Dust Sensor using GP2Y10

Dust sensors detect fine dust (“aerosol”) floating in the air. They are used to determine air quality indoor and outdoor.

Limits of the GP2Y10

The GP2Y10 sensor was developed to give a general value of the air quality. The sensor is originally used to control air cleaners so it’s capabilities are limited. It is not able to differentiate between dust sizes, e. g. PM2.5 and PM10. So the sensor device can give a relative value for air quality rating. You won’t get a value “xx µg/m^3”.

How Does the Sensor Work?

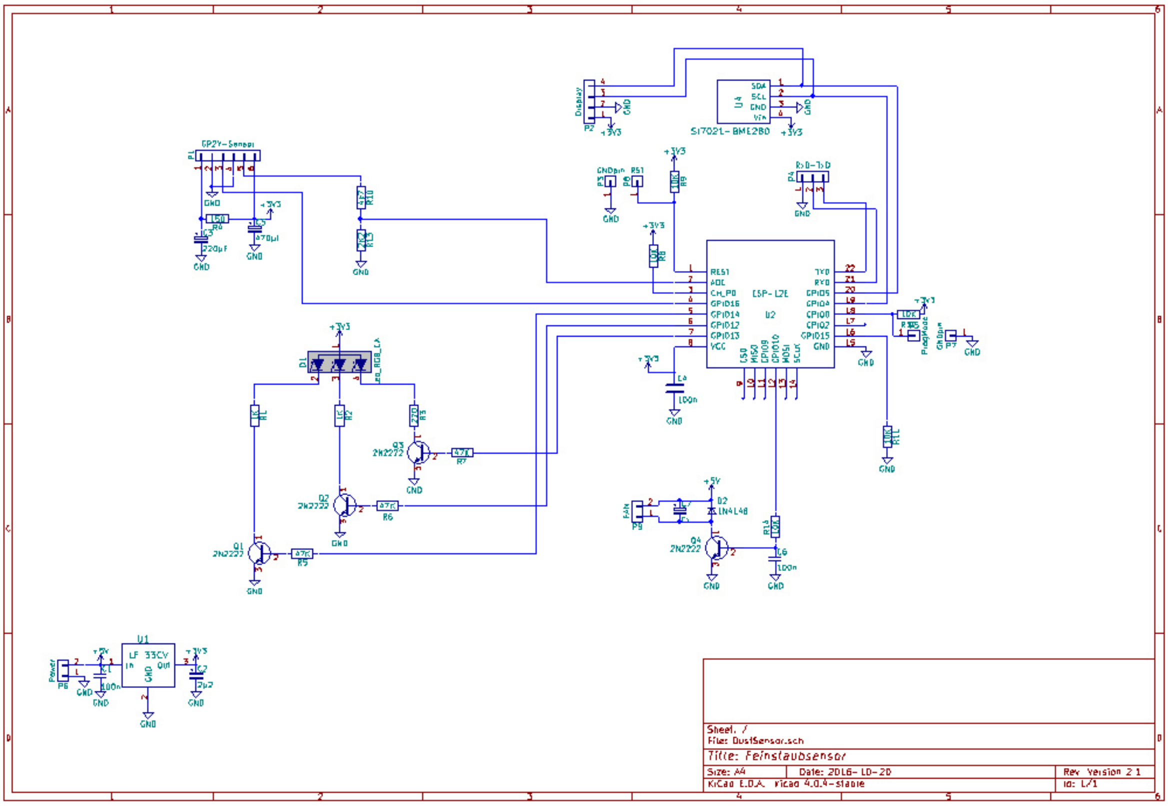
If you ever have used a pocket light in the dark you may have noticed floating dust in the light beam. This is basically the way these sensors work. Inside the sensor box is a dark chamber. A LED flashes inside the chamber, a photo transistor detects the light reflected by the dust. A small circuit converts the measurement into an analog voltage.

Prerequisites

The circuit needs an external 5V power supply.
Do not use a cheap power supply. It should give a reliable power of 1 … 1.5 A at least.

This circuit uses standard trough-hole parts so it is relatively simple to build.

Schematics



Don’t worry: It looks more complex than it is. We will walk through the parts and explain.
You may print a full sized schematics, it is provided with the PDF.

Starting at the bottom left you see the voltage regulator, a LF-33 (U1). Together with the capacitors C1 and C2 it provides the 3.3V for the ESP-12E/F. P6 is the connector to the external power supply.

P1 on the top left connects to the GP2Y10. The pins use the same order as the pins at the GP2Y10 so connecting is done easily. C3, C5 and R4 make a filter for the LED pulses to keep voltage spikes off from the other parts. R10 and R13 divide the output voltage down to a level the ESP can take. This is necessary as the GP2Y10 can give back around 3 volts, the analog input of the ESP can take up to 1 volt.

The indicator LED D1 is a RGB LED with common anode. It shows a raw indicator of air quality by colors: Blue – cyan – green – yellow – Red (From good to bad). The transistors Q1,Q2 and Q3 provide a bit more power for the LED as the GPIO’s of the ESP alone can give. R1, R2 and R3 are for limiting the LED current. R5, R6 and R7 are the basis resistors for driving the transistors.

The transistor Q4 has a special function.
The GP2Y10 has no internal fan. To get enough air from the environment into the sensor it needs an external fan. These little fans are noisy, this might be disturbing for example in the night at the sleeping room. You may use Q4 / GPIO10 to switch off the fan at night times.

It is even possible to turn the fan into slower rotation by using PWM on GPIO10. But the small fans tend to “whistle” if driven by PWM so I don’t recommend that. Use a 12…15 Ohm resistor in the fan cable to turn it down instead.

D2 is a wheeling diode to keep off high voltage spikes from the motor coils. This should be implemented inside the fan already, but who knows with the cheap fans offered on the market?
C7 is optional. It might be necessary to keep “humming” from the voltage supply with some fans. Try values from 2,2 … 10 µF if necessary.

On the top right you see the connector P2. It can be used to connect a SSD1306 OLED display.

Besides P6 you see a sensor, a BMP-280, BMP-180 or SI7021 can be used (“Thumbnail” size breakout).

P8 gives the Reset pin of the ESP-12E/F. Shorting to ground (P3) resets the ESP.

P5 shorted to ground (P7) sets the ESP into flash mode.

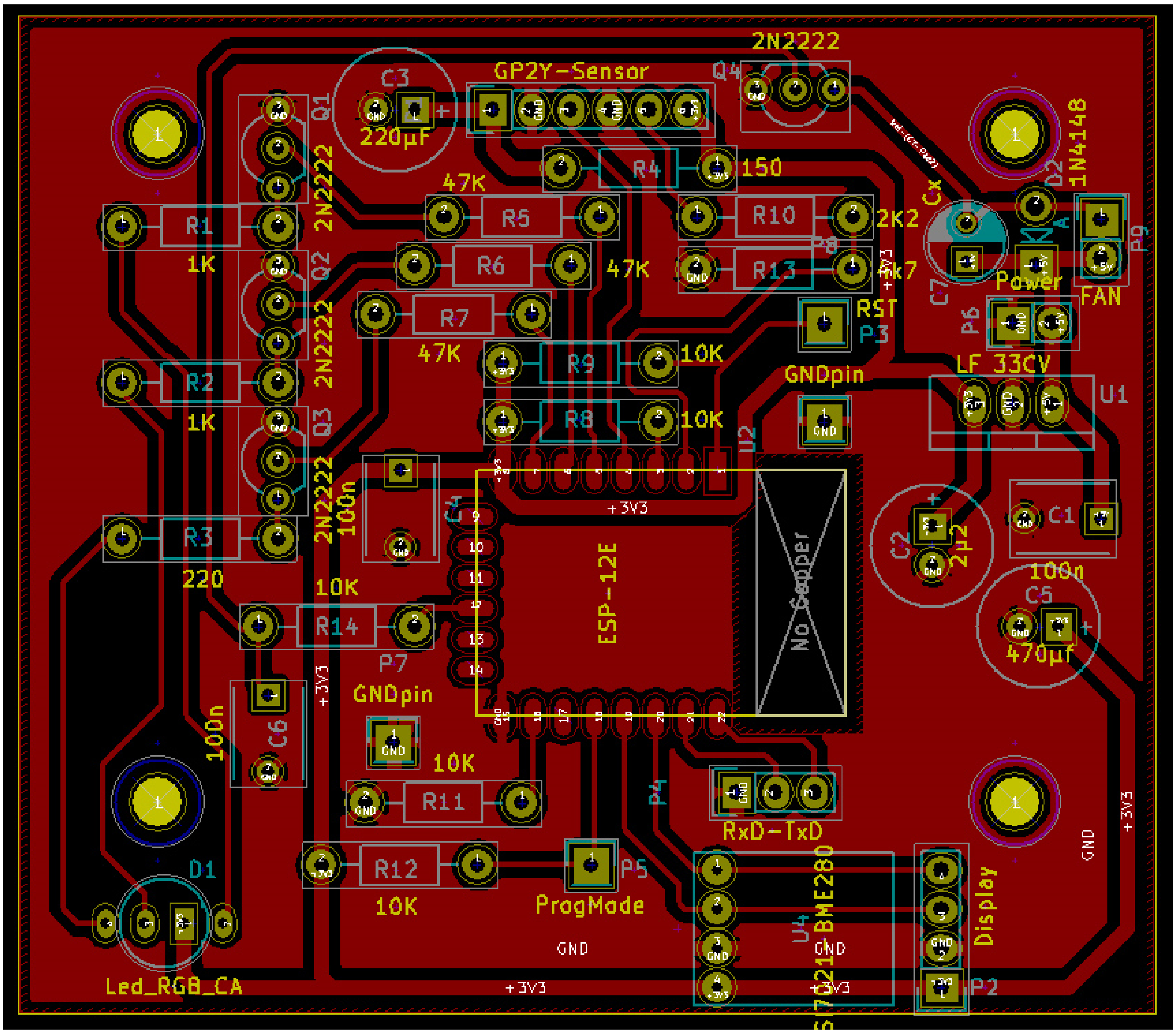
P4 provides the serial interface for your flash progging adapter.

So only the ESP-circuit itself is left.
You may use: ESP-12, ESP-12E and ESP-12F. IF you want to use an external antenna you may also use the ESP-07S which is an ESP-12 with an IPEX plug instead of an antenna. It has 4MB as the ESP-12 has.

C4 is a ceramic type capacitor to block high frequency generated by the ESP. Do not use foil capacitors here, they are not suitable for this purpose.

R8, R9, R11 and R12 are the necessary pull-up / pull-down resistors the ESP needs to set the standard running mode.

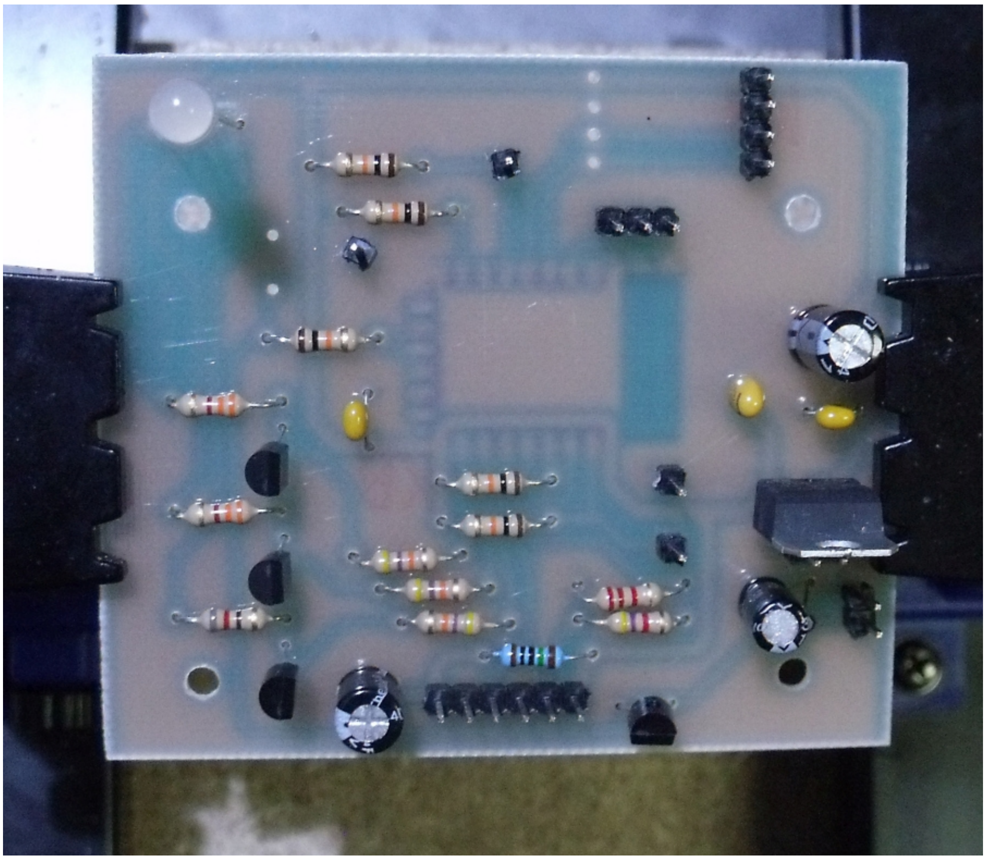
PCB



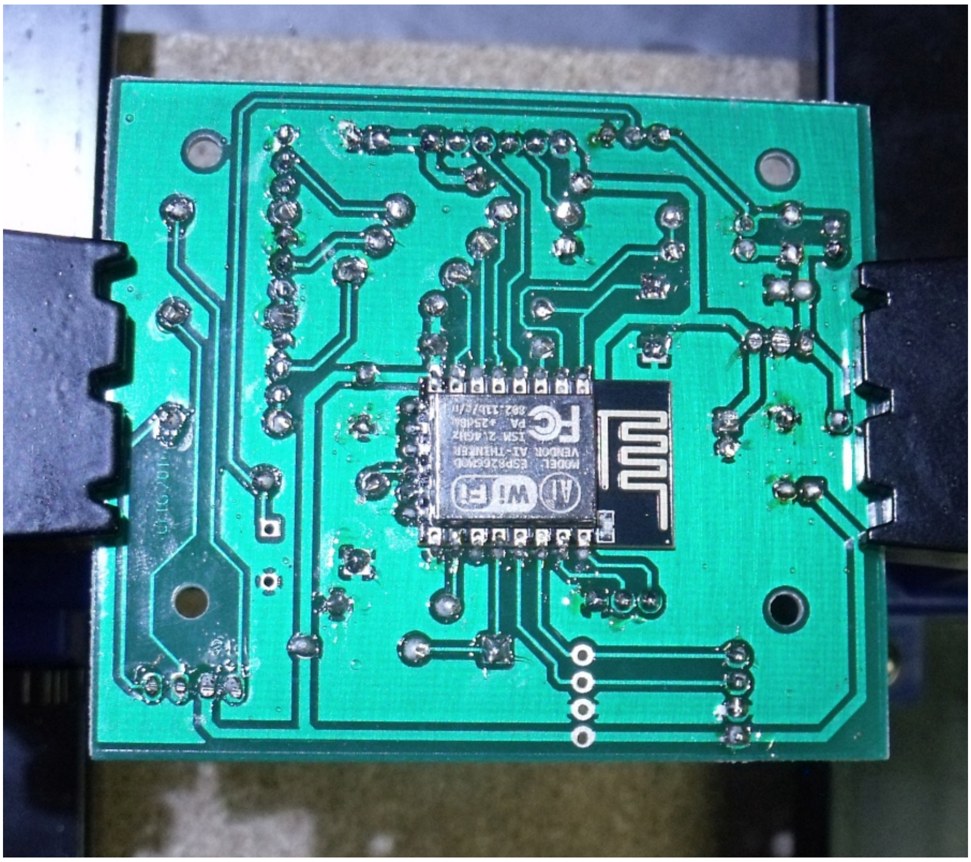
This single side PCB is kept simple, it should be possible to etch it at home. All parts are mounted from the front side “trough hole”.

Only the ESP is mounted on the bottom side of the PCB.

At the end of the PDF a 1:1 printout is provided for etching.



The fully populated PCB – component side…..



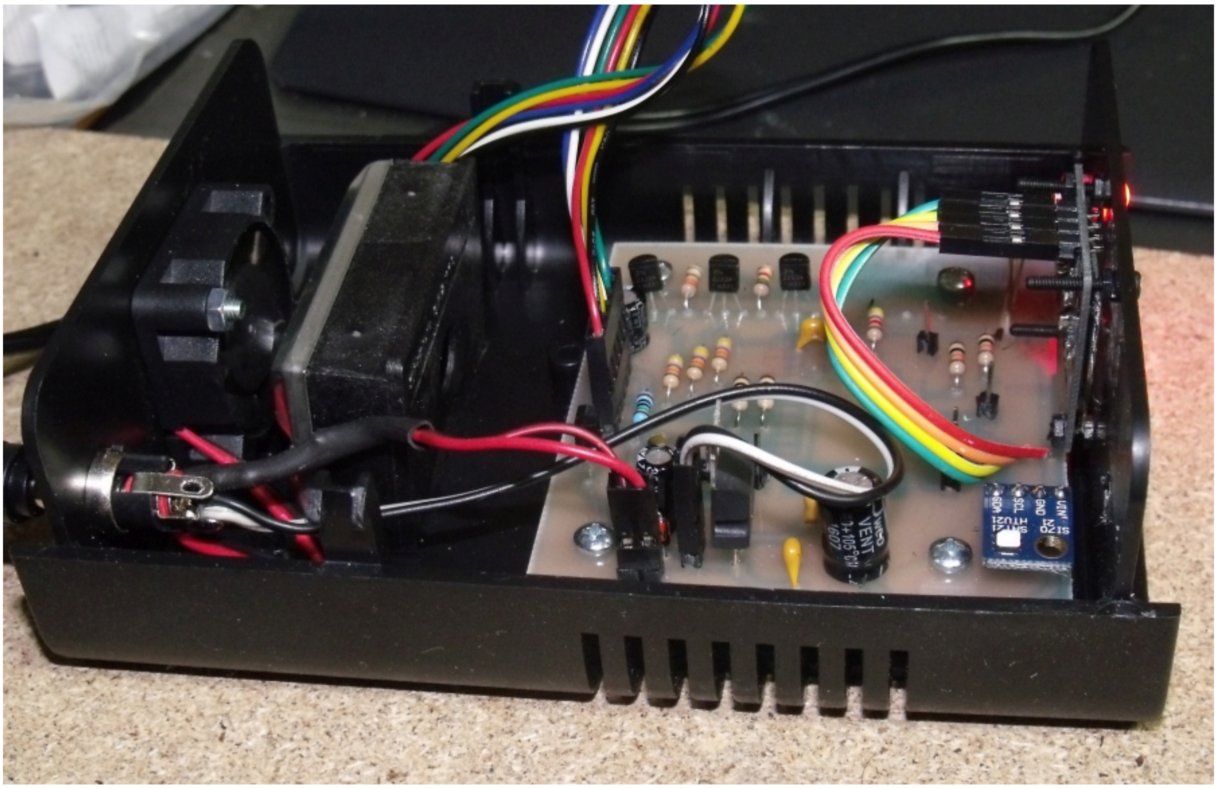
…and bottom (soldering) side.

Case

I’ve used a standard case from market. It is sold under several brand names, in fact you may find it even on Aliexpress or at many electronics providers. I’ve got it here:

https://www.reichelt.de/Kunststoff-Kleingehaeuse/EUROBOX-SW/3/index.html?ACTION=3&GROUPID=7715&ARTICLE=50429&SHOW=0&START=0&OFFSET=50&SID=94WeyucKwQATMAABkE9hodf3b921f5ffd24e8964d4dcc85ff2abf&LANGUAGE=EN

The PCB is developed to fit into this case including sensor, fan and display.
You may use other cases but you will have to drill mounting holes for the PCB.



Mounting the PCB, Sensor and fan together with display in the case.
The sensor was fixed with a double sided adhesive tape.

Building the Circuit

As we use though hole components this device do not need too much experience with soldering. A standard soldering iron for electronics will do for most parts. Only the ESP needs a pencil tip type iron.

Be very carefull with soldering the ESP-12.
The solder tends to creep under the ESP-chip short circuiting some pins.
I recommend to solder one single pin of the ESP and then check:
- Is it correctly aligned to the pcb?
- Is it really flat on the pcb or is there some “air” between pcb and chip?

If you solder just one pin first, these things are correctable.
A completely soldered ESP-12 is fixed. It is somewhat difficult to de-solder it, often the pcb and/or the chip get damaged.

Place resistors first, then capacitors and pin headers. The transistors and the LF-33 voltage regulator follow, and at last the ESP from the bottom side.

Before you power up first time, please check very carefully:
- Any bad soldering points?
- Any unwanted soldering bridges between solder points?

A steel needle or a sharp cutter knife are helpful here.

Flashing

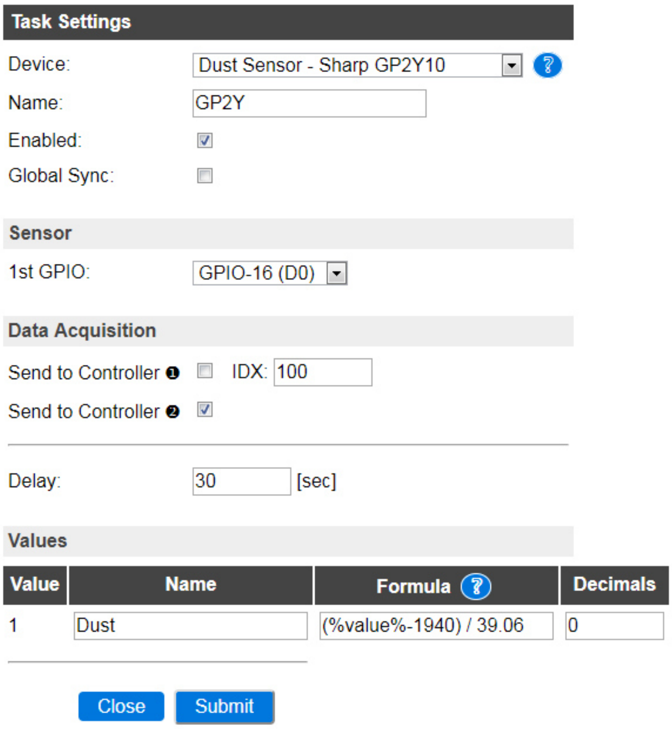
- Connect your programming adapter to the “serial” pins.
- Shorten the pins P5 and P7 to set flash mode.
- Start flashing in your flash tool and shorten P3-P8 for a short moment.
- Wait until flashing succeded.
- Switch off the device.
- Disconnect the adapter.
- disconnect P5-P7

Done, that’s it.

ESPEasy Settings

Set your devices as shown here. If you use a BMP-180 or BMP-280 change settings accordingly.

Settings for the GP2Y10:



Task Settings

Device:	Dust Sensor - Sharp GP2Y10
Name:	GP2Y
Enabled:	☑
Global Sync:	□

Sensor

1st GPIO:	GPIO-16 (D0)

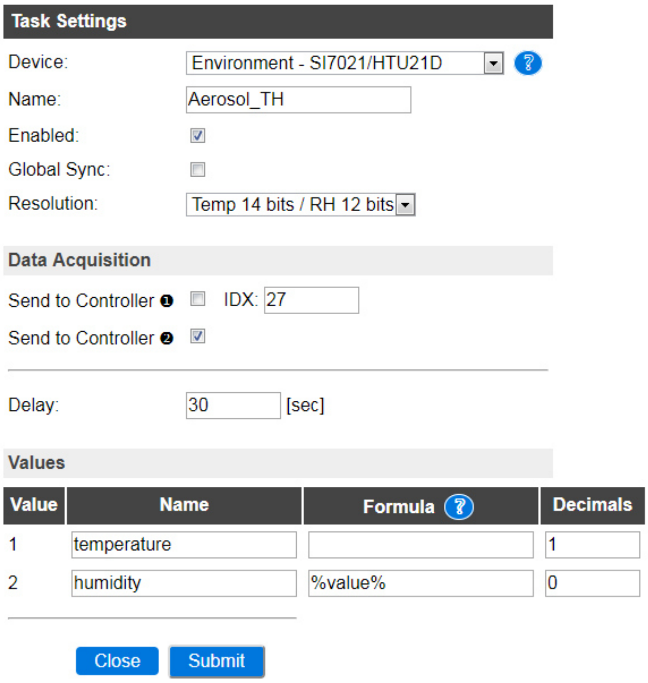
Data Acquisition

Send to Controller ❶	□ IDX: 100
Send to Controller ❷	☑
Delay:	30 [sec]

Values

Value	Name	Formula	Decimals
1	Dust	(%value%-1940) / 39.06	0

Settings for the SI7021 (Change accordingly for BMP-types):



Task Settings

Device:	Environment - SI7021/HTU21D
Name:	Aerosol_TH
Enabled:	☑
Global Sync:	□
Resolution:	Temp 14 bits / RH 12 bits

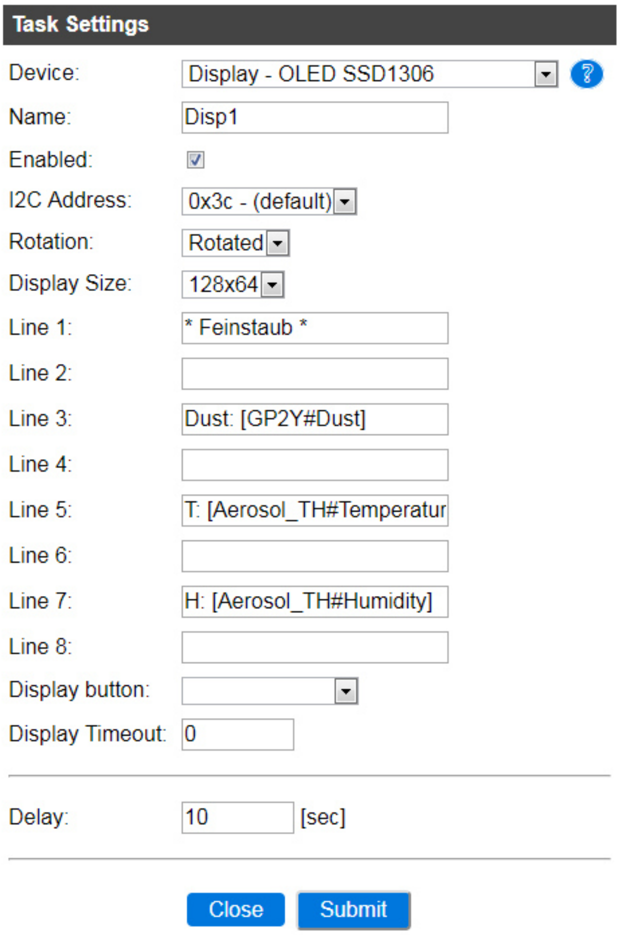
Data Acquisition

Send to Controller ❶	□ IDX: 27
Send to Controller ❷	☑
Delay:	30 [sec]

Values

Value	Name	Formula	Decimals
1	temperature		1
2	humidity	%value%	0

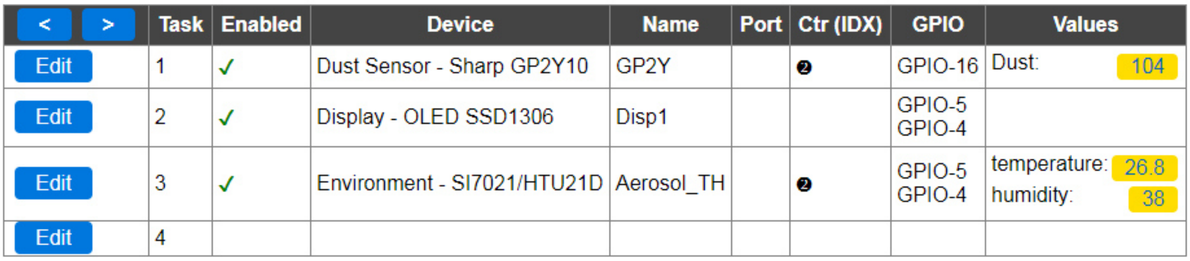
Settings for the Display (If you use one at all, it is optional):



Task Settings

Device:	Display - OLED SSD1306
Name:	Disp1
Enabled:	☑
I2C Address:	0x3c - (default)
Rotation:	Rotated
Display Size:	128x64
Line 1:	* Feinstaub *
Line 2:	
Line 3:	Dust: [GP2Y#Dust]
Line 4:	
Line 5:	T: [Aerosol_TH#Temperatur
Line 6:	
Line 7:	H: [Aerosol_TH#Humidity]
Line 8:	
Display button:	
Display Timeout:	0
Delay:	10 [sec]

If all settings are done, your device list should look similar to this:



< >	Task	Enabled	Device	Name	Port	Ctr (IDX)	GPIO	Values
Edit	1	✓	Dust Sensor - Sharp GP2Y10	GP2Y		❷	GPIO-16	Dust: 104
Edit	2	✓	Display - OLED SSD1306	Disp1			GPIO-5 GPIO-4	
Edit	3	✓	Environment - SI7021/HTU21D	Aerosol_TH		❷	GPIO-5 GPIO-4	temperature: 26.8 humidity: 38
Edit	4							

Congratulations, the sensor itself is up and running.

Getting LED and Fan to Work - Rules

The LED should show a color depending to the amount of dust the sensor detects.
For now the fan should be switched on when powering on the device.

For this a simple rule does the job:

```
On System#Boot do
  gpio,10,1
endon
```

This just sets GPIO10 to “1” on system boot

The Rules for LED need a bit of explanation.
As the PCB is developed the LED is connected to these GPIO’S:
GPIO12 = Green
GPIO13 = Blue
GPIO14 = Red

So we simply could say:
On a dust value below 25 switch GPIO13 on, otherwise off
On a dust value of 26…50 switch GPIO12 on, otherwise off
and so on.

But this would give just blue, green and red with an additional rule.
We left out cyan and yellow! What to do?

It’s simple: We define some overlapping between the colors.

Below 25:	Blue
26….40	Cyan
41….50	Green
51….75	Yellow
75….330	Red

So with this definition the Blue led should be “on” from 0….40, as cyan is mixed from blue and green.
Green should be on from 26 …. 75 as we need it for cyan, green and yellow (red/green mix).

Please note: These values are just what I use. You may adapt it to your needs.

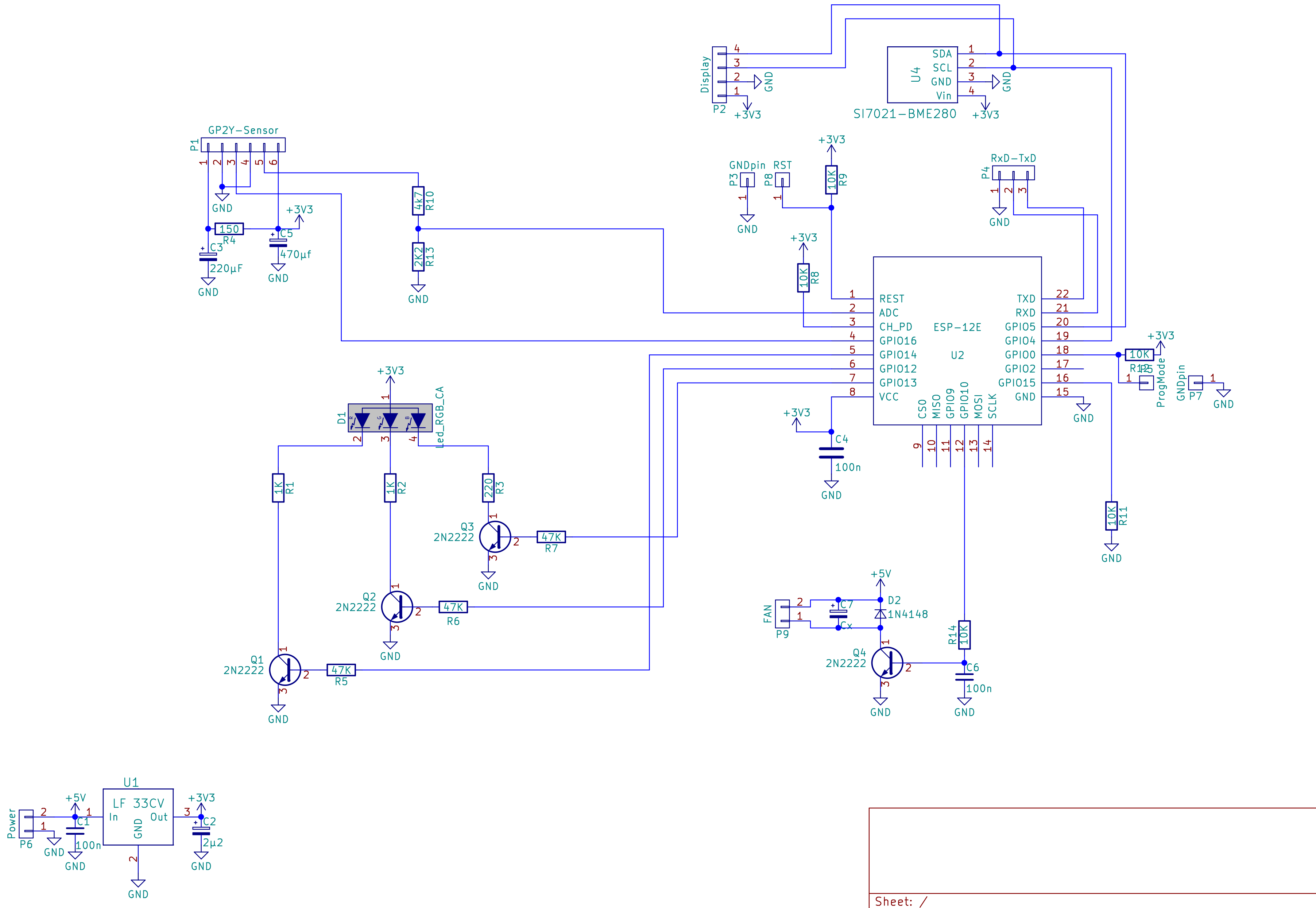
If you check the rules aou may notice an extra rule for values >330.
This switches off the LED on values out of the limits of the sensor and analog input.
A nice (and honestly not planned) side effect: If out of limits the LED flashes every some seconds shortly showing you’re out of range.

So let's see a complete set of rules for fan and LED:

```
On System#Boot do
 gpio,10,1
endon

on GP2Y#Dust do
  if [GP2Y#Dust] > 40
    gpio,13,0
  else
    gpio,13,1
  endif
  if [GP2Y#Dust] >25
    gpio,12,1
  else
    gpio,12,0
  endif
  if [GP2Y#Dust] > 75
    gpio,12,0
  endif
  if [GP2Y#Dust] > 50
    gpio,14,1
  else
    gpio,14,0
  endif
  if [GP2Y#Dust] > 330
    gpio,12,0
    gpio,13,0
    gpio,14,0
  endif
endon
```

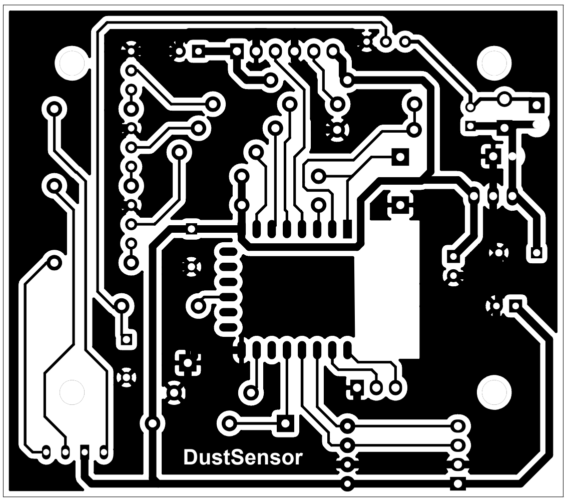
That's all, folks.
Have fun with your dust sensor.



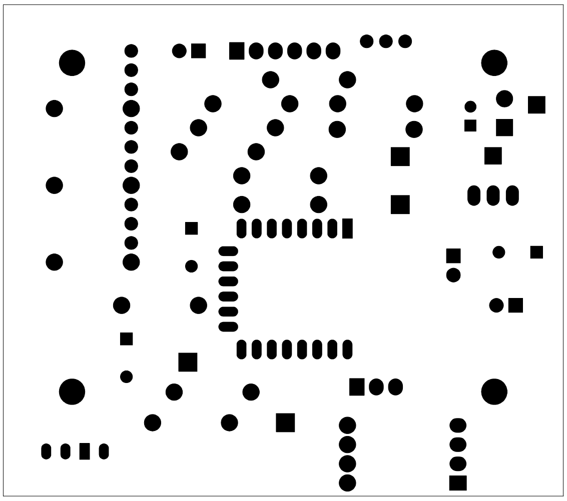
Sheet: /
File: DustSensor.sch

Title: Feinstaubsensor

Size: A4	Date: 2016-10-20	**Rev: Version 2.1**
KiCad E.D.A. kicad 4.0.4-stable		Id: 1/1

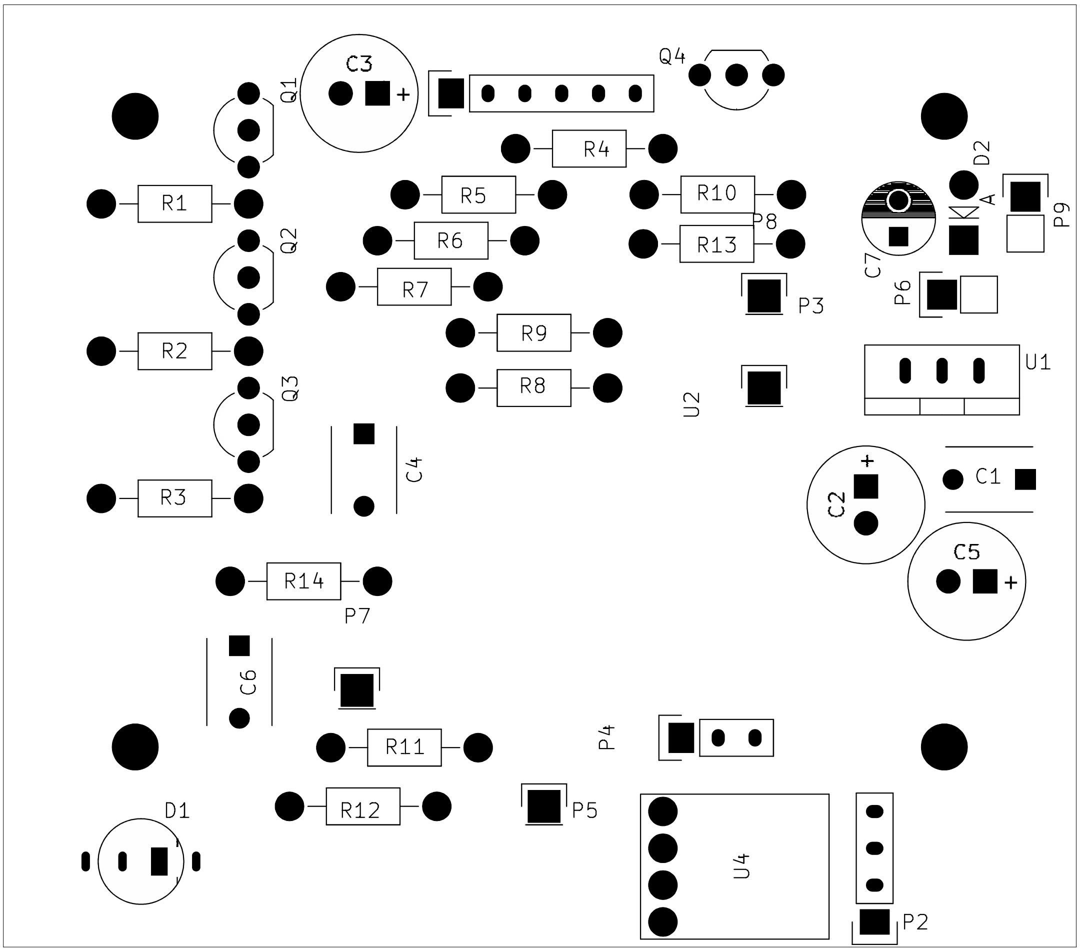


Copper side
For etching the text must be readable!



Solder resist mask

Silks


C3
Q1
Q4
R4
D2
R1
R5
R10
A
K
P9
R6
R13
P8
C7
Q2
R7
P6
P3
R9
R2
R8
U1
Q3
U2
C4
C2
C1
R3
C5
+
R14
P7
C6
P4
R11
R12
P5
D1
U4
P2