Arduino ASC-Kit shield

Edition 2/11/2017

Contents

1 Specifications

- External Micro-USB plug or any regulated power supply 5V/2A
- Main heater controlled by a single relay (SPDT – single latch 5V coil - 250VAC—10A)
- Air solar ventilation controlled by a relay (SPDT – single latch 5V coil - 250VAC—10A) *
- One user-controlled relay (SPDT – single latch 5V coil)
- Two numerical temperature sensors for user applications (-50/+125 °C)
- Heated zone measurement accuracy (DHT22 sensor):
    - temperature +/- 0.2 °C
    - humidity +/- 1%
- Network connection by Wifi or Ethernet cable
- Embedded Webserver (uhttpd / Linino on Arduino Yun)
- REST requests format for parameters access (compatible with most modern Home Automation systems)

* *the thermostat may be used without an air solar ventilation, in that case it is a classical single zone thermostat*

2 Heaters regulation

2.1 Main heater and solar heater

The system controlled by the ASC-Kit is composed of a central heater and a solar ventilation. The controller regulates the temperature of a single zone by activating the heaters in an on/off principle.

The set points of both heaters are adjusted automatically in order to reduce the demand on the main heater if the solar energy is available.

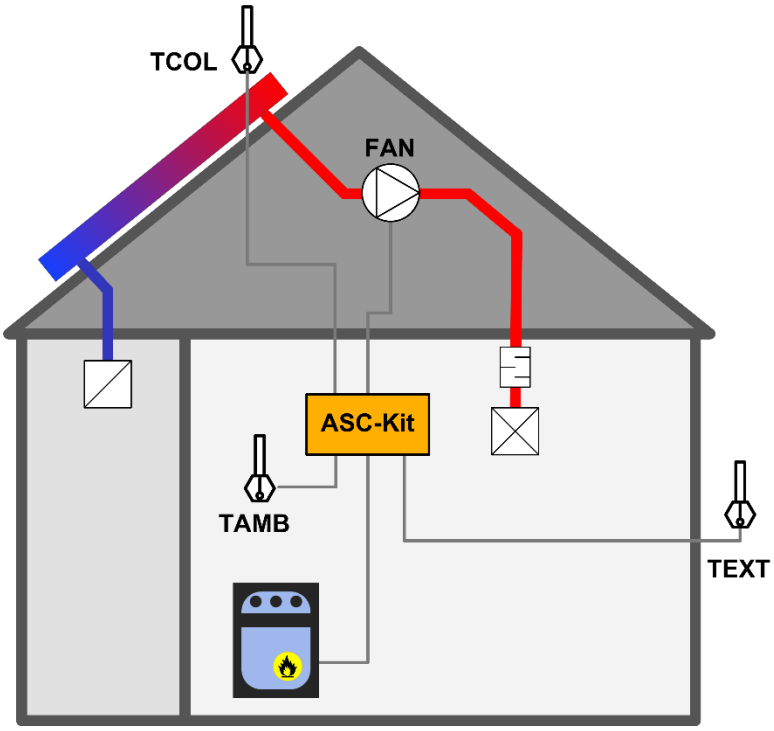


Figure 1: Regulation of the main heater coupled to an air solar ventilation

2.2 Main heater and ventilated wood fire

While initially developed for air solar ventilation systems, the principle can be applied to other situations where an auxiliary heating system is used. A common case is a wood fire with a ventilation able to diffuse the heated air either in a single zone, or in the ventilation ducts of the house. The controller is able to activate the auxiliary blower in case of fire use and to reduce automatically the demand on the main heater.

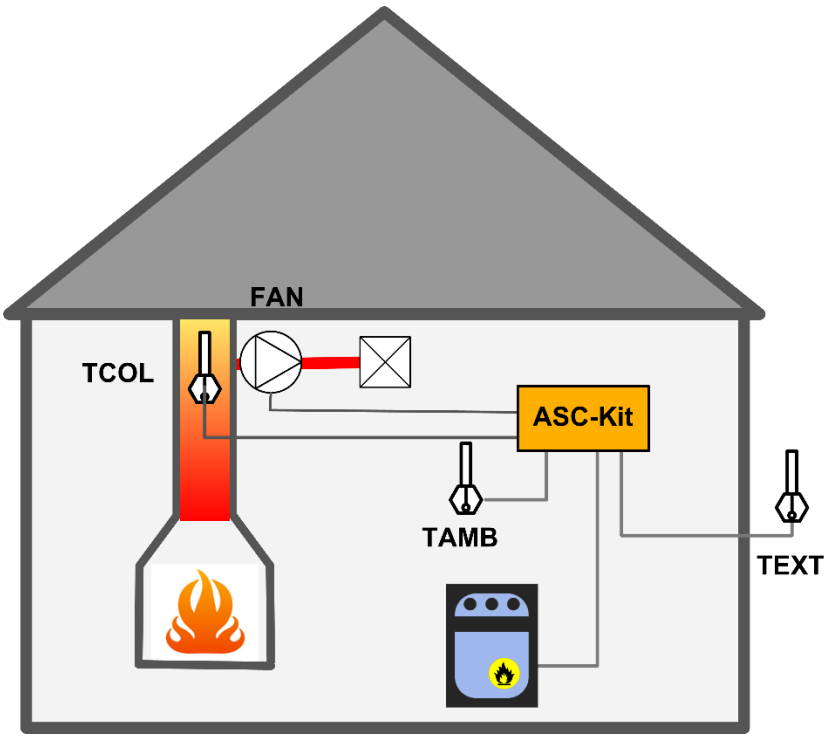


Figure 2: Regulation of the main heater coupled to ventilated wood fire (the wood fire icon is designed by Freepik.com)

2.3 Regulation principle

The controller needs two temperatures to activate the main heater and the auxiliary one (TAMB and TCOL). The external temperature (TEXT) and the ambiance humidity (HAMB) are not required for the regulation.

The controller activates the heaters with on/off regulation principle. The accuracy of the regulation is defined by a hysteresis parameter (HYST) which can be adjusted to the specific situation (Figure 3). In order to limit the commutation frequency, the user can define a minimum time within each states (on/off).

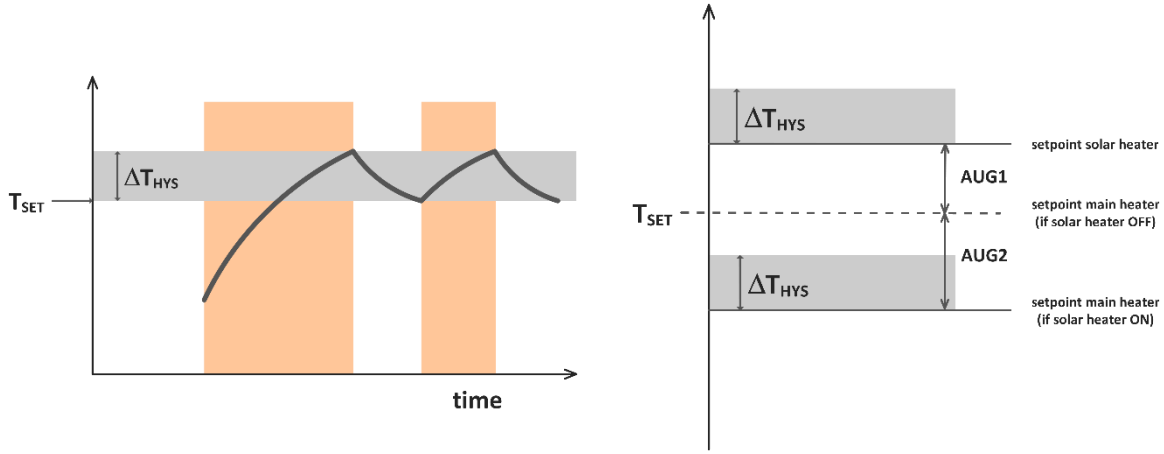


Figure 3: Illustration of the on/off temperature regulation (left) and parametric adjustment of the heaters setpoints (right)

SENSOR		REQUIRED
TAMB	Ambiance temperature (single zone)	YES
HAMB	Ambiance relative humidity (single zone)	NO
TCOL	Collector or auxiliary heater air temperature	YES
TEXT	External temperature	NO IF CONF1 = 1 YES IF CONF1 = 2

Table 1: Sensors for heaters regulation

2.4 Controller parameters

2.4.1 User parameters

PARAMETER	DEFAULT	UNIT	
TSET	22	°C	Main heater setpoint temperature
DTECO	3.5	°C	Main heater setpoint reduction in ECO mode
MODEMH	1	-	Main heater mode (0=OFF, 1=HEAT, 2=ECO, 3= FREEZE PROTECT)
MODESH	1	-	Solar heater mode (0=OFF, 1=HEAT)

2.4.2 Configuration parameters

PARAMETER	DEFAULT	UNIT	
TMHON	300	sec	Minimum time main heater ON
TMHOFF	300	sec	Minimum time main heater OFF
TMHON	300	sec	Minimum time solar heater ON
TMHOFF	300	sec	Minimum time solar heater OFF
DTSHON	6	°C	ΔT (TCOL-TAMB) for solar heater ON
DTSHOFF	3	°C	ΔT (TCOL-TAMB) for solar heater OFF
AUG1	2	°C	ΔT setpoint solar heater
AUG2	0	°C	ΔT setpoint main heater
TFP	5	°C	Setpoint for the freeze protect mode
DTDHT	0	°C	Overheating of the DHT sensor
HYST	1	°C	Hysteresis parameters
VFAN	400	m^3/h	FAN flow rate (est.)
CONF1	1	-	Air flow (1=recirculation, 2=external)
SYSTEM	1	-	SYSTEM=1 for single zone without solar heater SYSTEM=2 for single zone with solar heater

2.4.3 Outputs

PARAMETER	UNIT	
NLOOPS	1/sec	Number of loop executed per second
PSOLTH	W	Heating solar power (est.)
SWSH	-	Solar heater switch state (0=OFF, 1=ON)
SWMH	-	Main heater switch state (0=OFF, 1=ON)
STATESH	-	Solar heater state (0=OFF, 1=OFF)
STATEMH	-	Main heater state (0=OFF, 1=OFF)
STATECTRL	-	Controller state (0=STOP, 1=RUN, 2=INIT, 3=FAIL1, 4=FAIL2)
ERRSENSOR	-	Sensor error diagnostic
ERRCTRL	-	Controller error diagnostic
INDSH	Wh	Estimated energy from the solar heater
TCSH	h	Cumulated time solar heater usage
TCMH	h	Cumulated time main heater usage

3 Hardware

3.1 Compatibilities with Arduino boards

The Arduino **ASC-Kit shield** has been developed for the Arduino-Yun board. The PIN allocation should be compatible with most Arduino boards with the standard board design like: Arduino Uno, Arduino Mega, Arduino Ethernet…

The embedded software is only compatible with the Arduino Yun (BRIDGE communication usage).

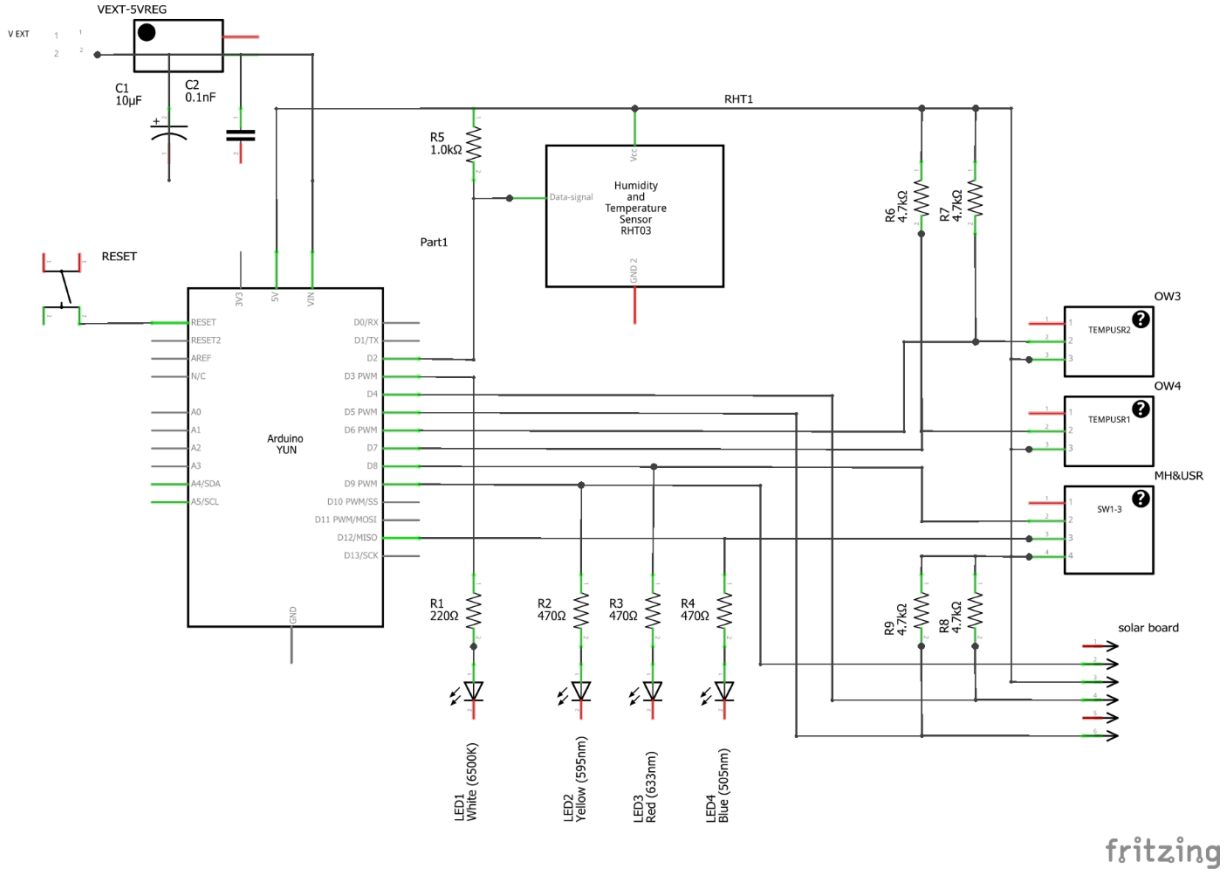
3.2 PINs allocation

PIN#	Label	Configuration	Usage	Comment
D0	(Tx)	OUT		Bridge
D1	(Rx)	IN		Bridge
D2	DHT	IN	DHT bus (TAMB + HAMB)	Model DHT22 (DHt11)
D3~	LED1	OUT	LED Status	
D4	OW3	IN	1-wire (TCOL or TUSR3)	CS (on ETHERNET)
D5~	OW4	IN	1-wire (TEXT or TUSR4)	
D6~	OW1	IN	1-wire (TUSR1)	
D7	OW2	IN	1-wire (TUSR2)	
D8	SW2	OUT	Main heater (SWMH) or SWUSR2	Red LED
D9~	SW3	OUT	Solar heater (SWSH) or SWUSR3	Yellow LED
D10~	-	-		CS (on YUN)
D11~	-	-		SDI
D12	SW1	OUT	User relay (SWUSR1)	Blue LED
D13	-	-		CLK
A0	-	IN	-	
A1	-	IN	-	
A2	-	IN	-	
A3	-	IN	-	
A4	-	IN	-	
A5	-	IN	-	

Table 2: PINs allocation in ASC-Kit Arduino shield

3.3 Shield electronic circuit

3.3.1 Schematic



Notes:

- The pull-up resistors on the numerical buses (R6, R7, R8, R9) and R5 are not critical
- The LEDs polarization resistors may be adjusted to reduce the luminosity if needed
- If you want to use an external power supply it is mandatory to choose a regulated one at 5.0-5.1 V/ 2A (a higher voltage would damage the processor)

3.3.2 Components list

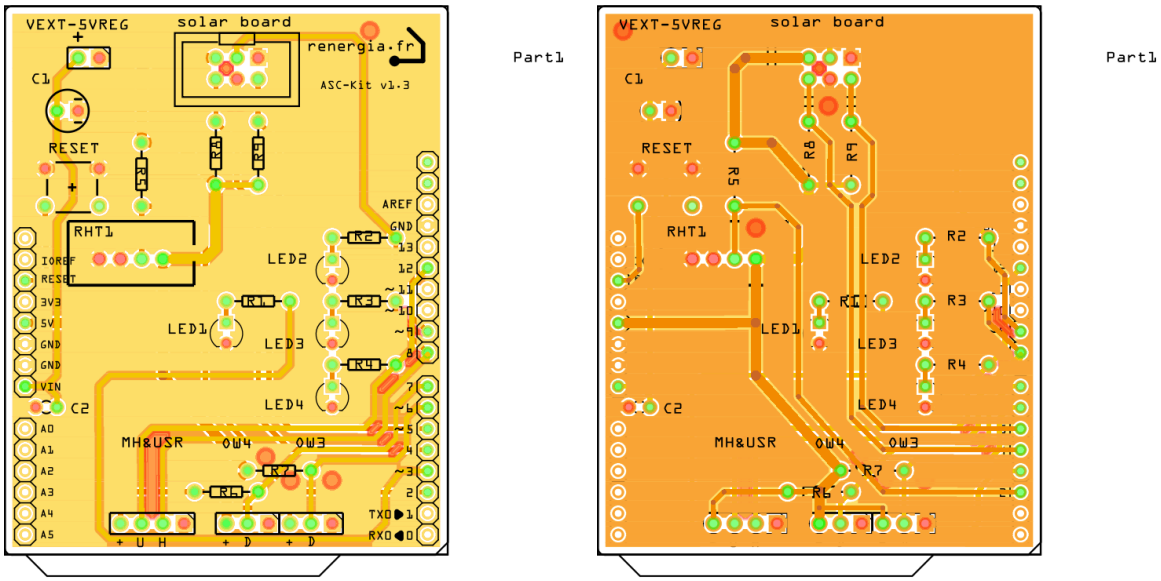
ID	Value	Comment	Ref	Provider
R1	220 Ω - 1/8W – 5%			
R2	470 Ω - 1/8W – 5%			
R3	470 Ω - 1/8W – 5%			
R4	470 Ω - 1/8W – 5%			
R5	1.0 kΩ - 1/8W – 5%			
R6	4.7 kΩ - 1/8W – 5%			
R7	4.7 k Ω - 1/8W – 5%			
R8	4.7 k Ω - 1/8W – 5%			
R9	4.7 k Ω - 1/8W – 5%			
C1	10 µF - 10V – elect.			
C2	100 pF - 10V – tant.			
LED1	5mm – White			
LED2	3mm - Yellow			
LED3	3mm – Red			
LED4	3mm – Blue			
J1	2 screws terminal – 0.1”	VEXT-5VREG	TERMB-254002	Creaton
J2	3x2 pins ICD shrouded header	Solar board	CONID-106506	Creaton
J3	Long breakable Header	I/F Yun#1	CONPH-116540	Creaton
J4	IC header	DHT CNX (*)		
J5	Long breakable Header	I/F Yun#2	CONPH-116540	Creaton
J6	Long breakable Header	I/F Yun#3	CONPH-116540	Creaton
J7	4 screws terminal – 0.1”	MH&USR	TERMB-254004	Creaton
J8	6 screws terminal – 0.1”	OW4 - OW3	TERMB-254006	Creaton
J9	Long breakable Header	I/F Yun#4	CONPH-116540	Creaton

(*)

- you may mount the DHT sensor on the shield board, but you will need to adjust the calibration of the sensor

- for a more accurate measurement you will need to mount the sensor outside the enclosure (e.g. on the wall), using wires between the sensor and J4

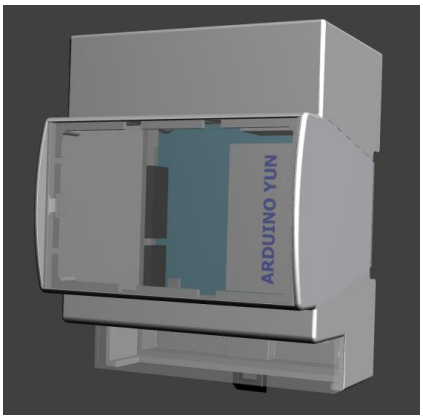
3.3.3 Board layouts



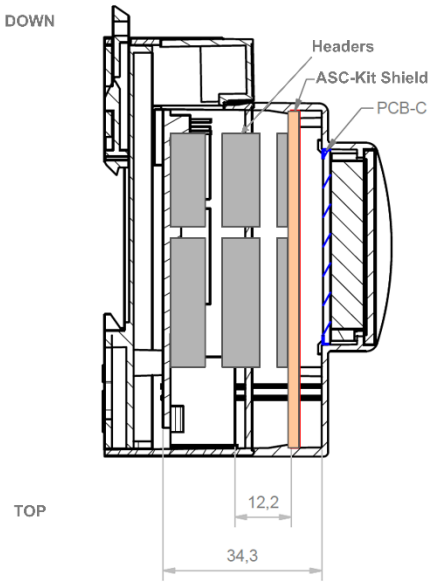
(top view – top & bottom copper layers) – 1 user relay (SWUSR) and two user temperatures (OW3 & OW4) available

4 Enclosures

4.1 DIN rail-4 modules



http://www.italtronic.info/download/embeddedbox/arduinoyun/



Shield board mounting: adapted from
http://www.italtronic.com/prodotti/embedded_box/embdedded_box_arduino_yun/?prodotto=33.0412000.YUN

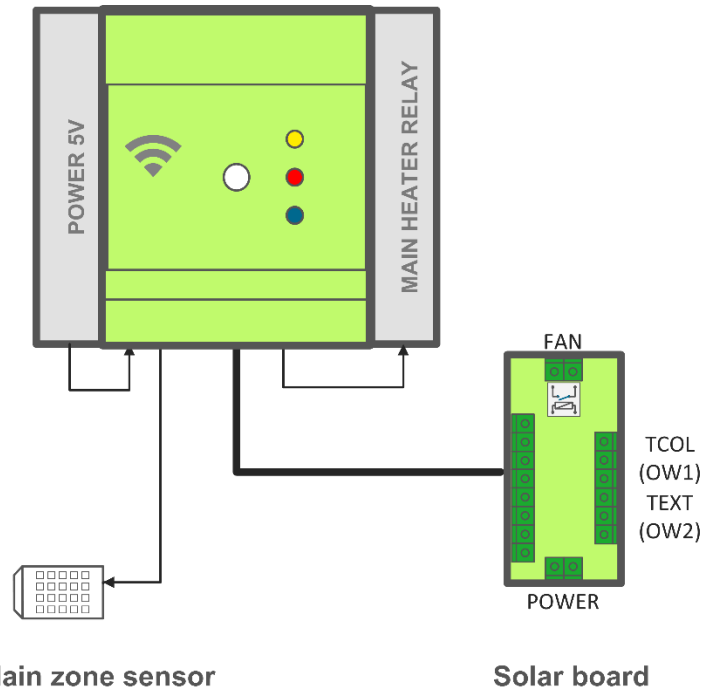
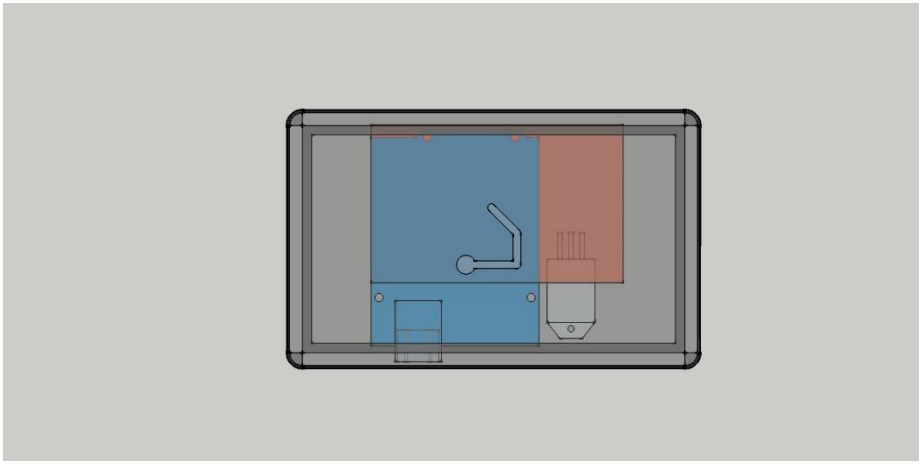
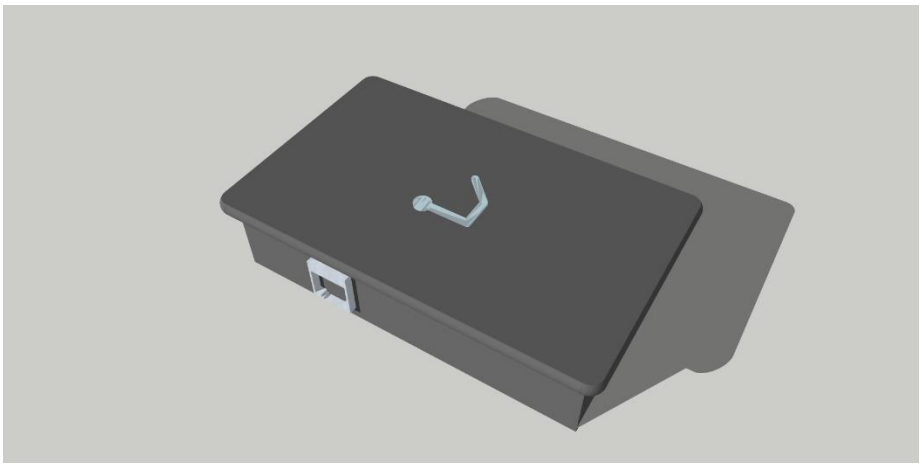


Figure 4: Example of connection (the main zone sensor may be mounted on the shield board)

4.2 3D printing design for wall mounting





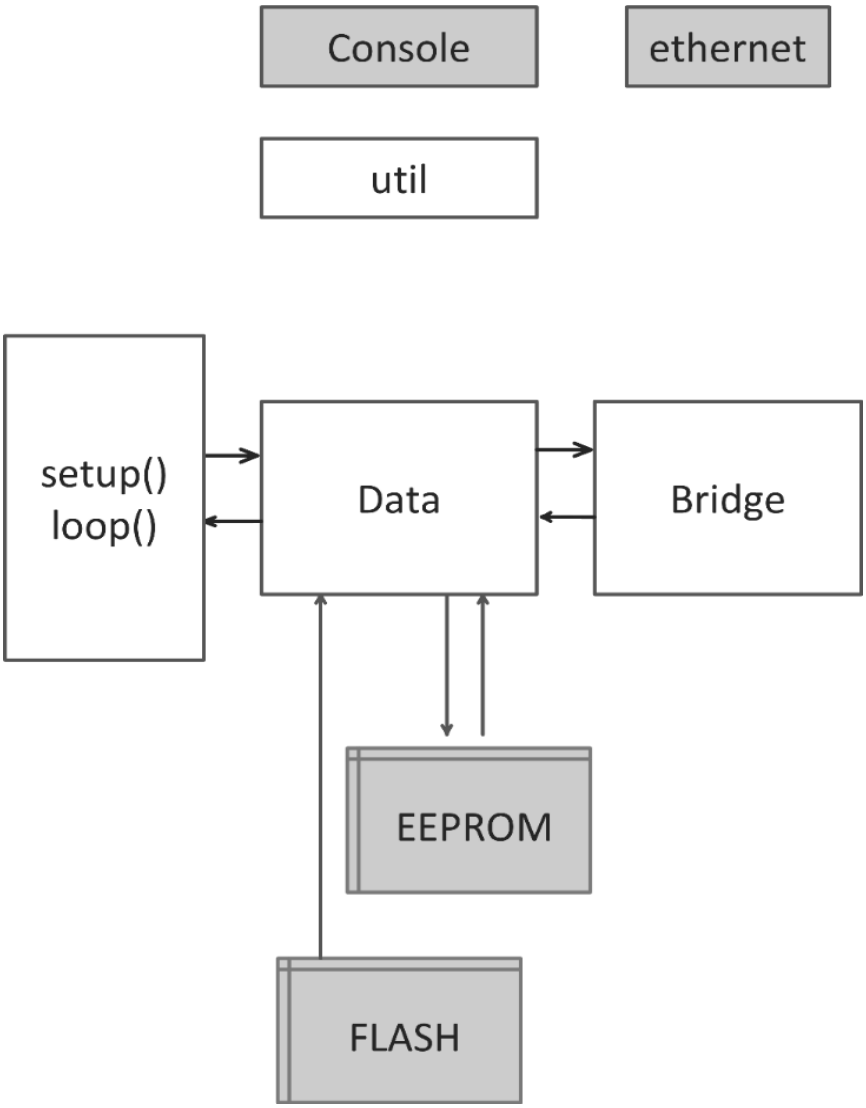
(could be done – just waiting for s/o to do it!)

5 Software

5.1 Installation

See https://github.com/karldm/asckit for on-line documentation and examples.

5.2 Software utilities



5.3 Sketch homemonitoring.ino

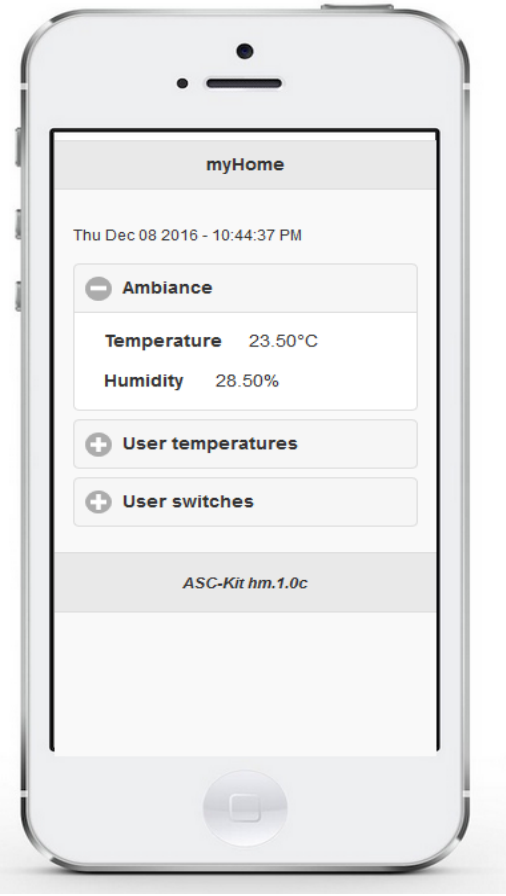
5.3.1 Installation

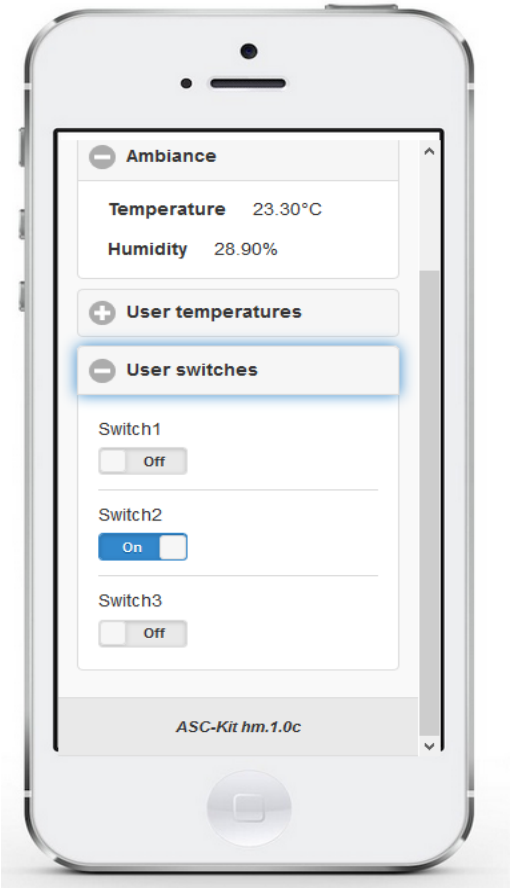
See INSTALL.TXT on https://github.com/karldm/asckit

5.3.2 Embedded Webserver usage

From the yun IP address:

http:/[IP]/renergia/hm





http://www.responsimulator.com

5.4 Install the sketch airsolarcontroller.ino

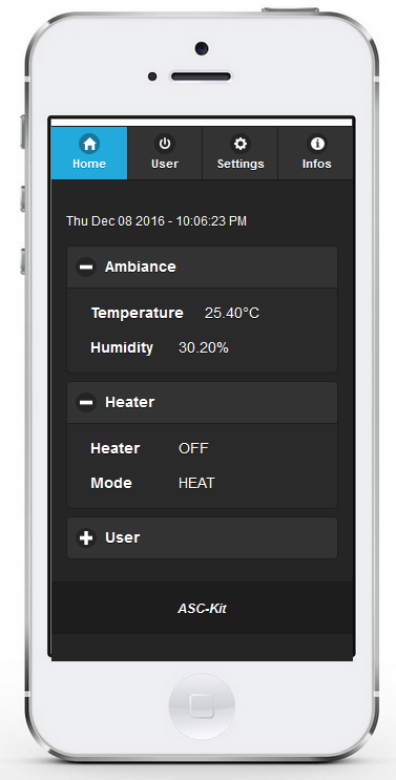
5.4.1 Installation

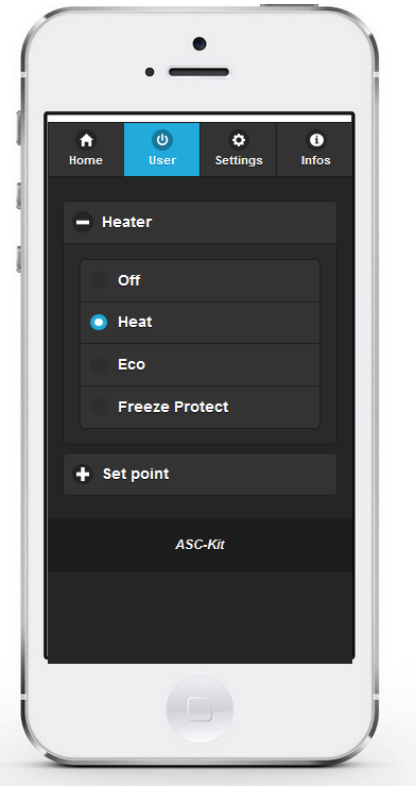
See INSTALL.TXT on https://github.com/karldm/asckit

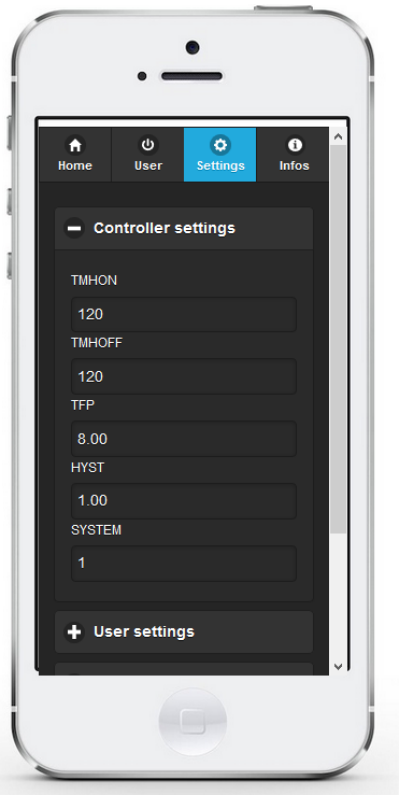
5.4.2 Embedded Webserver usage

From the yun IP address:

http:/[IP]/renergia/asc







http://www.responsimulator.com

In the settings folder, you may configure the controller parameters.

5.4.3 Ambiance temperature calibration (DHT sensor)

You will probably have to adjust the DTDHT parameter in order to get an accurate temperature readout out. Depending on the sensor mounting (on the board, outside, into the close DIN package,…), the sensor may be overheated. Typical overheating are:

- +2 to +3 C on the board
- +10 C in the closed DIN package

The relative humidity is corrected to take into account this heating. The best way to adjust this correction is to use a DS18B20 sensor for the calibration.

5.5 REST access examples (for integration in Home Automation Systems)

All the parameters are available through REST commands.

For example, to get the ambiance temperature, from your browser:

http://[IP]/data/get/tamb

Get all parameters:

http:// [IP]/data/get

To modify the setpoint:

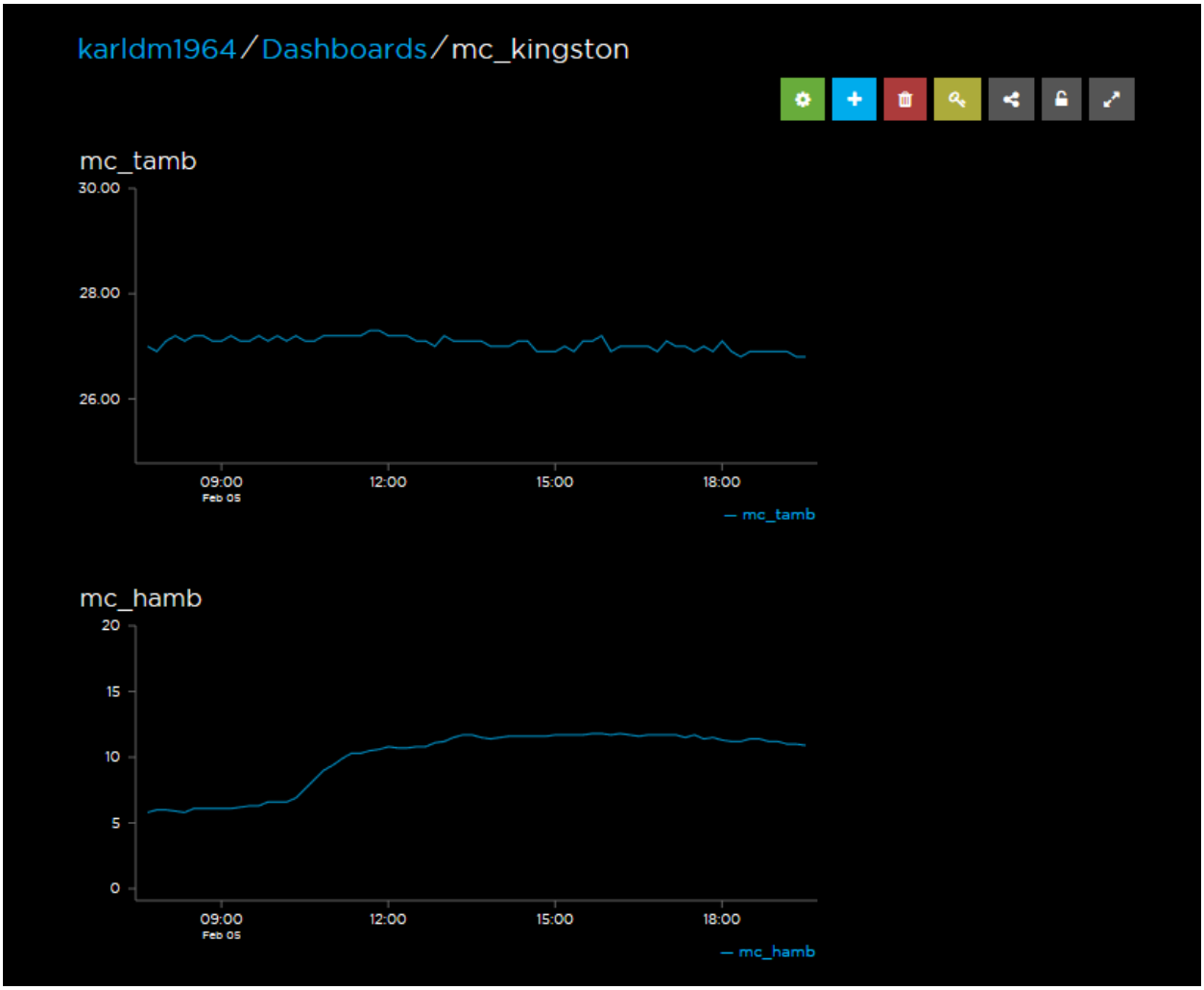
http:// [IP]/data/put/tset/18.00

You will get a JSON format compatible with most Home Automation Systems.

Note: the access can be protected by a password during the Yun configuration

5.6 Monitoring with io.adafruit.com

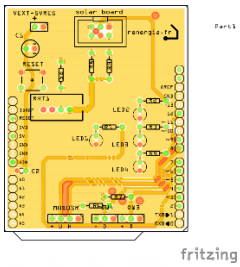
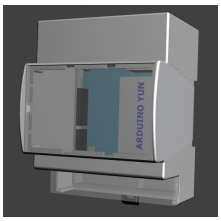
- Install the python script
- Open an Adafruit account (https://io.adafruit.com)
- Copy your key into the script
- You may rename the feeds to send in order to customize your installation
- Set up crontab (see procedure in the adafeedsMy.py)
- Create a dashboard on io.adafruit from the



Dashboard example with temperature and humidity

6 Price list

Indicative prices – may vary with the final quantity ordered and the shipment costs

	Arduino Yun http://www.robotshop.com/ca/fr/microcontroleur-arduino-yun-usb.html (incl. 13% VAT & shipment)	105 CAD
	ASC-Kit shield (High quality board from Fritzing) with DHT22 sensor and components	45 CAD
	1-board 5V Coil - 2 relays 250VAC-10A	5 CAD
	Enclosure DIN-4 modules	15 CAD
	2 X DS18B20 – 2M	10 CAD
	Power plug 5V/2A – Micro Usb	13 CAD
	Solar board (need to control a solar heater or an auxiliary heater)	ON REQUEST
	Total	193 CAD

Note: 1 CAD ~0.68€ *info: NEST = 400 CAD*