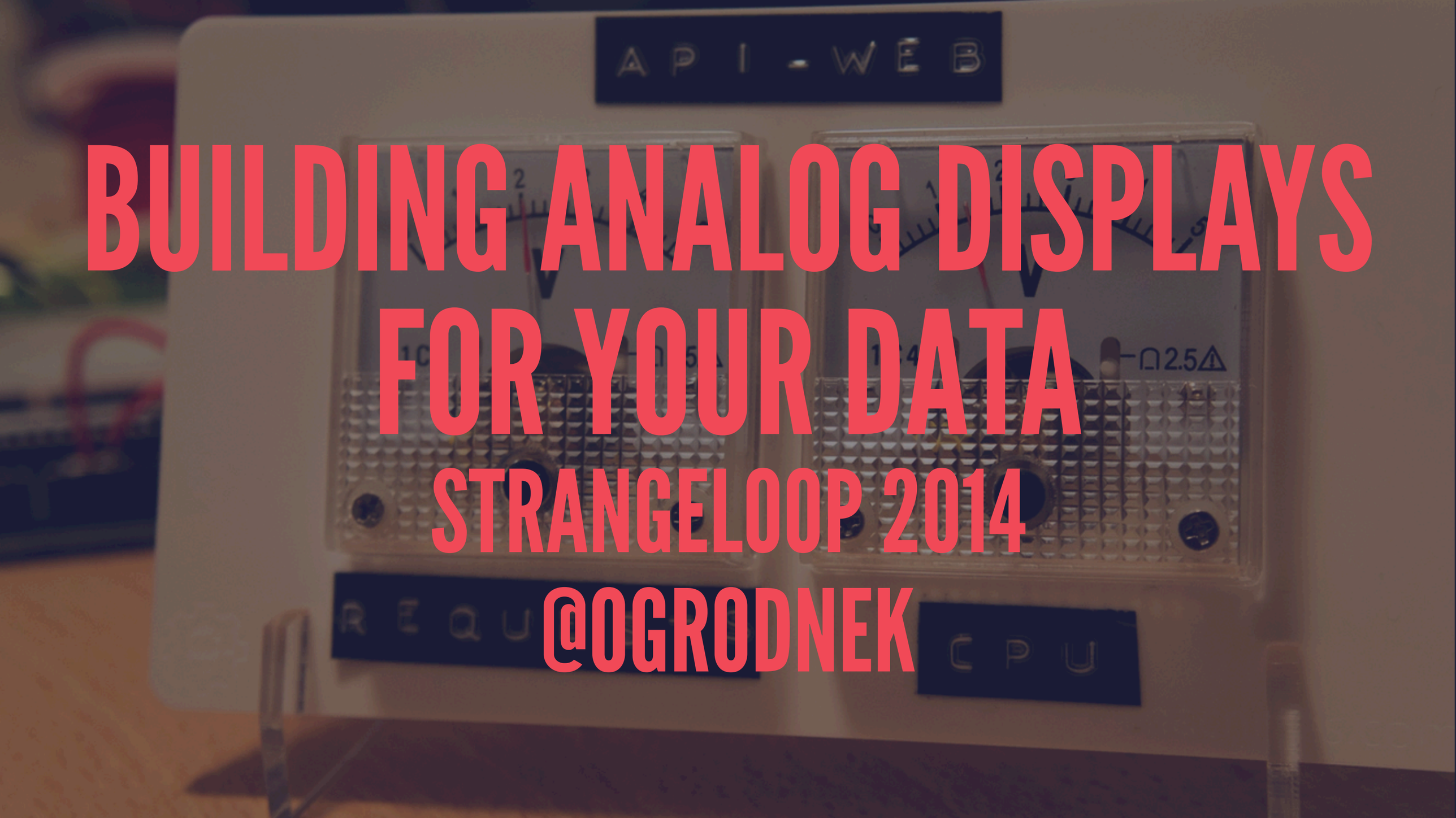


BUILDING ANALOG DISPLAYS FOR YOUR DATA

STRANGELOOP 2014

@OGRODNEK

WHY?

fun!
engaging!
becomes part of your environment!
learn surprising things!
use other senses!
constraints drive creativity!

GOALS

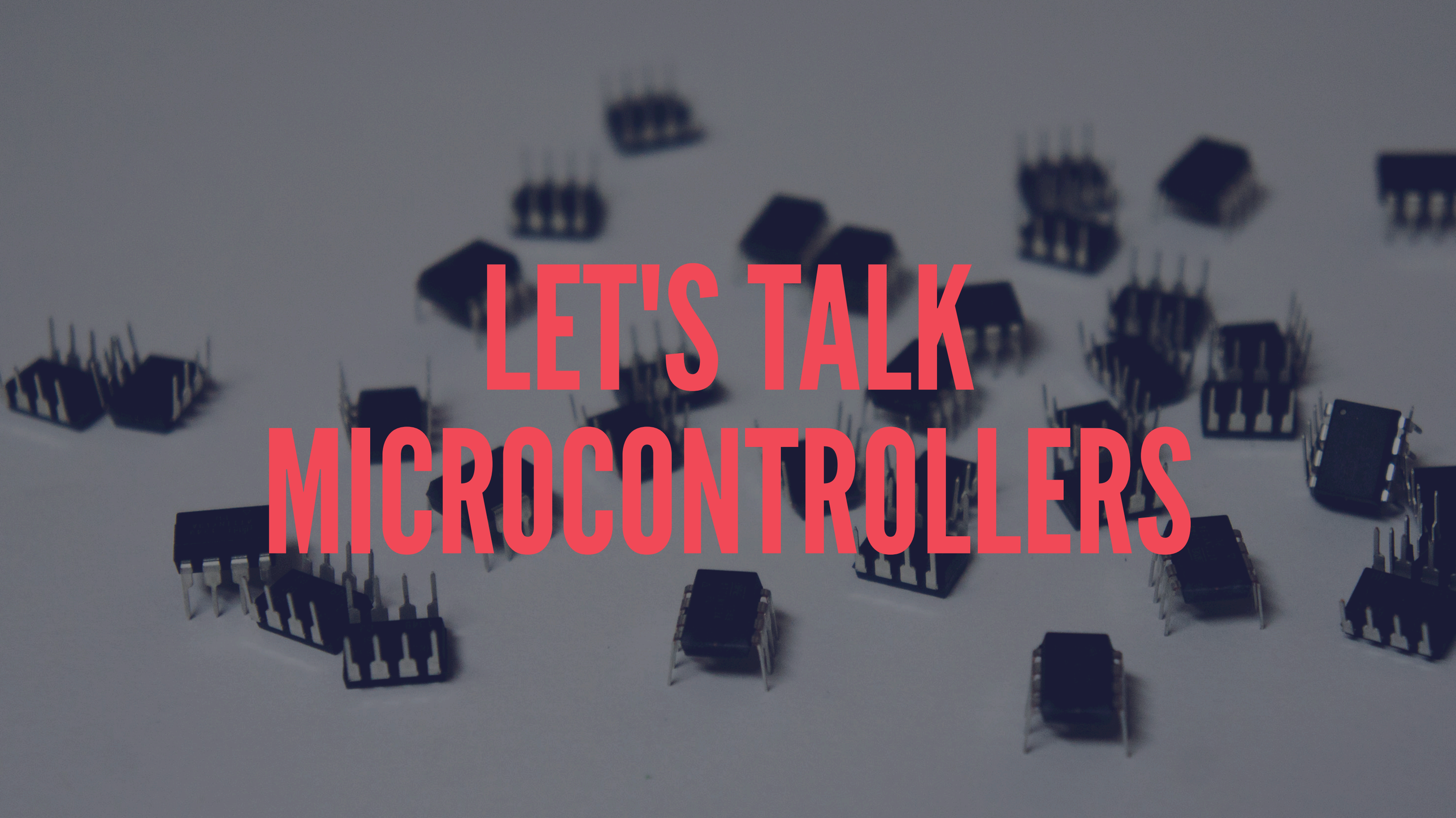
- Inspire you to create your own analog displays
- Convince you it's *easy*!
- Give you a starting point

AGENDA

- hardware platforms overview/intro
- cover analog metric display projects
- next steps

PLATFORMS

- arduino
- spark core
- raspberry pi

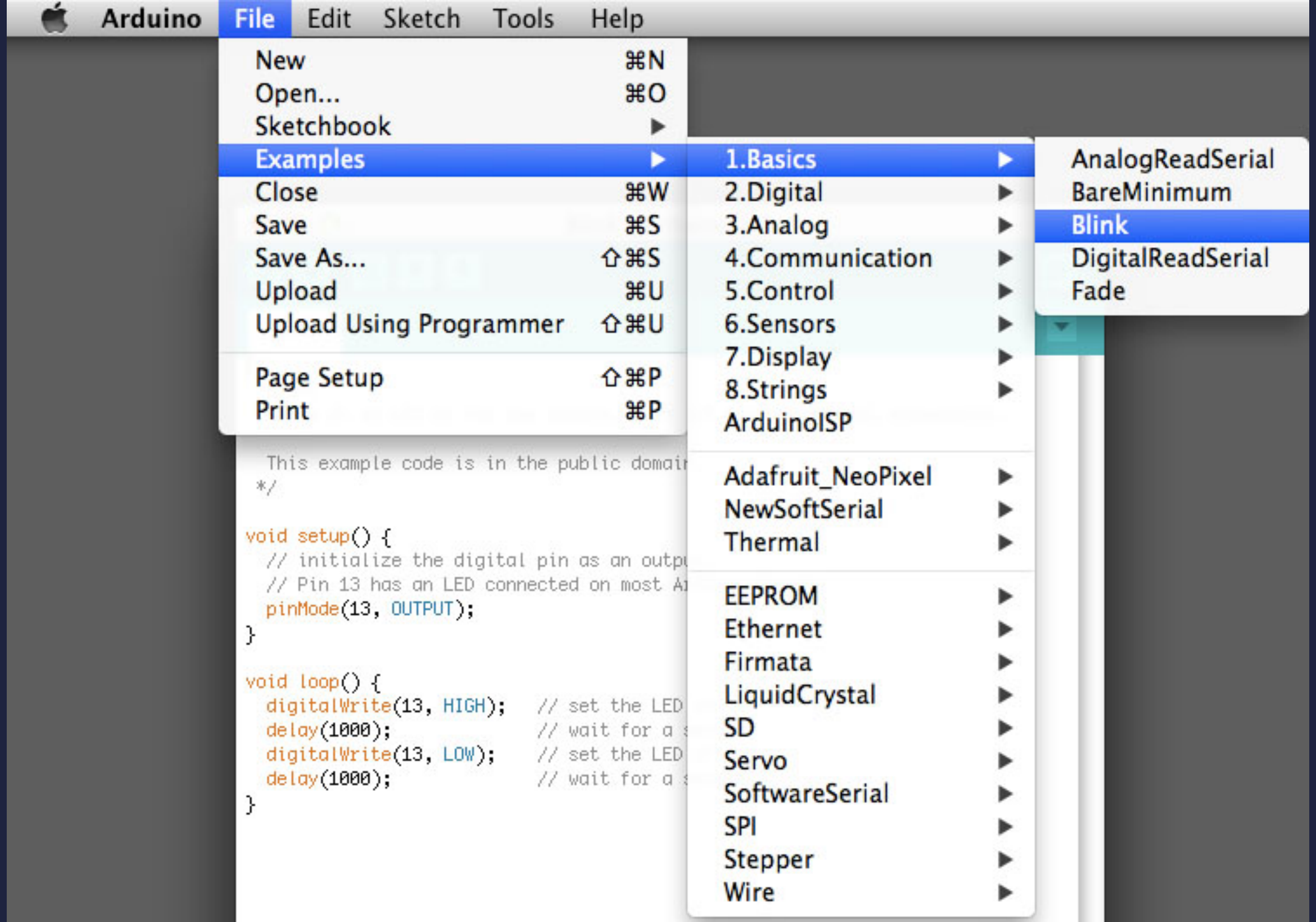

LET'S TALK
MICROCONTROLLERS


MADE
IN ITALY
AREF
GND
13
12
~11
~10
~9
8
7
~6
~5
4
~3
2
TX→1
RX←0
DIGITAL (PWM~)
L
TX
RX
ARDUINO
UNO
ON
RESET-EN
ICSP
RESET
POWER
RESET
3.3V
5V
GND
GND
Vin
ANALOG IN
A0
A1
A2
A3
A4
A5
WWW.ARDUINO.CC
ATMEGA328P-PU
ARDUINO


HELLO WORLD
DIGITAL (PWM~)
ARDUINO
UNO
ON
ANALOG IN

BLINK!

```
int led = 13; // Pin 13 has an LED connected on most Arduino boards.

// the setup routine runs once when you press reset:
void setup() {
  pinMode(led, OUTPUT);    // initialize the digital pin as an output.
}

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


Arduino
File
Edit
Sketch
Tools
Help
New ⌘N
Open... ⌘O
Sketchbook
Examples
Close ⌘W
Save ⌘S
Save As... ⇧⌘S
Upload ⌘U
Upload Using Programmer ⇧⌘U
Page Setup ⇧⌘P
Print ⌘P
1.Basics
2.Digital
3.Analog
4.Communication
5.Control
6.Sensors
7.Display
8.Strings
ArduinoISP
Adafruit_NeoPixel
NewSoftSerial
Thermal
EEPROM
Ethernet
Firmata
LiquidCrystal
SD
Servo
SoftwareSerial
SPI
Stepper
Wire
AnalogReadSerial
BareMinimum
Blink
DigitalReadSerial
Fade
This example code is in the public domain
*/
void setup() {
// initialize the digital pin as an output
// Pin 13 has an LED connected on most Arduino boards
pinMode(13, OUTPUT);
}
void loop() {
digitalWrite(13, HIGH); // set the LED
delay(1000); // wait for a second
digitalWrite(13, LOW); // set the LED
delay(1000); // wait for a second
}

COMMUNICATION

Arduino has built-in USB serial

ethernet, wifi, bluetooth possible

FIRMATA

Generic protocol for communicating with microcontrollers.

Client and device libraries

Makes it very easy to create 'dumb' devices.

Great for prototyping!

PYFIRMATA

https://github.com/tino/pyFirmata

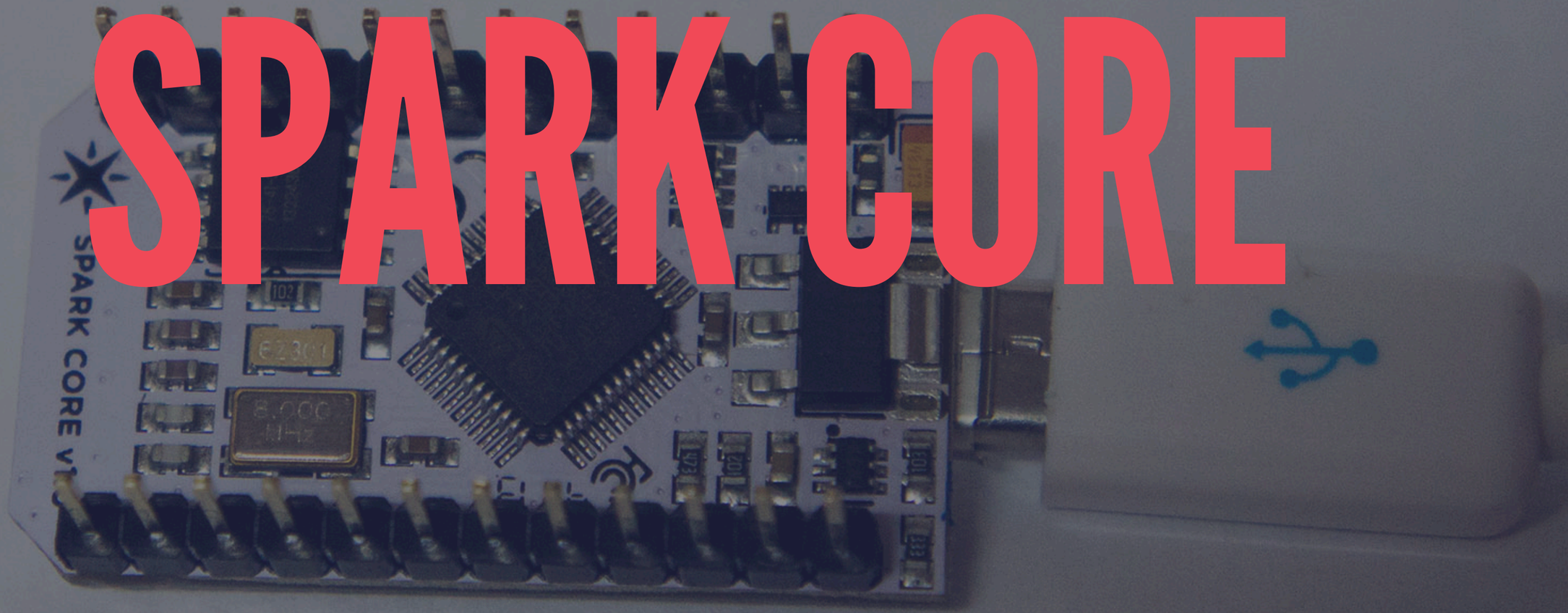
```
from pyfirmata import Arduino
import time

arduino = Arduino('/dev/tty.usbmodem1421')
led = arduino.get_pin('d:13:o')

while True:
  led.write(1)
  time.sleep(1)

  led.write(0)
  time.sleep(1)
```

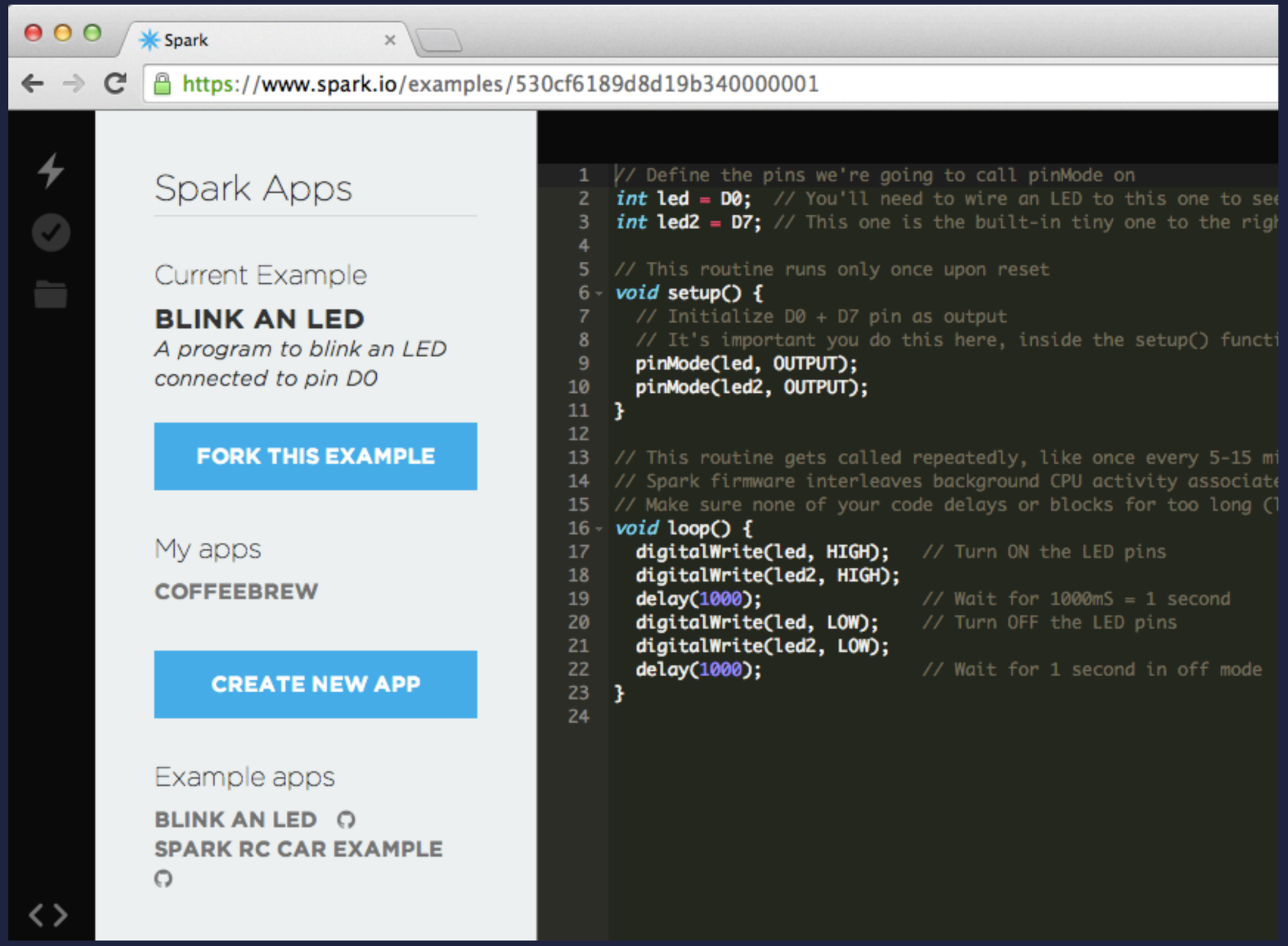
NOW YOU KNOW

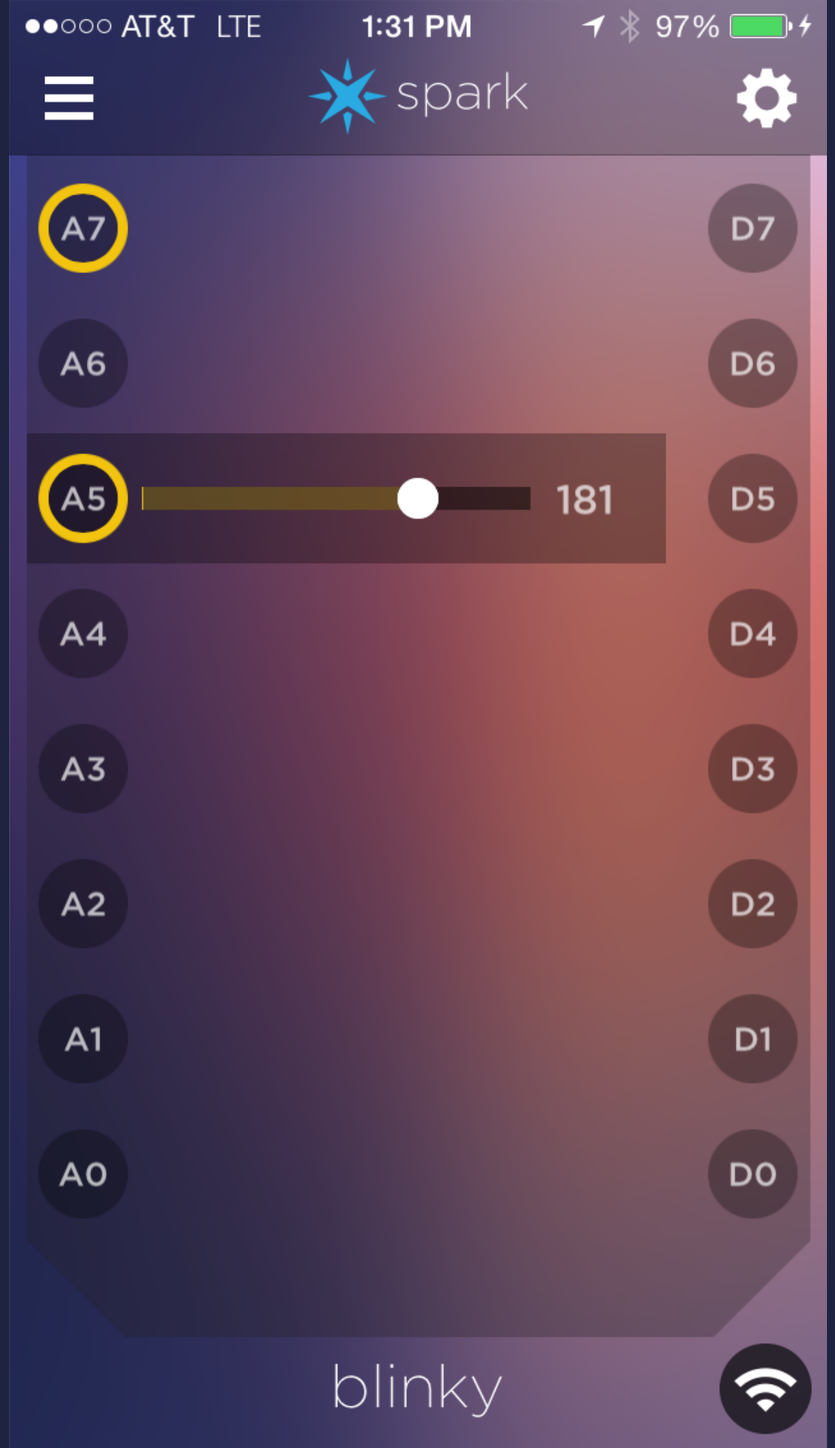
- how to blink an LED on an arduino
- how to make your computer tell the arduino to blink an LED

Go out and make a display!

SPARK CORE




Spark
https://www.spark.io/examples/530cf6189d8d19b340000001
Spark Apps
Current Example
BLINK AN LED
A program to blink an LED connected to pin D0
FORK THIS EXAMPLE
My apps
COFFEEBREW
CREATE NEW APP
Example apps
BLINK AN LED
SPARK RC CAR EXAMPLE
// Define the pins we're going to call pinMode on
int led = D0; // You'll need to wire an LED to this one to see
int led2 = D7; // This one is the built-in tiny one to the right
// This routine runs only once upon reset
void setup() {
// Initialize D0 + D7 pin as output
// It's important you do this here, inside the setup() functi
pinMode(led, OUTPUT);
pinMode(led2, OUTPUT);
}
// This routine gets called repeatedly, like once every 5-15 mi
// Spark firmware interleaves background CPU activity associate
// Make sure none of your code delays or blocks for too long (1
void loop() {
digitalWrite(led, HIGH); // Turn ON the LED pins
digitalWrite(led2, HIGH);
delay(1000); // Wait for 1000mS = 1 second
digitalWrite(led, LOW); // Turn OFF the LED pins
digitalWrite(led2, LOW);
delay(1000); // Wait for 1 second in off mode
}


●●○○○ AT&T LTE
1:31 PM
97%
spark
A7
D7
A6
D6
A5
181
D5
A4
D4
A3
D3
A2
D2
A1
D1
A0
D0
blinky

SPARK CORE REMOTE BLINK

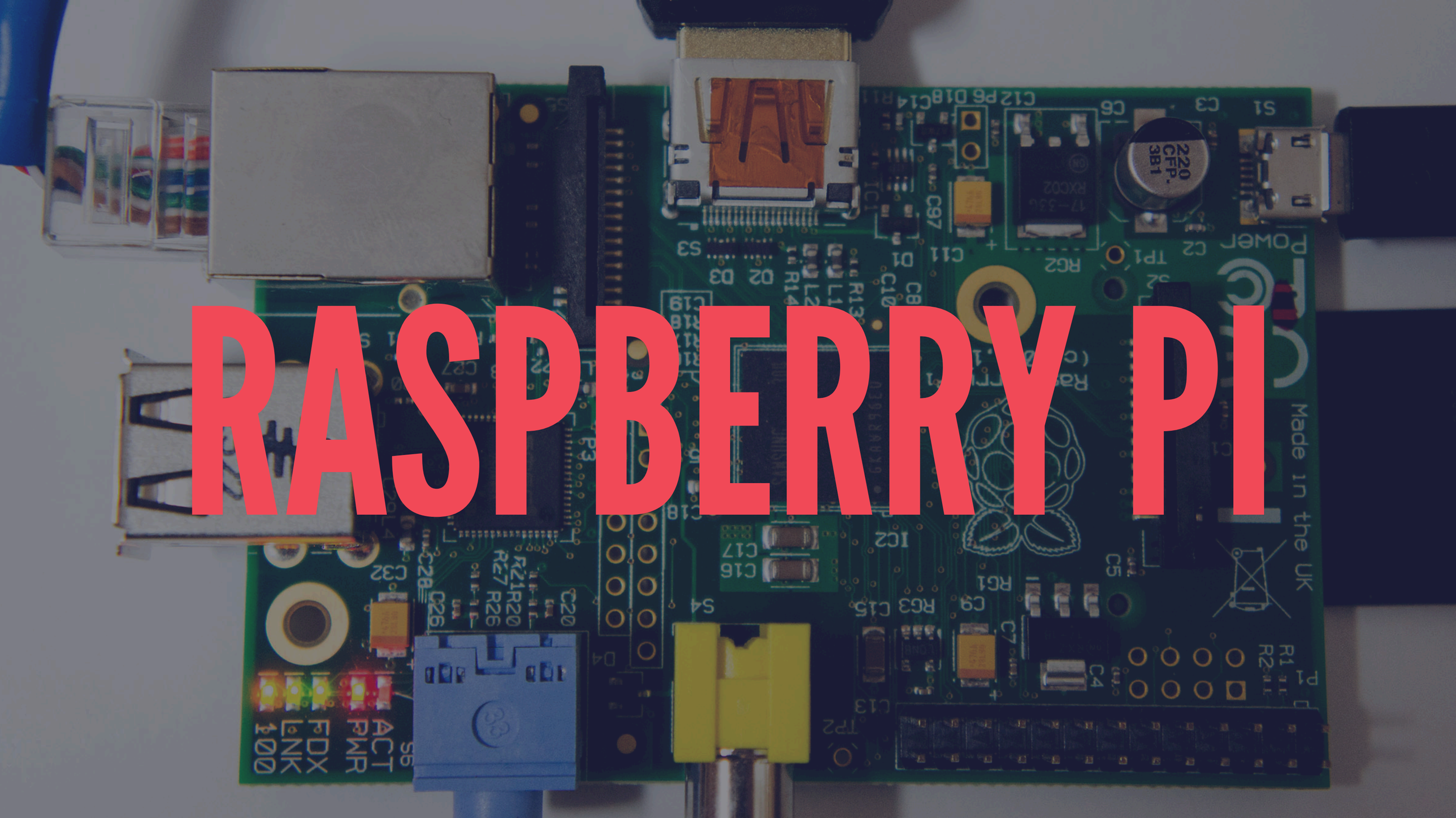
```
$ DEVICE="7adca5b8743743d0b4d257d0"
$ TOKEN="1eda6e8c08044613b8b5b29ce13a01e0"
$ curl https://api.spark.io/v1/devices/$DEVICE/digitalwrite \
>    -d access_token=$TOKEN \
>    -d params=D7,HIGH
{
  "id": "7adca5b8743743d0b4d257d0",
  "name": "blinky",
  "last_app": null,
  "connected": true,
  "return_value": 1
}
```

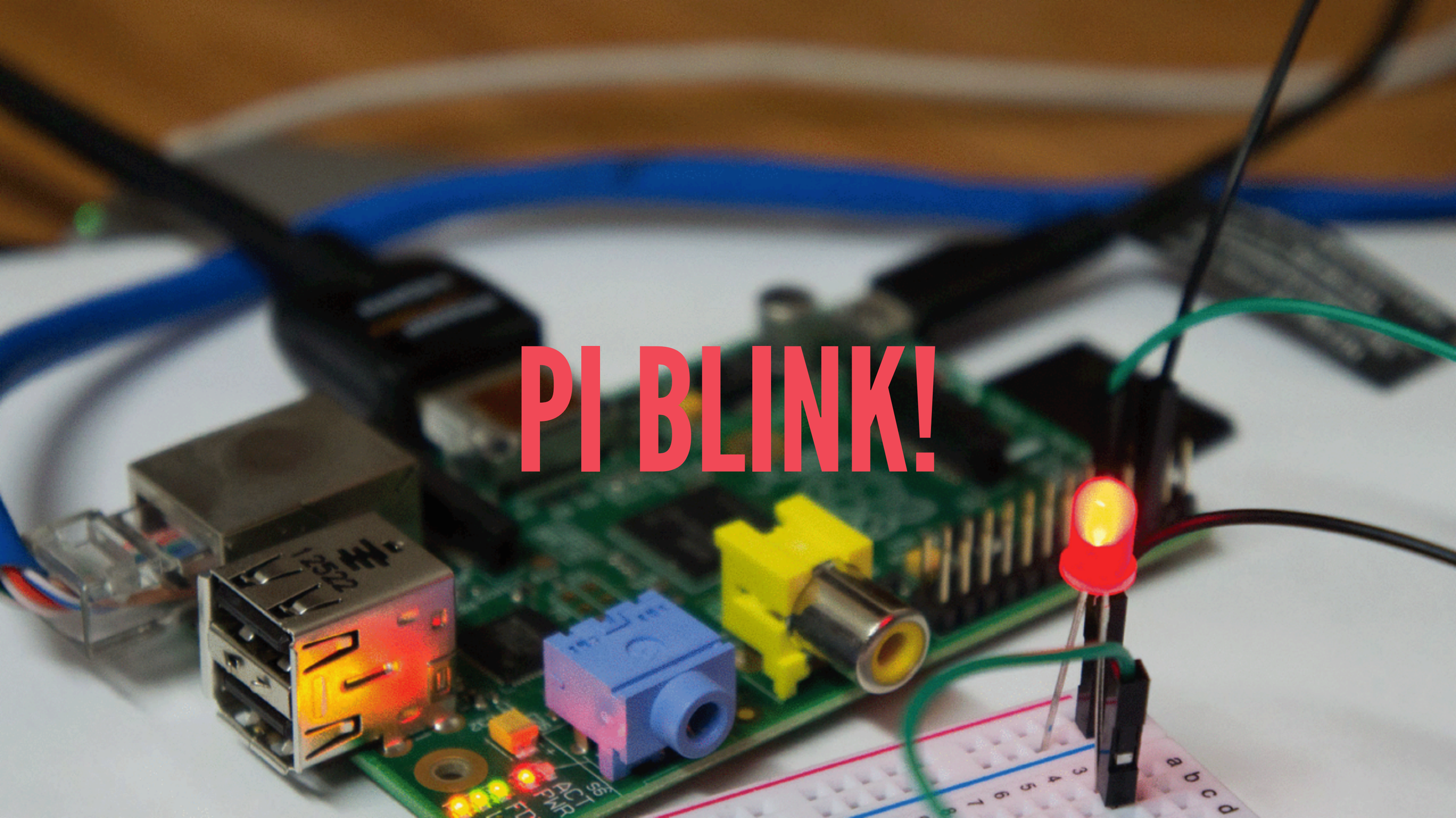
SPARK CORE CUSTOM FUNCTIONS

```
int brewCoffee(String command);

void setup() {
  Spark.function("brew", brewCoffee); // register
}

void loop() { }

// this function gets called upon a matching POST request
int brewCoffee(String command) {
  if (command == "coffee") {
    // do something here...
    return 1;
  }
  else return -1;
}
```

LET'S BREW!

```
$ curl https://api.spark.io/v1/devices/$DEVICE/brew \
>    -d access_token=$TOKEN \
>    -d params=coffee
{
  "id": "7adca5b8743743d0b4d257d0",
  "name": "blinky",
  "last_app": null,
  "connected": true,
  "return_value": 1
}
```


RASPBERRY PI


PI BLINK!

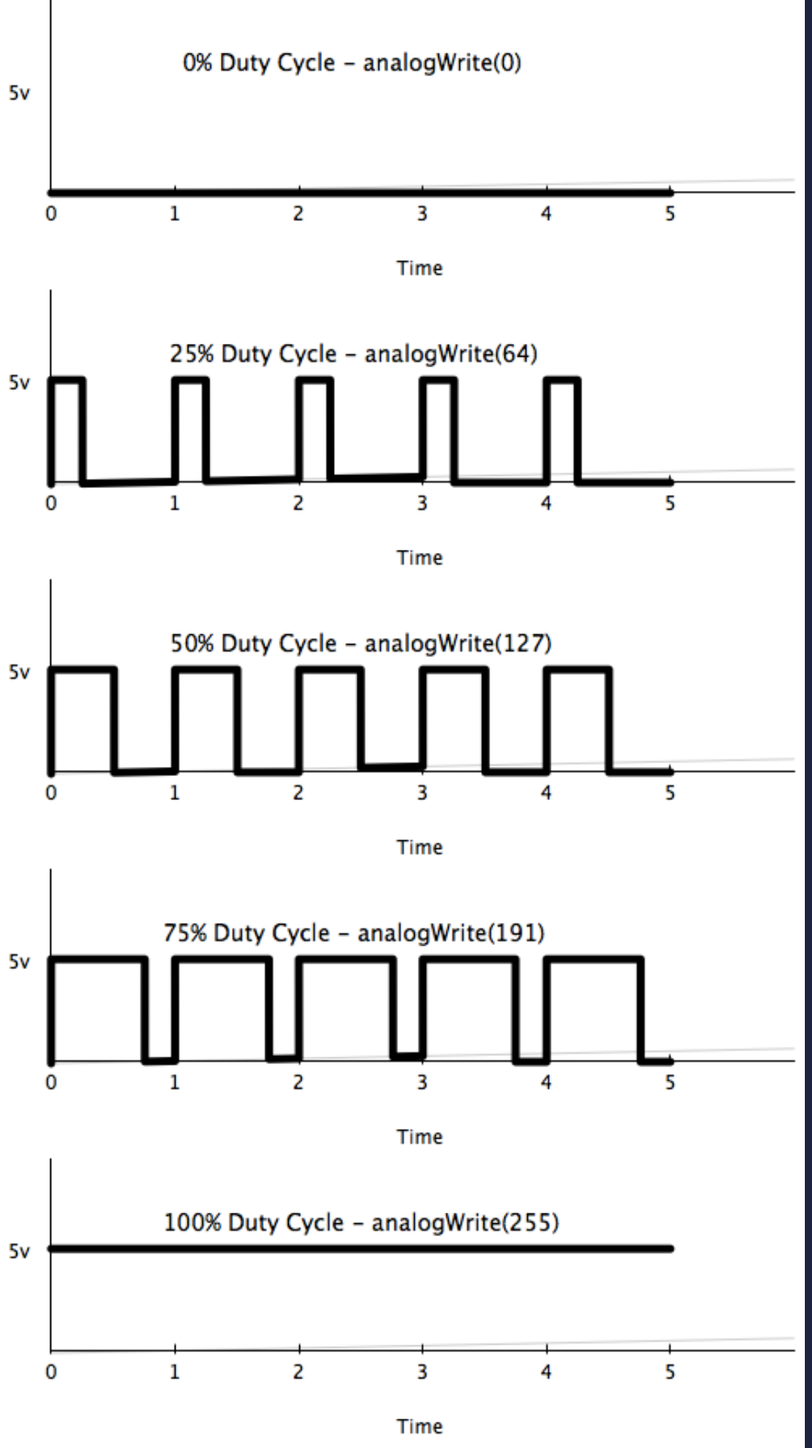
BLINK CODE

```
import RPi.GPIO as GPIO
import time

GPIO.setmode(GPIO.BOARD)
GPIO.setup(7, GPIO.OUT)

while True:
    GPIO.output(7, True)
    time.sleep(1)
    GPIO.output(7, False)
    time.sleep(1)
```

LET'S TALK DISPLAYS!

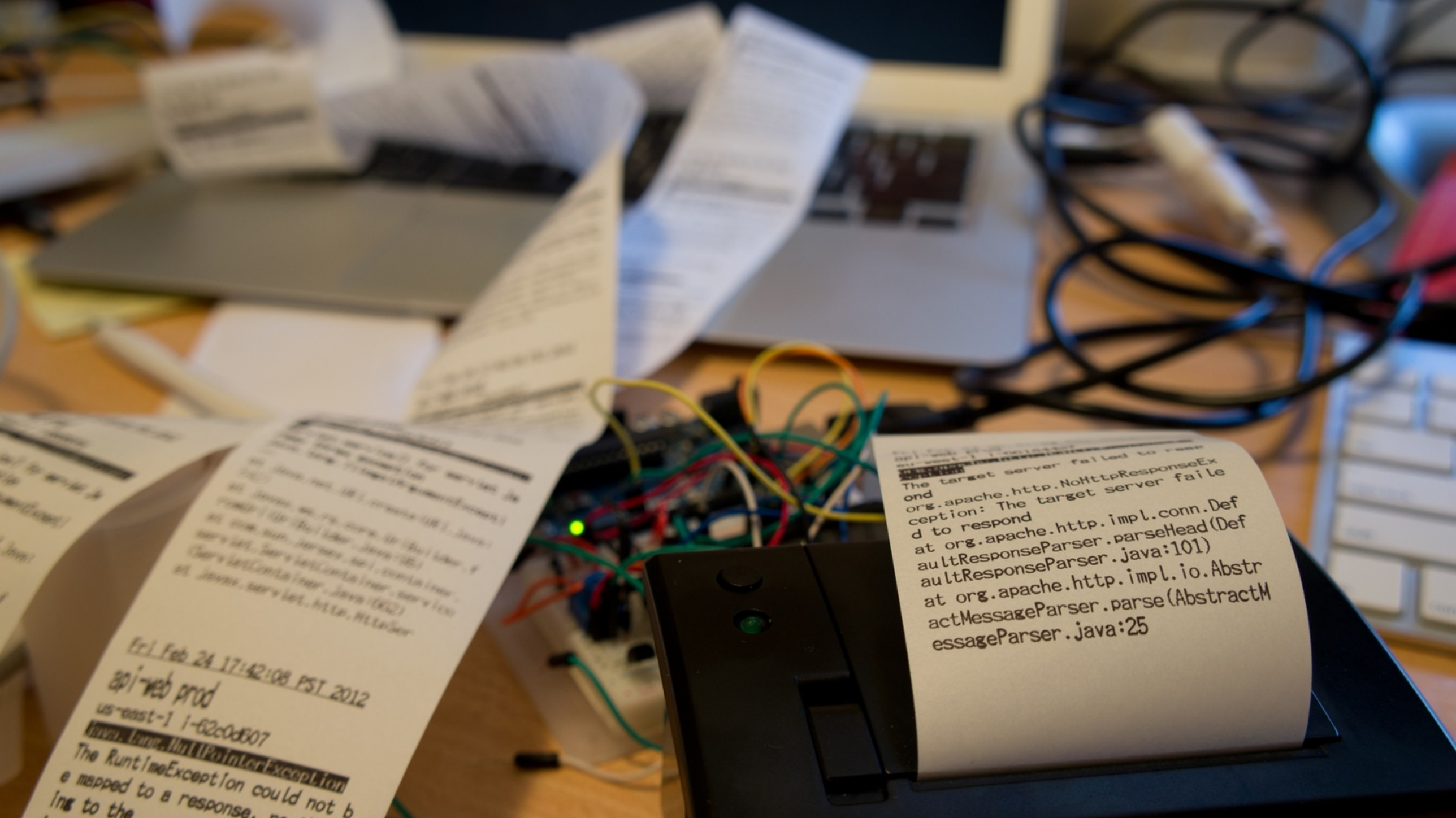

BIZOGRAPHER
0 1 2 3 4 5
V
91C4
⎓2.5⚠
REQUESTS
0 1 2 3 4 5
V
91C4
⎓2.5⚠
CPU

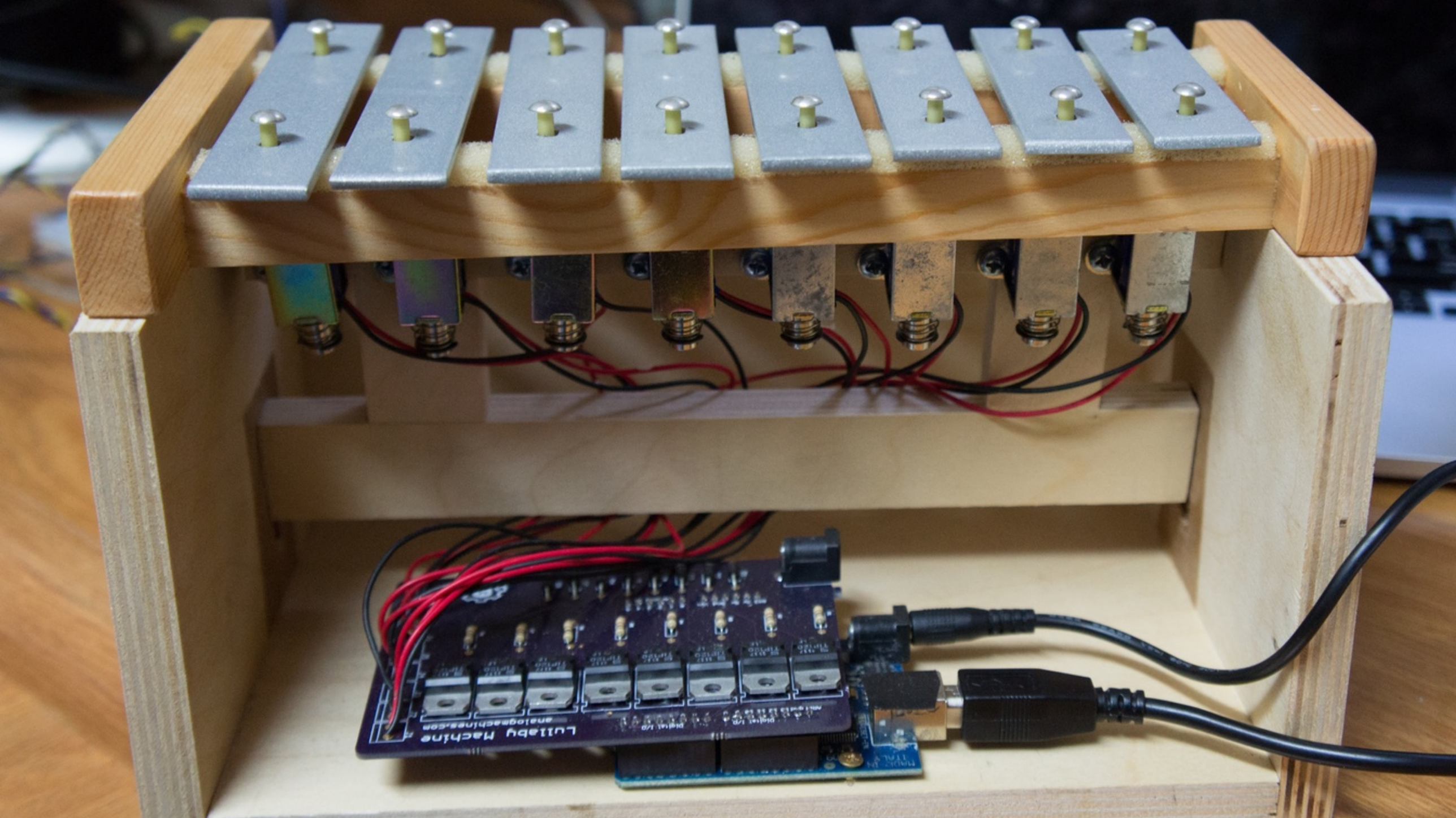
```
import boto.ec2.cloudwatch
from pyfirmata import Arduino

arduino = Arduino('/dev/tty.usbmodem1421')
cpu_pin = arduino.get_pin('d:5:p')

cw = boto.ec2.cloudwatch.connect_to_region("us-east-1")

def cpu_utilization(name):
  return cw.get_metric_statistics(60, .., ..,
    'CPUUtilization', 'AWS/EC2', 'Average',
      {'AutoScalingGroupName': name})[0]["Average"]

while True:
    cpu = cpu_utilization("my-group-name")
    cpu_pin.write(cpu / 100)

    time.sleep(10)
```

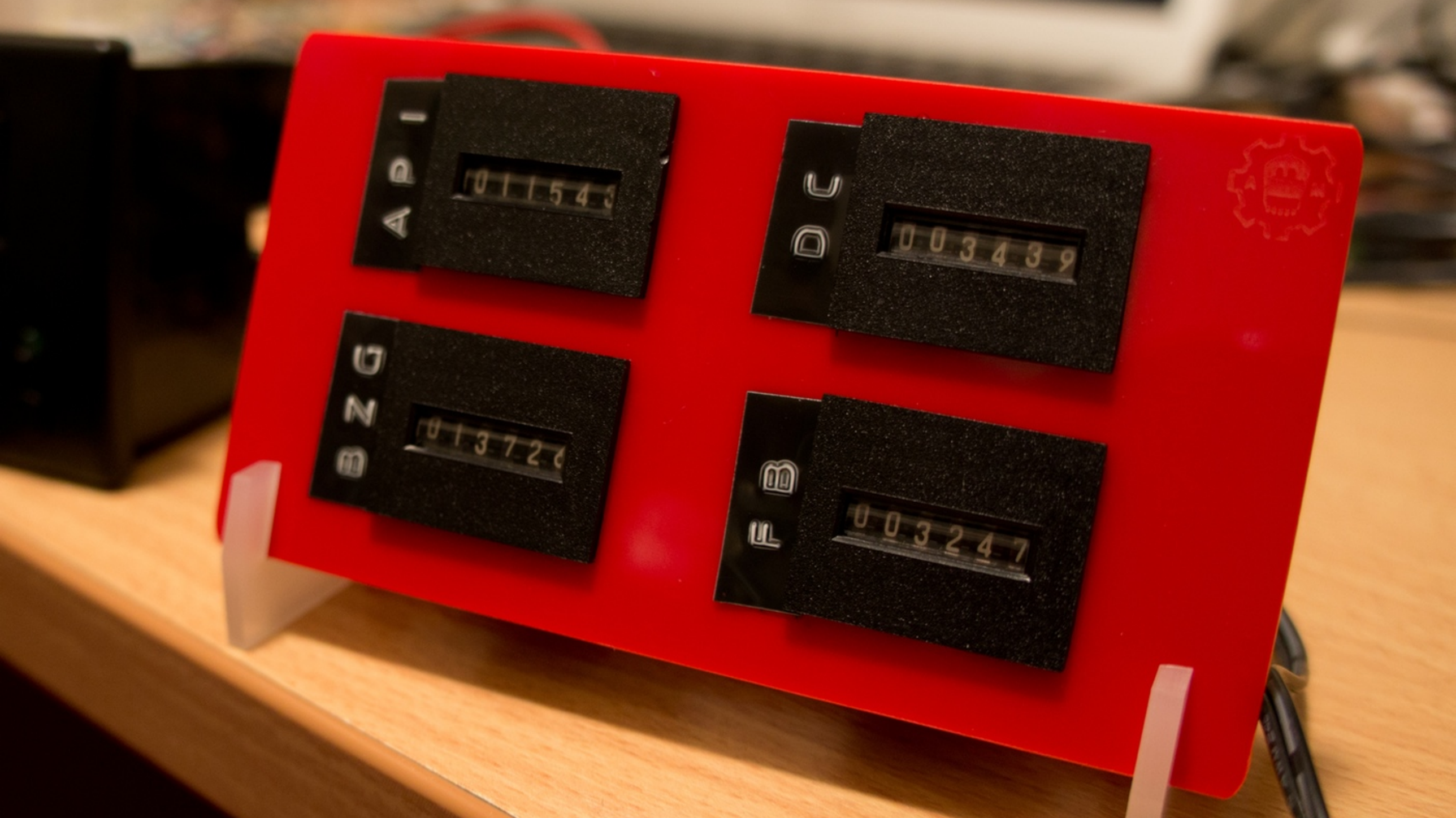

0% Duty Cycle – analogWrite(0)
5v
0
1
2
3
4
5
Time
25% Duty Cycle – analogWrite(64)
5v
0
1
2
3
4
5
Time
50% Duty Cycle – analogWrite(127)
5v
0
1
2
3
4
5
Time
75% Duty Cycle – analogWrite(191)
5v
0
1
2
3
4
5
Time
100% Duty Cycle – analogWrite(255)
5v
0
1
2
3
4
5
Time

```
import ...

GPIO.setmode(GPIO.BOARD)
GPIO.setup(7, GPIO.OUT)

cpuPin = GPIO.PWM(7, 50)
cpuPin.start(0)

cw = boto.ec2.cloudwatch.connect_to_region("us-east-1")

def cpu_utilization(name):
  return cw.get_metric_statistics(60, .., ..,
    'CPUUtilization', 'AWS/EC2', 'Average',
      {'AutoScalingGroupName': name})[0]["Average"]

while True:
    cpu = cpu_utilization("my-group")
    cpuPin.ChangeDutyCycle(cpu)
    time.sleep(10)
```

```
import ...

access_token = "abcde1234"

user = healthgraph.User(session=healthgraph.Session(access_token))
records = user.get_records()

url = 'https://api.spark.io/v1/devices/012345678/analogwrite'
spark_token = "x12345"

for t, recs in records.items():
    if t == "totals":
        val = recs["Running"]["THIS_WEEK"]
        scaled = (val / 10) * 255
        d = urllib.urlencode({'access_token': token, 'params' : "A0,%.0f" % scaled})
        content = urllib2.urlopen(url=url, data=d).read()
        print content
```


org.apache.http.NoHttpResponseEx
ception: The target server faile
d to respond
at org.apache.http.impl.conn.Def
aultResponseParser.parseHead(Def
aultResponseParser.java:101)
at org.apache.http.impl.io.Abstr
actMessageParser.parse(AbstractM
essageParser.java:25
Fri Feb 24 17:42:08 PST 2012
api-web prod
us-east-1 i-62c0d607
The RuntimeException could not b
e mapped to a response.


Lullaby Machine
analogmachines.com


A
0 1 1 5 4 3
U
0 0 3 4 3 9
N
0 1 3 7 2 6
M
0 0 3 2 4 7

FUTURE WORK?


J
K
L
M
O
P
delete
enter
return


MAGIC Etch A Sketch
1.22

NEXT STEPS

1. Get an Arduino
2. Blink an LED

SHOPPING LIST

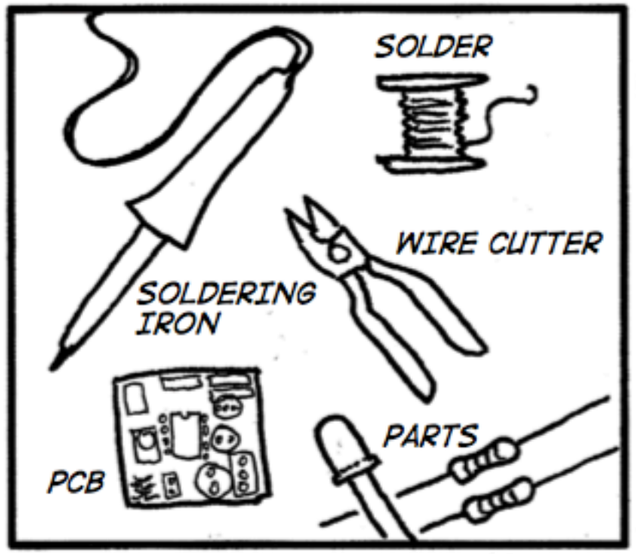
1. arduino/spark core/whatever
2. breadboard, jumper wires
3. LEDs! , meters , buttons
4. sensors
5. assorted resistors
6. multimeter?

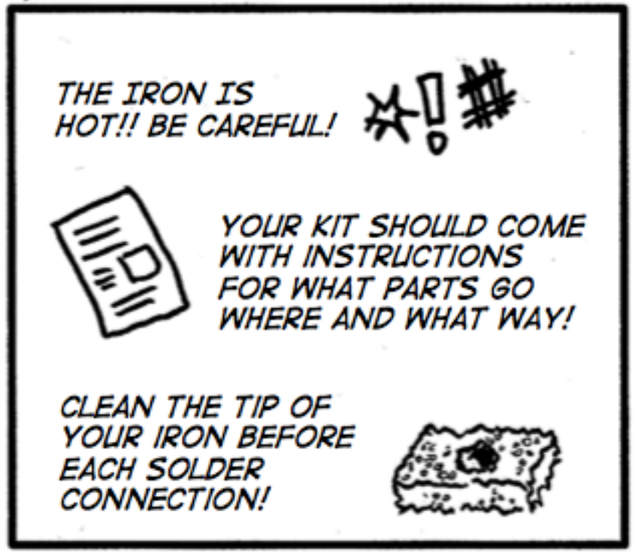
OUTFITTERS

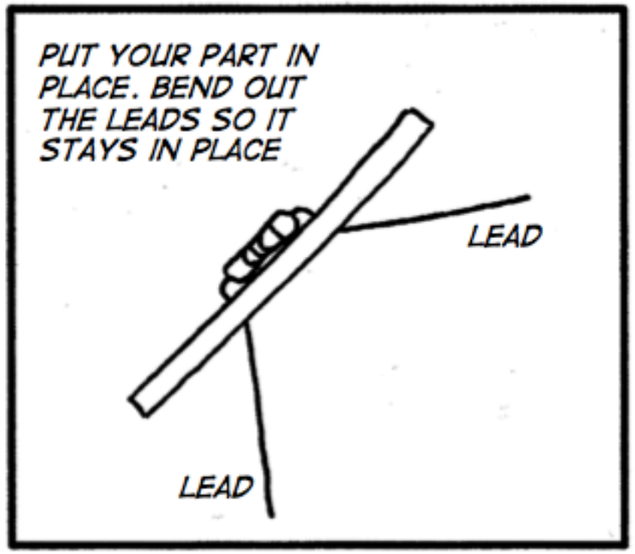
adafruit
sparkfun
evil mad scientist
mouser

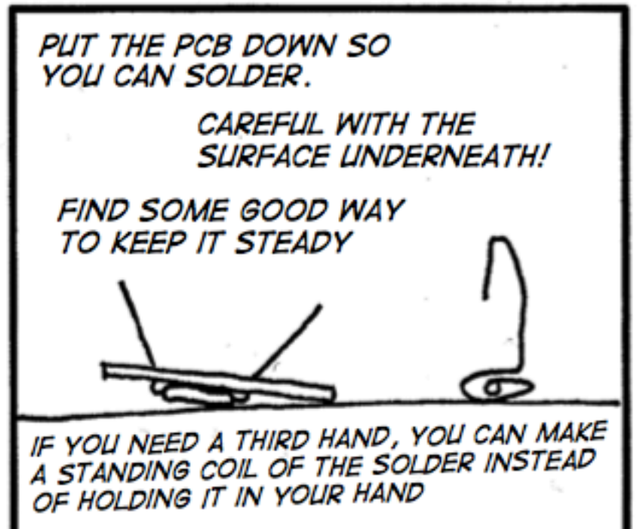
SOLDERING IS EASY

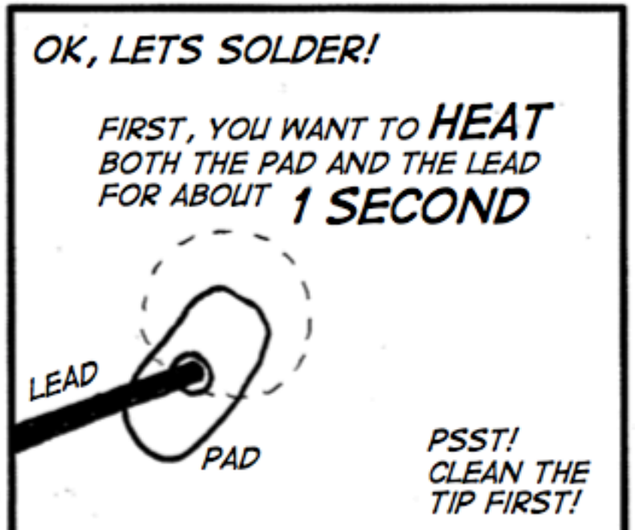
HERE'S HOW TO DO IT

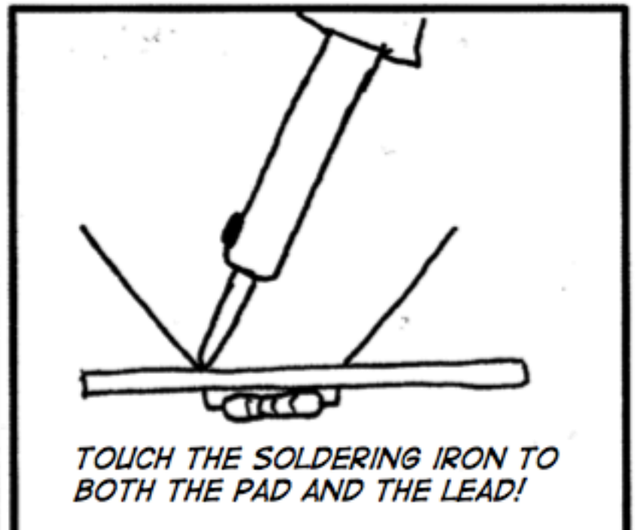


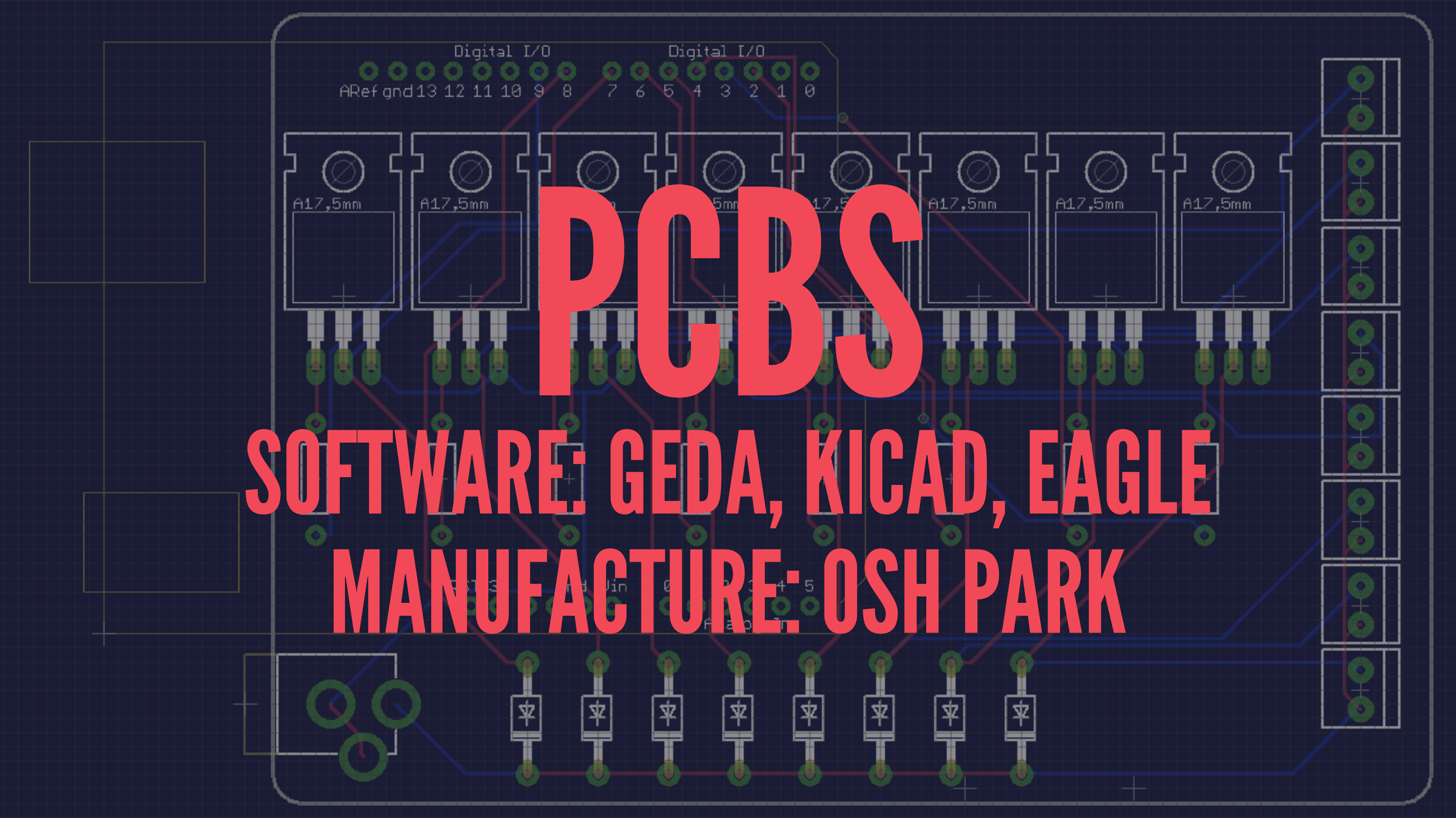












PCBS

SOFTWARE: GEDA, KICAD, EAGLE

MANUFACTURE: OSH PARK

QUESTIONS/COMMENTS?

http://github.com/ogrodnek/analog-displays-talk

SEND ME INFO ON YOUR ANALOG DISPLAYS!

ogrodnek@gmail.com
http://analogmachines.com/blog/