# Raspberry Pi 好好玩
# - GPIO 篇

台灣樹莓派

Sep 26, 2013/ Taipei.py

# Raspberry Pi 是什麼？

- 信用卡大小般的電腦

http://www.flickr.com/photos/fotero/7697063016/

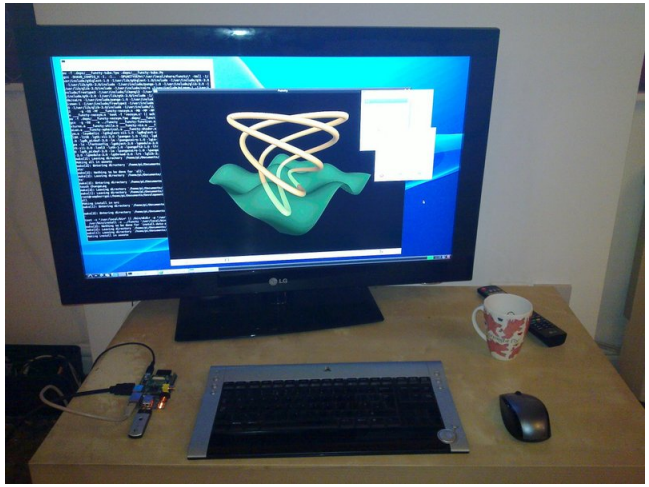
# Raspberry Pi 是 ...

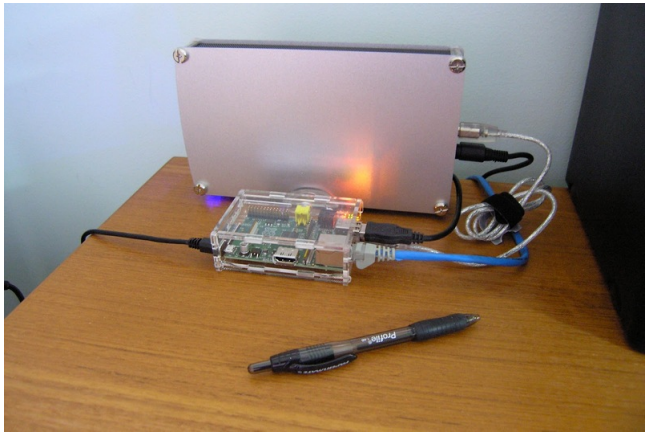
- Raspberrypi.org 基金會所設計開發
- 以低價硬體 & 自由軟體刺激電腦科學教育
- 公開的 datasheet & 線路圖 & 原始碼
- 由 Element14/RS Components 生產製造

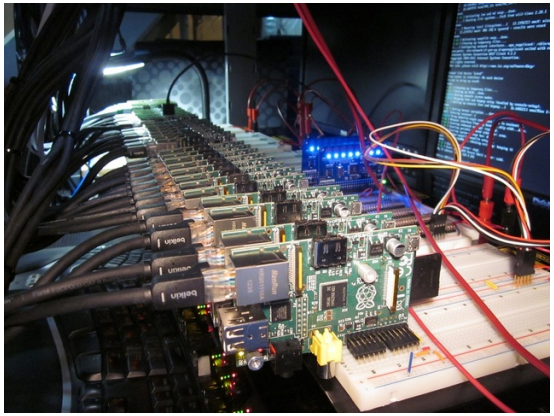
# Raspberry Pi 硬體規格 (Model B)

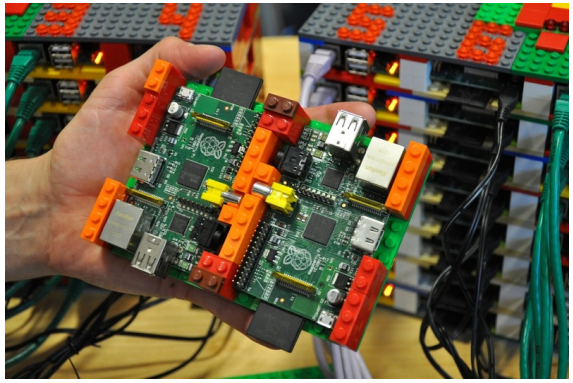
- SoC Broadcom BCM2835
  - CPU: ARM11 family, 700 MHz
  - GPU: Broadcom VideoCore IV, OpenGL ES 2.0, 1080p30 H.264/MPEG-4 AVC decoder
  - Memory: 512 Mb SDRAM
- Video outputs: Composite, HDMI
- Audio outputs: 3.5 mm jack, HDMI
- Onboard storage: SD, MMC, SDIO card slot
- Onboard 10/100 Ethernet RJ45

# Raspberry Pi 怎麼玩？









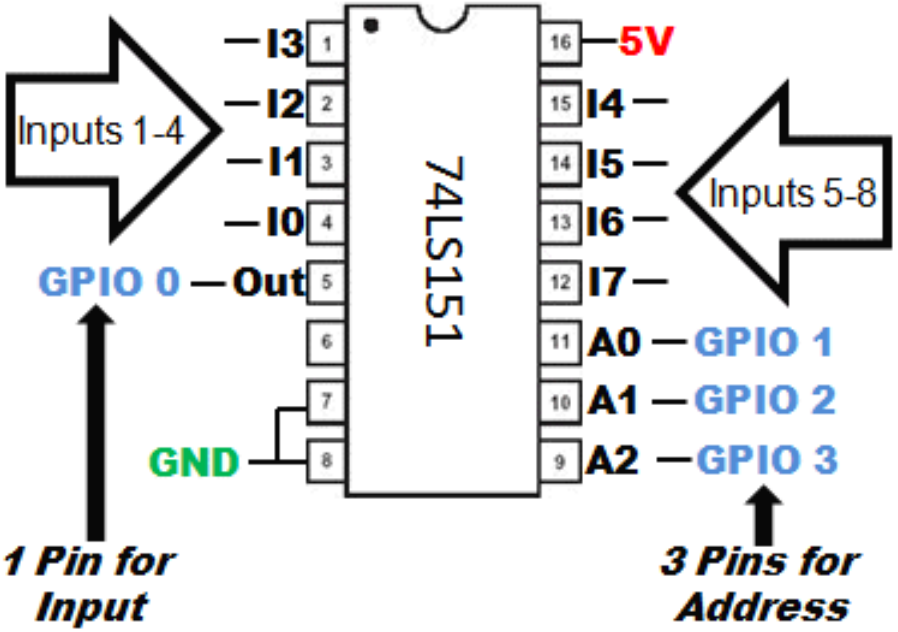
http://www.slideshare.net/raspberrypi-tw/introduction-toraspberrypi

# Raspberry Pi 還可以怎麼玩？

# Raspberry Pi 還可以怎麼玩？
# 玩他的 GPIO

# General Purpose Input Output(GPIO)

- A generic pin on an IC

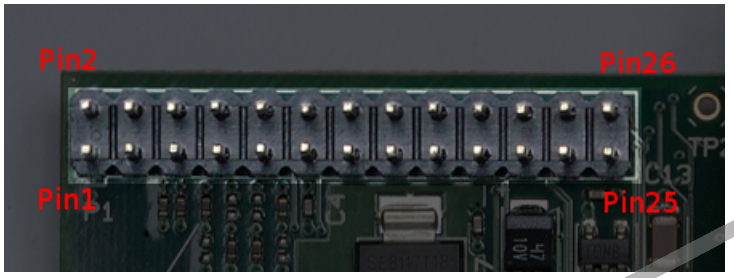


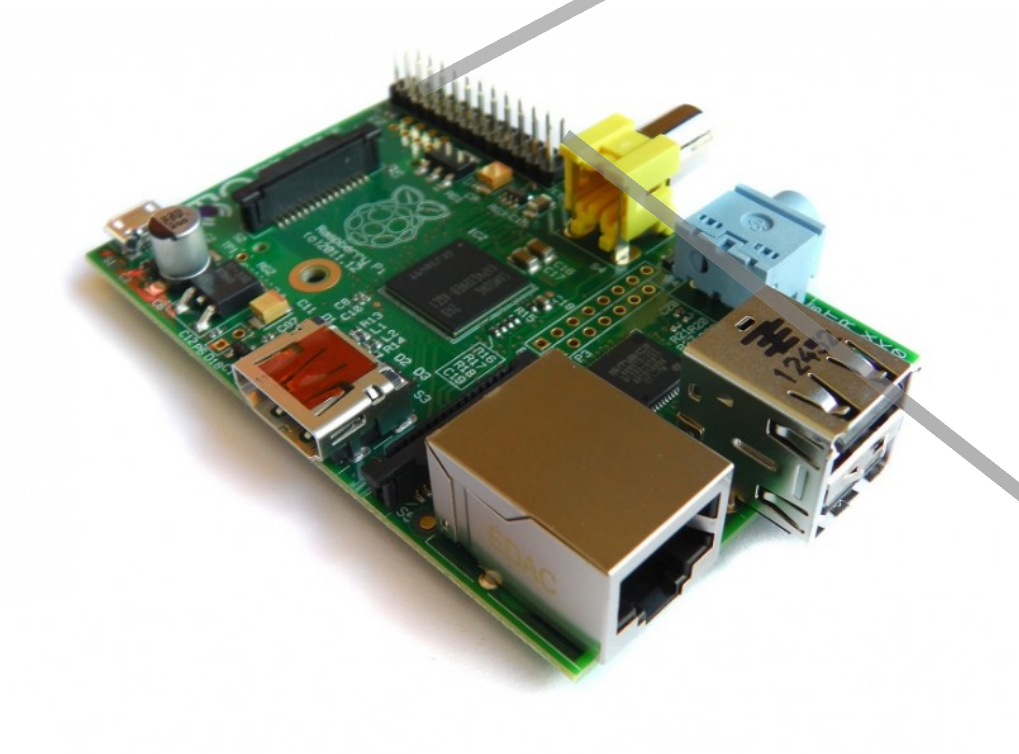

http://raspberrypihobbyist.blogspot.tw/2012/09/so-many-inputs-so-few-gpio-pins.html

# How GPIO Software Works

- Enable or disable a GPIO pin
- Set which signal level is 'active'
- Determine whether it's an input or output
- Write a value to a pin
- Read a value to a pin
- Set the edges that will generate input interrupt
- Wait for an interrupt to occur

# Raspberry Pi 的 GPIO



SPI / I$^2$C / UART / PWM

http://elinux.org/RPi_Low-level_peripherals

# Linux Software Support

- Kernel-level support
  - read, write, ioctl /dev/i2c, /dev/spidev, /dev/mem

```
pi@raspberrypi ~ $ ls -al /dev/i2c-* /dev/spidev0.* /dev/mem
crw-rw---T 1 root i2c   89, 0 Sep 26 10:17 /dev/i2c-0
crw-rw---T 1 root i2c   89, 1 Sep 26 10:17 /dev/i2c-1
crw-r----T 1 root kmem   1, 1 Jan  1  1970 /dev/mem
crw------T 1 root root 153, 0 Jan  1  1970 /dev/spidev0.0
crw------T 1 root root 153, 1 Jan  1  1970 /dev/spidev0.1
```

- Application-level support
  - sysfs → read, write /sys

```
pi@raspberrypi ~ $ ls /sys/
block/    class/    devices/  fs/       module/
bus/      dev/      firmware/ kernel/   power/
```

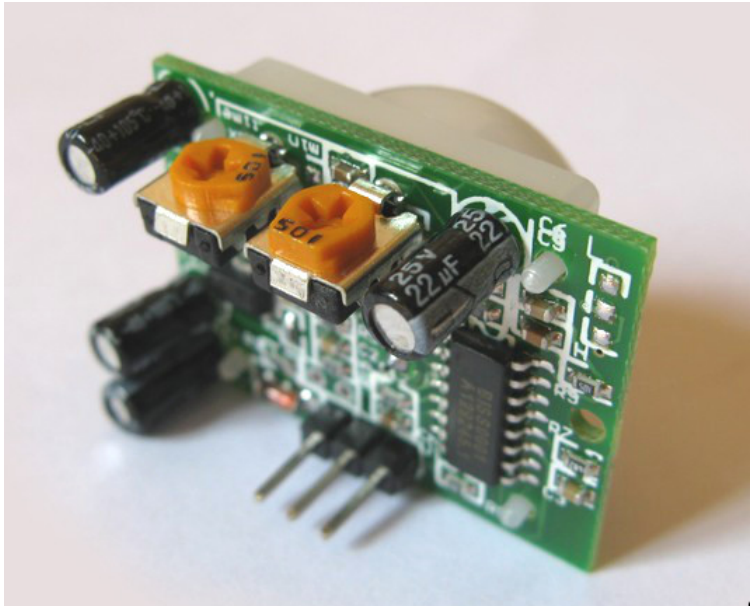
- Script-level support
  - C extension with /dev/mem + import module

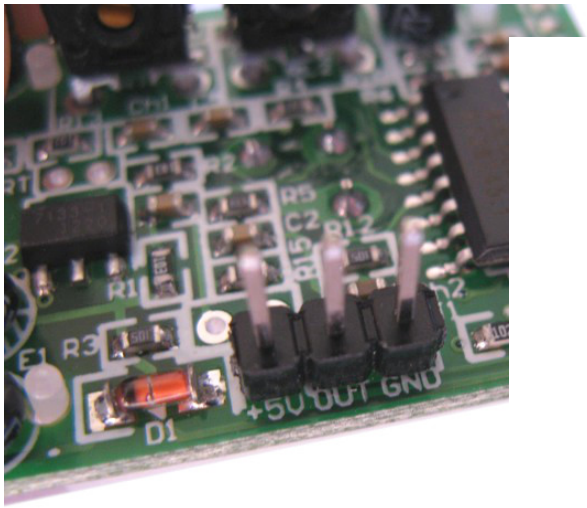
# Language Support

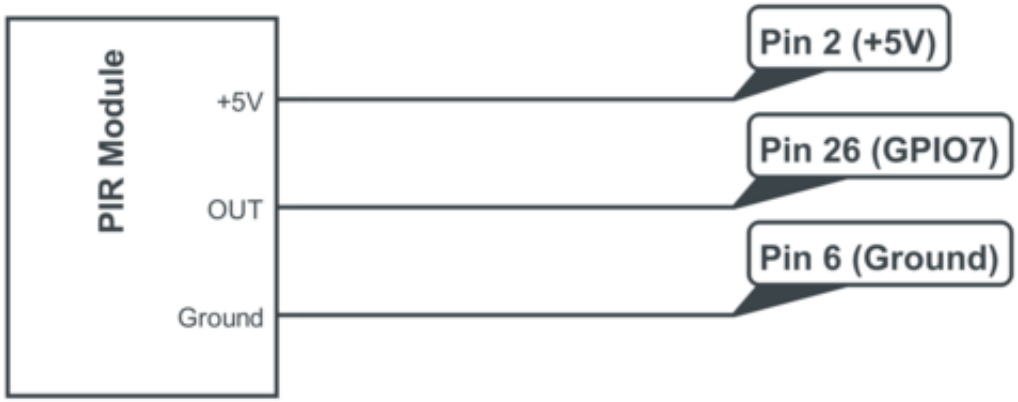
- C
  - Without library
  - wiringPi library / bcm2835 library
  - sysfs
- Python
  - RPi.GPIO / RPIO package
- C#, Ruby, Perl, Java, Free Pascal, Basic...

# 開始用 Python 控制 GPIO 吧

# PIR 人體紅外線感測器





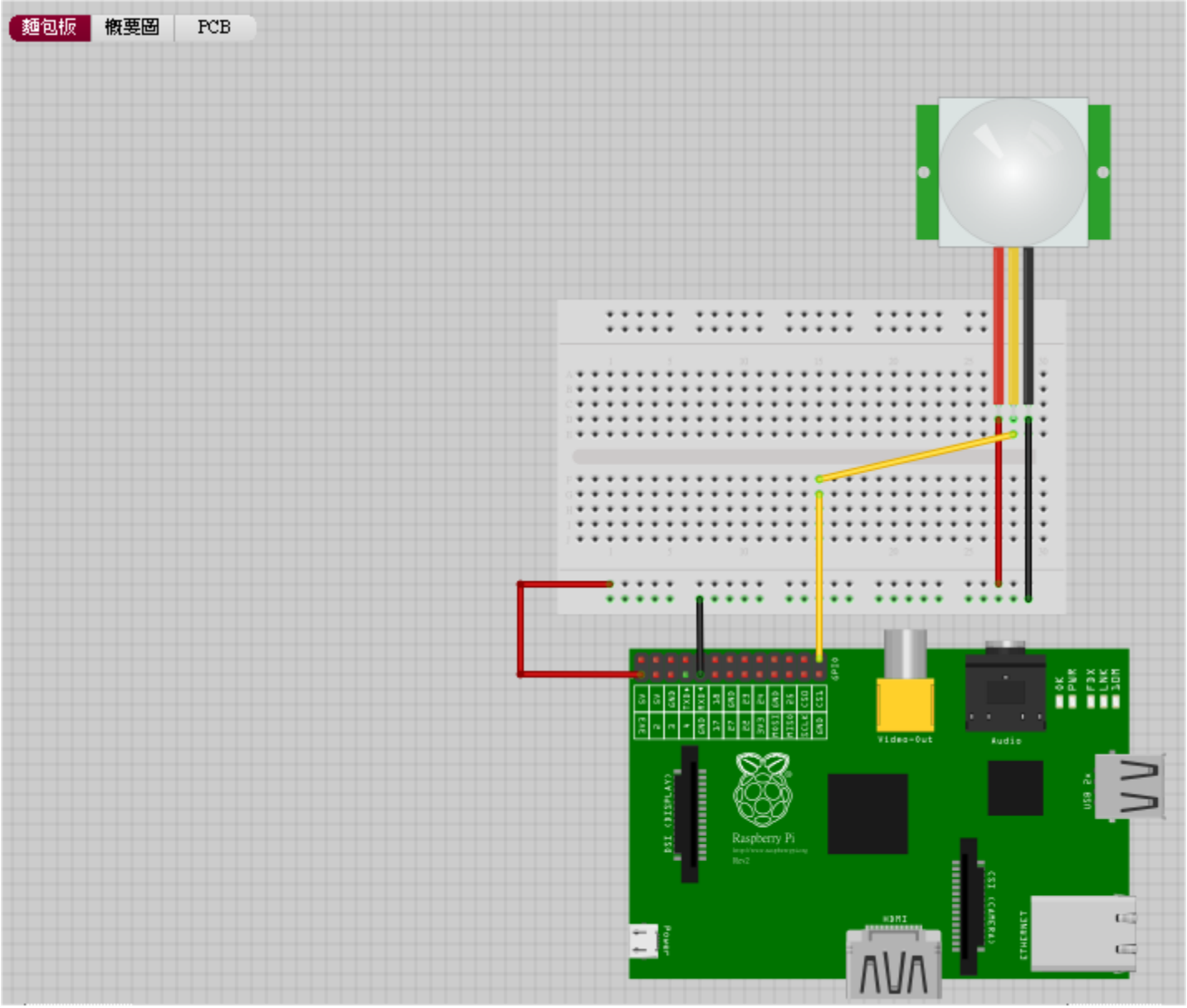

http://www.raspberrypi-spy.co.uk/2013/01/cheap-pir-sensors-and-the-raspberry-pi-part-1/

# Pin Definition

| P1: The Main GPIO connector | | | | | | | |
|---|---|---|---|---|---|---|---|
| WiringPi Pin | BCM GPIO | Name | Header | | Name | BCM GPIO | WiringPi Pin |
| | | 3.3v | 1 | 2 | 5v | | |
| 8 | Rv1:0 - Rv2:2 | SDA | 3 | 4 | 5v | | |
| 9 | Rv1:1 - Rv2:3 | SCL | 5 | 6 | 0v | | |
| 7 | 4 | GPIO7 | 7 | 8 | TxD | 14 | 15 |
| | | 0v | 9 | 10 | RxD | 15 | 16 |
| 0 | 17 | GPIO0 | 11 | 12 | GPIO1 | 18 | 1 |
| 2 | Rv1:21 - Rv2:27 | GPIO2 | 13 | 14 | 0v | | |
| 3 | 22 | GPIO3 | 15 | 16 | GPIO4 | 23 | 4 |
| | | 3.3v | 17 | 18 | GPIO5 | 24 | 5 |
| 12 | 10 | MOSI | 19 | 20 | 0v | | |
| 13 | 9 | MISO | 21 | 22 | GPIO6 | 25 | 6 |
| 14 | 11 | SCLK | 23 | 24 | CE0 | 8 | 10 |
| | | 0v | 25 | 26 | CE1 | 7 | 11 |
| WiringPi Pin | BCM GPIO | Name | Header | | Name | BCM GPIO | WiringPi Pin |

http://wiringpi.com/wp-content/uploads/2013/03/pins.pdf

# 線路圖


麵包板
概要圖
PCB
Raspberry Pi
Video-Out
Audio
HDMI
ETHERNET
Power

# Python Code

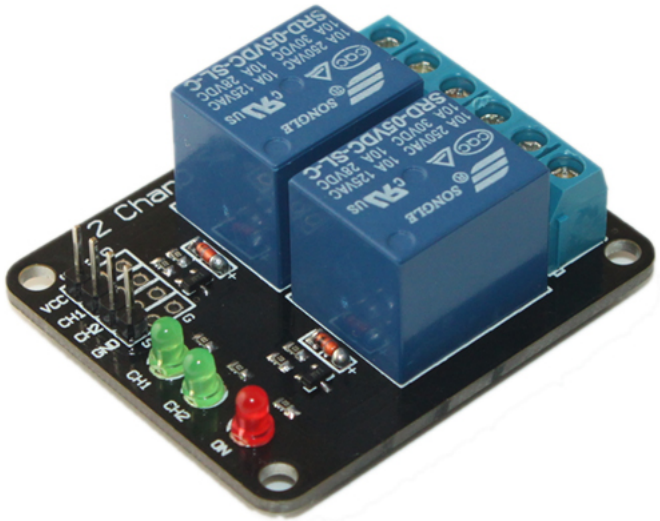
- Import module
- Define pin numbering
- Setup up a channel
- Input/Output
- Cleanup

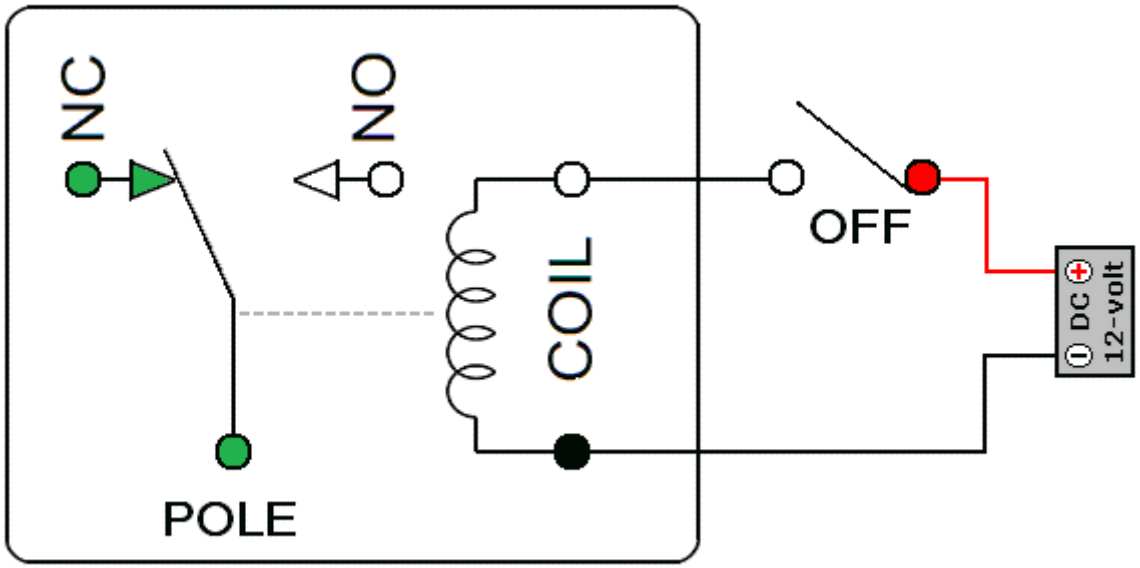
```python
#!/usr/bin/python

import RPi.GPIO as GPIO          # import module
import time

GPIO.setmode(GPIO.BCM)           # define pin
PIN_PIR = 7
GPIO.setup(PIN_PIR, GPIO.IN)     # setup a channel
Current_State  = 0
Previous_State = 0

try:
        print "Waiting for PIR to settle ..."

        while GPIO.input(PIN_PIR) == 1:
                Current_State = 0

        print "  Ready"

        while True :             # event loop
                Current_State = GPIO.input(PIN_PIR)     # read input

                if Current_State == 1 and Previous_State == 0:
                        print "  Motion detected!\n"
                        Previous_State = 1
                elif Current_State == 0 and Previous_State == 1:
                        print "  Ready"
                        Previous_State = 0

        time.sleep(0.01)

except KeyboardInterrupt:
        GPIO.cleanup()           # cleanup
```

再加點東西吧

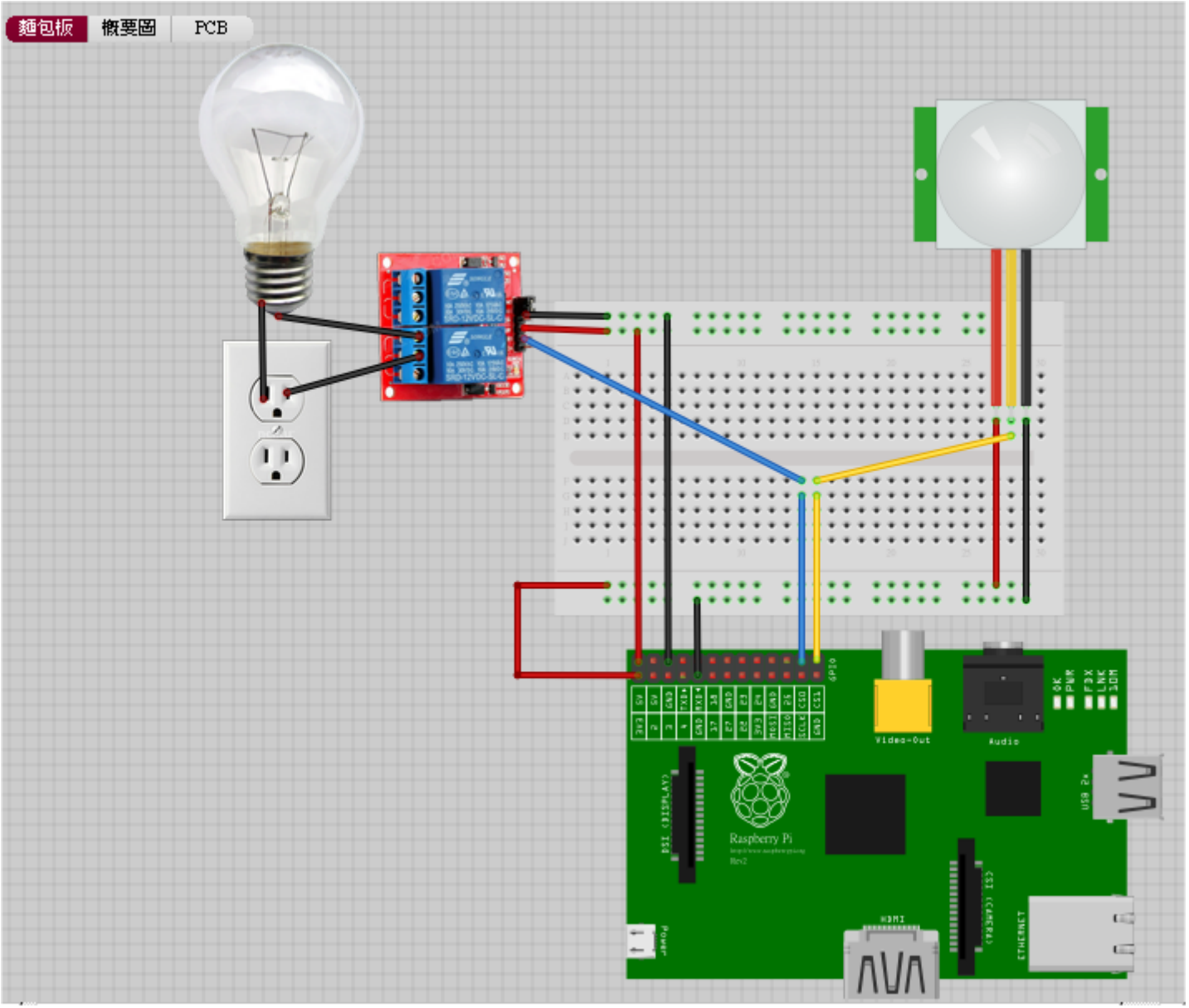
# Relay 繼電器

- 小電流控制大電流





# 線路圖


麵包板
概要圖
PCB
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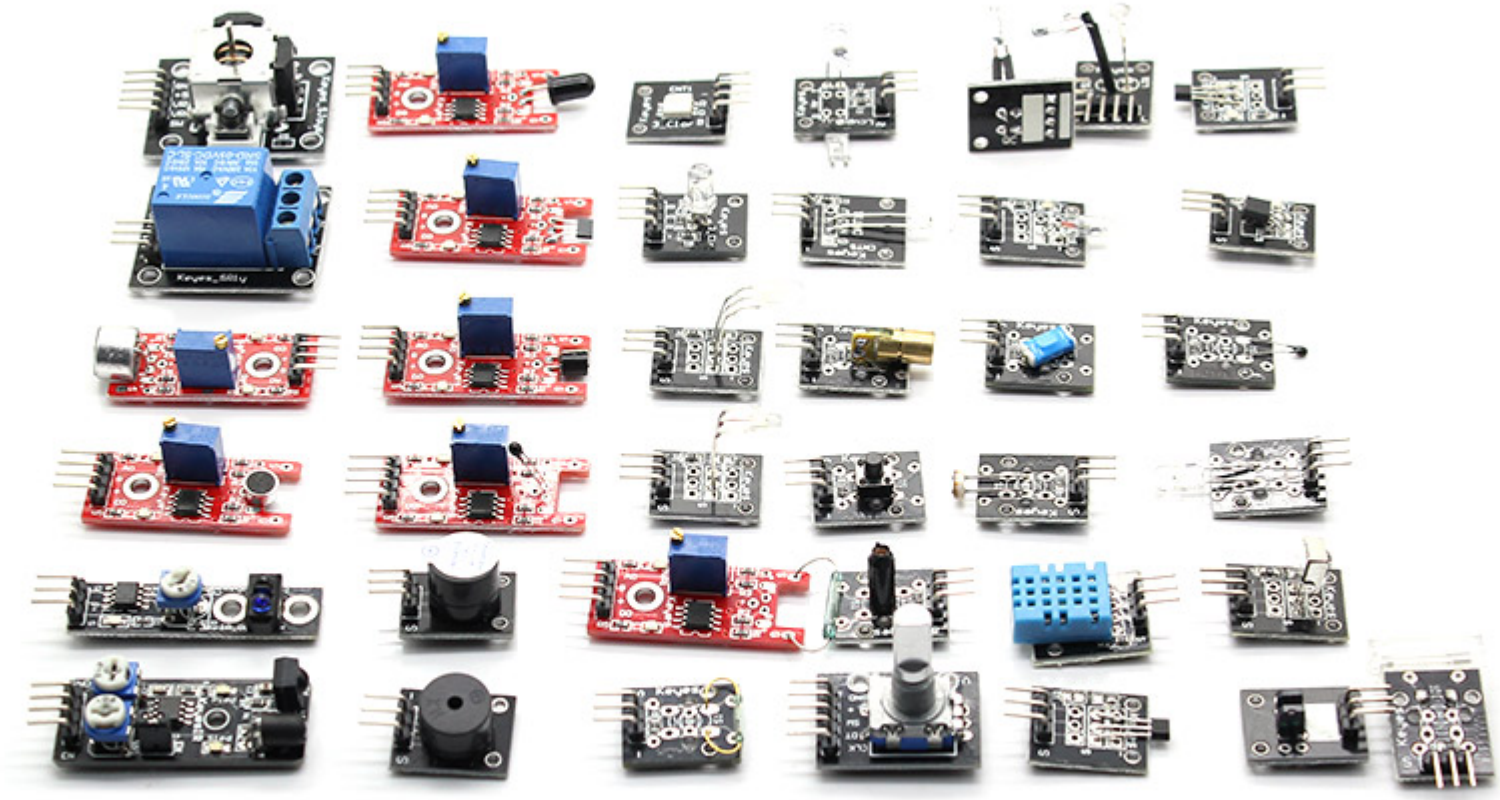
POWER

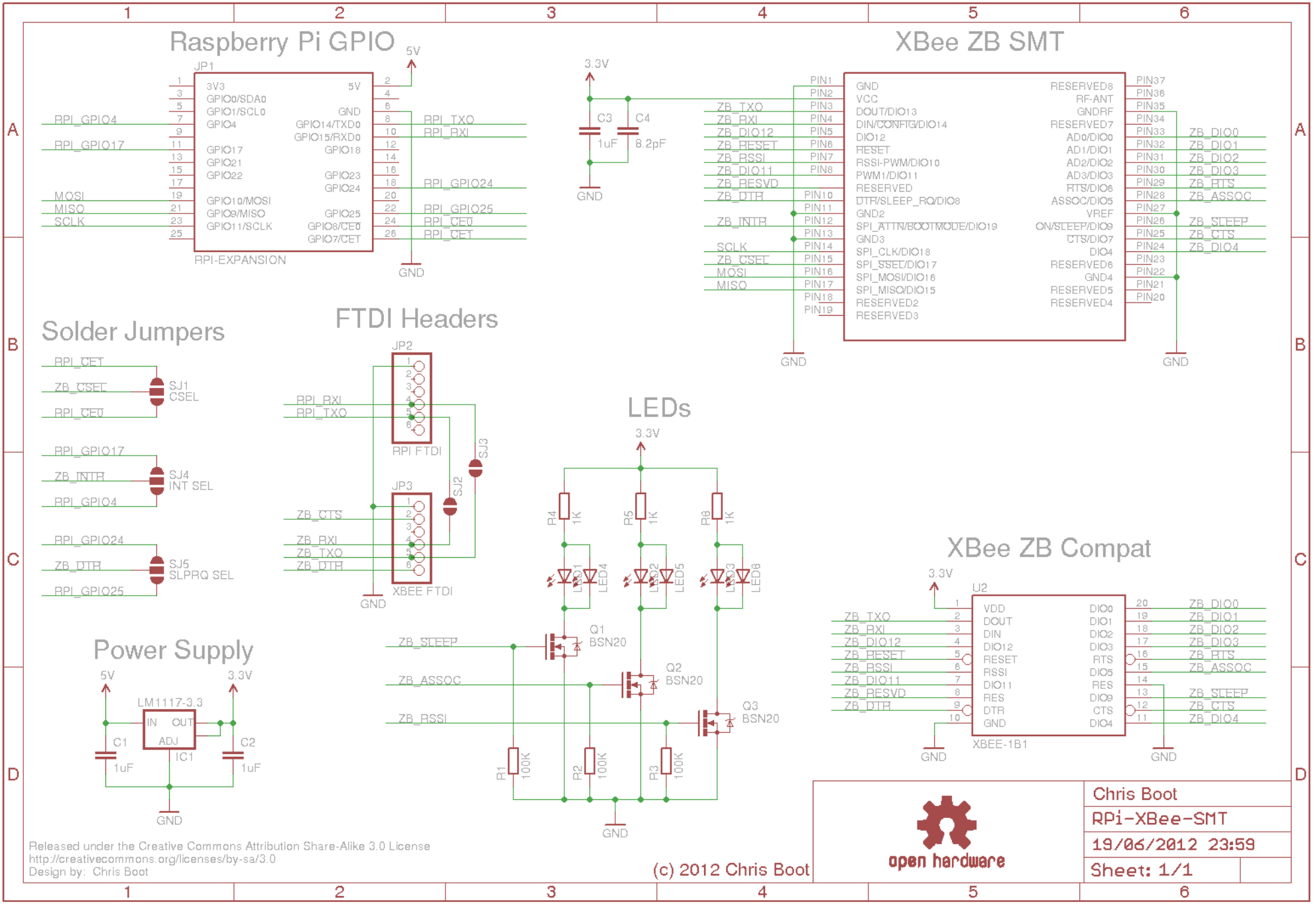
寫 1 個 = 寫 100 個？

# Sensors



http://www.fasttech.com/product/1257800-37-in-1-arduino-compatible-sensor-shields-mega

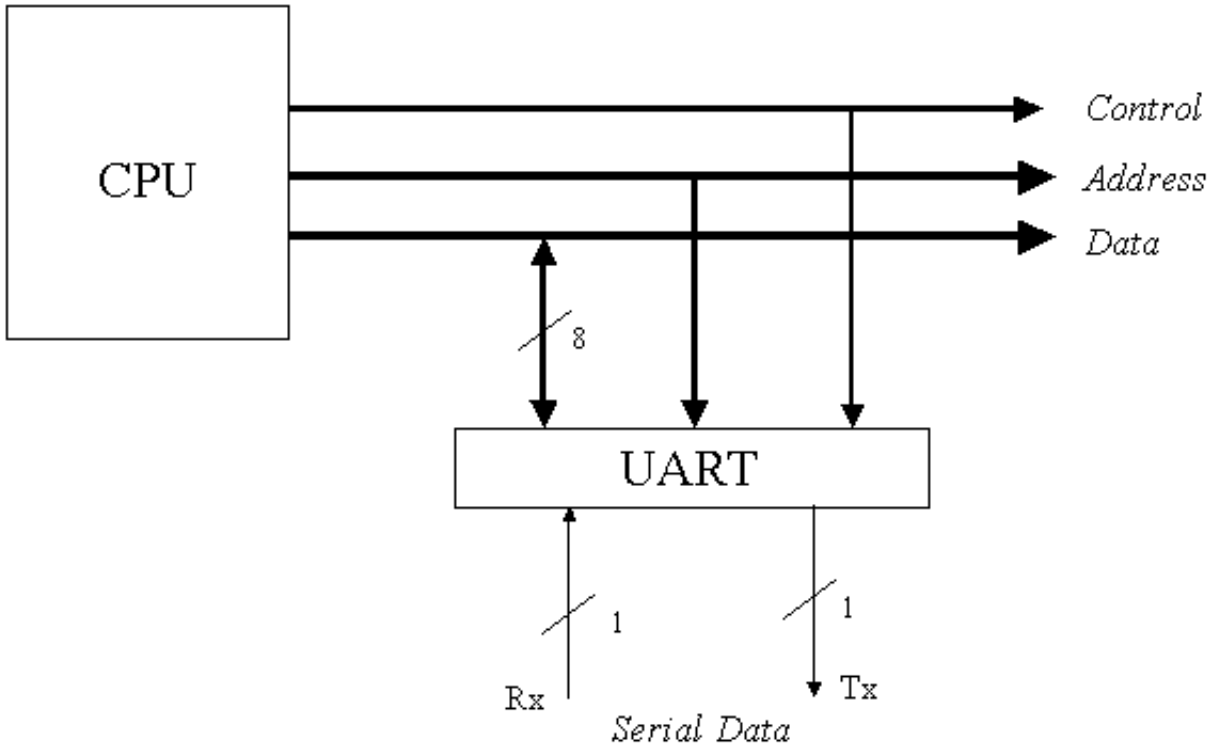
# 電子學入門




http://www.bootc.net/archives/2012/06/20/raspberry-pi-xbee-smt-backpack/

# UART

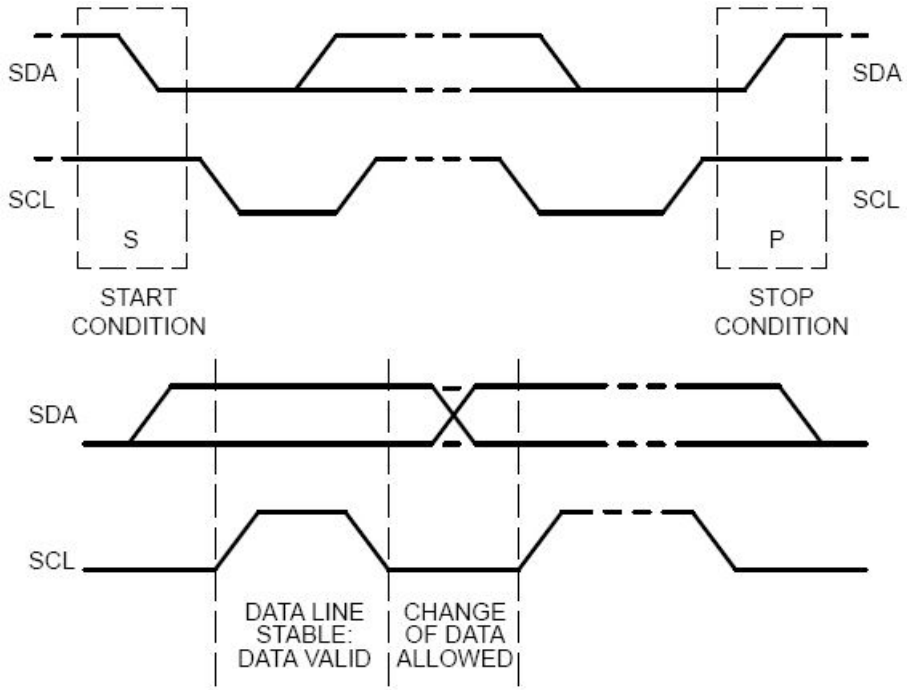
- 兩條線 ,TX(Transmits) + RX(Receive)

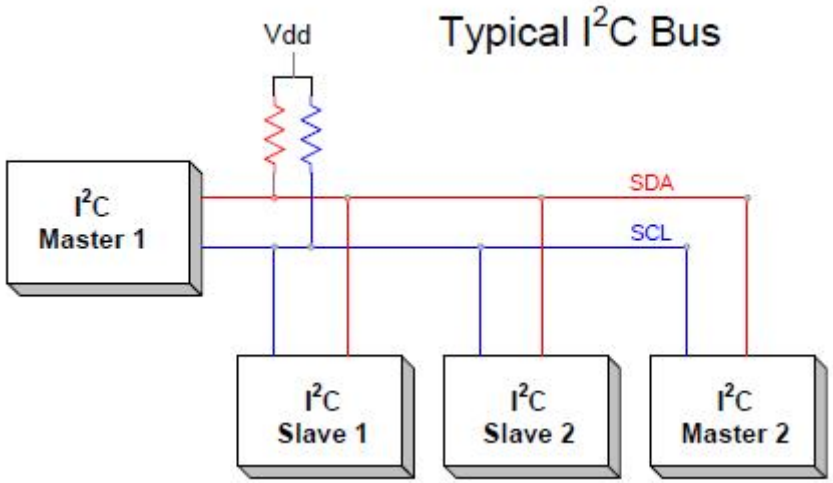



http://babbage.cs.qc.edu/courses/cs343/UART/

# I²C

- 兩條線 , SDA(Data) + SCL(Clock)
- Master/Slave



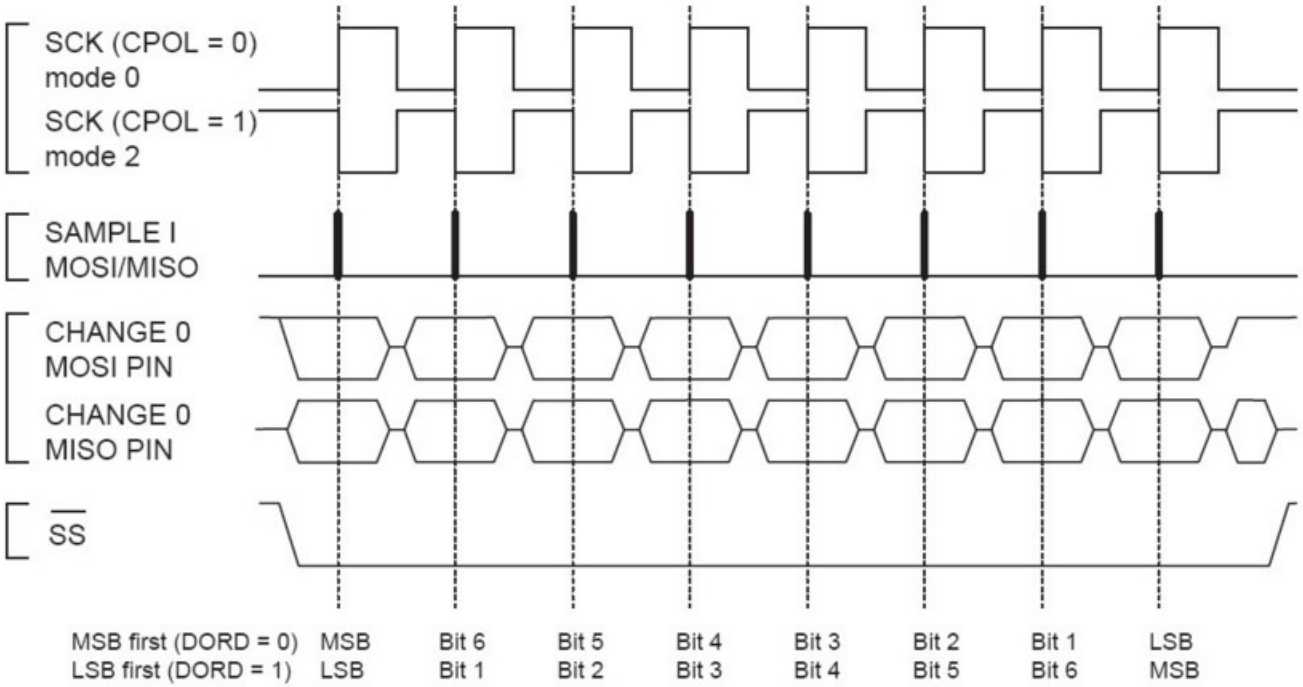



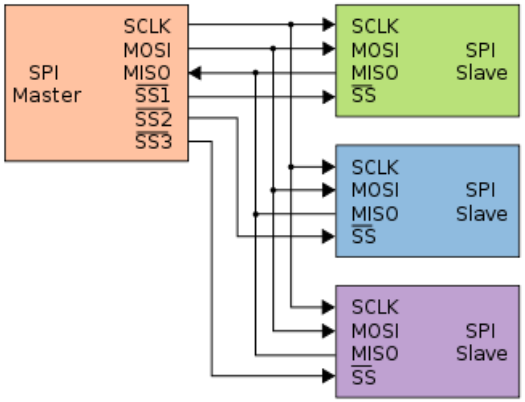

http://www.byteparadigm.com/applications/introduction-to-i2c-and-spi-protocols/

# SPI

- 四條線 , MISO, MOSI, SCLK, CS
- Master/Slave

**Figure 62.** SPI Transfer Format with CPHA = 0

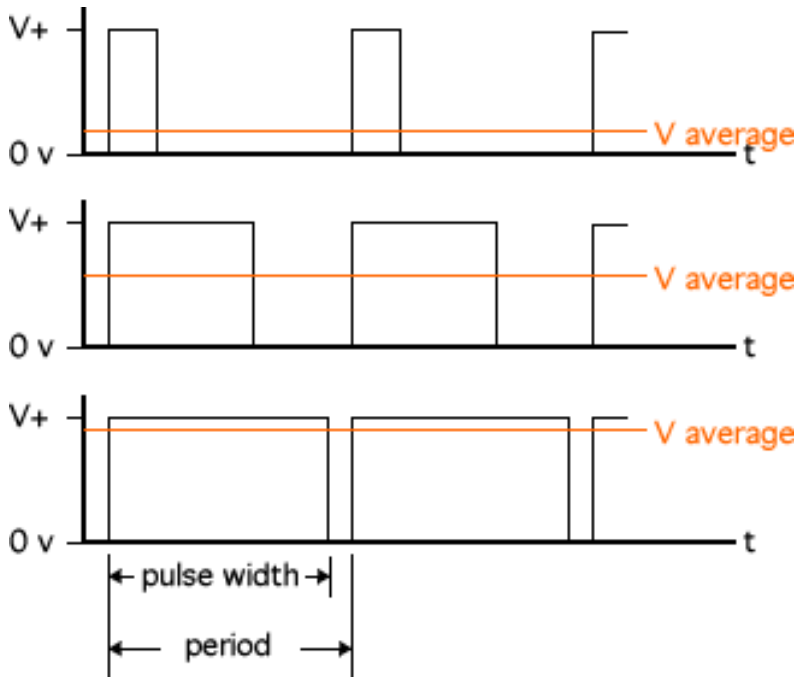


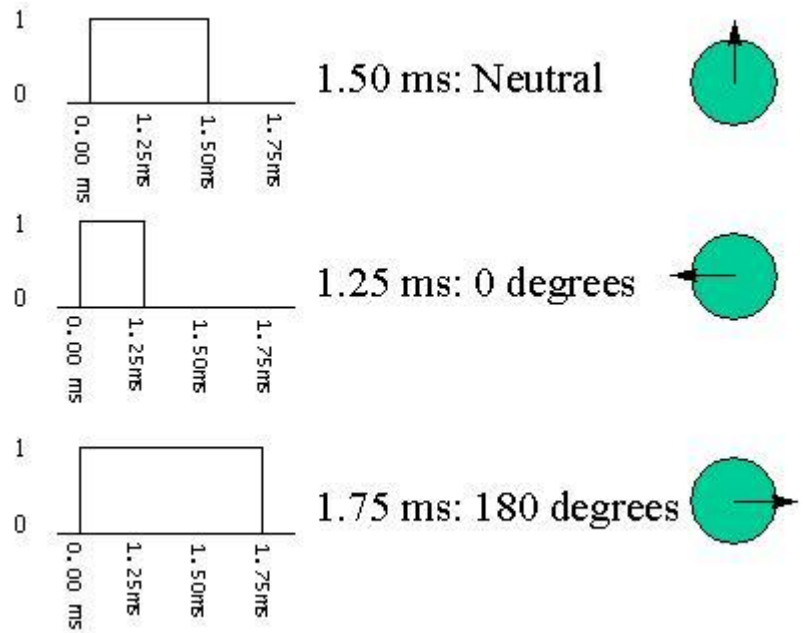




http://avrhelp.mcselec.com/index.html?using_the_spi_protocol.htm

# PWM

- 用數位訊號模擬類比訊號




http://www.seattlerobotics.org/guide/servos.html
http://www.societyofrobots.com/schematics_h-bridgedes.shtml

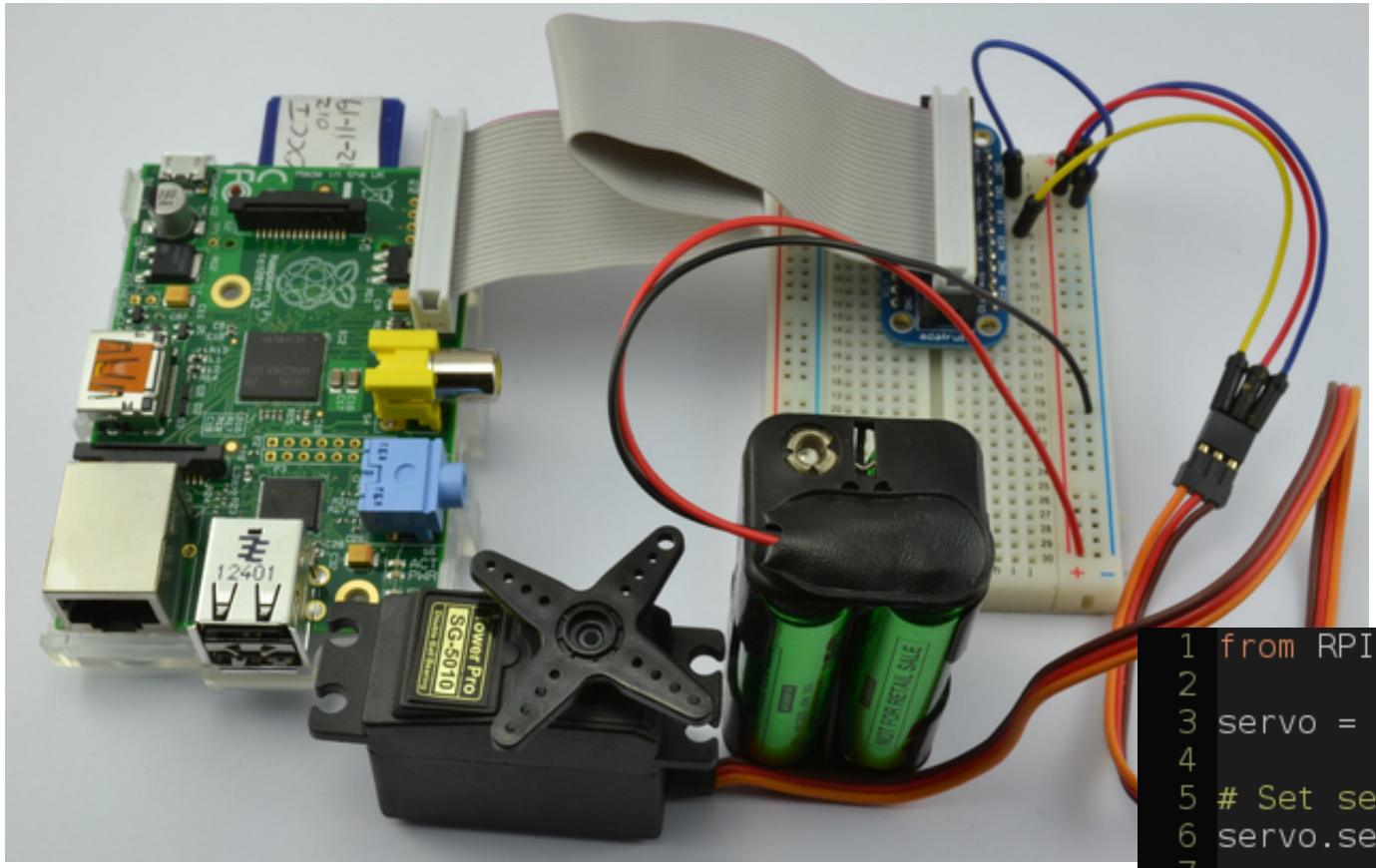
先別管這麼多了

你有聽過套件嗎？

# Python Packages

- RPi.GPIO
  - $ sudo apt-get install python-rpi.gpio
  - $ curl RPi.GPIO.tar.gz| tar zxvf && sudo python setup.py install
- UART
  - $ sudo apt-get install python-pip && sudo pip install pySerial
- PWM
  - $ git clone https://github.com/metachris/RPIO.git
- I2C
  - $ git clone https://bitbucket.org/thinkbowl/i2clibraries.git
- SPI
  - $ git clone https://github.com/lthiery/SPI-Py
  - $ sudo apt-get install python-smbus

# PWM + Servo Motor




```python
from RPIO import PWM

servo = PWM.Servo()

# Set servo on GPIO17 to 1200µs (1.2ms)
servo.set_servo(17, 1200)

# Set servo on GPIO17 to 2000µs (2.0ms)
servo.set_servo(17, 2000)

# Clear servo on GPIO17
servo.stop_servo(17)
```

http://pythonhosted.org/RPIO/pwm_py.html
http://learn.adafruit.com/adafruits-raspberry-pi-lesson-8-using-a-servo-motor/overview

I/O 不夠嗎？

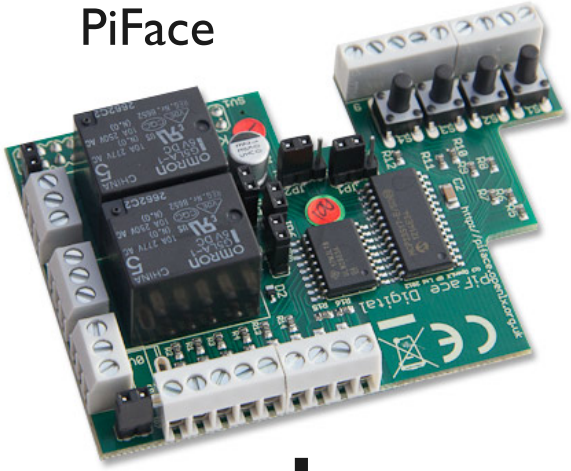
那就擴充吧 !!

- PiFace Digital
- Gertboard
- Arduino + Raspberry Pi
- AlaMode
- Arduino shields

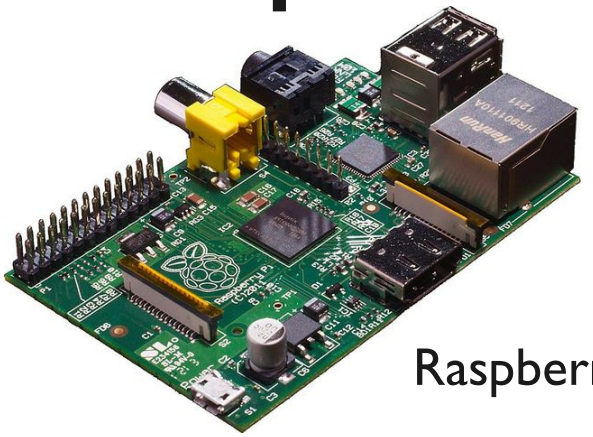
# PiFace Digital

## Official I/O Expansion Board

PiFace



+



Raspberry Pi

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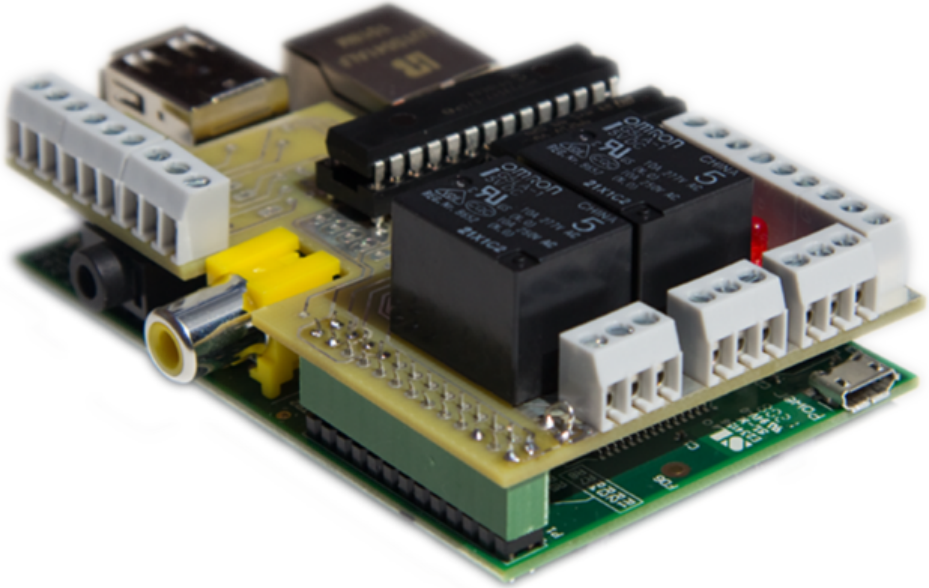
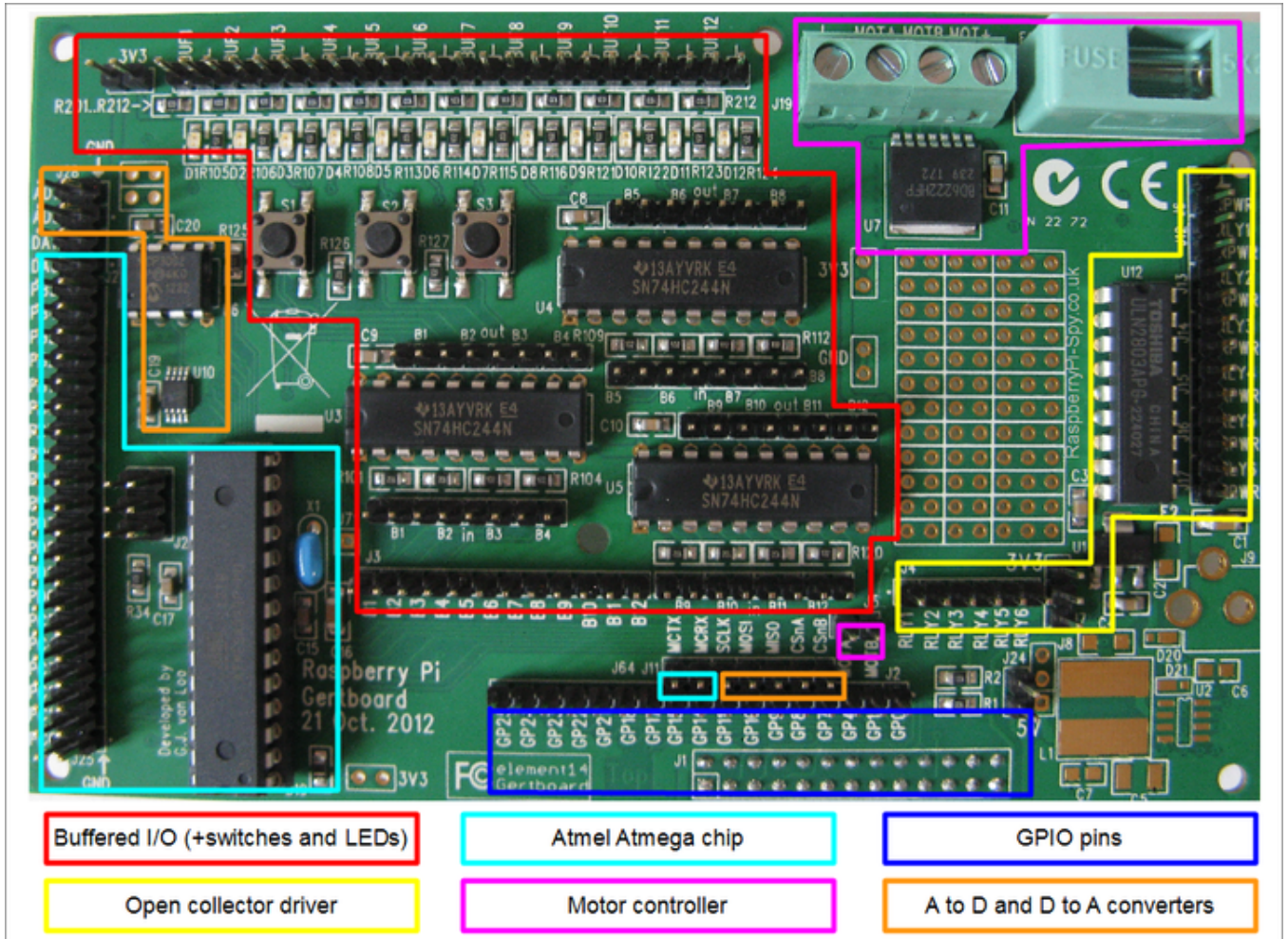


PiFace +
Raspberry Pi

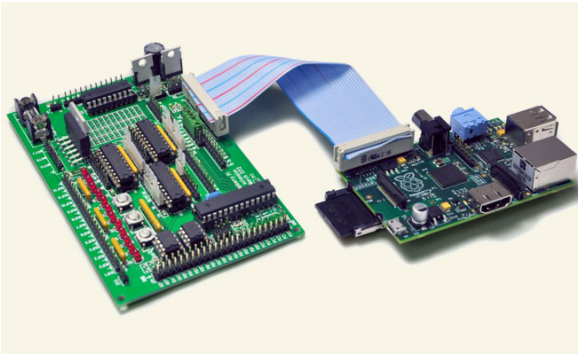
http://uk.farnell.com/piface/piface-digital/board-i-o-expansion-raspberry-pi/dp/2218566

# Gertboard

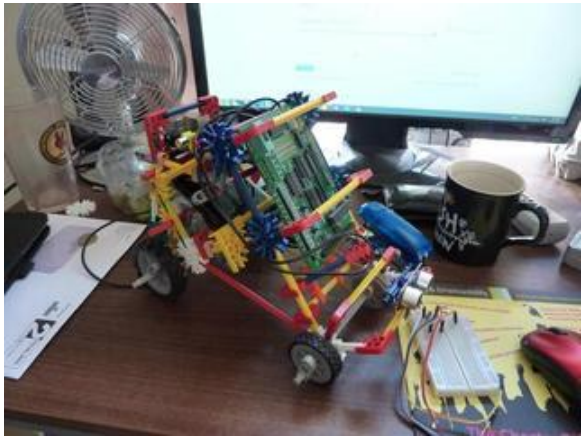
## Official Add-on GPIO Expansion Board




Gertboard Layout – Based on the User Manual by Gert van Loo and Myra VanInwegen



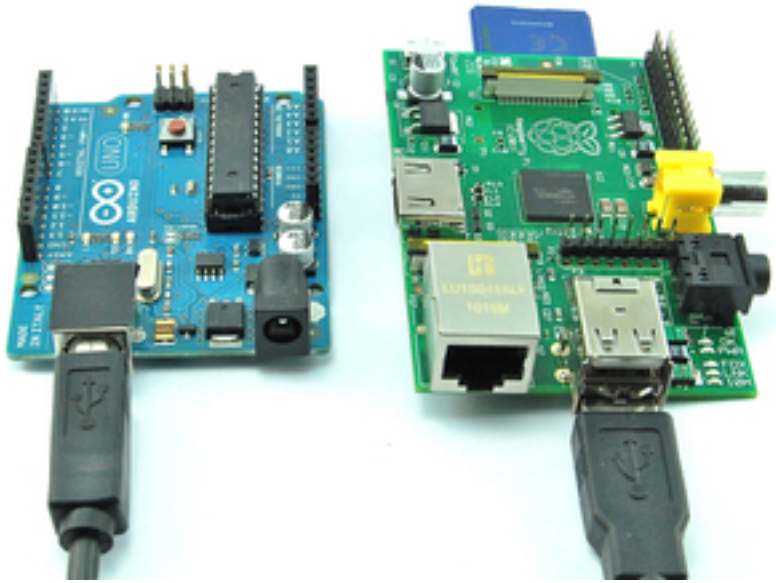
Gertboard + Raspberry Pi

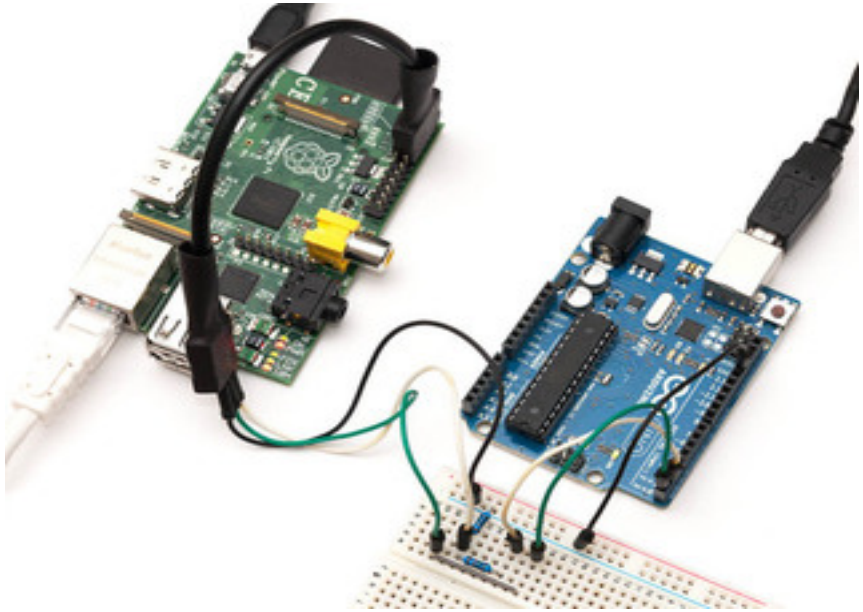


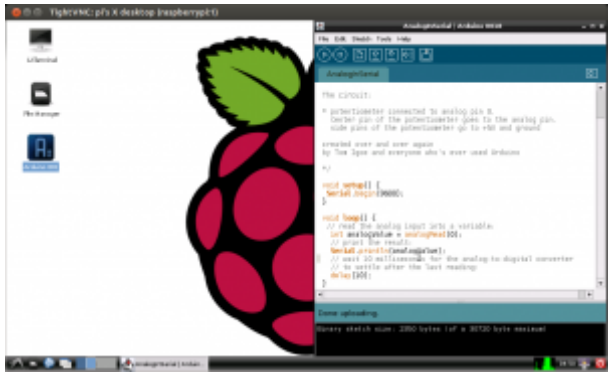
Gertboard AI Car

http://uk.farnell.com/jsp/search/productdetail.jsp?sku=2250034

# Arduino + Raspberry Pi



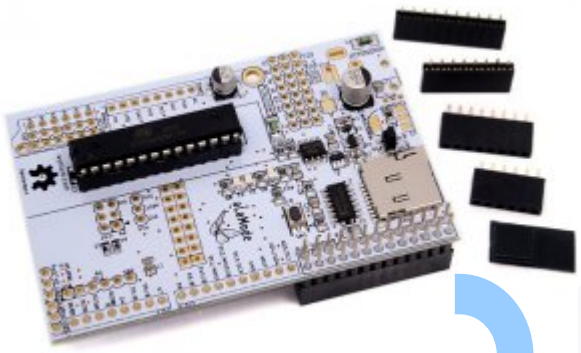




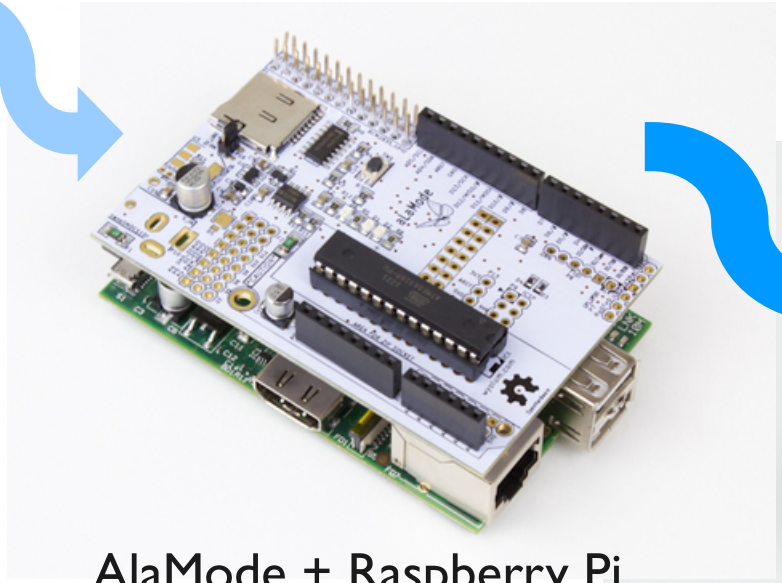
http://codeandlife.com/2012/07/29/arduino-and-raspberry-pi-serial-communication/

# AlaMode

## Arduino-Compatible Shield for Raspberry Pi

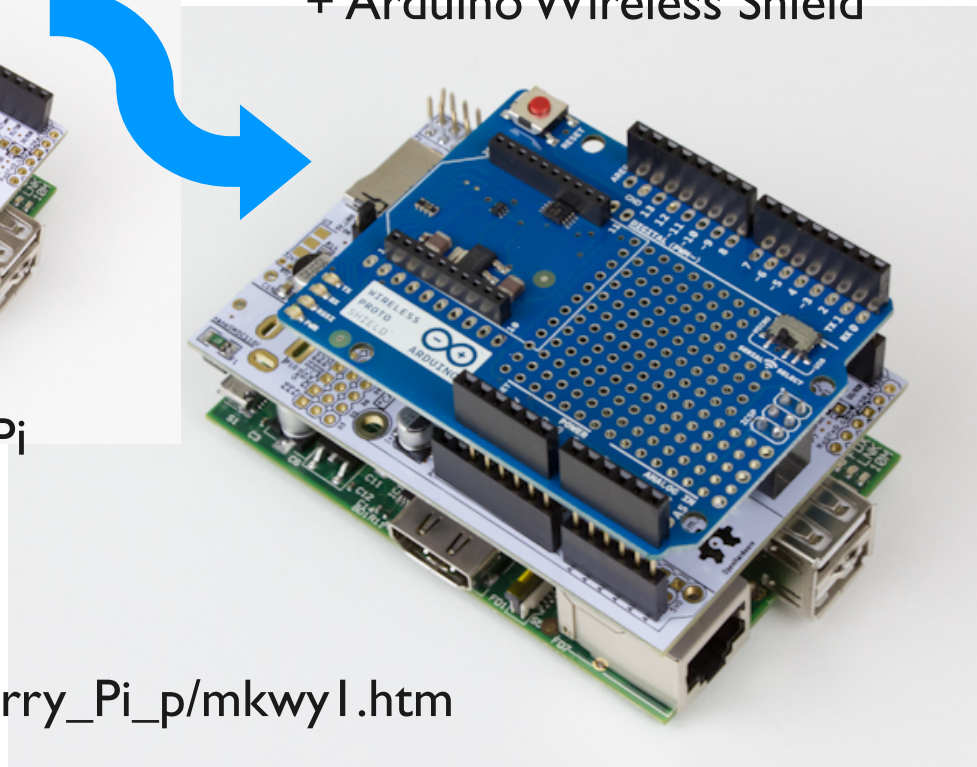


AlaMode



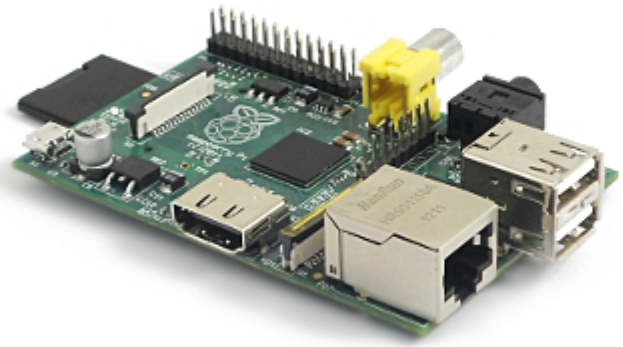
AlaMode + Raspberry Pi

AlaMode + Raspberry Pi
+ Arduino Wireless Shield

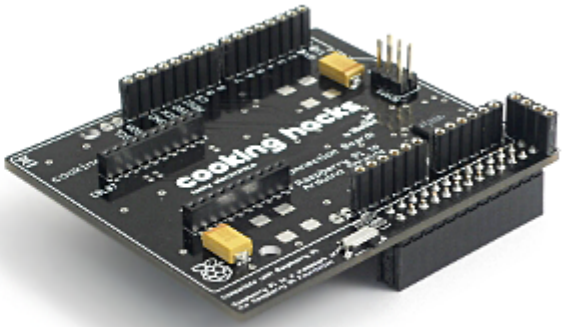


http://www.makershed.com/AlaMode_for_Raspberry_Pi_p/mkwy1.htm

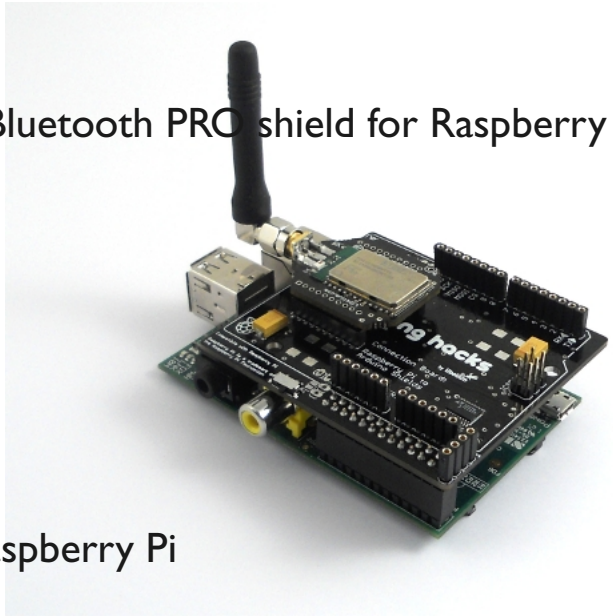
# Arduino Shields



Raspberry Pi

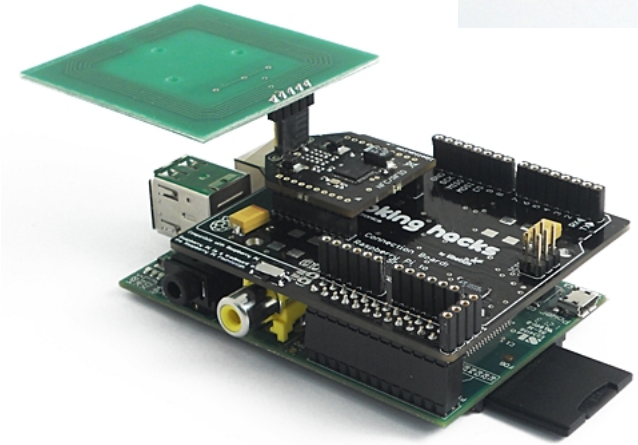


Raspberry Pi to Arduino shield



Bluetooth PRO shield for Raspberry Pi

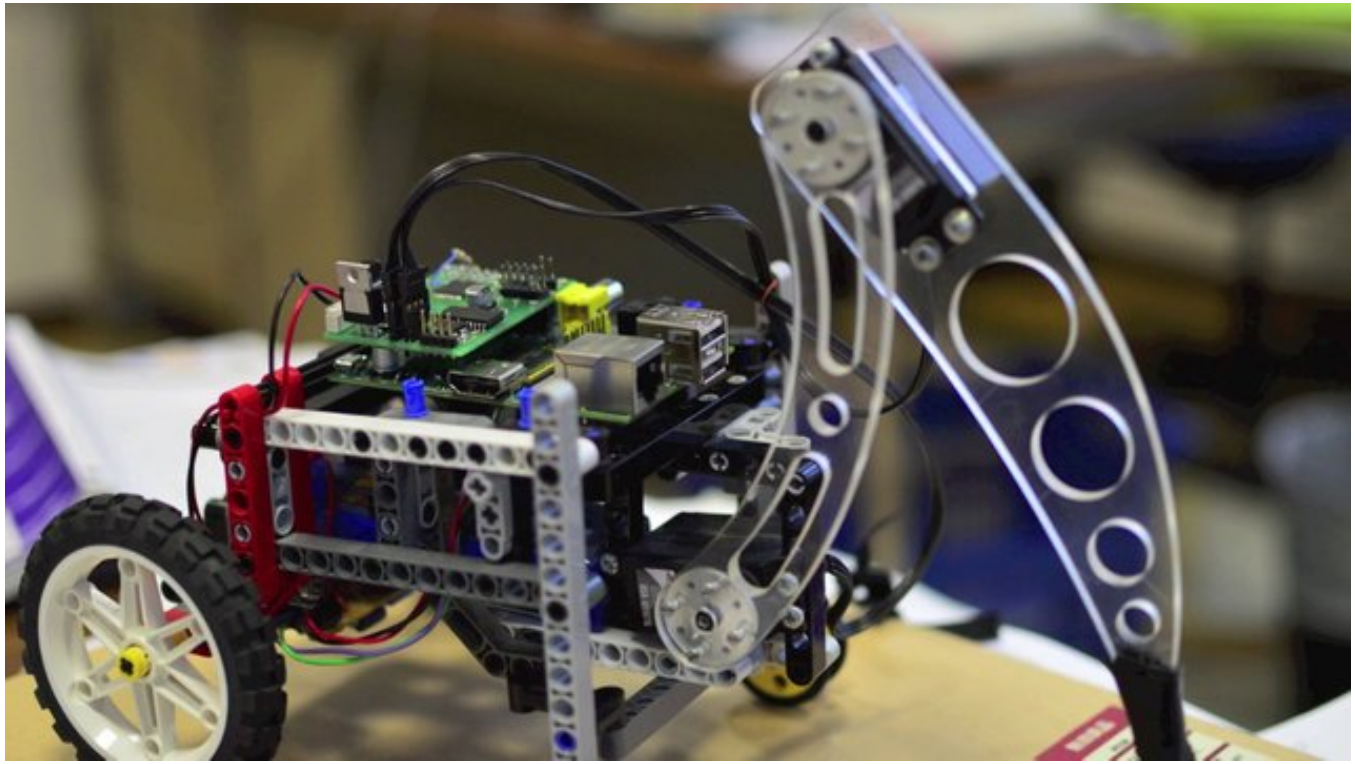
GPRS/GSM Shield for Raspberry Pi

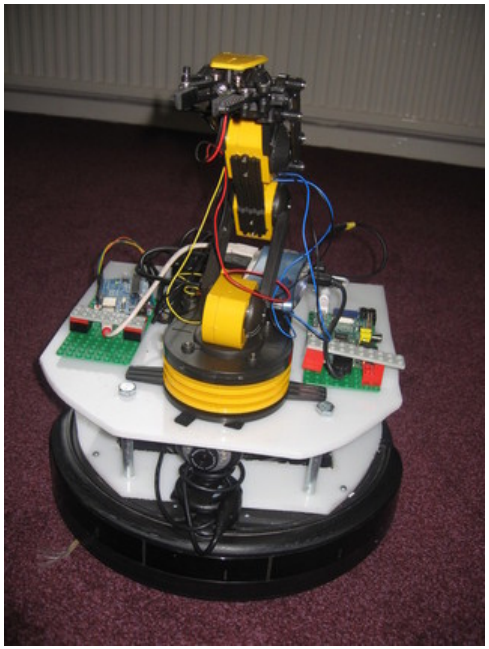


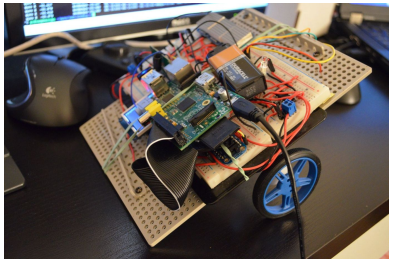
RFID Shield for Raspberry Pi

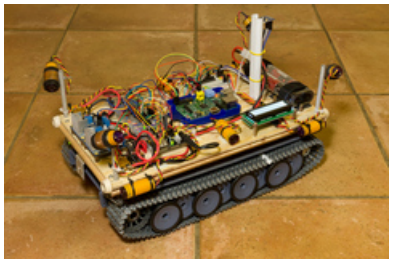
http://www.cooking-hacks.com/index.php/documentation/tutorials/raspberry-pi-to-arduino-shields-connection-bridge

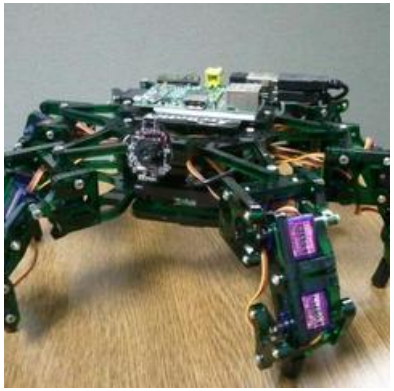
# 自走車　機器人

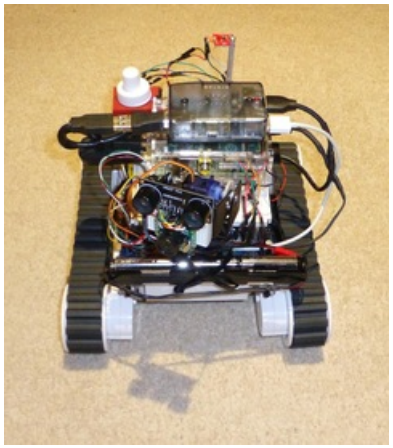






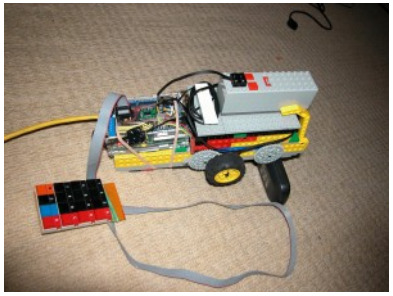




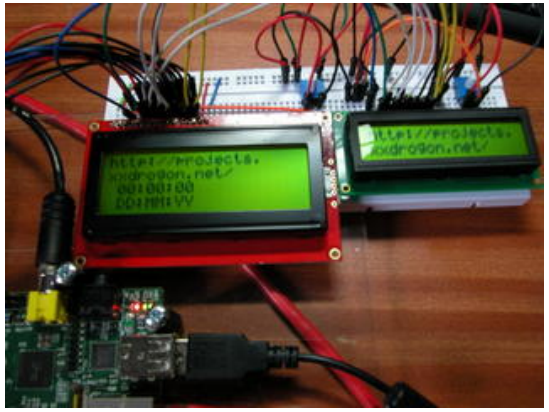


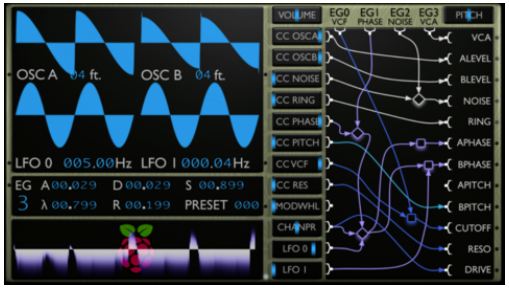
http://vimeo.com/54017137

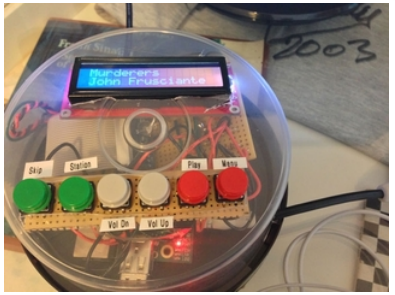
# And More...



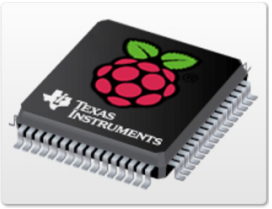
www.DavidHunt.ie

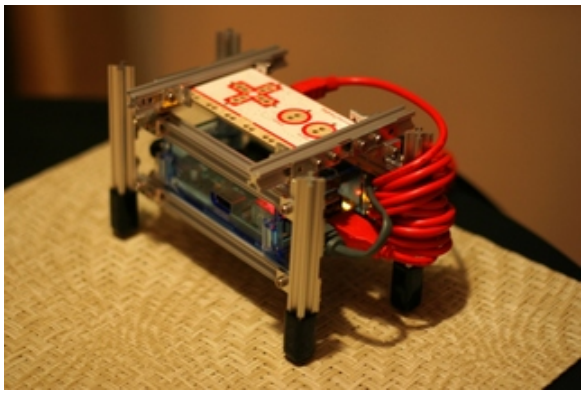



OSC A 04 ft.
OSC B 04 ft.
LFO 0 005.00Hz LFO 1 000.04Hz
EG A00.029 D00.029 S 00.899
λ 00.799 R 00.199 PRESET 000
VOLUME
EG0 VCF
EG1 PHASE
EG2 NOISE
EG3 VCA
PITCH
CC OSCA
CC OSCB
CC NOISE
CC RING
CC PHASE
CC PITCH
CC VCF
CC RES
MODWHL
CHANPR
LFO 0
LFO 1
VCA
ALEVEL
BLEVEL
NOISE
RING
APHASE
BPHASE
APITCH
BPITCH
CUTOFF
RESO
DRIVE


Murderers
John Frusciante
2003
Skip
Station
Play
Menu
Vol Dn
Vol Up

HACK
THINGS

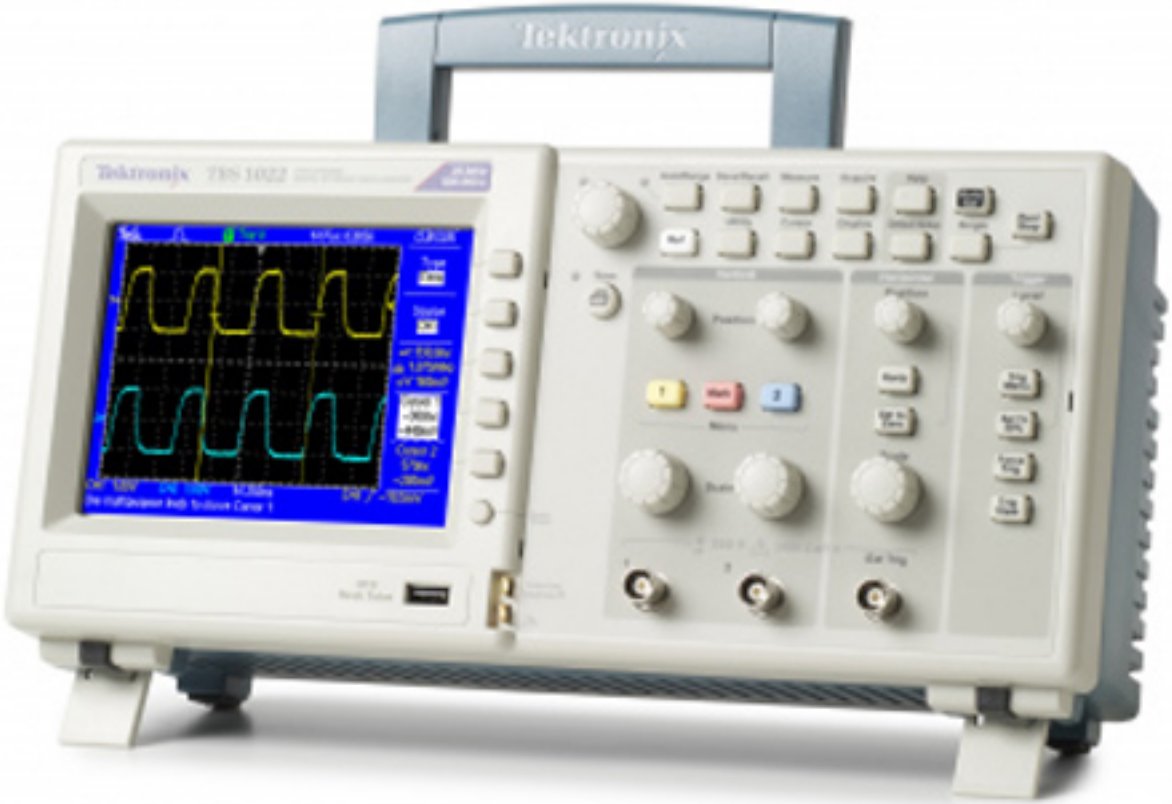

Texas Instruments



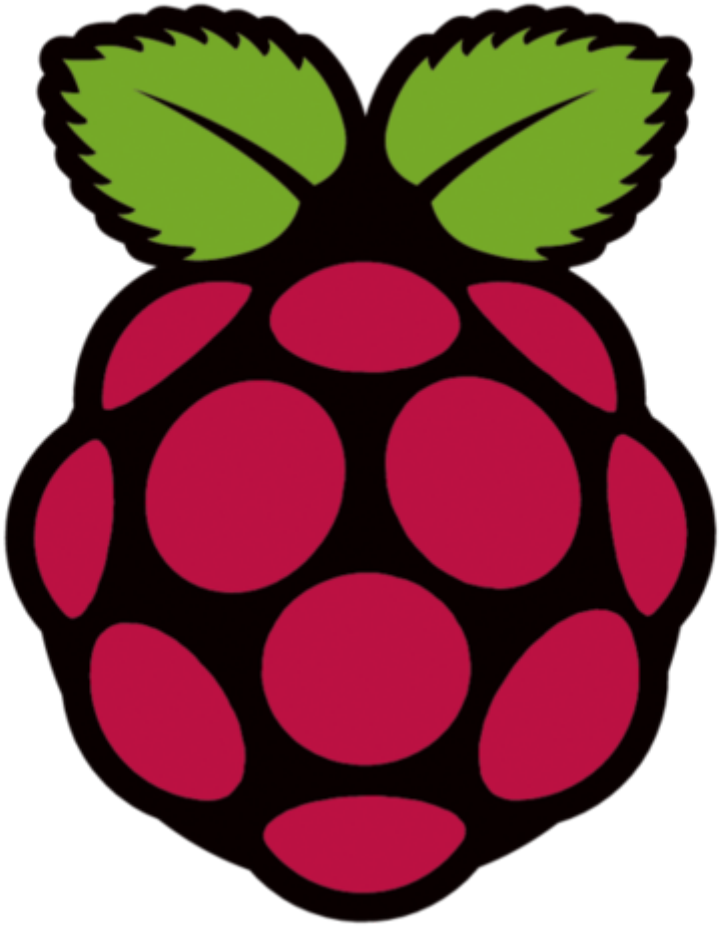
# 最後 ...

# GPIO Debugging

0.000
RPM
COM
VAT-885


Tektronix
Tektronix

# Raspberry Pi Rocks the World



Thanks