Sea Level Measurement Device Design Competition
Workshop on "Circuit Design and Its Applications"
海平面量度裝置設計比賽
「電路設計及應用」工作坊

Department of Electrical & Electronic Engineering

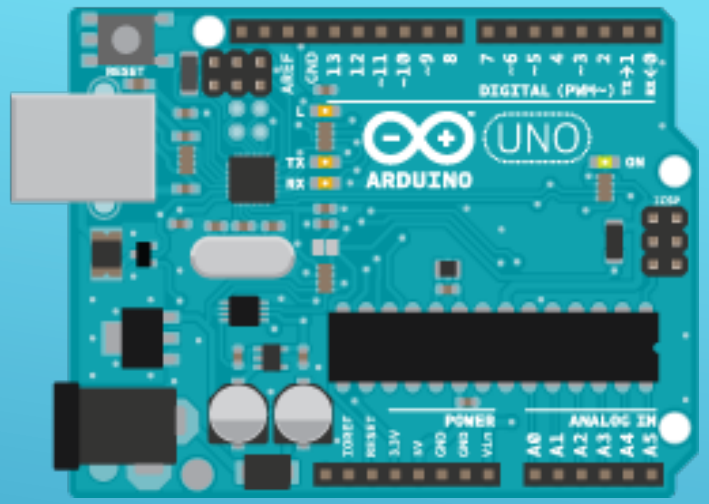
The University of Hong Kong

香港大學 電機電子工程系

Thomas Kwan / Andy Fok (CB103)

Garfield Lam / Simon Tam (CB-LG205)

What is Arduino?
Arduino 是甚麼？



Arduino is an Open-Source Electronics Platform based on easy-to-use hardware and software.

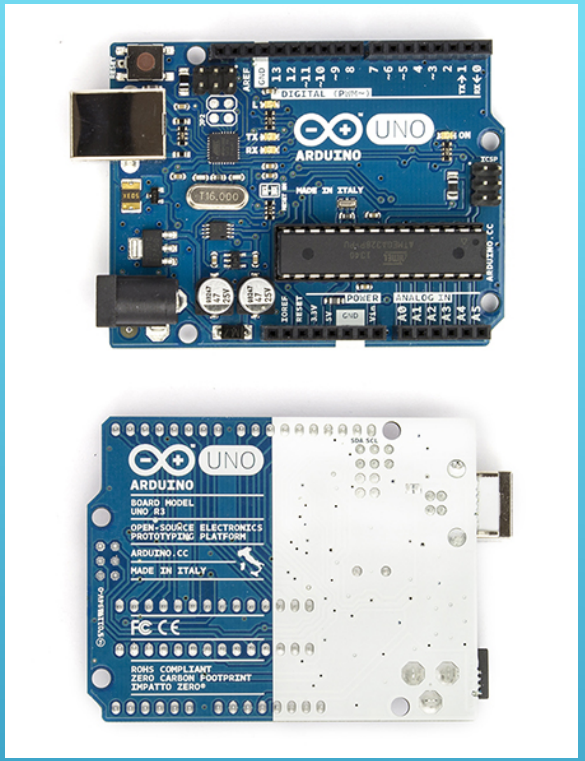
It’s intended for anyone making interactive projects.

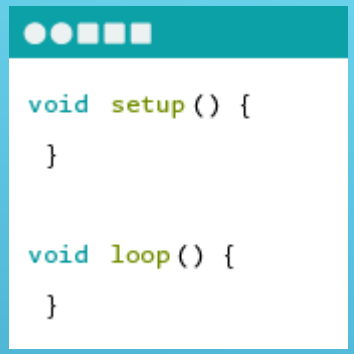
Arduino 是開源易用，包含軟硬件的電子平台，給所有人設計互動的電子項目。

Name	Processor	Operating Voltage/Input Voltage	CPU Speed	Analog In/Out	Digital IO/PWM	EEPROM [KB]	SRAM [KB]	Flash [KB]	USB	UART
Uno	ATmega328	5 V/7-12 V	16MHz	6/0	14/6	1	2	32	Regular	1
Due	AT91SAM3X8E	3.3 V/7-12 V	84 MHz	12/2	54/12	-	96	512	2 Micro	4
Leonardo	ATmega32u4	5 V/7-12 V	16MHz	12/0	20/7	1	2.5	32	Micro	1
Mega 2560	ATmega2560	5 V/7-12 V	16MHz	16/0	54/15	4	8	256	Regular	4
Mega ADK	ATmega2560	5 V/7-12 V	16MHz	16/0	54/15	4	8	256	Regular	4
Micro	ATmega32u4	5 V/7-12 V	16MHz	12/0	20/7	1	2.5	32	Micro	1
Mini	ATmega328	5 V/7-9 V	16MHz	8/0	14/6	1	2	32	-	-
Nano	ATmega168 ATmega328	5 V/7-9 V	16MHz	8/0	14/6	0.512 1	1 2	16 32	Mini-B	1
Ethernet	ATmega328	5 V/7-12 V	16MHz	6/0	14/4	1	2	32	Regular	-
Esplora	ATmega32u4	5 V/7-12 V	16MHz	-	-	1	2.5	32	Micro	-
ArduinoBT	ATmega328	5 V/2.5-12 V	16MHz	6/0	14/6	1	2	32	-	1
Fio	ATmega328P	3.3 V/3.7-7 V	8MHz	8/0	14/6	1	2	32	Mini	1
Pro (168)	ATmega168	3.3 V/3.35-12 V	8MHz	6/0	14/6	0.512	1	16	-	1
Pro (328)	ATmega328	5 V/5-12 V	16MHz	6/0	14/6	1	2	32	-	1
Pro Mini	ATmega168	3.3 V/3.35-12 V 5 V/5-12 V	8MHz 16MHz	6/0	14/6	0.512	1	16	-	1
LilyPad	ATmega168V ATmega328V	2.7-5.5 V/2.7-5.5 V	8MHz	6/0	14/6	0.512	1	16	-	-
LilyPad USB	ATmega32u4	3.3 V/3.8-5V	8MHz	4/0	9/4	1	2.5	32	Micro	-
LilyPad Simple	ATmega328	2.7-5.5 V/2.7-5.5 V	8MHz	4/0	9/4	1	2	32	-	-
LilyPad SimpleSnap	ATmega328	2.7-5.5 V/2.7-5.5 V	8MHz	4/0	9/4	1	2	32	-	-
Yun	ATmega32u4	5 V	16MHz	12/0	20/7	1	2.5	32	Micro	1

Arduino UNO

Microcontroller 微控制器	ATmega328
Operating Voltage 工作電壓	5V
Input Voltage (recommended) 輸入電壓（建議值）	7-12V
Input Voltage (limits) 輸入電壓（範圍）	6-20V
Digital I/O Pins 數碼輸入輸出端	14 (of which 6 provide PWM output) 14 （6 可作 PWM 輸出）
Analog Input Pins 模擬輸入端	6
DC Current per I/O Pin 每輸入輸出端之直流電流	40 mA
DC Current for 3.3V Pin 3.3V 端之直流電流	50 mA
Flash Memory Flash 記憶	32 KB (ATmega328), of which 0.5 KB used by bootloader 32 KB (ATmega328), 其中0.5KB予bootloader用
SRAM	2 KB (ATmega328)
EEPROM	1 KB (ATmega328)
Clock Speed 時鐘頻率	16 MHz





Arduino Software
Arduino 軟件

You can tell your Arduino what to do by writing code in the Arduino programming language and using the Arduino development environment.
你可以利用Arduino的開發環境，寫程式告訴Arduino做些甚麼。

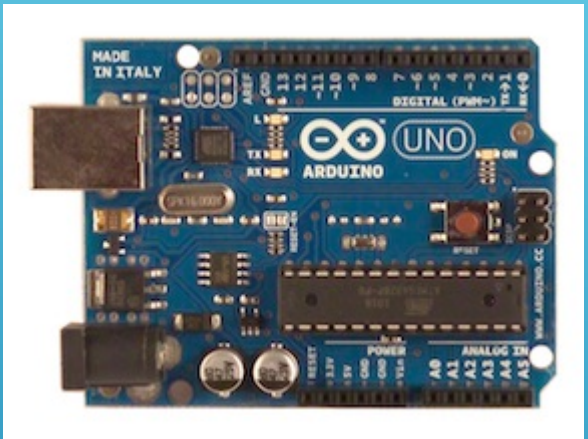
Arduino IDE 1.0.6

- Windows Installer, Windows ZIP file (for non-administrator install)
- Mac OS X
- Linux: 32 bit, 64 bit
- source

Getting Started with Arduino on Windows
Arduino 在 Windows 入門

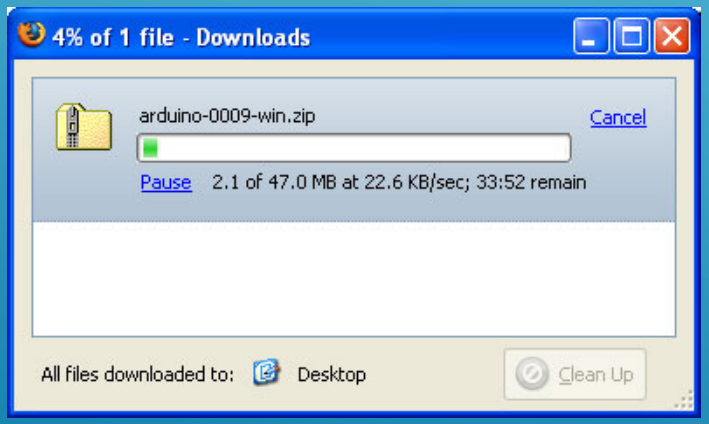
- 1 | Get an Arduino board and USB cable　取得 Arduino 模板及 USB 線
- 2 | Download the Arduino environment　下載 Arduino 環境
- 3 | Connect the board　接上 Arduino 板
- 4 | Install the drivers　安裝驅動程式
- 5 | Launch the Arduino application　啟動 Arduino 應用程式
- 6 | Open the blink example　打開範例程式 blink
- 7 | Select your board　選取所用的 Arduino 板
- 8 | Select your serial port　選擇所所用的串流連接埠
- 9 | Upload the program　上載程式

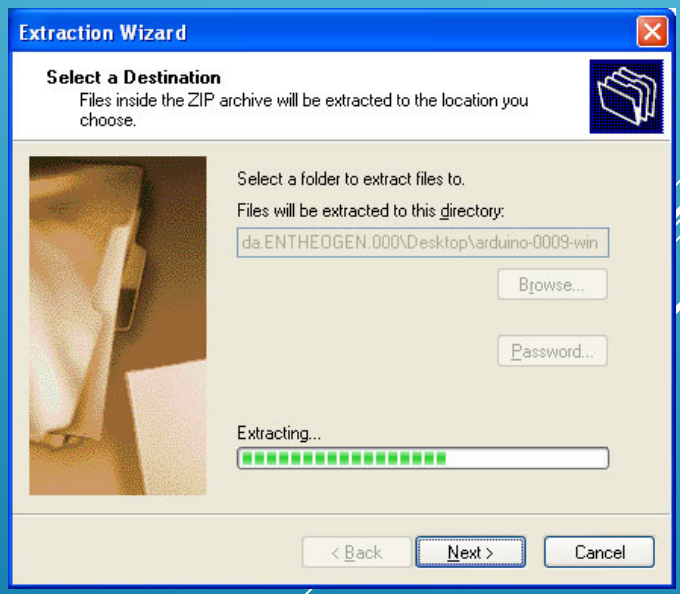
1 | Get an Arduino UNO board and USB cable
取得 Arduino 模板及 USB 線



2 | Download the Arduino environment　下載 Arduino 環境

Get the latest version from the download page.
When the download finishes, unzip the downloaded file. Make sure to preserve the folder structure. Double-click the folder to open it. There should be a few files and sub-folders inside.
從下載頁下載最新的 Arduino 環境。
下載後，unzip下載了的檔案。不要改動文件夾結構。打開文件夾，內裏應有一些文件和子文件夾。





3 | Connect the board 接上 Arduino 板

The Arduino automatically draw power from either the USB connection to the computer or an external power supply.

Connect the Arduino board to your computer using the USB cable. The green power LED (labelled **PWR**) should go on.

Arduino 可從 USB 取得電源，亦可利用外部電源。
利用 USB 線將 Arduino 板連接至電腦。你應見到一粒在旁印有 “PWR” 的綠色的發光二極管（LED）亮着。

4 | Install the drivers 安裝驅動程式

• Plug in your board and wait for Windows to begin it's driver installation process. After a few moments, the process will fail, despite its best efforts.
連接 Arduino 板至電腦。Windows 會尋找驅動程式，然後失敗。

• Click on the Start Menu, and open up the Control Panel. 按開始，打開控制台。

• While in the Control Panel, navigate to System and Security. Next, click on System. Once the System window is up, open the Device Manager. 控制台內，打開「系統」，開「裝置管理員」。

• Look under Ports (COM & LPT). You should see an open port named “Arduino UNO (COMxx)”. If there is no COM & LPT section, look under “Other Devices” for “Unknown Device”.
打開「連接埠（COM和LPT）」。如沒有，則打開「其他裝置」。

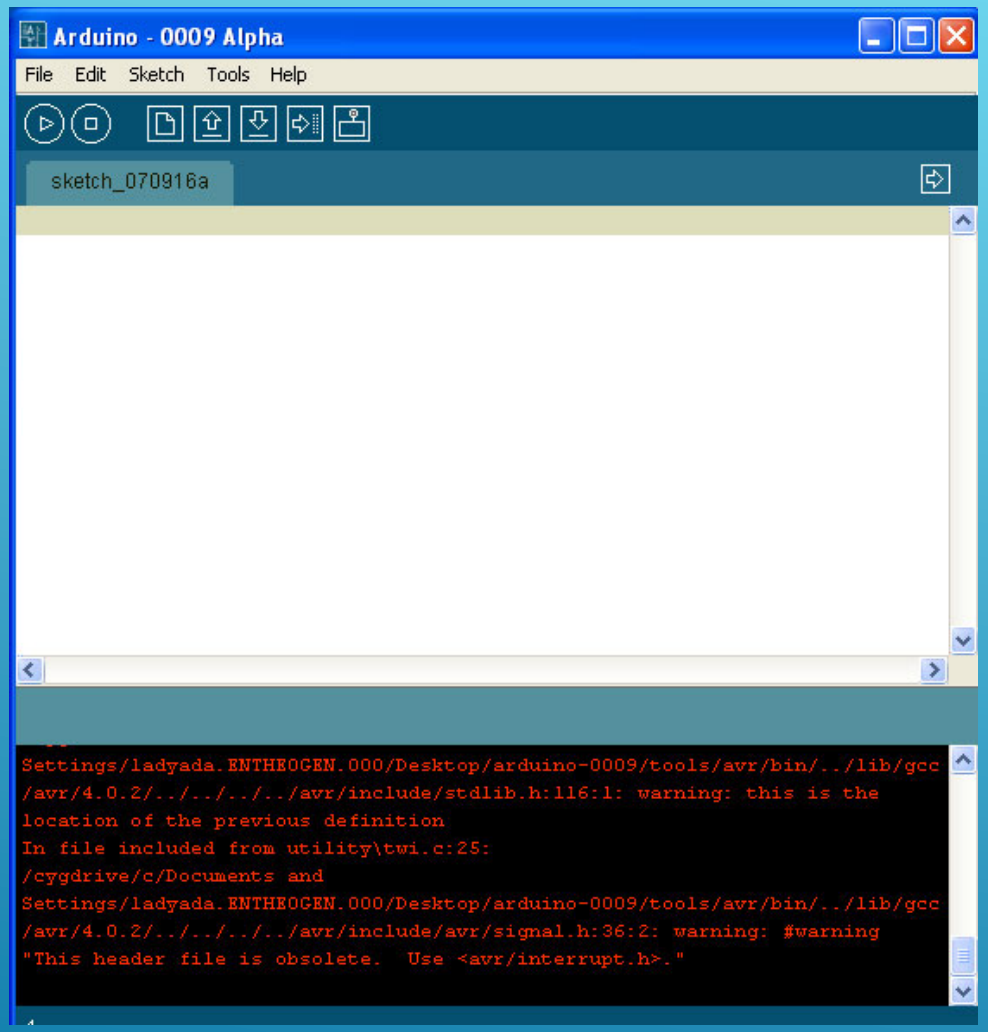
• Right click on the "Arduino UNO (COMxx)" port and choose the "Update Driver Software" option.
右擊「Arduino UNO (COMxx)」，選「更新驅動程式軟體」。

• Next, choose the “Browse my computer for Driver software” option.
選「手動尋找並安裝驅動程式軟體」。

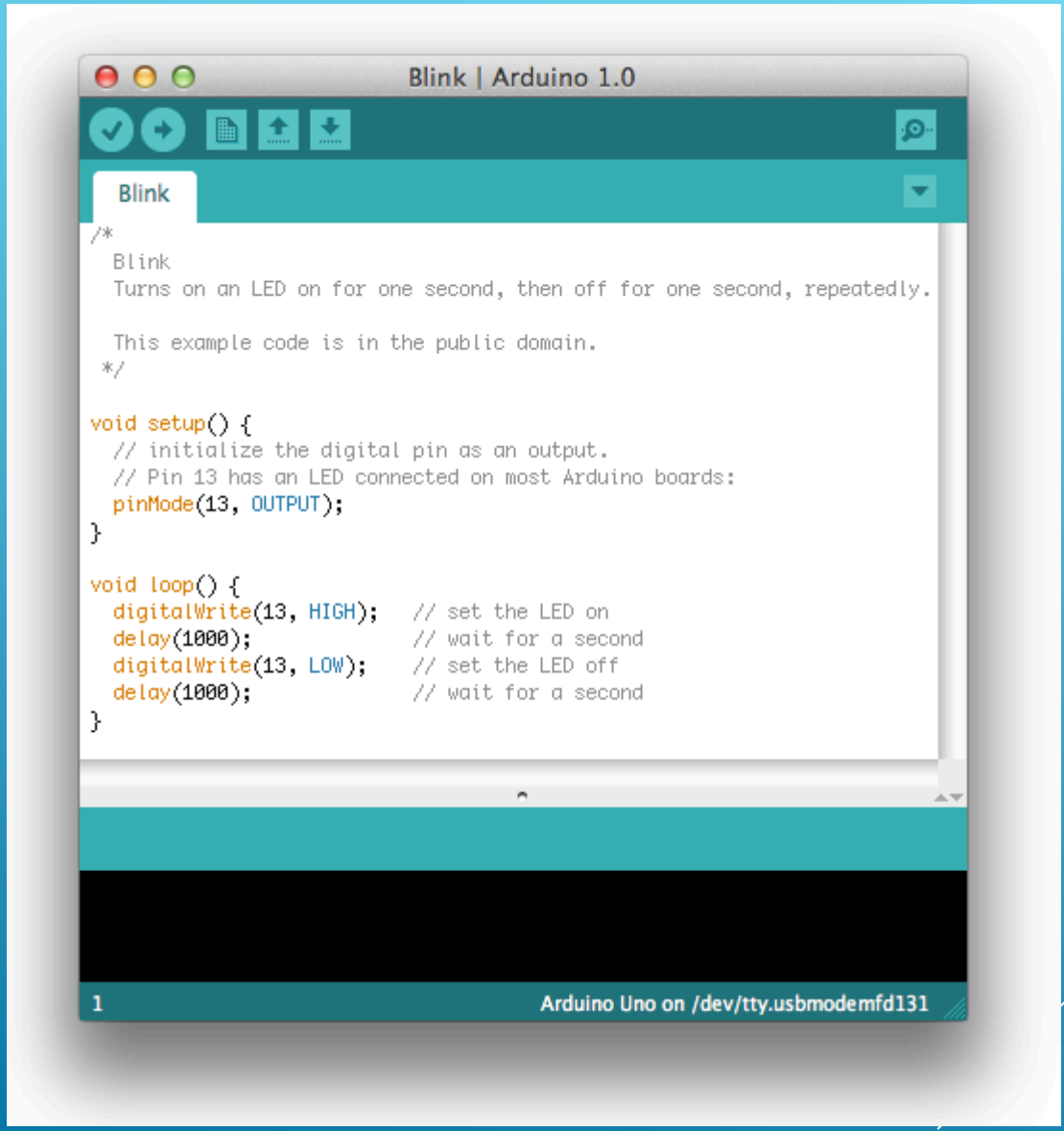
• Finally, navigate to and select the driver file named **"arduino.inf"**, located in the "Drivers" folder of the Arduino Software download (not the "FTDI USB Drivers" sub-directory). If you are using an old version of the IDE (1.0.3 or older), choose the Uno driver file named **"Arduino UNO.inf”**
選在 “Drivers” 文件夾內的 “arduino.inf”文件（注意：不是 “FTDI USB Drivers” 文件夾）。如你用舊版 Arduino IDE （1.0.3 版或以前），則選 “Arduino UNO.inf”.

• Windows will finish up the driver installation from there. 驅動程式會自動完成。

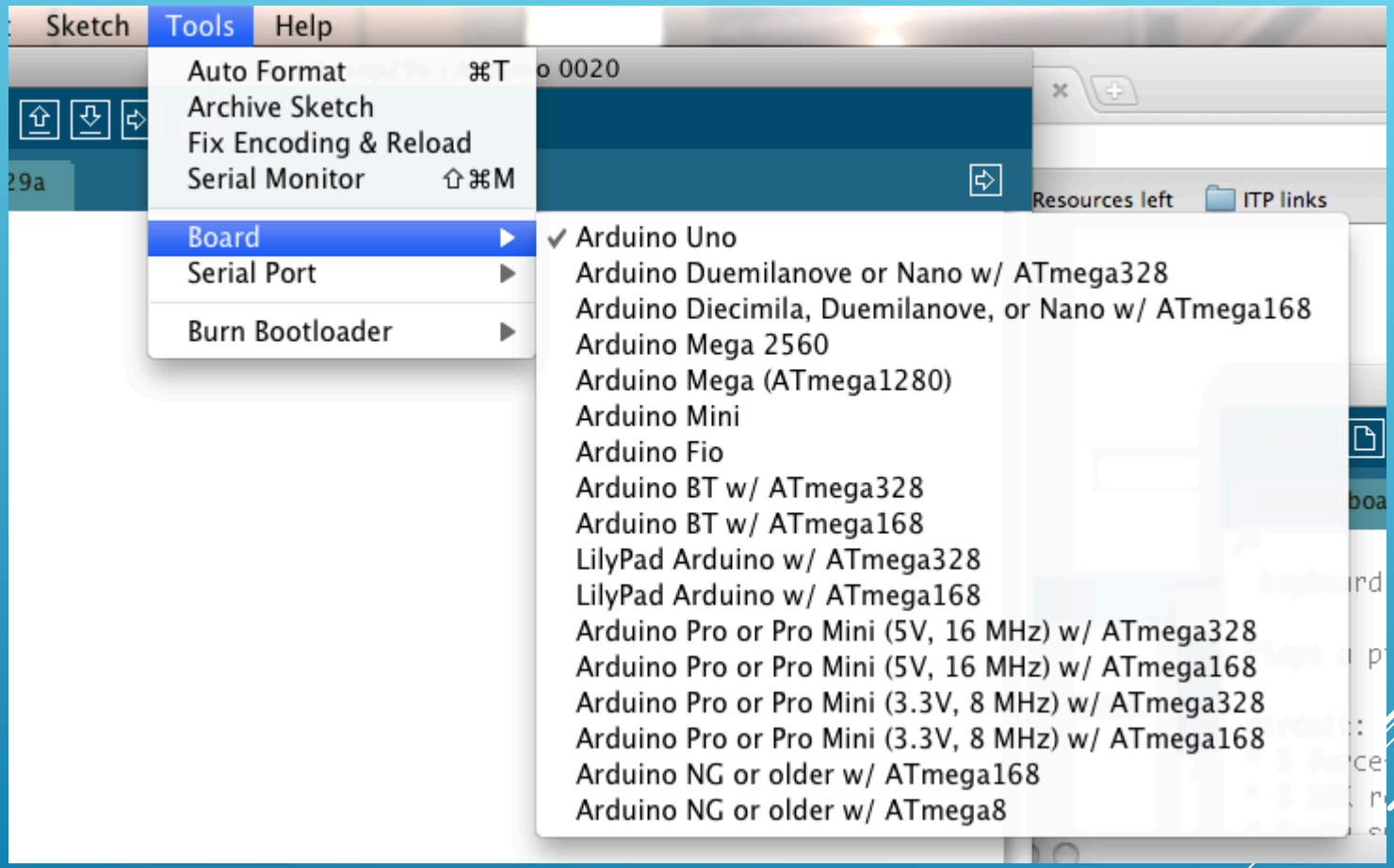
5 | Launch the Arduino application　啟動 Arduino 應用程式



6 | Open the blink example　打開範例程式 blink



7 | Select your board　選取所用的 Arduino 板



8 | Select your serial port　選擇所所用的串流接口

Select the serial device of the Arduino board from the Tools | Serial Port menu. This is likely to be **COM3** or higher (**COM1** and **COM2** are usually reserved for hardware serial ports). To find out, you can disconnect your Arduino board and re-open the menu; the entry that disappears should be the Arduino board. Reconnect the board and select that serial port.

從 Tools > Serial Port menu 選所用的串流連接埠。通常會是 COM3 或以上，因為 COM1 和 COM2 通常留作內部使用。要找出是哪個埠，可以斷開 Arduino 和電腦的連接，關掉重開 Tools > Serial Port 頁，消失了的 COM 埠，就是所用的那個。重接 Arduino 板後便可選取。

9 | Upload the program　上載程式

Click the “Upload” button in the environment　點擊 Upload 鍵。

After the upload finishes, you should see the pin 13 (L) LED on the board start to blink (in orange).

上載完成後，接到第 13 腳的發光二極管（橙色）會開始閃動。

Basic Command Description 基本程式碼的說明

`pinMode(`*n*`,INPUT)` Set pin *n* to act as an input. One-time command at top of program.
將第 *n* 腳作為輸入端。只需程式開始時進行一次。

`pinMode(`*n*`,OUTPUT)` Set pin *n* to act as an output 將第 *n* 腳作為輸出端。

`digitalWrite(`*n*`,HIGH)` Set pin *n* to 5V 將第 *n* 腳輸出成 5 伏特。

`digitalWrite(`*n*`,LOW)` Set pin *n* to 0V 將第 *n* 腳輸出成 0 伏特。

`delay(`*x*`)` Pause program for *x* milliseconds, *x* = 0 to 65535. 程式等待 x 毫秒。 *x* 由 0 至 65535。

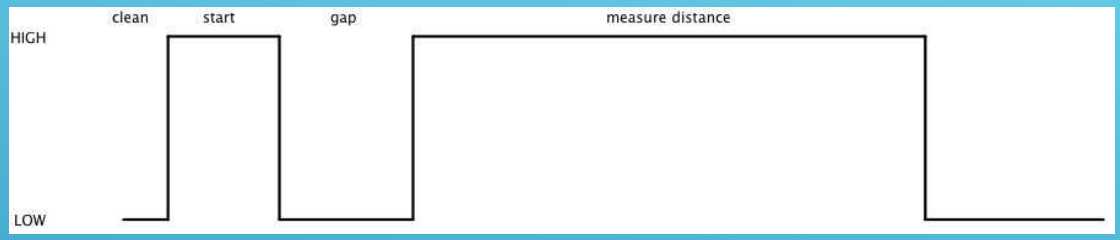
`for() {}` For loop. 迴圈敘述。
Example 例: for (i=0;i<3;i++) {}
Do the instructions enclosed by {} three times. 將 {} 內的指令做 3 次。

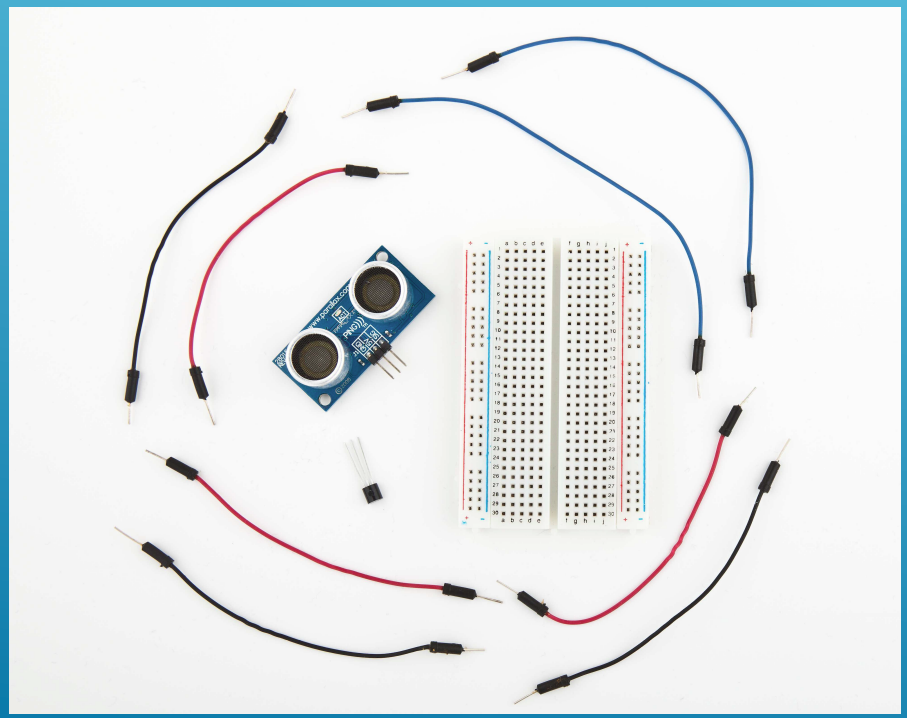
`if (`*expr*`) {}` Conditional branch. 條件式敘述。
If *expr* true, do instructions enclosed by {} 如 *expr* 條件式成立，執行 {} 內的指令。

`while (`*expr*`) {}` While loop. While 迴圈敘述。
While *expr* is true, repeat instructions in {} indefinitely
當 *expr* 條件式成立，執行 {} 內的指令，直至 *expr* 條件式不成立。

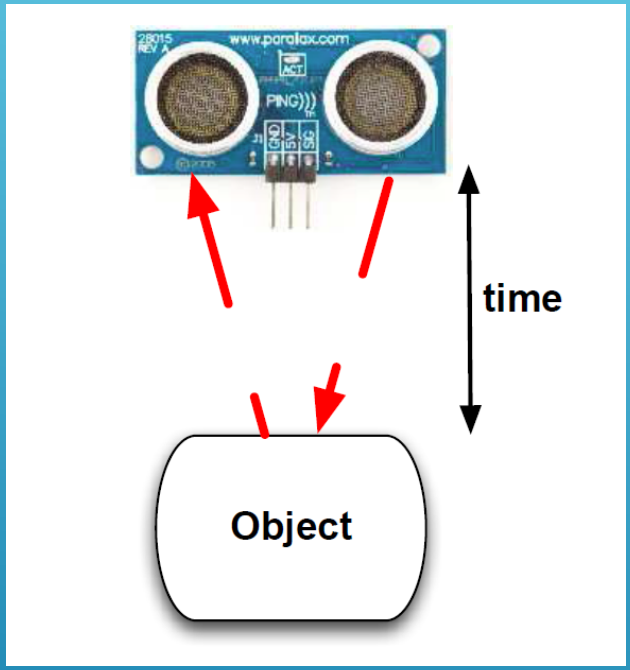
Parallax PING))) sensor
Parallax PING))) 傳感器

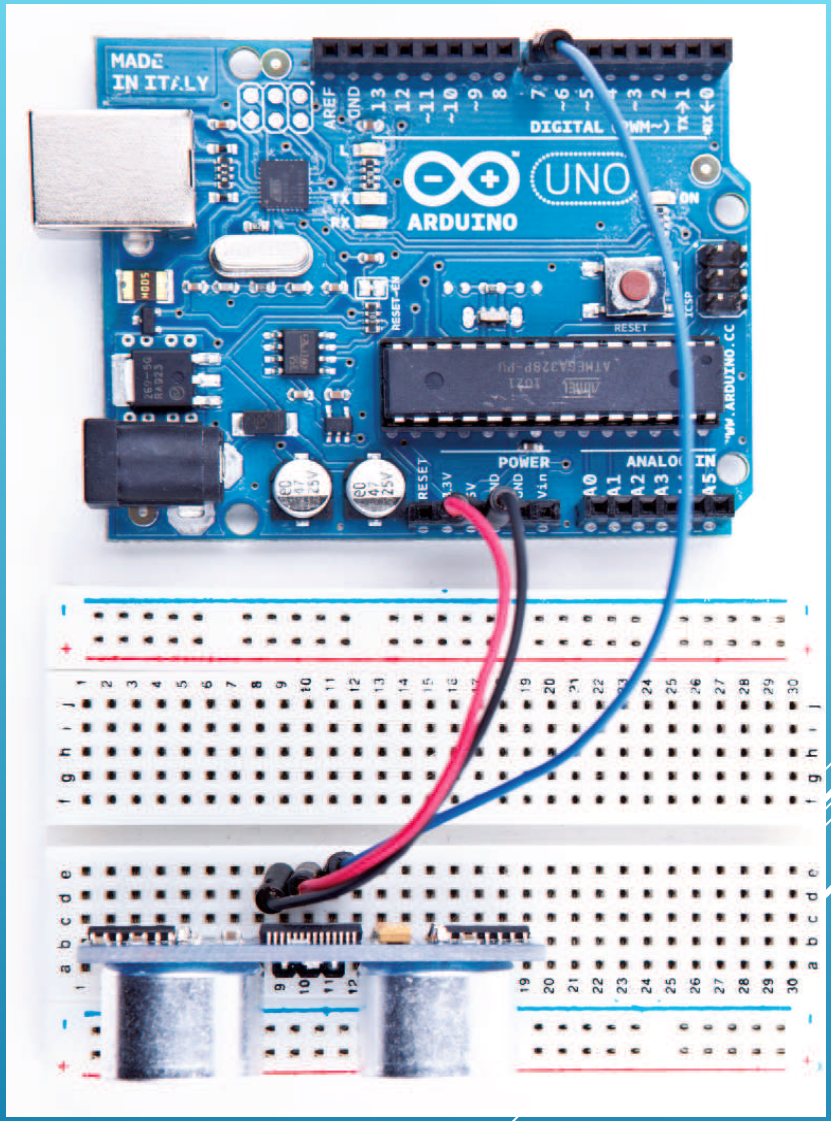
http://www.parallax.com/product/28015





Parallax PING))) sensor
Parallax PING))) 傳感器





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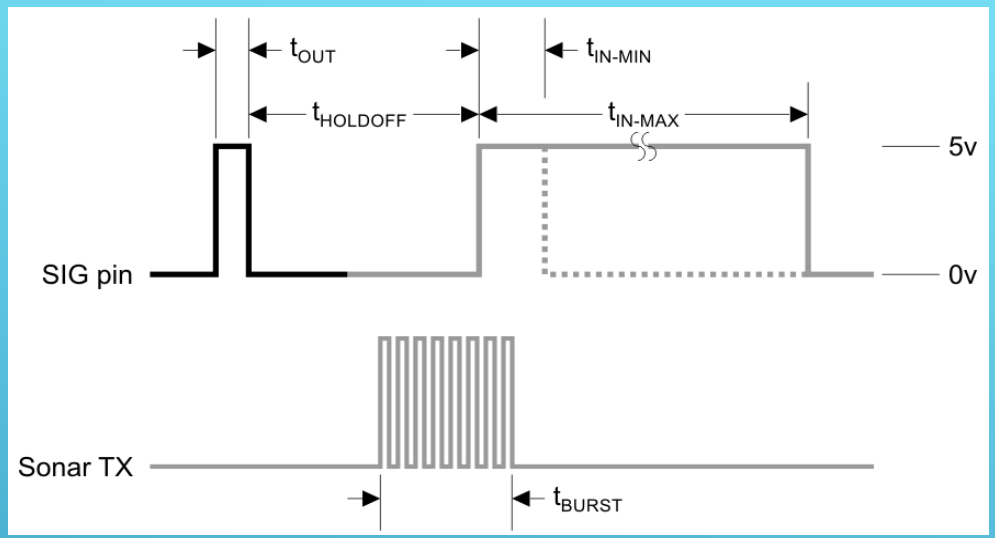


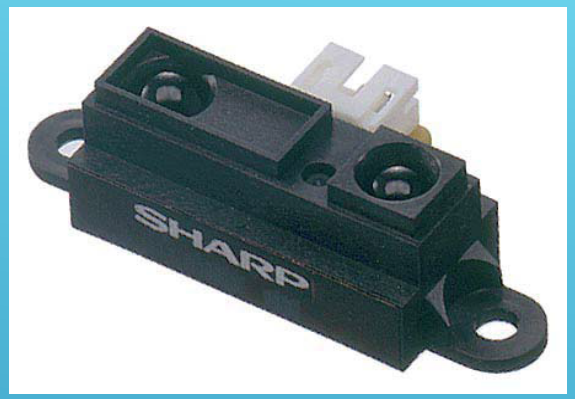

```
const unsigned int PING_SENSOR_IO_PIN = 7;
const unsigned int BAUD_RATE = 9600;

void setup() {
      Serial.begin(BAUD_RATE);
}

void loop() {
      pinMode(PING_SENSOR_IO_PIN, OUTPUT);
      digitalWrite(PING_SENSOR_IO_PIN, LOW);
      delayMicroseconds(2);

      digitalWrite(PING_SENSOR_IO_PIN, HIGH);
      delayMicroseconds(5);
      digitalWrite(PING_SENSOR_IO_PIN, LOW);

      pinMode(PING_SENSOR_IO_PIN, INPUT);
      const unsigned long duration = pulseIn(PING_SENSOR_IO_PIN, HIGH);
      if (duration == 0) {
        Serial.println("Warning: We did not get a pulse from sensor.");
      } else {
      Serial.print("Distance to nearest object: ");
      Serial.print(microseconds_to_cm(duration));
      Serial.println(" cm");
      }

      delay(100);
}

unsigned long microseconds_to_cm(const unsigned long microseconds) {
      return microseconds / 29 / 2;
}
```

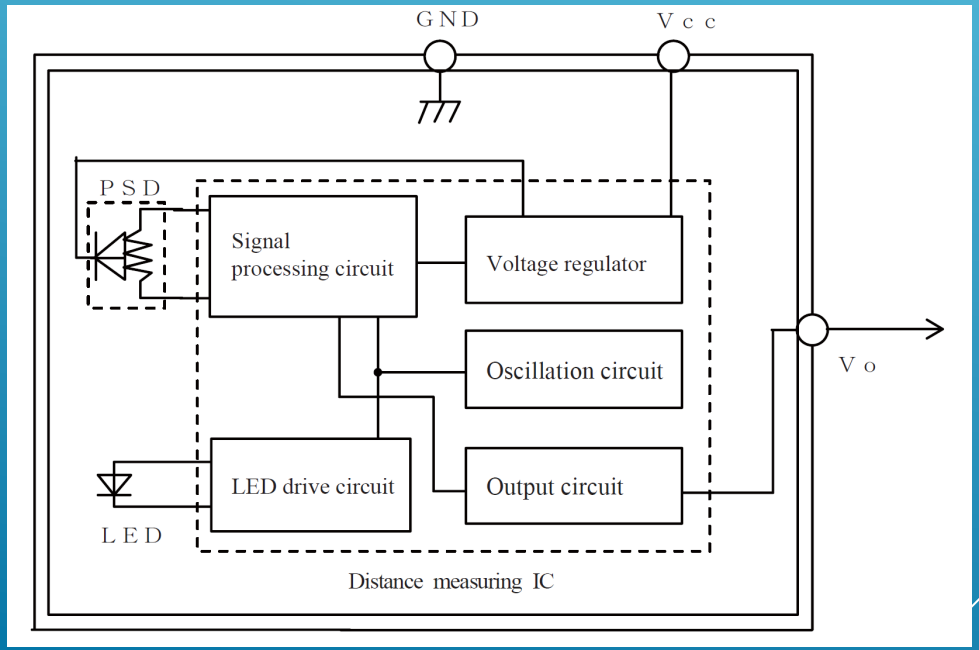
Sharp Distance Measuring Sensor
Sharp 測距傳感器

- Distance measurement range: 10 to 80 cm (3.9 to 31.5 inches)
  量度距離：10 至 80 厘米（3.9 至 31.5 吋）

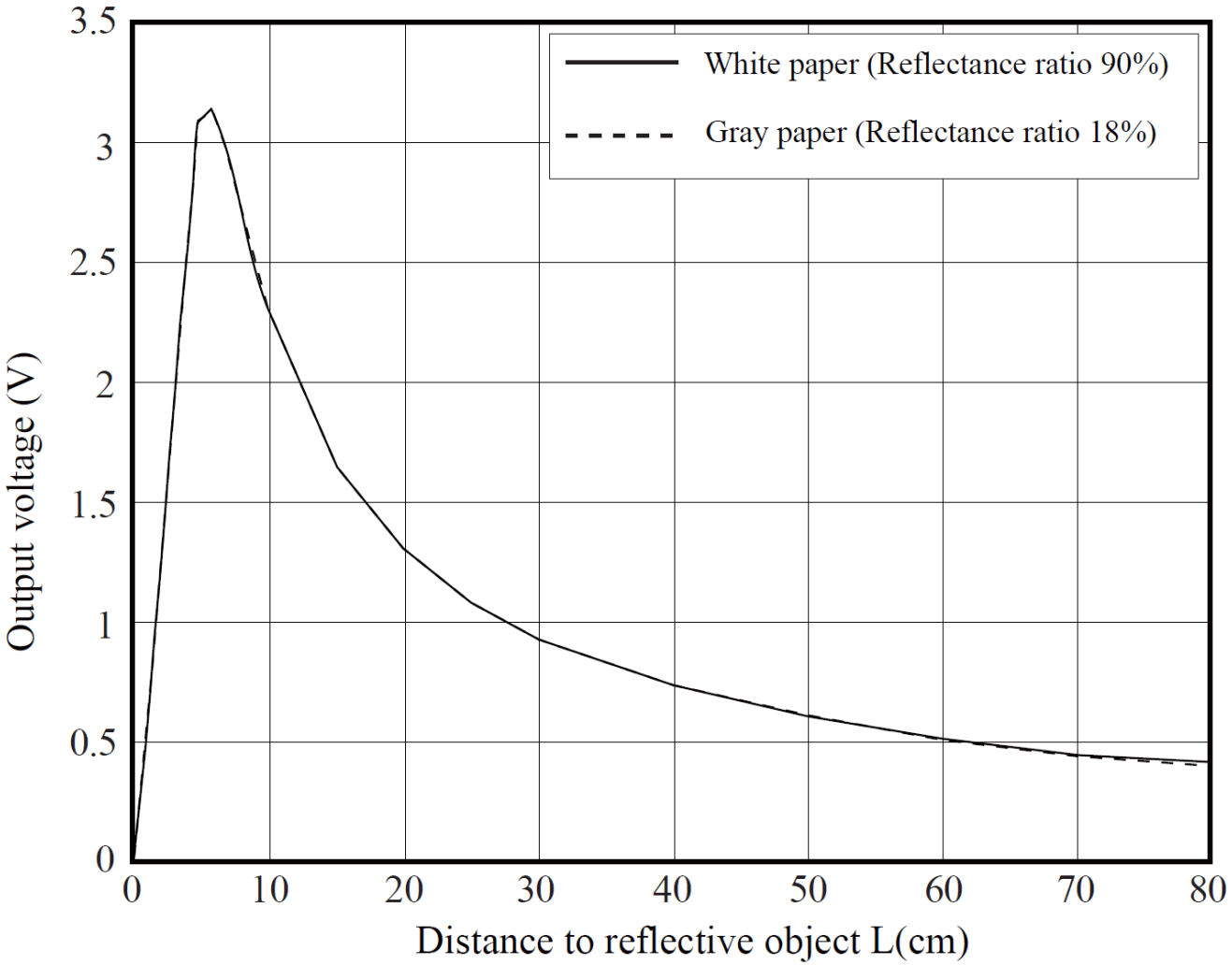
- Analog output voltage corresponds to distance.
  模擬輸出電壓和距離相關。

- Operates on 4.5-5.5 V supply.
  電源 4.5 至 5.5 伏特。

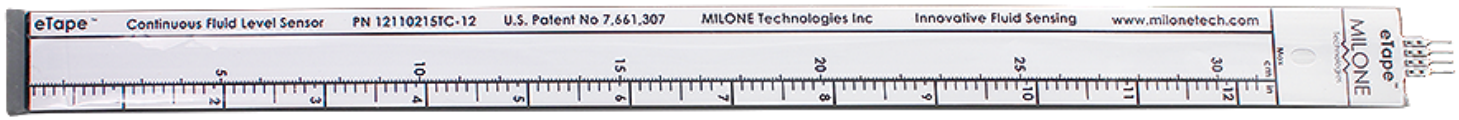




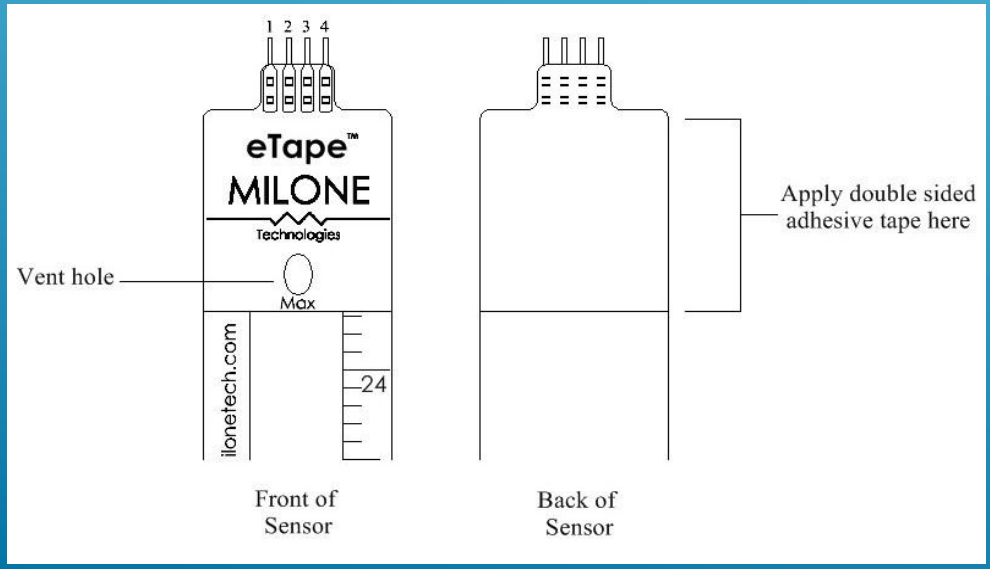
Sharp Distance Measuring Sensor
Sharp 測距傳感器



Parallax **eTape Standard Liquid Level Sensor (12-inch)** #29131
Parallax eTape 標準液位傳感器（12吋）#29131



http://www.parallax.com/product/29131



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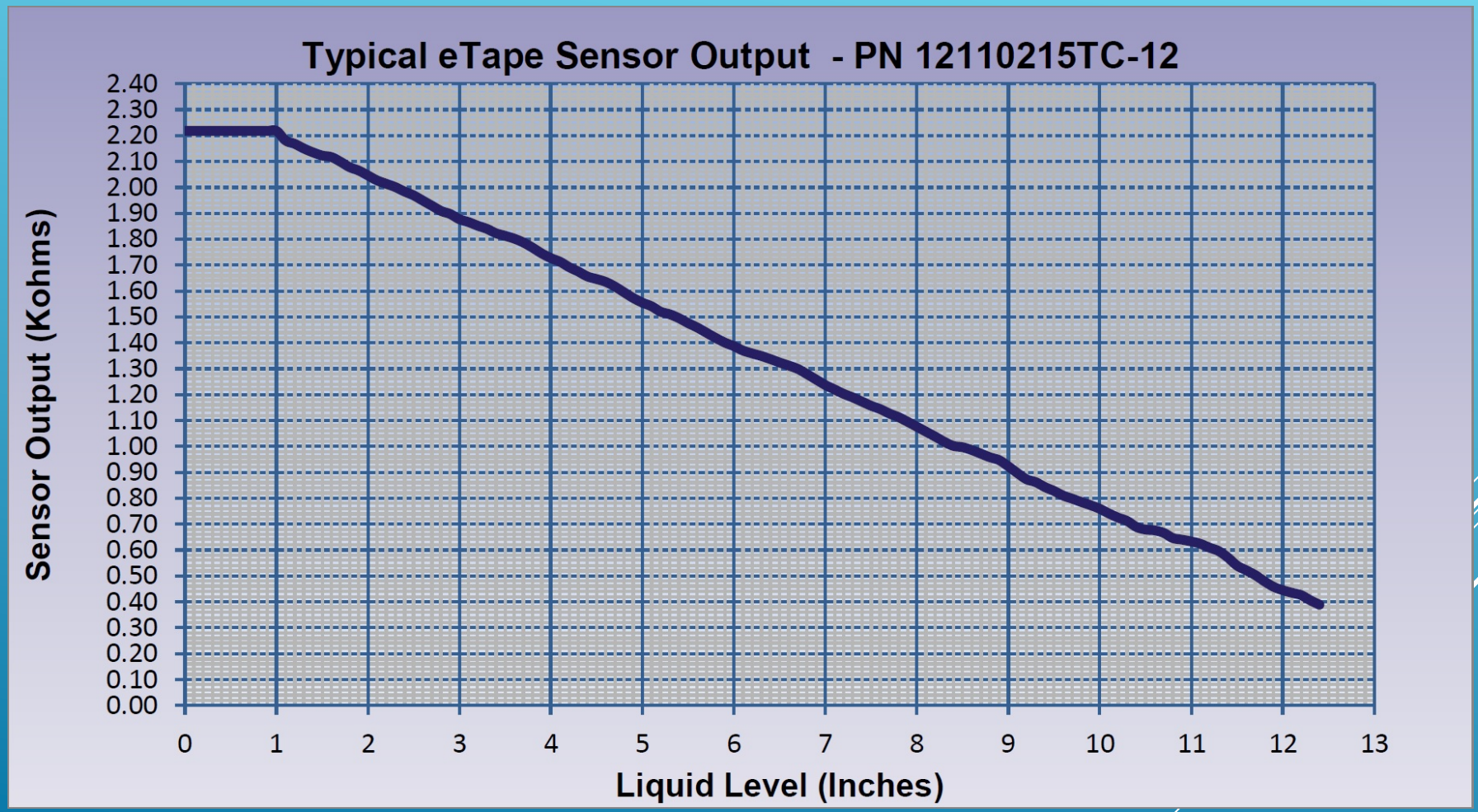

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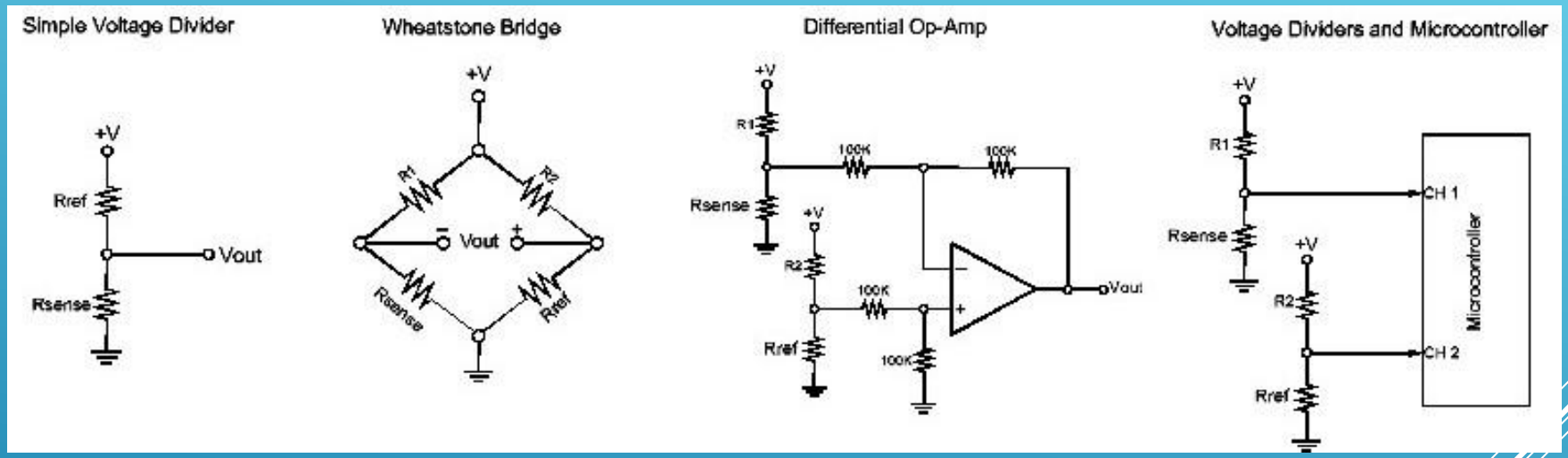
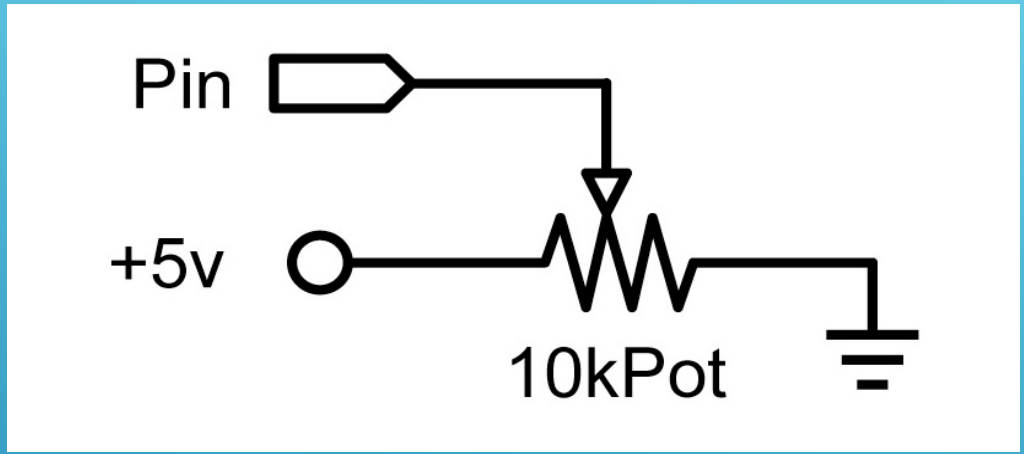
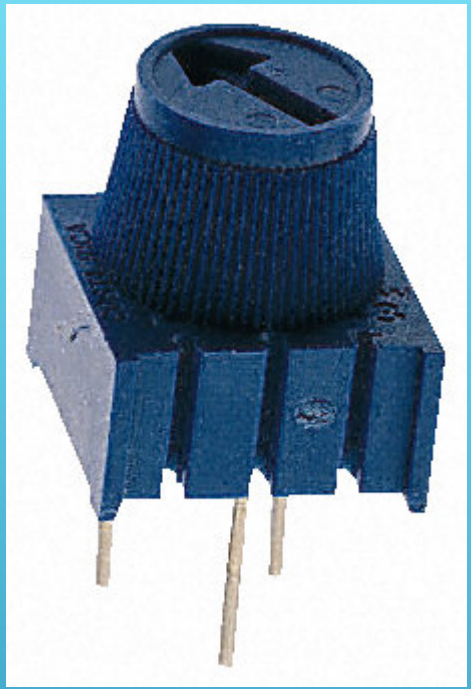
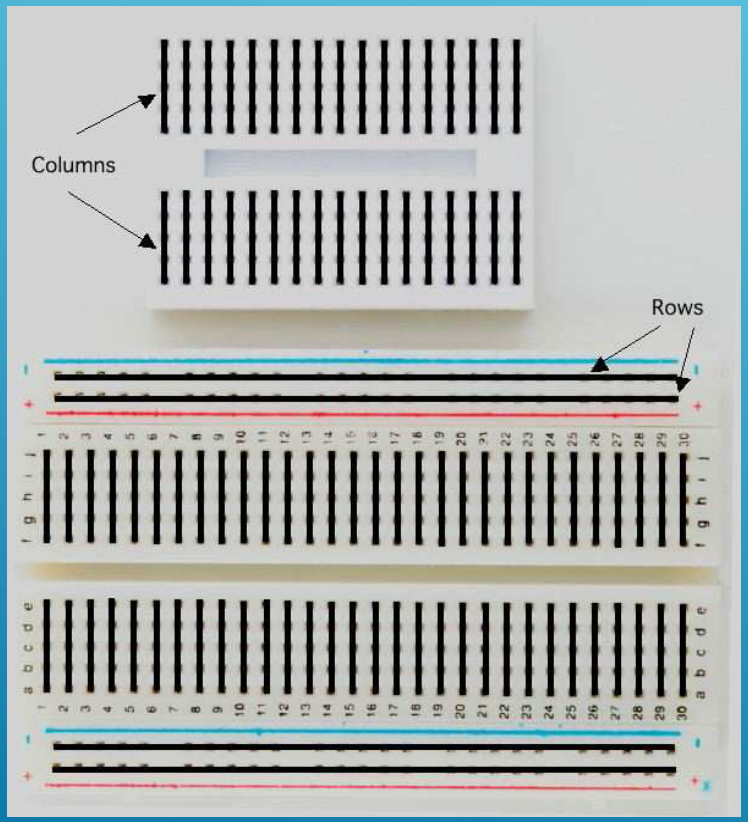


Potentiometer Input
電位器輸入

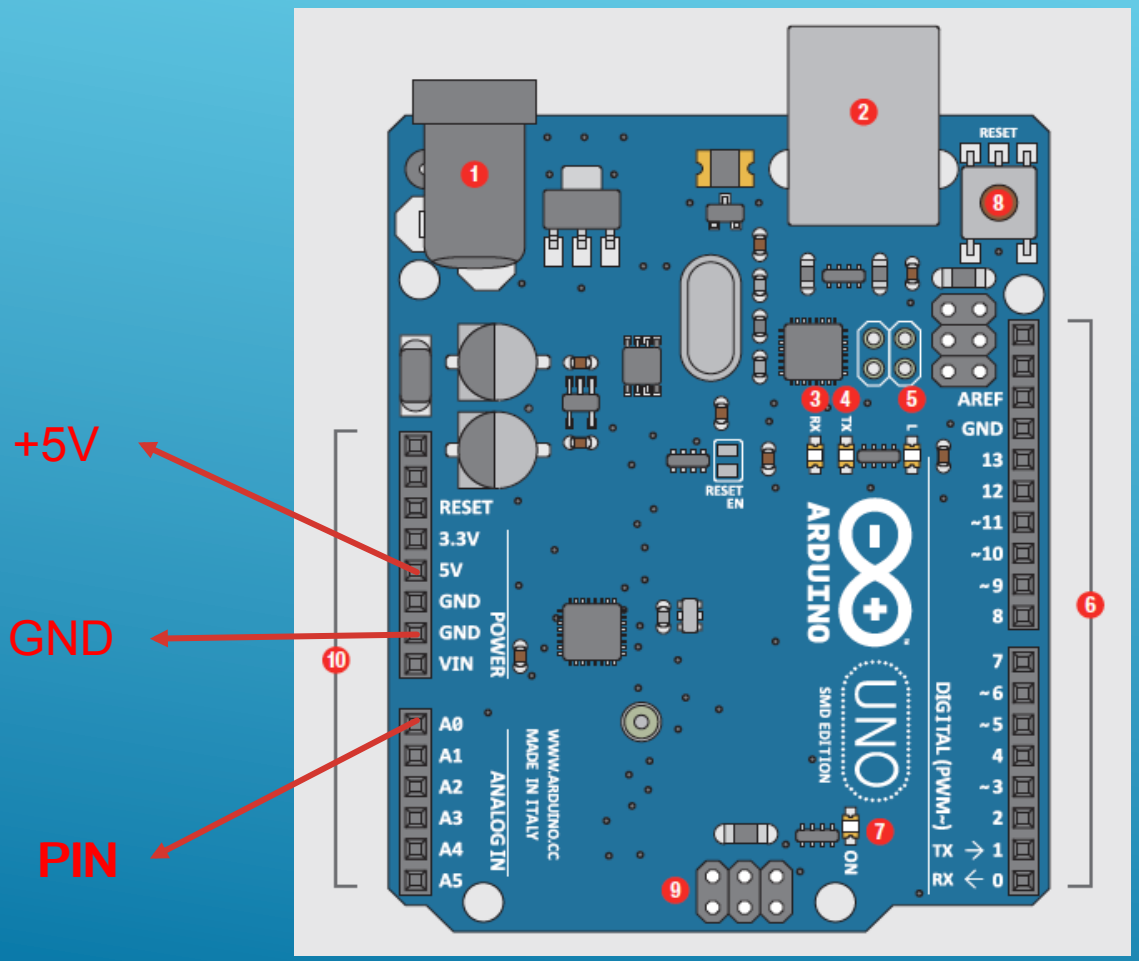




Bread Board　麵包板



Circuit connection　電路連接



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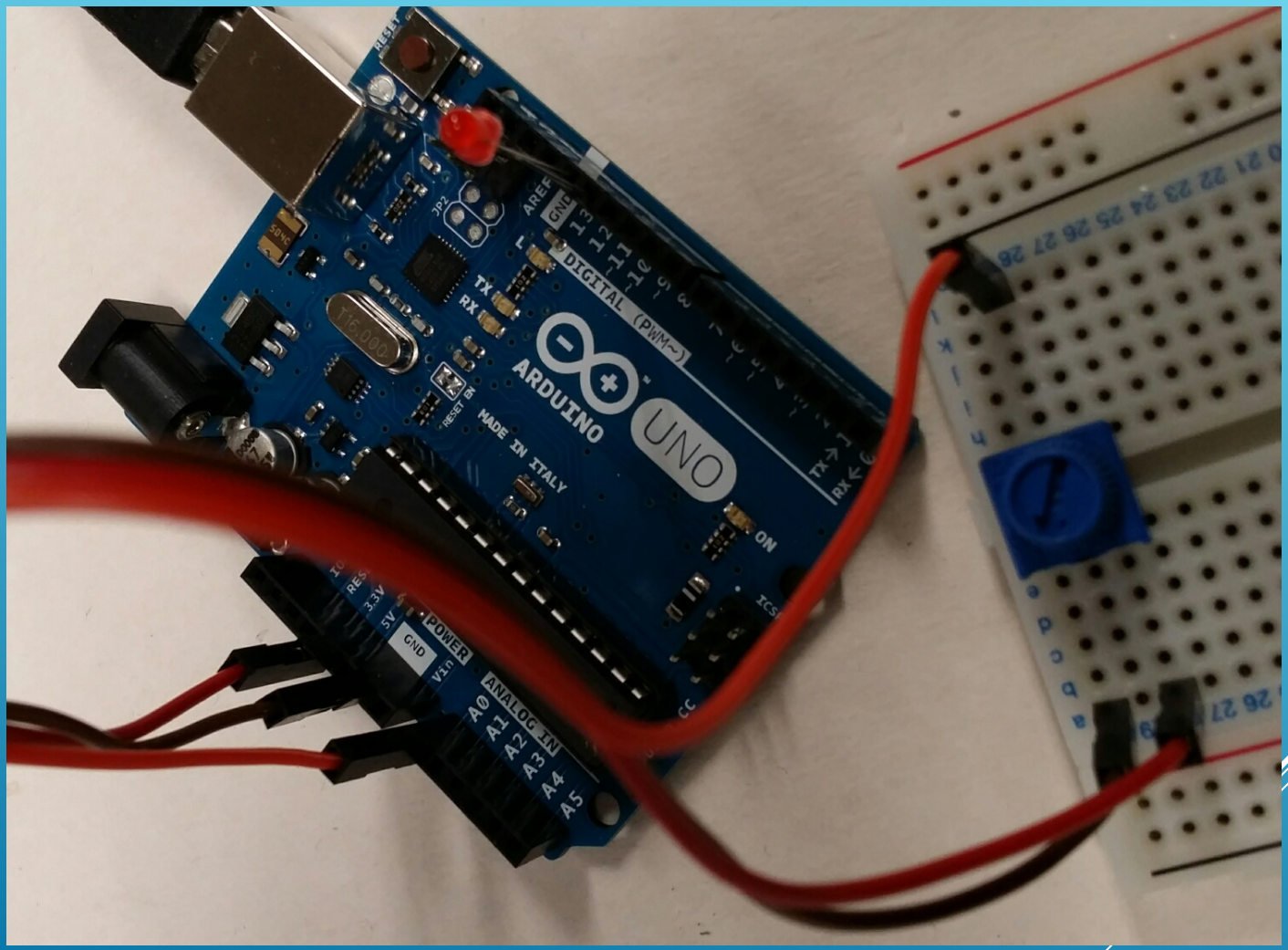
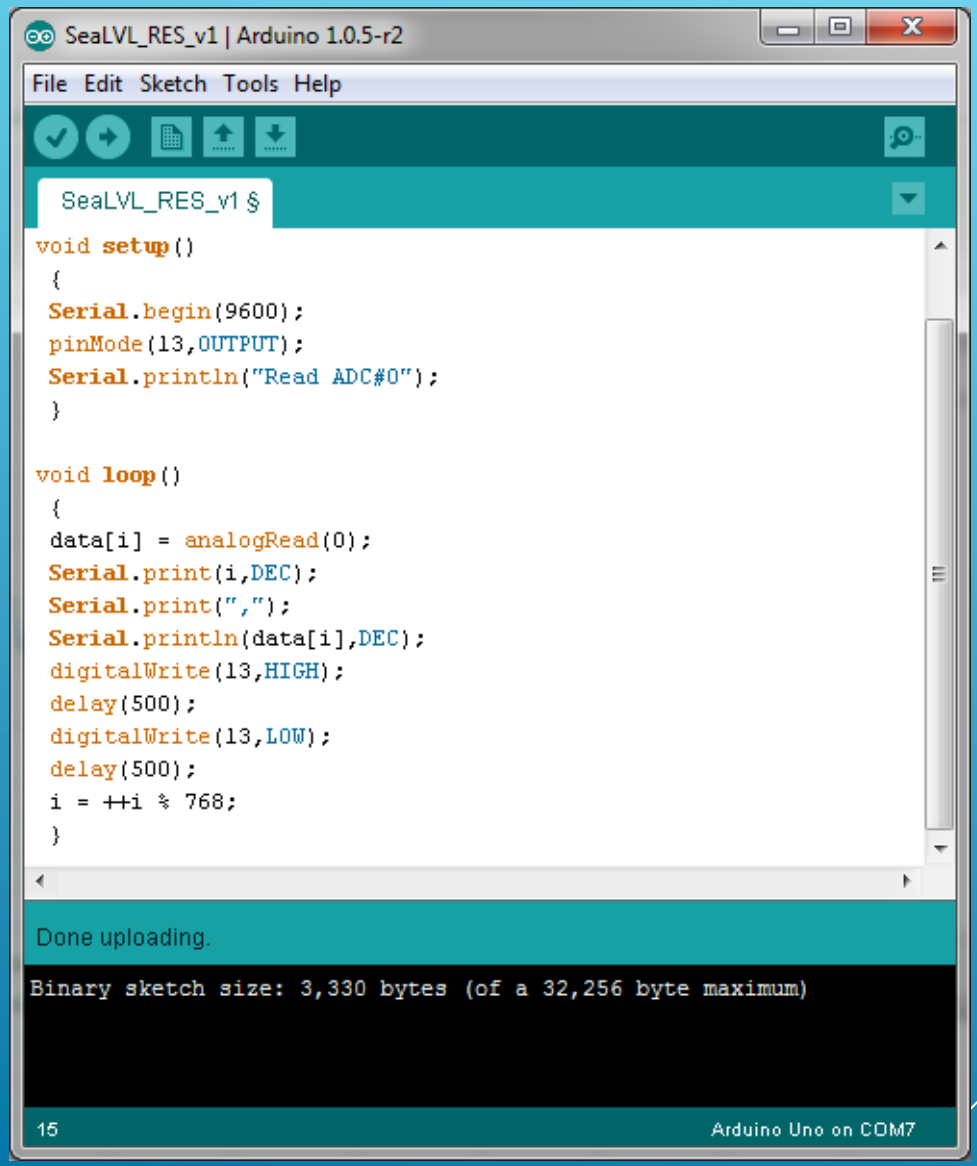
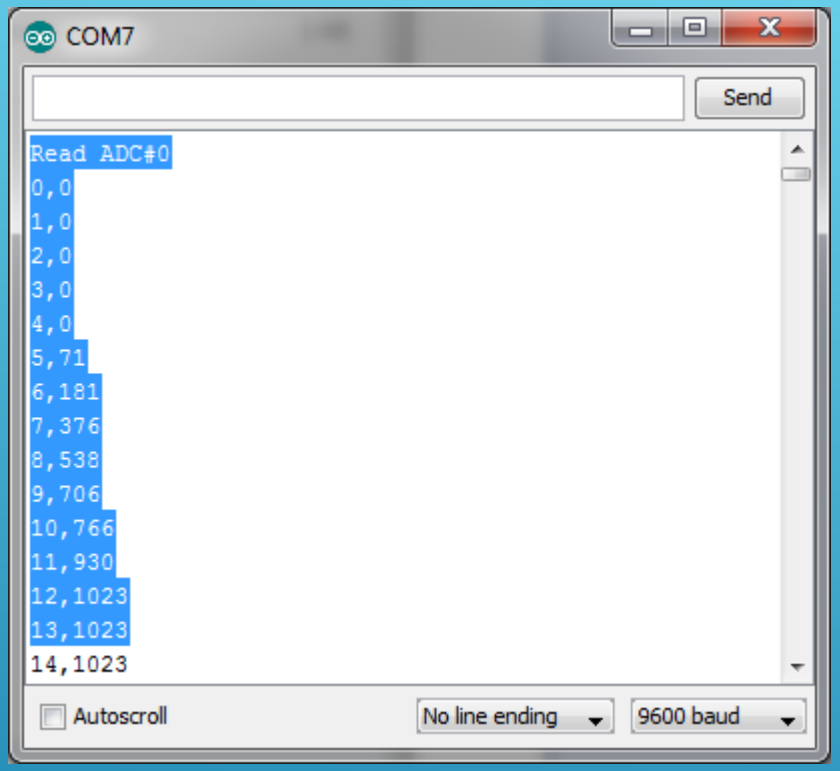
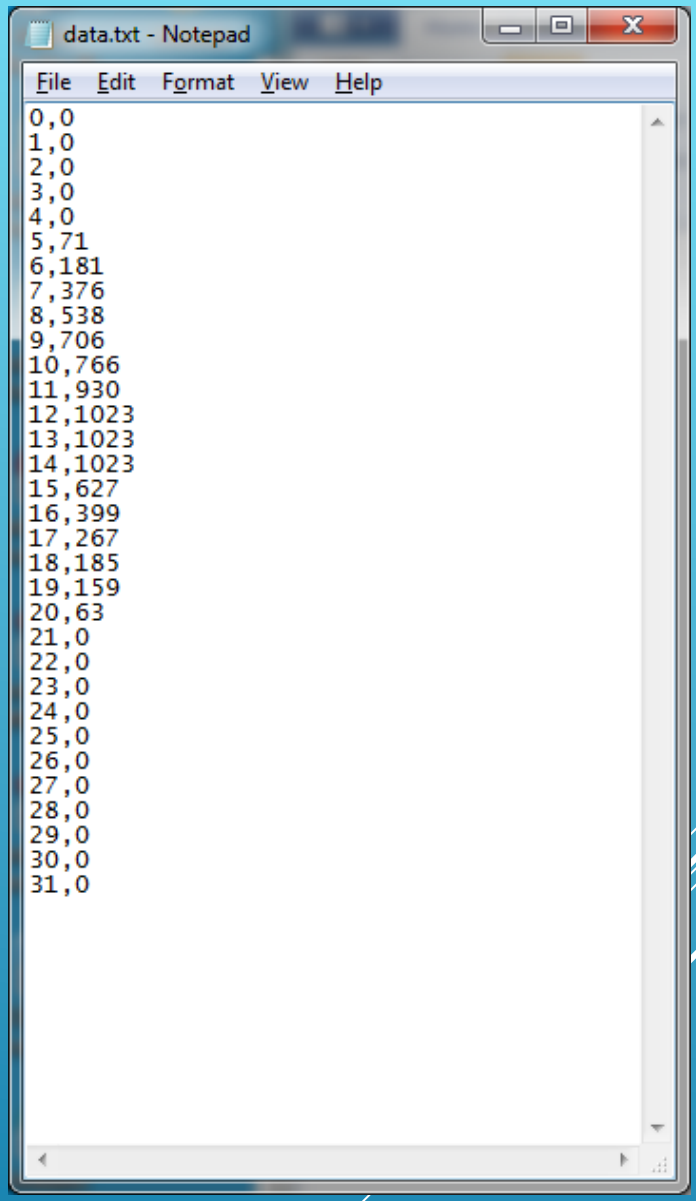


Programming 程式

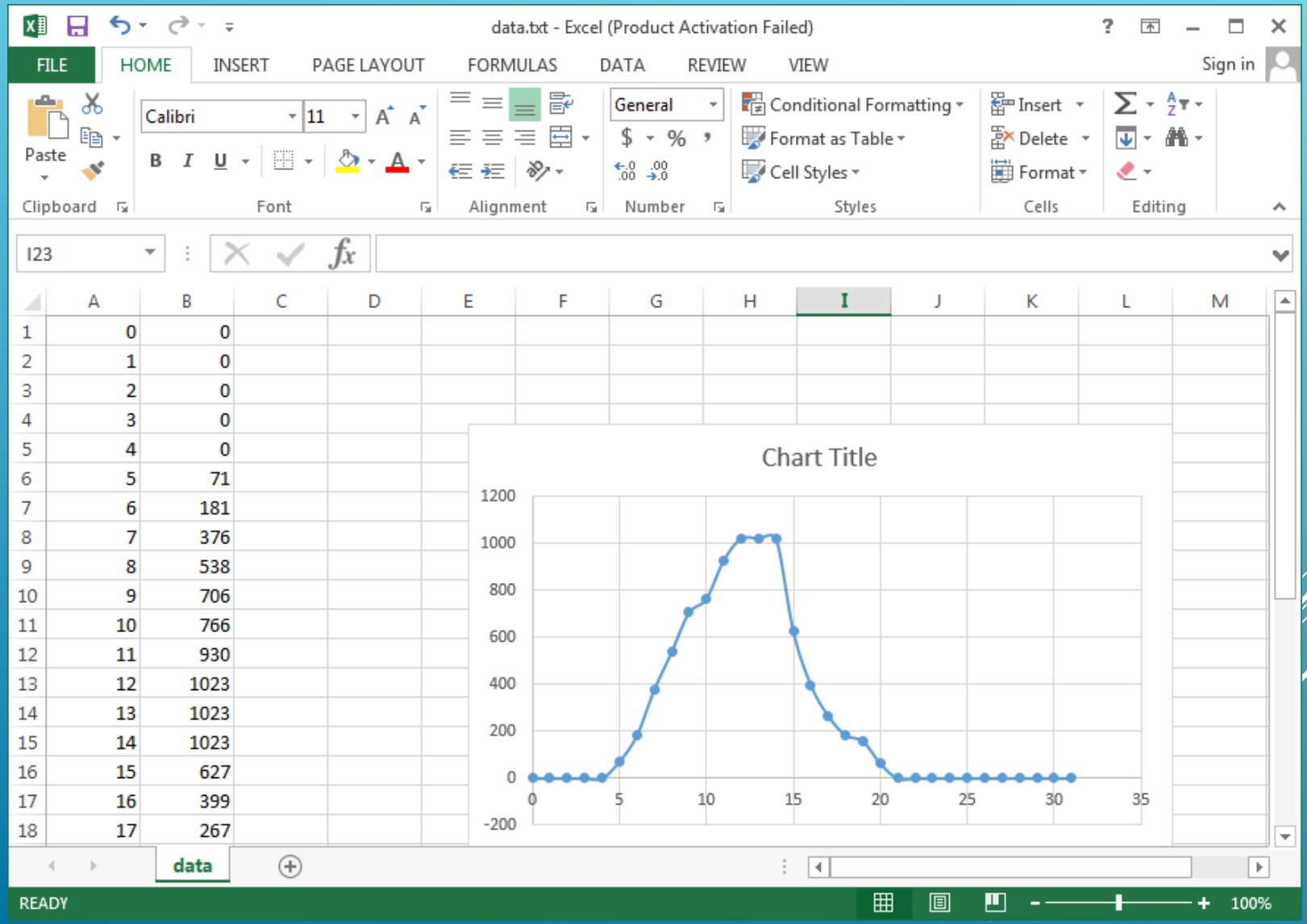


Data Logging　記錄資料





Graph Plotting　繪製圖表



	A	B
1	0	0
2	1	0
3	2	0
4	3	0
5	4	0
6	5	71
7	6	181
8	7	376
9	8	538
10	9	706
11	10	766
12	11	930
13	12	1023
14	13	1023
15	14	1023
16	15	627
17	16	399
18	17	267