Assembly Guide v1

AJDOS Air Pollution Sensor

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Introduction

This documentation contains the assembly instructions for the AJDOS air pollution sensor. The electronic components, the other components and the tools required for assembly are listed. Each step of the assembly and commissioning is described.

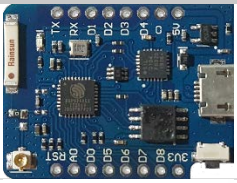
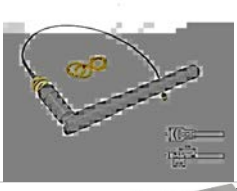
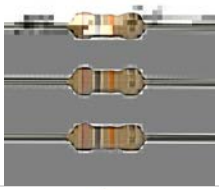
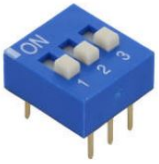
The reader of the documentation is expected to have basic electronic knowledge, such as reading wiring diagrams, measuring electronic components, basic knowledge of computer user and microcontroller development tools.

The installation techniques used to assemble the sensor are highly dependent on locally available products, therefore the present description is only a support. In reality, during assembly, individual solutions must be applied, which requires a small creativity

In the documentation, we use electrical installation materials to store the device, assuming that these types of products are available in all countries and are easy to obtain anywhere.

Parts list

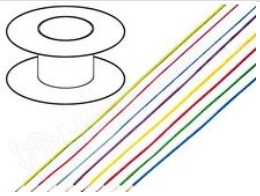
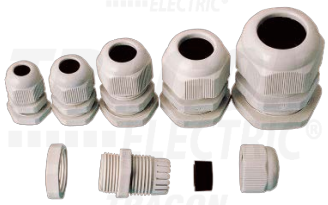
Elements for sensing

	part	type/description	picture
1.	Microcontroller	WEMOS D1 mini pro	
2.	WI-FI Antenna	3dBi 12cm with SMA connector and RP-SMA-uFL cable	
3.	Air Particle sensor	SDS-011 Nova PM Sensor	
4.	Temperature sensor	DHT-22 sensor module	
5.	Switching transistor	BC-546B NPN	
6.	Resistors	R1: 220Ω, R2: 130kΩ, R3: 1kΩ	
7.	DIP Switch	DS02 or DS03 Only two switches will be connected	

Elements for power supply

	part	type/description	picture
8.	Charging Module	TP4056 Li-Ion / Li-Po charging module with battery protection and micro USB connector	
9.	DC-DC converter (voltage regulator)	-2A DC-DC step up module, 2A / 3.7V to 5V converter	
10.	Battery holder	for ø18 x 66mm battery	
11.	Battery	EXC-18650-2000 3.7V/200mAh	
12.	Power supply adapter	AC 220V/DC 5V 1200mA with micro USB connector	

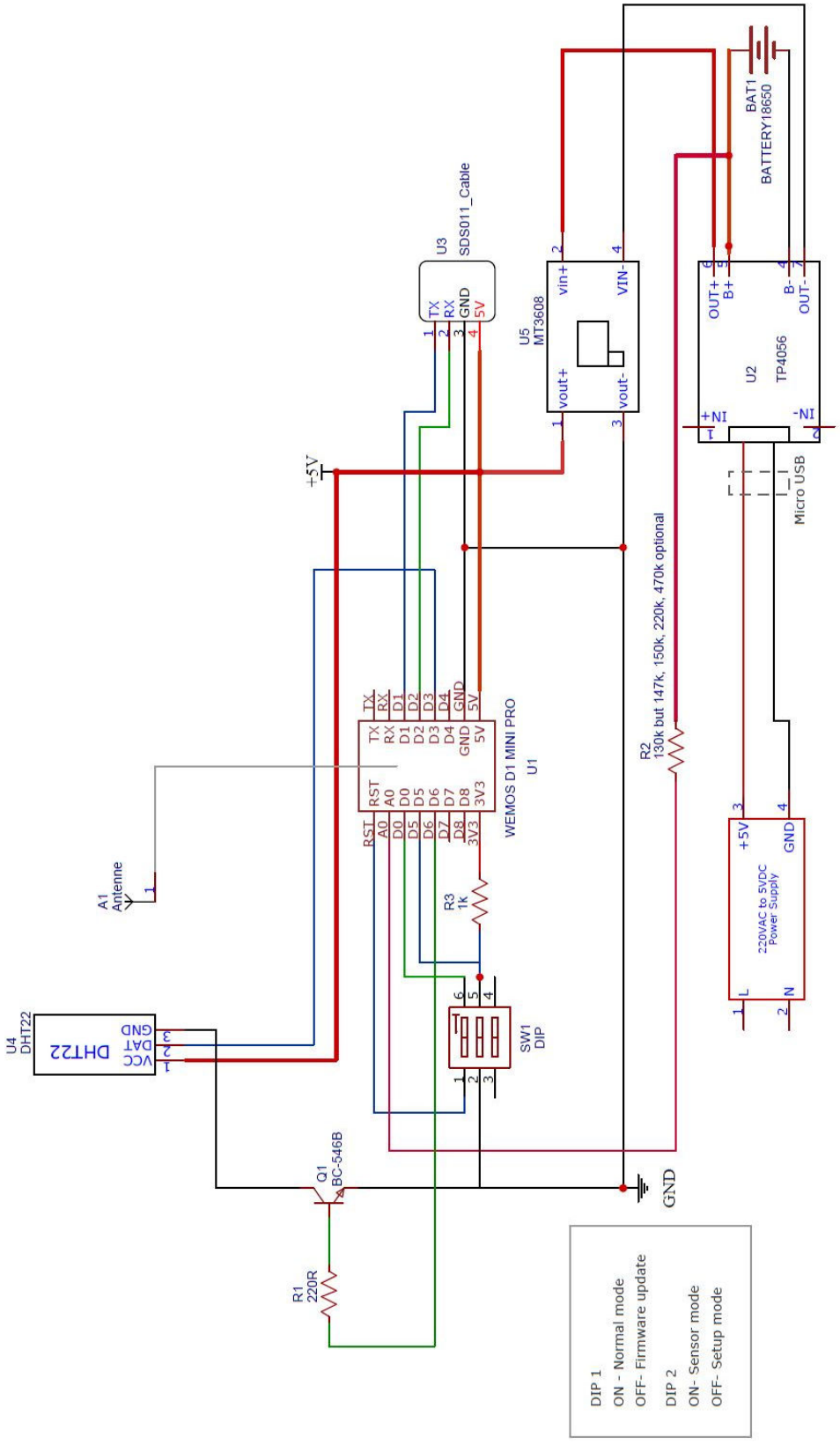
Other elements

	name	description	picture
13.	Prototype PCB panel	50x50mm panel is suitable for electronics	
14.	wires	depend ont he used prototype PCB. It is recommended to use different colored wires.	
15.	weather-proof junction box	The minimum size of the box is 120x120x50mm, but due to the convenient installation of the parts, a slightly larger use is recommended. (e.g. 140x120x60mm)	
16.	Cable gland for temperature sensor	depend on junction boksz size: M25x1.5	
17.	Cable gland for PM sensor inlet tube	depend on junction box	
18.	Cable gland for WIFI antenne	optional / depend on junction box	
19.	flexible tube for PM sensor inlet	6mm diameter cca. 50mm / sensor the colored is better than the transparent.	
20.	mosquito netting	2x20x20mm / sensor to inside of the cable glands for insect protection	

Required tools

name	description	picture
Soldering tools	use quality tools	
Solder wire	you can use solder grease too	
Multimeter	resistance, voltage and tear test required	
Hand tools	they are always needed	
Glue gun	for fixing temperature sensors and wires	
Adhesive putty	for detachable fixing of parts	
Insulating tape	optional	
Shrink tube	optional / depend ont he used wires	

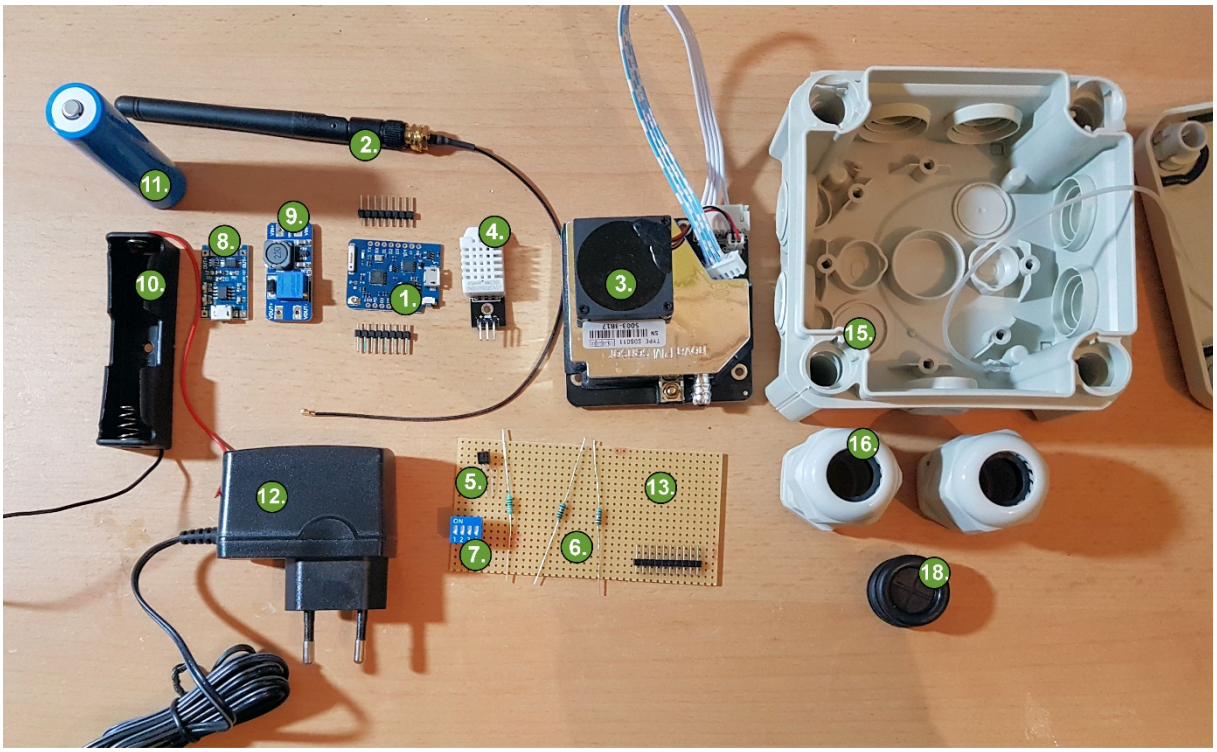
Schematic


BAT1
BATTERY18650
U3
SDS011_Cable
TX
RX
GND
5V
U5
MT3608
vin+
VIN-
vout+
vout-
U2
TP4056
OUT+
B+
B-
OUT-
+NI
-NI
Micro USB
+5V
R2
130k but 147k, 150k, 220k, 470k optional
U1
WEMOS D1 MINI PRO
RST
A0
D0
D1
D2
D3
D4
D5
D6
D7
D8
3V3
GND
R3
1k
A1
Antenne
U4
DHT22
VCC
DAT
GND
SW1
DIP
Q1
BC-546B
R1
220R
GND
220VAC to 5VDC
Power Supply
L
N
DIP 1
ON - Normal mode
OFF- Firmware update
DIP 2
ON- Sensor mode
OFF- Setup mode

Assembly

If the goal is to make several sensors at the same time, then first make a prototype on which you test the assembly process for the currently purchased parts. Thus, any modifications, the use of necessary accessories (eg wires, gluing, etc.) will be discovered during the assembly of the first sensor.

Preparation of electronic components



Prepare all the electronic components and sort them into as many packages as you want to build. Create a container for each sensor in which to collect the parts. Check the values of the resistors with a multimeter, if you have a suitable device, also check the transistors. Be sure to specify the pin assignments for the transistor you purchased, and note that different manufacturers may use different pin assignments. Note it down the established data of the transistors so that you do not have to deal with it later.

PCB design and / or preparation

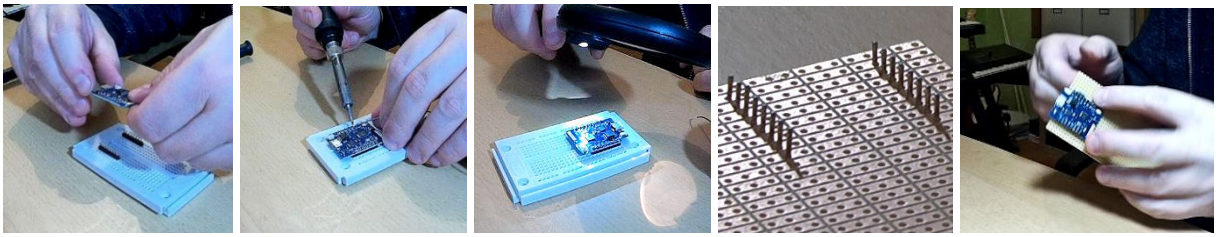
The assembly of the components depends on the characteristics of the PCB test panel purchased. If you have a panel with a copper surface, you need to plan the assembly and wiring that you can do with soldering or using wires.

Consider whether the connection of the sensors to the PCB will be fixed or can be disconnected. For the first prototype, if you have the opportunity, choose the

unplugable connections. For this, you can use the extra pin sets supplied with the WEMOS D1 as well as the test wires for electronic development.

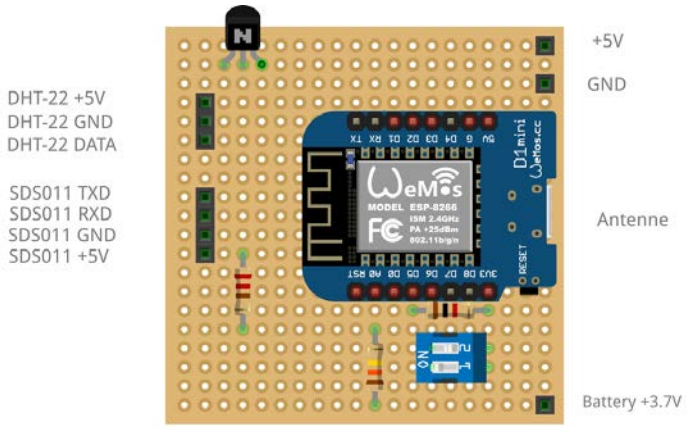
Microcontroller

The WEMOS D1 microcontroller(1) usually comes with several rows of pins and the base panel. Select the short-legged 2x8 pin row and solder it to the panel. Easy way to soldering if you use a prototype board for fixing the wemos pins. Then solder the microcontroller to the PCB panel. When placing, pay attention to the location of all other elements



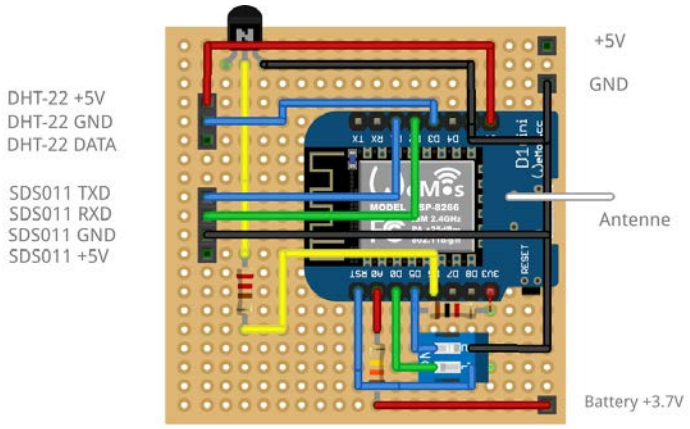
PCB assembly

The next step is to install the components on the test PCB panel (13). The figures show the pins to the sensors due to the detachable connections. For finalized sensors, this can be omitted, but it is advisable to arrange the connection of the external sensors in a similar way. The components of power supplier will not be on the motherboard, they will be located elsewhere.

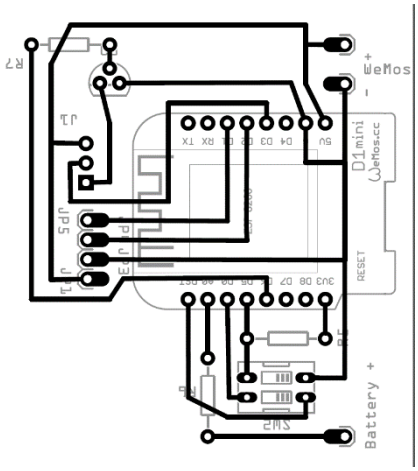


The following figure shows the wiring of the components. The color of the wires is grouped as follows:

- red: power +
- black: GND
- yellow: controll
- blue: data read
- green: data send



The assembly of the components as shown makes it possible to make a PCB. However, this further increases the cost of the sensor and on the other hand significantly simplifies the installation of the components.



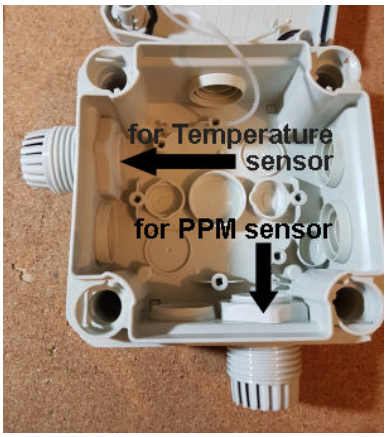
Assembly the following componoents tot he PCB panel: DIP switch (7), R1,R2, R3 resistors (6), transistor (5), and pins if you need. Wire them togather and to the microcontroller and pins.

Temperature sensor

Place approx. 10-15cm long wires (14) to the legs of the DHT-22 temperature sensor (4) module. The sensor module pin assignment from left to right:

+5V DATA GND.

If possible, use colored wires or Dupont cable, but you can also solder cables with fixed joints.

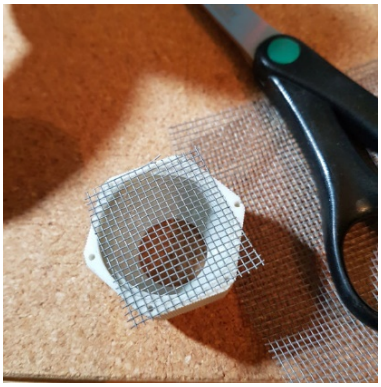


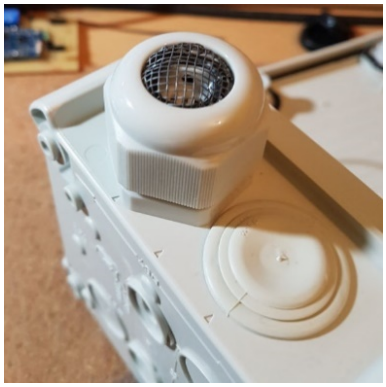
The temperature sensor will be located inside one of the M25x1.5 cable gland (16).

Prepare the junction box (15), cable gland (16), glue gun, and the mosquito net for the next step.

First, temporarily place the cable gland (16) to the box (15) for the temperature sensor like it will be installed in the final condition. Mark the top of the cable gland after installation. You will adjust the sensor placement to this marker. The goal is to protect the sensor from the weather so that the open part of the sensor is facing down after installation.

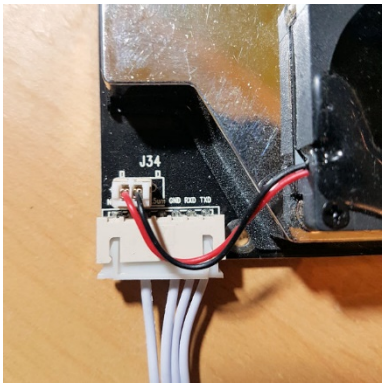

Use a glue gun to fix the sensor(4) inside the cable gland(16) in the correct position. To insect protection, use a pice of mosquito net (approx. 2x2cm) and round the corners, then place in the cable gland cap and assemble with the box(15).

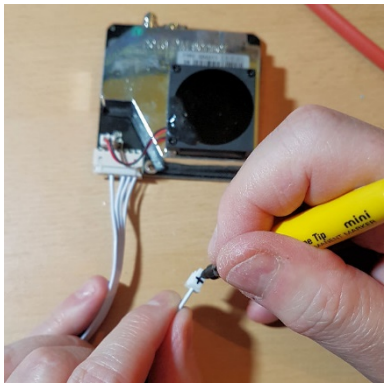




SDS-011 Nova PM Sensor

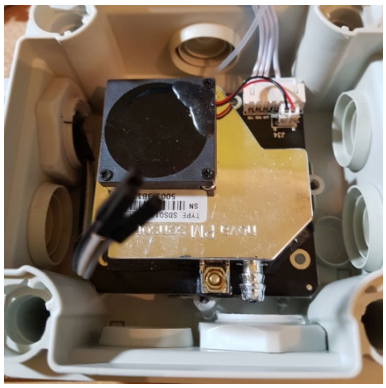
Check the connection of the PM sensor connector and mark the positive connection point.



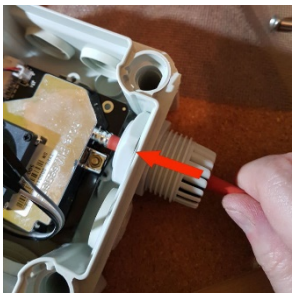


Place the PM sensor with the fan facing up in the box and fix it with a little glue.

Align the sensor air inlet with the box opening.


Use a plastic tube and push it onto the sensor air inlet from outside the box. Cut the pipe to size so that it extends to the end of the used cable gland. To insect protection, use a pice of mosquito net (approx. 2x2cm) and round the corners, then place in the cable gland cap



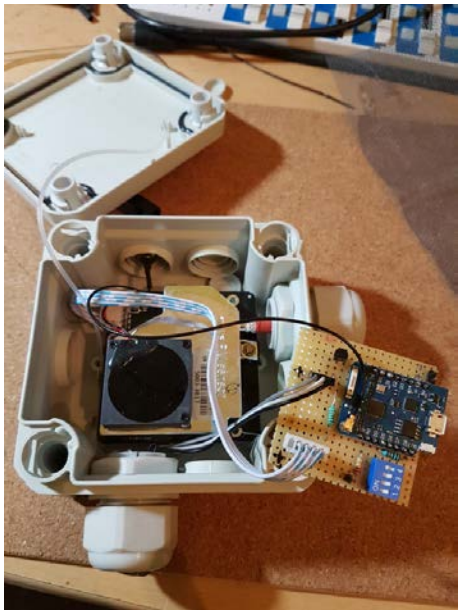

Antenna

Unscrew the antenna cable from the end of the antenna(2). Make a small hole on the closing cap of the junction box(15) where lead the antenna connector through into the inside of the junction box.


Fix it with nut. If the bond is loose, you can support it with a metal ring plate.


Motherboard and test

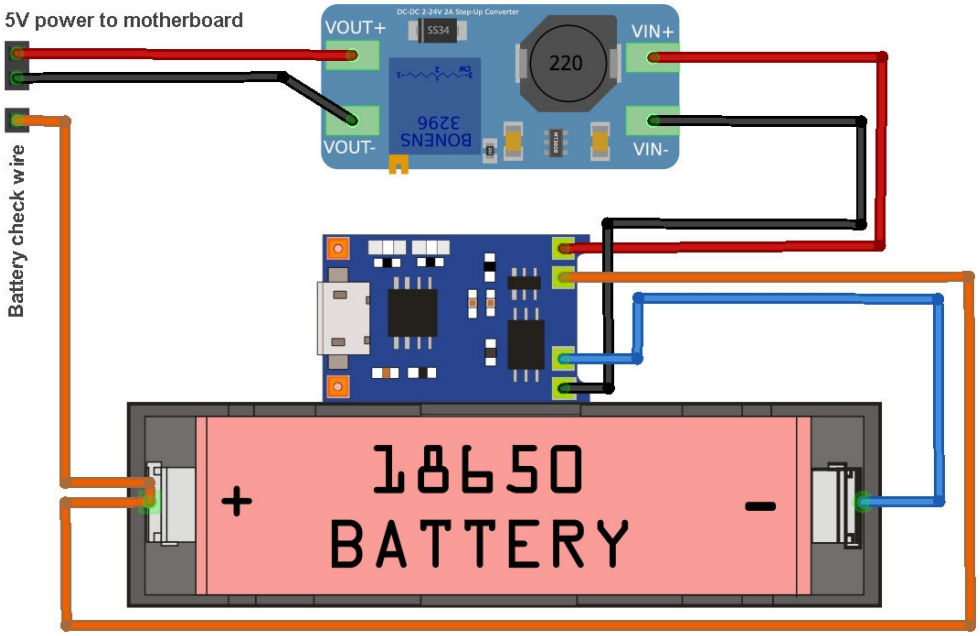
After installing the sensors, connect them according to the connection on the motherboard. When assembling or soldering the connectors, make sure that the connection points are correct. Also connect the antenna cable to the WEMOS D1 mini PRO microcontroller board(1).



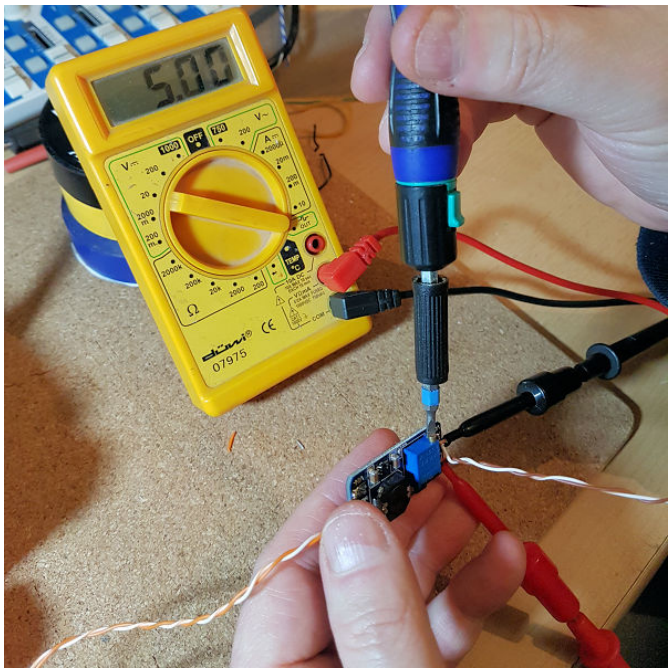

Now the sensor is ready for the first test. Upload the test firmware via USB connector of WEMOS D1 mini Pro. (the uploading the firmware is described in an other capter.) Open the serial monitor window in Arduino IDE, reset the microcontroller and follow the instructions ont he serial monitor. The expected result, the positions of the microswitch and the measurement data of the sensors can be read.

Power supply

You have to wire the power supplier components as below. Use 8-10cm long color wires to practical layout.



After the wiring finished put the battery(11) in the holder(10) and connect the power adapter(12) to the charger(8). Check the voltages on the charger(8) output and then connect the multimeter to the voltage regulator(9) outputs. Use a screwdriver to set the output value to exactly 5V.



The placement of the parts depends on the size of the used junction box. The following example shows the possible installation in a small (115x115x50mm) box.

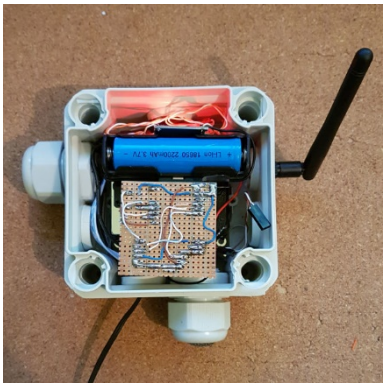
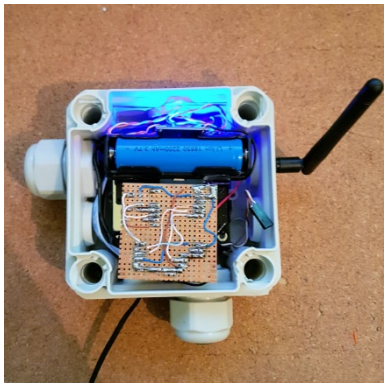
As you can see on the picture the house of the PM sensor(3) is conductive. Check it with a multimeter. The space should be used well in a small box(15), so the 5V converter module(9) is placed on top of the PM sensor(3). To do this, an insulation must be placed on the sensor housing.

After wiring, glue the battery-charger(8) to the side of the battery holder(10) so that the USB connection is trouble-free. (We use a different type of power connector, so the figure shows more wires than necessary.) Use addhesive putty on the insulated housing of the PM sensor(3) to fix the voltage regulator(9).




ow, it is the time to connect the wires of the voltage regulator and the battery check wire to the moderboard. Route the adapter(12) cable through one of the bottom inlet of the box and connect it to the charger(8) inside the box.

All components in the box looks like this.


Led Colors:

Red	charging
Blue	battery fully charged
None	no external power, the sensor works from the battery

Sensor installation

Because each installation location is different, a survey should be conducted prior to installation to select the necessary equipment. In this chapter, we call the attention to the main criteria.

The correct position

The sensor is placed outdoors. A place should be chosen where the measurement results are not affected by environmental influences or factors. Do not install in dusty environments or near construction sites. For proper measurement results, it is necessary to measure the outdoor temperature instead of the inside temperature of the box. Therefore, we placed the measuring devices near the holes of the box. This is optimal for measurement, but the sensors must be protected from the weather, especially rain. That it is possible to place the sensor in a rain- or water-protected place.

The best position is to fix the sensor box by rotating it at a 45-degree angle to a column so that the measurement points are facing down.

In a rainproof place, the following two placement methods may be appropriate, the third image shows an incorrect position.



The mounting method of the sensor depends on the mounting box used. There are screw holes in the back of several outdoor electrical boxes. You can use a metal strap with holes or other mounting materials to fix the box.

Power supply

Place the sensor near a power outlet. The cable length of the adapter determines how far the sensor can be placed from the power supply location. The power source may need to be located.

It is important that the connection of the adapter to the power supply to be safe and waterproof.

Because the adapter cable is usually thin, pet protection should be considered, which may require the installation of a protective tube.

Uploading firmware

Arduino IDE 1.8.12

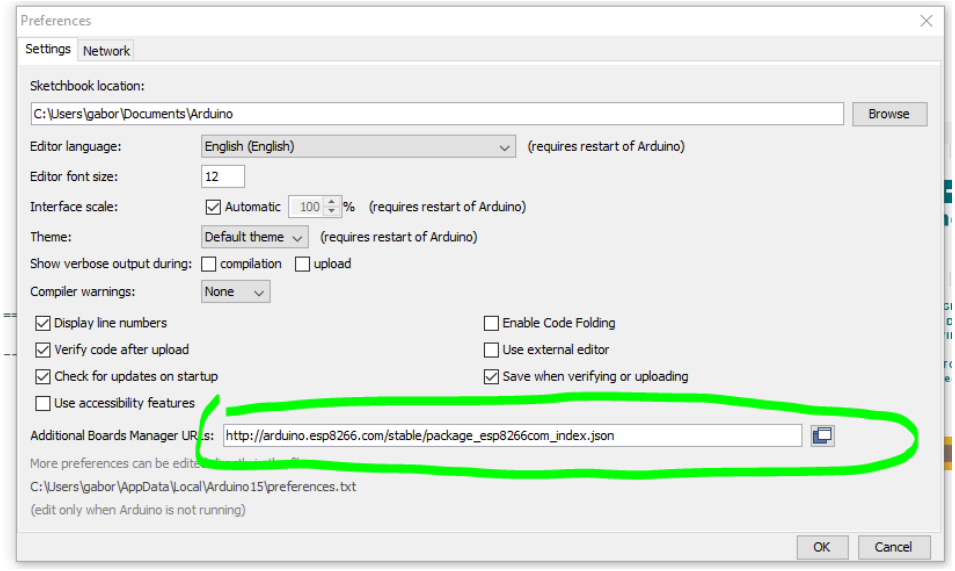
Arduino is an open-source electronics platform based on easy-to-use hardware and software. The Arduino IDE supports the WEMOS D1 minit microcontroller. The easiest way to upload firmware is to use the IDE. The Arduino IDE is constantly developing, the procedure libraries associated with the release version may change. Always stick to the specified 1.8.12 version when installing the sensor program. It can be downloaded here from the link below:

https://www.arduino.cc/en/Main/OldSoftwareReleases

Setup

The Arduino IDE is designed for those who use Arduino development panels as the motherboard for their IoT devices. Our project uses an ESP8266-based WEMOS motherboard with WiFi support, which is not included in the newly installed Arduino IDE program. It is therefore necessary to install the ESP8266 kit separately as follows:

Add the ESP8266 boards on the Preferences panel from the File menu.



Type the following links in the „Additional Boards Manager URL's:"
http://arduino.esp8266.com/stable/package_esp8266com_index.json
then press OK.

Dependencies

Sensor libraies

Nova Fittness SDS dust sensors library 1.4.1 by Pawel Kolodzejczyk

https://github.com/lewapek/sds-dust-sensors-arduino-library

DHT sensor library 1.4.0 by Adafruit

https://github.com/adafruit/DHT-sensor-library

Other libraries

- ESP8266WebServer
- ESP8266mDNS
- EEPROM
- SoftwareSelrials
- WifiClient
- Base64 1.2.0 by Densaugeo

Libraries can be downloaded from the **"Tools"** menu using the **"Manage Libraries ..."** function.

Install firmware

The sensor control software can be downloaded from the link below

https://github.com/competterra/ajdos

There are two components in the repository:

- Sensor Test
- Firmware vX.x

Download the directories, start the Arduino IDE and open the file from ajdostest.ino or ajdosfw.ino.

In the **"Boards manager"** function from the **"Tools"** menu, select the **"LOLIN (WEMOS) D1 R2 & mini"** motherboard.

Disconnect the power, remove the battery from the holder and, the DIP 1 switch must be switched off.

Connect the WEMOS D1 PRO microcontroller to the computer via the USB port using a USB cable.

Check if the connection port has become available in the "Port" function of the "Tools" menu.

Some models may require the installation of USB driver.

Check the compilation of the program, if there is no error you can upload it to the motherboard.