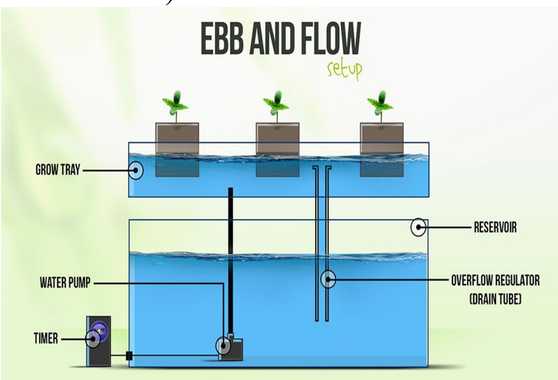
DIY ebb and flow project for orchids and hydroponics

(To make links work, download this file and use a pdf-viewer on your PC)

For many, the best watering system for orchids is the immersion of the pot. But I am very lazy: since I had a couple of orchids, I have studied this automatic sill irrigation system.
The pots are watered with cyclical dives controlled by a timer. A watering cycle is adjustable in duration (flow) [1.60 minutes] and in repetition (ebb) [from every 2 minutes to one every 14 days] to adapt to all needs. In the case of multiple cycles within 24 hours, the times between day and night can be differentiated.
This project can also be used in *hydroponics*, for all types of plant, according to the method known as 'ebb and flow' (flow and reflux: like the tides).



Just replace the water with the nutritive solution and put the plants in pots with an inert substrate (excellent expanded clay with controlled neutral pH, also suitable for orchids). The pots can also be eliminated, filling the whole upper tank with inert substrate, and planting the seedlings in rows (in this case, put a net with a filter function on the bottom, but above the spacer, and protect the overflow).

The project criteria are:

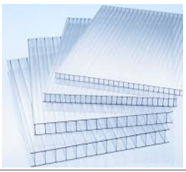
- Flexible project, easily modifiable and adaptable to different needs.
- Availability of the parts (many references are for the Italian market, but from the photos and descriptions it is easy to find similar products: all the parts are very common and not critical)
- Simplicity and reliability of DIY operations
- Low cost

We can consider this project divided into two parts:

1. containers: grow tray and reservoir
2. special timer for ebb & flow

Containers: material

	2 x Transparent container, Deahome mod EASY BOX 330 30x20x13 (5 l) http://www.deahome.it/it/product/easy-box-xs-330.html (sold by Maury's)	€ 4.00

	Pump for aquarium PM550 (220V - 8 W, H = 0.9 m, Q = 200-500 l/h) http://www.prodacinternational.it/en/prodotti-tecnici-gb/magic-pump.html (pet shops, chinese shops ...)	€ 16.00
	4 x M4 threaded bars (stainless steel or brass) 13 cm 10 x Nuts M4 10 x Washers M4 (by Leroy Merlin)	€ 3.00
	30 cm Flexible hose (for pump connection) (shops of technical articles - plastics, agriculture, hardware)	€ 0.50
	15 cm rigid tube 2.5-3 cm diameter, double compared to the flexible tube. (shops of technical articles - plastics)	€ 0.50
	Glass grill (chinese shops, housewares)	€ 2.00
	Alveolar polycarbonate, 6 mm, 12x11 cm (shops of technical articles - plastics)	€ 0.50
	Aluminum sheet, 1.1 m (housewares shops)	€ 0.10

Containers: tools

	Multipurpose drill
	Hot glue gun

Containers: construction

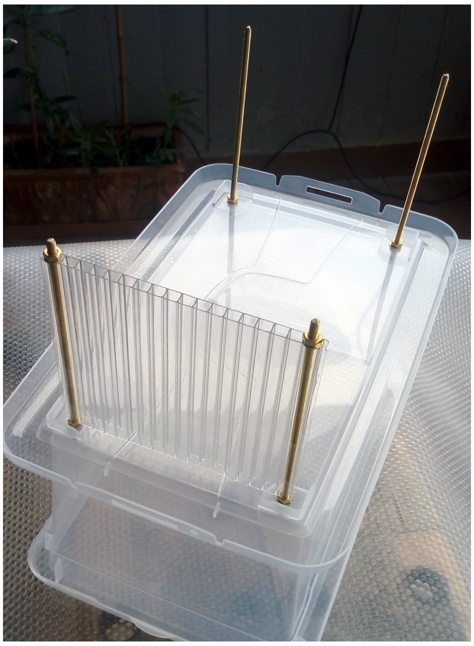
The practical problems for the DIY realization of the grow tray and reservoir are:

1. *The support for the grow tray, which must be placed higher than the reservoir to take advantage of gravity during reflux.*
2. *The realization of the watertight joints between the pipes and the grow tray, in particular the inflow-outflow pipe, which should be realized as the drain of a shower tray to allow a complete emptying, and the overflow pipe to be height adjustable.*

My choice fell on two transparent plastic containers, stackable, very cheap and 'food safe' (see note at the end). They have the characteristic of having a recess on the lid to accommodate the bottom of the upper container. The 30 x 20 dimensions allow an easy movement and can contain from 3 to 5 orchids (a little narrow ... 40 plants / m² . recommended).
Obviously you can use different containers: the important thing is that the containers are stackable and that the lid has a recess.

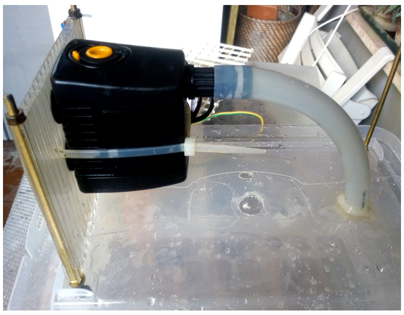
The first problem is solved: grow tray and reservoir are simply superimposed.
By fixing the upper grow tray to the reservoir lid, the lid acts as a funnel for any small leakage of the grow tray. A hole in the center of the lid causes the water to fall into the reservoir below.

The second problem can be solved simply with hot glue.
Not having to worry about small water leaks from the grow tray you can use hot glue to fix the inflow pipe to the bottom of the grow tray, trying to not exceed 2 mm in thickness: any leaks are recovered from the lid. On the contrary, the overflow is only forced into an hole, without glue: so it is easy to adjust the height of the water in the grow tray depending on the pots.



Four threaded bars secure the upper grow tray with the reservoir lid. They are positioned at the four corners, stopped with 2 nuts and 2 washers: forming 4 feet that support the grow tray on the flat when the reservoir is to be removed from above. To cut the threaded rods see PoC: Bolts diamond saw using 3Drag/K8200 and Valex drill.

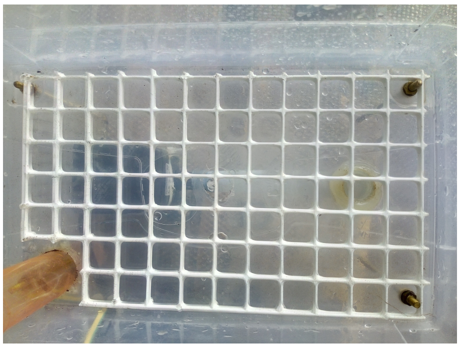
The pump is mounted under the grow tray, obtaining a compact whole and completely freeing the reservoir. A rectangular piece of 6 mm alveolar polycarbonate (12 x 11 cm) is inserted into two threaded bars and fixed with two bolts to make the pump support.



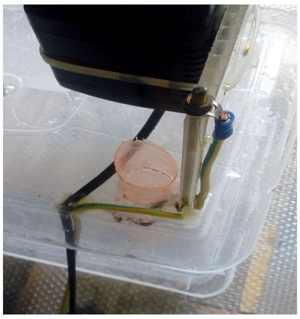
The pump is an 8W aquarium pump, with a head of 90 cm and a flow of 200-500 l/h (adjustable).
Considering that the maximum flow is measured at head 0 and that the maximum head is measured with flow 0, in the first approximation you can linearize the pump curve and use values equal to half of the maximum ones: in this case head 45 cm and flow 1.6 - 4 l/min.
I measured the filling time of the upper tank (empty, 5 l) and was about 1:30 min (3.3 l/min)
The pump is only switched on for a few minutes a day: its duration is guaranteed for many years. The pump is mounted in such a way as to have maximum draft, through its suction cups (reduce noise) and a nylon cable tie. You can of course use different submersible pumps, but do not go below 6 W, for fast filling times.

A hose feeds the water to the grow tray when the pump is switched on and empties it with the pump off: it is important that this pipe protrudes as little as possible from the bottom of the grow tray. To improve the solidity the hose is glued (with plenty of hot glue) even underneath, from the side of the lid.

A piece of plastic 'drainer-glasses' is used like a cauldron in a boat, to keep the pots dry even if 1 or 2 mm of water remain on the bottom of the tank.



In the case of orchids, the presence of a little liquid on the bottom of the grow tray is positive, locally increasing the humidity of the air. The important thing is that the bottom of the pots is dry.



Another small hole in the cover allows the passage of the motor cable and the ground connection which is fixed with an eyelet to one of the threaded bars that support the pump (see note at the end).

The wide holes in the plastic were made with a grinding wheel attached to a small drill, at a speed not too high in order to melt but not burn the plastic.

If you want to change the project, keep the following points in mind:

1. A larger reservoir guarantees greater autonomy.
2. The reservoir lid, fixed under the grow tray, collects the inevitable small losses and conveys them, through a large central hole, into the reservoir below. This greatly simplifies the project.
3. The overflow pipe must be larger in diameter than the pump tube (about double). I used a semi-rigid transparent plastic tube, fixed by force, without glue: so the height is easily adjustable. Losses are collected from the lid.
4. The water level, regulated by the height of the overflow, must remain 1 or 2 cm, below the upper level of the substrate. In my case, I settled on the average pots of commercial orchids (Phalaenopsis sold by Ikea, for example): diameter and height 11 cm, water level: 8 cm. For smaller pots I use supports (upturned and perforated plastic cups).
5. For orchids it is important that light can reach the roots: container and pots must be transparent. For small orchids, use 200 cc transparent plastic cups, abundantly perforated on the bottom.
6. If the reservoir is opaque, algae growth is reduced: algae are not harmful to plants, but consume oxygen.
7. The solution temperature should be between 18 and 24 ° C (65-75 F). In summer, cover the reservoir with a reflective coating (I used aluminum kitchen sheet fixed with hot glue, which also blocks the light), in cold periods the solution can be heated with a submerged heater for aquariums (but in my case simply I move everything inside the house).
8. In the ebb phase, the water that comes out sucks air into the substrate, like a plunger, generating a good replacement of oxygen at the roots. The film of moisture that covers the roots promotes the exchange of oxygen. The overflow water, falling from the top in the reservoir, near the pump, facilitates the oxygenation of the solution.

   If the reservoir is large, however, it is advisable to add an aerator for aquariums with a porous stone, which also guarantees the mixing of the solution.

Timer

Compared to mechanical timers, which usually have a resolution of 15 minutes, and a 24-hour cycle, this timer has a resolution of one minute, thus allowing very short periods of flow, and programming from many times a day up to a once every 14 days.
It can also be integrated into any Home Automation project that uses the MQTT standard, is simple to construct and has a ridiculous cost.

Note: *Using a solenoid valve or a pump (up to 500 W) this timer can also be used for the programmed watering of gardens and vegetable gardens (see also* https://github.com/msillano/sonoff_watering*: another specialized timer for irrigation of the terrace).*

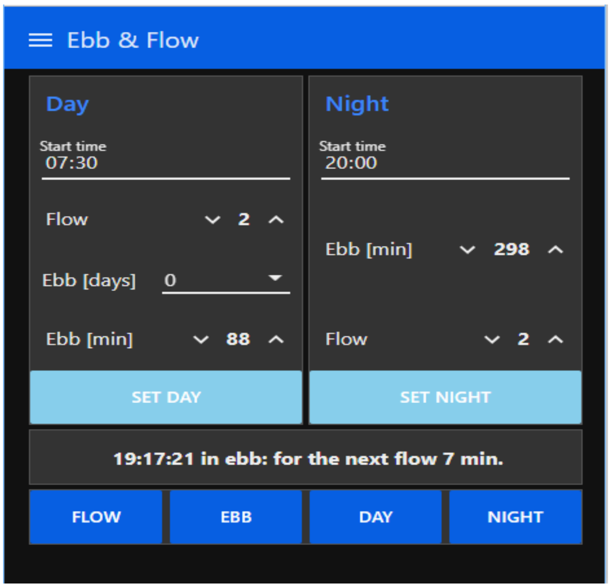
Timer: performances

Mode A (Ebb [days] = 1...14):

- one cycle (*flow*) every N days, at *Start time*
- Flow duration 1..60 min
- *it does not use the Night, Ebb [min] values.*

Mode B (Ebb [days] = 0):

- many cycles (*flow*) in 24 hours
- two periods: Day and Night, with start time.
- Flow and Ebb [min] separately adjustable for Day and Night
- Ebb [min] values: 1..1441 min (24 h)



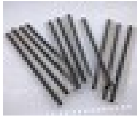
Commands:

SET DAY, SET NIGHT (timer setting)
FLOW, EBB (immediate start)
DAY, NIGHT (cycle starts): *Day cycle begins with a Flow, Night cycle begins with an Ebb.*

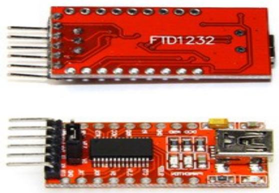
Timer: features:

- ✔ *Autonomous:* contains an MQTT server with the operating logic (script).
- ✔ *Compatible*: can be used with MQTT client and standard MQTT server, has a complete set of commands and information via MQTT
- ✔ *Autostart*: maintain status and configuration in flash RAM: in case of reset or blackout restore the previous status autonomously.
- ✔ *NTP-client*: requires connection to the domestic WIFI, with access to the Internet, to have the correct time. Commands for summer/winter time.
- ✔ *Console serial:* for installation and debugging, via WIFI (telnet) or serial (COM)
- ✔ *OTA update*: the operating logic (script) can be updated via OTA (Over The Air), without moving or opening the timer.
- ✔ *MQTT client:* Full client on PC (*node-red*)
- ✔ *Power supply: 90* - 250 V
- ✔ *Stand-by consumption:* not measurable (<1 W @220V)
- ✔ *On consumption*: 8 W @220V

Timer: material

	Sonoff basic WiFi wireless switch https://www.itead.cc/smart-home/sonoff-wifi-wireless-switch.html	$ 4.85
	5 pin for c.s.	$ 0.10
	1 x Mammuth (Screw terminal)	$ 0.10

Timer: tool

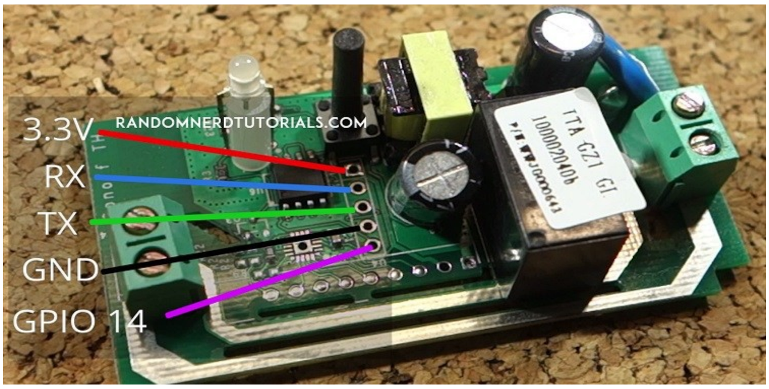
	Thin-tip soldering iron (I use PBLK 6 A1 Parkside)
	FTDI USB 3.3 V 5.5 V Serial Adapter Module TTL for Arduino (US$ 2.41)
	4 Female To Female Jumper Cable Dupont (US$ 0.10)

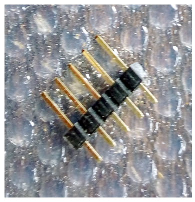
Timer: software

esp_MQTT https://github.com/martin-ger/esp_mqtt
esptool https://github.com/espressif/esptool
puTTY https://putty.org/
Notepad++ https://notepad-plus-plus.org/
wpp_pampa http://www.winpenpack.com/en/index.php
node-red https://nodered.org/docs/getting-started/installation

Preparation of the Sonoff-basic card

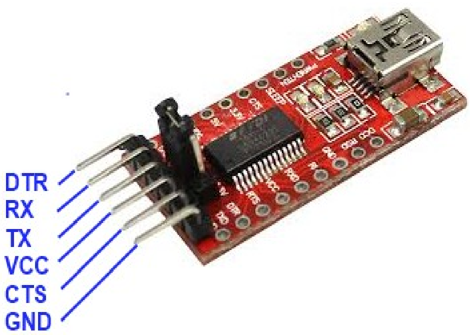
1. **Remove the Sonoff card** from the container
2. **Solder a 5-pin connector** in the Sonoff-Basic pads (to load the firmware and then to connect the humidity sensor)

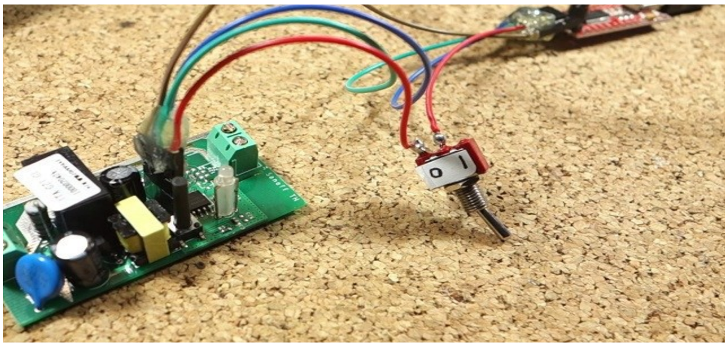




note: *previous versions of Sonoff-basic have only 4 pins (GPIO 14 is missing).*

3. **Prepare the 4-wire** FTDI ↔ Sonoff connection using female-female jumper cable:





FTDI: VCC	→ 3.3 (with switch) Sonoff	
RX	→ TX	
TX	→ RX	
GND	→ GND	

For full instructions see: http://randomnerdtutorials.com/how-to-flash-a-custom-firmware-to-sonoff/

4. Installation of *esp_MQTT*, using a Windows PC
esp_MQTT does not have to be compiled: *martin_ger*, besides publishing the sources, also publishes the 'bin' files ready to be loaded on Sonoff.

- Download and install esptool (https://github.com/espressif/esptool) needed to copy the firmware,
- Download from https://github.com/martin-ger/esp_mqtt/tree/master/firmware the 'bin' files with the compiled firmware, put them in the same dir of esptool.py
- ***Disconnect Sonoff from the main AC!***
- Connect FTDI via USB to the PC.
- Check the port number used (Control Panel, System, Device Management, Ports) In my case: COM6.
- Configure FTDI for 3.3 V and connect Sonoff.

- Press and hold down the Sonoff button before supplying power to Sonoff (use the switch on the FTDI-Sonoff connection): release the button on Sonoff 1 or 2 seconds after supplying power.
- Use the following command to copy the firmware into Sonoff-basic (COM6 can change). I use a small BAT file (`esptool/write-esp-Sonoff.bat`):

```
esptool.py --port COM6 write_flash -fs 1MB -fm dout 0x00000 0x00000.bin 0x10000 0x10000.bin
```

note: The original Itead firmware can be restored with some complications (see https://wiki.almeroth.com/doku.php?id=projects:sonoff). But this is usually not necessary: in fact, the "script.sonoff", a script from martin-ger, perfectly emulates the original Sonoff Basic operation (see - https://github.com/martin-ger/esp_mqtt/tree/master/scripts) .

note: Writing flash is not always successful at first sight. Try several times. The problem is often due to the little current supplied by FTDI to 3.3V. A simple solution (for me it worked) is to insert an electrolytic capacitor between VCC and GND (I used 100 µF). A more drastic solution is to use a separate 3.3V power supply (e.g. one step-down 5 → 3.3).

DO NOT POWER AC Sonoff when FTDI is connected !! *An oversight (a screwdriver that falls on the circuit) and your PC (in the best case) is to be thrown away! But you could even risk your life !!*

note: For more information, for Linux etc. see martin-ger: "Building and Flashing".

5. **First run, serial configuration**

When the messages inform us of the correct writing of the flash memory, switch Sonoff off and on with the switch, without pressing the button and leaving FTDI connected.

The basic configuration can now be done with the serial console. You can use *puTTY* (https://putty.org/), with the configuration: 'serial', COM6, 115200

Pressing [ENTER] the '`CMD>`' prompt of esp_MQTT should appear, confirming the correct operation. Now we can give all console commands accepted by esp_MQTT (see https://github.com/martin-ger/esp_mqtt).

Note: ***alternative configuration with Telnet***

Using a laptop, connect via WIFI with Sonoff + esp_MQTT using the AP (enabled by default). Search for "MyAP". Now use PuTTY, previously installed on the laptop, to connect with Sonoff + esp_MQTT (Telnet, IP: 192.168.4.1, port: 7777).

For our purposes, we want ***Sonoff+esp_MQTT*** to connect as an STA to the home WIFI router:

```
CMD>set ssid  <your_home_router's_SSID>
CMD>set password <your_home_router's_password>
CMD>set ap 0
CMD>set speed 160
CMD>set npt_server 1.it.pool.ntp.org
CMD>set npt_timezone 2
```

setting up the MQTT server (for simplicity I omit any security configuration):

```
CMD>set mqtt_host <orchis_name>
CMD>save
CMD>reset
```

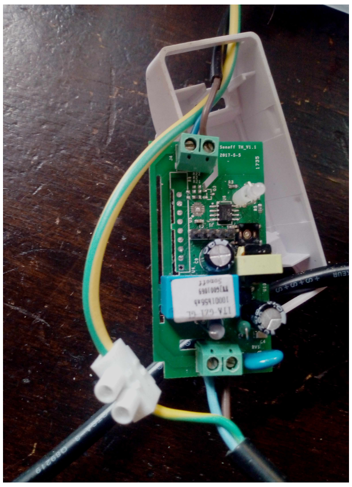
- After the reset ***Sonoff+esp_MQTT*** connects to the router indicated in the configuration.
- We check the connection and the ***Sonoff+esp_MQTT*** address on the router. On the

router we must set a fixed address for ***Sonoff+esp_MQTT*** (e.g.: 192.168.0.53).

- From now the ***Sonoff+esp_MQTT*** *console can be remotely activated from every node in the network to the fixed address, with a telnet client* (e.g. *puTTY*) via tcp port 7777 to receive commands and tests.
- The MQTT server can be reached at the same fixed address, port 1883 (default).
- We can definitively disconnect FDTI, and check the correct operation of ***Sonoff+esp_MQTT*** connected to AC (**be careful !**, better to put Sonoff back in its case) with the remote console.

*The **Sonoff+esp_MQTT** card is ready: the script with the operating logic will be loaded OTA.*

Timer: wiring



Assembly is very simple: just you need a screwdriver and a wire stripper:

1. Cut the pump cable at 60 cm-1 m and just a little longer the ground wire.
2. Prepare a 3-wire cable with a plug of the required length.
3. Connect the 2 wires of the pump to the 'OUT' terminals
4. Connect 2 wires of the plug (neutral and phase) to the 'IN' terminals
5. Connect the mass from the reservoir to the ground wire from the plug, with a mammuth.
6. Close Sonoff in its container.

Timer: working logic

The "`ef0102.eub`" file is the script used for our Timer. The easiest way to load a script into ***Sonoff+esp_MQTT*** via OTA is to use a WEB server.

In development it is convenient to have the local server in the main PC: in my case I used the portable server "*wpp_pampa*" from http://www.winpenpack.com/en/index.php contained in a USB stick "*winPenPack*". Otherwise you can use any *WAMP / LAMP* server or even a remote server on the Internet, for example by downloading directly from Gitub.

Using the remote console (*puTTY*) you must give the command '`CMD> script <url_to_script>`'. For convenience the command to be used on the console is written in the third line of the file: modify it to adapt it to the used configuration, then use copy-paste.

To create the script I used *Notepad++* (https://notepad-plus-plus.org/), an excellent text editor for programmers. Note: *the script must be codified ANSI.*

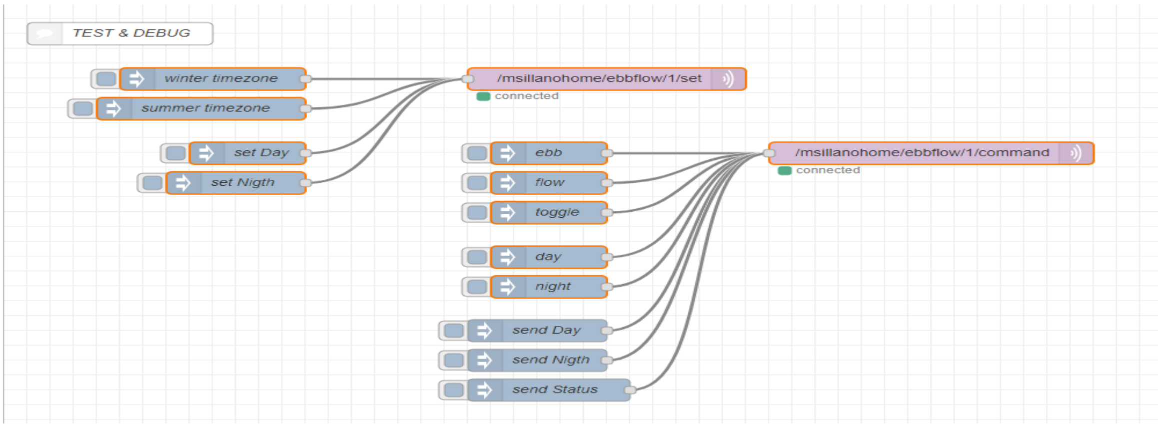
To stay within the memory limits (4,000 bytes), in the script I have eliminated the indentation.

Customizations - the following lines can be edited in the file es0102.eub. N.B. Do not use quotes for strings (""):

```
3     % telnet: script http://192.168.178.23:85/www/sonoff/ef0102.eub
4     config ntp_server  1.pool.ntp.org
5     config ntp_timezone 2
6     config @6 /msillanohome/ebbflow/1
```

note: The WIFI connection is critical: you can not choose where to place the timer without first checking the reliability of the WIFI at that point.

Timer: messages



Messages MQTT in input (commands):

Topic: `/msillanohome/ebbflow/1/command`

- `ebb` cycle ebb (pump off), immediate start
- `flow` cycle flow (pump on), immediate start
- `toggle` toggle cycle (Sonoff button action)
- `day` start day way (starts with a flow)
- `night` start night way (starts with an ebb)
- `sendD` send immediate data stored for 'day'
- `sendN` send immediate data stored for 'night'
- `status` send immediate 'status' string

Topic: `/msillanohome/ebbflow/1/set`

- `{"data":"timezone","value":"1"}`
  set 'timezone': Italy winter = 1, summer = 2
- `{"data":"setD","value":"{\"time\":\"07:30\",\"days\":0,\"ebb\":2,\"flow\":88}"}`
  set values for 'day'
- `{"data":"setN","value":"{\"time\":\"20:00\",\"ebb\":2,\"flow\":298}"}`
  set values for 'night'

note: *The values are fixed, wired in the properties of the nodes, so this flow only serves as a test.*

Messages MQTT in output (status informations):

Topic: `/msillanohome/ebbflow/1/status/timeD`

- `{"data":"setD", "value":{"time":"07:30","days":0,"ebb":2,"flow":88}}`
  data stored for 'day', reply to the sendD command

Topic: `/msillanohome/ebbflow/1/status/timeN`

- `{"data":"setN", "value":{"time":"20:00","ebb":2,"flow":298}}`
  data stored for 'night', reply to the sendN command

Topic: `/msillanohome/ebbflow/1/status/ebbflow`

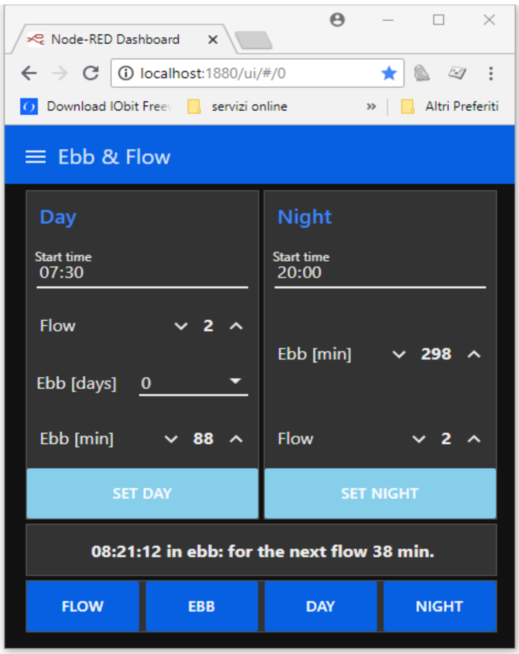
- `string like "13:56:38 in ebb: for the next flow 94 min."`
  sent automatically every minute, after each change, reply to the status command

Topic: `$SYS/broker/time"`

- `string like "hh:mm:ss"`
  sent automatically every second after NTP synchronization

Timer: node-red client

This client, realized using *node-red*, allows to monitor the timer status and to set its configuration, acting as a simple PC user interface for the Timer.
The Timer is autonomous: once the values for the required cycles have been set, this client is no longer required.



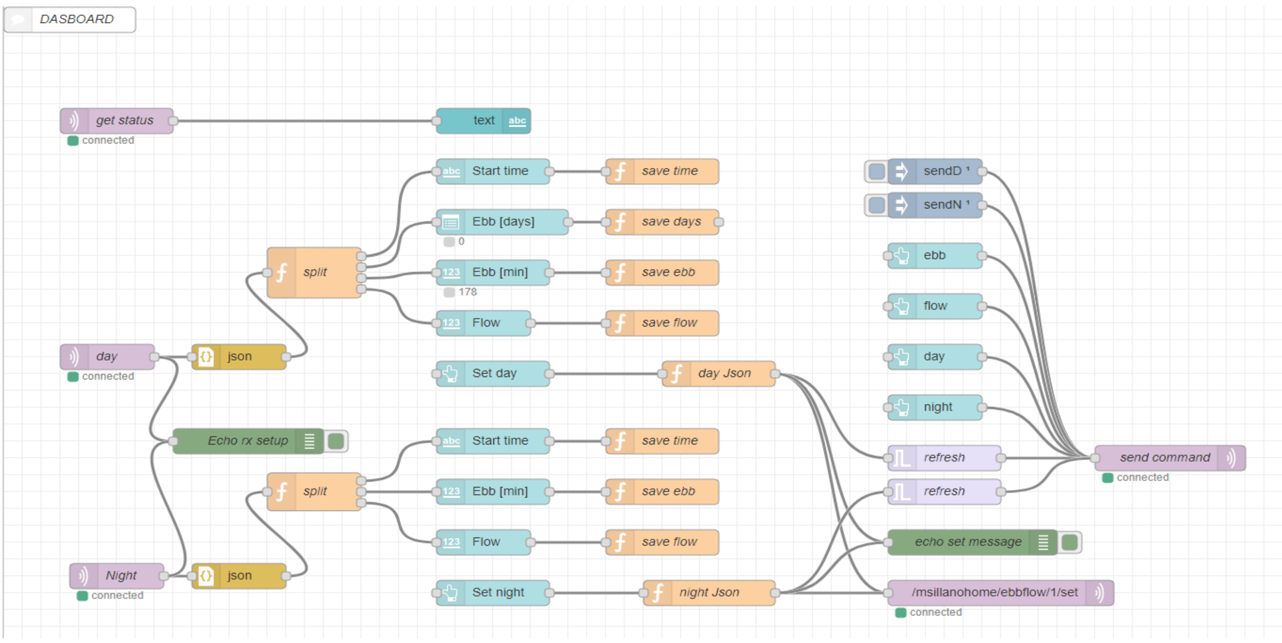
It can be used standalone, or it can serve as a model for more ambitious realizations, for example to automatically change the watering parameters based on the temperature readings made by *Flower care* (see note at the end).
Data storage on a database has not been implemented, but if desired it is easy to add it.

Node-red can be installed on every PC (Win / Linux) and also on *Raspberry pi 3* if you want a low-cost dedicated computer:

For node-red installation, see https://nodered.org/docs/getting-started/installation.

- If not installed by default, also import the library '`node-red-dashboard`'.
- Copy the contents of the "`node-red/ef102-client-red.txt`" file to the clipboard and import it into a new node-red dashboard tab.
- Configure access to **Sonoff + esp_MQTT.**

Complete flow:



Enjoy easy orchids flowers and tasty hydroponic vegetables.

Notes on *ebb and flow*

The duration of the flow periods and the interval between two irrigations (ebb) depend on the plants and the substrate: the more the substrate retains the water, the longer the flow periods must be spaced.
In the prototype I measured: filling time 0:30 min, emptying time 1:30 min.

> *Flow time:* the time necessary to fill the tank and to obtain a good impregnation of the substrate, however always less than 60 min to avoid damaging the roots. I use 2 minutes: (0:30 min filling + 1:30 full min) + 1:30 min emptying.
>
> *Ebb time:* depending on the substratum, the temperature, the humidity of the air and the type of plant: the substratum must be damp but not soaked and it must be dried a bit between one watering and the other.
> *For hydroponics:* during the light hours: from 2 to 10 or more times (60-45 min). In the night, from 0 to 3 or more times. In the Timer a high Ebb night time (max 1441 min = 24 hours) is equivalent to no irrigation.

- *If the leaves show signs of wilting at the end of the flow period: decrease the waterings.*
- *If the leaves show signs of wilting at the end of the ebb period: increase the watering.*

Night cycles are not useful for feed plants, but they have two beneficial effects:

- *They promote the oxygenation of the roots, protecting them from bacterial infections and molds.*
- *They increase the oxygenation of the nutritive solution, shuffling it and keeping it healthy.*

For orchids: preferably use pure water, for example rainwater, water from the air conditioner or demineralized water, however water with EC <500 µS/cm.
Depending on the substrate and the vegetation phase, fertilizer can be added. 20-20-20 (without urea) is recommended for phalaenopsis. Dose: ¼ of that indicated in the instructions. Never exceed 1000-1500 µS/cm. Every 3 weeks it is best to rinse with cycles of pure water to eliminate salts accumulation.
In case of excess fertilizer, the tips of the leaves and the tips of the roots of the phalaenopsis orchids become black.

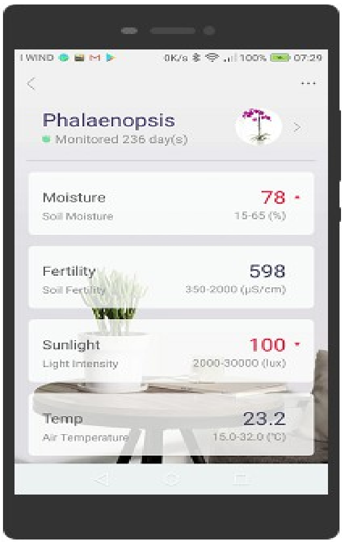
For hydroponics: also use tap water, if the nutritive solution is calibrated for hard water, otherwise use demineralized water. Use low concentrated solutions (800-600 ppm): during the ebb phase the concentration increases by evaporation.
Allow the water to rest for at least one night in another container before using it to remove chlorine and to avoid thermal shock. Adjust the pH.

> *In both cases top up with pure water (or solution) at room temperature and change the solution when topping up have reached 50% of the solution (in my case, 2 liters out of 4) and in any case once a week (longer intervals are possible, but advised). For safety, check and adjust the pH after topping up.*

Remember that root rot is caused by anaerobic bacteria: oxygenation is the best defense. Increasing the number of watering cycles increases the oxygenation of the solution and of the roots, because each cycle introduces new air into the containers.
In case of root rot, add hydrogen peroxide to the solution (3 ml/l of 3% H_2O_2, 10 Volumes) and increase the oxygenation. Check that in phase ebb no standing water remains in contact with the bottom of the vessels (this is the purpose of the spacer).

Notes on the use of *Flower care*

To control the health of the solution and the plants I use [Xiaomi Huahuacaocao Flower Care](#) *(Mi Flora): a probe for light, temperature, soil moisture and EC. This probe can be used directly with a smartphone (*[Flower Care](#) app*) but it is also readable in MQTT environment with the* [miflora_mqtt_daemon](#) software.
The probes can be purchased for 25 US$ from [Banggood](#) *(N.B.: it must be the international/English version).*



During the flow phase the EC of the solution (Fertility) can be read in ***µS/cm*** *with good precision (tested with samples).* [Recommended](#) *values for Phalaenopsis: 300-400 µS/cm. If you want to push the plant, you can even reach 600-800 µS/cm.*

In the ebb phase the moisture can be read in ***%****. The value is purely indicative (in pure water the used probe shows 88% and not 100%) and is affected by the type of substrate used.*

The [recommended](#) *light for Phalaenopsis is:*

- *In the vegetative phase: 5000 - 15000* ***lux*** *(500-1500 fc or 100-300* ***µmol/m²s****).*
- *For flowering: 10000 - 15000* ***lux*** *(1000-1500 fc or 200-300* ***µmol/m²s)****.*
  From the comparison with a professional luximeter the probe is reliable

Temperature (very precise probe: ± 0.5 °C) for Phalaenopsis: never below 10 °C (50 F).

- *In the vegetative phase 28-32 °C (82-90 F).*
- *To induce flowering, 4-6 weeks at 17-25 °C (63-77 F).*
- *Flowering after another 10 weeks at 23 °C (73 F) or 20 weeks at 17 °C (63 F).*

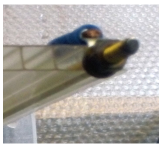
Notes on the safety of materials

FOOD GRADE

This project is intended for ornamental plants and NOT for human food plants. If you want to use it for salad, tomatoes, strawberries or basil, you ***must use all components "food grade"*** *and stainless steel. This is simple for containers, screws and pipes, while it is more complex and expensive to find a submersible pump, electric cables and hot glue guaranteed "food grade". Even the 3% peroxide* [presents problems](#).

- *The aquarium pumps (like the one used here) can NOT be used.*
- *DO NOT use PVC in any form, it is* [never suitable for food](#).

Notes on electrical safety



In the presence of electricity and water you must be very cautious.
A ground connection is present on one of the immersed threaded bars. Should the pump or cables lose insulation, the "life-saving" safety switch would be activated in complete safety.

Furthermore, it is advisable to bend the cable exiting the tank: any drops of condensation must not enter the Timer. I added a spiral of hard plastic-coated wire around the cables and then shaped it all at the elbow. Or fix the timer permanently in an higher position of the tanks.