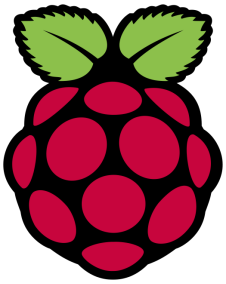
Carnegie Mellon University



Raspberry Pi
Lab I/O Board

Specifications Sheet

Table of Contents

Board Overview.....3

Motor Control.....5

Servos.....10

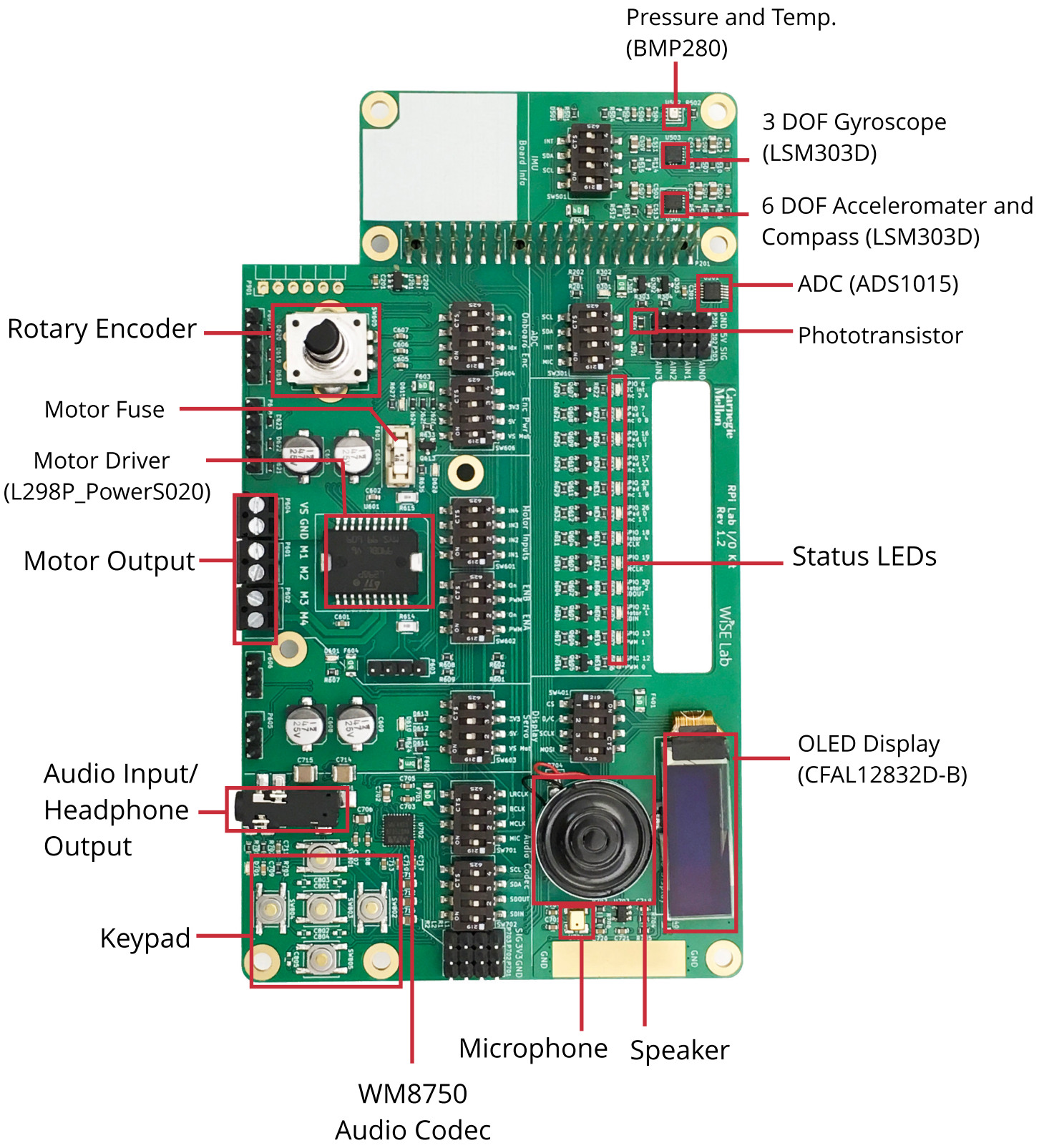
Environmental Sensors.....11

Audio Codec.....13

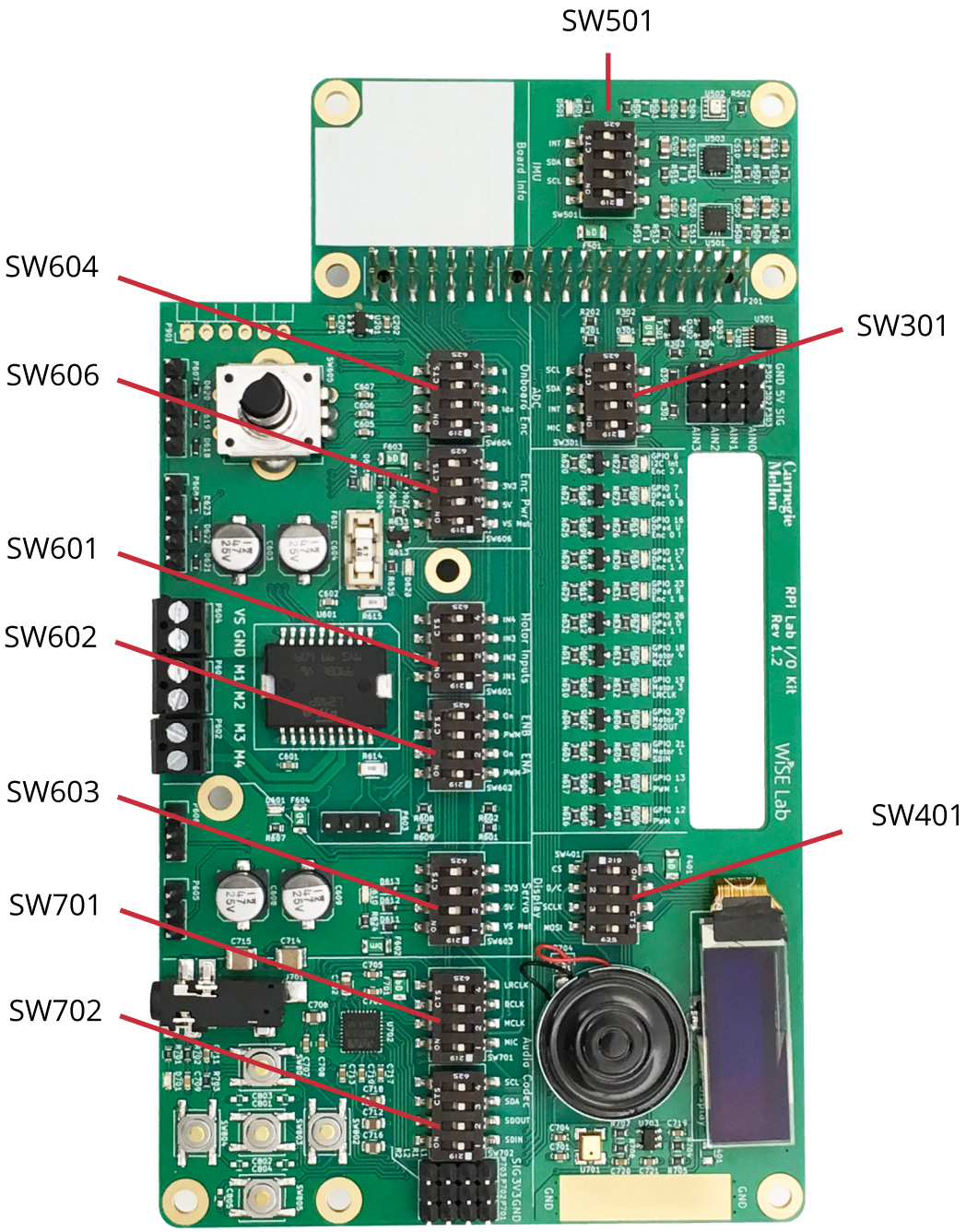
GPIO.....15

LED Display.....16

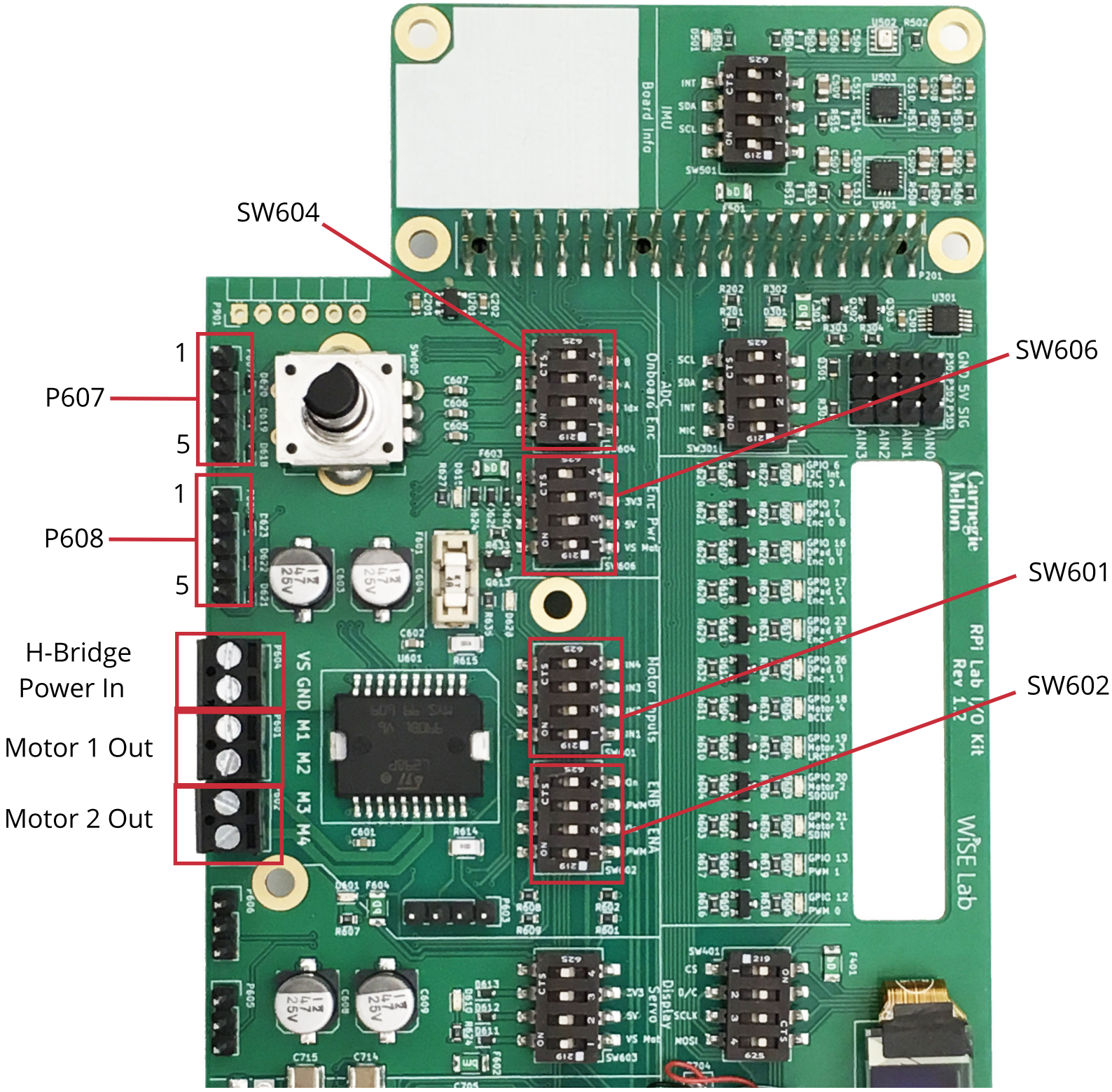
Board Overview



Switch Overview



Motor Control



SW606

Switch Number	ON	Off	Description
1	Connect VS_MOTOR to VDD_Encoder	Disconnected	Connect external motor power to encoders. WARNING this could pass high voltage into your encoders....
2	Connect 5v to VDD_Encoder	Disconnected	Power encoders from on board regulated 5V supply
3	Connect 3v to VDD_Encoder	Disconnected	Power encoders from on board regulated 3V supply

P606

This is the output of PWM1 that provides voltage source and PWM1 pin for controlling servo motors.

Pin Number	From	Description
1	Ground	This Pin provides ground.
2	VDD_Servo	This Pin provides on board regualted 5v.
3	PWM1	This Pin is connected with Rpi GPIO13

SW604

Quadrature encoders take two offset PWM signals that use a grey code to measure the precise rotation of a motor. This jumper selects if the pins from the rotary encoder are connected to the RPi or if the external inputs should be used instead.

Switch Number	ON	OFF	Description
2	Connect Encoder1_IDX to ROT_ENC_D	Disconnect	The IDX or index pin of an encoder is used to determine when the encoder has reach its starting point.
3	Connect Encoder1_A to ROT_ENC_A	Disconnect	This is channel A of the encoder that should ideally generate a 0-3v3 or 5 volt PWM signal.
4	Connect Encoder1_B to ROT_ENC_B	Disconnect	This is channel B of the encoder that should ideally generate a 0-3v3 or 5 volt PWM signal.

P608

This is an encoder input that is shared with the rotary encoder dial.

Pin Number	Connection	Description
1	Ground	This pin provides ground.
2	from Encoder1_IDX	This is the index pin that references the starting point of an encoder. This not provided by all encoders. Connected to Rpi GPIO26
3	from Encoder1_A	This is the A Channel from the encoder that is connected to pin GPIO17 on the RPi.
4	from VDD_Encoder	This pin provides power to the encoder.
5	from Encoder1_B	This is the A Channel from the encoder that is connected to pin GPIO23 on the RPi.

P607

This is an encoder input that is not shared with rotary encoder dial.

Pin Number	Connection	Description
1	Ground	This pin provides ground.
2	from Encoder0_IDX	This is the index pin that references the starting point of an encoder. This not provided by all encoders.
3	from Encoder0_A	This is the A Channel from the encoder that is connected to pin GPIO6 on the RPi.
4	from VDD_Encoder	This pin provides power to the encoder.
5	from Encoder0_B	This is the A Channel from the encoder that is connected to pin GPIO7 on the RPi.

SW602

This switch enables PWM lines with VDD_MOT . Switch 1 and 2 are for motor 1 and 2. Switch 3 and 4 are for motor 3 and 4.

Switch Number	ON	OFF	Description
1	Connect PWM0 to ENABLE_A	Disconnect	Connect PWM0 to ENALBEA which includes motor in 1 and 2
2	Connect VDD_MOT to ENABLE_A	Disconnect	Connect on board regulated 3.3V to ENABLEA
3	Connect PWM1 to ENABLE_B	Disconnect	Connect PWM1 to ENALBEA which includes motor in 3 and 4
4	Connect VDD_MOT to ENABLE_B	Disconnect	Connect on board regulated 3.3V to ENABLEB

P605

This is the output of PWM0 that provides voltage source and PWM0 pin for controlling servo motors.

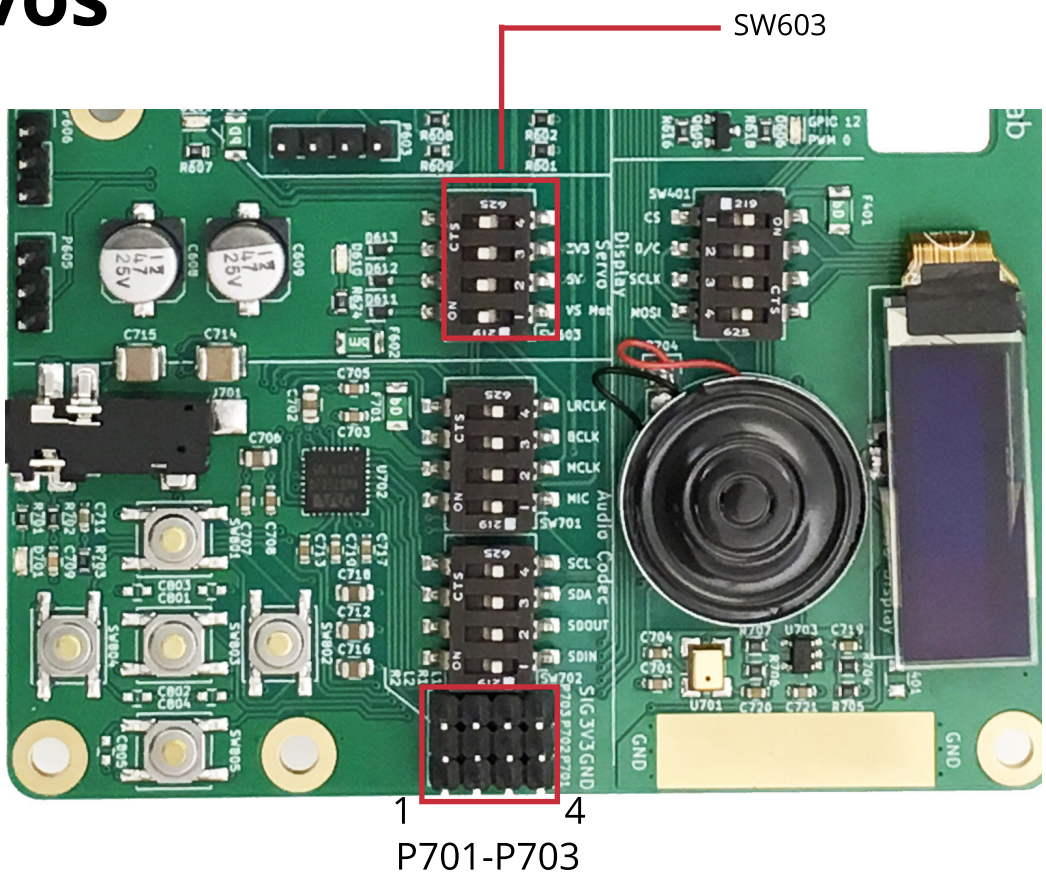
This Pin is connected	From	Description
1	Ground	This Pin provides ground.
2	VDD_Servo	This Pin provides on board regualted 5v.
3	PWM0	This Pin is connected with Rpi GPIO12

P603

this is output pin that can sense Motor 1,2 (A) and Motor 3,4 (B).

Pin Number	From	OFF	Description
1	Ground	Disconnect	This Pin provides ground.
2	Motor_Sense B	Disconnect	Connect Motor_Sense_B Pin
3	Ground	Disconnect	This Pin provides ground.
4	Motor_Sense A	Disconnect	Connect Motor_Sense_A Pin

Servos



SW603

Select the voltage output on VDD_Servo from 3 choices

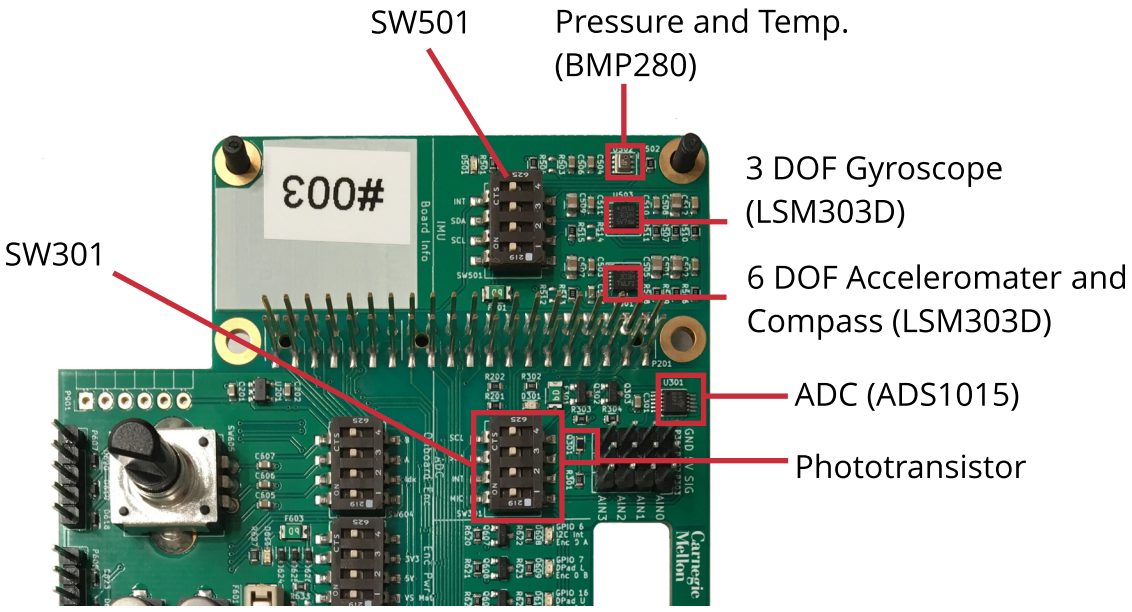
Switch Number	ON	OFF	Description
1	Connect VS_MOTOR to VDD_Servo	Disconnect	Connect external motor power to encoders. WARNING this could pass high voltage into your encoders....
2	Connect 5v to VDD_Servo	Disconnect	Power Servo from on board regulated 5V supply
3	Connect 3v to VDD_Servo	Disconnect	Power Servo from on board regulated 3V supply

Environmental Sensors

The I/O Board exposes the following sensors:

- MEMs Microphone
- Light Sensor
- 3 Axis Accelerometer
- 3 Axis Rate Gyro
- 3 Axis Magnetometer
- Barometric Pressure
- Temperature

Most sensors are digital and sit on the I2C bus. The light sensor and Microphone are analog and connected to the on-board ADC. The ADC also has two free input channels that can be used for external devices or monitoring RPi power consumption when used with the debugger board.



Microphone and Audio Codec not shown.

SW301

There is a MEMs microphone on the board that can be either connected to the audio codec on board or directly to the ADC.

Switch Number	ON	OFF	Description
1	ADC_Analog2 to Microphone Pin Connection	Disconnect	This switch will connect the output of the mic to channel 2 of the ADC.
2	ADC_Interrupt Pin to Rpi GPIO6 Pin Connection	Disconnect	This pin connects the ADC interrupt pin to the RPi header. This is needed if your system needs to respond to ADC interrupts.
3	ADC_SDA Pin to Rpi GPIO1 Pin Connection	Disconnect	This connects the SDA i2c pin from the ADC to the RPi header.
4	ADC_SCL Pin to Rpi GPIO3 Pin Connection	Disconnect	This connects the SCL i2c pin from the ADC to the RPi header.

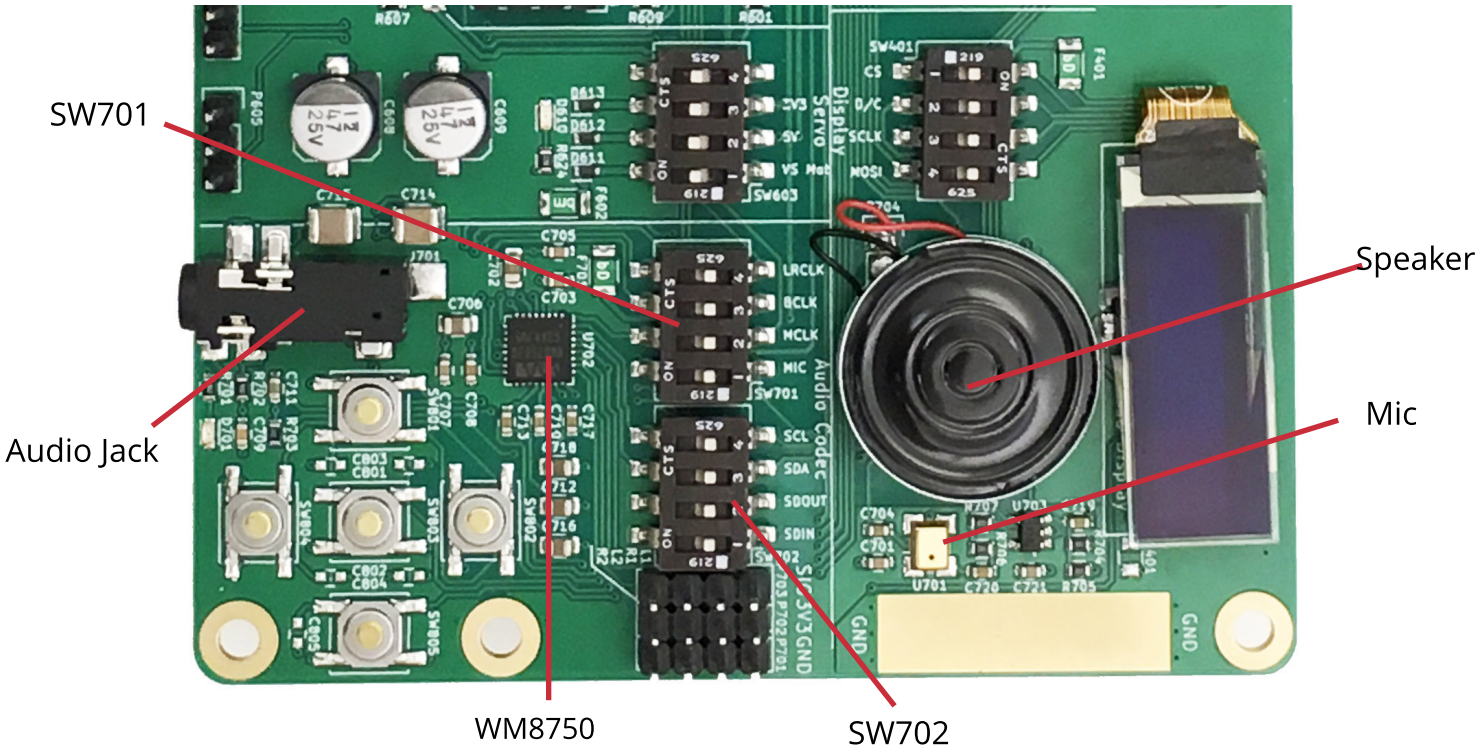
SW501 (Gyroscope, Accelerometer, Pressure+Temp)

The I/O board has an LSM303 MEMs gyroscope that sits on the i2c bus for measuring rotation in 3 dimensions.

Switch Number	ON	OFF	Description
2	Rpi GPIO3 Pin to Sensors SCL Pin Connection	Disconnect	This connects the SCL clock i2c communication pin to the gyro.
3	Rpi GPIO1 Pin to Sensors SDA Pin	Disconnect	This connects the SDA data i2c communication pin to the gyro.
4	Rpi GPIO6 Pin to Sensors Interrupt Pin	Disconnect	This provides an interrupt pin from the gyro to the RPi for interrupt driven transactions.

Audio Codec

This board is equipped with an WM8750 audio codec that is able to record and playback 16-bit sound at 192KHz. The chip requires I2C for configuration and I2S for audio data.



SW702

Controls I2C communication between Rpi and stereo codec.

Switch Number	ON	OFF	Description
1	Rpi GPIO21 with SDIN	Disconnect	Connect Rpi with stereo codec's SDIN
2	Rpi GPIO20 with SDOUT	Disconnect	Connect Rpi with stereo codec's SDOUT
3	Rpi GPIO1 with SDA	Disconnect	Connect Rpi with stereo codec's I2C data pin.
4	Rpi GPIO3 with SCL	Disconnect	Connect Rpi with stereo codec's I2C clock pin.

SW701

This jumper set controls the connection of on board MEMs microphone and Rpi with WM8750 stereo codec . This line uses the I2S communication protocol for audio and I2C to configure registers.

Switch Number	ON	OFF	Description
1	MEMS_MIC_C to LINPUT1	Disconnect	Connect output of MEMs microhone with stereo codec's LINPUT1 pin.
2	Rpi GPIO5 to MCLK_J	Disconnect	Connect Rpi with audio codec's master clock pin.
3	Rpi GPIO18 to BCLK_J	Disconnect	Connect Rpi with audio codec's bit clock pin.
4	Rpi GPIO19 to LRCLK	Disconnect	Connect Rpi with audio codec's left right clock pin.

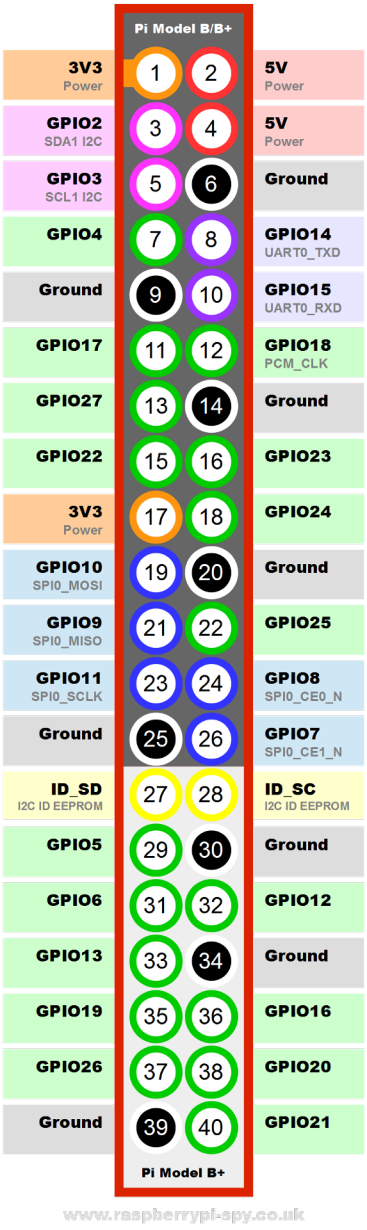
P701,P702,P703

Pins for extra codec inputs for on board stereo codec.

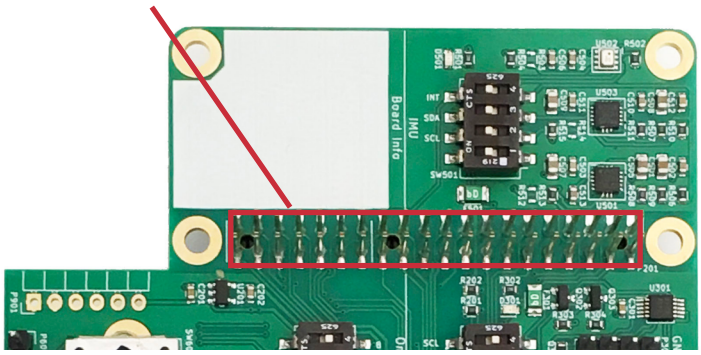
Pin Number	Connection	Description
1	RINPUT2	Connect external input to RINPUT2 of stereo codec.
2	LINPUT2	Connect external input to LINPUT2 of stereo codec.
3	RINPUT1	Connect external input to RINPUT1 of stereo codec.
4	LINPUT1	Connect external input to LINPUT1 of stereo codec.

General Purpose Input Output

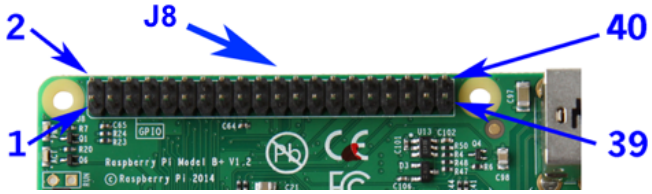
For debugging or adding your own peripherals, the RPi GPIO pinout is posted here for reference. This is for the RPi version 2. Be sure to check the pin out if using a different RPi version.



Pass Through Header



Raspberry Pi 2 B+ GPIO



Display

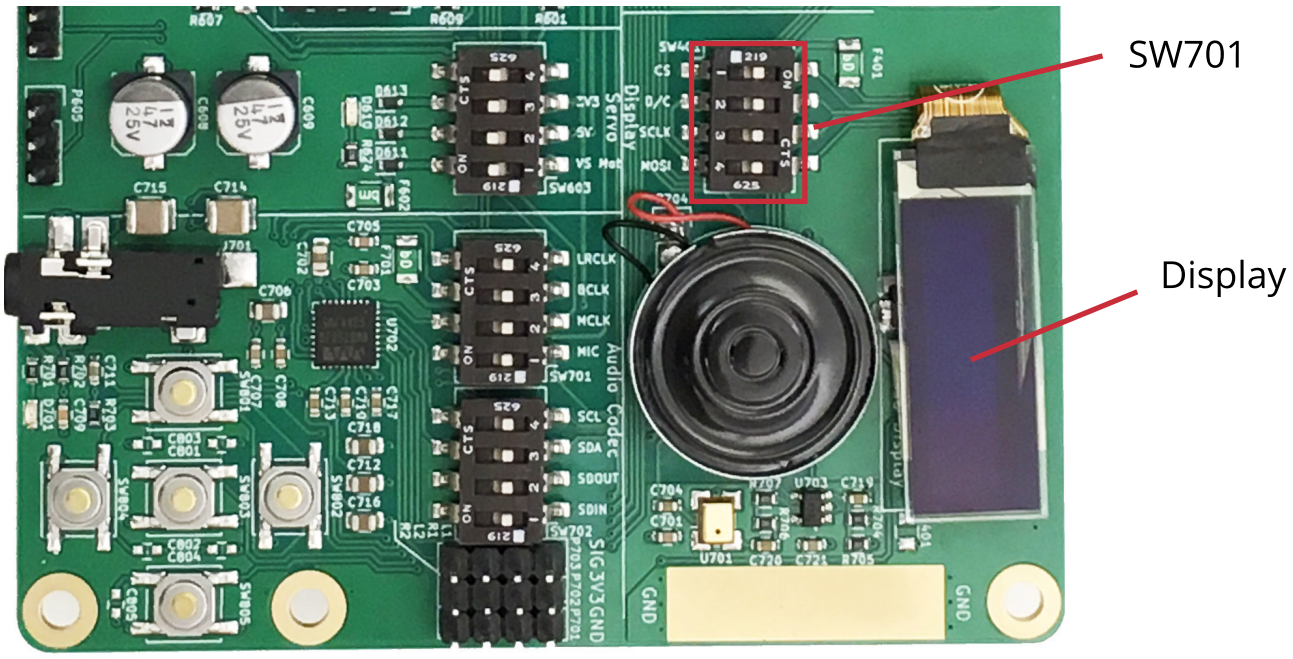
SW401

These switches control OLED display's SPI connection with Rpi. The LED display uses 4 wire SPI mode for the display which is write-only. The 4-wire mode was selected instead of 3-wire mode so that the hardware SPI module can be used which simplifies Linux support. With just 3-wire mode, one would need to bit-bang the protocol.

The OLED display is CFAL12832D-B which can be found here:

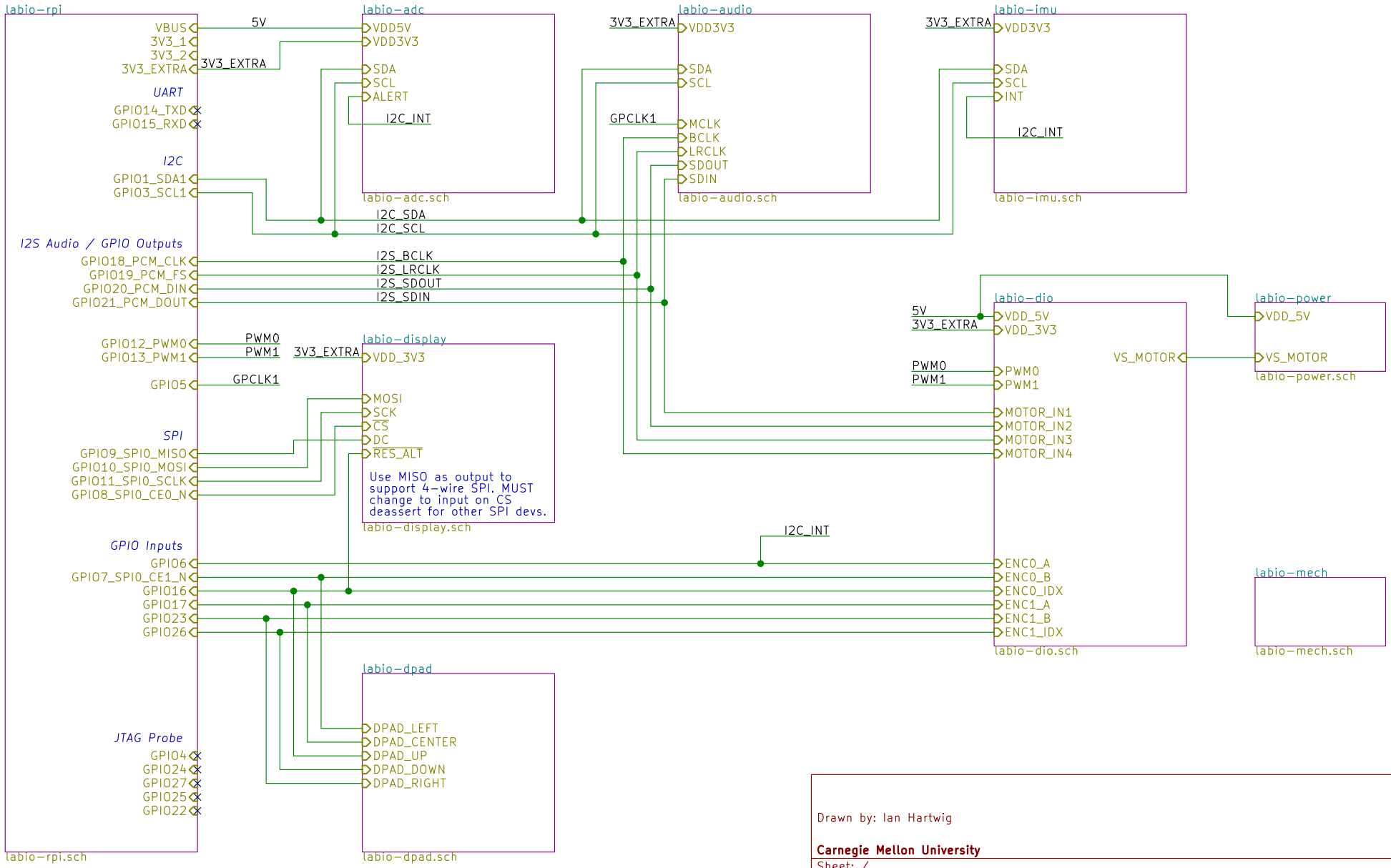
https://www.crystalfontz.com/product/cfal12832db-graphic-128x32-oled

Switch Number	ON	OFF	Description
1	Connect Rpi ID_CS to OLED_CS	Disconnect	Connects the CS line of Rpi SPI to select the OLED screen on board.
2	Connect Rpi DC to OLED_DC	Disconnect	TODO
3	Connect Rpi GPIO11 to OLED_SCK	Disconnect	Connects the Clock line of Rpi SPI to the OLED's SPI clock line.
4	Connect Rpi GPIO10 to OLED_MOSI	Disconnect	Connect the MOSI line to OLED' SPI MOSI line.



Revision History

10/3/2016	Initial Release



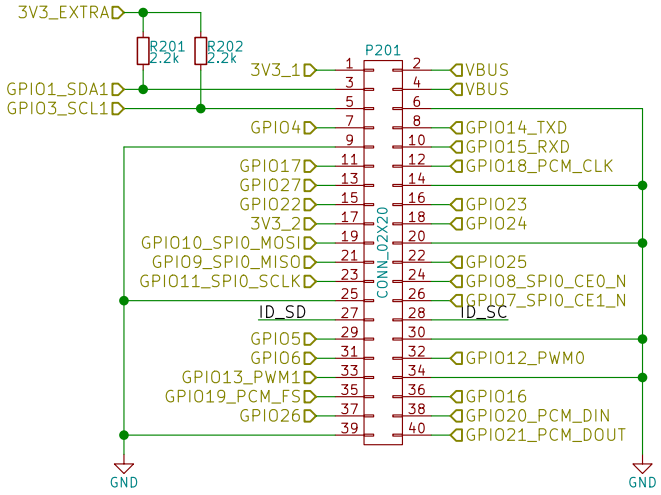
Drawn by: Ian Hartwig

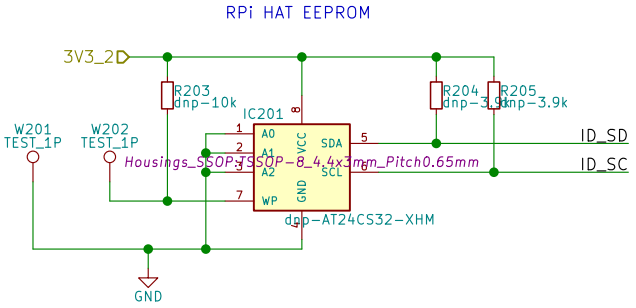
Carnegie Mellon University

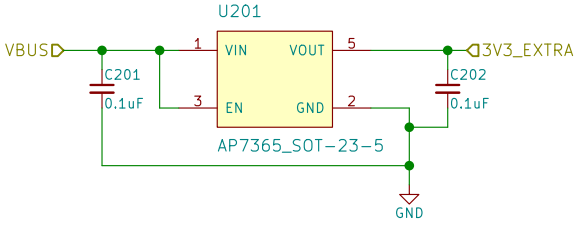
Sheet: /
File: labio.sch

Title: Raspberry Pi Embedded Lab I/O

Size: A4	Date:	**Rev: 1.2.0**
KiCad E.D.A. kicad 4.0.2-stable		Id: 1/10







Drawn by: Ian Hartwig

Carnegie Mellon University

Sheet: /labio-rpi/
File: labio-rpi.sch

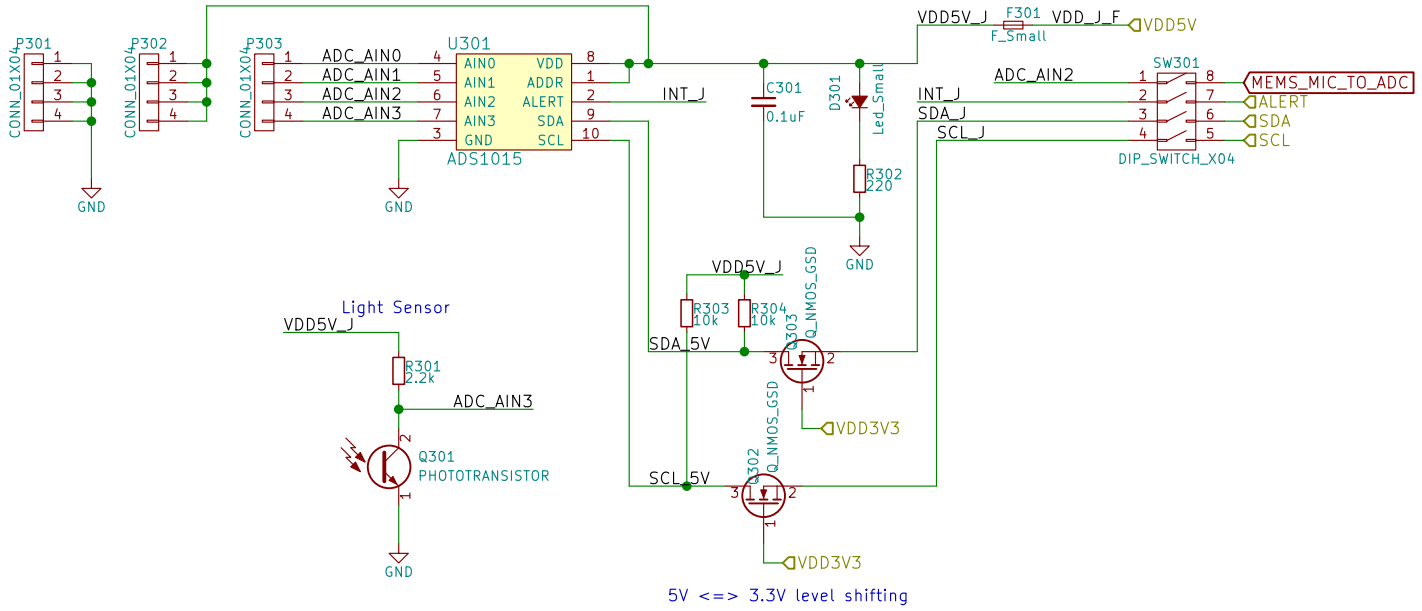
Title: Raspberry Pi Embedded Lab I/O

Size: A4	Date:	**Rev: 1.2.0**
KiCad E.D.A. kicad 4.0.2-stable		Id: 2/10

12-bit (ADS1015) or 16-bit (ADS1115) ADC
with differential PGA and 4-channel mux.

7-bit addr: 0x73

5V VDD to safely sample RPi VBUS.



Drawn by: Ian Hartwig

Carnegie Mellon University

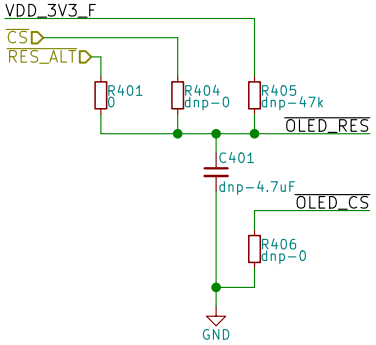
Sheet: /labio-adc/
File: labio-adc.sch

Title: Raspberry Pi Embedded Lab I/O

Size: A4	Date:	**Rev: 1.2.0**
KiCad E.D.A. kicad 4.0.2-stable		Id: 3/10

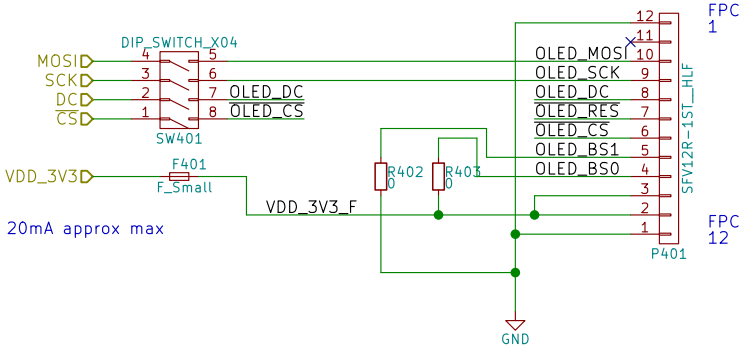
Backup options for OLED reset line

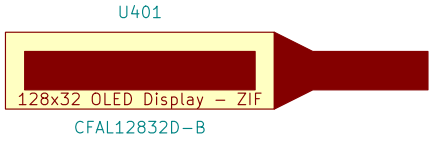
GPIO control on CS or alt or driven
from VDD with an RC delay > 110ms.



CFAL12832D-B* OLED Display
3-wire SPI mode.

Note: top side ZIF connector has pins reversed from FPC.





	Interface			
Pin No	Sym	3 Wire SPI	4 Wire SPI	I2C
1	GND	**GND**	**GND**	**GND**
2	D2	NC	NC	SDA*
3	D1	SDA	SDA	SDA*
4	D0	CLK	SCLK	SCL
5	D/C#	NC	D/C	**Vcc**
6	RES#	RESET	RESET	RESET
7	CS#	**GND**	**GND**	**GND**
8	BS1	**GND**	**GND**	**Vcc**
9	BS0	**Vcc**	**GND**	**GND**
10	Vdd	**Vcc****	**Vcc****	**Vcc****
11	Vbat	**Vcc****	**Vcc****	**Vcc****
12	GND	**GND**	**GND**	**GND**

Microcontroller	Control lines defined by layout / code
+3.3v	Supply voltage
Ground	Supply ground

Notes:

*	Tie D2 and D1 together
**	Okay to Tie Vdd and Vbat together

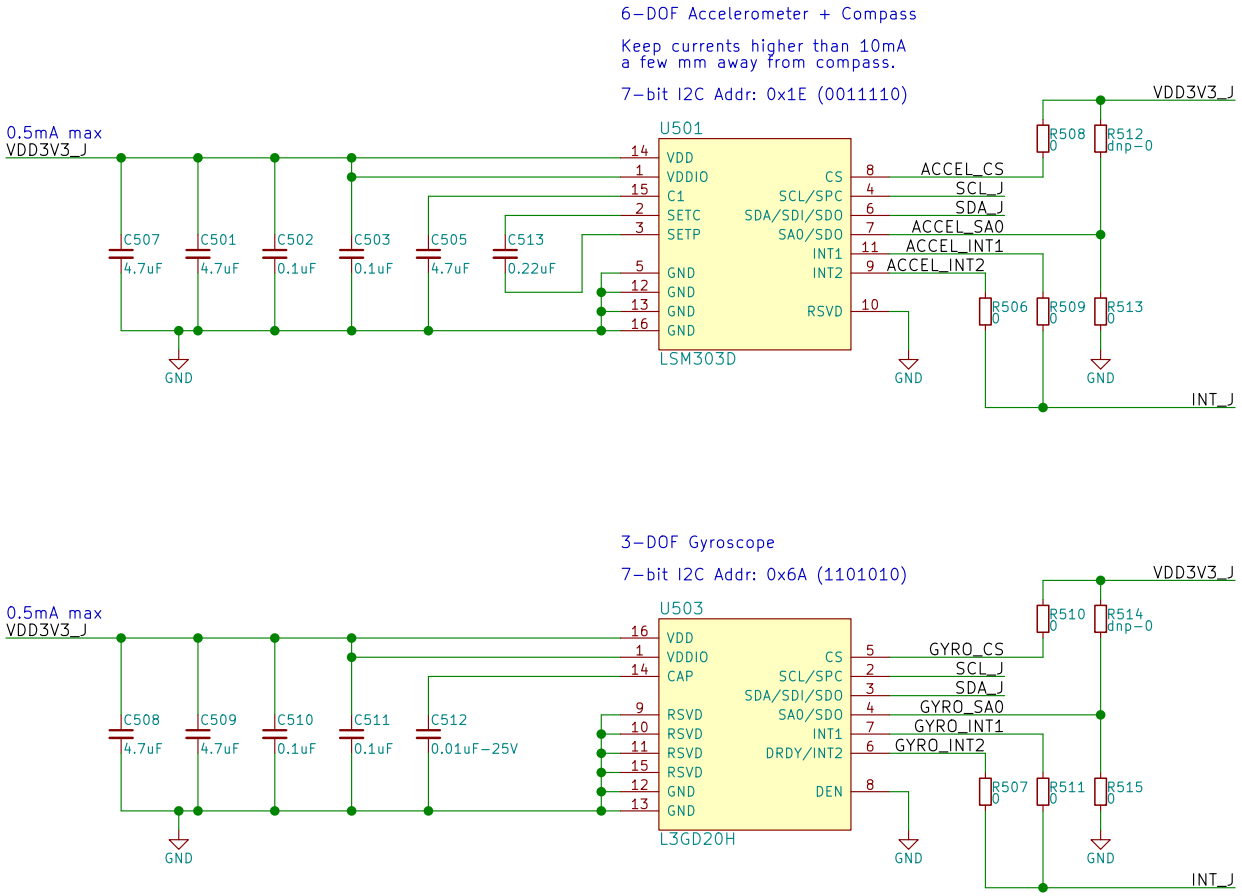
Drawn by: Ian Hartwig

Carnegie Mellon University

Sheet: /labio-display/
File: labio-display.sch

Title: Raspberry Pi Embedded Lab I/O

Size: A4	Date:	**Rev: 1.2.0**
KiCad E.D.A. kicad 4.0.2-stable		Id: 4/10



Drawn by: Ian Hartwig

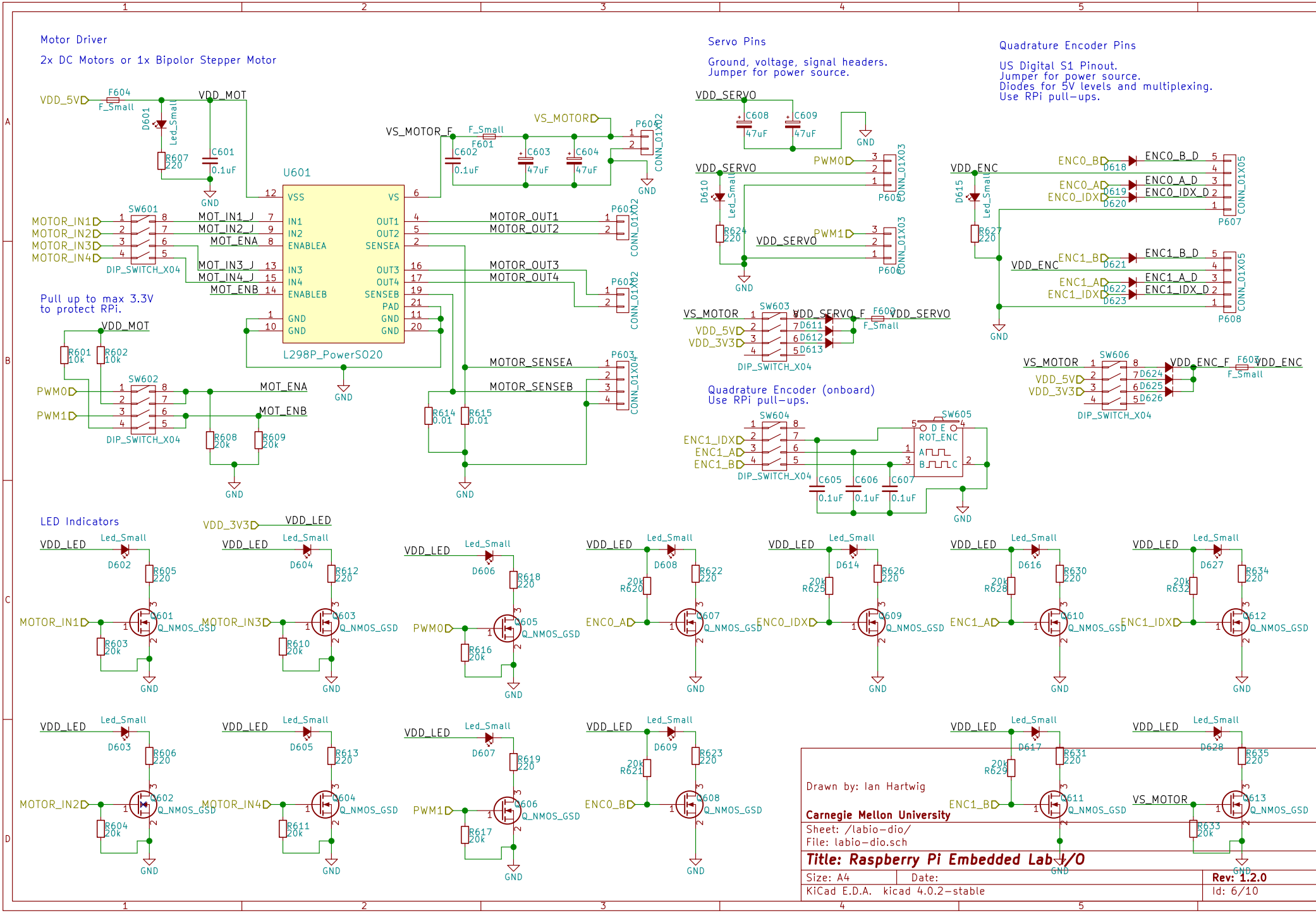
Carnegie Mellon University

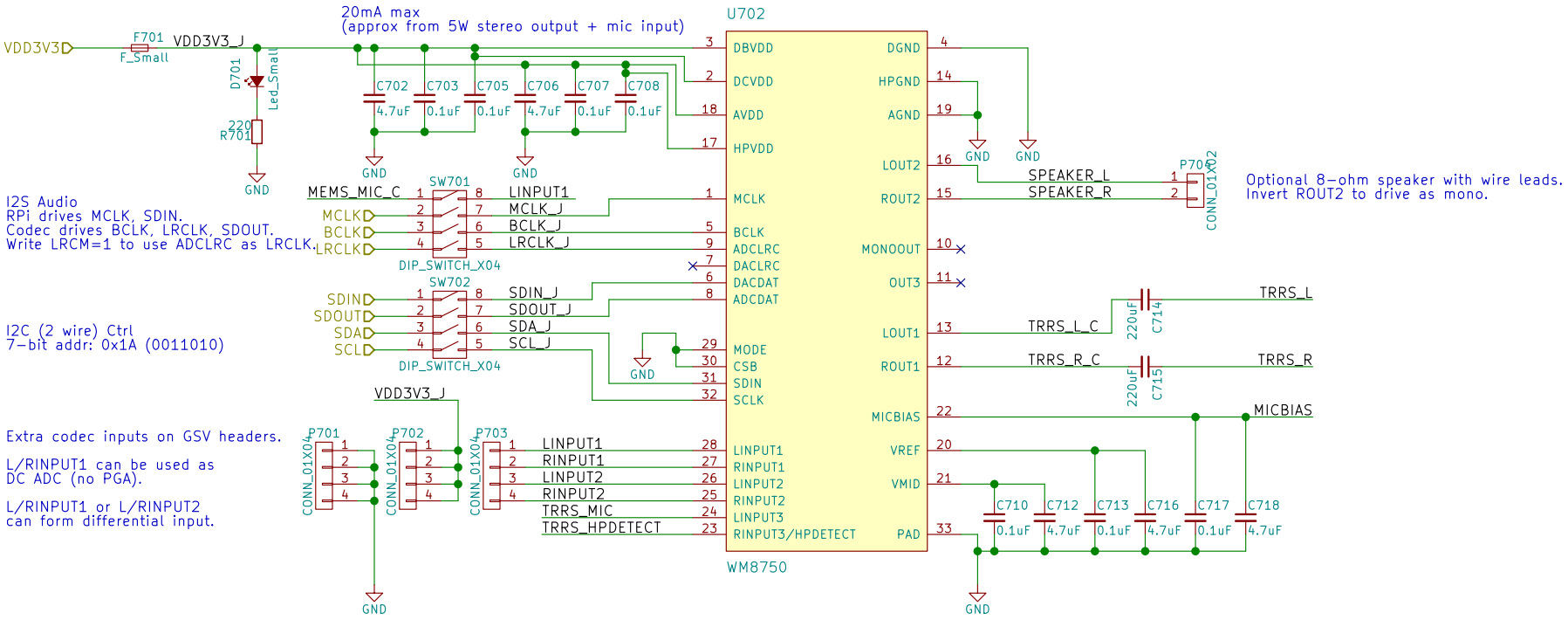
Sheet: /labio-imu/

File: labio-imu.sch

Title: Raspberry Pi Embedded Lab I/O

Size: A4	Date:	**Rev: 1.2.0**
KiCad E.D.A. kicad 4.0.2-stable		Id: 5/10


Motor Driver
2x DC Motors or 1x Bipolor Stepper Motor
Servo Pins
Ground, voltage, signal headers.
Jumper for power source.
Quadrature Encoder Pins
US Digital S1 Pinout.
Jumper for power source.
Diodes for 5V levels and multiplexing.
Use RPi pull-ups.
Pull up to max 3.3V
to protect RPi.
Quadrature Encoder (onboard)
Use RPi pull-ups.
LED Indicators
U601
L298P_PowerSO20
VDD_5V
VDD_MOT
VS_MOTOR
VS_MOTOR_F
VDD_SERVO
VDD_ENC
VDD_3V3
VDD_LED
GND
MOTOR_IN1
MOTOR_IN2
MOTOR_IN3
MOTOR_IN4
MOT_IN1_J
MOT_IN2_J
MOT_IN3_J
MOT_IN4_J
MOT_ENA
MOT_ENB
MOTOR_OUT1
MOTOR_OUT2
MOTOR_OUT3
MOTOR_OUT4
MOTOR_SENSEA
MOTOR_SENSEB
PWM0
PWM1
ENC0_A
ENC0_B
ENC0_IDX
ENC1_A
ENC1_B
ENC1_IDX
ENC0_A_D
ENC0_B_D
ENC0_IDX_D
ENC1_A_D
ENC1_B_D
ENC1_IDX_D
VDD_SERVO_F
VDD_ENC_F
ROT_ENC
Drawn by: Ian Hartwig
Carnegie Mellon University
Sheet: /labio-dio/
File: labio-dio.sch
Title: Raspberry Pi Embedded Lab I/O
Size: A4
Date:
Rev: 1.2.0
KiCad E.D.A. kicad 4.0.2-stable
Id: 6/10



Drawn by: Ian Hartwig

Carnegie Mellon University

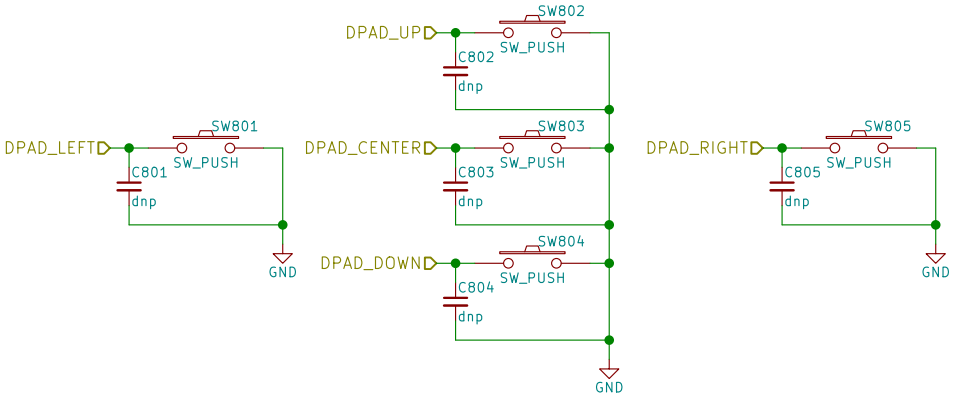
Sheet: /labio-audio/
File: labio-audio.sch

Title: Raspberry Pi Embedded Lab I/O

Size: A4	Date:	**Rev: 1.2.0**
KiCad E.D.A. kicad 4.0.2-stable		Id: 7/10

D-Pad

Use RPi pull-ups.
Optional C for decoupling.
Individual IO lines for interrupts.



Drawn by: Ian Hartwig

Carnegie Mellon University

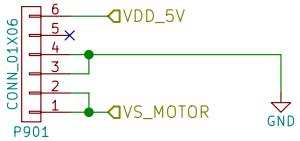
Sheet: /labio-dpad/
File: labio-dpad.sch

Title: Raspberry Pi Embedded Lab I/O

Size: A4	Date:	**Rev: 1.2.0**
KiCad E.D.A. kicad 4.0.2-stable		Id: 8/10

External Power (Future)

Provides logic and motor power from power supply or
battery pack with possible charging from USB (rpi) power.
2x motor power for current rating.



Drawn by: Ian Hartwig

Carnegie Mellon University

Sheet: /labio-power/
File: labio-power.sch

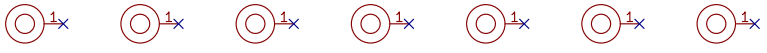
Title: Raspberry Pi Embedded Lab I/O

Size: A4	Date:	**Rev: 1.2.0**
KiCad E.D.A. kicad 4.0.2-stable		Id: 9/10

RPi-like Mounting Holes

M3 for M3/no 4/M2.5 hardware.

H1001 H1003 H1004 H1005 H1007 H1008 H1009



hole hole hole hole hole hole hole

Heatsink Mounting

25x25mm with 30x30mm M3 holes

H1002 H1006

hole hole

WiSE Lab

Carnegie Mellon

WiSE Lab

Carnegie Mellon

Drawn by: Ian Hartwig

Carnegie Mellon University

Sheet: /labio-mech/
File: labio-mech.sch

Title: Raspberry Pi Embedded Lab I/O

Size: A4	Date:	**Rev: 1.2.0**
KiCad E.D.A. kicad 4.0.2-stable		Id: 10/10