Agente para monitorear la calidad del aire

¿por qué es importante?

Ideas y notas de prensa

http://piratepad.net/AgentesCalidadAire

Dispositivo

¿Variables que mide??:

- location (lat,lon,alt): Mediante un GPS tomamos la ubicación de las muestras
- timestamp: Esta información también proviene de los datos del GPS.
- temperature: Obtenida de un sensor DHT-11
- humidity: Obtenida de un sensor DHT-11
- PM2dot5: Mide concentración de partículas de polvo. Tenemos dos sensores (Shinyei Model PPD42NS, Sharp GP2Y1010AU, PMS3003, PMS5003, PMS1003)
- mq-XXX: Detección de gases basado en los sensores mq. http://playground.arduino.cc/Main/MQGasSensors

Firmware

Comparación de diferentes sensores http://aqicn.org/sensor/
http://www.gassensor.com.cn/product_en/typeid/19.html

Sensores

Sensor bosch portable

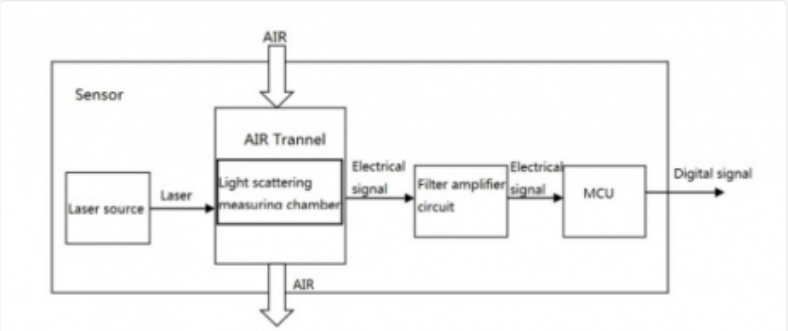
https://www.pddnet.com/news/2015/01/bosch-environmental-sensor-measures-indoor-air-quality
https://www.bosch-sensortec.com/bst/products/all_products/bme680

Sensores de planttower PMSx003

https://www.dfrobot.com/wiki/index.php/PM2.5_laser_dust_sensor_SKU:SEN0177
https://www.dfrobot.com/wiki/index.php/Air_Quality_Monitor_(PM_2.5,_Formaldehyde,_Temperature_%26_Humidity_Sensor)_SKU:_SEN0233#Board_Overview

How it works?

This pm2.5 sensor uses a laser scattering theory. And namely the scattering of laser irradiation in the air suspended particles, while collecting the scattered light at a specific angle, to obtain the scattering intensity versus with time curve. After the microprocessor data collection, get the relationship between the time domain and frequency domain by Fourier transform, and then through a series of complex algorithms to obtain the number of particles in the equivalent particle size and volume units of different size. Each functional block diagram of the sensor portion as shown:



sensor structure diagram

PMS3003

Precio U$17

```
#include <Arduino.h>

#define LENG 23   //0x42 + 23 bytes equal to 24 bytes ->
//#define LENG 31   //0x42 + 31 bytes equal to 32 bytes
unsigned char buf[LENG];

int PM01Value=0;          //define PM1.0 value of the air detector module
int PM2_5Value=0;         //define PM2.5 value of the air detector module
int PM10Value=0;         //define PM10 value of the air detector module

char checkValue(unsigned char *thebuf, char leng)
{
  char receiveflag=0;
  int receiveSum=0;

  for(int i=0; i<(leng-2); i++){
    receiveSum=receiveSum+thebuf[i];
  }
  receiveSum=receiveSum + 0x42;

  if(receiveSum == ((thebuf[leng-2]<<8)+thebuf[leng-1]))  //check the serial
data
    {
```

```
      receiveSum = 0;
      receiveflag = 1;
    }
  return receiveflag;
}

int transmitPM01(unsigned char *thebuf)
{
  int PM01Val;
  PM01Val=((thebuf[3]<<8) + thebuf[4]); //count PM1.0 value of the air
detector module
  return PM01Val;
}

//transmit PM Value to PC
int transmitPM2_5(unsigned char *thebuf)
{
  int PM2_5Val;
  PM2_5Val=((thebuf[5]<<8) + thebuf[6]);//count PM2.5 value of the air
detector module
  return PM2_5Val;
}

//transmit PM Value to PC
int transmitPM10(unsigned char *thebuf)
{
  int PM10Val;
  PM10Val=((thebuf[7]<<8) + thebuf[8]); //count PM10 value of the air
detector module
  return PM10Val;
}

void setup()
{
  Serial.begin(9600);   //use serial0
  Serial.setTimeout(1500);    //set the Timeout to 1500ms, longer than the
data transmission periodic time of the sensor

}

void loop()
{
  if(Serial.find(0x42)){    //start to read when detect 0x42
    Serial.readBytes(buf,LENG);
    // for(int i=0; i< LENG; i++) {
    //   Serial.print(buf[i]);Serial.print("|");
    // }
    // Serial.println();
```

```
    if(buf[0] == 0x4d){
      if(checkValue(buf,LENG)){
        PM01Value=transmitPM01(buf); //count PM1.0 value of the air detector
module
        PM2_5Value=transmitPM2_5(buf);//count PM2.5 value of the air
detector module
        PM10Value=transmitPM10(buf); //count PM10 value of the air detector
module
      }
    }
  }

  static unsigned long OledTimer=millis();
    if (millis() - OledTimer >=1000)
    {
      OledTimer=millis();

      Serial.print("PM1.0: ");
      Serial.print(PM01Value);
      Serial.println("  ug/m3");

      Serial.print("PM2.5: ");
      Serial.print(PM2_5Value);
      Serial.println("  ug/m3");

      Serial.print("PM1 0: ");
      Serial.print(PM10Value);
      Serial.println("  ug/m3");
      Serial.println();
  }

}
```

https://community.particle.io/t/dust-sensor-pms-5003-6003-7003/24221/16
http://njiot.blogspot.com.co/2016/01/pm25-sensor-g3-pms3003.html
https://github.com/igrr/aqi-sensor-demo/blob/master/Sds011.cpp
https://github.com/sensor-web/js-station
https://www.dfrobot.com/wiki/index.php/PM2.5_laser_dust_sensor_SKU:SEN0177
https://github.com/jbanaszczyk/pms5003

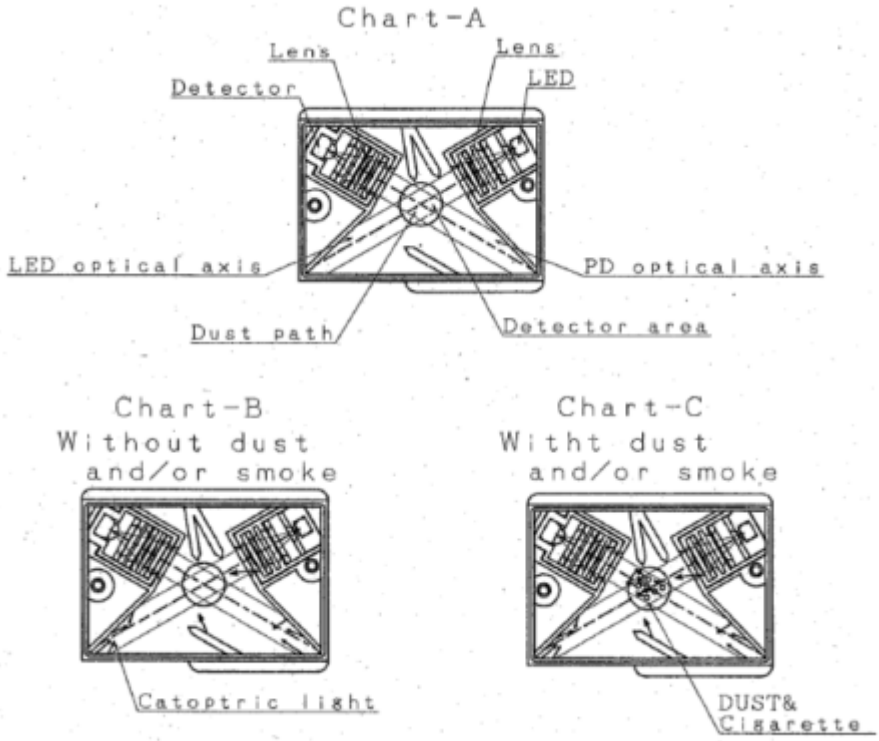
Sensor Shinyei Model PPD42NS

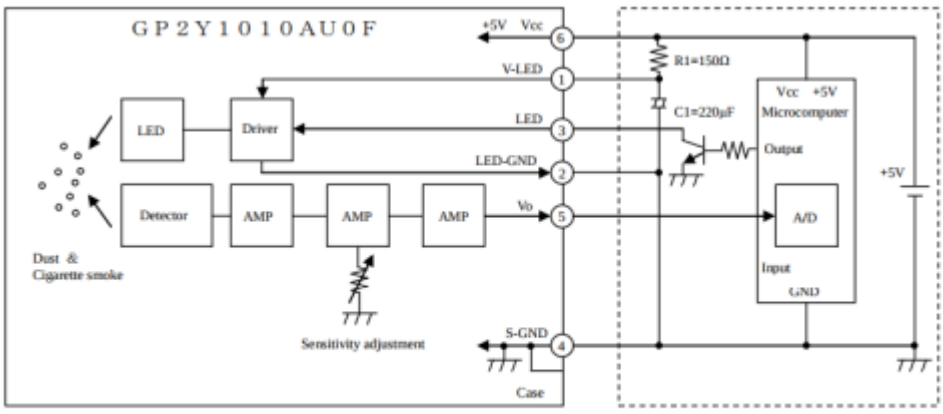
https://forum.mysensors.org/topic/147/air-quality-sensor/194
http://www.howmuchsnow.com/arduino/airquality/grovedust/
https://github.com/empierre/arduino/blob/master/DustSensor_Shinyei_PPD42NS.ino

Sensor Sharp GP2Y1010AU

1)

< Fix Me! Transcribir y traducir





- Resister, R1=150Ω and capacitor, C1=220uF mentioned above is required for pulse drive of the LED of GP2Y1010AU0F. Please use the ones with the above mentioned constants. Without these cmponents, the device does not work.

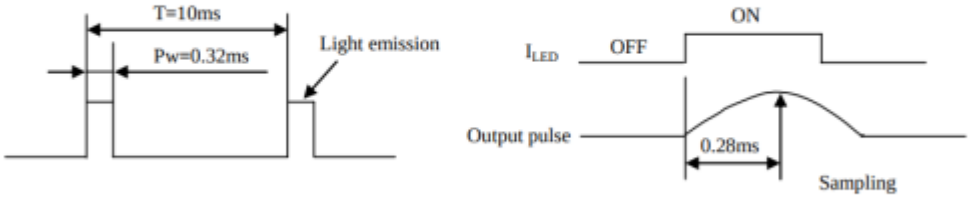
System Connection

- As input conditions of the LED terminal, please apply LED drive conditions mentioned in Electro-optical characteristics chart of the specification. When it is impossible to apply those conditions, please make it within the recommended input conditions mentioned in the specification. When the LED is driven under the condition beyond the specification, characteristics of the device will be affected.

Parameter	Symbol	Specified condition	Recommended condition	Unit
Pulse cycle	T	10	10±1	ms
Pulse width	Pw	0.32	0.32±0.02	ms

- The LED emits pulse light. Detected signal is amplified by the amplifier circuit and goes out as the output synchronized to the pulse mission of the LED.
- The specified output value is the one that is measured 0.28ms after the LED is turned on. Therefore, it is recommended that microcomputer to read the output 0.28ms after the LED emission also.

Sampling timing of output pulse



- Time required for the device to be ready to detect dust from when the system is turned on is less than 1 sec.

LED pulse input

Cautions - Vibración - Humedad

- Vibration may affect the characteristics of the device. Therefore, please make sure that the device works properly under actual usage conditions.
- The device does not work properly if bedewing occurs inside of it. Please design products so that the bedewing does not occur inside of the device.

Miligramos por metro cúbico

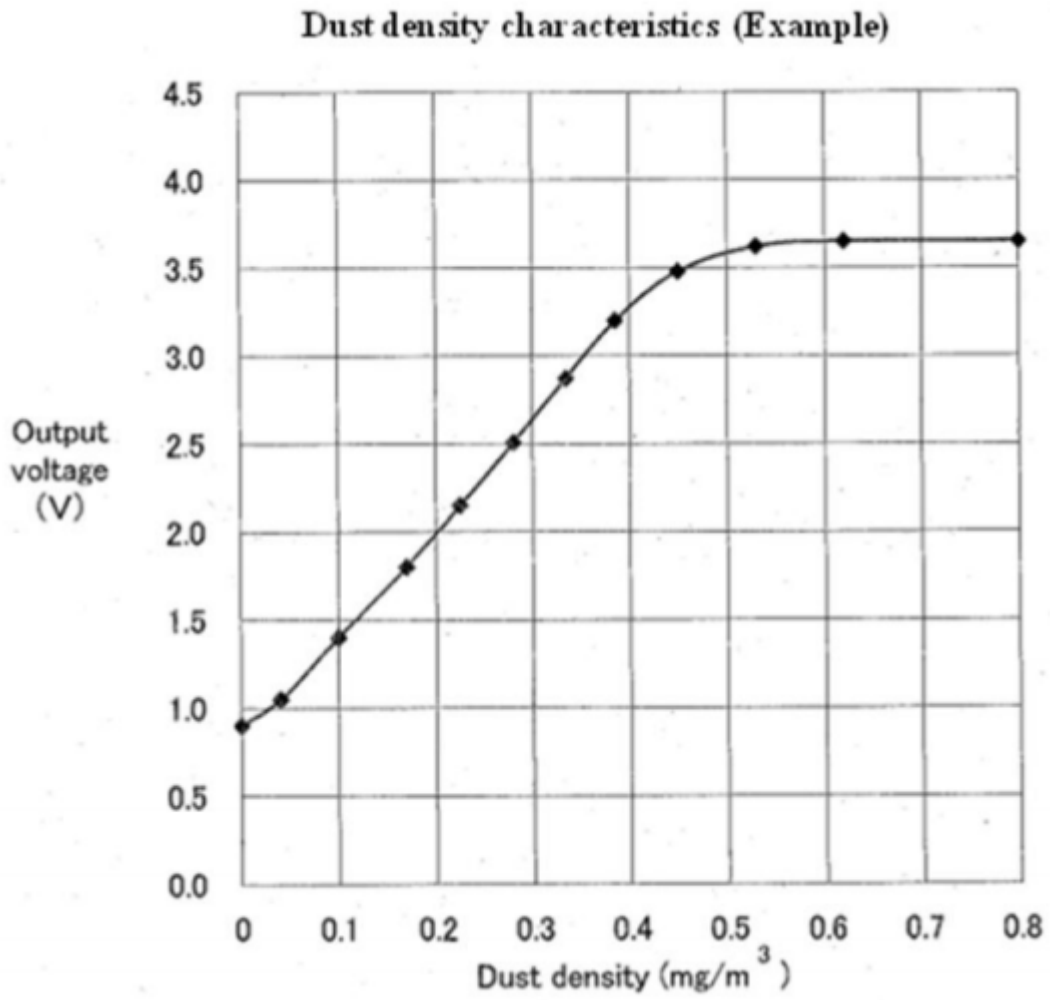
¿Cuáles son los niveles tolerables de PM 2,5? [2)]

Aunque las partículas 2,5 son quizás el mayor peligro para la salud de los ciudadanos, existe un promedio diario que es tolerable para el cuerpo humano.

- Bueno: 0 a 12.4 microgramos por metro cúbico
- Moderado: 12.5 a 35.4 microgramos por metro cúbico
- Dañina a grupos sensibles: 35.5 a 55.4 microgramos por metro cúbico
- Dañino: de 55 microgramos por metro cúbico en adelante

Veáse que el sensor en cuestión lee hasta 500 micro gramos / metro cúbico (.5mg/m3)

$$0{,}5\times10^{-3}\times\frac{1000\times10^{-6}}{1\times10^{-3}}=500\times10^{-6}$$



Código para arduino

OJO: El voltaje máximo que lee el adc del esp8266 es 1v, valores por encima de esto se leen como 1024 en la lectura del ADC

¿Es posible leer 5V a través del ADC del ESP8266?

Según esto http://www.esp8266-projects.com/2016/08/esp8266-internal-adc-2-easy-way-example.html es necesario usar un divisor de voltaje y para mayor confiabilidad usar resistencias de precisión.

También hay que tener en cuenta la curva de salida del sensor que va desde 1v hasta un poco más 3.6v

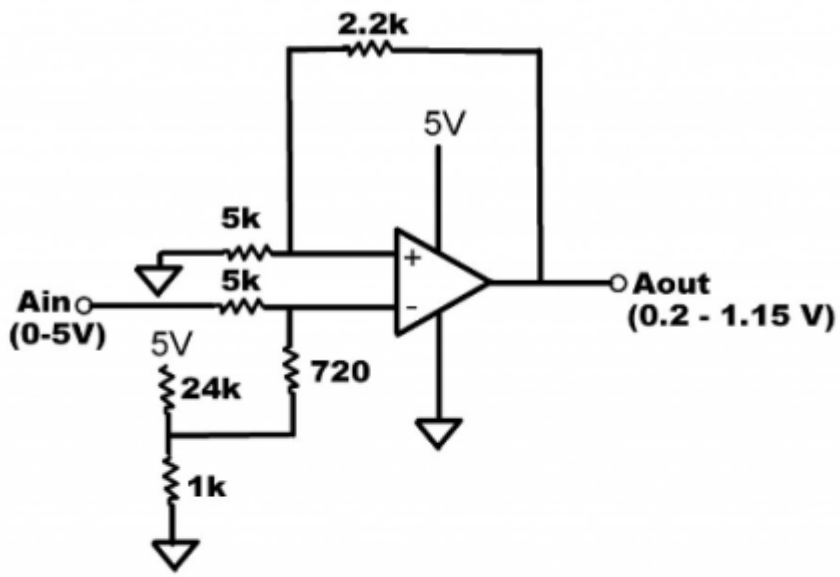
Es posible también usar un OPAMP

So what can you do if your sensor range is outside the ESP8266 0.2 to 1.2 V window?

Scaling of course.

This can be accomplished passively, using a resistor divider, or actively, with the addition of an op-amp. The interface of choice would be an active op-amp based circuit.

For example, suppose your sensor has a 0-5V range. This would need to be scaled to fit in the ESP8266 0.2 to 1.2 V input range. Obviously, resolution will be compromised as we go from a larger range to a smaller one, but it can be done. And with a single power supply.



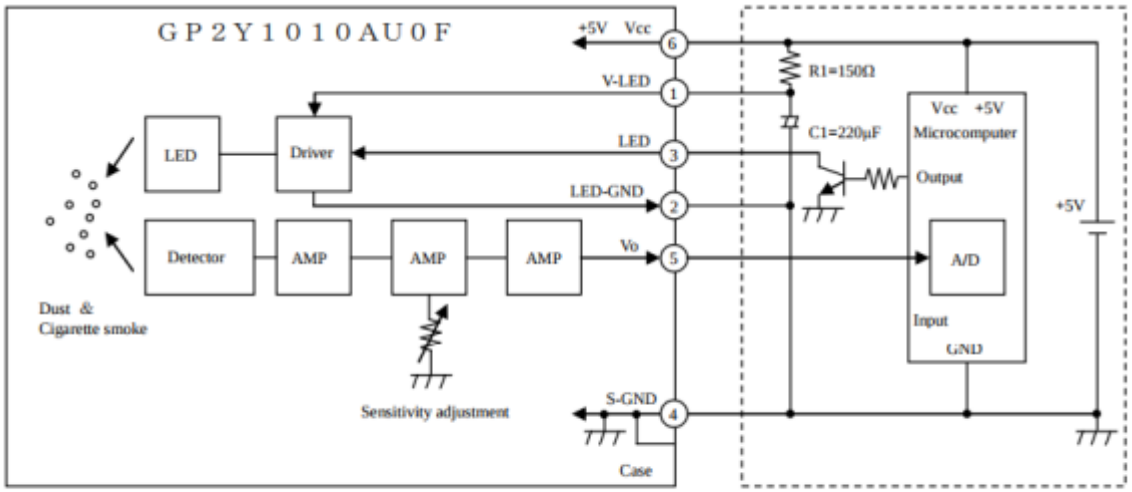
Resistor values calculated here. The 24K/1K resistor divider supplies the 0.2V offset with the gain set for the 1.15 V output with a 5V maximum input applied. This circuit would need to be modified for your specific sensor voltage range.

También, ¿Cómo es posible manejar el LED del sensor que funciona con 5v? con un transistor?

```
/*
 Standalone Sketch to use with a Arduino UNO and a
 Sharp Optical Dust Sensor GP2Y1010AU0F
*/

int measurePin = 0; //Connect dust sensor to Arduino A0 pin
int ledPower = 2;   //Connect 3 led driver pins of dust sensor to Arduino D2

int samplingTime = 280;
int deltaTime = 40;
int sleepTime = 9680;

float voMeasured = 0;
float calcVoltage = 0;
float dustDensity = 0;
```

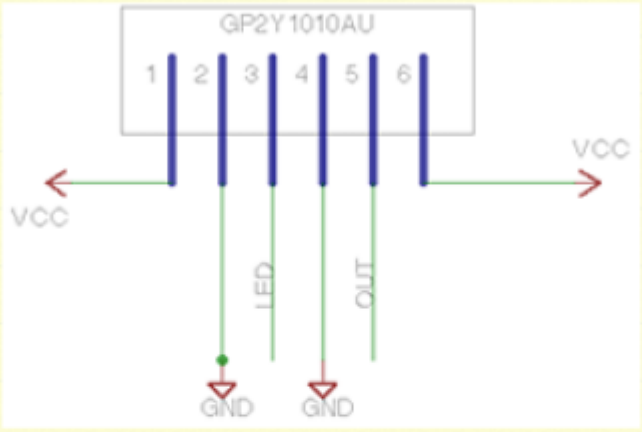
```
void setup(){
  Serial.begin(9600);
  pinMode(ledPower,OUTPUT);
}

void loop(){
  digitalWrite(ledPower,LOW); // power on the LED
  delayMicroseconds(samplingTime);

  voMeasured = analogRead(measurePin); // read the dust value

  delayMicroseconds(deltaTime);
  digitalWrite(ledPower,HIGH); // turn the LED off
  delayMicroseconds(sleepTime);

  // 0 - 5V mapped to 0 - 1023 integer values
  // recover voltage
  calcVoltage = voMeasured * (5.0 / 1024.0);

  // linear eqaution taken from
http://www.howmuchsnow.com/arduino/airquality/
  // Chris Nafis (c) 2012
  dustDensity = 0.17 * calcVoltage - 0.1;

  Serial.print("Raw Signal Value (0-1023): ");
  Serial.print(voMeasured);

  Serial.print(" - Voltage: ");
  Serial.print(calcVoltage);

  Serial.print(" - Dust Density: ");
  Serial.println(dustDensity); // unit: mg/m3

  delay(1000);
}
```

Conexión del sensor



- Resister, R1=150Ω and capacitor, C1=220uF mentioned above is required for pulse drive of the LED of GP2Y1010AU0F. Please use the ones with the above mentioned constants. Without these cmponents, the device does not work.

According to the GP2Y1010AU0F data sheet, all 6 pins on sensor need to be connected to Arduino:

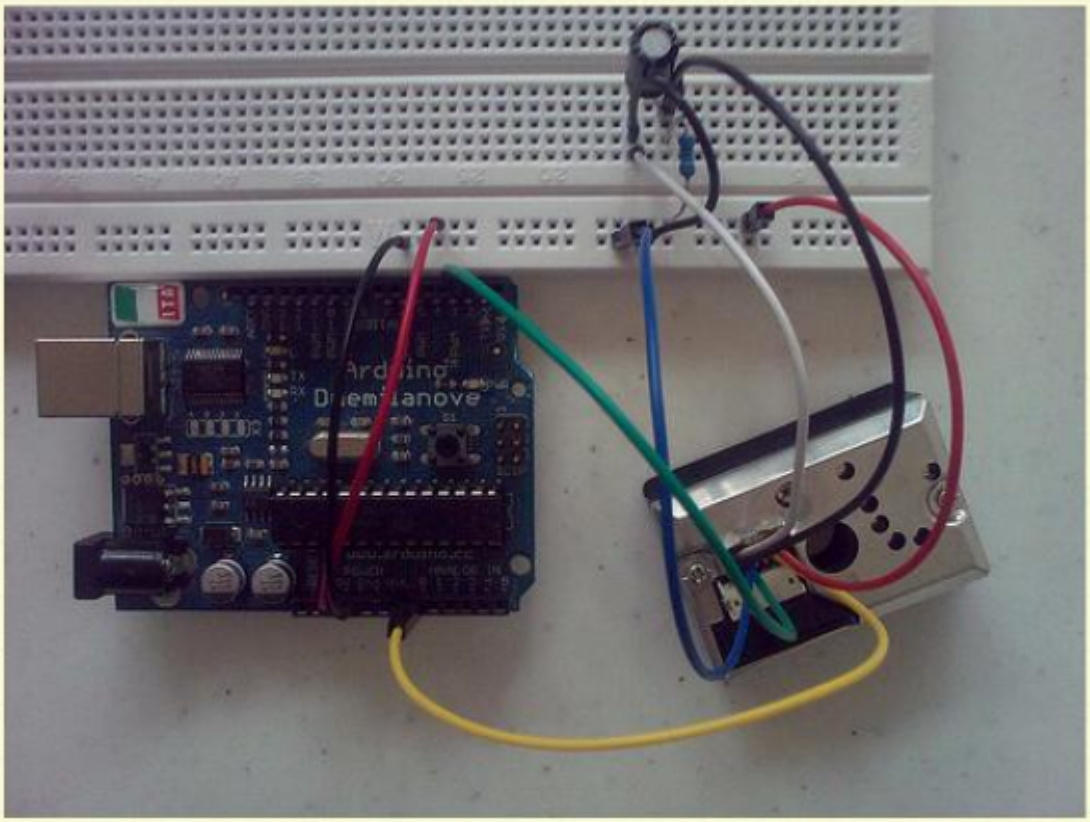


Do not miss the 150ohm resistor and a 220uF capacitor:

	Sensor Pin		Arduino Pin
1	Vled	–>	5V (150ohm resistor)
2	LED-GND	–>	GND
3	LED	–>	Digital pin 2
4	S-GND	–>	GND
5	Vo	–>	Analog pin 0
6	Vcc	–>	5V

The LED pin has to be modulated with a cycle of 1ms as discussed in the datasheet.
The LED seems to use a PNP transistor so to power on, the LED pin must actually recieve a lower voltage.

Ok, you should now have every thing connected:



Nota aplicación ti.com TIDA-00378 PM2.5 and PM10 Particle Sensor Analog Front-End for Air Quality Monitoring Reference Design | TI.com The TIDA-00378 TI Design provides an analog front-end solution for measuring PM2.5 and PM10 particle matter. The design detects the light scattered by particles suspended in air. A sample software algorithm is provided to convert the analog output of the design into a particle size and concentration measurement. Test result data for cigarette smoke, Arizona dust, and mulberry pollen is provided along with all software and hardware design files.
http://www.ti.com/tool/TIDA-00378#1

Es posible usar un conversor análogo-digital externo como el ADS1115 el cual cuenta con 4 canales de 16bit

Posibles Filtros Para enfocar la lectura en partículas más pequeñas se pueden probar varios materiales calibrando la eficiencia con un sensor laser. Otra opción que comentó Valentin es una corona de iones que al parecer concentra las partículas grandes en los bordes, todavía no sabemos como funciona pero una primera búsqueda arrojó esto: “ The DiSCmini (Matter Engineering) is a personal diffusion charging device introduced by Fierz et al. [60]. In the DiSCmini, a positive corona is used to produce a high concentration of positive ions that attach to the particles entering the inlet. The charged particles then pass through an induction stage (or ion filter), a diffusion stage, and a high-efficiency particulate air (HEPA) filter. The diffusion stage and the HEPA filter are each connected to an electrometer, which measures the charge of depositing particles. The smallest particles deposit on the screen in the diffusion stage, whereas larger particles penetrate to the HEPA filter. ” de este buen texto https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4807653/

TI's ADS1115 I2C 16bits ADC+PGA

Durante el MDE15 se empezó la investigación sobre este integrado http://wiki.unloquer.org/proyectos/jardin_delicias/tecnologicos/microprocesadores-esp8266?#integrado_ads1115

4-ways-to-expand-adc-in-esp8266 http://codelectron.com/4-ways-to-expand-adc-in-esp8266/

Dentro del repositorio de librerías de platformio se encuentran 3 resultados:

- http://platformio.org/lib/show/95/I2Cdevlib-ADS1115/examples **(No tiene soporte oficial para espressif8266)**
- http://platformio.org/lib/show/342/Adafruit%20ADS1X15 **(Soporta espressif8266, Version 1.0.0 last updated 4 months ago)**
- http://platformio.org/lib/show/344/ADS1X15 **(Soporta espressif8266, Version 1.2.0 last updated 4 months ago)**

Sensores MQ

improving-the-accuracy-of-gas-sensors

http://hackaday.com/2017/07/13/improving-the-accuracy-of-gas-sensors/?utm_content=buffer324d1&utm_medium=social&utm_source=twitter.com&utm_campaign=buffer

Notas del datasheet

Introduction

The MQ series of gas sensors use a small heater inside with an electro-chemical sensor. They are sensitive for a range of gasses and are used indoors at room temperature.

They can be calibrated more or less (see the section about "Load-resistor" and "Burn-in") but a know concentration of the measured gas or gasses is needed for that.

The output is an analog signal and can be read with an analog input of the Arduino.

Wiring

The preferred wiring is to connect both 'A' pins together and both 'B' pins together. It is safer and it is assumed that is has more reliable output results. Although many schematics and datasheets show otherwise, you are advised to connect both 'A' pins together and connect both 'B' pins together.

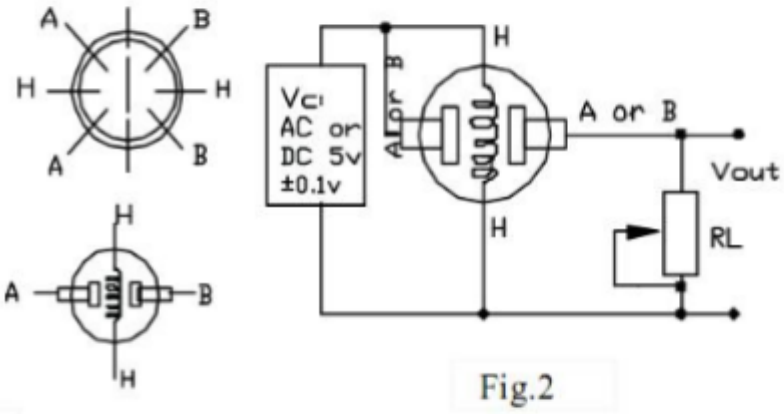


Fig.2

In the picture, the heater is for +5V and is connected to both 'A' pins. This is only possible if the heater needs a fixed +5V voltage.

The variable resistor in the picture is the load-resistor and it can be used to determine a good value. A fixed resistor for the load-resistor is used in most cases.

The Vout is connected to an analog input of the Arduino.

The heater

The voltage for the internal heater is very important.
Some sensors use 5V for the heater, others need 2V. The 2V can be created with a PWM signal, using analogWrite() and a transistor or logic-level mosfet.
The heater may not be connected directly to an output-pin of the Arduino, since it uses too much current for that.

Some sensors need a few steps for the heater. This can be programmed with an analogWrite() function and delays. A transistor or logic-level mosfet should also in this situation be used for the heater.

If it is used in a battery operated device, a transistor or logic-level mosfet could also be used to switch the heater on and off.

The sensors that use 5V or 6V for the internal heater do get warm. They can easily get 50 or 60 degrees Celcius.

After the "burn-in time", the heater needs to be on for about 3 minutes (tested with MQ-2) before the readings become stable.

Burn-in

Some datasheets use the term "preheat", but it is the time to burn-in the sensor. This is meant to make the sensor readings more consistent. A time of 12 or 24 hours is usually used for the burn-in time.

The Burn-in is achieved by applying normal power to the sensor (to the heater and with the 'A' and 'B' pins connected, and with a load-resistor). In some special cases a specific burn-in is needed. See the datasheet if the sensor needs such a specific burn-in.

Sensor MQ-2

http://wiki.seeed.cc/Grove-Gas_Sensor-MQ2/

MQ-2

Sensitive for Methane, Butane, LPG, smoke.

This sensor is sensitive for flamable and combustible gasses.

The heater uses 5V.

The MQ-2 at seeed: http://www.seeedstudio.com/wiki/Grove_-_Gas_Sensor%28MQ2%29

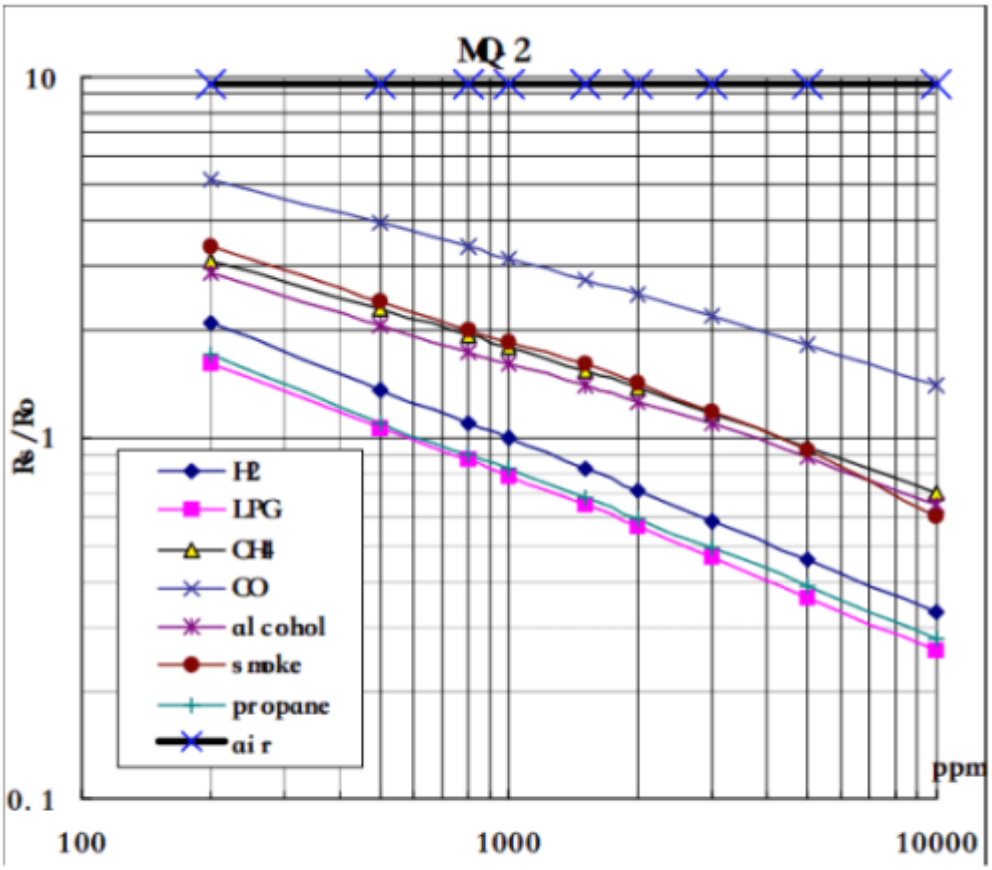
Search for datasheet: http://duckduckgo.com/?q=%22mq-2%22+gas+sensor+filetype%3Apdf

5.0V Analog

The Grove - Gas Sensor(MQ2) module is useful for gas leakage detection (in home and industry). It is suitable for detecting H2, LPG, CH4, CO, Alcohol, Smoke or Propane. Due to its high sensitivity and fast response time, measurements can be taken as soon as possible. The sensitivity of the sensor can be adjusted by using the potentiometer.

Note

The sensor value only reflects the approximated trend of gas concentration in a permissible error range, it DOES NOT represent the exact gas concentration. The detection of certain components in the air usually requires a more precise and costly instrument, which cannot be done with a single gas sensor. If your project is aimed at obtaining the gas concentration at a very precise level, then we do not recommend this gas sensor.



According to the graph, we can see that the minimum concentration we can test is 100ppm and the maximum is 10000ppm, in a other word, we can get a concentration of gas between 0.01% and 1%. However, we can't provide a formula because the relation between ratio and concentration is nonlinear.

Sensor MQ-5

MQ-5

Sensitive for Natural gas, LPG

The heater uses 5V.

The MQ-5 at seeed: http://www.seeedstudio.com/wiki/Electronic_brick_-_Gas_sensor%28MQ5%29 and http://www.seeedstudio.com/wiki/Gas_Sensor_-_MQ5

Search for datasheet: http://duckduckgo.com/?q=%22mq-5%22+gas+sensor+filetype%3Apdf

STORAGE

SPI FLASH

http://www.diyprojects.io/esp8266-web-server-part-4-arduinojson-load-save-files-spiffs/
https://github.com/G6EJD/SPIFFS-Examples
https://github.com/ourairquality/oaq-esp-open-rtos

Se llama la librería FS para el esp8266

```
#include <FS.h>
```

Se inicializa la flash en la función **setup()**

```
void setup() {
  Serial.begin(115200);
  Serial.println("Starting...");

  SPIFFS.begin();

}
```

Se crean funciones para leer, escribir, borrar o conocer el estado del flas

Para escribir

```
void fs_write_frame(String frame) {
  char filename [] = "datalog.txt";                    // Assign a filename
or use the format e.g. SD.open("datalog.txt",...);
  File myDataFile = SPIFFS.open(filename, "a+");       // Open a file for
reading and writing (appending)
  if (!myDataFile)Serial.println("file open failed");  // Check for errors

  myDataFile.println(frame);
  myDataFile.close();
}
```

y luego se llama la función en el código

```
fs_write_frame(variable_string_que_contiene_la_data);
```

Para leer

```
void fs_read_file() {
  char filename [] = "datalog.txt";                    // Assign a filename
or use the format e.g. SD.open("datalog.txt",...);
```

```
  File myDataFile = SPIFFS.open(filename, "a+");        // Open a file for
reading and writing (appending)
  myDataFile = SPIFFS.open(filename, "r");              // Open the file
again, this time for reading
  if (!myDataFile) Serial.println("file open failed");  // Check for errors
  while (myDataFile.available()) {
    wdt_disable();
    //yield();
    Serial.write(myDataFile.read());                    // Read all the data
from the file and display it
    Serial.flush();
    wdt_enable(1000);
  }
  myDataFile.close();
}
```

Para borrar

```
void fs_delete_file() {
  // Assign a file name e.g. 'names.dat' or 'data.txt' or 'data.dat' try to
use the 8.3 file naming convention format could be 'data.d'
  char filename [] = "datalog.txt";                     // Assign a filename
or use the format e.g. SD.open("datalog.txt",...);

  if (SPIFFS.exists(filename)) SPIFFS.remove(filename); // First
blu175.mail.live.com in this example check to see if a file already exists,
if so delete it
}
```

Para conocer el estado de la flash
Se declara primero una estructura global

```
FSInfo fs_info;
```

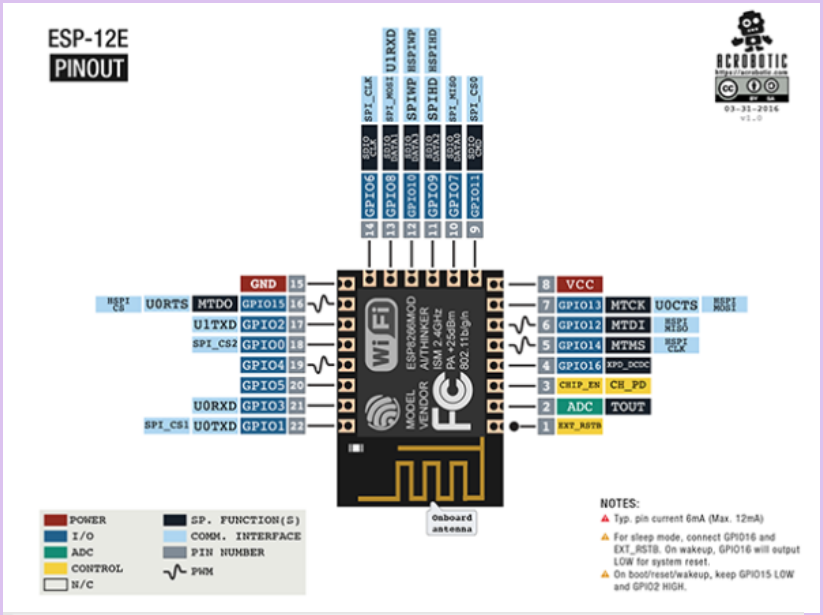
a la cual se accede luego mediante una función como esta

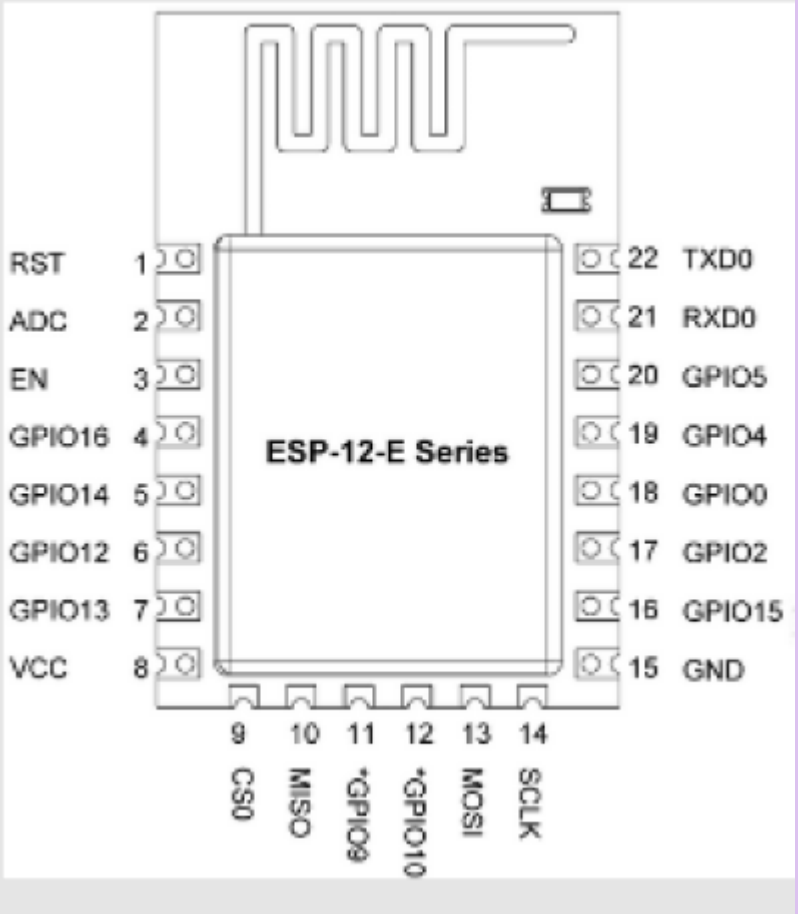
```
void fs_info_print() {
  SPIFFS.info(fs_info);
  Serial.print("totalBytes ");Serial.println(fs_info.totalBytes);
  Serial.print("usedBytes ");Serial.println(fs_info.usedBytes);
  Serial.print("blockSize ");Serial.println(fs_info.blockSize);
  Serial.print("pageSize ");Serial.println(fs_info.pageSize);
  Serial.print("maxOpenFiles ");Serial.println(fs_info.maxOpenFiles);
  Serial.print("maxPathLength ");Serial.println(fs_info.maxPathLength);
}
```

SD Card

https://github.com/esp8266/Arduino/blob/master/libraries/SD/examples/Datalogger/Datalogger.ino

¿Cómo usar directamente los pines MOSI, MISO, SCLK y CS del chip ESP8266-12E y que no tenemos mapeados en la primera versión de la tarjeta que diseñamos?





GPS

El GPIO16 no se puede usar para softserial
https://forum.arduino.cc/index.php?topic=354933.0

Solo necesito un el pin Rx acá hay una alternativa **ReadOnlySerial**
http://forum.arduino.cc/index.php?topic=112013.0

https://www.linuxpinguin.de/project/wifiscanner/
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Transcribir y traducir >

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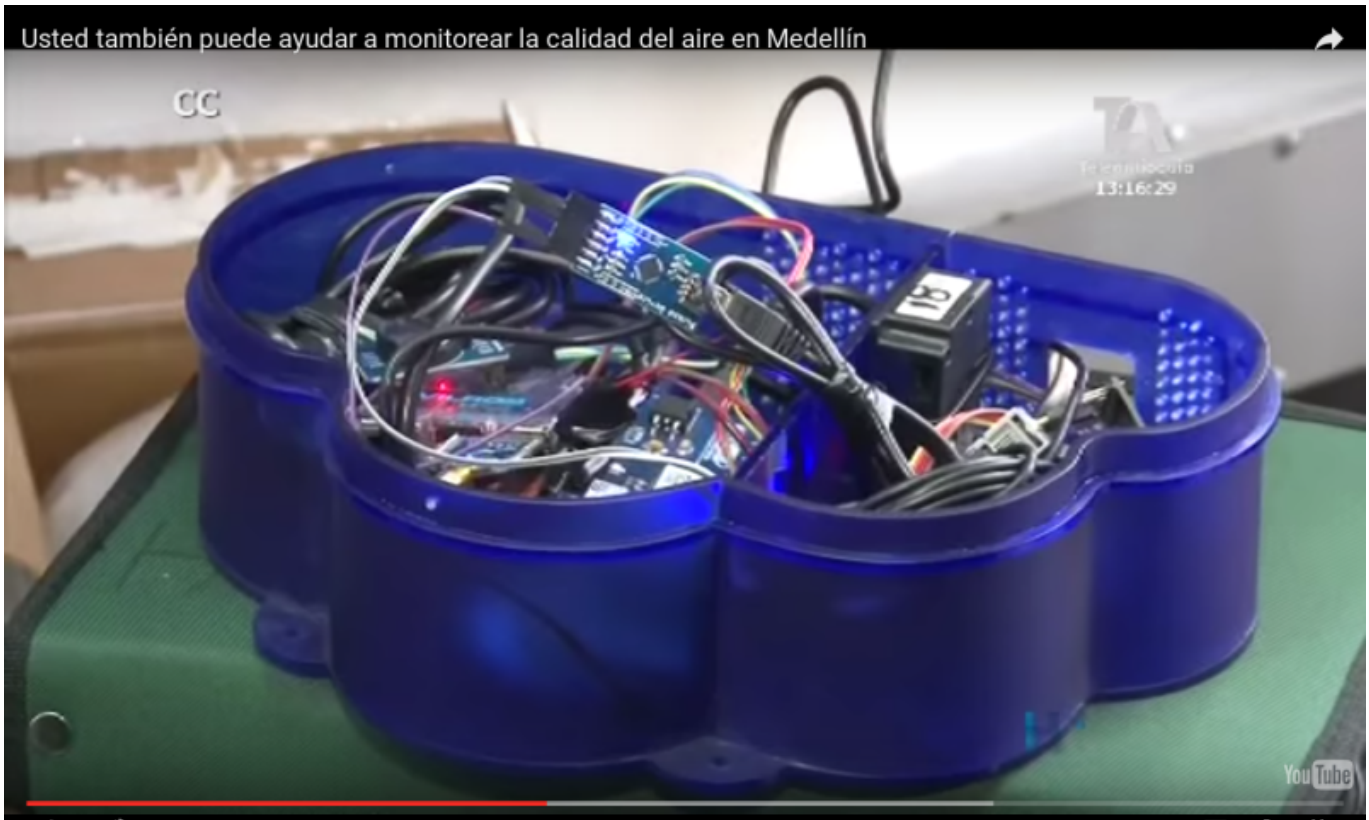
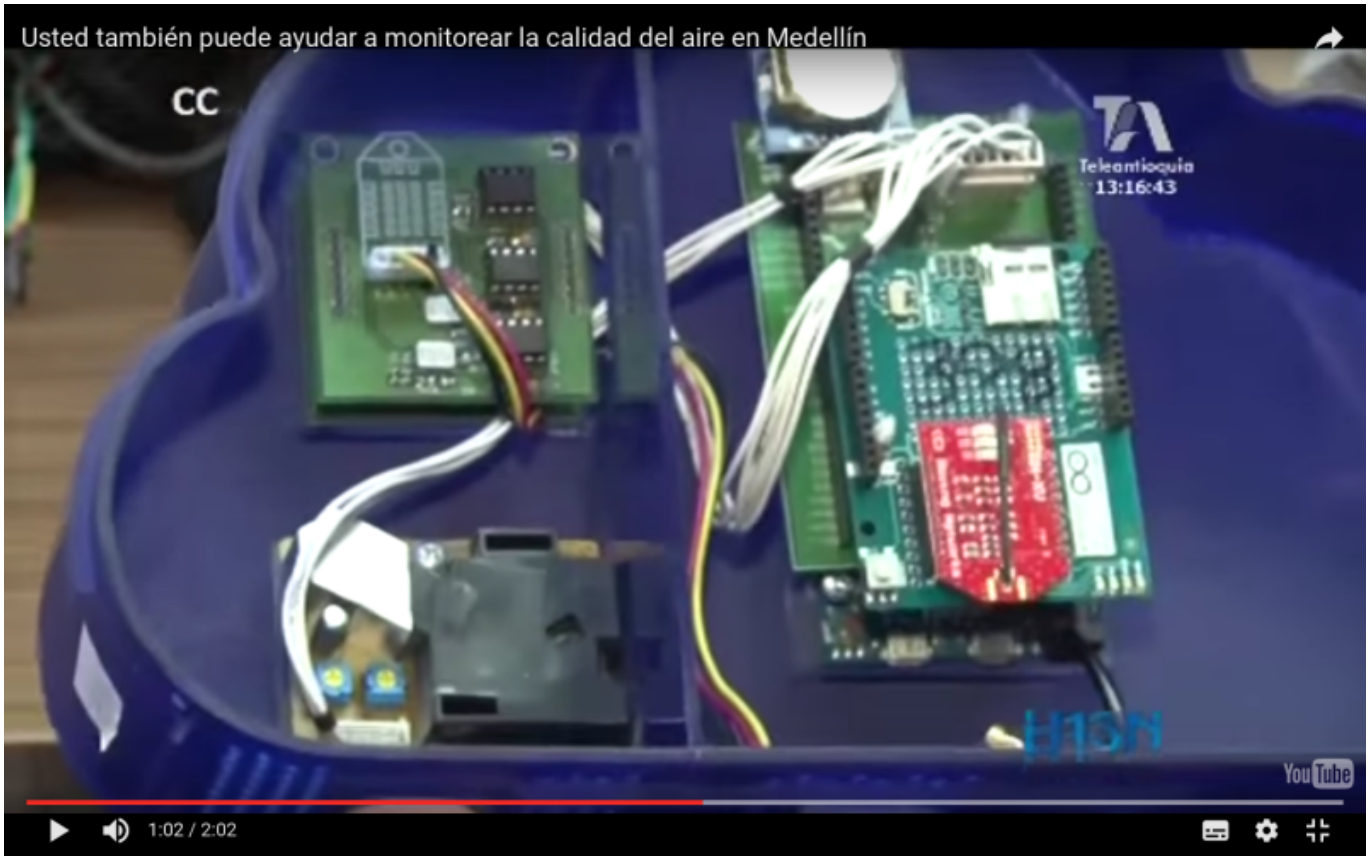
Ingeniería inversa

Nube SIATA


Usted también puede ayudar a monitorear la calidad del aire en Medellín
CC
13:16:29
YouTube
0:48 / 2:02


#NoticiasCaracol
MEDELLÍN
NTIC
CIUDADANOS AYUDAN EN MONITOREO DEL AIRE
1:27 / 5:33



Crea tu propio sensor - kit/taller

https://www3.epa.gov/airnow/teachers/gh_pmsensorkit_handoutandinstructions.pdf

Plantower Sensor Accuracy

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Proyecto en Bucaramanga → https://twitter.com/nunezluis/status/1042896971969843202
https://halley.uis.edu.co/tierra/?page_id=143

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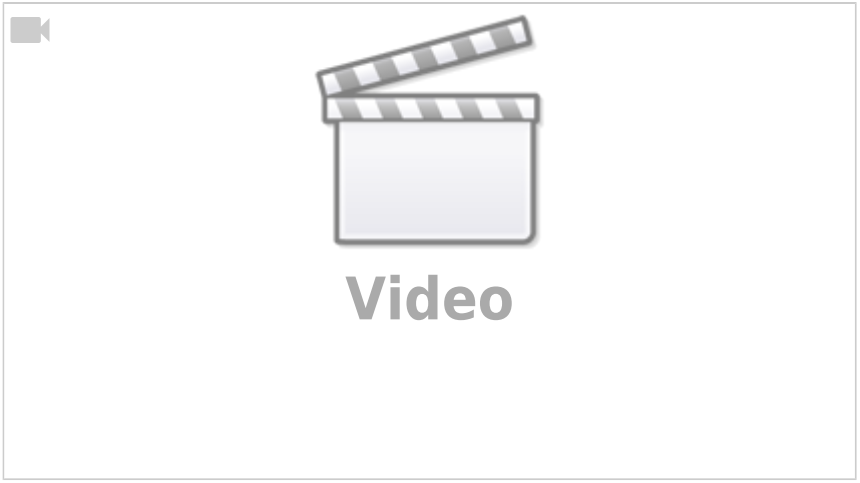

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Este proyecto como dispositivo pedagógico

que lleva consigo unos valores de unloquer y una maneras muy particulares de crear y aprender.

similar a esto http://blinkenrocket.de/

Argumentos ¿por qué es importante motivar esto?:

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License

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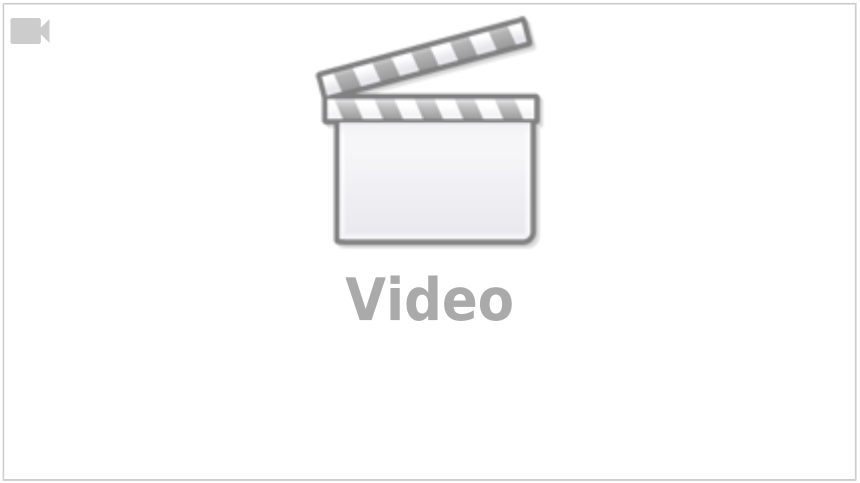
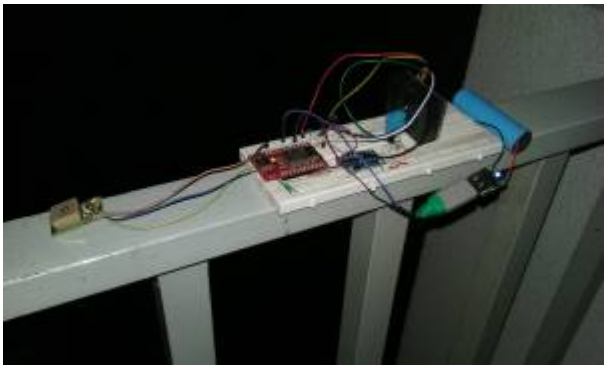
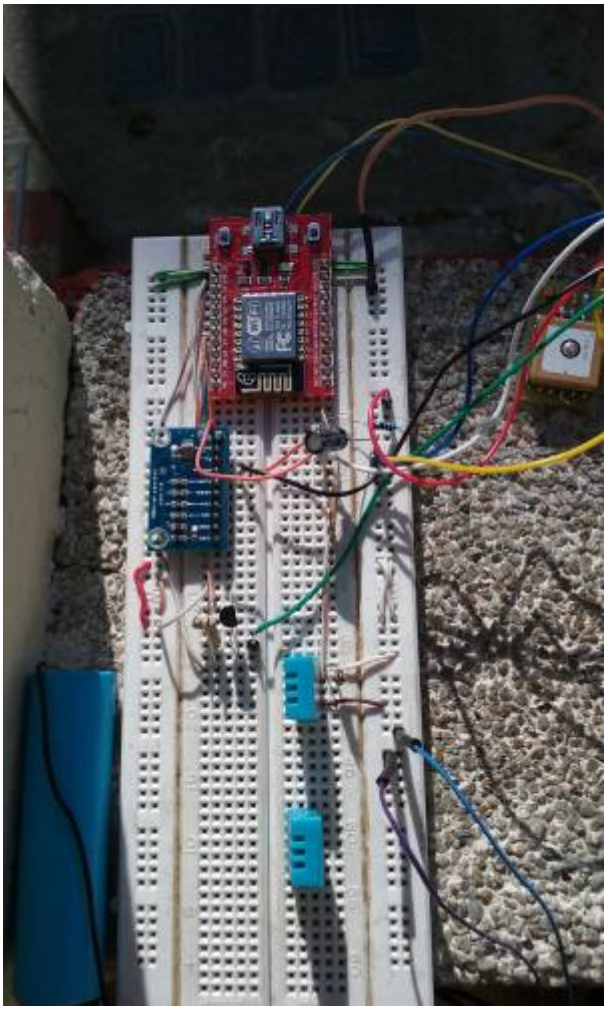
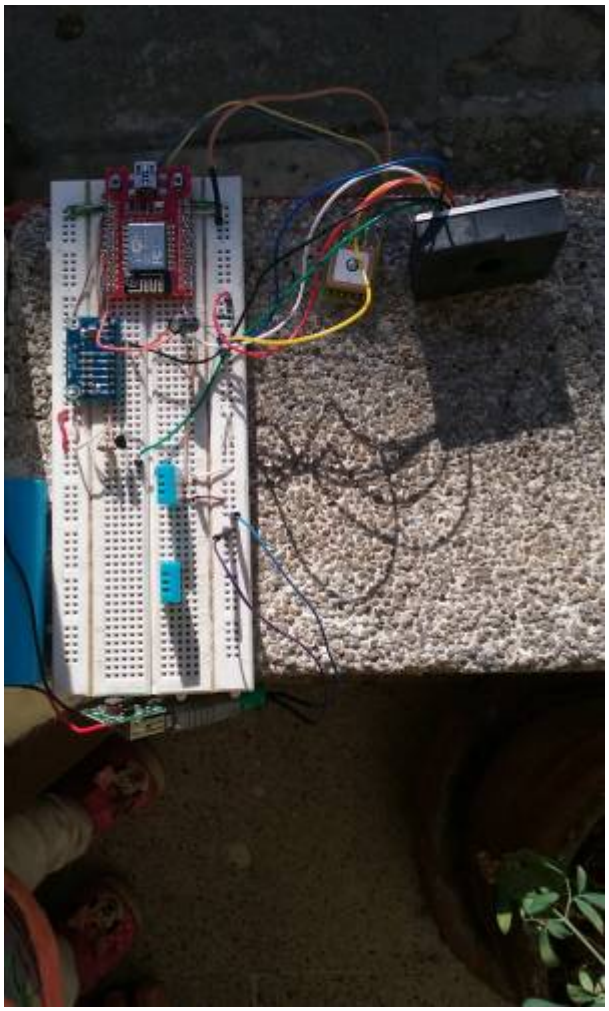


Bitácora







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Construcción de carcaza - AQA Mouse



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