中小學
Primary &
Secondary Schools

# 校園發明大賽

# INVENTION FOR SCHOOLS CONTEST

## Intermediate Raspberry Pi
## 樹莓派進階

Dr. YIP Chi Lap [Beta], Faculty of Engineering, HKU
香港大學工程學院 葉志立博士

# Topics to cover...
# 內容...

- Raspberry Pi: the software side　樹莓派：軟件篇
  - Raspbian and Linux
  - Raspberry Pi system maintenance　樹莓派系統維護
  - Communicating with Raspberry Pi by sound
    利用聲音和你的樹莓派溝通
  - USB web cam support　USB 網絡攝影機支援

# Topics to cover...
# 內容...

- Know some more about electronic components
  認識多些電子零件
  - Switches 開關
  - Relays 繼電器
  - Some technical info about Raspberry Pi GPIO
    樹莓派 GPIO 的一些技術資料
  - Power MOSFET
  - USB as power source　USB 用作電源
  - PIR (Passive Infra-Red) sensor module 被動紅外線傳感器

# Raspberry Pi: the software side
# 樹莓派：軟件篇

It's a full Linux system!

是個完整的 Linux 系統啊！

# Raspbian and Linux

- Raspbian is a Linux variant, and so can run most commands an Linux installation can.
  Raspbian 是一種 Linux 作業系統，故可以運行大部分 Linux 指令。

- Linux usage guide can be found at:
  Linux 使用指南可以在這裡找到：
  https://www.raspberrypi.org/documentation/linux/

# Read the fine manual!
# 要讀精美的指令手冊啊！

- Manual pages can be viewed using the `man` command:
  `man` 指令可以用來查看各指令的手冊頁：
  `man` *command*

- For example 例：
  ```
  man man
  man ls
  man shutdown
  ```

# Some common commands
# 一些常用的指令

- Reboot the system 重新啟動系統：
  `sudo shutdown -r now`

- List the contents of a directory 列出目錄的內容：
  `ls`
  `ls -la`

- Change the working directory (a `bash` command); directories in a path are separated by slashes:
  改變工作目錄（這是 `bash` 指令）；路徑內子目錄用斜線分開：
  `cd` *directory*
  `cd /home/pi`

# Some common commands
# 一些常用的指令

- Listing USB devices 查看有甚麼 USB 設備：
  `lsusb`

- Text editors 文字編輯器：
  `nano`
  `vi`
  `emacs`

- Run a command with superuser privilege:
  以超級用戶權限運行指令：
  `sudo` *command*

# Some common commands
# 一些常用的指令

- Install software 安裝軟件：
  `sudo apt-get install` *package-name*

- Example 例：
  ```
  sudo apt-get install emacs
  sudo apt-get install imagemagick
  ```

- List of software packages 可裝軟件列表：
  ```
  apt-cache pkgnames
  apt-cache show package-name
  ```

# Raspberry Pi system maintenance
# 樹莓派系統維護

- Raspberry Pi, running Raspbian or any other operating system, needs to be maintained regularly like any other computer.
  行 Raspbian 或其他作業系統的樹莓派如其他的電腦一樣，需要定期維護。

- Maintenance involves update of software and drivers and would make the system run more smoothly and securely.
  維護包括更新軟件和驅動器，使電腦更暢順和安全。

- You are suggested to at least update the system immediately after installing your operating system.
  我們建議安裝系統後，至少進行一次更新。

# Raspberry Pi system maintenance
# 樹莓派系統維護

- The software **`rpi-update`** provides a easy way to update the firmware of your Raspberry Pi.
  樹莓派的韌體可用 **`rpi-update`** 軟件更新。
  https://github.com/Hexxeh/rpi-update

- Run it using the command 執行軟件的指令：
  ```
  sudo rpi-update
  ```

- If it cannot be run, install it using the following command and try again.
  如不能執行軟件，請用以下指令安裝該軟件再試：
  ```
  sudo apt-get install rpi-update
  ```

# Raspberry Pi system maintenance
# 樹莓派系統維護

- Installed packages can be updated using the following commands: 用以下指令更新安裝了的軟件：

```
sudo apt-get update
sudo apt-get upgrade
```

- `update` updates list of available software  packages, `upgrade` upgrades installed software packages.
`update` 更新可裝軟件表, `upgrade` 更新已裝軟件。

# Communicating with Raspberry Pi by sound
# 利用聲音和你的樹莓派溝通

- You can use USB microphone or web camera with audio support for input.
  你可用 USB 麥克風或支援聲音輸入的網絡攝影機輸入聲音。

- Install the system packages for audio support:
  安裝以下軟件以用支援聲音資訊：
  ```
  sudo apt-get install alsa-utils
  sudo apt-get install lame
  ```

- Commands `aplay` and `arecord` can be used for playing and recording sound, and `lame` for creating MP3 audio files.
  可用 `aplay` 和 `arecord` 指令來播音或錄音，用 `lame` 製造 MP3 檔案。

# Use Python program to process audio data
# 用 Python 程式處理聲音資訊

- Install the system packages for audio support:
  安裝以下軟件以用支援聲音資訊：
  ```
  sudo apt-get install libasound2-dev
  sudo apt-get install python-dev
  sudo apt-get install python3-dev
  ```

- Python 2 and 3 packages are managed by the `pip` and `pip3` commands respectively.
  Python 2 及 Python 3 的軟件包分別用 `pip` and `pip3` 指令管理。

- Install the alsaaudio Python package for processing audio:
  安裝 Python 軟件包以編程處理聲音資訊：
  http://larsimmisch.github.io/pyalsaaudio/
  ```
  sudo pip install pyalsaaudio
  ```

# USB web cam support
# USB 網絡攝影機支援

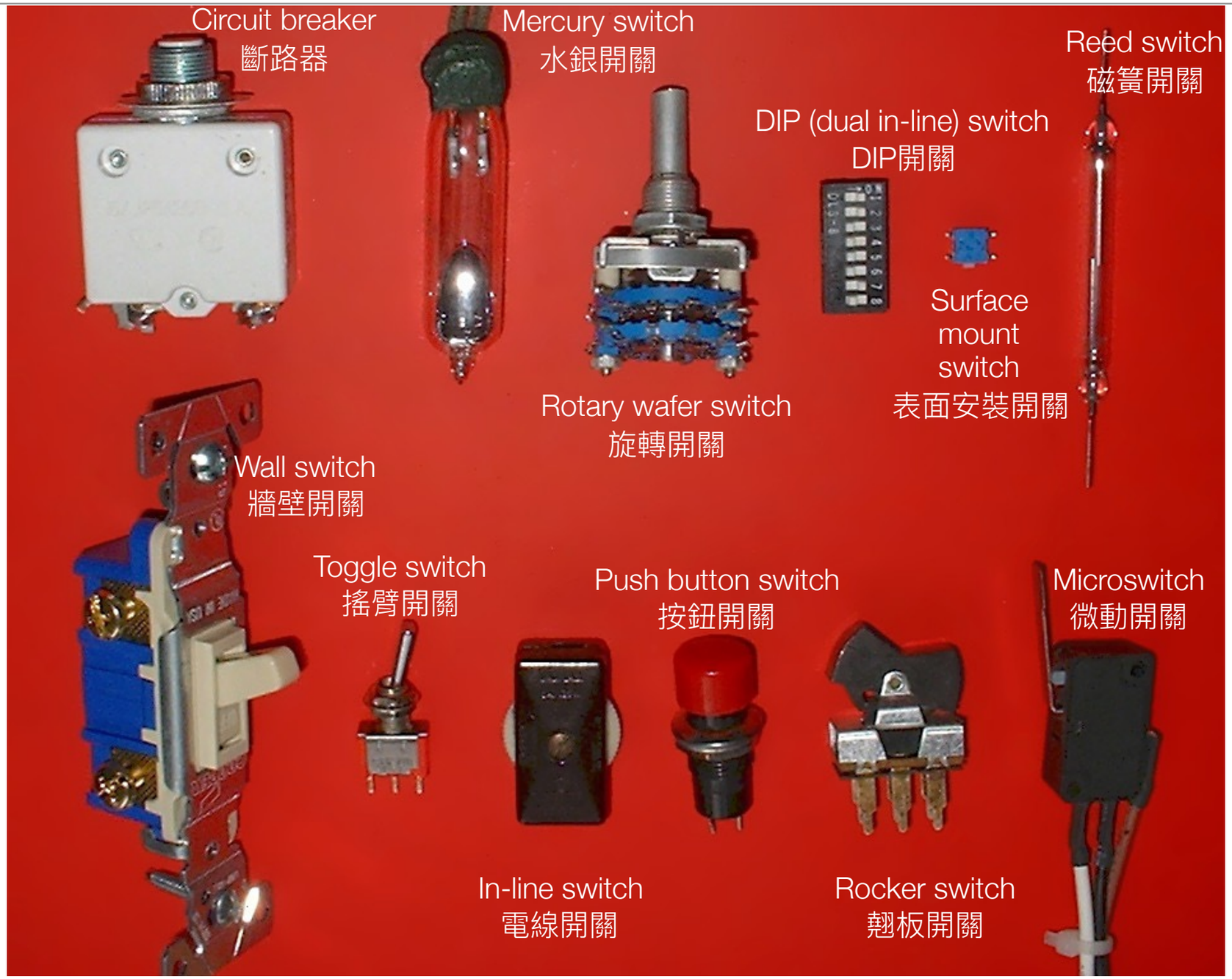
- Standard USB web cams can be used for video input.
  視像資訊可用標準的 USB 網絡攝影機輸入。
  https://www.raspberrypi.org/documentation/usage/webcams/

- Install a package for video support 安裝軟件包：
  ```
  sudo apt-get install fswebcam
  ```

- Capture a frame of video 從網絡攝影機頡取一幅相片：
  ```
  fswebcam capture.jpg
  ```

# Know some more about electronic components
# 認識多些電子零件

# Switches 開關



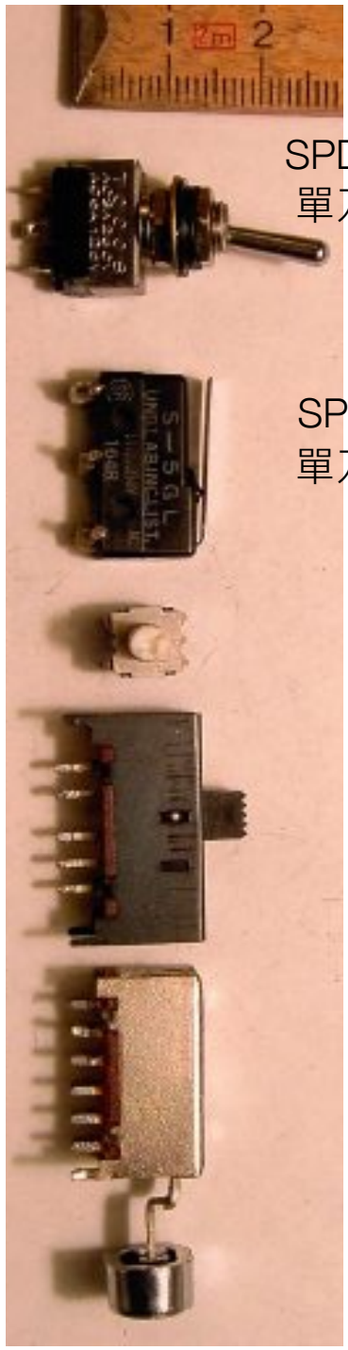




Image sources:

- Electrical switches. By ArnoldReinhold. CC-BY-SA-3.0, GFDL. https://commons.wikimedia.org/wiki/File:Switches-electrical.agr.jpg
- Image of electrical changeover switches. By Glenn. GFDL, CC-BY-SA-3.0 https://commons.wikimedia.org/wiki/File:Changeover_switches.jpg

# Switches 開關

- Switches lets current through under some conditions.
  開關在某些情況下允許電流通過。

- How can they be used 它們如何使用?
  - Key switch 鎖匙開關
  - Push button 按鈕開關
  - Tilt switch 傾斜開關
  - Float switch 浮控開關

- Sensors giving digital output and can be seen as switches conditionally connecting to the power or ground.
  用數碼輸出傳感器可以看作是有條件地將輸出連接到電源或接地的開關。
  - Pressure switch 壓力開關
  - Passive InfraRed (PIR) sensor 被動紅外線傳感器
  - Bluetooth remote switch 藍芽遙控開關

# Poles and throws
# 刀數和擲數

- Switches are categorised by the number of poles and throws.
  開關用刀數和擲數分類。

- Poles are the number of switches, and throws are the number of choices for each switch.
  刀數即開關數目，擲數即每個開關有多少選擇。

- They are abbreviated as xPyT where x and y are numbers, or S for Single, and D for Double. 分類用 xPyT 表示，x 和 y 為數字，或以 S 代表單，D 代表雙。

- Examples, used in both relays and switches 用於繼電器和開關的例子：
  - SPST = Single Pole Single Throw 單刀單擲
  - SPDT = Single Pole Double Throw 單刀雙擲
  - DPST = Single Pole Single Throw 雙刀單擲
  - DPDT = Single Pole Double Throw 雙刀雙擲

Image source:
- Relay symbols: FDominec; https://commons.wikimedia.org/wiki/File:Relay_symbols.svg

# About switches 關於開關

- 2P6T, etc. can be used for ganged rotary switches.
  2P6T 等會用於開關旋轉開關。

- Some switches like push buttons has a normal state.
  有些開關有常態，例如按鈕開關。

- A Normally Open (NO) switch has a normal state that does not conduct electricity.
  常開 (NO) 開關常態為開路，即電流不能通過。

- A Normally Closed (NC) switch has a normal state that conducts electricity.
  常閉或常關 (NC) 開關常態為閉路，即電流可以通過。

- Relay contacts can also be designated by NO and NC.
  繼電器的接點亦能以 NO 和 NC 表示。

# Electrical switches: Relay
# 電機開關：繼電器

**TAKAMISAWA RY3W-K** Relay (2P2T, 3VDC, 18£[])

07-01-3003

**TAKAMISAWA RY5W-K** Relay (2P2T, 5VDC, 167£[])

07-01-3005

**TAKAMISAWA RY6W-K** Relay (2P2T, 6VDC, 240£[])

07-01-3006

**TAKAMISAWA RY12W-K** Relay (2P2T, 12VDC, 960£[])

**TAKAMISAWA RY24W-K** Relay (2P2T, 24VDC, 2880£[])


**TAKAMISAWA SY-3-K** Relay (1P2T, 3VDC, 15£[])

**OMRON H3Y-2** Timer Relay (24VDC, 3min)

07-20-2430

**OMRON MK2P-I** Timer Relay (2P2T, 12VDC, 7A)

07-99-0012

**OMRON MK2P-I** Timer Relay (2P2T, 24VDC, 7A)

07-99-0024

**OMRON MK2P-I** Timer Relay (2P2T, 110VAC, 7A)

**OMRON LY2J** Timer Relay (2P2T, 12VDC, 10A)

**OMRON LY2J** Timer Relay (2P2T, 24VDC, 10A)

Image source:

- http://www.weclonline.com/eng/productlist.asp?page=1&display=photo&mc_code=08&sc_code=012&s2c_code=0001&s3c_code=0010

K05 K06 K07 K08

07-01-3005 HK$
TAKAMISAWA RY-5W-K
DC5V/1A 2P2T 8 Pin Relay, 167Ω

07-01-3006 HK$
TAKAMISAWA RY-6WK
DC6V/1A 2P2T 8 Pin Relay,

07-01-3012 HK$
TAKAMISAWA RY-12WK
DC12V/1A 2P2T 8 Pin Relay,

07-01-3024 HK$
TAKAMISAWA RY-24W-K
DC24V/1A 2P2T 8 Pin Relay,

K09 K10 K11 K12

07-01-3205 HK$
TAKAMISAWA JY-5H-K
DC5V/5A 1P1T 4 Pin Relay,

07-01-3212 HK$
TAKAMISAWA JY-12H-K
DC12V/5A 1P1T 4 Pin Relay,

07-01-3224 HK$
TAKAMISAWA JY-24H-K
DC24V/5A 1P1T 4 Pin Relay,

07-01-3103 HK$
TAKAMISAWA SY-3K DC 3V/2A 1P2T 6 Pin Relay, 15Ω

K13 K14 K15 K16

07-01-3105 HK$
TAKAMISAWA SY-5-K DC 5V/2A 1P2T 6 Pin Relay, 167Ω

07-01-3109 HK$
TAKAMISAWA SY-9-K DC 9V/2A 1P2T 6 Pin Relay, 540Ω

07-01-3112 HK$
TAKAMISAWA SY-12K
DC12V/2A 1P2T 6 Pin Relay,

07-01-3124 HK$
TAKAMISAWA SY-24K
DC24V/2A 1P2T 6 Pin Relay,

K17 K18 K19 K20

07-01-4005 HK$
TAKAMISAWA A-5W-K DC 5V/2A 2P2T 10 Pin Relay, 178Ω

07-01-4012 HK$
TAKAMISAWA A-12W-K
DC12V/2A 2P2T 10Pin Relay,

07-01-3305 HK$
TAKAMISAWA NY-5W-K
DC5V/5A 1P1T 4 Pin Relay,

07-01-3312 HK$
TAKAMISAWA NY-12W-K
DC12V/5A 1P1T 4 Pin Relay,

K21 K22 K23 K24

07-01-3324 HK$
TAKAMISAWA NY-24W-K
DC24V/5A 1P1T 4 Pin

07-08-5303 HK$
MASSUSE ME-4-L1-3
DC3V 1 Coil Latch 2P2T 8

07-08-5305 HK$
MASSUSE ME-4-L1-5B
DC5V 1 Coil Latch 2P2T

07-08-5312 HK$
MASSUSE ME-4-L1-12B
DC12V 1 Coil Latch 2P2T 8

L05 L06 L07

07-08-1412 HK$
MASSUSE ME-15M-012-HTS
DC12V 12A 1P1T 4 Pin Relay, 400Ω

07-08-9017 HK$
MASSUSE ME-25-012-HS
DC12V (617Ω/ 8A 250V)

L09 L10 L11

07-08-1509 HK$
MASSUSE ME-15M-009-TS
DC9V 12A 1P2T 5 Pin Relay,

07-08-1512 HK$
MASSUSE ME-15M-012-TS
DC12V 12A 1P2T 5 Pin Relay,

L13 L14 L15

07-08-5012 HK$
MASSUSE ME-1A-12B
DC12V 2A 1P2T 5 Pin Relay, 400Ω

07-08-5024 HK$
MASSUSE ME- 1A-24B
DC24V 2A 1P2T 5 Pin Relay, 1600Ω

L17 L18 L19

07-08-6012 HK$
MASSUSE ME-3-012-1ZS
DC12V 1A 1P2T 6 Pin Relay, 720Ω

07-08-9007 HK$
MASSUSE ME-12-12
12V DC 2P2T 10 Pin Relay, 1028Ω

L21 L22 L23

07-08-1112 HK$
MASSUSE ME-11-012-1Z1
DC12V 12A 1P2T 5 Pin Relay, 360Ω

07-08-1124 HK$
MASSUSE ME-11-024-1Z1
DC24V 12A 1P2T 5 Pin Relay, 1440Ω

J11 J12

07-10-1224 HK$
Dae Yang DYR-MY-4C
4P2T 3A/DC 24V Relay

J15 J16

07-10-1022 HK$
Dae Yang DYR-LY-2CMA
2P2T 10A/ AC220V Relay

J19 J20

07-08-3024 HK$
MASSUSE ME-13F-012-2Z2
DC12V 2P2T 8 Pin Relay

J23 J24

07-08-9003 HK$
MASSUSE ME-28A-012-1
DC12V 1P1T 4 Pin Relay,

# Relays 繼電器

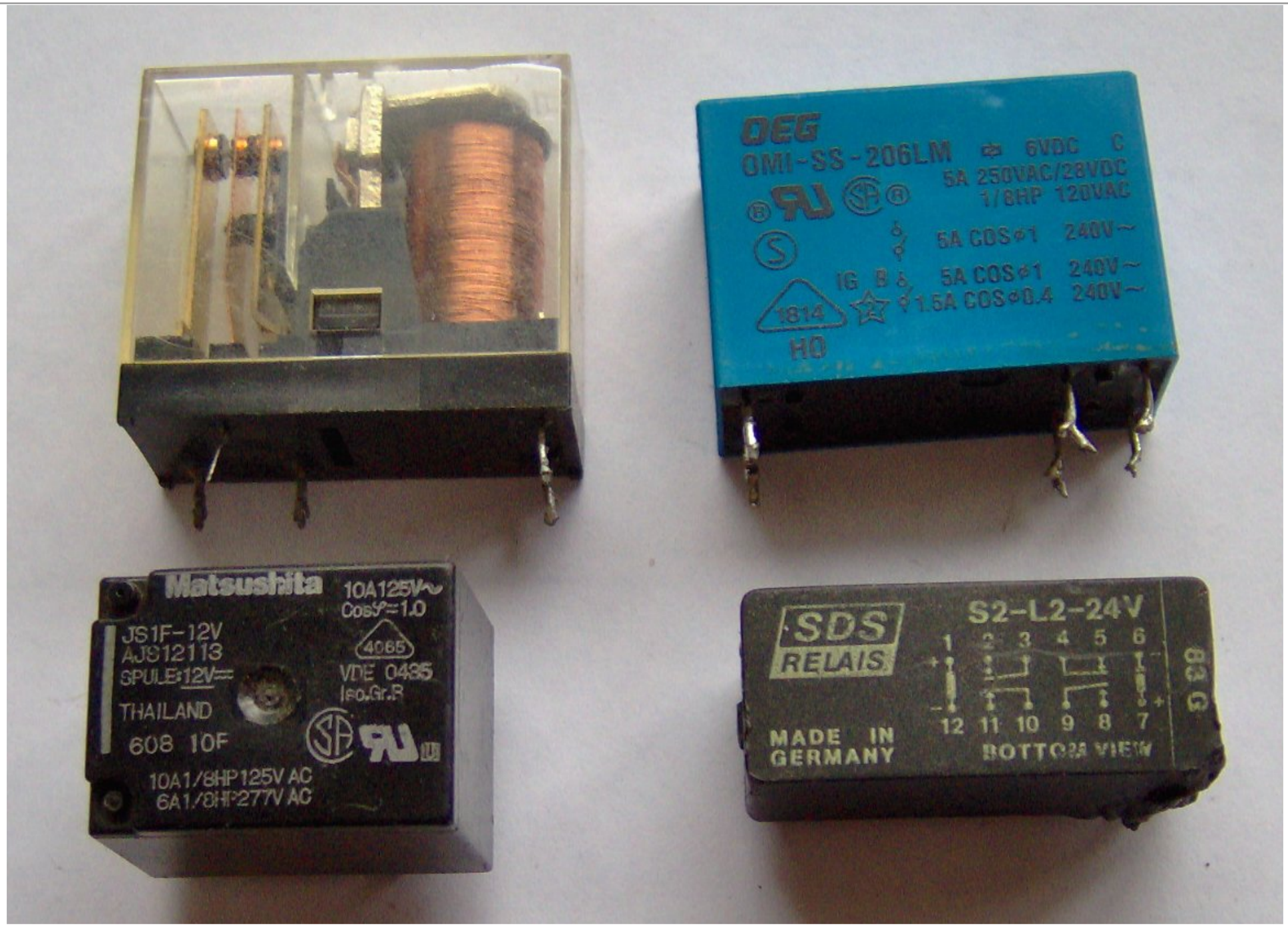


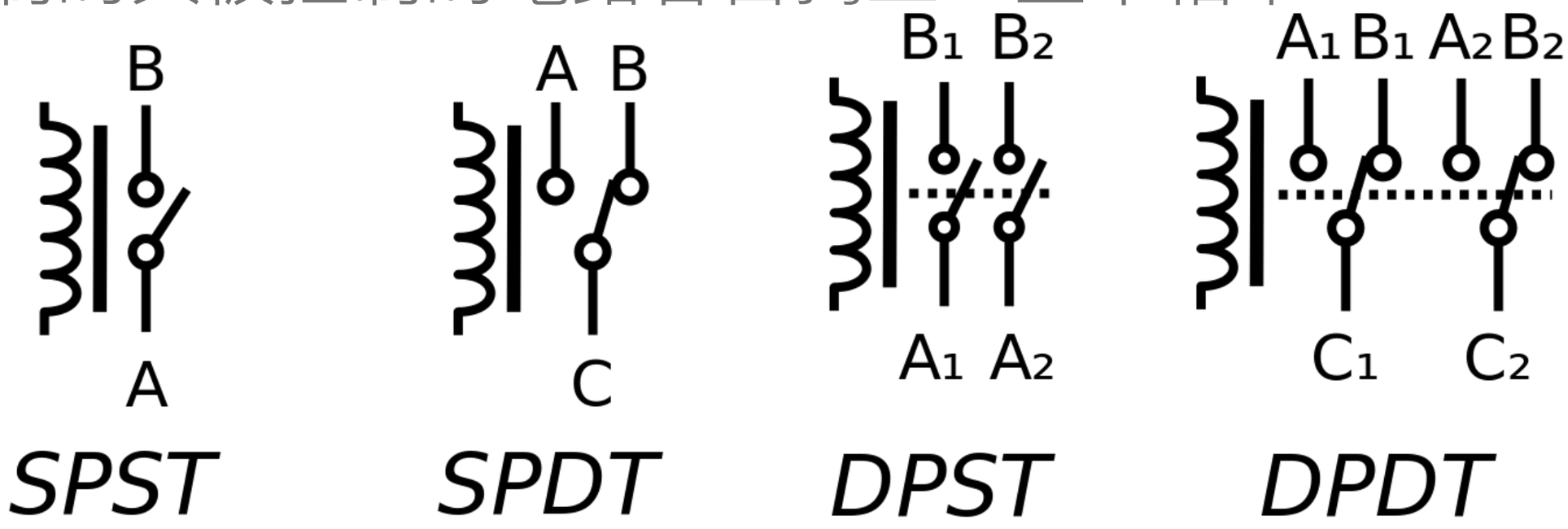

Image source:

- Electronic component relays; FDominec; GFDL, CC-BY-SA-3.0-migrated, CC-BY-SA-2.5,2.0,1.0 https://commons.wikimedia.org/wiki/File:Electronic_component_relays.jpg

# Relays 繼電器

- Relays are switches controlled by electromagnets.
  繼電器是用電磁鐵控制的開關。

- The controlling and controlled circuitries are isolated from each other.
  控制的與被控制的電路各自獨立，互不相干。



# Some technical info about Raspberry Pi GPIO
# 樹莓派 GPIO 的一些技術資料

- Some technical info about Raspberry Pi GPIO outputs:
  樹莓派 GPIO 輸出的技術資料：
  - It is driven by a 3.3V source. 利用 3.3V 電源驅動。
  - Output high means ⩾ 1.3V. 高輸出代表 ⩾ 1.3V.
  - Output low means ⩽ 0.8V. 低輸出代表 ⩽ 0.8V.
  - Maximum current drain is 16mA. 最大電流 16mA.

- i.e., GPIO outputs cannot drive devices that take more than 16mA.
  即是說 GPIO 輸出不能驅動要多於 16mA 電流的器件。

- Actually it is more complicated. Read this for details.
  實際上比這裏複雜，想知更多，請讀此文：
  http://www.scribd.com/doc/101830961/GPIO-Pads-Control2

# How much current is needed?
# 需要多少電流？

- LED 發光二極管：3 – 20mA
- Buzzer 蜂鳴器：10 – 200mA
- Miniature relays 微型繼電器, e.g., Fujitsu Takamisawa RY series:
  150mW to 560mW at 3V to 5V, i.e., 33mA to 166mA
  http://www.weclonline.com/downloads/pdf/07-01-3005.pdf
- Other electronic interfaces 其他電子界面： 0.1μA – 5mA
- Some components like LEDs can work with smaller currents, while some, like motors and relays, have minimum current requirements.
  有些零件如發光二極管用少些電流也可以運作，而有些零件如馬達和繼電器則有最低電流要求。
- What can be done if a Raspberry Pi GPIO pin need to drive a high-current component?
  樹莓派 GPIO 要驅動高電流的零件要怎辦？

# Driving high current components
# 驅動高電流的零件

- For Raspberry Pi GPIO to drive a high current component, a electronic switch is needed.
  樹莓派 GPIO 要驅動高電流的零件，需要一個電子開關。

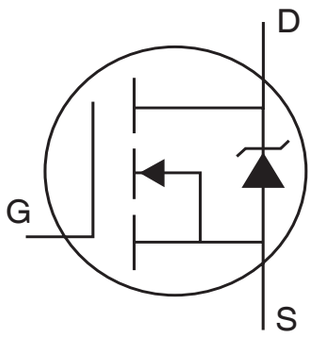
- This can be done using a Power Metal Oxide Semiconductor Field Effect Transistor (MOSFET).
  可以用大功率金屬氧化半導體場效應晶體管 (Power MOSFET)。

# Power MOSFET

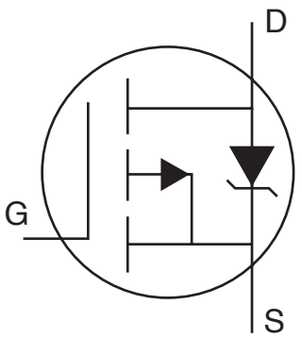
- A MOSFET has three connections: Source (S), Drain (D), and Gate (G).
  MOSFET 有三個接腳：源極 (S)、汲極 (D)、和閘極 (G)。

- There are two types: N-channel and P-channel.
  分 N通道和 P通道兩種。

- They can be seen as voltage-controlled amplifiers which is often used as solid state switches.
  它們可看成電壓控制的放大器，常用作固態開關。



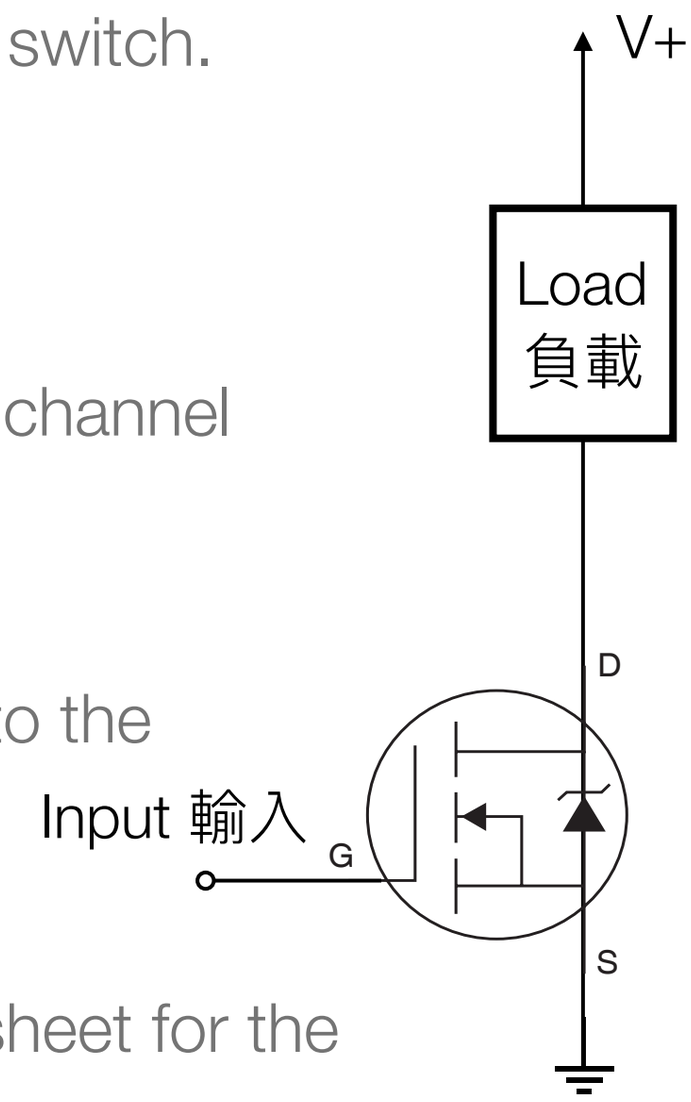

N-channel MOSFET
e.g., IRF520




P-channel MOSFET
e.g., IRF5210

# Power MOSFET as electronic switch
# 大功率 MOSFET 用作電子開關

- Sample use of an N-channel MOSFET as an electronic switch.
  N通道 MOSFET 作電子開關的應用。
  - Connect the Source to ground. 源極接地。
  - A positive voltage applied at the Gate opens up the channel from Drain to Source.
    對地為正的閘極電壓開通汲極至源極的通道。
  - A load can be serially connected through the Drain to the ground via the Power MOSFET.
    負載可由電源經 MOSFET 串聯至地。




- Again, actually it is more complicated.  Read the data sheet for the MOSFET for details.
  實際上比這裏複雜，要知細節，請讀所選 MOSFET 的數據資料。

# Power MOSFET references 參考資料

- IRF520
  Product info 產品資料：http://hken.rs-online.com/web/p/mosfet-transistors/5411180/
  Data sheet 技術資料：http://docs-asia.electrocomponents.com/webdocs/0791/0900766b807910f4.pdf

- IRF5210
  Product info 產品資料：http://hken.rs-online.com/web/p/mosfet-transistors/5411720/
  Data sheet 技術資料：http://docs-asia.electrocomponents.com/webdocs/0791/0900766b807910f5.pdf

- Application Note 558: Introduction to Power MOSFETs and their Applications; Ralph Locher; Fairchild October 1998.
  https://www.fairchildsemi.com/application-notes/AN/AN-558.pdf

- Application Note 7500: Understanding Power MOSFETs; Fairchild October 1999.
  https://www.fairchildsemi.com/application-notes/AN/AN-7500.pdf

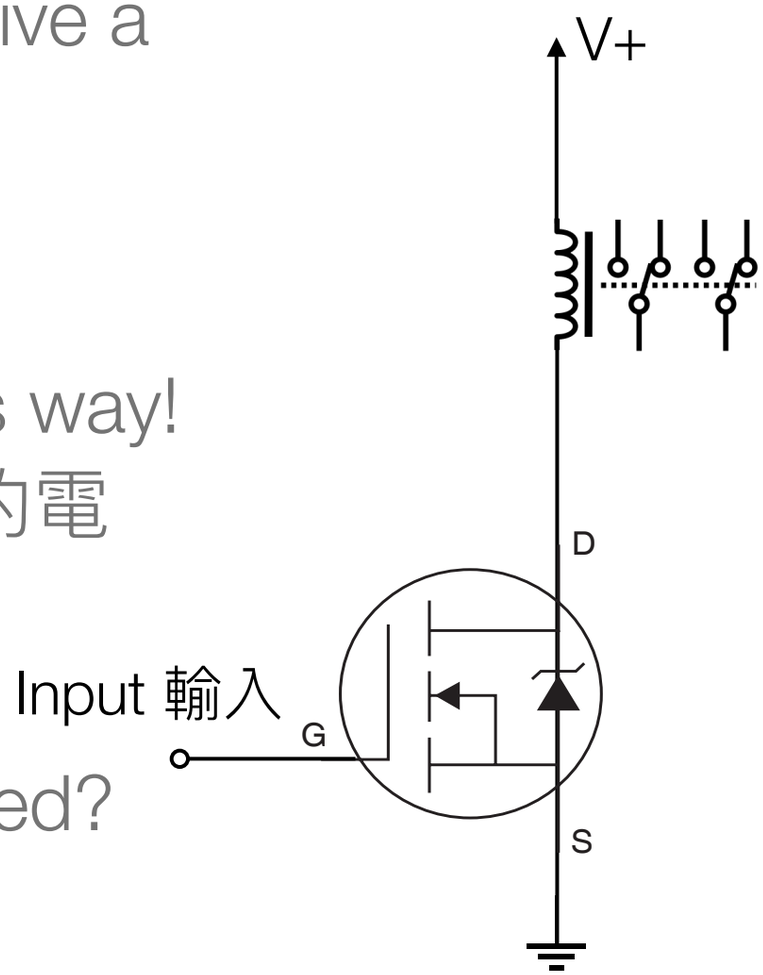
- AN11158: Understanding power MOSFET data sheet parameters; Rev. 4; NXP Semiconductors 2014-02-04.
  http://www.nxp.com/documents/application_note/AN11158.pdf

# How to use a MOSFET to drive a relay?

# 如何利用 MOSFET 驅動繼電器？

# Using MOSFET to drive a relay
# 利用 MOSFET 驅動繼電器

- The circuit schematic for using MOSFET to drive a relay is as shown on the right.
  利用 MOSFET 驅動繼電器的電路圖如右。




- We have built a electrically isolated switch this way!
  我們設計了一個用樹莓派來控制，互相獨立的電路！

- How can the two sets of relay contacts be used?
  繼電器的兩組開關可以用來控制甚麼？

- Let's try controlling USB power!
  試試控制 USB 的電源吧！

# USB as power source
# USB 用作電源

- USB = Universal Serial Bus 通用序列匯流排 / 通用串行總線
  http://www.usb.org/

- Many USB devices like fans, cup heaters, lights use the USB connection as a 5V power source only.  The USB data connections are not used.
  許多USB設備如風扇、暖杯器、燈都使用 USB 連接，只因為它是個5V電源，而沒有使用 USB 的數據線。

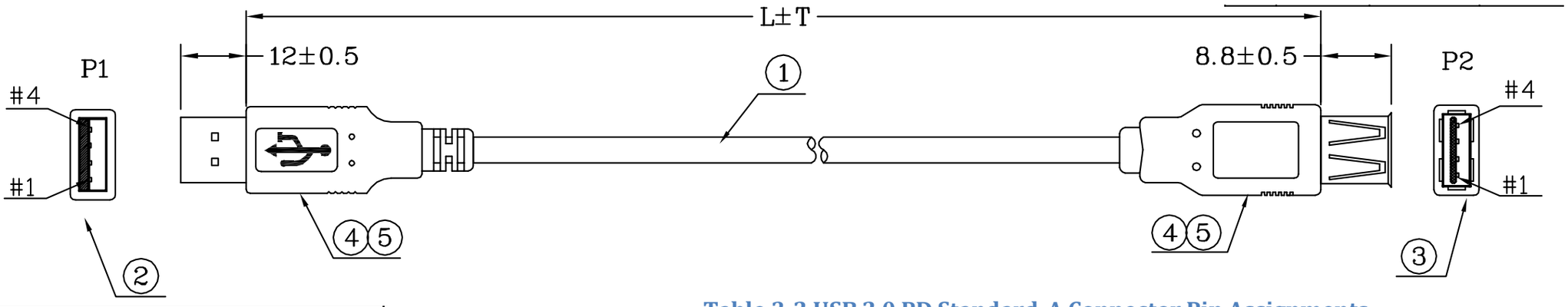
- There are four pins in a USB connector, two for power, two for data.
  USB 連接器有四個接點，兩點為電源，兩點作資料傳送。

# USB extension cable
# USB 延長線

- On bottom left is part of the technical specification of a USB extension cable.
  左下為一條 USB 延長線的部分技術資料。
  Product info 產品資料：http://hken.rs-online.com/web/p/usb-cable-assemblies/7587510/
  Data sheet 技術資料：http://docs-asia.electrocomponents.com/webdocs/1145/0900766b811456a2.pdf

- From the USB specification (bottom right), pin 1 is the bus power, and pin 4 is the ground.  Pins 2 and 3 are for data.
  從右下 USB 規格得知，第一腳為匯流排電源，第四腳為地，第二三腳則是資料線。

Universal Serial Bus, Power Delivery Specification, Revision 2.0, V1.1. 2015-05-07.
http://www.usb.org/developers/docs/



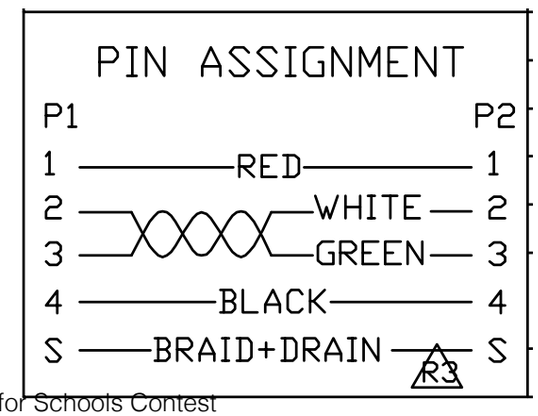




**Table 3-2 USB 2.0 PD Standard-A Connector Pin Assignments**

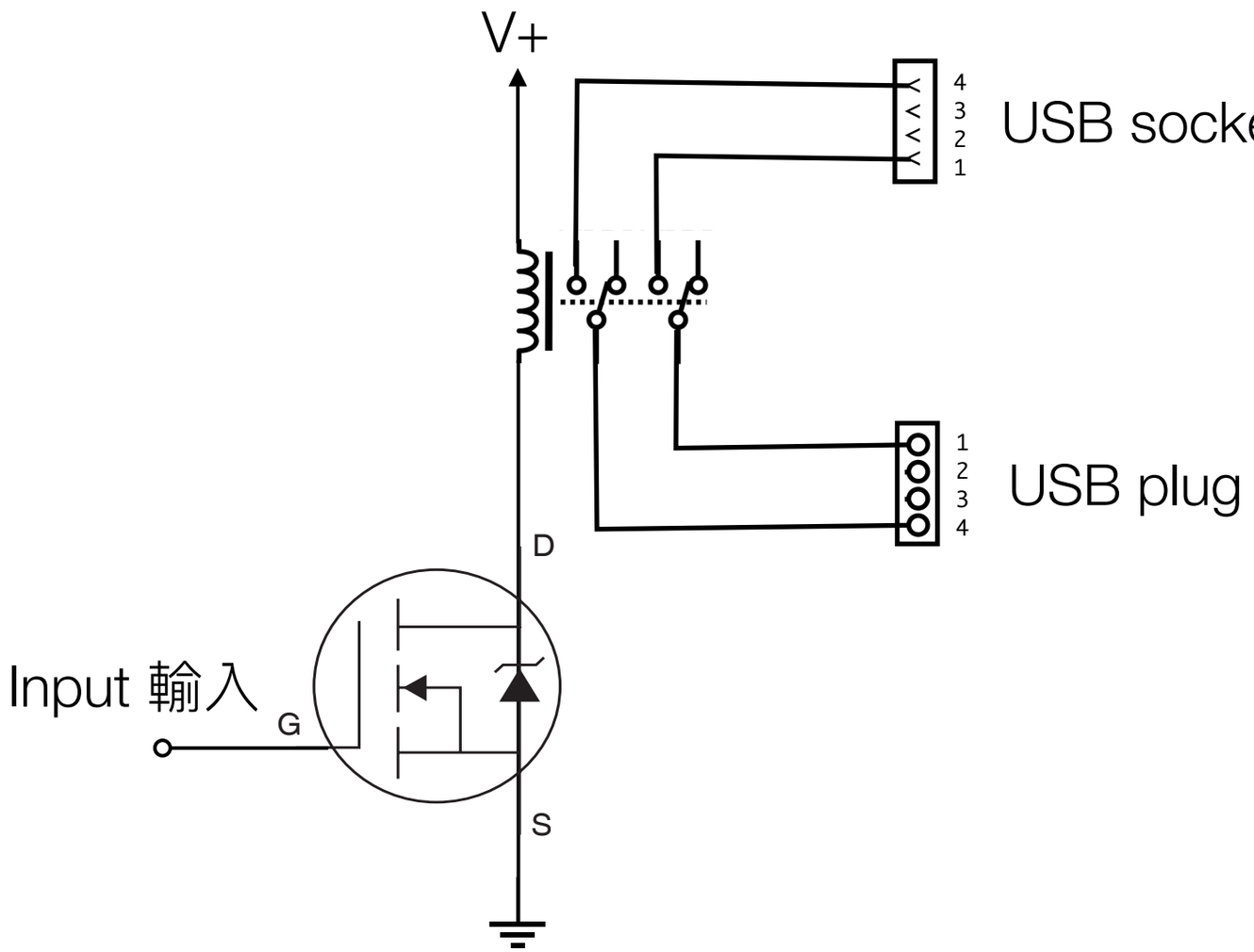
| Pin Number[1] | Signal Name | Description | Mating Sequence |
|---|---|---|---|
| 1 | $V_{BUS}$ | Power | Third |
| 2 | D- | Differential pair as defined in *[USB 2.0]* | Fourth |
| 3 | D+ | | |
| 4 | GND | Ground for power return | Third |
| 10[2] | PD DETECT 1 | Contact in PD receptacle to detect a PD plug | Last |
| 11[2] | PD DETECT 2 | Contact in PD receptacle to detect a PD plug | Last |
| 12[3],13 | INSERTION DETECT | Receptacle only. Detects | Second |

# How to switch USB power on and off using the MOSFET-controlled relay?

# 如何利用 MOSFET 控制的繼電器開關 USB 電源？

# Using MOSFET to drive a relay
# 利用 MOSFET 驅動繼電器

- The circuit schematic for using MOSFET to drive a relay tp switch USB power is as shown.
  利用 MOSFET 驅動繼電器開關 USB 電源的電路圖。

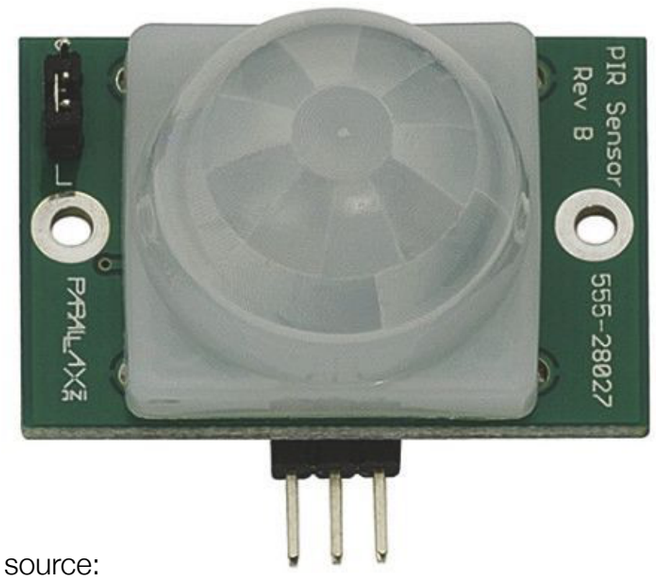


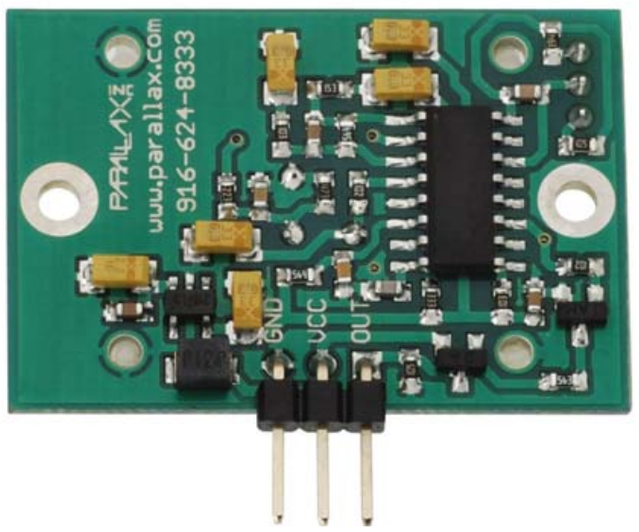
# PIR (Passive Infra-Red) sensor module
# 被動紅外線傳感器

- A pyroelectric device that detects motion by sensing changes in the infrared (radiant heat) levels emitted by surrounding objects.
  以熱電原理，感應周圍物體發出的紅外線（熱輻射）水平變化，來偵測物體移動的傳感器。

- Example 例：
  Parallax PIR Sensor #555-28027
  http://hken.rs-online.com/web/p/interface-development-kits/7813024/

- Supply voltage 3 to 6V DC, digital output, high=movement.
  電源電壓直流 3V 至 6V，數位輸出，高代表有移動。



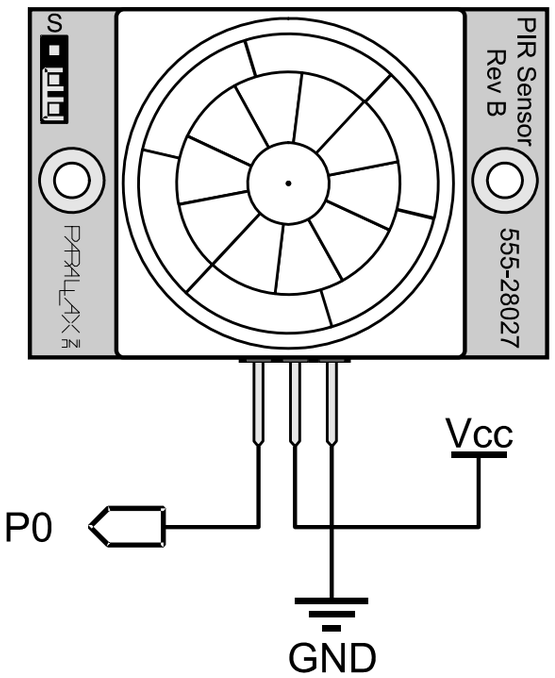



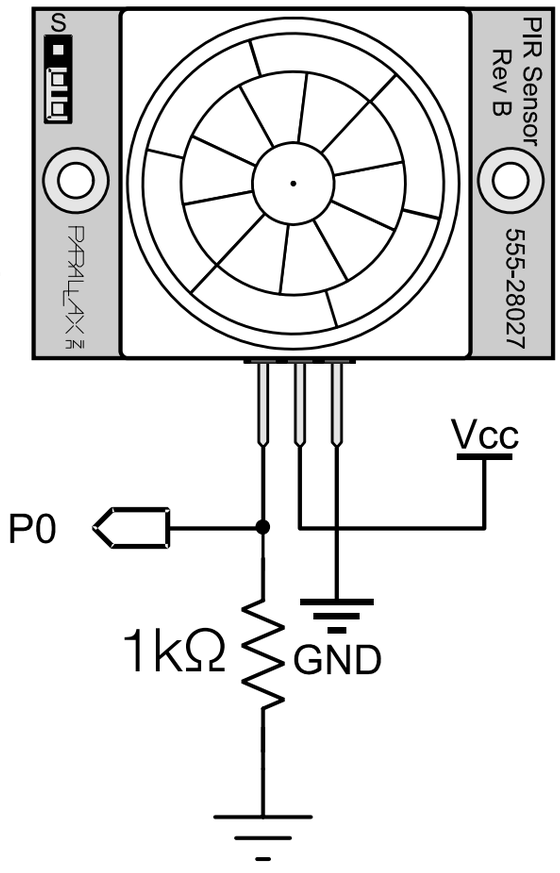

Image source:
- http://hken.rs-online.com/web/p/interface-development-kits/7813024/
- http://docs-asia.electrocomponents.com/webdocs/125a/0900766b8125a3ed.pdf

# Interfacing the PIR sensor with Raspberry Pi
# 樹莓派連接被動紅外線傳感器

- Connect Vcc of the PIR sensor module to a 3.3V pin of Raspberry Pi. Also connect the Ground pin.
  將被動紅外線傳感器的 Vcc 連接至樹莓派的 3.3V 腳位，亦將其接地。

- The output of the PIR sensor module can be connected to a GPIO pin of Raspberry Pi.
  被動紅外線傳感器的輸出可以直接接到樹莓派的 GPIO 接口。

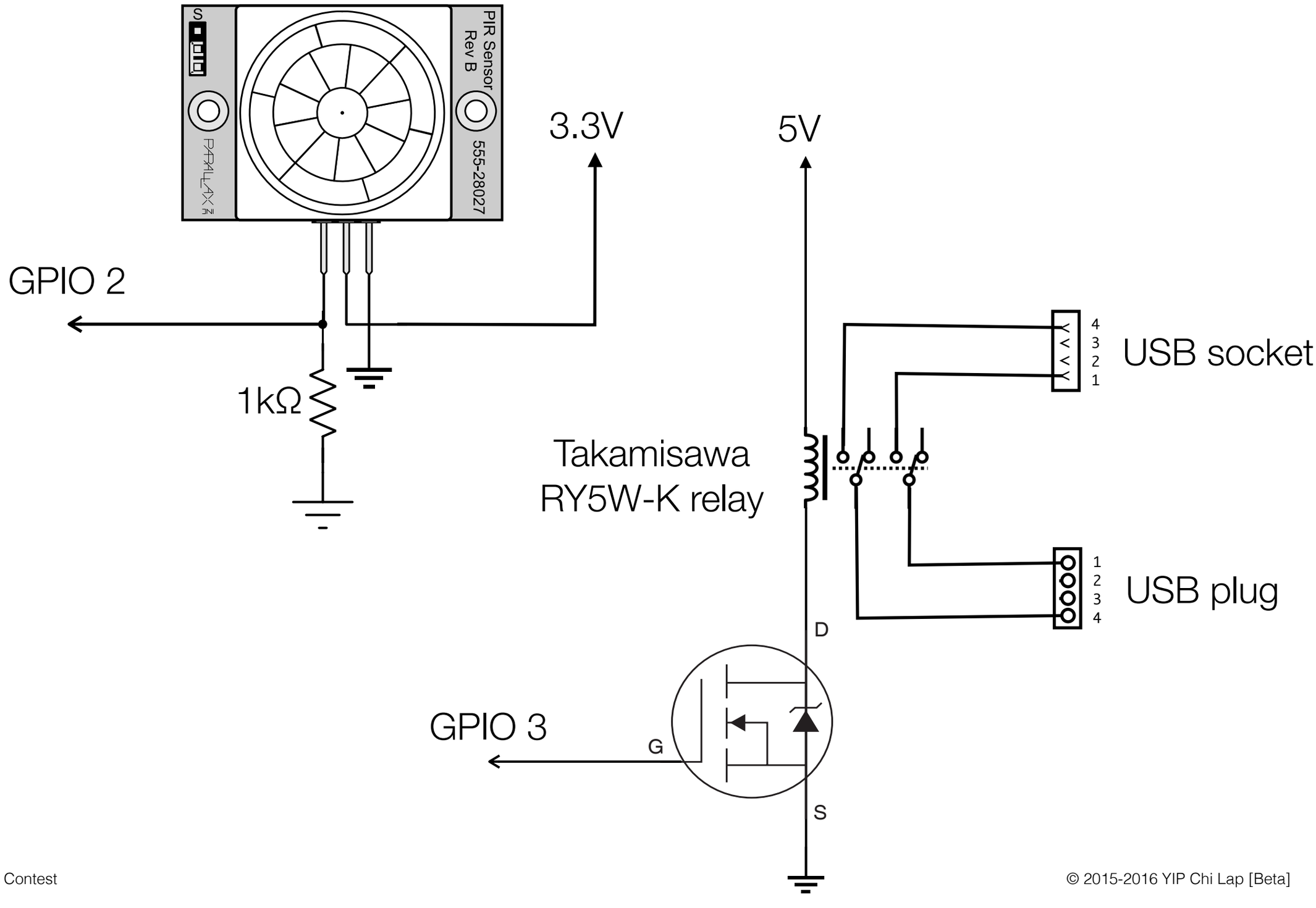
- If a Raspberry Pi cannot detect its low level output, connect a pull down resistor of about 1kΩ, as in the schematic on the right.
  如樹莓派檢則不到被動紅外線傳感器的低輸出，可將其輸出腳用約 1kΩ 的下拉電阻，如右電路圖。



# How to control USB power using PIR sensor?

# 如何用被動紅外線傳感器控制 USB 電源開關？

# The circuit schematic
# 電路圖



# How about the program? 程式呢？

```
import RPi.GPIO as GPIO
import time
GPIO.setmode(GPIO.BCM)
GPIO.setwarnings(False)
pir = 2
relay = 3
GPIO.setup(pir, GPIO.IN, pull_up_down=GPIO.PUD_DOWN)
GPIO.setup(relay, GPIO.OUT)
while True:
    if GPIO.input(pir):
        GPIO.output(relay,1)
    else:
        GPIO.output(relay,0)
    time.sleep(0.2)
```

- The RPi.GPIO package should be used to access GPIO pins in Python.
  在 Python 用 GPIO，要用 RPi.GPIO 軟件包。
- Use time package for generating a delay. 利用 time 軟件包使程式等待。
- Specify that the GPIO numbers (as opposed to the physical pin numbers) are used to name the GPIO pins
  告訴系統你會用 GPIO 號碼（而不是引腳位置號碼）命名 GPIO 的引腳。
- Suppress the warning that the GPIO pin is in use.
  抑制 GPIO 引腳在使用的警告.
- GPIO number for PIR sensor module. 被動紅外線傳感器的 GPIO 號碼。
- GPIO number for relay. 繼電器的 GPIO 號碼。
- GPIO for PIR sensor module is for input.
  接被動紅外線傳感器的 GPIO 作輸入用。
- GPIO for relay is for output.
  接繼電器的 GPIO 作輸出用。
- Loop forever 無限迴圈
- If movement has been sensed 如感測到移動
- Relay output is set to high 繼電器輸出高
- Otherwise 否則
- Relay output is set to low 繼電器輸出低
- Wait for 0.2 seconds before next check 等 0.2 秒再測試

# How to turn off the USB power only after some time there is no motion?

# 如何在感知到沒有移動一陣子後才關閉 USB 電源？

# Thank you 謝謝

## Questions? 問題?