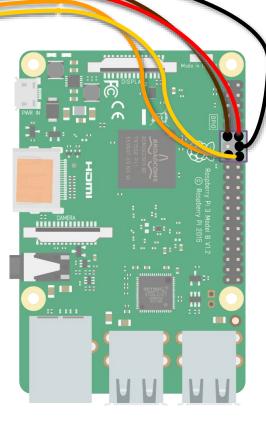




Ground is *optional* if the Pi and Motor Driver have a common ground to the battery pack.



See Motor Driver Power Wires stide for these connections.

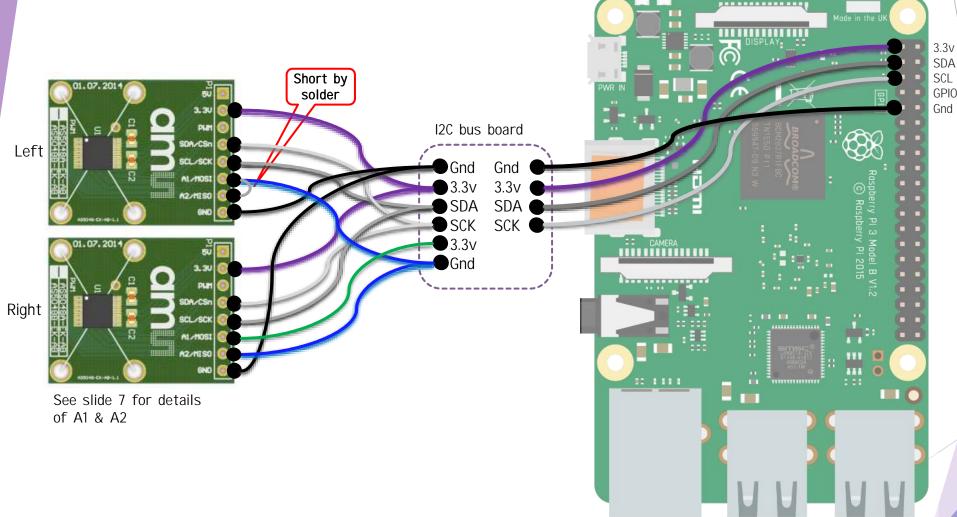


Pins on RasPi

GPI017 11 12 GPI018 GPI027 13 14 GND GPI022 15 16 GPI023

Pi - Encoder AMS AS5048 (I2C)

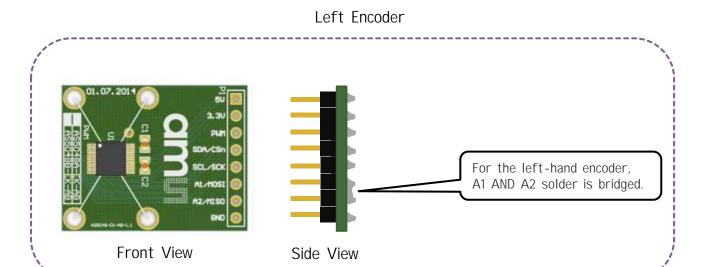




GPI04 Gnd

Encoder Details





The i2c address is determined by the signals on A1 and A2 pins.

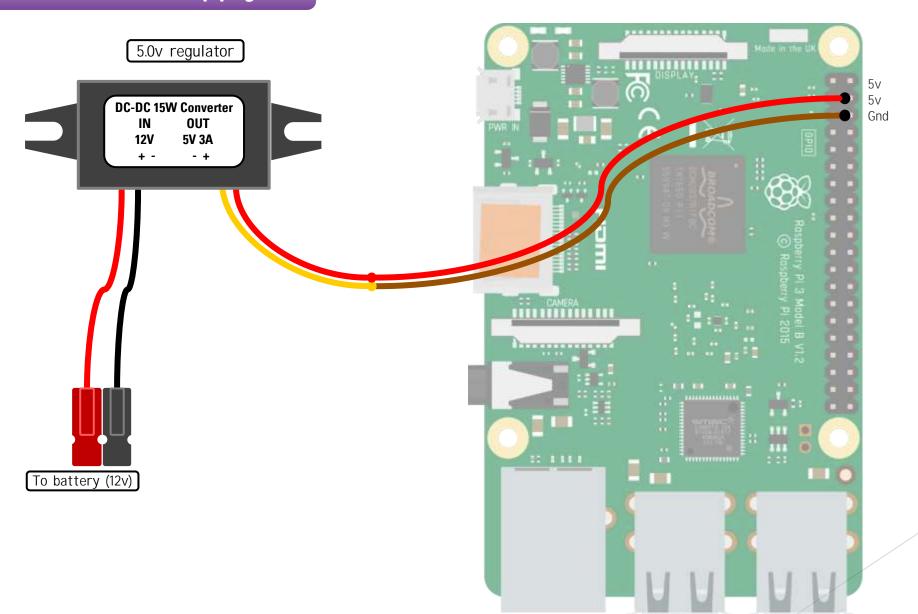
Left Hand Encoder A1 is pulled **down** to GND. I2C address is 0x40

Right Hand Encoder pin A1 is pulled **up** to 3.3v. I2C address is 0x41

	Pin A1	Pin A2	Resulting i2c address
Left Encoder	LOW	LOW	0x40
Right Encoder	LOW	HIGH	0x41

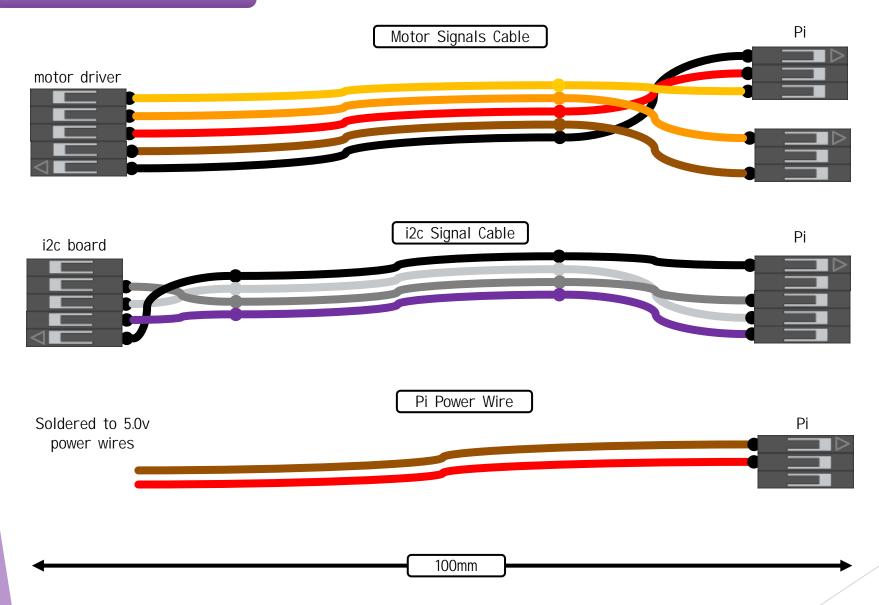
Pi - Power Supply





Dupont Cables





Guidelines:

<u>Ground:</u> When possible, insert the ground in the housing pin with the arrow.

Opening: Make the opening face the outside of the Pi headers when plugged in. This makes it easier to probe.

<u>Bonding:</u> Do not peel the wires apart unless you must. Keep wires bonded for strength

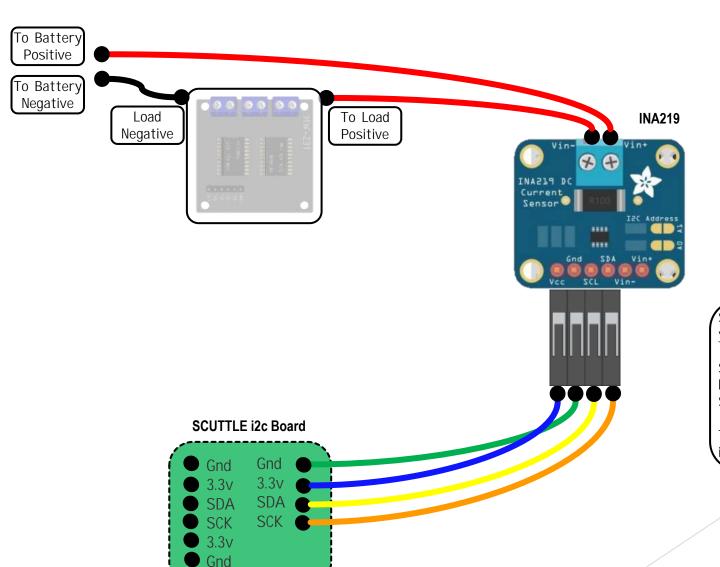
<u>Pin Groups:</u> Always use grouped housings instead of individuals. Then, the cable resists tugging, unplugging, and bending male pins.

<u>Tug Test:</u> After inserting pins into housings, lightly tug each pin to ensure it is locked in.

Voltage Meter – Adafruit INA219

This sensor can measure current and voltage.





Study an Example like <u>this one</u> if you plan to measure current

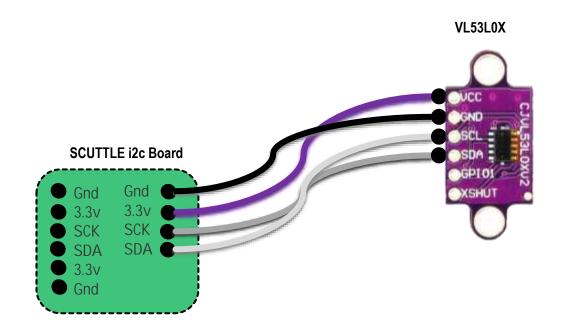
Set the i2c address to 0x44 by bridging the A1 contact with solder. See this guide for details.

The default Address of 0x40 would interfere with the encoders.

Distance Sensor - VL53L0X

This is a time-of-flight distance sensor.

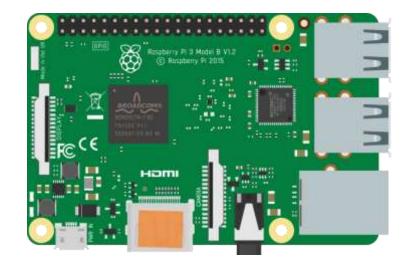




Pi - Configuration for remo.tv

Coming for this slide: configuration of hardware on RasPi B 3+, Linux default device numbers for branded speakers, and text-to-speech selection (ie, alsamixer).







We recommend a speaker that receives power AND signals from the USB port.



If you need to use an Aux cord, a right-angle adapter can keep your wires neat.

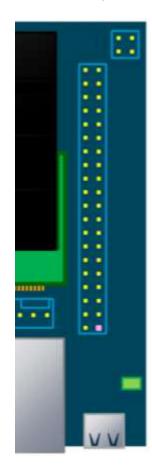
Jetson Nano Wiring



Diagram from <u>Jetsonhacks.com</u>

Sysfs GPIO	Name	Pin	Pin	Name	Sysfs GPIO
	3.3 VDC Power	1	2	5.0 VDC <i>Power</i>	
	I2C_2_SDA I2C Bus 1	3	4	5.0 VDC Power	
	12C_2_SCL <i>12C Bus 1</i>	5	6	GND	
gpio216	AUDIO_MCLK	7	8	UART_2_TX /dev/ttyTHS1	
	GND	9	10	UART_2_RX /dev/ttyTHS1	
gpio50	UART_2_RTS	11	12	I2S_4_SCLK	gpio79
gpio14	SPI_2_SCK	13	14	GND	
gpio194	LCD_TE	15	16	SPI_2_CS1	gpio232
	3.3 VDC <i>Power</i>	17	18	SPI_2_CS0	gpio15
gpio16	SPI_1_MOSI	19		GND	
gpio17	SPI_1_MISO	21	22	SPI_2_MISO	gpio13
gpio18	SPI_1_SCK	23	24	SPI_1_CS0	gpio19
	GND	25	26	SPI_1_CS1	gpio20
	12C_1_SDA <i>12C Bus 0</i>	27	28	12C_1_SCL <i>12C Bus 0</i>	
gpio149	CAM_AF_EN	29	30	GND	
gpio200	GPIO_PZ0	31	32	LCD_BL_PWM	gpio168
gpio38	GPIO_PE6	33	34	GND	
gpio76	I2S_4_LRCK	35	36	UART_2_CTS	gpio51
gpio12	SPI_2_MOSI	37	38	I2S_4_SDIN	gpio77
	GND	39	40	I2S_4_SDOUT	gpio78

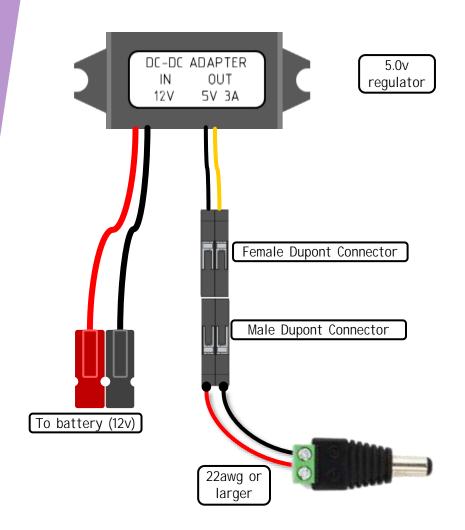
40 Pin Array on Jetson Nano



Jetson Nano - power

Diagram for powering Jetson Nano

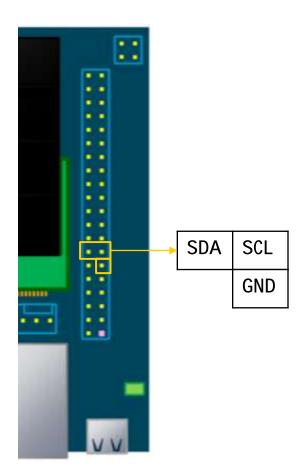




Plug into Nano power Jack Nvidia recommends at least 2.5A, with 4.0A optimal for peak power.

Jetson Nano - i2c

Diagram for connecting i2C to SCUTTLE



TO BE COMPLETED...





▶ Wiring section in progress... to be completed in May 2022!









		PIN					
1	2	Power_5.0					
3	4	Power					
5	6	GND					
7	8	UART_TXD					
9	10	UART_RXD					
11	12	I2S_SCLK					
13	14	GND					
15	16	GPIO					
17	18	GPIO					
19	20	GND					
21	22	GPIO					
23	24	SPI_CS0					
25	26	SPI_CS1					
27	28	ID_SCL					
29	30	GND					
31	32	PWM0					
33	34	GND					
35	36	GPIO					
37	38	I2S_DIN					
39	40	I2S_DOUT					
	3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35 37	3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38					

