UNIVERSITAT POLITÈCNICA DE CATALUNYA
BARCELONATECH
Escola d'Enginyeria de Barcelona Est

TRABAJO FIN DE GRADO

Grado en Ingeniería Electrónica Industrial y Automática

SISTEMA DE ADQUISICIÓN DE DATOS PARA UNA BICICLETA ELÉCTRICA

Anexos

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ÍNDICE

```
#include <LiquidCrystal.h>
#include <Wire.h>
#include "RTClib.h"


LiquidCrystal lcd (13, 12, 11, 10, 9, 8);
RTC_DS1307 RTC;

volatile float tiempo0 = 0;
volatile float tiempo1 = 0;

const int hallPin = 2;
const int pin_mq = 3;
const int pot = A2;
const int LDR = A1;
const int LEDL = 7;
const int LEDA = 6;
const int BOTON1 = 5;
const int BOTON2 = 4;
const int BOTON3 = A3;

int val1;                 //valor botón temperatura
int val2;                 //valor botón velocidad
int val3;                 //valor botón batería
int valor;                //variable que almacena la lectura del potenciómetro
int posicion;             //posición del potenciómetro en tanto por ciento
int luminosidad;
int umbral = 500;         //valor entre 0 y 1023


int cont = 0;
int estadoActual1 = 0;
int estadoActual2 = 0;
int estadoUltimo = 0;
float VEL = 0.00;
float VELMAX = 0.00;
float omega = 0;
const float pi = 3.14159;
const float dosPi = 6.28318;
const float radioRueda = 0.33;   //rueda de 26'', en m. Hace falta para calcular la velocidad lineal
float perimetroRueda = dosPi*(radioRueda);  //calcula el perímetro en m.
float distRecorrida = 0;
float distKM = 0;
```

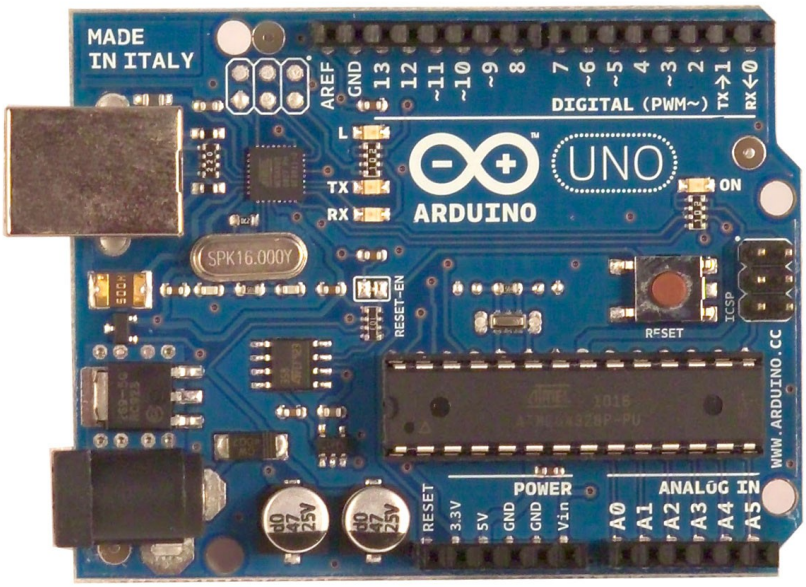
```
void setup () {
  Wire.begin ();              //configura el bus I2C estableciendo Arduino como MASTER
  RTC.begin ();
  if (! RTC.isrunning())      // se verifica si el módulo rtc está en funcionamiento, de lo contrario,
                              se imprime: RTC is NOT running!
    {
          lcd.println ("RTC is NOT running!");
           delay (10000);
    }
          RTC.adjust (DateTime (__DATE__, __TIME__));
          pinMode (pin_mq, INPUT);
          pinMode (pot, INPUT);
          pinMode (BOTON1, INPUT);
          pinMode (BOTON2, INPUT);
          pinMode (BOTON3, INPUT);
          pinMode (LEDL, OUTPUT);
          pinMode (LEDA, OUTPUT);
          pinMode (hallPin, INPUT);

          lcd.begin (16, 2);
          lcd.clear ();
          attachInterrupt (0, pulsoRueda, FALLING);
}

void loop () {
        calidad ();
        luz ();
        val1 = digitalRead (BOTON1);
        val2 = digitalRead (BOTON2);
        val3 = digitalRead (BOTON3);
        if (val1 == HIGH) {
          lcd.print ("Temperatura");
          lcd.setCursor (0, 1);
          lcd.print ("C=");
          float centigrados = leerGradosC ();
          lcd.setCursor (2, 1);
          lcd.print (centigrados);
          delay (1000);
          lcd.clear ();
     }
        else if (val 2== HIGH) {
          velocidad ()
          delay (1000);
          lcd.clear ();
    }
        else if (val3 == HIGH) {
          tension ();
          delay (1000);
          lcd.clear ();
    }
```

```
        else {
            mostrarRTCLCD ();
            delay (1000);
            lcd.clear ();
    }
}

float leerGradosC() {
    float dato;
    float gradosC;
    dato = analogRead (A0);
    gradosC = ((500.0 * dato /1024)-50);
    return gradosC;
     }

void calidad ()
{
     boolean mq_estado = digitalRead(pin_mq);          //Leemos el sensor
     if (mq_estado)                                    //si la salida del sensor es 1
     {
          digitalWrite (LEDA, LOW);                    //apaga led rojo
          delay (10);
     }
     else                                              //si la salida del sensor es 0
     {
          digitalWrite (LEDA, HIGH);                   //enciende led rojo
          delay (10);
     }
}

void luz ()
{
     luminosidad = analogRead (LDR);
     if (luminosidad > umbral)                         //valor experimental
     {
          digitalWrite (LEDL, LOW);
     }
      else
     {
          digitalWrite (LEDL, HIGH);
          delay (500);
          digitalWrite (LEDL, LOW);
          delay (500);
     }
}
```

```
void tensión ()
{
    valor = analogRead (pot);
    posicion = map (valor, 0, 1023, 0, 100);
    lcd.print ("Nivel Bateria");
    lcd.setCursor (0,1);
    lcd.print (posicion);
    lcd.setCursor (2,1);
    lcd.print ("%");

}

void velocidad ()
{
    lcd.setCursor (0, 0);
    lcd.print ("D = ");
    lcd.setCursor (0, 1);
    lcd.print ("V = ");
    lcd.setCursor (9, 1);
    lcd.prin t("km/h");
    lcd.setCursor (4, 0);
        if (distRecorrida <= 999) {
                lcd.print (distRecorrida);
                lcd.write ("m");
                delay (1000);
        }
        else {
                lcd.print (distKM);
                lcd.write ("Km");
                delay (1000);
        }
 lcd.setCursor (4, 1);
 lcd.print (VEL, 2);
 if (VEL >= VELMAX) {
  VELMAX = VEL;
 }
 else {
 }
 estadoActual1 = digitalRead (2);
    delay (10);
    estadoActual2 = digitalRead (2);
    if (estadoActual1 == estadoActual2) {        //Si los estados no son iguales, el sketch no
                                                 hace gran cosa
        if (estadoActual1 != estadoUltimo){
            if (estadoActual1 == HIGH) {
               cont = cont + 1;
               distancia ();
             }
        }
    }
  estadoUltimo= estadoActual1;
}
```

```
void pulsoRueda () {
    tiempo1 = micros ();
    omega = (dosPi * 1000000 / (tiempo1 - tiempo0));    //Omega en radianes/segundo
    VEL = omega * radioRueda * 3.6;                     //Velocidad en Km/hora
    tiempo0 = tiempo1;
    }

void distancia () {
    distRecorrida = perimetroRueda*cont;
    distKM = distRecorrida/1000;
     }

void mostrarRTCLCD ()           //Función que lee los datos de modulo RTC y después los
                                imprime en el display
{
    DateTime now = RTC.now ();          // obtiene datos del módulo RTC
    lcd.clear ();
    lcd.setCursor (0, 0);
    if (now.day () < 10)
    {
          lcd.print ("0");
   }
    lcd.print (now.day (), DEC);        // imprime el día
    lcd.print ('/');
    if (now.month () < 10)
     {
          lcd.print ("0");
     }
    lcd.print (now.month (), DEC);      // imprime el mes
    lcd.print ('/');
    lcd.print (now.year (), DEC);       //imprime el año
    lcd.setCursor (0,1);
    if (now.hour () < 10)
     {
          lcd.print ("0");
     }
    lcd.print (now.hour(), DEC);        // imprime la hora
    lcd.print (':');
    if(now.minute()  <  10)
    {
          lcd.print ("0");
    }
    lcd.print (now.minute(), DEC);      // imprime los minutos
    lcd.print (':');
    if (now.second() < 10)
     {
          lcd.print ("0");
     }
    lcd.print (now.second(), DEC);      // imprime los segundos
}
```

Arduino UNO



Product Overview

The Arduino Uno is a microcontroller board based on the ATmega328 (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started. The Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega8U2 programmed as a USB-to-serial converter.

"Uno" means one in Italian and is named to mark the upcoming release of Arduino 1.0. The Uno and version 1.0 will be the reference versions of Arduno, moving forward. The Uno is the latest in a series of USB Arduino boards, and the reference model for the Arduino platform; for a comparison with previous versions, see the index of Arduino boards.

Index

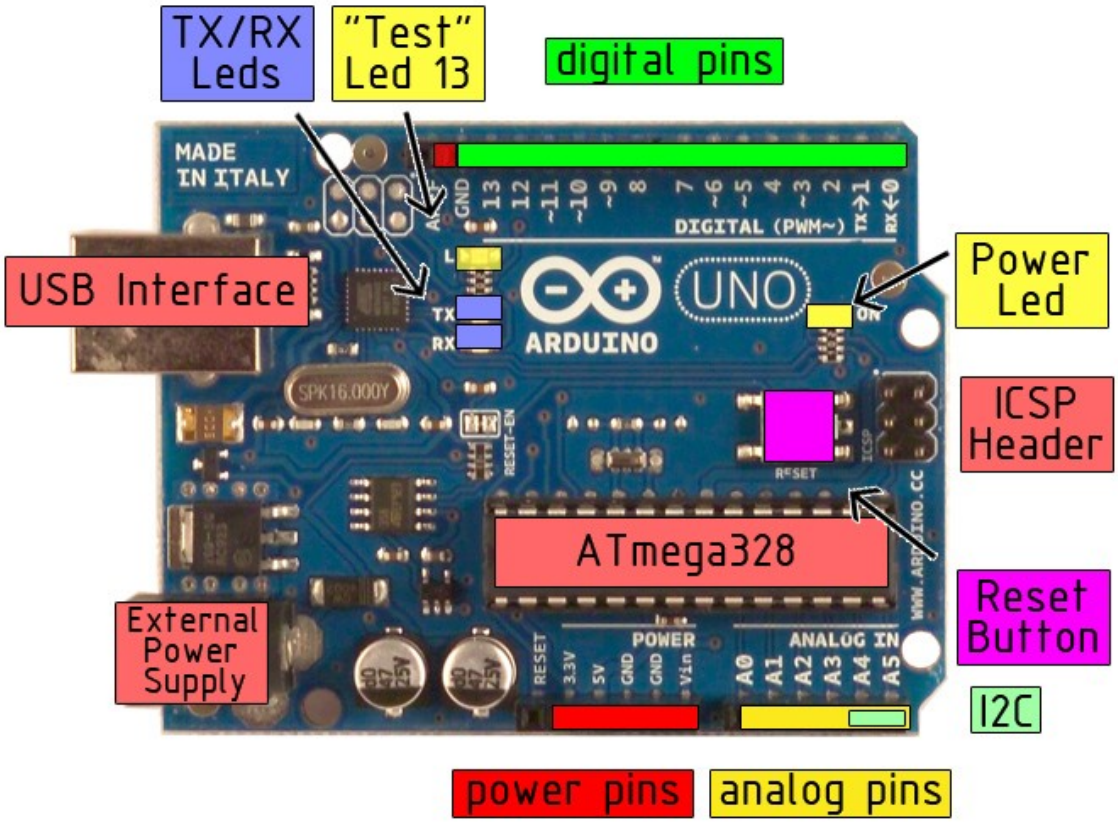
Technical Specification

EAGLE files: arduino-duemilanove-uno-design.zip Schematic: arduino-uno-schematic.pdf

Summary

Microcontroller	ATmega328
Operating Voltage	5V
Input Voltage (recommended)	7-12V
Input Voltage (limits)	6-20V
Digital I/O Pins	14 (of which 6 provide PWM output)
Analog Input Pins	6
DC Current per I/O Pin	40 mA
DC Current for 3.3V Pin	50 mA
Flash Memory	32 KB of which 0.5 KB used by bootloader
SRAM	2 KB
EEPROM	1 KB
Clock Speed	16 MHz

the board



Power

The Arduino Uno can be powered via the USB connection or with an external power supply. The power source is selected automatically.

External (non-USB) power can come either from an AC-to-DC adapter (wall-wart) or battery. The adapter can be connected by plugging a 2.1mm center-positive plug into the board's power jack. Leads from a battery can be inserted in the Gnd and Vin pin headers of the POWER connector.

The board can operate on an external supply of 6 to 20 volts. If supplied with less than 7V, however, the 5V pin may supply less than five volts and the board may be unstable. If using more than 12V, the voltage regulator may overheat and damage the board. The recommended range is 7 to 12 volts.

The power pins are as follows:

- **VIN.** The input voltage to the Arduino board when it's using an external power source (as opposed to 5 volts from the USB connection or other regulated power source). You can supply voltage through this pin, or, if supplying voltage via the power jack, access it through this pin.
- **5V.** The regulated power supply used to power the microcontroller and other components on the board. This can come either from VIN via an on-board regulator, or be supplied by USB or another regulated 5V supply.
- **3V3.** A 3.3 volt supply generated by the on-board regulator. Maximum current draw is 50 mA.
- **GND.** Ground pins.

Memory

The Atmega328 has 32 KB of flash memory for storing code (of which 0,5 KB is used for the bootloader); It has also 2 KB of SRAM and 1 KB of EEPROM (which can be read and written with the EEPROM library).

Input and Output

Each of the 14 digital pins on the Uno can be used as an input or output, using pinMode(), digitalWrite(), and digitalRead() functions. They operate at 5 volts. Each pin can provide or receive a maximum of 40 mA and has an internal pull-up resistor (disconnected by default) of 20-50 kOhms. In addition, some pins have specialized functions:

- **Serial: 0 (RX) and 1 (TX).** Used to receive (RX) and transmit (TX) TTL serial data. TThese pins are connected to the corresponding pins of the ATmega8U2 USB-to-TTL Serial chip .
- **External Interrupts: 2 and 3.** These pins can be configured to trigger an interrupt on a low value, a rising or falling edge, or a change in value. See the attachInterrupt() function for details.
- **PWM: 3, 5, 6, 9, 10, and 11.** Provide 8-bit PWM output with the analogWrite() function.
- **SPI: 10 (SS), 11 (MOSI), 12 (MISO), 13 (SCK).** These pins support SPI communication, which, although provided by the underlying hardware, is not currently included in the Arduino language.

- **LED: 13.** There is a built-in LED connected to digital pin 13. When the pin is HIGH value, the LED is on, when the pin is LOW, it's off.

The Uno has 6 analog inputs, each of which provide 10 bits of resolution (i.e. 1024 different values). By default they measure from ground to 5 volts, though is it possible to change the upper end of their range using the AREF pin and the analogReference() function. Additionally, some pins have specialized functionality:

- **I²C: 4 (SDA) and 5 (SCL).** Support I²C (TWI) communication using the Wire library.

There are a couple of other pins on the board:

- **AREF.** Reference voltage for the analog inputs. Used with analogReference().
- **Reset.** Bring this line LOW to reset the microcontroller. Typically used to add a reset button to shields which block the one on the board.

See also the mapping between Arduino pins and Atmega328 ports.

Communication

The Arduino Uno has a number of facilities for communicating with a computer, another Arduino, or other microcontrollers. The ATmega328 provides UART TTL (5V) serial communication, which is available on digital pins 0 (RX) and 1 (TX). An ATmega8U2 on the board channels this serial communication over USB and appears as a virtual com port to software on the computer. The '8U2 firmware uses the standard USB COM drivers, and no external driver is needed. However, on Windows, an *.inf file is required..

The Arduino software includes a serial monitor which allows simple textual data to be sent to and from the Arduino board. The RX and TX LEDs on the board will flash when data is being transmitted via the USB-to-serial chip and USB connection to the computer (but not for serial communication on pins 0 and 1).

A SoftwareSerial library allows for serial communication on any of the Uno's digital pins.

The ATmega328 also support I2C (TWI) and SPI communication. The Arduino software includes a Wire library to simplify use of the I2C bus; see the documentation for details. To use the SPI communication, please see the ATmega328 datasheet.

Programming

The Arduino Uno can be programmed with the Arduino software (download). Select "Arduino Uno w/ ATmega328" from the **Tools > Board** menu (according to the microcontroller on your board). For details, see the reference and tutorials.

The ATmega328 on the Arduino Uno comes preburned with a bootloader that allows you to upload new code to it without the use of an external hardware programmer. It communicates using the original STK500 protocol (reference, C header files).

You can also bypass the bootloader and program the microcontroller through the ICSP (In-Circuit Serial Programming) header; see these instructions for details.

The ATmega8U2 firmware source code is available . The ATmega8U2 is loaded with a DFU bootloader, which can be activated by connecting the solder jumper on the back of the board (near the map of Italy) and then resetting the 8U2. You can then use Atmel's FLIP software (Windows) or the DFU programmer (Mac OS X and Linux) to load a new firmware. Or you can use the ISP header with an external programmer (overwriting the DFU bootloader).

Automatic (Software) Reset

Rather than requiring a physical press of the reset button before an upload, the Arduino Uno is designed in a way that allows it to be reset by software running on a connected computer. One of the hardware flow control lines (DTR) of the ATmega8U2 is connected to the reset line of the ATmega328 via a 100 nanofarad capacitor. When this line is asserted (taken low), the reset line drops long enough to reset the chip. The Arduino software uses this capability to allow you to upload code by simply pressing the upload button in the Arduino environment. This means that the bootloader can have a shorter timeout, as the lowering of DTR can be well-coordinated with the start of the upload.

This setup has other implications. When the Uno is connected to either a computer running Mac OS X or Linux, it resets each time a connection is made to it from software (via USB). For the following half-second or so, the bootloader is running on the Uno. While it is programmed to ignore malformed data (i.e. anything besides an upload of new code), it will intercept the first few bytes of data sent to the board after a connection is opened. If a sketch running on the board receives one-time configuration or other data when it first starts, make sure that the software with which it communicates waits a second after opening the connection and before sending this data.

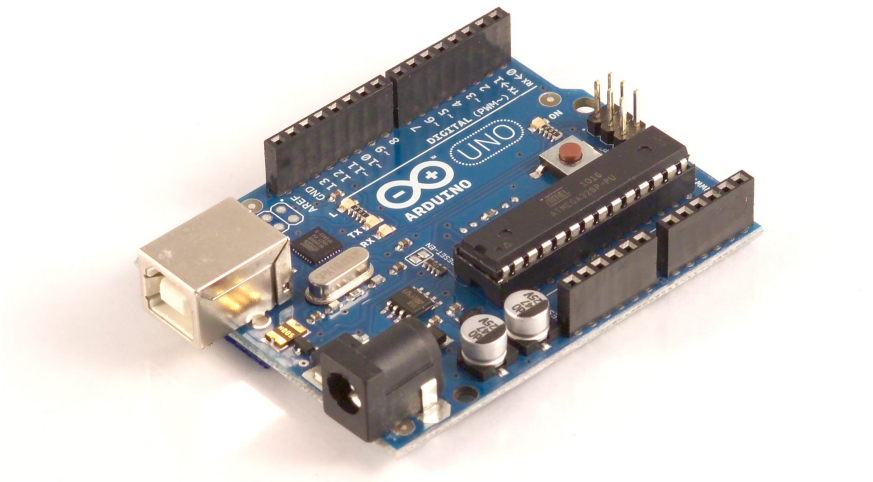
The Uno contains a trace that can be cut to disable the auto-reset. The pads on either side of the trace can be soldered together to re-enable it. It's labeled "RESET-EN". You may also be able to disable the auto-reset by connecting a 110 ohm resistor from 5V to the reset line; see this forum thread for details.

USB Overcurrent Protection

The Arduino Uno has a resettable polyfuse that protects your computer's USB ports from shorts and overcurrent. Although most computers provide their own internal protection, the fuse provides an extra layer of protection. If more than 500 mA is applied to the USB port, the fuse will automatically break the connection until the short or overload is removed.

Physical Characteristics

The maximum length and width of the Uno PCB are 2.7 and 2.1 inches respectively, with the USB connector and power jack extending beyond the former dimension. Three screw holes allow the board to be attached to a surface or case. Note that the distance between digital pins 7 and 8 is 160 mil (0.16"), not an even multiple of the 100 mil spacing of the other pins.



How to use Arduino

Arduino can sense the environment by receiving input from a variety of sensors and can affect its surroundings by controlling lights, motors, and other actuators. The microcontroller on the board is programmed using the Arduino programming language (based on Wiring) and the Arduino development environment (based on Processing). Arduino projects can be stand-alone or they can communicate with software on running on a computer (e.g. Flash, Processing, MaxMSP).

Arduino is a cross-platoform program. You'll have to follow different instructions for your personal OS. Check on the Arduino site for the latest instructions. *http://arduino.cc/en/Guide/HomePage*

Linux Install Windows Install Mac Install

Once you have downloaded/unzipped the arduino IDE, you can Plug the Arduino to your PC via USB cable.

Blink led

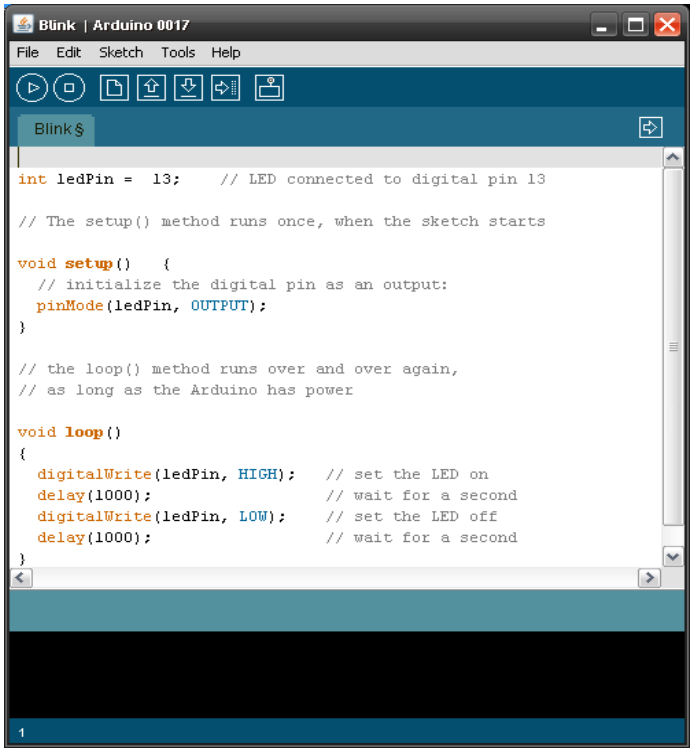
Now you're actually ready to "burn" your first program on the arduino board. To select "blink led", the physical translation of the well known programming "hello world", select

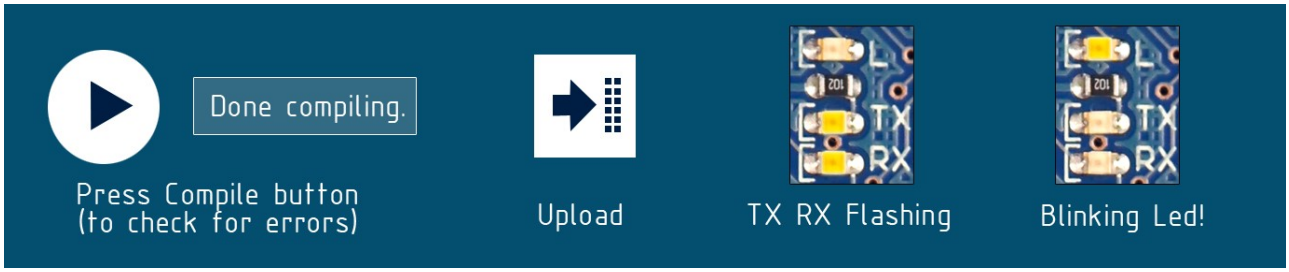
File>Sketchbook>
Arduino-0017>Examples>
Digital>Blink

Once you have your skecth you'll see something very close to the screenshot on the right.

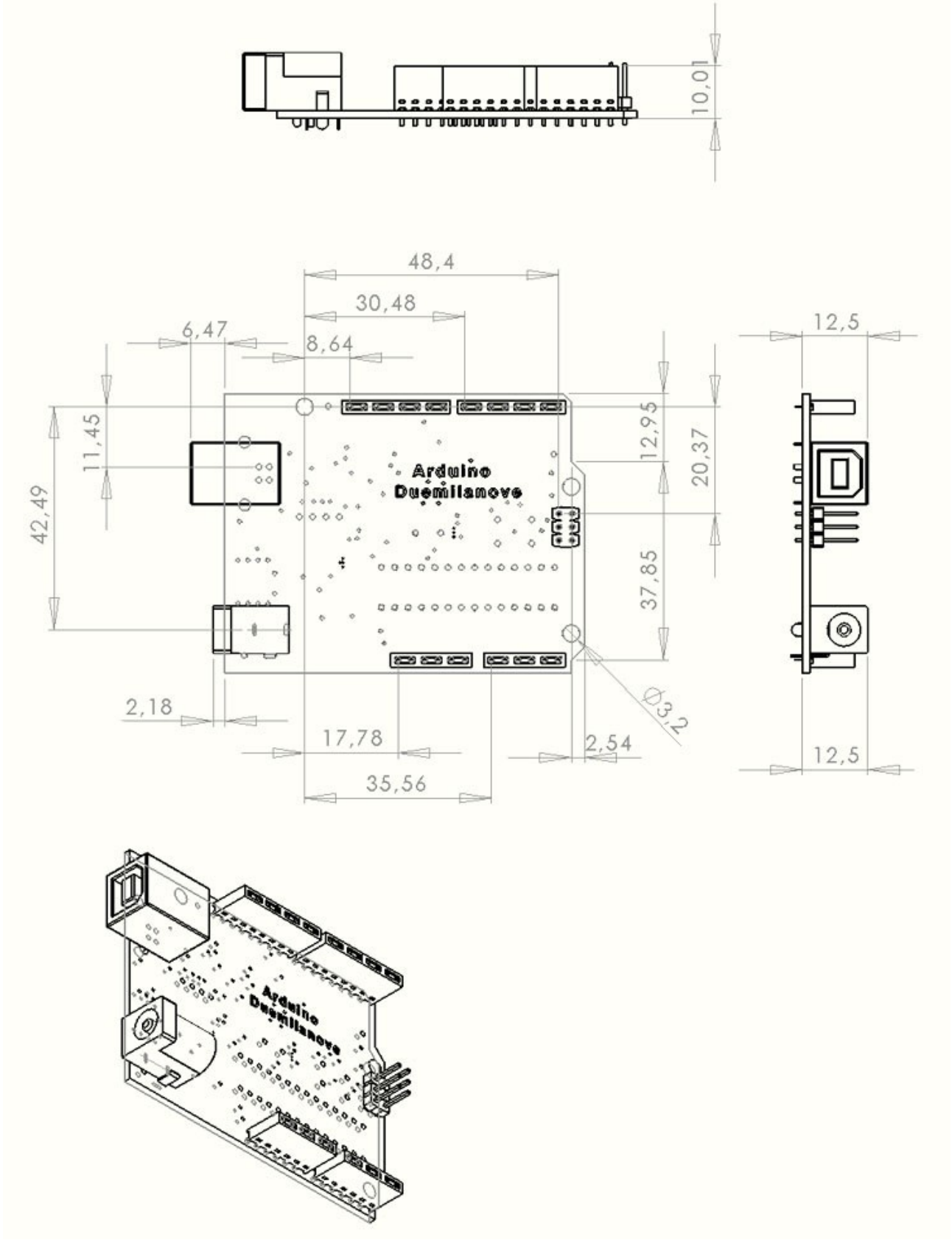
In **Tools>Board** select

Now you have to go to
Tools>SerialPort
and select the right serial port, the one arduino is attached to.





Dimensioned Drawing



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1.2 If any products fail to conform to the warranty set forth above, the producer's sole liability shall be to replace such products. The producer's liability shall be limited to products that are determined by the producer not to conform to such warranty. If the producer elects to replace such products, the producer shall have a reasonable time to replacements. Replaced products shall be warranted for a new full warranty period.

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Enviromental Policies

The producer of Arduino™ has joined the Impatto Zero® policy of LifeGate.it. For each Arduino board produced is created / looked after half squared Km of Costa Rica's forest's.

TECHNICAL DATA MQ-135 GAS SENSOR

FEATURES

Wide detecting scope Fast response and High sensitivity
Stable and long life Simple drive circuit

APPLICATION

They are used in air quality control equipments for buildings/offices, are suitable for detecting of NH3,NOx, alcohol, Benzene, smoke,CO_2 ,etc.

SPECIFICATIONS

A. Standard work condition

Symbol	Parameter name	Technical condition	Remarks
Vc	Circuit voltage	5V±0.1	AC OR DC
V_H	Heating voltage	5V±0.1	ACOR DC
R_L	Load resistance	can adjust	
R_H	Heater resistance	33Ω±5%	Room Tem
P_H	Heating consumption	less than 800mw	

B. Environment condition

Symbol	Parameter name	Technical condition	Remarks
Tao	Using Tem	-10□-45□	
Tas	Storage Tem	-20□-70□	
R_H	Related humidity	less than 95%Rh	
O_2	Oxygen concentration	21%(standard condition)Oxygen concentration can affect sensitivity	minimum value is over 2%

C. Sensitivity characteristic

Symbol	Parameter name	Technical parameter	Ramark 2
Rs	Sensing Resistance	30KΩ-200KΩ (100ppm NH_3)	Detecting concentration scope□ 10ppm-300ppm NH_3 10ppm-1000ppm Benzene 10ppm-300ppm Alcohol
α (200/50) NH_3	Concentration Slope rate	≤0.65	
Standard Detecting Condition	Temp: 20□±2□ Vc:5V±0.1 Humidity: 65%±5% Vh: 5V±0.1		
Preheat time	Over 24 hour		

D. Structure and configuration, basic measuring circuit

	Parts	Materials
1	Gas sensing layer	SnO_2
2	Electrode	Au
3	Electrode line	Pt
4	Heater coil	Ni-Cr alloy
5	Tubular ceramic	Al_2O_3
6	Anti-explosion network	Stainless steel gauze (SUS316 100-mesh)
7	Clamp ring	Copper plating Ni
8	Resin base	Bakelite
9	Tube Pin	Copper plating Ni

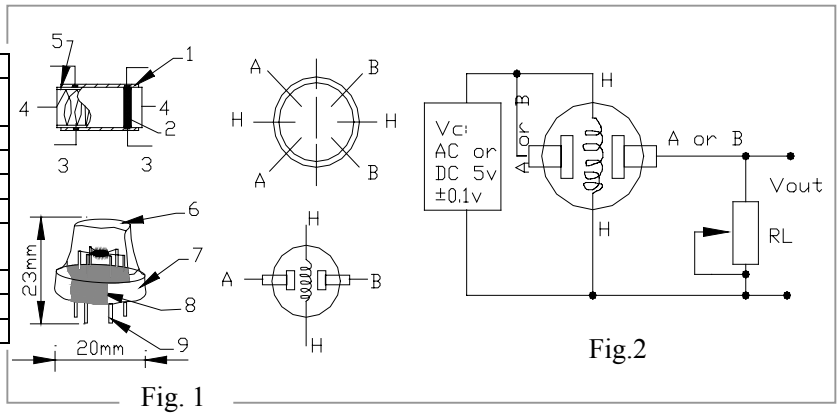
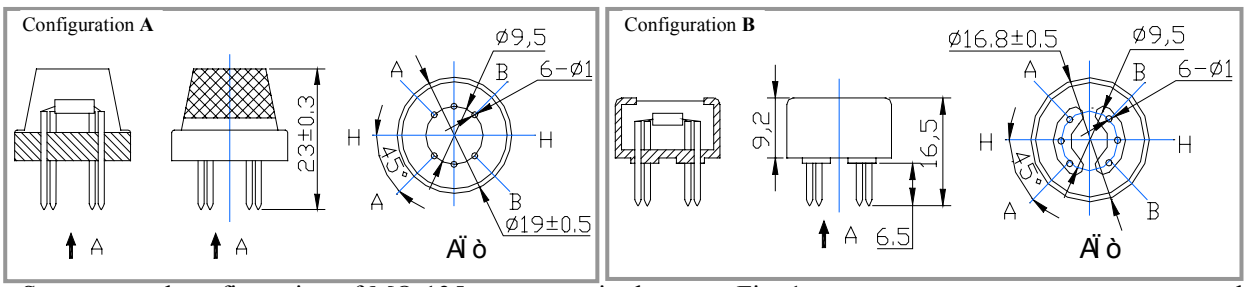


Fig. 1 Fig.2



Structure and configuration of MQ-135 gas sensor is shown as Fig. 1 (Configuration **A or B),** sensor composed by micro AL_2O_3 ceramic tube, Tin Dioxide (SnO_2) sensitive layer, measuring electrode and heater are fixed into a crust made by plastic and stainless steel net. The heater provides necessary work conditions for work of sensitive

components. The enveloped MQ-135 have 6 pin ,4 of them are used to fetch signals, and other 2 are used for providing heating current.

Electric parameter measurement circuit is shown as Fig.2

E. Sensitivity characteristic curve

Fig.2 sensitivity characteristics of the MQ-135

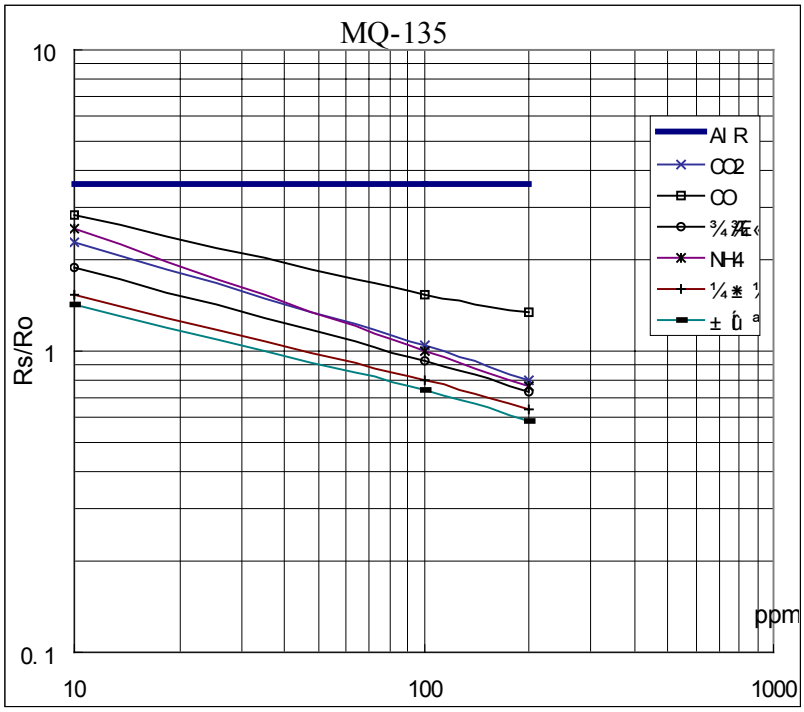


Fig.3 is shows the typical sensitivity characteristics of the MQ-135 for several gases.
in their: Temp: 20℃
Humidity: 65%
O_2 concentration 21%
RL=20kΩ
Ro: sensor resistance at 100ppm of NH_3 in the clean air.
Rs:sensor resistance at various concentrations of gases.

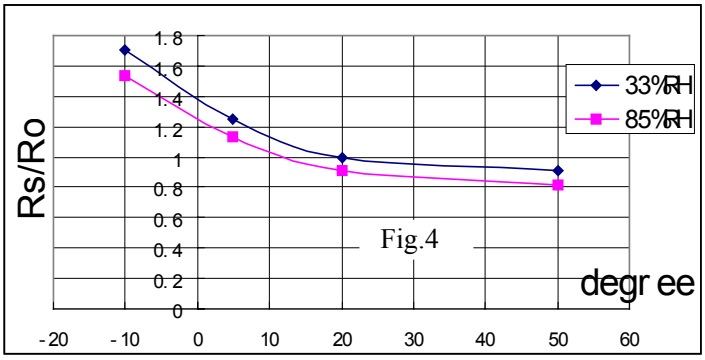


Fig.4 is shows the typical dependence of the MQ-135 on temperature and humidity.
Ro: sensor resistance at 100ppm of NH_3 in air at 33%RH and 20 degree.
Rs: sensor resistance at 100ppm of NH_3 at different temperatures and humidities.

SENSITVITY ADJUSTMENT

Resistance value of MQ-135 is difference to various kinds and various concentration gases. So,When using this components, sensitivity adjustment is very necessary. we recommend that you calibrate the detector for 100ppm NH_3 or 50ppm Alcohol concentration in air and use value of Load resistancethat(R_L) about 20 KΩ(10KΩ to 47 KΩ).

When accurately measuring, the proper alarm point for the gas detector should be determined after considering the temperature and humidity influence.