Lecture of Raspberry Pi

-electronic work for controlling a robot-

Part #2

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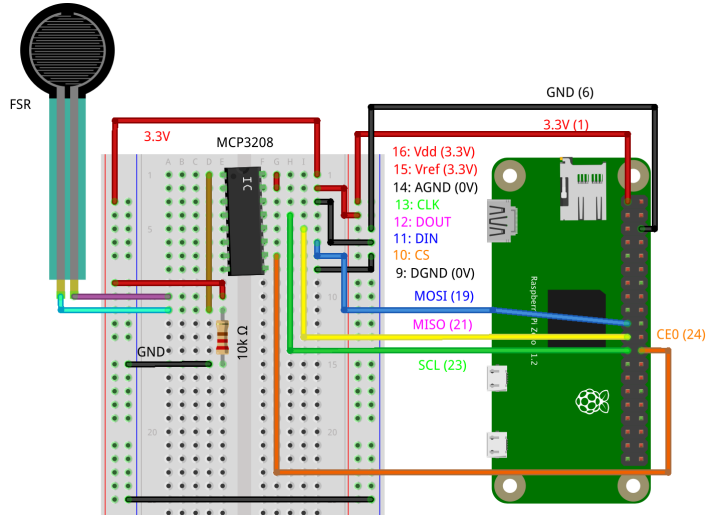


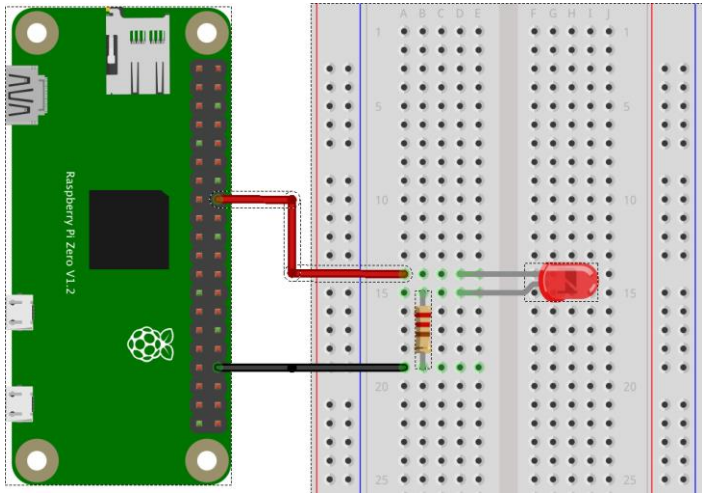
Schedule of This Lecture

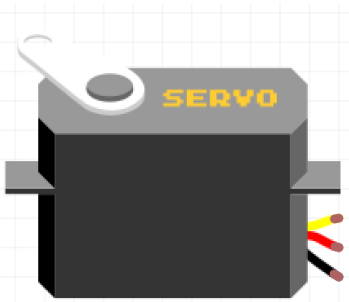
Part 1: Blinking LEDs and Control a Servo motors

Part 2: Getting sensory information (A/D conversion)

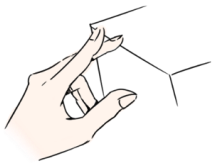
Part 3: Using myo

Part 4: Controlling Dynamixel

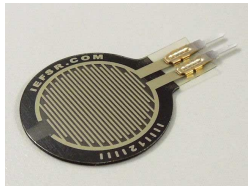




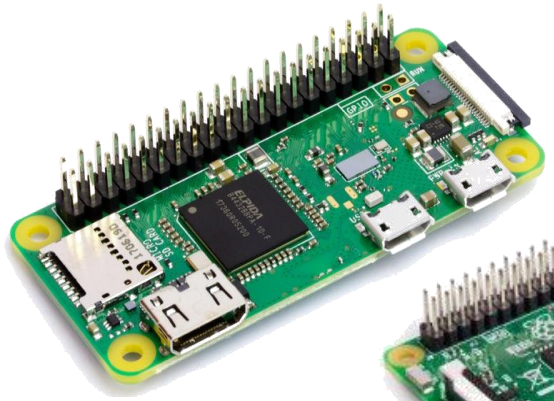
Toward Making An Intelligent System in Real

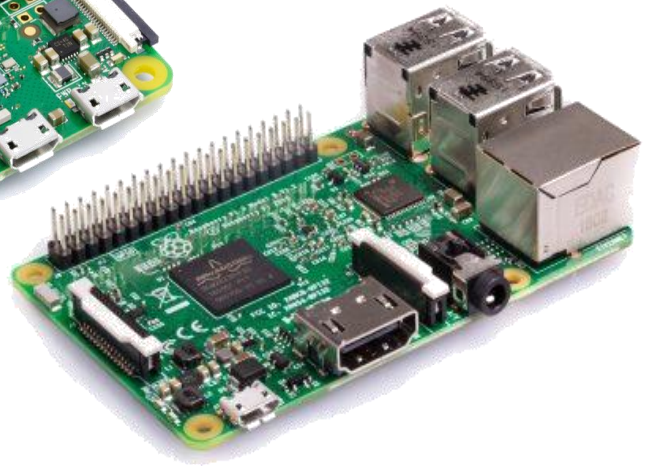


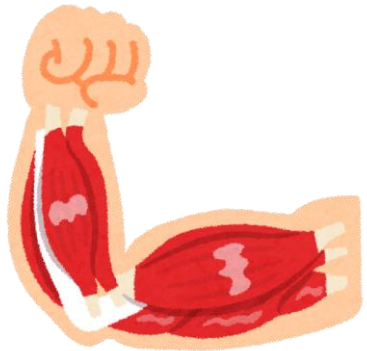
Part #2

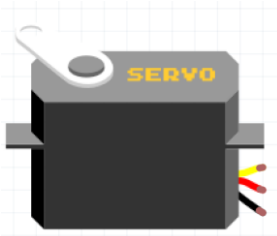


Part #0



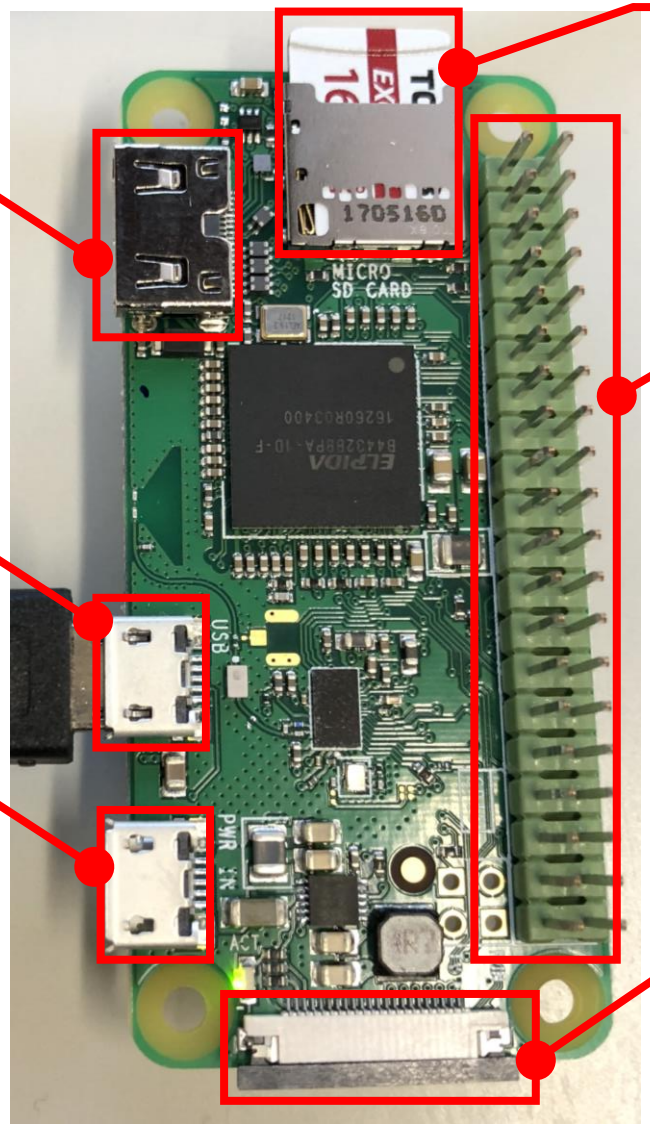






Part #1

Hardware Configurations on Raspberry Pi Zero W



micro SD card slot

Mini-HDMI terminal

GPIO (General Purpose Input/Output)

micro USB port (2.0)

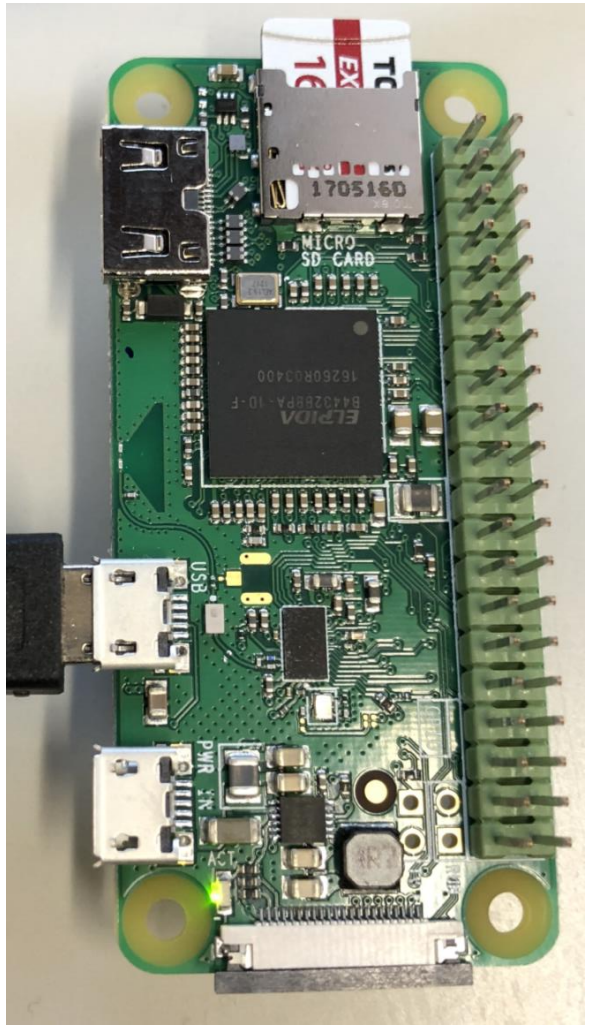
Power supply terminal

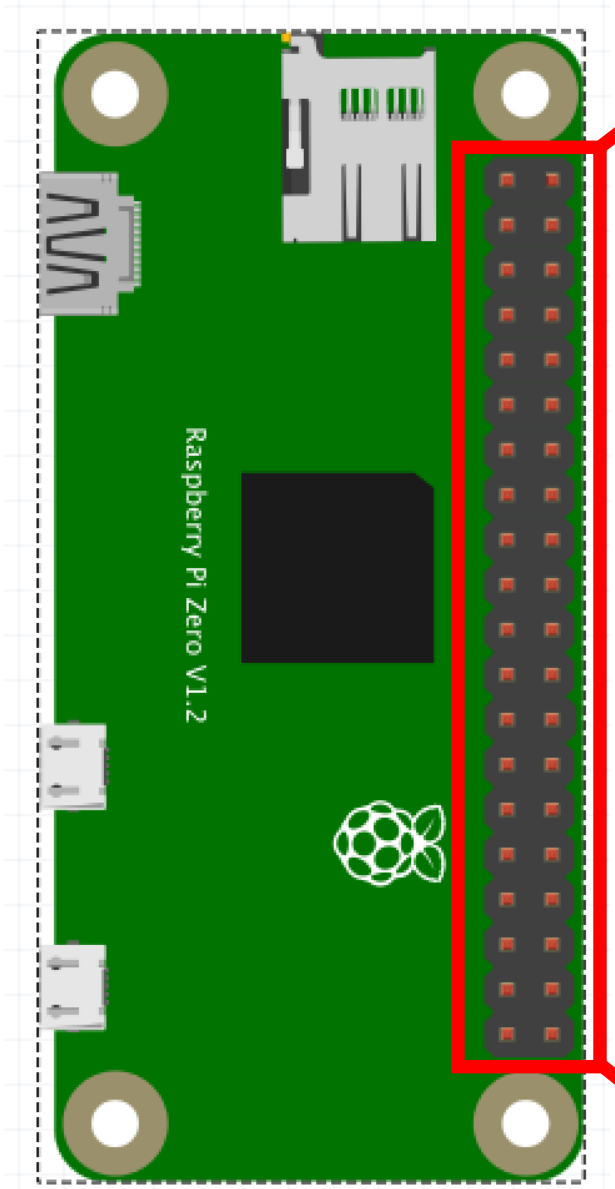
Camera Serial Interface (CSI)

GPIO is the interfaces between Raspberry pi and real world

I/O Interfaces on Raspberry PI

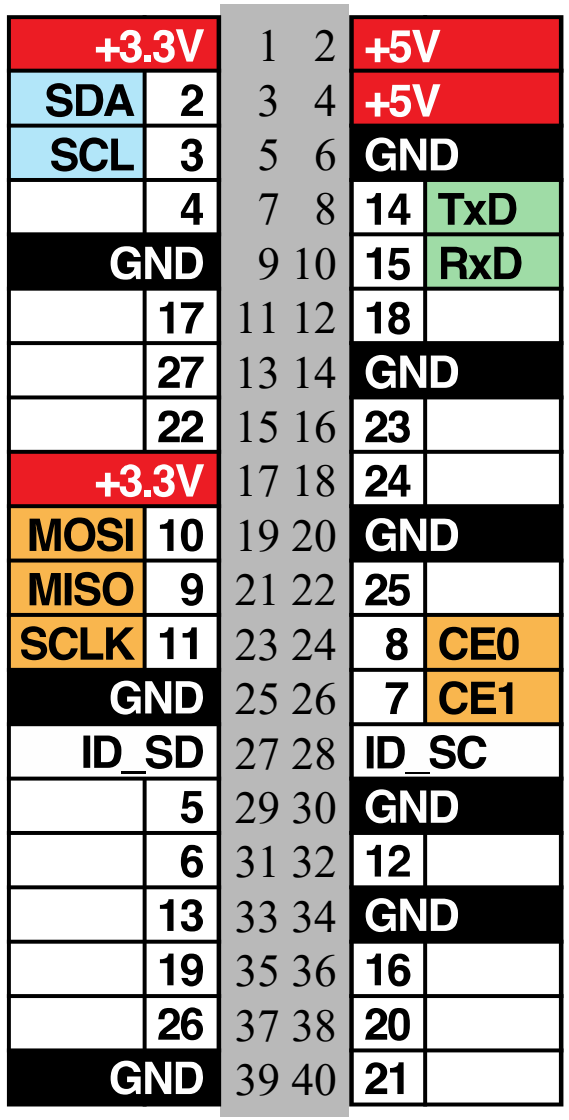
SD side is up





1	+3.3V			+5V	2
3	SDA	2		+5V	4
5	SCL	3		GND	6
7		4	14	TxD	8
9	GND		15	RxD	10
11		17	18		12
13		27		GND	14
15		22	23		16
17	+3.3V		24		18
19	MOSI	10		GND	20
21	MISO	9	25		22
23	SCLK	11	8	CE0	24
25	GND		7	CE1	26
27	ID_SD			ID_SC	28
29		5		GND	30
31		6	12		32
33		13		GND	34
35		19	16		36
37		26	20		38
39	GND		21		40

GPIO (General Purpose Input/Output)



+3.3V		1	2	+5V	
SDA	2	3	4	+5V	
SCL	3	5	6	GND	
	4	7	8	14	TxD
GND		9	10	15	RxD
	17	11	12	18	
	27	13	14	GND	
	22	15	16	23	
+3.3V		17	18	24	
MOSI	10	19	20	GND	
MISO	9	21	22	25	
SCLK	11	23	24	8	CE0
GND		25	26	7	CE1
ID_SD		27	28	ID_SC	
	5	29	30	GND	
	6	31	32	12	
	13	33	34	GND	
	19	35	36	16	
	26	37	38	20	
GND		39	40	21	

Power: +3.3V (1&17) and +5V(2 & 4) can use for power supply to electronic devices or input for circuit

GND (6,9,11,20,25,30,34,39): 0V output pins

GPIO(white): General Purpose input and output pins (3.3V or 0 V)

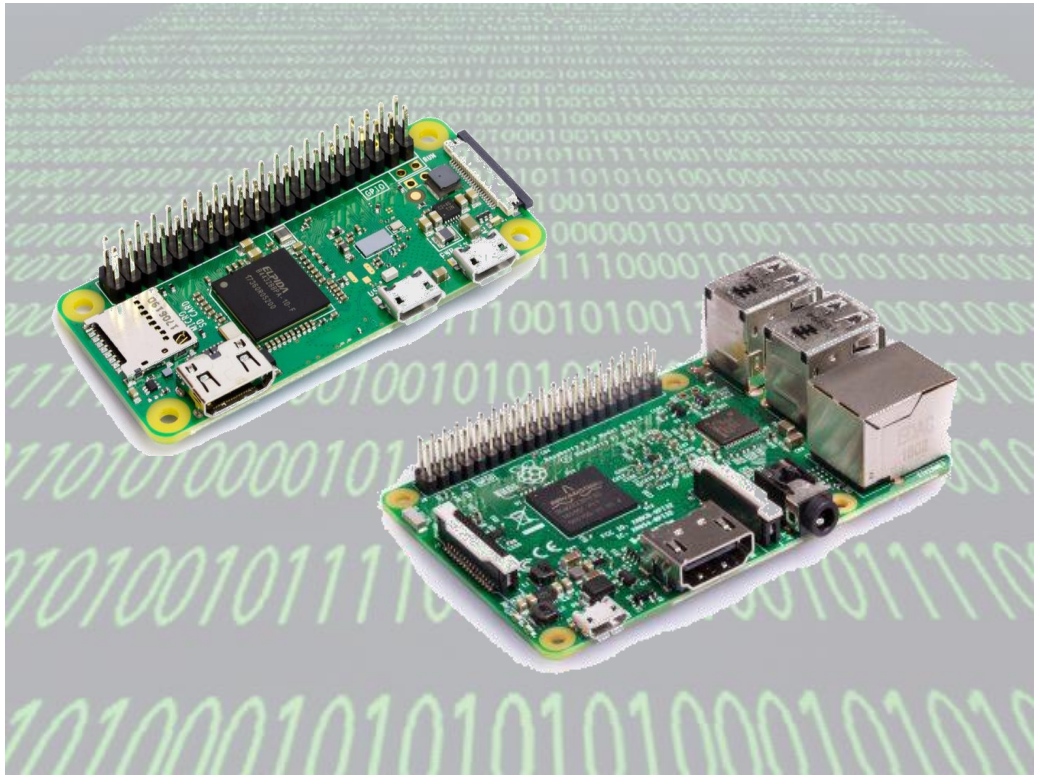
UART (Universal Asynchronous Receiver Transmitter):
2-wired (TxD: Transmit, RxD: Receive) Communication to PC or electronics devices

I2C (Inter-Integrated Circuit): Communication standard to electronics devices (motors and sensors). SDA (3) is for data transmission and reception. SCL (5) is for clock synchronization between devices.

SPI (Serial Peripheral Interface): Communication standard to electronics devices. MOSI (19)=data transmission, MISO (21)=data reception, SCLK (23)=synchronization between devices, CE0(24), CE1(26) = port for selecting the target device

Real World is "*Analog*" World

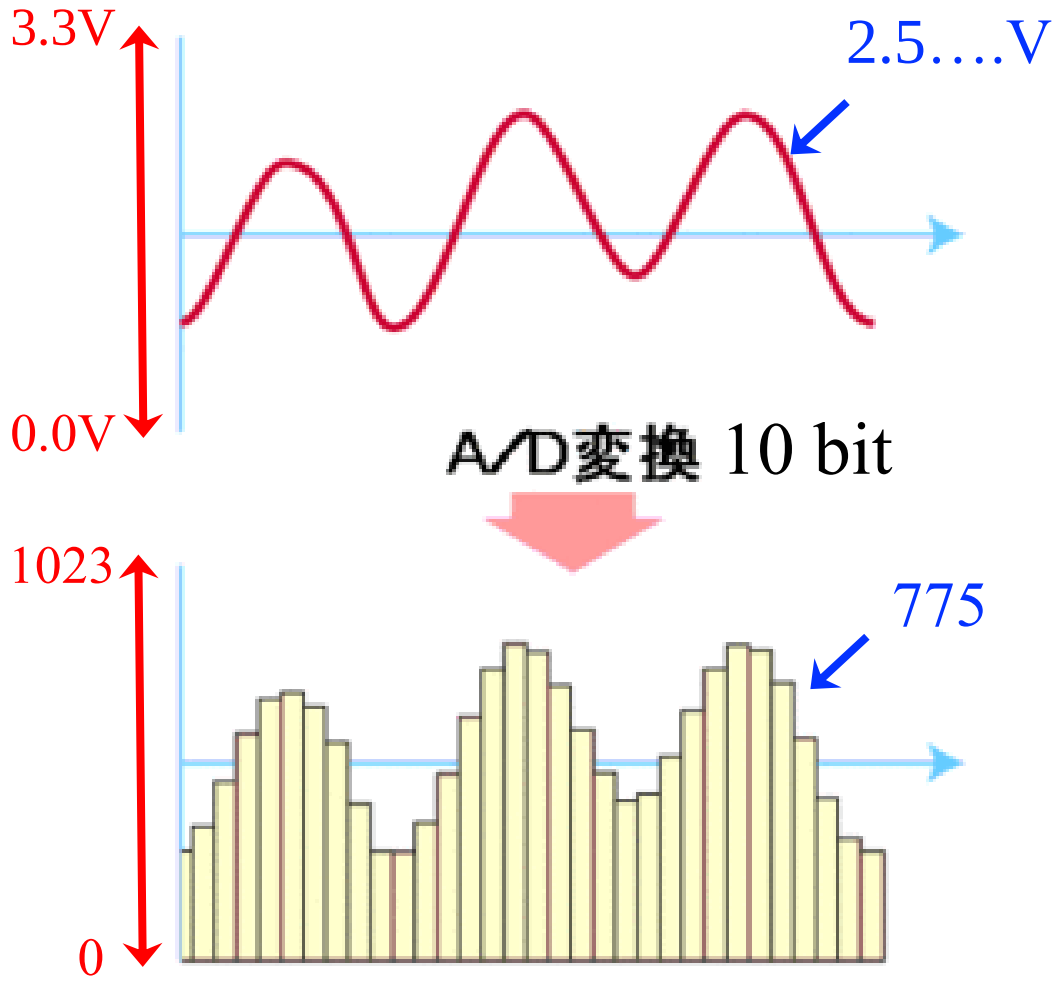
Computers does not process "analog" signals…, it's on the "digital" world, what we call, 0/1 world.



We need "Analog-to-Digital" converter!!!

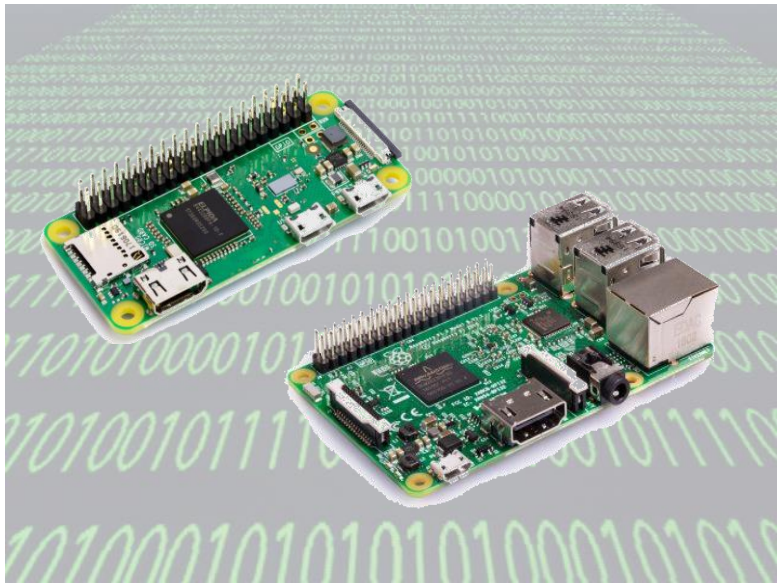
A/D (Analog-to-Digital) Converter

- Convert analog signal to digital signals (Analog-to-Digital Converter)
- Sampling rate (Hz, time resolution) and voltage resolution (bit) are important parameters.
- 10 bit resolution means, 3.3V is divided to 2^10=1024 units.



Digital Communications to Raspi After A/D Convert

A/D converter (IC)

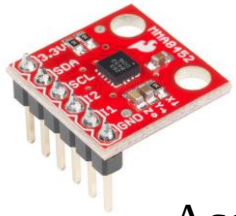


Digital communication to Raspi, e.g., UART, I2C, SPI

Sensors and A/D converter on the chip

Ultrasonic sensor

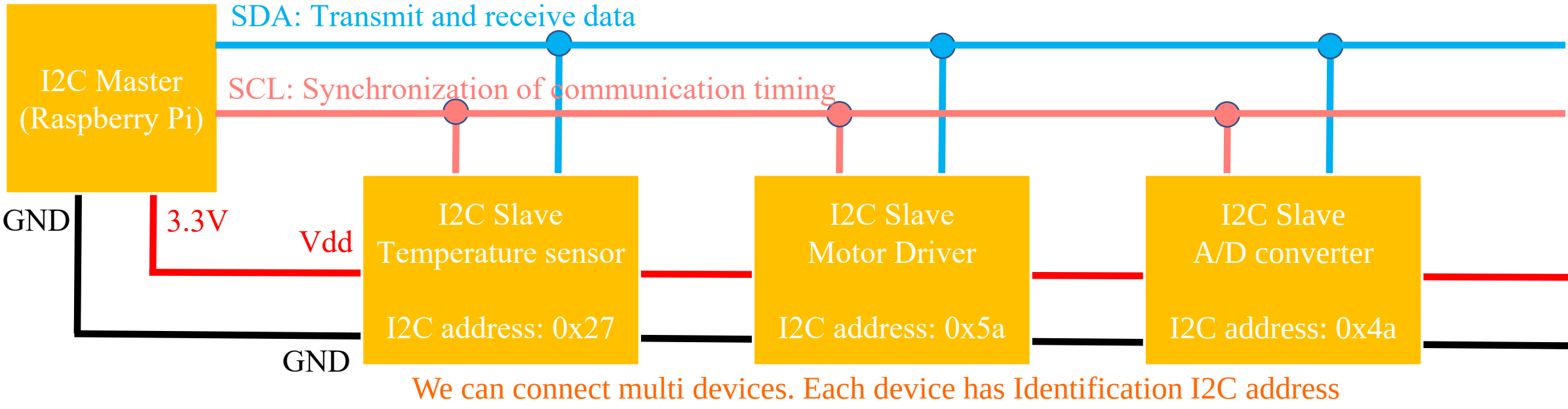
Gyro sensor



Acceleration sensor

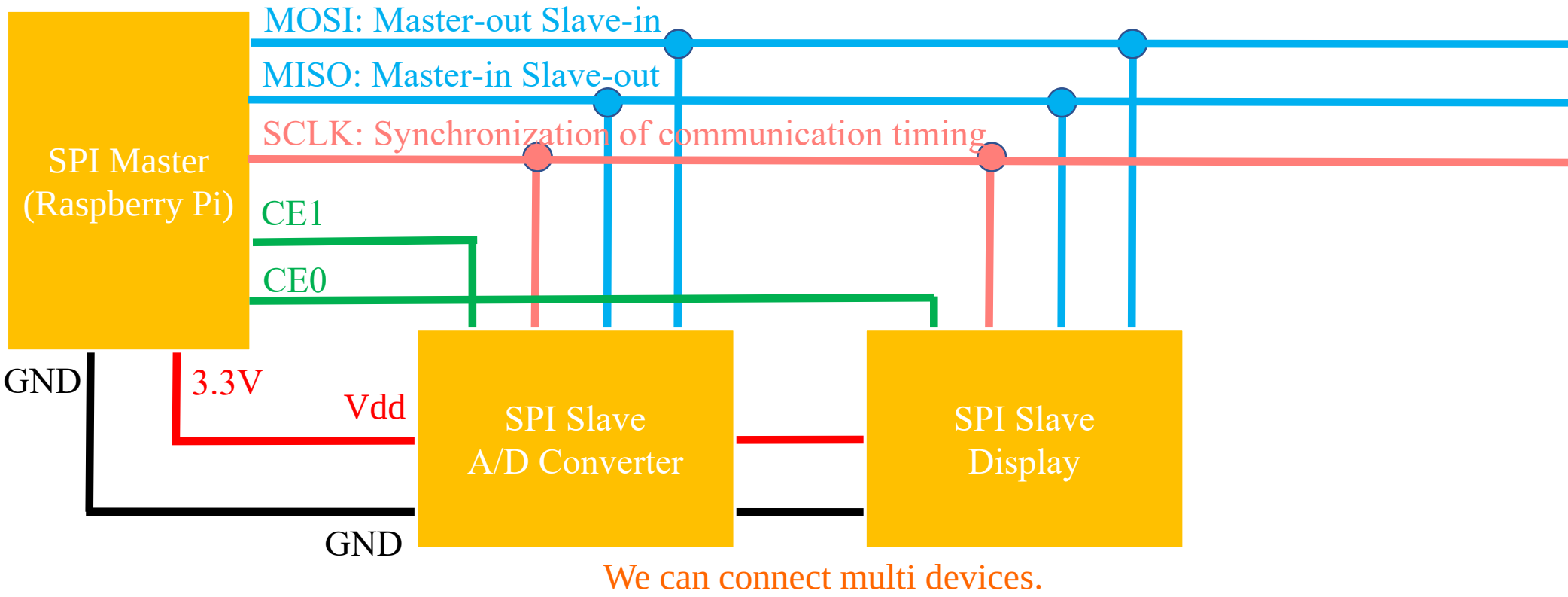
I2C (Inter Integrated Circuit) Communication

- ✓ Serial communication protocol between IC devices (by Philips)
- ✓ 2-wired communication: SDA (Serial Data) and SCL (Serial Clock) (+ Power supply Vcc and GND are required)
- ✓ Communication speed is low (around 100k-3.4Mbps)



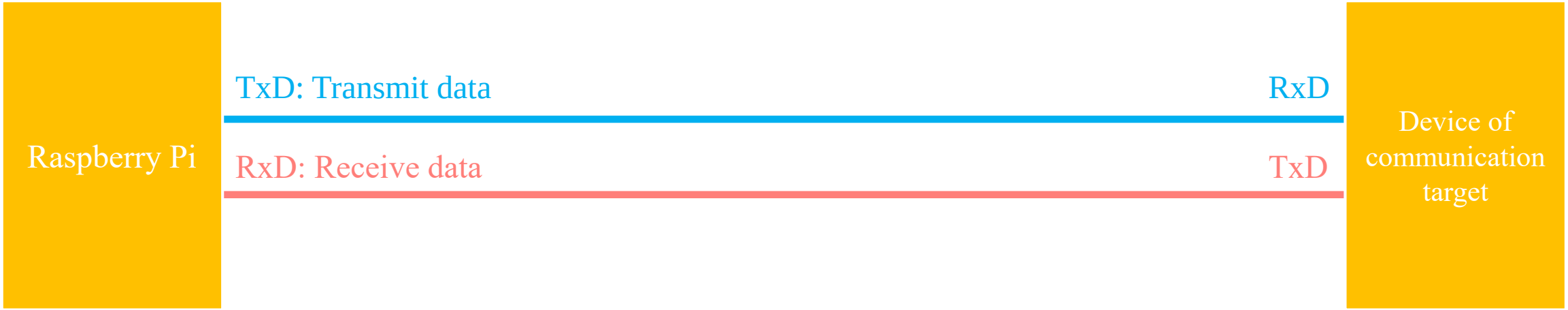
SPI (Serial Peripheral Interface) Communication

- ✓ Serial communication protocol between IC devices (by Motorola)
- ✓ 4-wired communication: MOSI (Master Out Save In: Data from master to slave), MISO (Master In Save Out: Data from slave to master), SCLK (Serial Clock), and CE (Chip Enable: Select device, 0V means “On”) (+ Power supply Vcc and GND are required)
- ✓ Communication speed is high (around several dozen Mbps)



UART Communication

- ✓ UART = Universal Asynchronous Receiver Transmitter, simply called “Serial” communication
- ✓ Serial communication protocol between PCs, Peripheral devices, as well as IC devices
- ✓ 2-wired communication: TxD (Data Transmission) and RxD (Data Receive). Don’t use synchronous signals by setting to the same communication speed between devices.
- ✓ Communication speed is generally max. 1115.2kbps (16Mbps, depend on device)



One to One Communication on UART

How to Choose A/D Converter IC

1. Select resolution
2. Select number of channels
3. Select communication protocol

●購入可能な主なA/Dコンバータ

製品名	分解能	チャンネル数	通信方式	参考価格
MCP3002	10ビット	2	SPI	180円（秋月電子通商）
MCP3008	10ビット	8	SPI	220円（秋月電子通商）
MCP3204	12ビット	4	SPI	360円（秋月電子通商）
MCP3208	12ビット	8	SPI	300円（秋月電子通商）
MCP3425	16ビット	1	I²C	250円（秋月電子通商）
LTC1298	12ビット	2	SPI	600円（秋月電子通商）
MAX1118	8ビット	2	SPI	200円（秋月電子通商）
ADS1015	12ビット	4	I²C	1,393円（スイッチサイエンス）
ADS1115	16ビット	4	I²C	2,095円（スイッチサイエンス）

Pin Configuration of A/D Converter IC

秋月電子通商

商品カタログ | 新商品 | お知らせ | 注文方法 | 振込先 | よくある質問 | ダウンロード | 広告PDF | 配送状況確認 | ログイン

トップ > 半導体 > インターフェースIC > ADコンバータ > 12bit 8ch ADコンバータ MCP3208−CI／P

12bit 8ch ADコンバータ MCP3208−CI／P

[MCP3208-CI/P]
通販コード I-00238
発売日 2002/08/28
メーカーカテゴリ Microchip Technology Inc.(マイクロチップ)

マイクロチップの12ビットADコンバータ
Cグレード(INL ±2LSB)
※INL:積分非直線性誤差
※フラットタイプもあります→ I-05813

参考資料
データシート

ADコンバーター覧
DAコンバーター覧

商品画像

MICROCHIP

MCP3204/3208

2.7V 4-Channel/8-Channel 12-Bit A/D Converters with SPI Serial Interface

Features

- 12-bit resolution
- ± 1 LSB max DNL
- ± 1 LSB max INL (MCP3204/3208-B)
- ± 2 LSB max INL (MCP3204/3208-C)
- 4 (MCP3204) or 8 (MCP3208) input channels
- Analog inputs programmable as single-ended or pseudo-differential pairs
- On-chip sample and hold
- SPI serial interface (modes 0,0 and 1,1)
- Single supply operation: 2.7V - 5.5V
- 100 ksps max. sampling rate at V_{DD} = 5V
- 50 ksps max. sampling rate at V_{DD} = 2.7V
- Low power CMOS technology:
  - 500 nA typical standby current, 2 µA max.
  - 400 µA max. active current at 5V

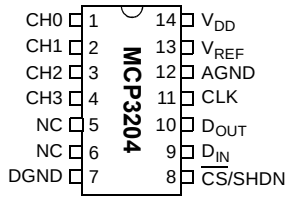
Description

The Microchip Technology Inc. MCP3204/3208 devices are successive approximation 12-bit Analog-to-Digital (A/D) Converters with on-board sample and hold circuitry. The MCP3204 is programmable to provide two pseudo-differential input pairs or four single-ended inputs. The MCP3208 is programmable to provide four pseudo-differential input pairs or eight single-ended inputs. Differential Nonlinearity (DNL) is specified at ±1 LSB, while Integral Nonlinearity (INL) is offered in ±1 LSB (MCP3204/3208-B) and ±2 LSB (MCP3204/3208-C) versions.

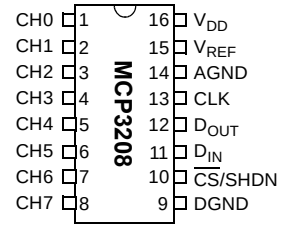
Communication with the devices is accomplished using a simple serial interface compatible with the SPI protocol. The devices are capable of conversion rates of up to 100 ksps. The MCP3204/3208 devices operate over a broad voltage range (2.7V - 5.5V). Low current design permits operation with typical standby and

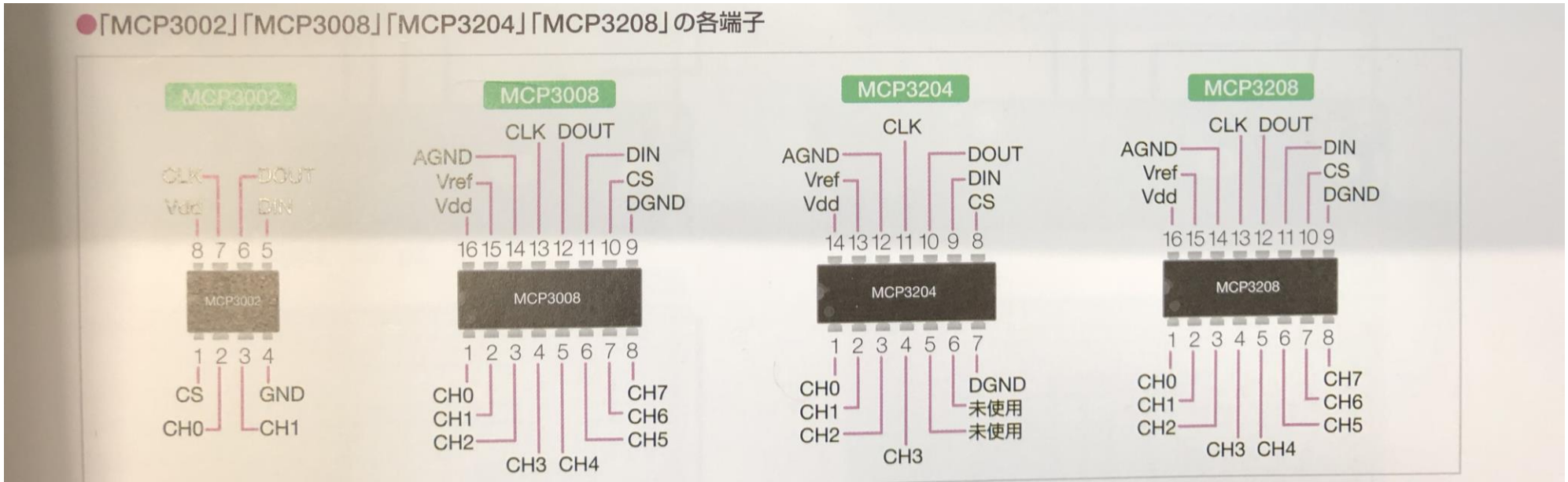
Package Types

PDIP, SOIC, TSSOP

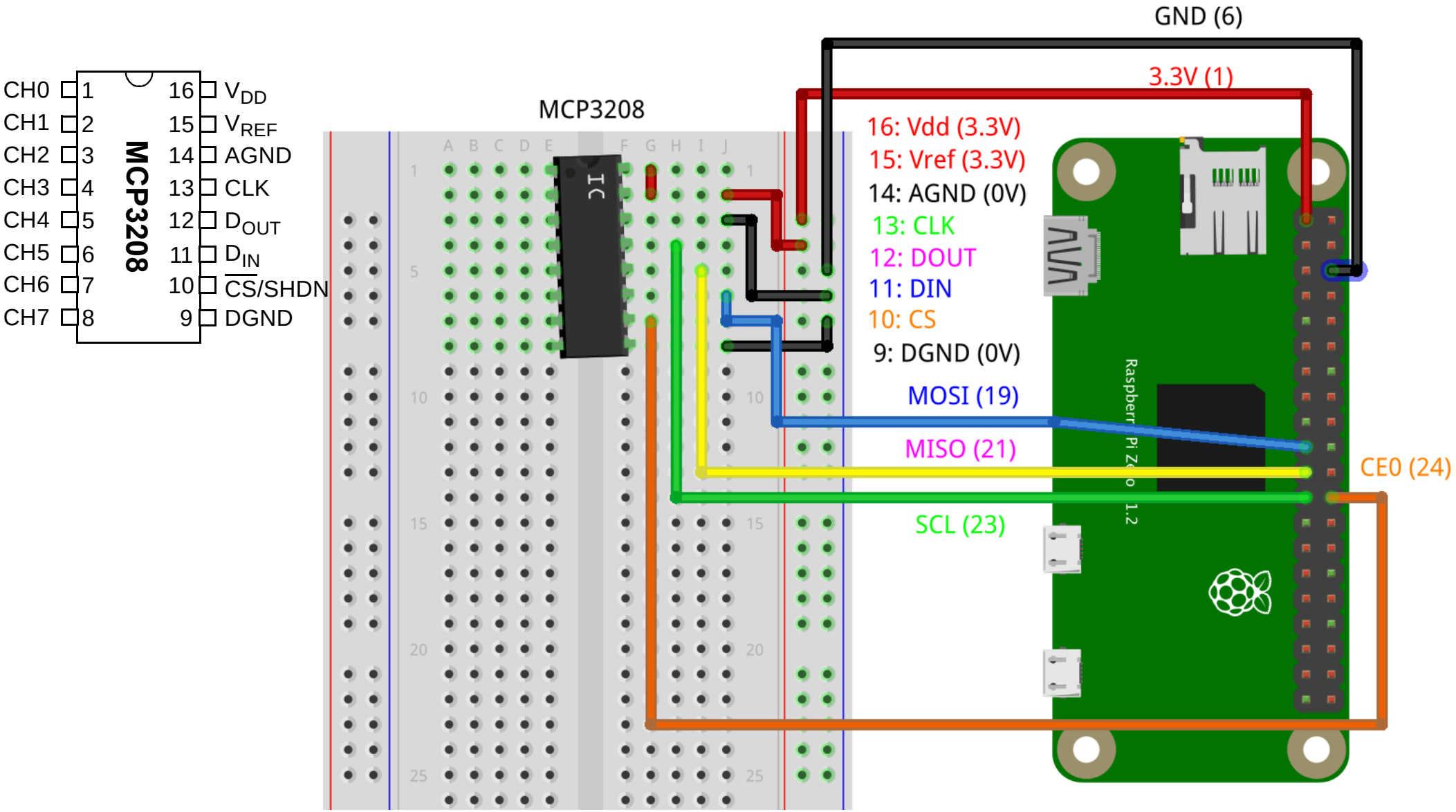


PDIP, SOIC





Test Circuit on Breadboard: IC-to-Raspi



Python Script for A/D Converter

mcp_adc.py | *mcp3208_read.py*

```
1  import wiringpi as pi
2  import time
3  import mcp_adc
4
5  SPI_CE = 0
6  SPI_SPEED = 1000000
7  READ_CH = 0
8  VREF = 3.3
9
10 adc = mcp_adc.mcp3208( SPI_CE, SPI_SPEED, VREF )
11
12 while True:
13     value = adc.get_value( READ_CH )
14     volt = adc.get_volt( value )
15     print ("Value:", value, " Volt:", volt )
16
17     time.sleep( 0.1 )
18
```

#1: import wiringpi as pi (for GPIO)
#2: import time module
#3: import mcp_adc module

#5: Using “CE0” channel for SPI
#6: Communication speed of SPI: 1Mbps
#7: Select Channel on IC (CH0 - CH7)
#8: Voltage on Vref

#10: Setting for ADC of MPC3208

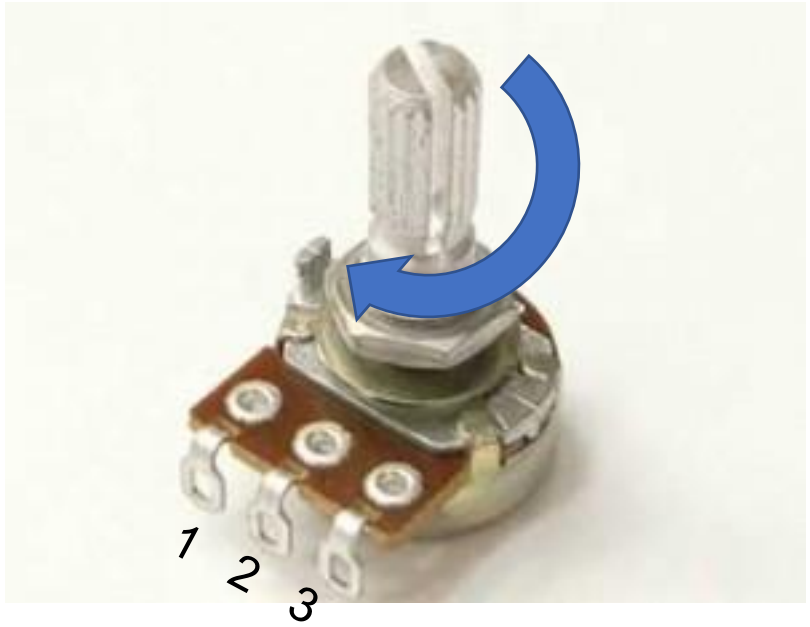
#13 Getting Digital Value (12bit=0 - 4095)
#14 Getting Voltage Value (0-Vref)

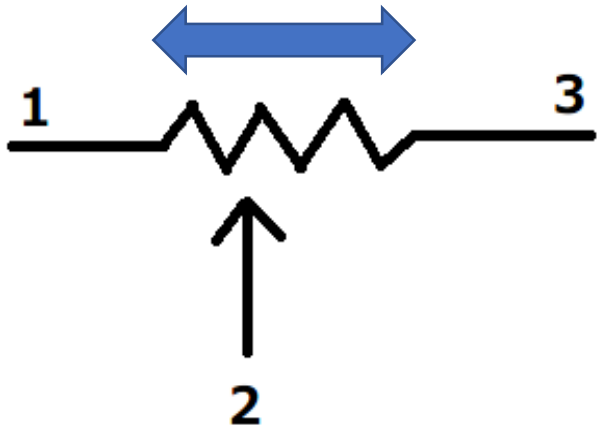
Note:
$ sudo pip3 install wiringpi

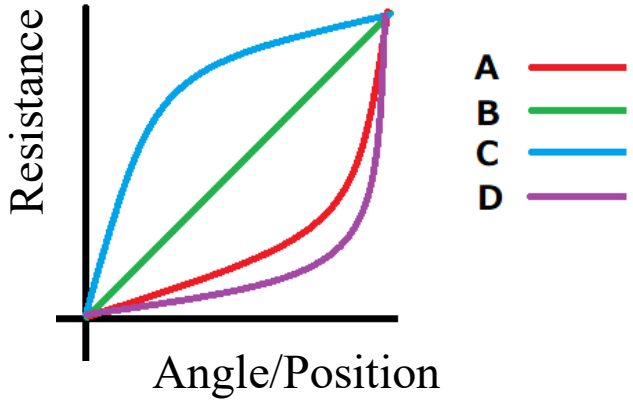
$ python3 mcp3208_read.py

Volume: Variable Resistor

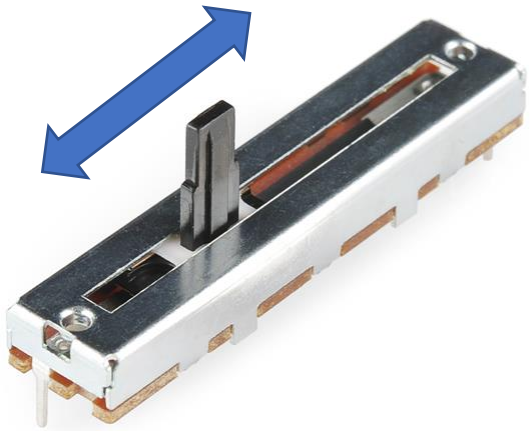
Rotary volume



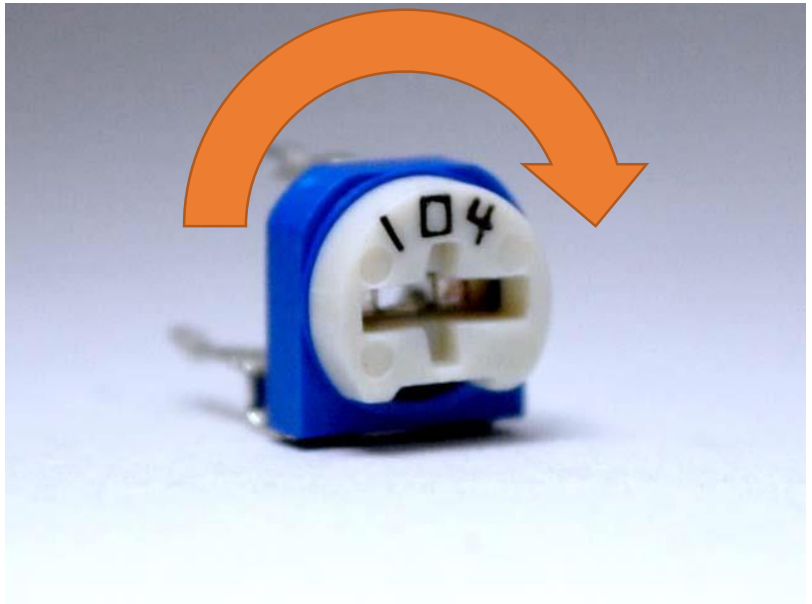




The property of resistance change are different, linear B or nonlinear A, C, and D, depending on individual type, so you should check the data sheet of your resistor



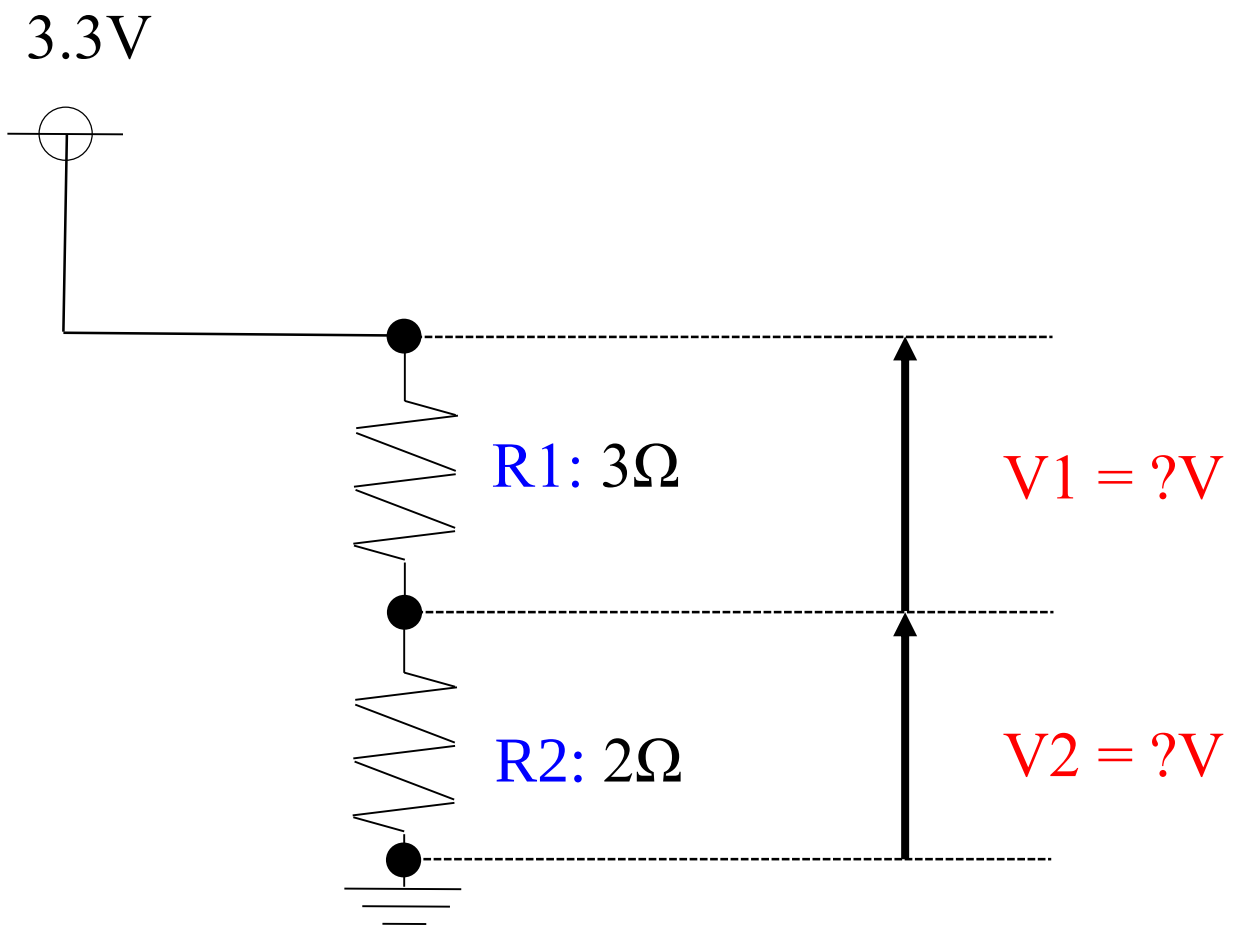
Slide volume



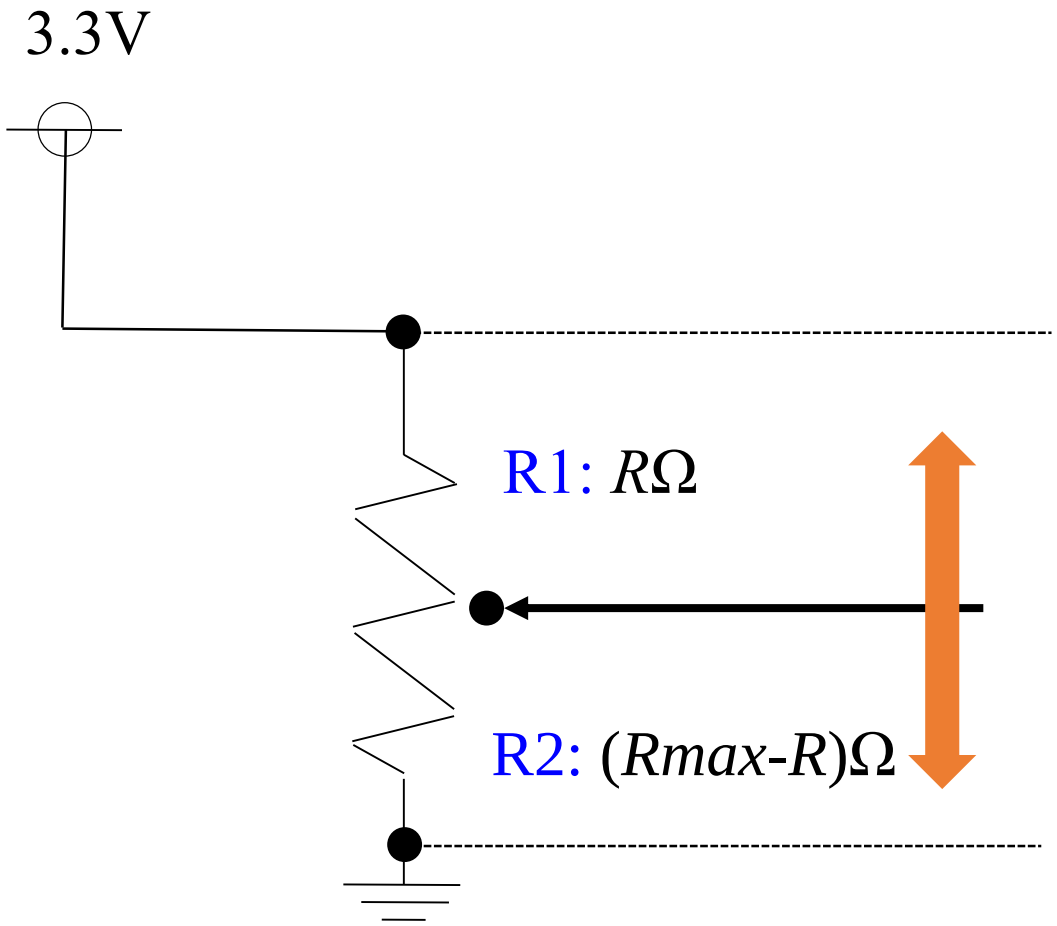
Semi-fixed resistance

What is *Voltage Divider*?

Question1: V1=?, V2=?

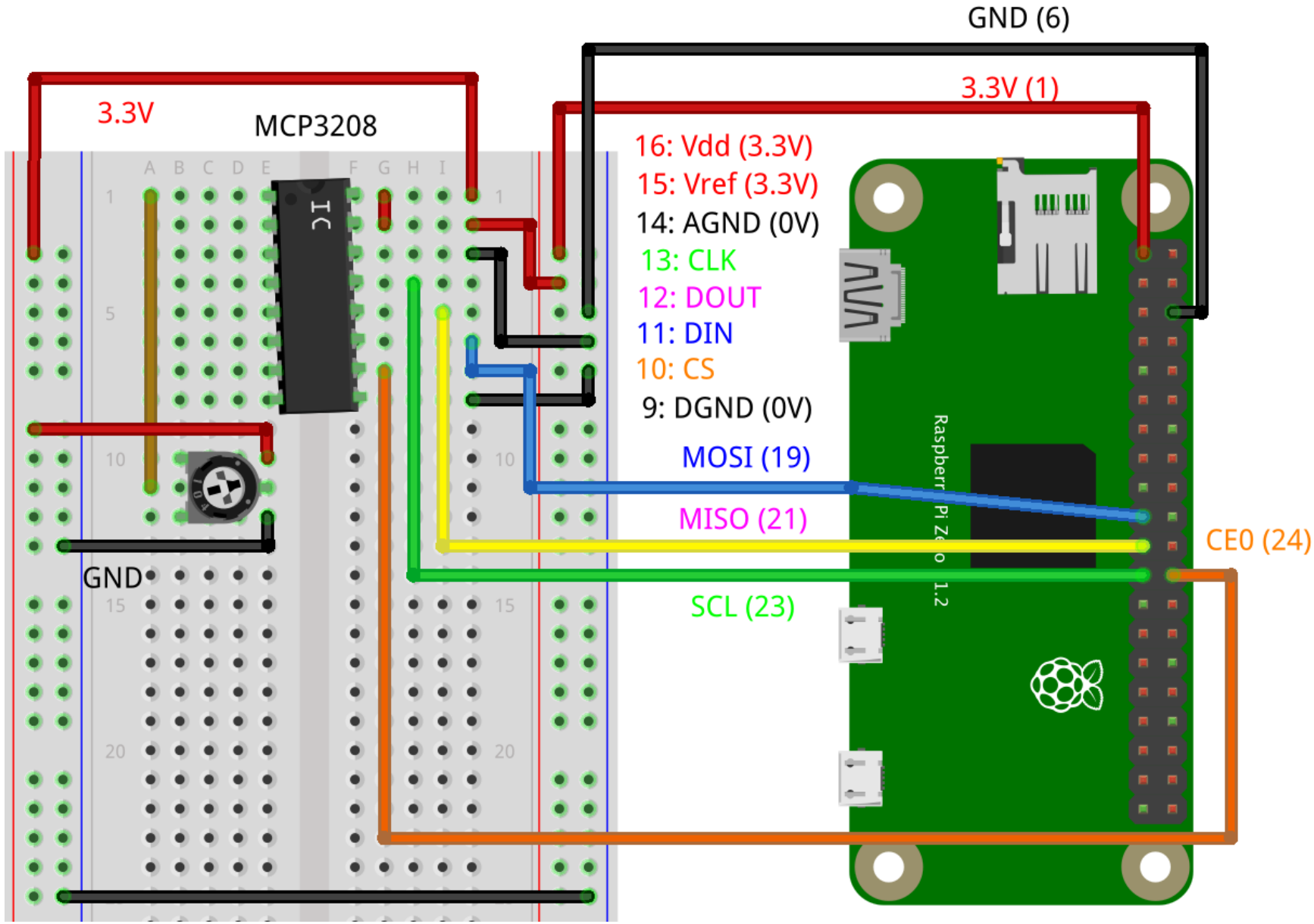


A Basic Principle of Physical Analog Sensors

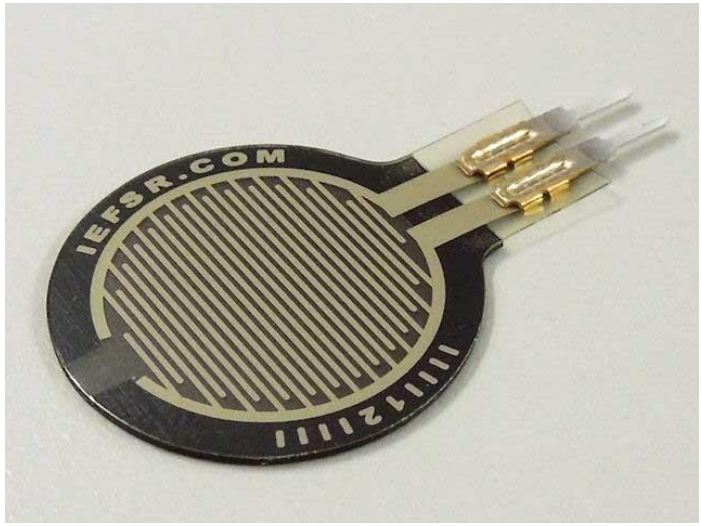


"Analog" sensors = device that can detect the electrical change in its resistor values depending on the change in dynamical information (angle, velocity, acceleration, strain, pressure, temperature, brightness, magnetism)

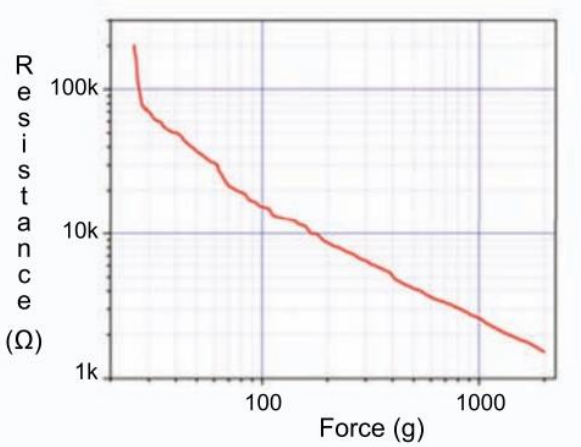
Test Circuit to Read Volume

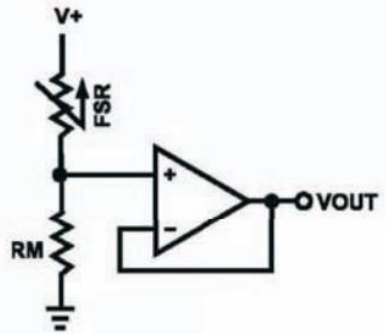


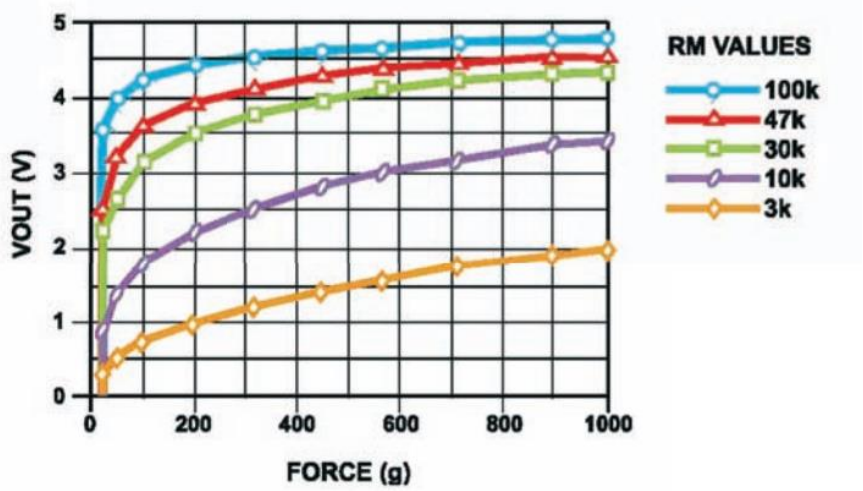
Pressure Sensor: FSR402



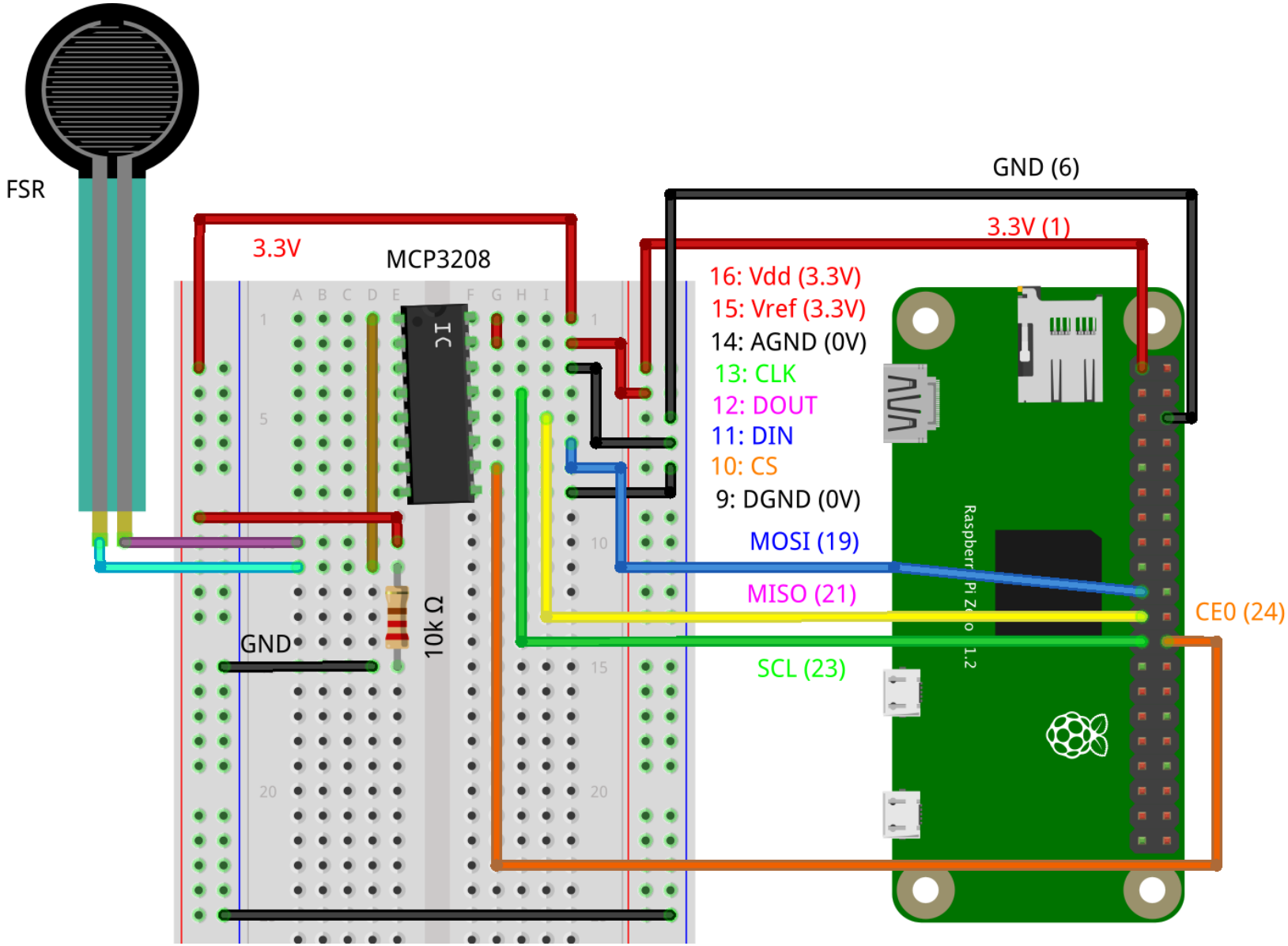
From Data Sheet





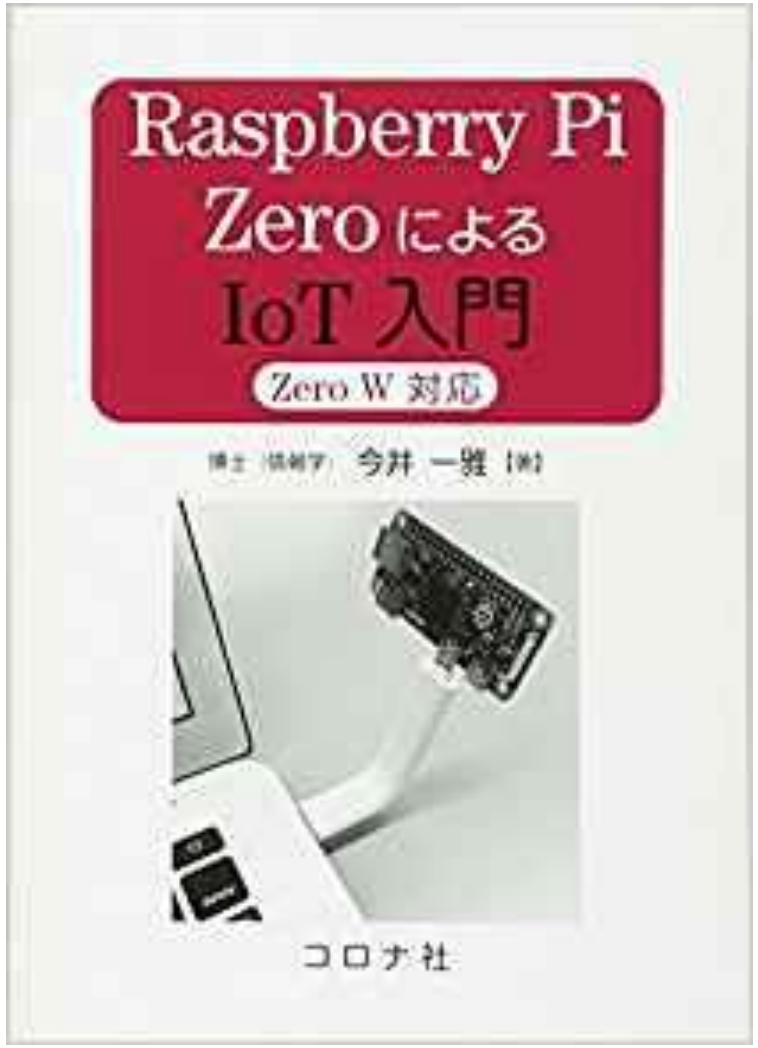


To Get Pressure Sensor Value



Appendix

Books


Raspberry Pi
Zeroによる
IoT入門
Zero W 対応
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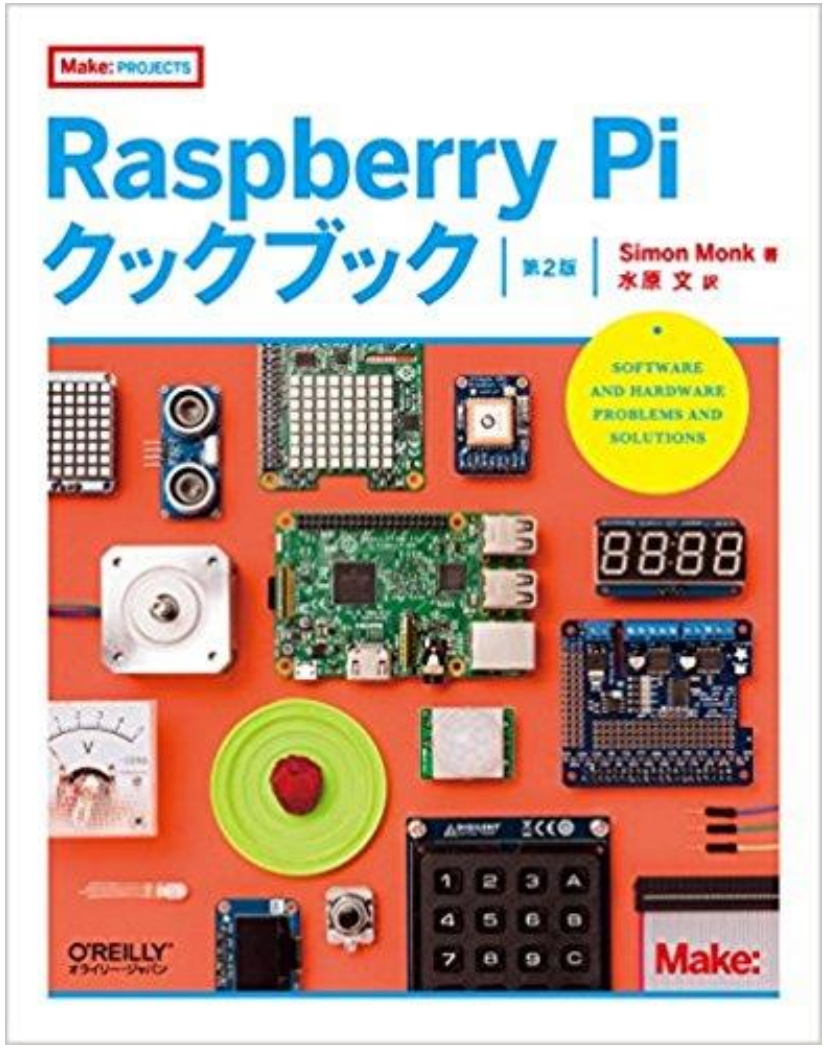
コロナ社


電子部品ごとの制御を学べる!
ラズベリーパイ
Raspberry Pi
電子工作
実践講座
福田和宏
Raspberry Pi 1・/2/3/Zero/ZeroW 対応
センサー・電子部品の組み合わせ、
自由自在!
●LEDやスイッチ、モーター、ボリューム、各種センサーなど電子部品ごとの制御方法をマスターしよう!
●サンプルプログラムで作って学ぶ! 初心者でも安心!
●最新版Raspberry Pi Zero・Zero Wにも完全対応!
ダウンロード提供!


Make: PROJECTS
Raspberry Pi
クックブック
第2版
Simon Monk 著
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SOFTWARE AND HARDWARE PROBLEMS AND SOLUTIONS
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