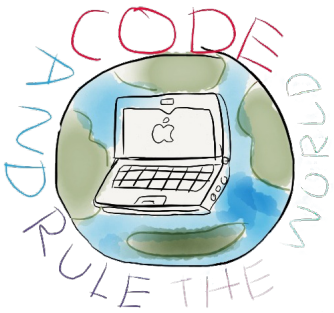
PROCODE CG



PROCODECG

DYCODEX ESPECTRO

TUTORIAL

Notes:

Ver 0.7 – 18 March 2017: adding more codes. adding traffic light FSM

Ver 0.6 – 17 March 2017: adding traffic light mqtt

Ver 0.5 – 10 Feb 2017: adding screenshots of connecting to mqtt. Adding table of contents

Ver 0.4: adding potentiometer and LDR

Table of Contents

1 GETTING STARTED

HARDWARE REQUIRED:

- DyCodeX ESPectro
- A connector cable to computer USB port

DRIVERS:

- http://www.silabs.com/products/development-tools/software/usb-to-uart-bridge-vcp-drivers

SOFTWARE AND LIBRARY REQUIRED:

- Arduino Software (downloaded from https://www.arduino.cc)

  or
- CLION (https://www.jetbrains.com/clion/)
- Platform IO IDE (http://platformio.org/)
- FTDI driver (http://www.silabs.com/products/development-tools/software/usb-to-uart-bridge-vcp-drivers).
- EspX library. (https://github.com/andriyadi/EspX)
- PubSubClient.
- Adafruit BMP Library. (https://github.com/adafruit/Adafruit-BMP085-Library)
- MQTT.fx. (http://www.mqttfx.org/)
- AzureIoTHubMQTT (https://github.com/andriyadi/AzureIoTHubMQTTClient)

WEBSITES & REFERENCES:

- https://learn.sparkfun.com/tutorials/esp8266-thing-hookup-guide/installing-the-esp8266-arduino-addon

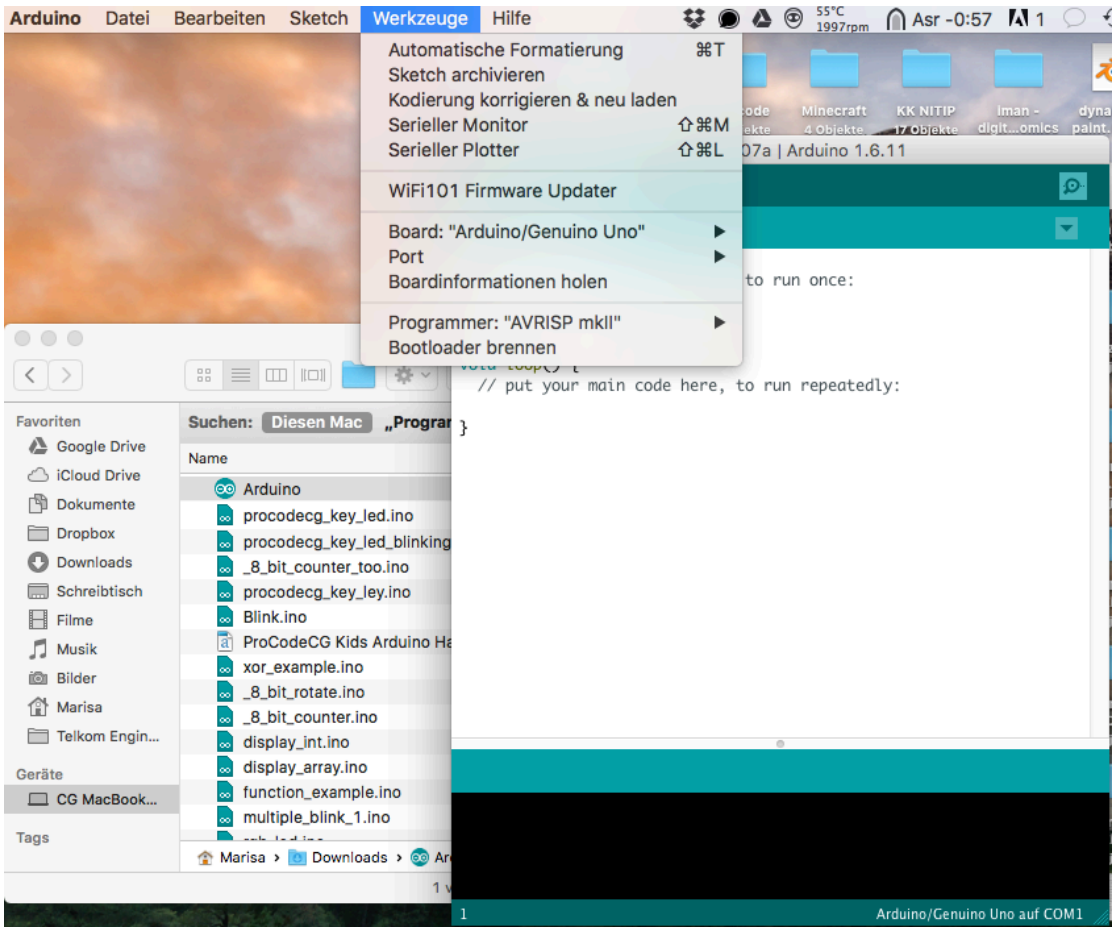
- https://shop.dycodex.com/type/development-board/espectro/
- https://www.youtube.com/watch?v=XtSIW9wVSaU&feature=share

GITHUB REPOSITORIES:

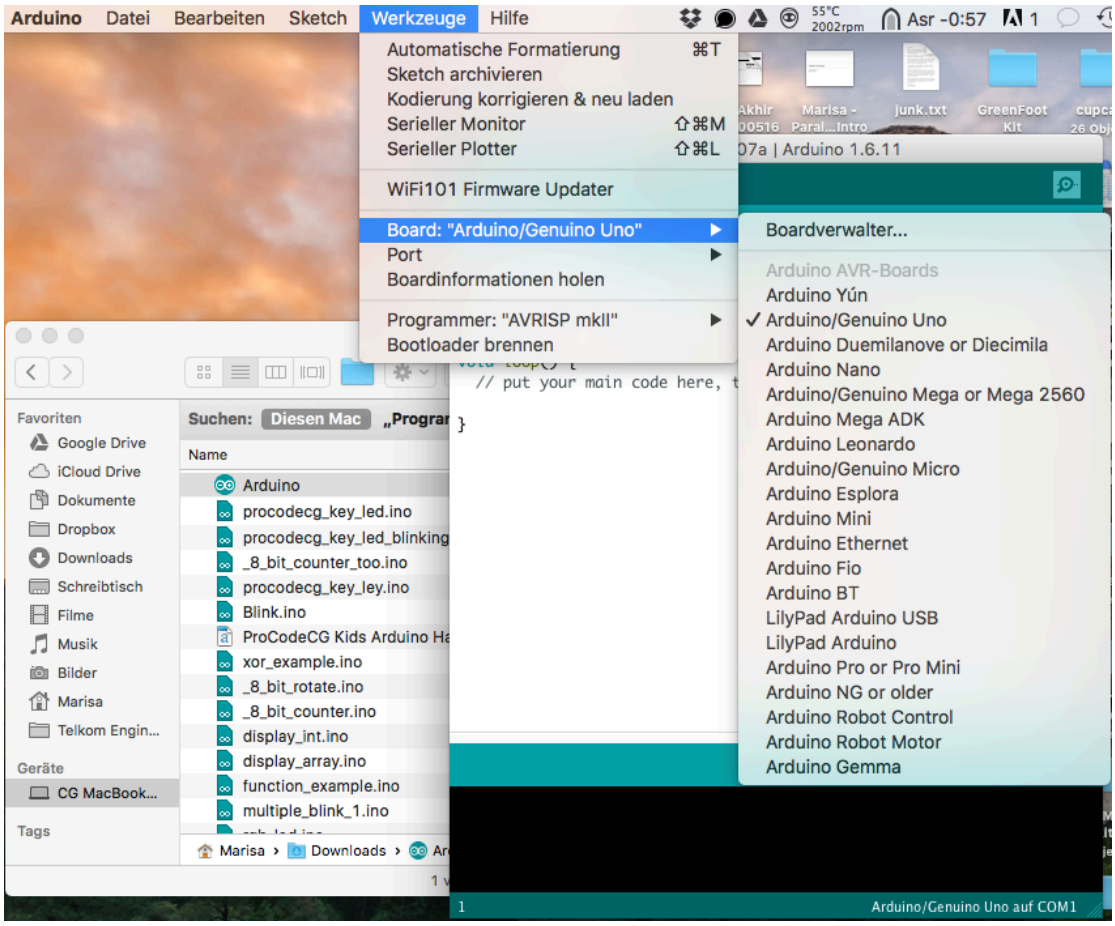
- https://github.com/andriyadi/EspX
- https://github.com/knolleary/pubsubclient
- https://github.com/cryptocodecg/CG-IoT
- https://github.com/rahard/BRiot-stuff

1.1 SETTING UP

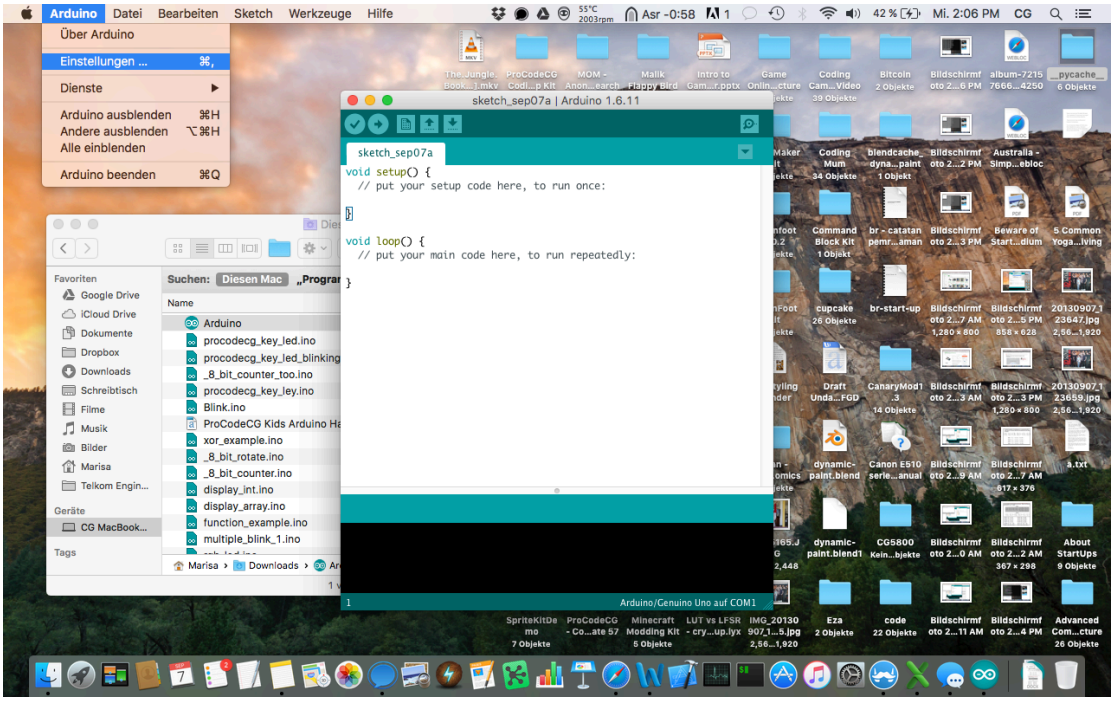
- Open "Tools"



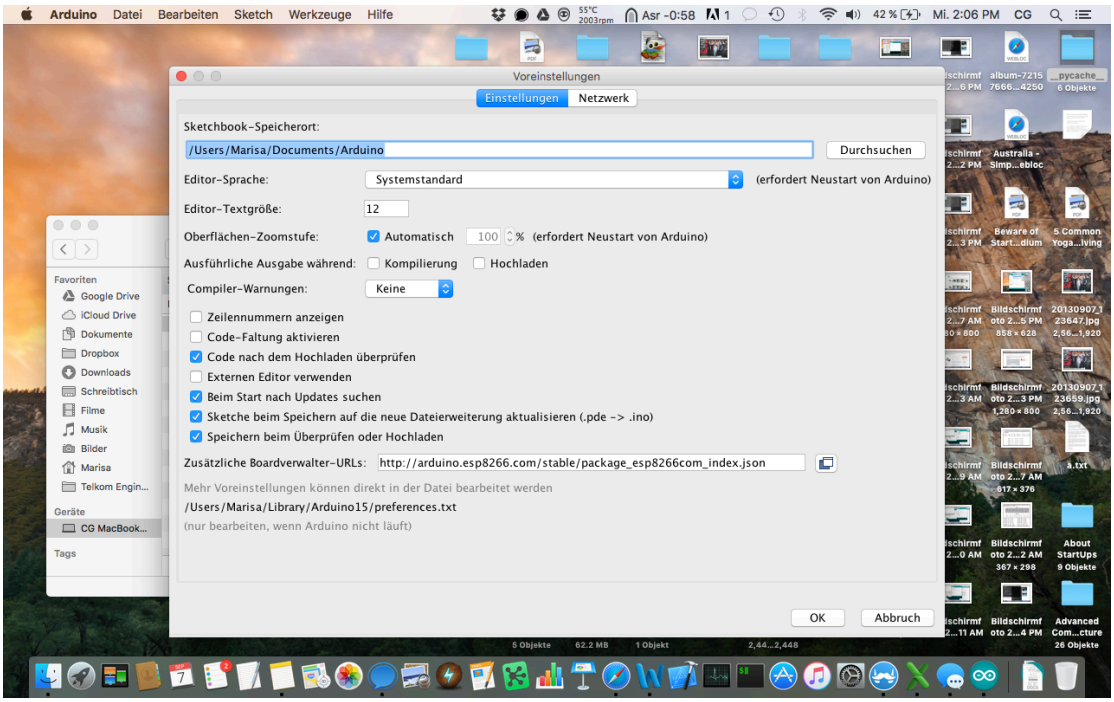
- Choose "Board". If we don't have options other than Arduino, that means we have to download the library



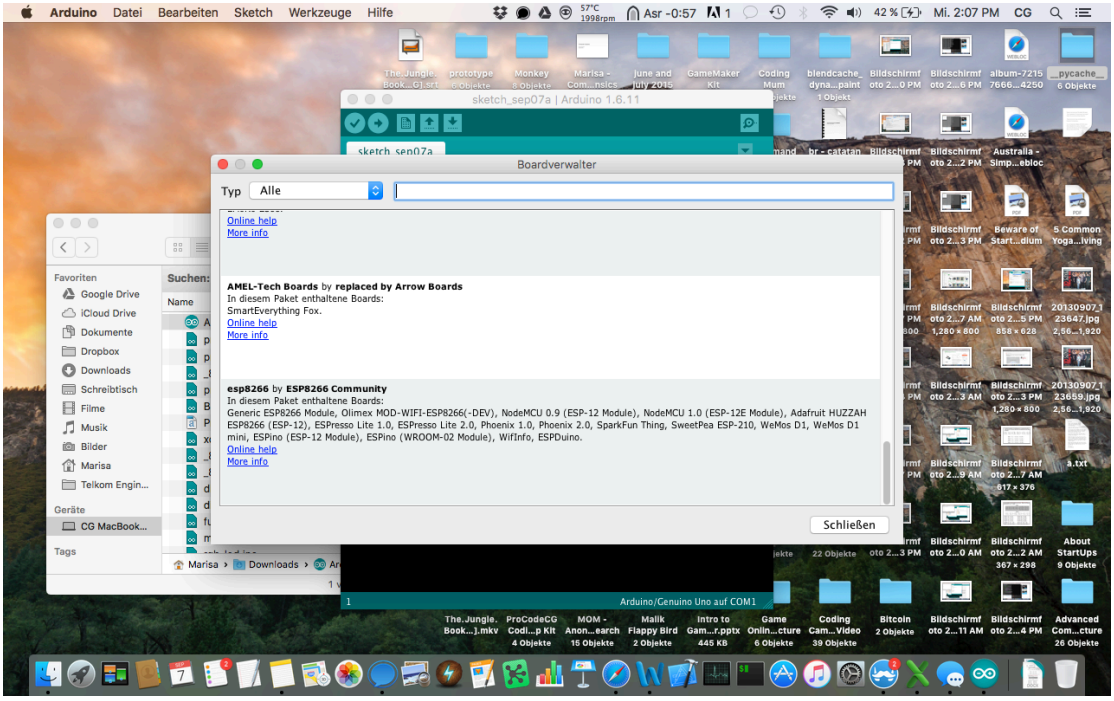
- Open “Setting”



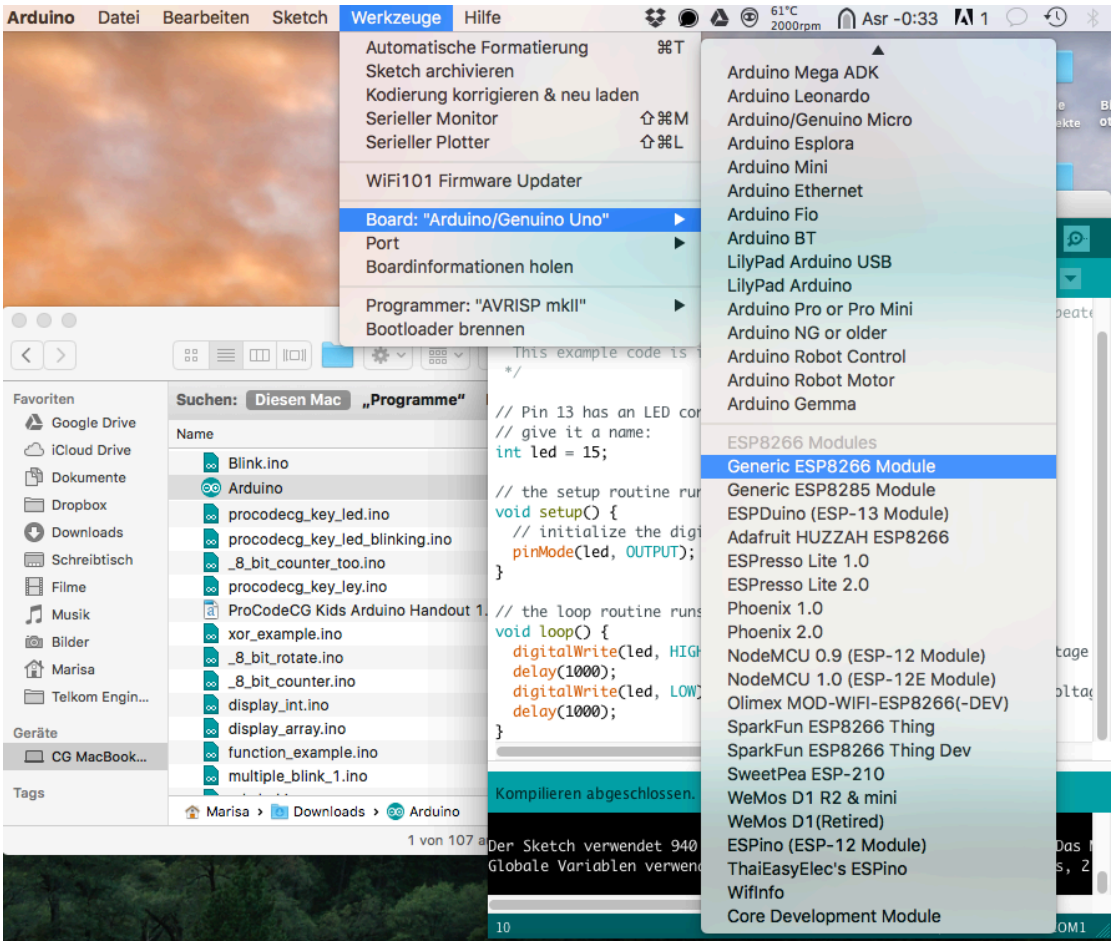
- Copy this URL:
  http://arduino.esp8266.com/stable/package_esp8266com_index.json
  to the "Additional Board Manager URLs" text box. Press OK.



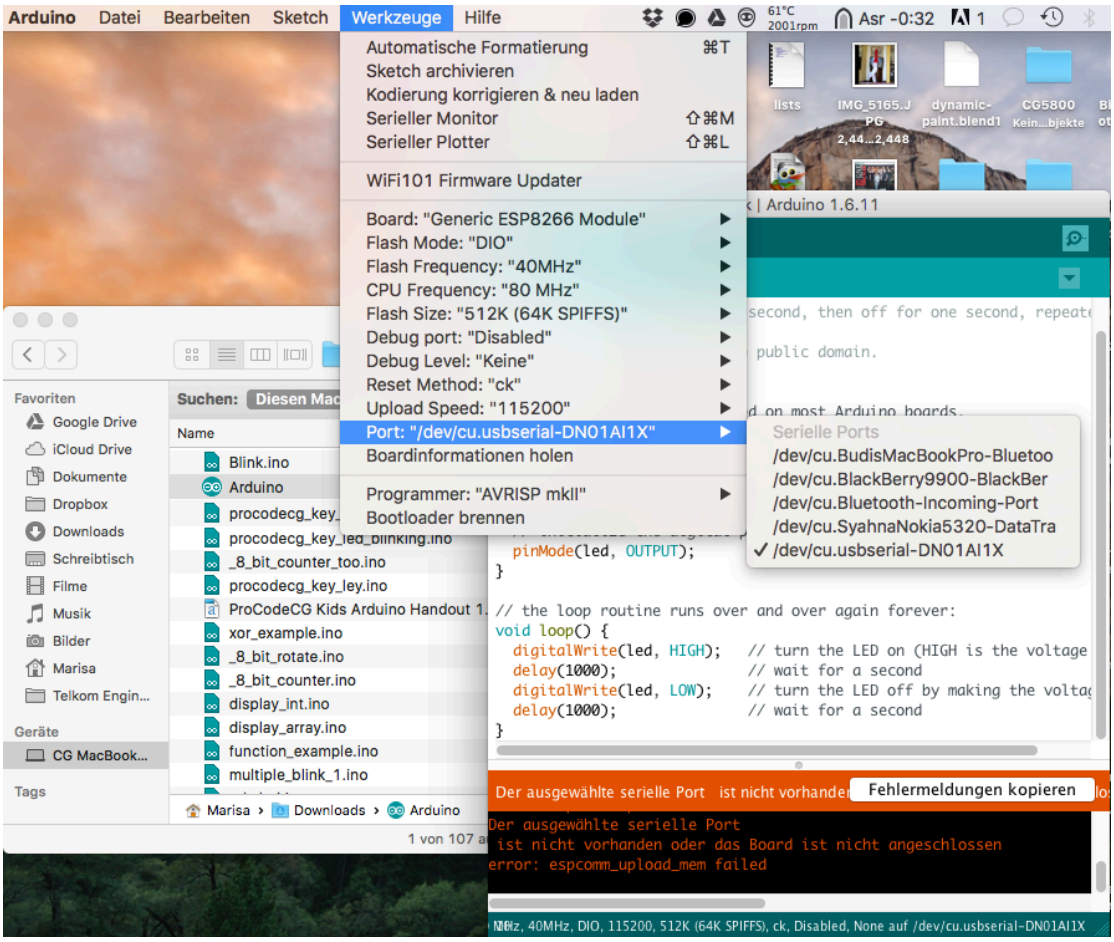
- Navigate to Board Manager by going to **Tools** > **Boards** > **Boards Manager**. There should be a couple new entries in addition to the standard Arduino boards. Look for **esp8266**. Click on that entry, then select **Install**.



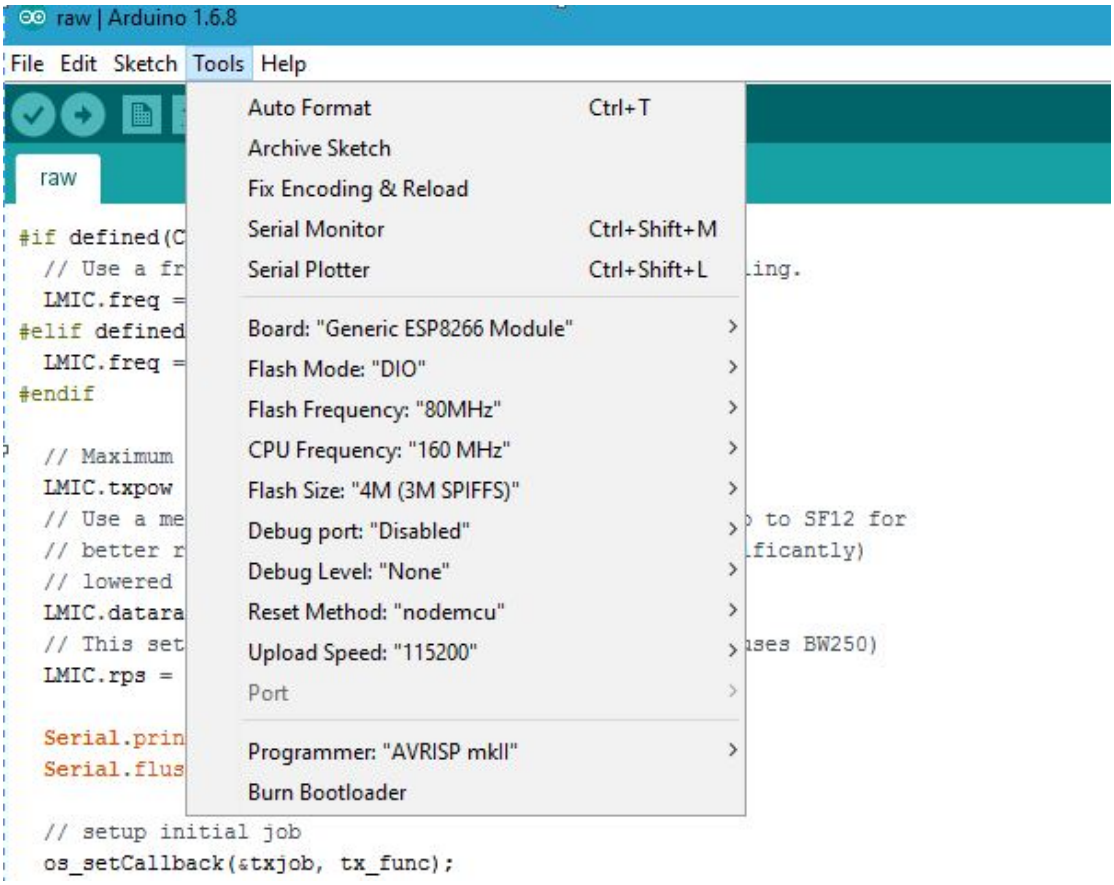
- Now we should have more board options. Select “ESP8266 Thing” from the **Tools** > **Boards** menu.


Arduino Datei Bearbeiten Sketch Werkzeuge Hilfe
Automatische Formatierung ⌘T
Sketch archivieren
Kodierung korrigieren & neu laden
Serieller Monitor ⇧⌘M
Serieller Plotter ⇧⌘L
WiFi101 Firmware Updater
Board: "Arduino/Genuino Uno"
Port
Boardinformationen holen
Programmer: "AVRISP mkII"
Bootloader brennen
Arduino Mega ADK
Arduino Leonardo
Arduino/Genuino Micro
Arduino Esplora
Arduino Mini
Arduino Ethernet
Arduino Fio
Arduino BT
LilyPad Arduino USB
LilyPad Arduino
Arduino Pro or Pro Mini
Arduino NG or older
Arduino Robot Control
Arduino Robot Motor
Arduino Gemma
ESP8266 Modules
Generic ESP8266 Module
Generic ESP8285 Module
ESPDuino (ESP-13 Module)
Adafruit HUZZAH ESP8266
ESPresso Lite 1.0
ESPresso Lite 2.0
Phoenix 1.0
Phoenix 2.0
NodeMCU 0.9 (ESP-12 Module)
NodeMCU 1.0 (ESP-12E Module)
Olimex MOD-WIFI-ESP8266(-DEV)
SparkFun ESP8266 Thing
SparkFun ESP8266 Thing Dev
SweetPea ESP-210
WeMos D1 R2 & mini
WeMos D1(Retired)
ESPino (ESP-12 Module)
ThaiEasyElec's ESPino
WifInfo
Core Development Module
Favoriten
Google Drive
iCloud Drive
Dokumente
Dropbox
Downloads
Schreibtisch
Filme
Musik
Bilder
Marisa
Telkom Engin...
Geräte
CG MacBook...
Tags
Suchen: Diesen Mac „Programme"
Name
Blink.ino
Arduino
procodecg_key_led.ino
procodecg_key_led_blinking.ino
_8_bit_counter_too.ino
procodecg_key_ley.ino
ProCodeCG Kids Arduino Handout 1.
xor_example.ino
_8_bit_rotate.ino
_8_bit_counter.ino
display_int.ino
display_array.ino
function_example.ino
multiple_blink_1.ino
Marisa › Downloads › Arduino
1 von 107
// Pin 13 has an LED
// give it a name:
int led = 15;
// the setup routine
void setup() {
pinMode(led, OUTPUT);
}
// the loop routine
void loop() {
digitalWrite(led, HIGH
delay(1000);
digitalWrite(led, LOW
delay(1000);
}
Kompilieren abgeschlossen.
Der Sketch verwendet 940
Globale Variablen verwen
10

- Choose port



- Make sure the configuration is exactly like shown below



1.2 BLINKING LED ONBOARD

When you first unbox your ESPectro Board, first thing to do is to test it. ESPectro has LED (and resistor) connected to port 15. We will go through the following steps to make it blinking:

- Download the Arduino Software https://www.arduino.cc/en/Main/Software
- Install the Arduino Software on your computer
- Connect your ESPectro to your computer via the USB cable.
- On the ESPectro board, there is a resistor next to pin 15 and an LED next to it. That LED works just as if it were connected between pin 15 and the ground (GND) pin next to it. If the LED is NOT on your board, just connect an LED between 15 and GND. You don't need to do anything else since a resistor is already built in and limits the current through the LED so you don't put your board at risk of a short circuit.
- Open the blink example from the software kit: "**File | Sketchbook |**

Examples | Digital". The onboard LED (or the one you added) should blink on and off after you upload the **Blink** "sketch" (as Arduino projects are called) to the board (**File | Upload**).

- When you write programs for your Arduino, you will normally do much of your debugging in the software development kit by doing a Verify/Compile before uploading.

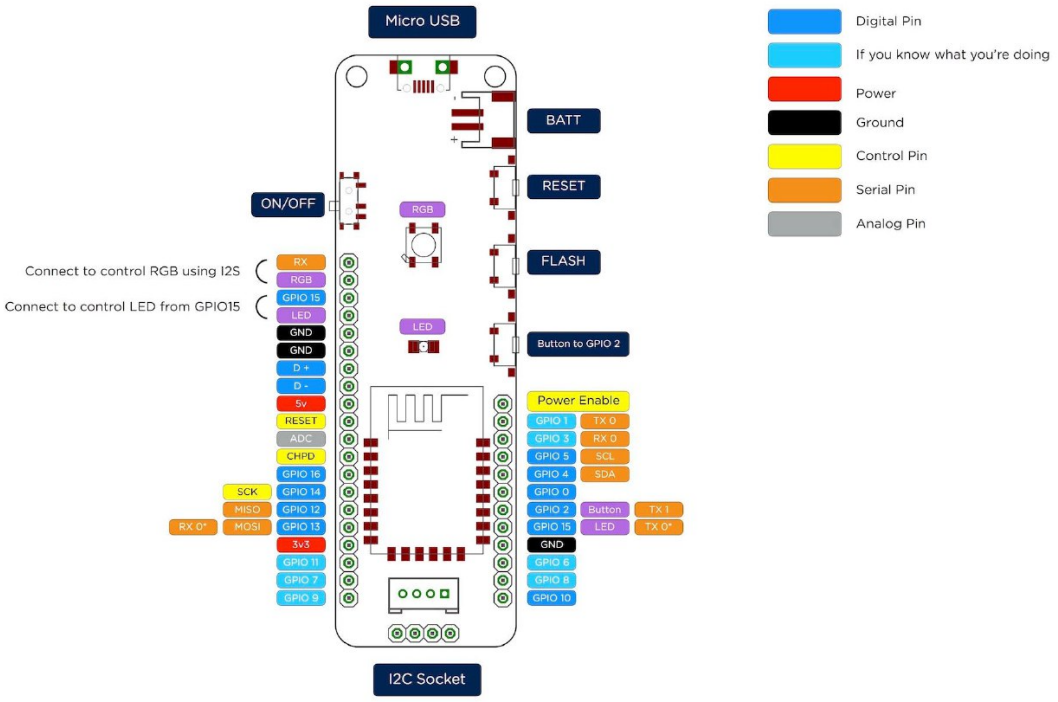
THE CODE:

```
/*
  Blink
  Turns on an LED on for one second, then off for one second,
  repeatedly.

  Most Arduinos have an on-board LED you can control. On the Uno and
  Leonardo, it is attached to digital pin 13. If you're unsure what
  pin the on-board LED is connected to on your Arduino model, check
  the documentation at http://www.arduino.cc

  This example code is in the public domain.

  modified 8 May 2014
  by Scott Fitzgerald
 */


// the setup function runs once when you press reset
// or power the board
void setup() {
  // initialize digital pin 13 as an output.
  pinMode(13, OUTPUT);
}

// the loop function runs over and over again forever
void loop() {
  digitalWrite(13, HIGH); // turn LED on (HIGH is the voltage level)
  delay(1000);            // wait for a second
  digitalWrite(13, LOW);// turn the LED off by making the voltage LOW
  delay(1000);            // wait for a second
}
```

Now that you have a blinking LED onboard, so you are good to do more things.

1.3 GETTING KNOW MORE ABOUT ESPectro BOARD

Below is the detail hardware layout of ESPectro. To connect it to breadboard and other components you have to refer to the picture. Next we will connect the board to a LED on a breadboard, using GPIO, Power and Ground port.



GPIO 2 is active low (connected to push button). It uses pull up resistor to VCC 3,3 V. GPIO 15 is active high. Uses pull down resistor. Power enable pin can be set up to 1 to activate all the circuit on the board. All ground is connected. There is only one analog port (ADC) but we can use I2C Socket. ADC 1V (1024) -> needs voltage divider. No charger on board so charger module should be added.

RESET is for resetting the whole program. To be able to upload the program to the board, FLASH mode should be in ON position. Press FLASH and hold, RESET then release RESET and then release FLASH.

1.4 ESPectro LIBRARY - BLINK

command prompt:

git clone https://github.com/andriyadi/EspX.git

Open folder Arduino Support, copy it to Arduino Library on your computer. Restart Arduino and check Tools > Board. It should have ESPectro Core option now.

Copy EspX folder to Arduino Library -> Documents > Arduino > Libraries

Restart Arduino. Load Blink from ESPectro folder.

```
/*
  Blink
  Turns on an LED on for one second, then off for one second,
repeatedly.

  Most Arduinos have an on-board LED you can control. On the UNO,
MEGA and ZERO
  it is attached to digital pin 13, on MKR1000 on pin 6. LED_BUILTIN
takes care
  of use the correct LED pin whatever is the board used.
  If you want to know what pin the on-board LED is connected to on
your Arduino model, check
  the Technical Specs of your board  at
https://www.arduino.cc/en/Main/Products

  This example code is in the public domain.

  modified 8 May 2014
  by Scott Fitzgerald

  modified 2 Sep 2016
  by Arturo Guadalupi

  modified 22 Sep 2016
  by Andri Yadi
*/

/*
```

```
 * ESPectro LED_BUILTIN = 15;
 */

// the setup function runs once when you press reset or power the
board
void setup() {
  // initialize digital pin LED_BUILTIN as an output.
  pinMode(LED_BUILTIN, OUTPUT);
}

// the loop function runs over and over again forever
void loop() {
  digitalWrite(LED_BUILTIN, HIGH);   // turn the LED on (HIGH is the
voltage level)
  delay(1000);                       // wait for a second
  digitalWrite(LED_BUILTIN, LOW);    // turn the LED off by making
the voltage LOW
  delay(1000);                       // wait for a second
}
```

1.5 ESPectro LIBRARY – BLINK WITHOUT DELAY

```
/* Blink without Delay

 Turns on and off a light emitting diode (LED) connected to a digital
 pin, without using the delay() function.  This means that other code
 can run at the same time without being interrupted by the LED code.

 The circuit:
 * LED attached from pin 13 to ground.
 * Note: on most Arduinos, there is already an LED on the board
 that's attached to pin 13, so no hardware is needed for this
example.

 created 2005
 by David A. Mellis
 modified 8 Feb 2010
 by Paul Stoffregen
 modified 11 Nov 2013
```

```
 by Scott Fitzgerald


 This example code is in the public domain.

 http://www.arduino.cc/en/Tutorial/BlinkWithoutDelay
 */

// constants won't change. Used here to set a pin number :
const int ledPin =  LED_BUILTIN;      // the number of the LED pin

// Variables will change :
int ledState = LOW;             // ledState used to set the LED

// Generally, you should use "unsigned long" for variables that hold
time
// The value will quickly become too large for an int to store
unsigned long previousMillis = 0;        // will store last time LED
was updated

// constants won't change :
const long interval = 1000;           // interval at which to blink
(milliseconds)

void setup() {
  // set the digital pin as output:
  pinMode(ledPin, OUTPUT);
}

void loop() {
  // here is where you'd put code that needs to be running all the
time.

  // check to see if it's time to blink the LED; that is, if the
  // difference between the current time and last time you blinked
  // the LED is bigger than the interval at which you want to
  // blink the LED.
  unsigned long currentMillis = millis();

  if (currentMillis - previousMillis >= interval) {
    // save the last time you blinked the LED
```

```
    previousMillis = currentMillis;

    // if the LED is off turn it on and vice-versa:
    if (ledState == LOW) {
      ledState = HIGH;
    } else {
      ledState = LOW;
    }

    // set the LED with the ledState of the variable:
    digitalWrite(ledPin, ledState);
  }
}
```

2 EXPLORING ESPECTRO

2.1 ESPectro LIBRARY – BUTTON

```
/*
  Button

 Turns on and off a light emitting diode(LED) connected to digital
 pin 13, when pressing a pushbutton attached to pin 2.


 The circuit:
 * LED attached from pin 13 to ground
 * pushbutton attached to pin 2 from +5V
 * 10K resistor attached to pin 2 from ground

 * Note: on most Arduinos there is already an LED on the board
 attached to pin 13.


 created 2005
 by DojoDave <http://www.0j0.org>
 modified 30 Aug 2011
 by Tom Igoe

 This example code is in the public domain.

 http://www.arduino.cc/en/Tutorial/Button
 */

// constants won't change. They're used here to
// set pin numbers:
const int buttonPin = BUTTON_BUILTIN;     // the number of the
pushbutton pin
const int ledPin =  LED_BUILTIN;      // the number of the LED pin
```

```
// variables will change:
int buttonState = 0;         // variable for reading the pushbutton
status

void setup() {
  // initialize the LED pin as an output:
  pinMode(ledPin, OUTPUT);
  // initialize the pushbutton pin as an input:
  pinMode(buttonPin, INPUT);
}

void loop() {
  // read the state of the pushbutton value:
  buttonState = digitalRead(buttonPin);

  // check if the pushbutton is pressed.
  // if it is, the buttonState is HIGH:
  if (buttonState == HIGH) {
    // turn LED on:
    digitalWrite(ledPin, HIGH);
  } else {
    // turn LED off:
    digitalWrite(ledPin, LOW);
  }
}
```

2.2 ESPectro LIBRARY – NeoPixel

GITHUB REPOSITORIES:

- https://github.com/adafruit/Adafruit_NeoPixel

Don't forget to shift the jumper to the center

2.2.1 Simple Example

```
// NeoPixel Ring simple sketch (c) 2013 Shae Erisson
// released under the GPLv3 license to match the rest of the AdaFruit
NeoPixel library

#include <Adafruit_NeoPixel.h>
#ifdef __AVR__
```

```
  #include <avr/power.h>
#endif

// Which pin on the Arduino is connected to the NeoPixels?
// On a Trinket or Gemma we suggest changing this to 1
#define PIN            15

// How many NeoPixels are attached to the Arduino?
#define NUMPIXELS      1

// When we setup the NeoPixel library, we tell it how many pixels,
and which pin to use to send signals.
// Note that for older NeoPixel strips you might need to change the
third parameter--see the strandtest
// example for more information on possible values.
Adafruit_NeoPixel pixels = Adafruit_NeoPixel(NUMPIXELS, PIN, NEO_GRB
+ NEO_KHZ800);

int delayval = 500; // delay for half a second

void setup() {
  // This is for Trinket 5V 16MHz, you can remove these three lines
if you are not using a Trinket
#if defined (__AVR_ATtiny85__)
  if (F_CPU == 16000000) clock_prescale_set(clock_div_1);
#endif
  // End of trinket special code

  pixels.begin(); // This initializes the NeoPixel library.
}

void loop() {

  // For a set of NeoPixels the first NeoPixel is 0, second is 1, all
the way up to the count of pixels minus one.

  for(int i=0;i<NUMPIXELS;i++){

    // pixels.Color takes RGB values, from 0,0,0 up to 255,255,255
    pixels.setPixelColor(i, pixels.Color(0,150,0)); // Moderately
bright green color.
```

```
    pixels.show(); // This sends the updated pixel color to the
hardware.

    delay(delayval); // Delay for a period of time (in milliseconds).

  }
}
```

2.2.2 RGBW Strand Test

```
#include <Adafruit_NeoPixel.h>
#ifdef __AVR__
  #include <avr/power.h>
#endif

#define PIN 15

// Parameter 1 = number of pixels in strip
// Parameter 2 = Arduino pin number (most are valid)
// Parameter 3 = pixel type flags, add together as needed:
//   NEO_KHZ800  800 KHz bitstream (most NeoPixel products w/WS2812
LEDs)
//   NEO_KHZ400  400 KHz (classic 'v1' (not v2) FLORA pixels, WS2811
drivers)
//   NEO_GRB     Pixels are wired for GRB bitstream (most NeoPixel
products)
//   NEO_RGB     Pixels are wired for RGB bitstream (v1 FLORA pixels,
not v2)
//   NEO_RGBW    Pixels are wired for RGBW bitstream (NeoPixel RGBW
products)
Adafruit_NeoPixel strip = Adafruit_NeoPixel(60, PIN, NEO_GRB +
NEO_KHZ800);

// IMPORTANT: To reduce NeoPixel burnout risk, add 1000 uF capacitor
across
// pixel power leads, add 300 - 500 Ohm resistor on first pixel's
data input
// and minimize distance between Arduino and first pixel.  Avoid
connecting
// on a live circuit...if you must, connect GND first.
```

```
void setup() {
  // This is for Trinket 5V 16MHz, you can remove these three lines
if you are not using a Trinket
  #if defined (__AVR_ATtiny85__)
    if (F_CPU == 16000000) clock_prescale_set(clock_div_1);
  #endif
  // End of trinket special code


  strip.begin();
  strip.show(); // Initialize all pixels to 'off'
}

void loop() {
  // Some example procedures showing how to display to the pixels:
  colorWipe(strip.Color(255, 0, 0), 50); // Red
  colorWipe(strip.Color(0, 255, 0), 50); // Green
  colorWipe(strip.Color(0, 0, 255), 50); // Blue
//colorWipe(strip.Color(0, 0, 0, 255), 50); // White RGBW
  // Send a theater pixel chase in...
  theaterChase(strip.Color(127, 127, 127), 50); // White
  theaterChase(strip.Color(127, 0, 0), 50); // Red
  theaterChase(strip.Color(0, 0, 127), 50); // Blue

  rainbow(20);
  rainbowCycle(20);
  theaterChaseRainbow(50);
}

// Fill the dots one after the other with a color
void colorWipe(uint32_t c, uint8_t wait) {
  for(uint16_t i=0; i<strip.numPixels(); i++) {
    strip.setPixelColor(i, c);
    strip.show();
    delay(wait);
  }
}

void rainbow(uint8_t wait) {
  uint16_t i, j;
```

```
  for(j=0; j<256; j++) {
    for(i=0; i<strip.numPixels(); i++) {
      strip.setPixelColor(i, Wheel((i+j) & 255));
    }
    strip.show();
    delay(wait);
  }
}

// Slightly different, this makes the rainbow equally distributed
throughout
void rainbowCycle(uint8_t wait) {
  uint16_t i, j;

  for(j=0; j<256*5; j++) { // 5 cycles of all colors on wheel
    for(i=0; i< strip.numPixels(); i++) {
      strip.setPixelColor(i, Wheel(((i * 256 / strip.numPixels()) +
j) & 255));
    }
    strip.show();
    delay(wait);
  }
}

//Theatre-style crawling lights.
void theaterChase(uint32_t c, uint8_t wait) {
  for (int j=0; j<10; j++) {  //do 10 cycles of chasing
    for (int q=0; q < 3; q++) {
      for (uint16_t i=0; i < strip.numPixels(); i=i+3) {
        strip.setPixelColor(i+q, c);    //turn every third pixel on
      }
      strip.show();

      delay(wait);

      for (uint16_t i=0; i < strip.numPixels(); i=i+3) {
        strip.setPixelColor(i+q, 0);        //turn every third pixel
off
      }
    }
```

```
  }
}

//Theatre-style crawling lights with rainbow effect
void theaterChaseRainbow(uint8_t wait) {
  for (int j=0; j < 256; j++) {     // cycle all 256 colors in the
wheel
    for (int q=0; q < 3; q++) {
      for (uint16_t i=0; i < strip.numPixels(); i=i+3) {
        strip.setPixelColor(i+q, Wheel( (i+j) % 255));    //turn
every third pixel on
      }
      strip.show();

      delay(wait);

      for (uint16_t i=0; i < strip.numPixels(); i=i+3) {
        strip.setPixelColor(i+q, 0);        //turn every third pixel
off
      }
    }
  }
}

// Input a value 0 to 255 to get a color value.
// The colours are a transition r - g - b - back to r.
uint32_t Wheel(byte WheelPos) {
  WheelPos = 255 - WheelPos;
  if(WheelPos < 85) {
    return strip.Color(255 - WheelPos * 3, 0, WheelPos * 3);
  }
  if(WheelPos < 170) {
    WheelPos -= 85;
    return strip.Color(0, WheelPos * 3, 255 - WheelPos * 3);
  }
  WheelPos -= 170;
  return strip.Color(WheelPos * 3, 255 - WheelPos * 3, 0);
}
```

2.3 PROCODECG LED

2.3.1 ALTERNATE LED

```
/*
This is an alternating blinking LEDs demo
1 0 1 0 1 0
0 1 0 1 0 1

Done for ESPectro board, but can be used by other boards.
Just change the pin definition

This code is in public domain
26 Sep 2016
Budi Rahardjo (@rahard)
*/

// pin definition of ESPectro board
// I am connecting this to ProcodeCG LED board
// thus, this pin configuration
uint8_t BRD1 = 15;
uint8_t BRD2 = 2;
uint8_t BRD3 = 0;
uint8_t BRD4 = 4;
uint8_t BRD5 = 5;
uint8_t BRD6 = 3;

int TUNGGU = 500;


// the setup function runs once when you press reset or power the
board
void setup() {
  pinMode(BRD1, OUTPUT);
  pinMode(BRD2, OUTPUT);
  pinMode(BRD3, OUTPUT);
  pinMode(BRD4, OUTPUT);
  pinMode(BRD5, OUTPUT);
  pinMode(BRD6, OUTPUT);
}

void loop() {
```

```
  digitalWrite(BRD1, HIGH);
  digitalWrite(BRD2, LOW);
  digitalWrite(BRD3, HIGH);
  digitalWrite(BRD4, LOW);
  digitalWrite(BRD5, HIGH);
  digitalWrite(BRD6, LOW);
  delay(TUNGGU);

  digitalWrite(BRD1, LOW);
  digitalWrite(BRD2, HIGH);
  digitalWrite(BRD3, LOW);
  digitalWrite(BRD4, HIGH);
  digitalWrite(BRD5, LOW);
  digitalWrite(BRD6, HIGH);
  delay(TUNGGU);
}
```

2.3.2 LED METER

```
/*
LED Meter

Public Domain
September 2016
Budi Rahardjo (@rahard)

*/

// pin configuration for DycodeX ESPectro board
int led[] = {15, 2, 0, 4, 5, 3};
// pin configuration for Arduino UNU board
// int led[] = {13, 12, 11, 10, 9, 8};
int NUMLED = 6; // number of LEDS
int WAITFOR = 100;
int i;
int LEDON=0;

void setup() {
   // setup pins for output
   for (i=0; i<NUMLED; i++) { pinMode(led[i], OUTPUT); }
}
```

```
void display(int n) {
   // protection
   if (n < 0) { n = 0; }
   if (n > NUMLED) { n = NUMLED; }

   // turn off all LED first
   for (i=0; i<NUMLED; i++) { digitalWrite(led[i], LOW); }

   // turn on LED from 1 to n; 0 means do not display
   for (i=1; i<=n; i++) {
      digitalWrite(led[i-1], HIGH);
   }
}

void loop() {
   int j;
   // increment
   for (j=0; j < NUMLED; j++) {
      display(j);
      delay(WAITFOR);
   }
   for (j=NUMLED; j >= 0; j--) {
      display(j);
      delay(WAITFOR);
   }
}
```

2.3.3 ENTER EXIT

```
/*
Enter - Exit

Public Domain
September 2016
Budi Rahardjo (@rahard)

*/

// pin configuration for DycodeX ESPectro board
int led[] = {15, 2, 0, 4, 5, 3};
// pin configuration for Arduino UNU board
// int led[] = {13, 12, 11, 10, 9, 8};
```

```
int x[] = {0, 0, 0, 0, 0, 0};
int NUMLED = 6; // number of LEDS
int WAITFOR = 100;
int i;

void setup() {
   // setup pins for output and reset low
   for (i=0; i<NUMLED; i++) { pinMode(led[i], OUTPUT); }
   for (i=0; i<NUMLED; i++) { digitalWrite(led[i], LOW); }
}

void display() {
   for (i=0; i < NUMLED ; i++) {
      digitalWrite(led[i], x[i]);
   }
}

void loop() {
   int j;
   // populate LED
   for (j=0; j<NUMLED; j++) {
      x[j]=1;
      display();
      delay(WAITFOR);
   }
   // unpopulate LED
   for (j=0; j<NUMLED; j++) {
      x[j]=0;
      display();
      delay(WAITFOR);
   }

}
```

2.3.4 KNIGHT RIDER

```
/*
Knight Rider LED

Public Domain
September 2016
```

```
Budi Rahardjo (@rahard)

*/

// pin configuration for DycodeX ESPectro board
// int led[] = {15, 2, 0, 4, 5, 3};
// pin configuration for Arduino UNU board
int led[] = {13, 12, 11, 10, 9, 8};
int NUMLED = 6; // number of LEDS
int WAITFOR = 10;
int i;
int LEDON=0;
int direction=1;

void setup() {
   // setup pins for output
   for (i=0; i<NUMLED; i++) { pinMode(led[i], OUTPUT); }
}

void loop() {

   // turn off all LED
   for (i=0; i<NUMLED; i++) { digitalWrite(led[i], LOW); }
   // turn on LED with current counter
   digitalWrite(led[LEDON], HIGH);

   delay(WAITFOR);

   LEDON = LEDON + direction;

   // if already hit the largest number, reverse direction
   if (LEDON >= NUMLED) {
      direction = -1;
      LEDON = NUMLED - 1;
   }

   // if already hit the lowest number
   if (LEDON < 0) {
      direction = 1;
      LEDON = 0;
   }
```

```
}
```

3 CONNECTING TO CLOUD

3.1 CONNECTING TO WIFI

```
// Example to connect Espectro to WiFi
// code taken from places
// public domain
// Budi Rahardjo @rahard 2016



#include <ESP8266WiFi.h>
#include <ESP8266WiFiMulti.h>

ESP8266WiFiMulti WiFiMulti;

int z=0;

void setup() {
    Serial.begin(9600);
    delay(1000);

    WiFiMulti.addAP("procodecg LG", "12345678");

    while(WiFiMulti.run() != WL_CONNECTED) {
        Serial.print(".");
        delay(500);
        // just to limit the tries ... so that I doesnt loop forever
        z++;
        if (z>100) {
           Serial.println("Fail connecting. Exiting");
           return;
           }
    }

}
```

```
void loop() {

    // yayyy we are connected
    Serial.println("");
    Serial.println("WiFi connected");
    Serial.println("IP address: ");
    Serial.println(WiFi.localIP());

    delay(500);
}
```

3.2 CONNECTING TO MQTT

REFERENCES:

1. http://stackoverflow.com/questions/26716279/how-to-test-the-mosquitto-server
2. http://www.hivemq.com/hivemq/
3. http://www.hivemq.com/resources/getting-started/
4. http://www.mqtt-dashboard.com/index.html

3.2.1 ESPectro LIBRARY – Basic ESP8266 Example

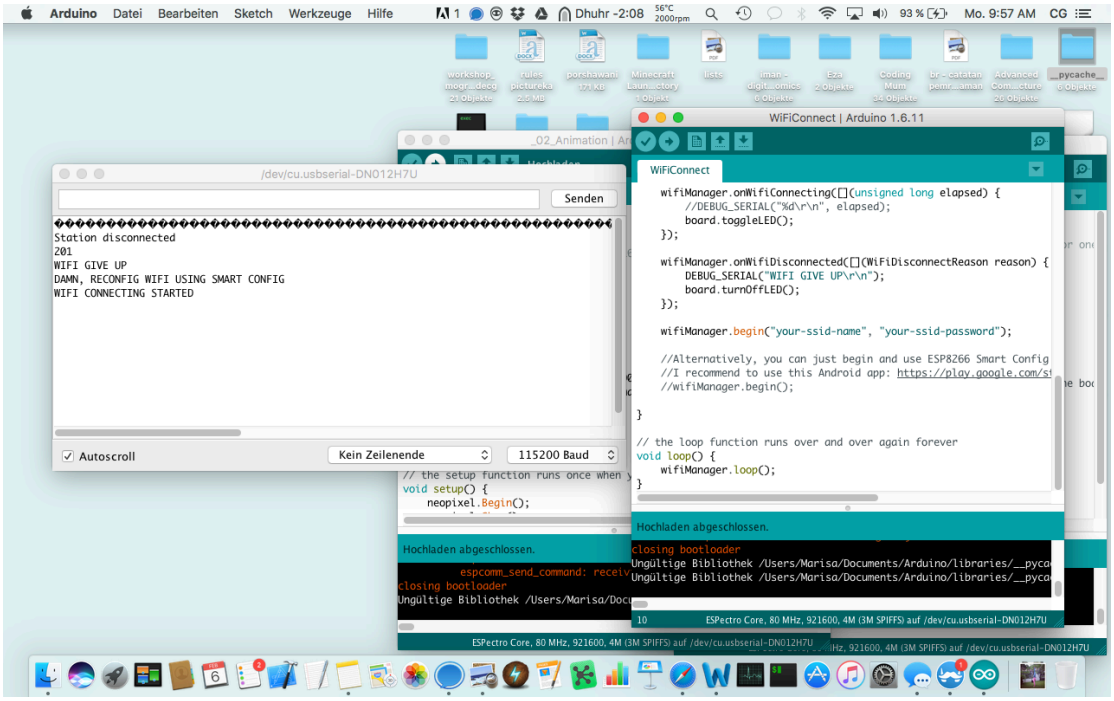
```
/*
 Basic ESP8266 MQTT example

 This sketch demonstrates the capabilities of the pubsub library in
combination
 with the ESP8266 board/library.

 It connects to an MQTT server then:
  - publishes "hello world" to the topic "outTopic" every two seconds
  - subscribes to the topic "inTopic", printing out any messages
    it receives. NB - it assumes the received payloads are strings
not binary
  - If the first character of the topic "inTopic" is an 1, switch ON
the ESP Led,
```

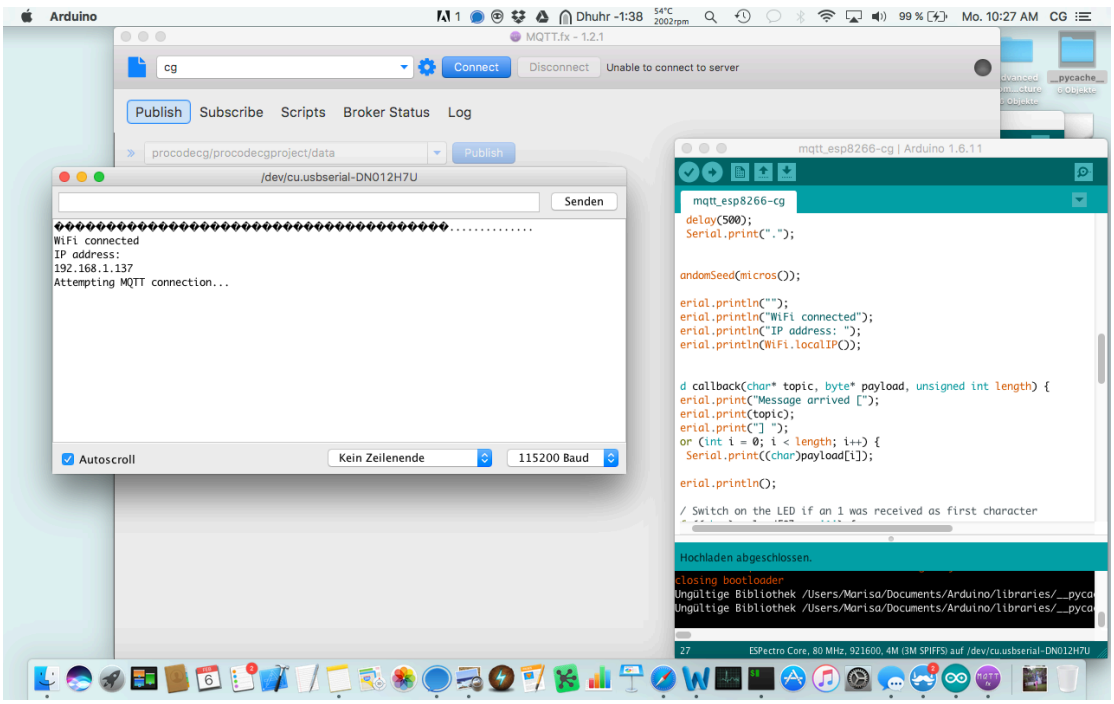
```
    else switch it off

 It will reconnect to the server if the connection is lost using a
blocking
 reconnect function. See the 'mqtt_reconnect_nonblocking' example for
how to
 achieve the same result without blocking the main loop.

 To install the ESP8266 board, (using Arduino 1.6.4+):
  - Add the following 3rd party board manager under "File ->
Preferences -> Additional Boards Manager URLs":

http://arduino.esp8266.com/stable/package_esp8266com_index.json
  - Open the "Tools -> Board -> Board Manager" and click install for
the ESP8266"
  - Select your ESP8266 in "Tools -> Board"

*/

#include <ESP8266WiFi.h>
#include <PubSubClient.h>

// Update these with values suitable for your network.

const char* ssid = "DyWare-AP2";
const char* password = "957DaegCen";
const char* mqtt_server = "iothub.id";

WiFiClient espClient;
PubSubClient client(espClient);
long lastMsg = 0;
char msg[50];
int value = 0;

void setup_wifi() {

  delay(10);
  // We start by connecting to a WiFi network
  Serial.println();
  Serial.print("Connecting to ");
  Serial.println(ssid);
```

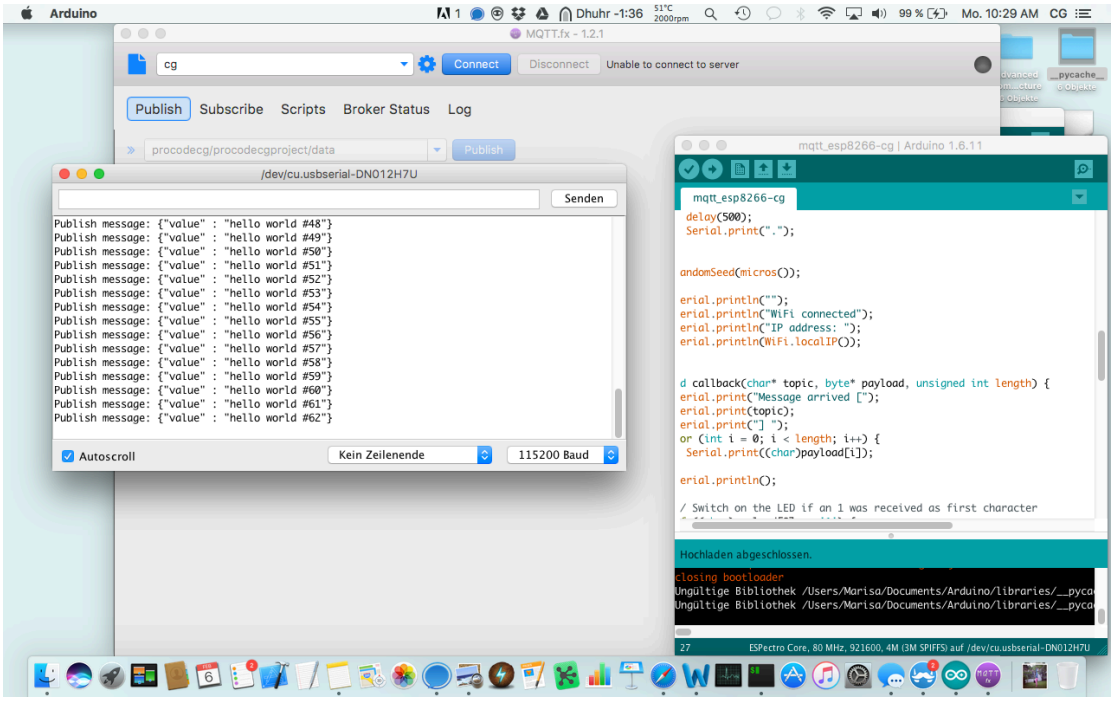
```
  WiFi.begin(ssid, password);

  while (WiFi.status() != WL_CONNECTED) {
    delay(500);
    Serial.print(".");
  }

  randomSeed(micros());

  Serial.println("");
  Serial.println("WiFi connected");
  Serial.println("IP address: ");
  Serial.println(WiFi.localIP());
}

void callback(char* topic, byte* payload, unsigned int length) {
  Serial.print("Message arrived [");
  Serial.print(topic);
  Serial.print("] ");
  for (int i = 0; i < length; i++) {
    Serial.print((char)payload[i]);
  }
  Serial.println();

  // Switch on the LED if an 1 was received as first character
  if ((char)payload[0] == '1') {
    digitalWrite(BUILTIN_LED, LOW);   // Turn the LED on (Note that
LOW is the voltage level
    // but actually the LED is on; this is because
    // it is acive low on the ESP-01)
  } else {
    digitalWrite(BUILTIN_LED, HIGH);  // Turn the LED off by making
the voltage HIGH
  }

}

void reconnect() {
  // Loop until we're reconnected
  while (!client.connected()) {
```

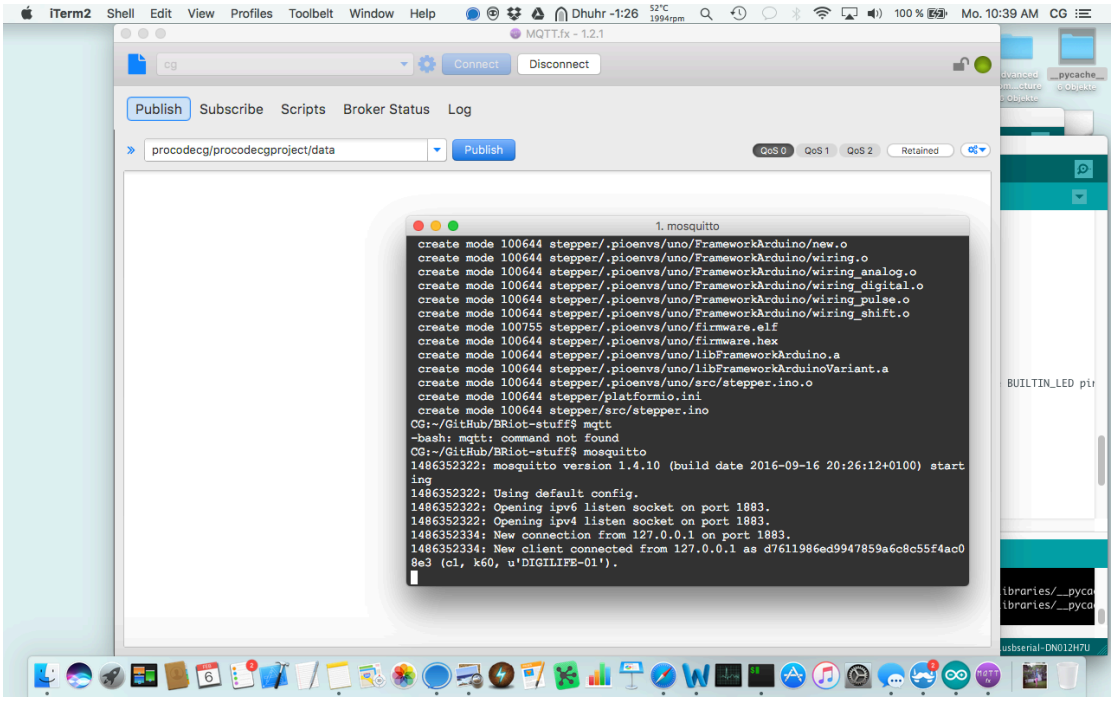
```
    Serial.print("Attempting MQTT connection...");
    // Create a random client ID
    String clientId = "ESP8266Client-";
    clientId += String(random(0xffff), HEX);
    // Attempt to connect
    if (client.connect(clientId.c_str(), "procodecg",
"procodeiothubCG")) {
      Serial.println("connected");
      // Once connected, publish an announcement...
      //client.publish("procodecg/procodecgproject/data", "hello
world");
      // ... and resubscribe
      client.subscribe("inTopic");
    } else {
      Serial.print("failed, rc=");
      Serial.print(client.state());
      Serial.println(" try again in 5 seconds");
      // Wait 5 seconds before retrying
      delay(5000);
    }
  }
}

void setup() {
  pinMode(BUILTIN_LED, OUTPUT);     // Initialize the BUILTIN_LED pin
as an output
  Serial.begin(115200);
  setup_wifi();
  client.setServer(mqtt_server, 1883);
  client.setCallback(callback);
}

void loop() {

  if (!client.connected()) {
    reconnect();
  }
  client.loop();

  long now = millis();
  if (now - lastMsg > 2000) {
```

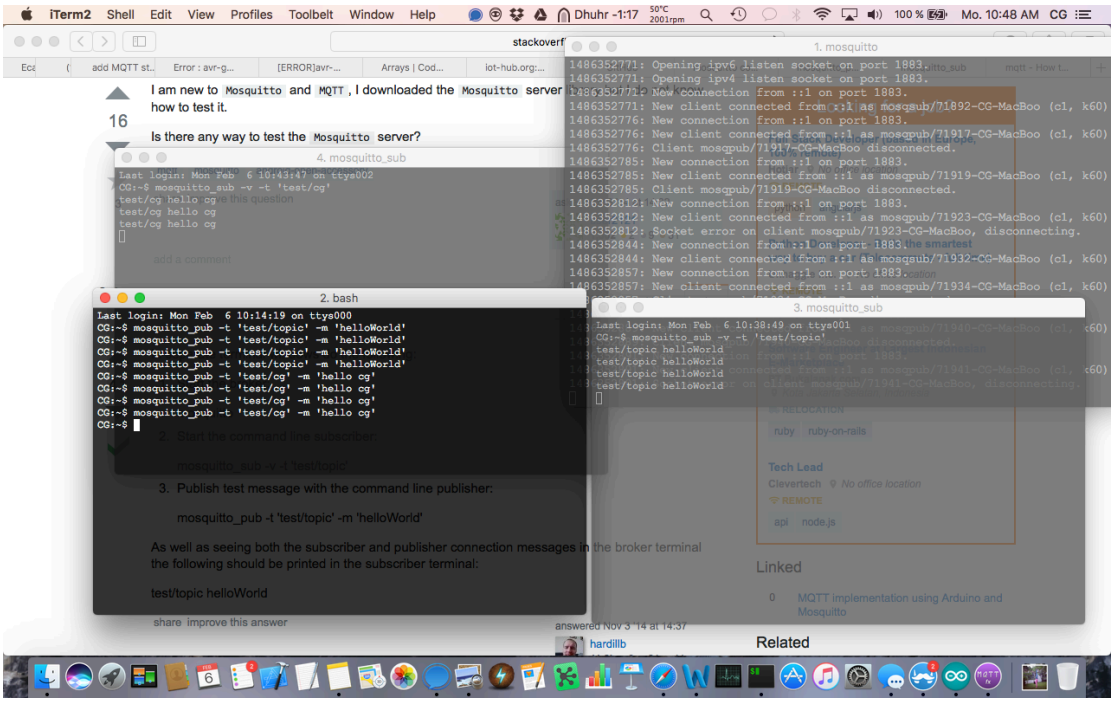
```
    lastMsg = now;
    ++value;
    snprintf (msg, 75, "{\"value\" : \"hello world #%ld\"}", value);
    Serial.print("Publish message: ");
    Serial.println(msg);
    client.publish("procodecg/procodecgproject/data", msg);
  }
}
```

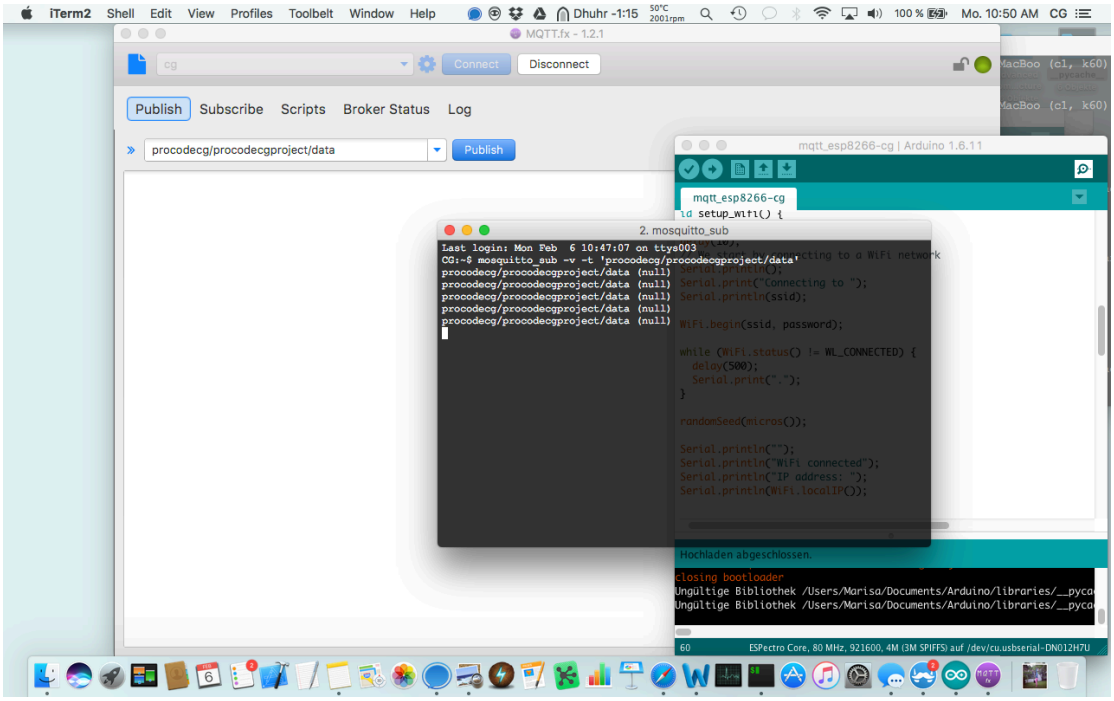


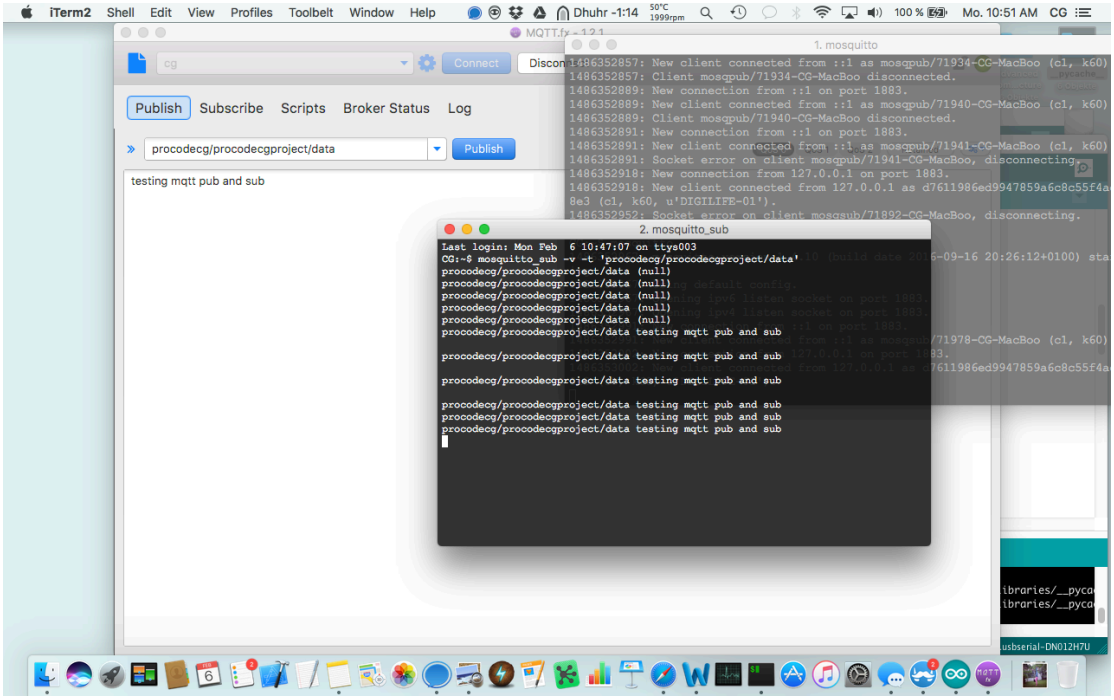


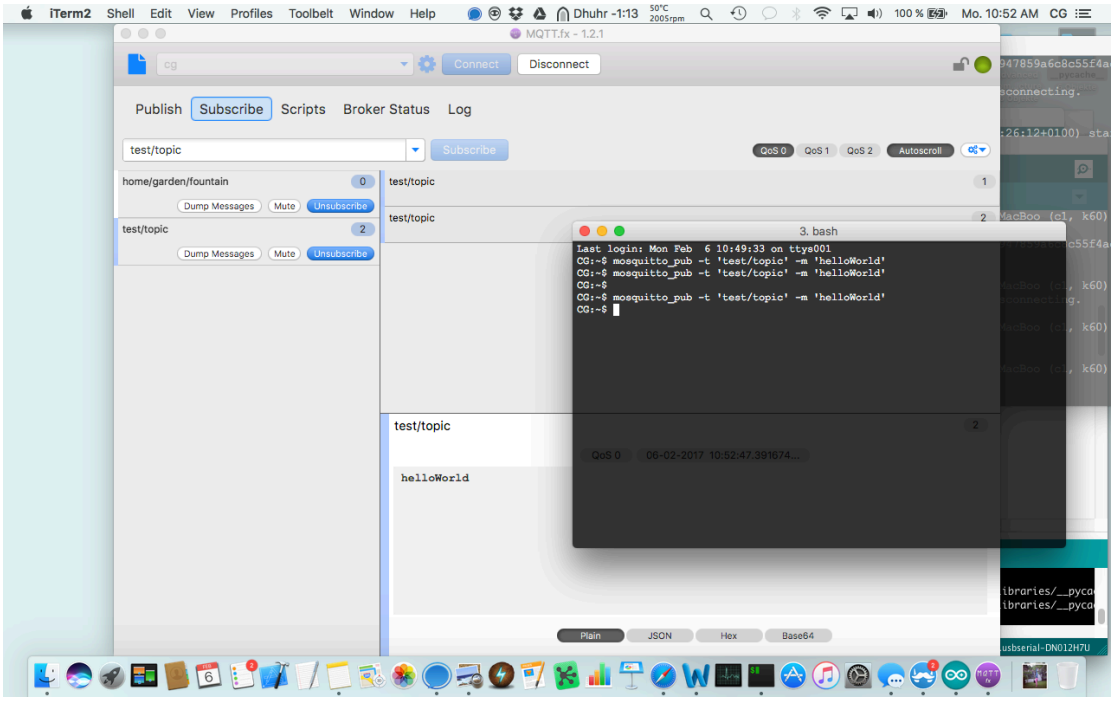

Arduino
MQTT.fx - 1.2.1
cg
Connect
Disconnect
Unable to connect to server
Publish
Subscribe
Scripts
Broker Status
Log
procodecg/procodecgproject/data
/dev/cu.usbserial-DN012H7U
Senden
Publish message: {"value" : "hello world #48"}
Publish message: {"value" : "hello world #49"}
Publish message: {"value" : "hello world #50"}
Publish message: {"value" : "hello world #51"}
Publish message: {"value" : "hello world #52"}
Publish message: {"value" : "hello world #53"}
Publish message: {"value" : "hello world #54"}
Publish message: {"value" : "hello world #55"}
Publish message: {"value" : "hello world #56"}
Publish message: {"value" : "hello world #57"}
Publish message: {"value" : "hello world #58"}
Publish message: {"value" : "hello world #59"}
Publish message: {"value" : "hello world #60"}
Publish message: {"value" : "hello world #61"}
Publish message: {"value" : "hello world #62"}
Autoscroll
Kein Zeilenende
115200 Baud
mqtt_esp8266-cg | Arduino 1.6.11
mqtt_esp8266-cg
Hochladen abgeschlossen.
ESPectro Core, 80 MHz, 921600, 4M (3M SPIFFS) auf /dev/cu.usbserial-DN012H7U

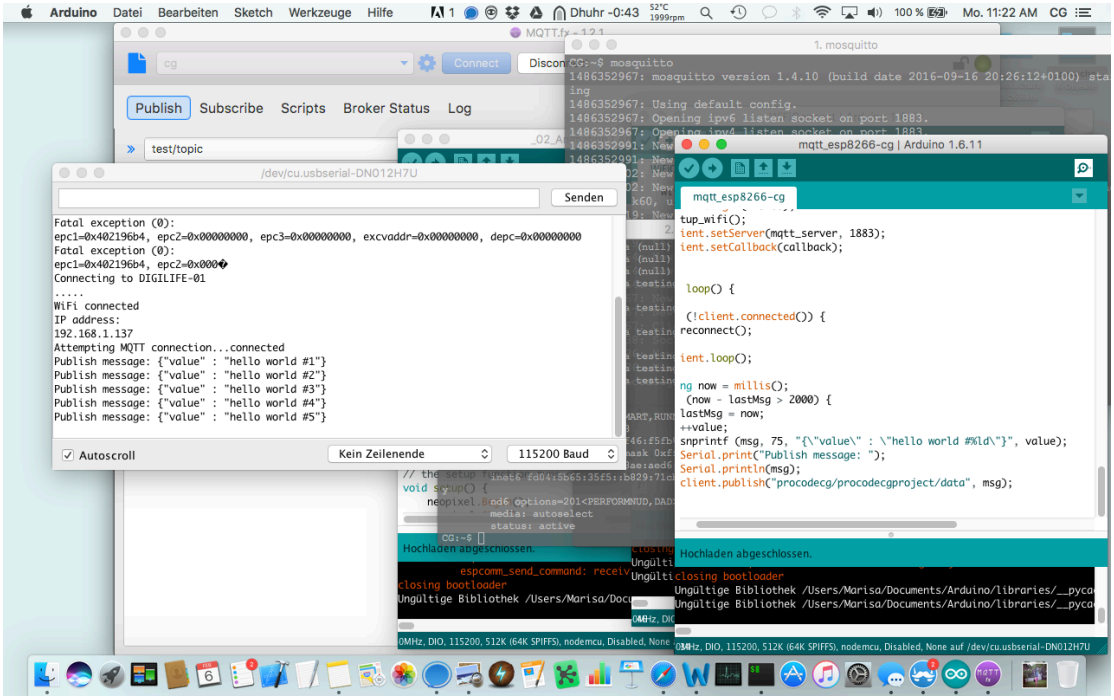

iTerm2
Shell
Edit
View
Profiles
Toolbelt
Window
Help
MQTT.fx - 1.2.1
Connect
Disconnect
Publish
Subscribe
Scripts
Broker Status
Log
procodecg/procodecgproject/data
QoS 0
QoS 1
QoS 2
Retained
1. mosquitto
create mode 100644 stepper/.pioenvs/uno/FrameworkArduino/new.o
create mode 100644 stepper/.pioenvs/uno/FrameworkArduino/wiring.o
create mode 100644 stepper/.pioenvs/uno/FrameworkArduino/wiring_analog.o
create mode 100644 stepper/.pioenvs/uno/FrameworkArduino/wiring_digital.o
create mode 100644 stepper/.pioenvs/uno/FrameworkArduino/wiring_pulse.o
create mode 100644 stepper/.pioenvs/uno/FrameworkArduino/wiring_shift.o
create mode 100755 stepper/.pioenvs/uno/firmware.elf
create mode 100644 stepper/.pioenvs/uno/firmware.hex
create mode 100644 stepper/.pioenvs/uno/libFrameworkArduino.a
create mode 100644 stepper/.pioenvs/uno/libFrameworkArduinoVariant.a
create mode 100644 stepper/.pioenvs/uno/src/stepper.ino.o
create mode 100644 stepper/platformio.ini
create mode 100644 stepper/src/stepper.ino
CG:~/GitHub/BRiot-stuff$ mqtt
-bash: mqtt: command not found
CG:~/GitHub/BRiot-stuff$ mosquitto
1486352322: mosquitto version 1.4.10 (build date 2016-09-16 20:26:12+0100) start
ing
1486352322: Using default config.
1486352322: Opening ipv6 listen socket on port 1883.
1486352322: Opening ipv4 listen socket on port 1883.
1486352334: New connection from 127.0.0.1 on port 1883.
1486352334: New client connected from 127.0.0.1 as d7611986ed9947859a6c8c55f4ac0
8e3 (c1, k60, u'DIGILIFE-01').

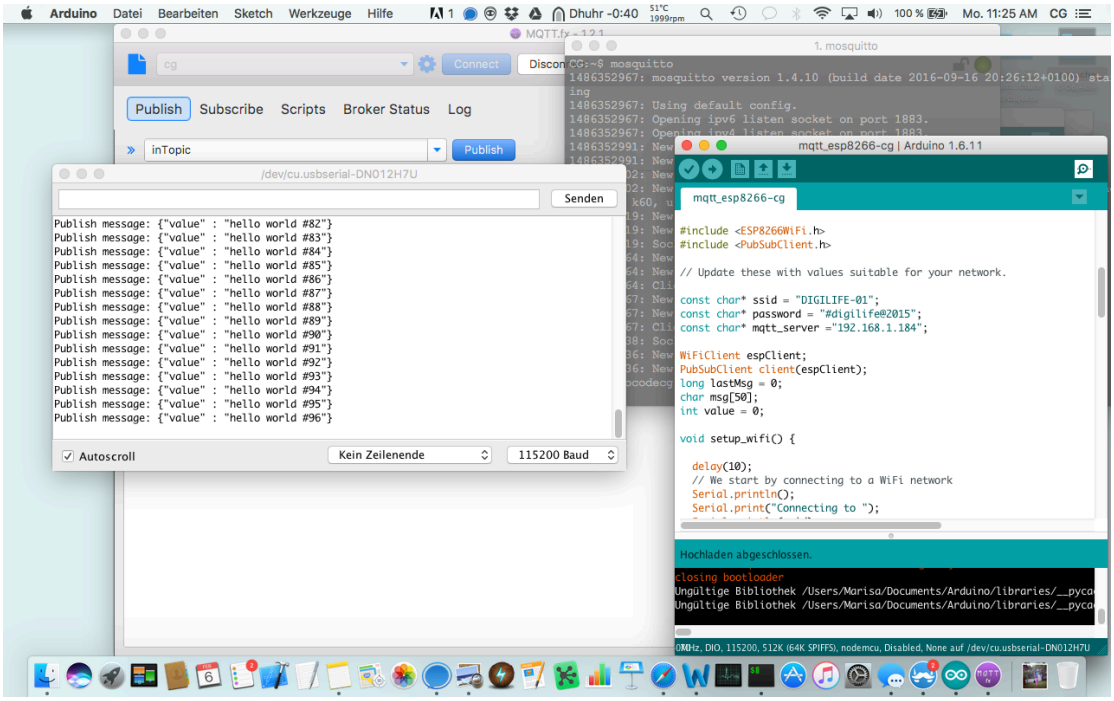

I am new to Mosquitto and MQTT, I downloaded the Mosquitto server how to test it.
Is there any way to test the Mosquitto server?
2. bash
Last login: Mon Feb 6 10:14:19 on ttys000
CG:~$ mosquitto_pub -t 'test/topic' -m 'helloWorld'
CG:~$ mosquitto_pub -t 'test/topic' -m 'helloWorld'
CG:~$ mosquitto_pub -t 'test/topic' -m 'helloWorld'
CG:~$ mosquitto_pub -t 'test/topic' -m 'helloWorld'
CG:~$ mosquitto_pub -t 'test/cg' -m 'hello cg'
CG:~$ mosquitto_pub -t 'test/cg' -m 'hello cg'
CG:~$ mosquitto_pub -t 'test/cg' -m 'hello cg'
CG:~$ mosquitto_pub -t 'test/cg' -m 'hello cg'
3. Publish test message with the command line publisher:
mosquitto_pub -t 'test/topic' -m 'helloWorld'
As well as seeing both the subscriber and publisher connection messages in the broker terminal the following should be printed in the subscriber terminal:
test/topic helloWorld
1. mosquitto
3. mosquitto_sub
Last login: Mon Feb 6 10:38:49 on ttys001
CG:~$ mosquitto_sub -v -t 'test/topic'
test/topic helloWorld
test/topic helloWorld
test/topic helloWorld
test/topic helloWorld
Linked
MQTT implementation using Arduino and Mosquitto
Related

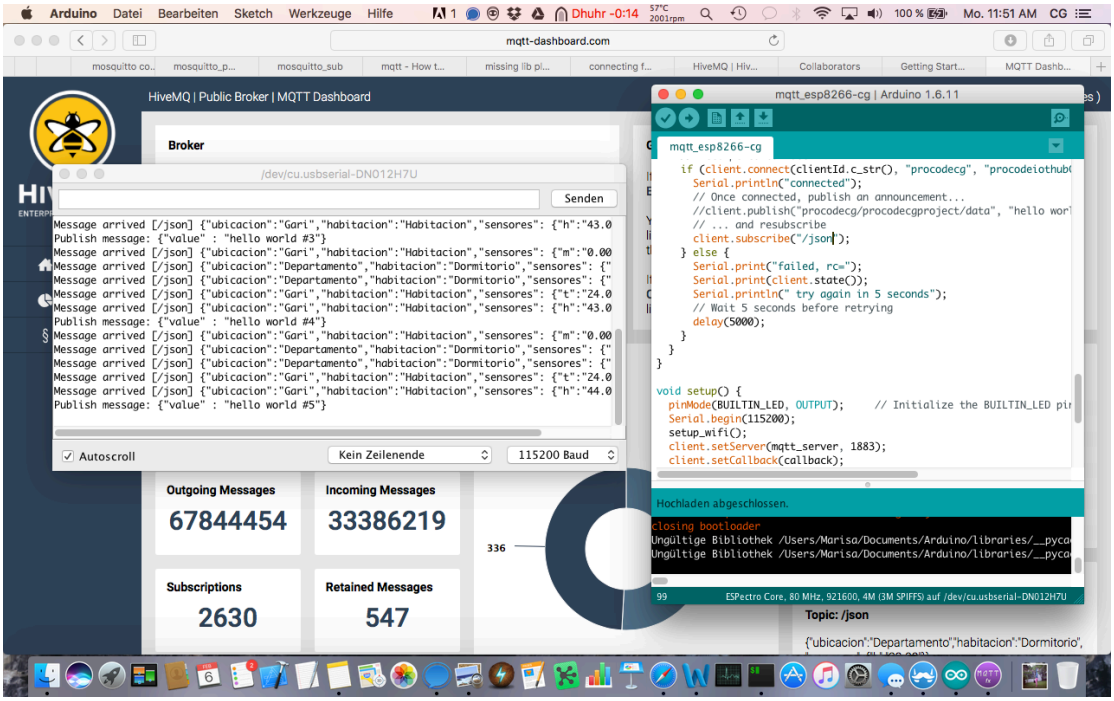

MQTT.fx - 1.2.1
Connect
Disconnect
Publish
Subscribe
Scripts
Broker Status
Log
procodecg/procodecgproject/data
Publish
2. mosquitto_sub
Last login: Mon Feb 6 10:47:07 on ttys003
CG:~$ mosquitto_sub -v -t 'procodecg/procodecgproject/data'
procodecg/procodecgproject/data (null)
procodecg/procodecgproject/data (null)
procodecg/procodecgproject/data (null)
procodecg/procodecgproject/data (null)
procodecg/procodecgproject/data (null)
mqtt_esp8266-cg | Arduino 1.6.11
mqtt_esp8266-cg
Hochladen abgeschlossen.
closing bootloader
Ungültige Bibliothek /Users/Marisa/Documents/Arduino/libraries/__pyca
Ungültige Bibliothek /Users/Marisa/Documents/Arduino/libraries/__pyca
ESPectro Core, 80 MHz, 921600, 4M (3M SPIFFS) auf /dev/cu.usbserial-DN012H7U

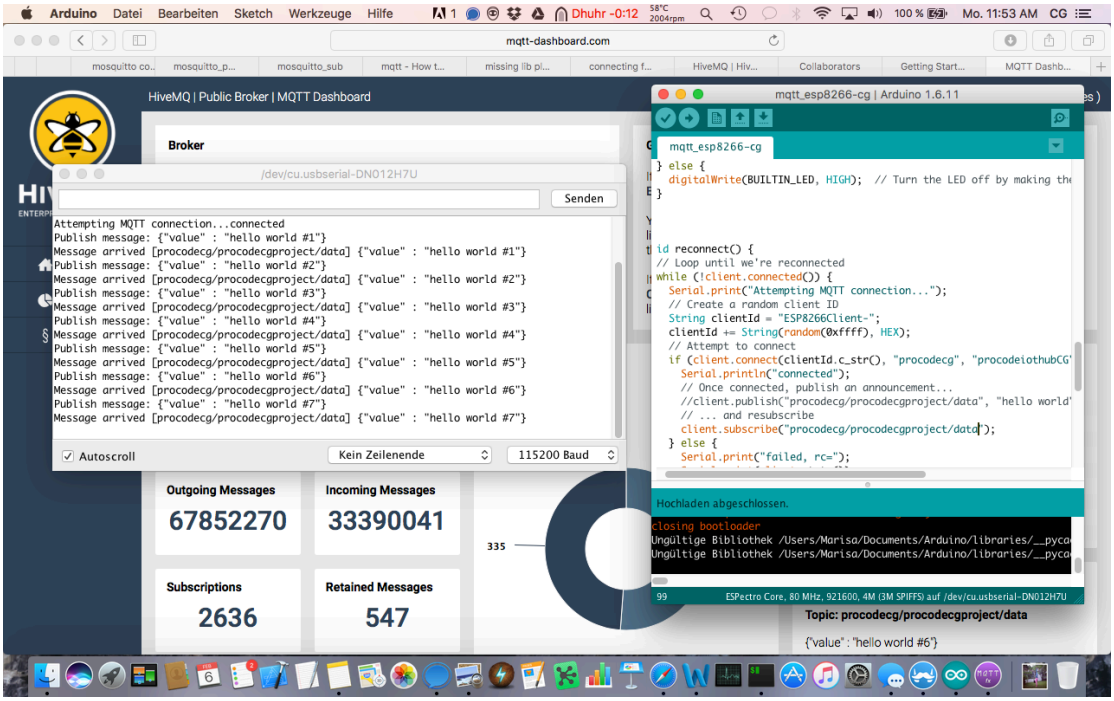

Publish
Subscribe
Scripts
Broker Status
Log
procodecg/procodecgproject/data
Publish
testing mqtt pub and sub
2. mosquitto_sub
Last login: Mon Feb 6 10:47:07 on ttys003
CG:~$ mosquitto_sub -v -t 'procodecg/procodecgproject/data'
procodecg/procodecgproject/data (null)
procodecg/procodecgproject/data (null)
procodecg/procodecgproject/data (null)
procodecg/procodecgproject/data (null)
procodecg/procodecgproject/data (null)
procodecg/procodecgproject/data testing mqtt pub and sub
procodecg/procodecgproject/data testing mqtt pub and sub
procodecg/procodecgproject/data testing mqtt pub and sub
procodecg/procodecgproject/data testing mqtt pub and sub
procodecg/procodecgproject/data testing mqtt pub and sub
procodecg/procodecgproject/data testing mqtt pub and sub

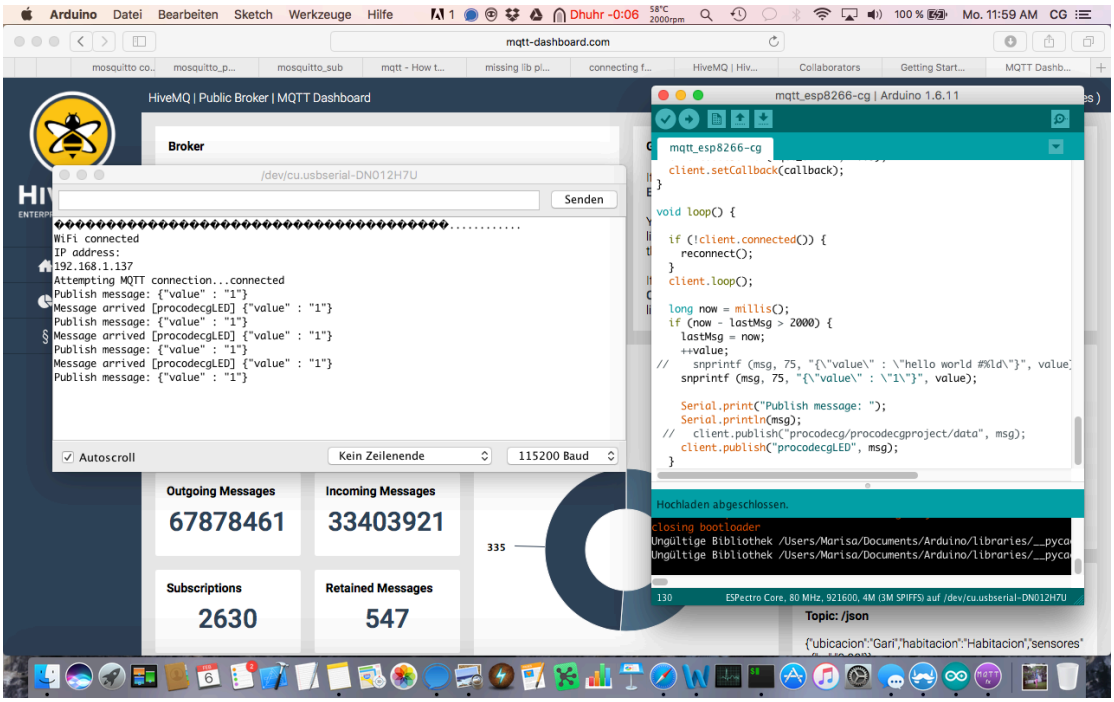

Connect
Disconnect
Publish
Subscribe
Scripts
Broker Status
Log
test/topic
Subscribe
home/garden/fountain
Dump Messages
Mute
Unsubscribe
test/topic
3. bash
Last login: Mon Feb 6 10:49:33 on ttys001
CG:~$ mosquitto_pub -t 'test/topic' -m 'helloWorld'
CG:~$ mosquitto_pub -t 'test/topic' -m 'helloWorld'
CG:~$
CG:~$ mosquitto_pub -t 'test/topic' -m 'helloWorld'
CG:~$
helloWorld
Plain
JSON
Hex
Base64


Arduino Datei Bearbeiten Sketch Werkzeuge Hilfe
Publish Subscribe Scripts Broker Status Log
test/topic
/dev/cu.usbserial-DN012H7U
Senden
Fatal exception (0):
epc1=0x402196b4, epc2=0x00000000, epc3=0x00000000, excvaddr=0x00000000, depc=0x00000000
Fatal exception (0):
epc1=0x402196b4, epc2=0x000
Connecting to DIGILIFE-01
.....
WiFi connected
IP address:
192.168.1.137
Attempting MQTT connection...connected
Publish message: {"value" : "hello world #1"}
Publish message: {"value" : "hello world #2"}
Publish message: {"value" : "hello world #3"}
Publish message: {"value" : "hello world #4"}
Publish message: {"value" : "hello world #5"}
Autoscroll
Kein Zeilenende
115200 Baud
mqtt_esp8266-cg | Arduino 1.6.11
mqtt_esp8266-cg
Hochladen abgeschlossen.
closing bootloader
Ungültige Bibliothek /Users/Marisa/Documents/Arduino/libraries/__pycache__
Ungültige Bibliothek /Users/Marisa/Documents/Arduino/libraries/__pycache__


Arduino Datei Bearbeiten Sketch Werkzeuge Hilfe
Publish Subscribe Scripts Broker Status Log
inTopic
Publish
/dev/cu.usbserial-DN012H7U
Senden
Publish message: {"value" : "hello world #82"}
Publish message: {"value" : "hello world #83"}
Publish message: {"value" : "hello world #84"}
Publish message: {"value" : "hello world #85"}
Publish message: {"value" : "hello world #86"}
Publish message: {"value" : "hello world #87"}
Publish message: {"value" : "hello world #88"}
Publish message: {"value" : "hello world #89"}
Publish message: {"value" : "hello world #90"}
Publish message: {"value" : "hello world #91"}
Publish message: {"value" : "hello world #92"}
Publish message: {"value" : "hello world #93"}
Publish message: {"value" : "hello world #94"}
Publish message: {"value" : "hello world #95"}
Publish message: {"value" : "hello world #96"}
Autoscroll
Kein Zeilenende
115200 Baud
mqtt_esp8266-cg | Arduino 1.6.11
mqtt_esp8266-cg
#include <ESP8266WiFi.h>
#include <PubSubClient.h>
// Update these with values suitable for your network.
const char* ssid = "DIGILIFE-01";
const char* password = "#digilife@2015";
const char* mqtt_server ="192.168.1.184";
WiFiClient espClient;
PubSubClient client(espClient);
long lastMsg = 0;
char msg[50];
int value = 0;
void setup_wifi() {
delay(10);
// We start by connecting to a WiFi network
Serial.println();
Serial.print("Connecting to ");
Hochladen abgeschlossen.
closing bootloader
Ungültige Bibliothek /Users/Marisa/Documents/Arduino/libraries/__pycache__
Ungültige Bibliothek /Users/Marisa/Documents/Arduino/libraries/__pycache__


HiveMQ | Public Broker | MQTT Dashboard
Broker
Outgoing Messages
67844454
Incoming Messages
33386219
Subscriptions
2630
Retained Messages
547
mqtt_esp8266-cg | Arduino 1.6.11
Topic: /json


HiveMQ | Public Broker | MQTT Dashboard
Broker
Outgoing Messages
67852270
Incoming Messages
33390041
Subscriptions
2636
Retained Messages
547
mqtt_esp8266-cg | Arduino 1.6.11
Topic: procodecg/procodecgproject/data



Testing MQTT Server

In separate terminal windows do the following:

1. Start the broker:

   mosquitto

2. Start the command line subscriber:

   mosquitto_sub -v -t 'test/topic'

3. Publish test message with the command line publisher:

   mosquitto_pub -t 'test/topic' -m 'helloWorld'

As well as seeing both the subscriber and publisher connection messages in the broker terminal the following should be printed in the subscriber terminal:

test/topic helloWorld

3.2.2 ESPectro LIBRARY – LEDByCloud

3.3 TRAFFIC LIGHT MQTT

```
#include <Adafruit_NeoPixel.h>
#include <ESP8266WiFi.h>
#include <PubSubClient.h>

#define PIN            15
#define NUMPIXELS      1
```

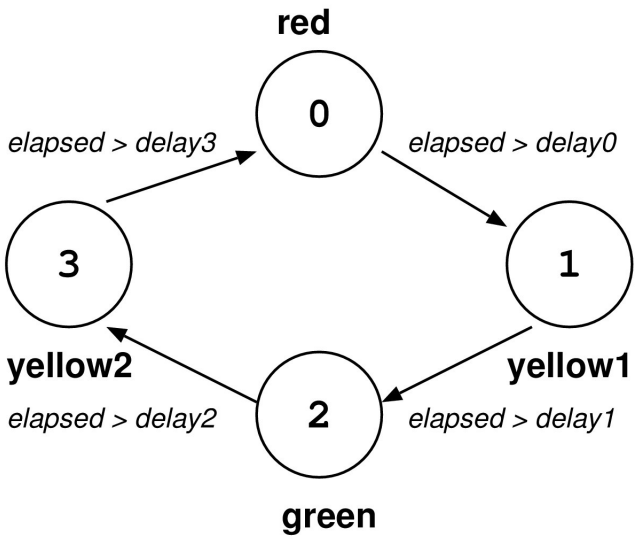
```
const char* ssid = "procodecg";
const char* password = "12345678";
//const char* mqtt_server = "broker.mqtt-dashboard.com";
//const char* mqtt_server = "192.168.1.118";
const char* mqtt_server = "192.168.1.101";

Adafruit_NeoPixel pixels = Adafruit_NeoPixel(NUMPIXELS, PIN, NEO_GRB
+ NEO_KHZ800);
int delayval = 1000;
int i=0;



WiFiClient espClient;
PubSubClient client(espClient);
long lastMsg = 0;
char msg[50];
int value = 0;

void setup_wifi() {

  delay(10);
  // We start by connecting to a WiFi network
  Serial.println();
  Serial.print("Connecting to ");
  Serial.println(ssid);

  WiFi.begin(ssid, password);

  while (WiFi.status() != WL_CONNECTED) {
    delay(500);
    Serial.print("x");
  }

  randomSeed(micros());

  Serial.println("");
  Serial.println("WiFi connected");
  Serial.println("IP address: ");
  Serial.println(WiFi.localIP());
}
```

```
void callback(char* topic, byte* payload, unsigned int length) {
  Serial.print("Message arrived [");
  Serial.print(topic);
  Serial.print("] ");
  for (int i = 0; i < length; i++) {
    Serial.print((char)payload[i]);
  }
  Serial.println();

  // Switch on the LED if an 1 was received as first character
  if ((char)payload[0] == '0') {
    digitalWrite(BUILTIN_LED, LOW);   // Turn the LED on (Note that
LOW is the voltage level
    // but actually the LED is on; this is because
    // it is acive low on the ESP-01)
  } else {
    digitalWrite(BUILTIN_LED, HIGH);  // Turn the LED off by making
the voltage HIGH
  }

}

void reconnect() {
  // Loop until we're reconnected
  while (!client.connected()) {
    Serial.print("Attempting MQTT connection...");
    // Create a random client ID
    String clientId = "ESP8266Client-";
    clientId += String(random(0xffff), HEX);
    // Attempt to connect
    if (client.connect(clientId.c_str())) {
      Serial.println("connected");
      // Once connected, publish an announcement...
//      client.publish("outTopic", "hello world");
      // ... and resubscribe
      client.subscribe("led1");
    } else {
      Serial.print("failed, rc=");
      Serial.print(client.state());
      Serial.println(" try again in 5 seconds");
      // Wait 5 seconds before retrying
```

```
      delay(5000);
    }
  }
}


void setup() {
  pixels.begin(); // This initializes the NeoPixel library.
  Serial.begin(9600);
  setup_wifi();
  client.setServer(mqtt_server, 1883);
  client.setCallback(callback);
}

void loop() {
  if (!client.connected()) {
    reconnect();
  }
  client.loop();


    // red
    client.publish("led1", "red");
    pixels.setPixelColor(0, pixels.Color(63,0,0));
    pixels.show();
    delay(3000);


    client.publish("led1", "yellow");
    for (i=0; i<5; i++) {
      // yellow
      pixels.setPixelColor(0, pixels.Color(63,63,0)); pixels.show();
delay(500);
      // blank
      pixels.setPixelColor(0, pixels.Color(0,0,0)); pixels.show();
delay(500);
    }

    // green
    client.publish("led1", "green");
    pixels.setPixelColor(0, pixels.Color(0,63,0));
```

```
    pixels.show();
    delay(3000);



    client.publish("led1", "yellow");
    for (i=0; i<3; i++) {
      // orange
      pixels.setPixelColor(0, pixels.Color(63,40,0)); pixels.show();
delay(500);
      // blank
      pixels.setPixelColor(0, pixels.Color(0,0,0)); pixels.show();
delay(500);
    }
}
```

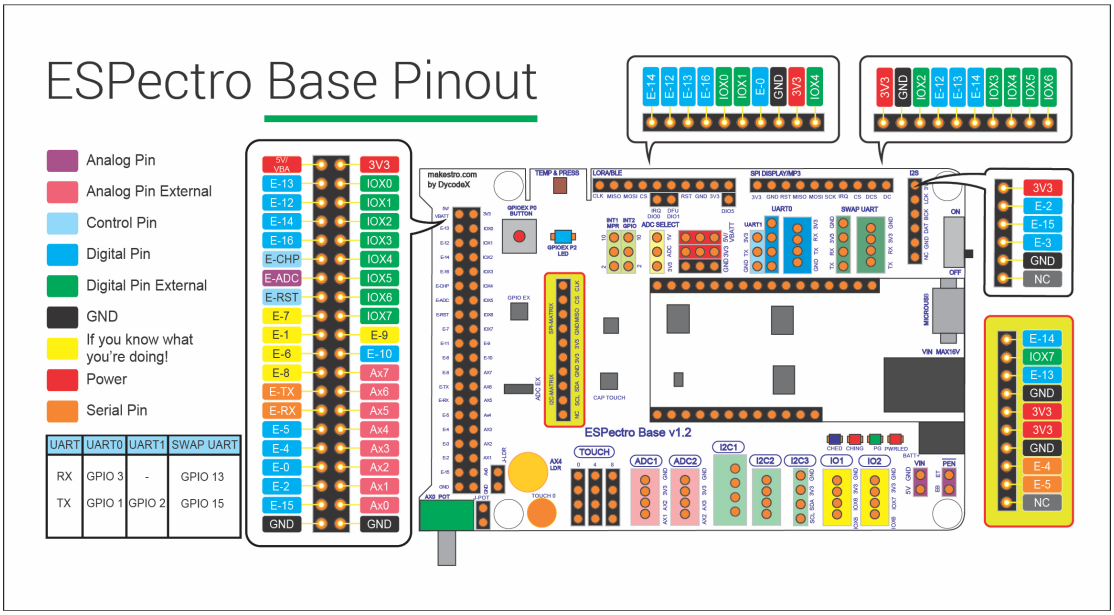
3.4 TRAFFIC LIGHT FSM




```
/* traffic light with FSM */
/* Budi Rahardjo @rahard 2017 */

#include <Adafruit_NeoPixel.h>
#define PIN 15
#define NUMPIXELS 1

Adafruit_NeoPixel pixels = Adafruit_NeoPixel(NUMPIXELS, PIN, NEO_GRB
+ NEO_KHZ800);
int state=0; // 0=red, 1=yellow1, 2=green; 3=yellow2
int delay0=3000;
int delay1=1000;
int delay2=3000;
int delay3=2000;
unsigned long lastTime=0;
unsigned long elapsed=0;

void setup() {
  pixels.begin();
  state=1; // start with red
  lastTime = millis(); //
  Serial.begin(9600);
}

void loop() {
  elapsed = millis() - lastTime;
  // if red -> yellow1
```

```
  if ((state==0) && (elapsed > delay0)) {
    state=1;
    lastTime = millis();
    elapsed=0;
    pixels.setPixelColor(0, 63, 30, 0);
    pixels.show();
    Serial.println("yellow1");
  }
  // yellow1 -> green
  if ((state==1) && (elapsed > delay1)) {
    state=2;
    lastTime = millis();
    elapsed=0;
    pixels.setPixelColor(0, 0, 63, 0);
    pixels.show();
    Serial.println("green");
  }
  // green -> yellow2
  if ((state==2) && (elapsed > delay2)) {
    state=3;
    lastTime = millis();
    elapsed=0;
    pixels.setPixelColor(0, 63, 30, 0);
    pixels.show();
    Serial.println("yellow2");
  }
  // yellow2 -> red
  if ((state==3) && (elapsed > delay3)) {
    state=0;
    lastTime = millis();
    elapsed=0;
    pixels.setPixelColor(0, 63, 0, 0);
    pixels.show();
    Serial.println("red");
  }
  Serial.println("unknown state");
}
```

4 ESPECTRO BASE



4.1 POTENTIOMETER

CODE:

```
/*
  Getting started with on-board ADC on ESPectro Base.
  This sketch demoes how to read analog value from on-board
potentiometer

  Created by 22 Sep 2016
  by Andri Yadi
*/

#include <ESPectroBase.h>

ESPectroBase base;

int lastAdcPot = 0;

// the setup function runs once when you press reset or power the
board
void setup() {
    Serial.begin(115200);
    //Wait Serial to be ready
```

```
    while (!Serial);

    //Should explicitely call this to activate ADC
    base.beginADC();
}

// the loop function runs over and over again forever
void loop() {
    int pot = base.analogRead(ESPECTRO_BASE_ADC_POT_CHANNEL);
    if (pot != -1 && abs(pot - lastAdcPot) > 10) {
        lastAdcPot = pot;
        Serial.printf("Pot value: %d\r\n", pot);
    }

    delay(500);
}
```

4.2 LDR

CODE:

```
/*
  Getting started with on-board ADC on ESPectro Base.
  This sketch demoes how to read analog value from on-board LDR

  Created by 22 Sep 2016
  by Andri Yadi
*/

#include <ESPectro.h>
#include <ESPectroBase.h>

ESPectro board;
ESPectroBase base;

int lastAdcLdr = 0;
const int LED_THRESHOLD = 500;
```

```
// the setup function runs once when you press reset or power the
board
void setup() {
    Serial.begin(115200);
    //Wait Serial to be ready
    while (!Serial);

    //Should explicitely call this to activate ADC
    base.beginADC();
}

// the loop function runs over and over again forever
void loop() {
    int ldr = base.analogRead(ESPECTRO_BASE_ADC_LDR_CHANNEL);
    if (ldr != -1 && abs(ldr - lastAdcLdr) > 10) {
        lastAdcLdr = ldr;
        Serial.printf("Pot value: %d\r\n", ldr);

        if (ldr < LED_THRESHOLD) {
            board.turnOnLED();
        }
        else {
            board.turnOffLED();
        }
    }

    delay(500);
}
```