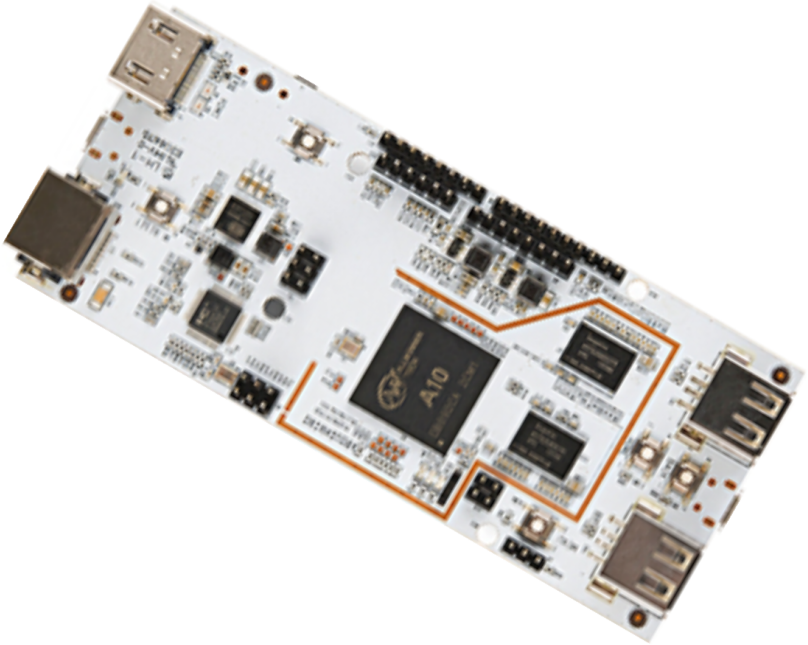

PiNGO

API "UNIVERSAL" PARA HARDWARE HACKING

UM PROJETO DO GAROA

- Garoa Hacker Clube (garoa.net.br)
- um **hackerspace**
  == laboratório comunitário **independente**
- em São Paulo (próximo do metrô **Pinheiros**)
- mantido por uma associação sem fins lucrativos operada pelos **associados**
  - hoje somos 46 associados pagando mensalidades de R$ 60 ou R$ 100
  - isso paga o aluguel, a manutenção da casa e permite a compra de equipamentos

GAROA: #COMOFAZ

- Todas as atividades são **abertas** a **todos** os interessados
  - **não** precisa se associar para participar
  - mas é preciso **participar** para poder se associar
- Aberto todos os dias úteis a partir de 19:3
  - às vezes também no fim de semana
- Veja a programação no site:

http://garoa.net.br

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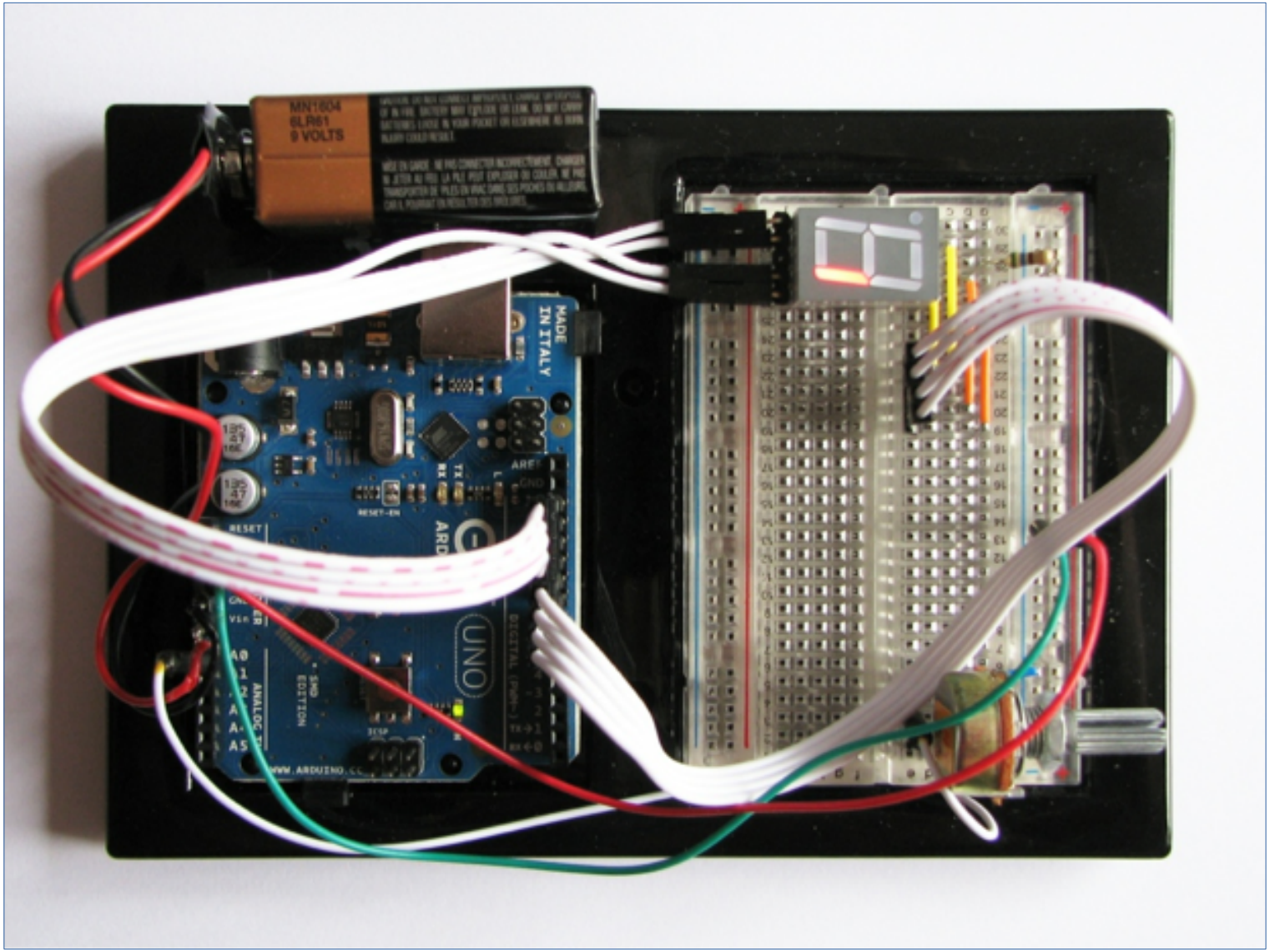
O “PROBLEMA”

Pinos GPIO

- Todas as placas interessantes para computação física possuem pinos **GPIO**
  - General Purpose I/O
- Pinos **digitais** I/O
  - 0/1 == HIGH/LOW
- Pinos **analógicos**
  - conversor A/D
- Pinos digitais com suporte a **PWM**
  - substituto saída analógica sem conversor D/A

DOJO COM ARDUINO



GAROA
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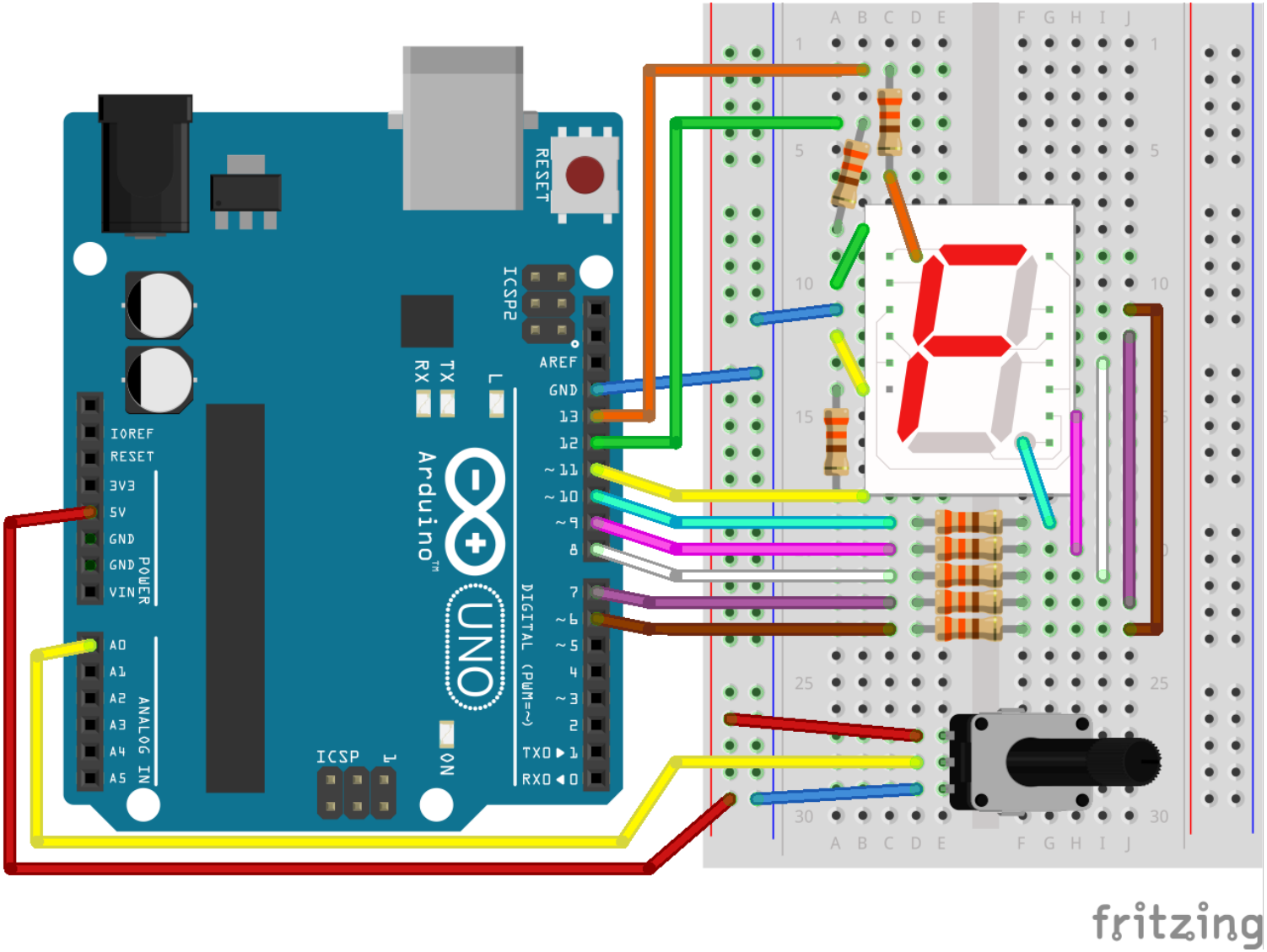
DOJO COM ARDUINO



GAROA HACKER CLUBE

PCDUINO

	pcDuino
SoC	Allwinner A10
CPU	ARM Cortex A8 (ARMv7 + NEON SIMD)
GPU	Mali 400
clock	1 GHz
SO	GNU/Linux (vários) Android
RAM	1 GB
Flash onboard	2 GB
SD card	micro-SD
GPIO	14
PWM	6
ADC	6
USB client	1
USB host	1
Ethernet	10/100
Wifi	✘
HDMI	HDMI
video composto	✘
audio	via HDMI
preço USD	59
Arduinos	1.7
open hardware	?

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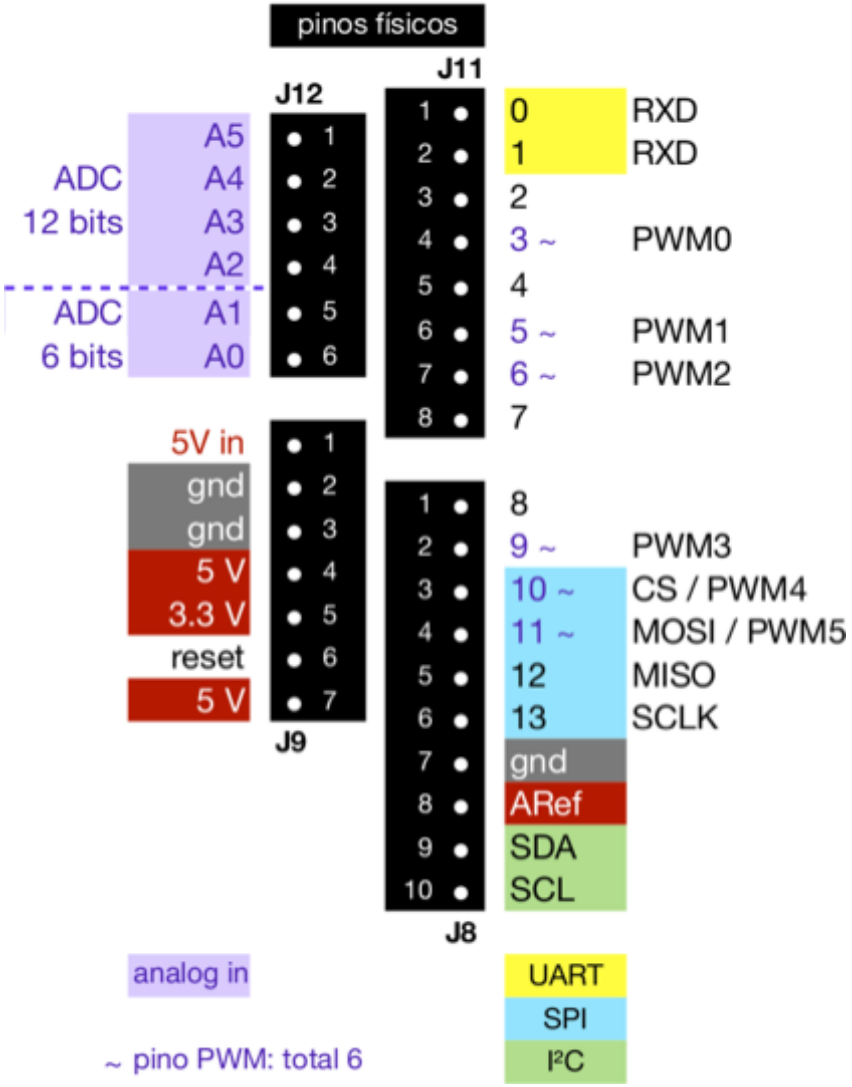
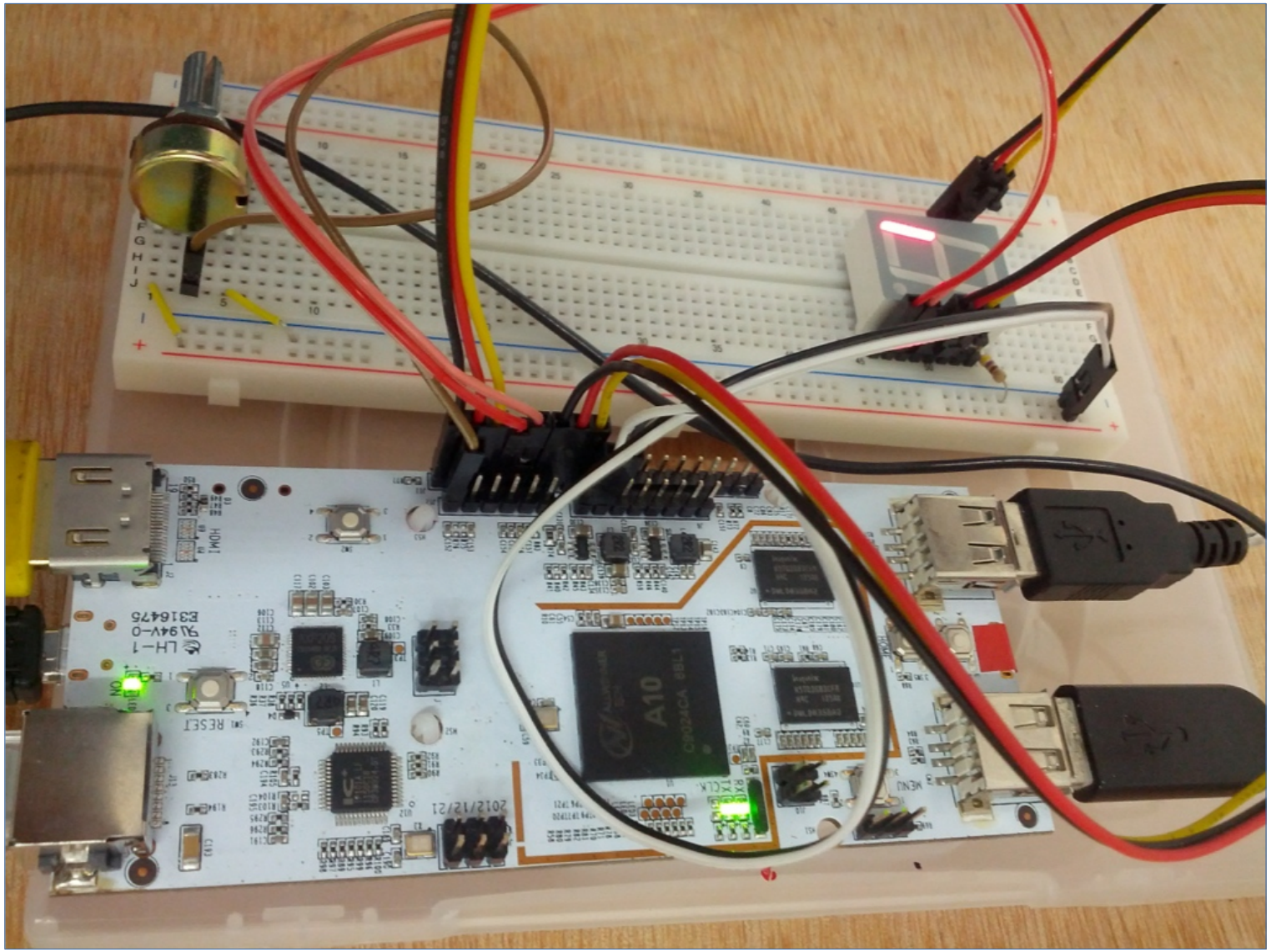
PCDUINO

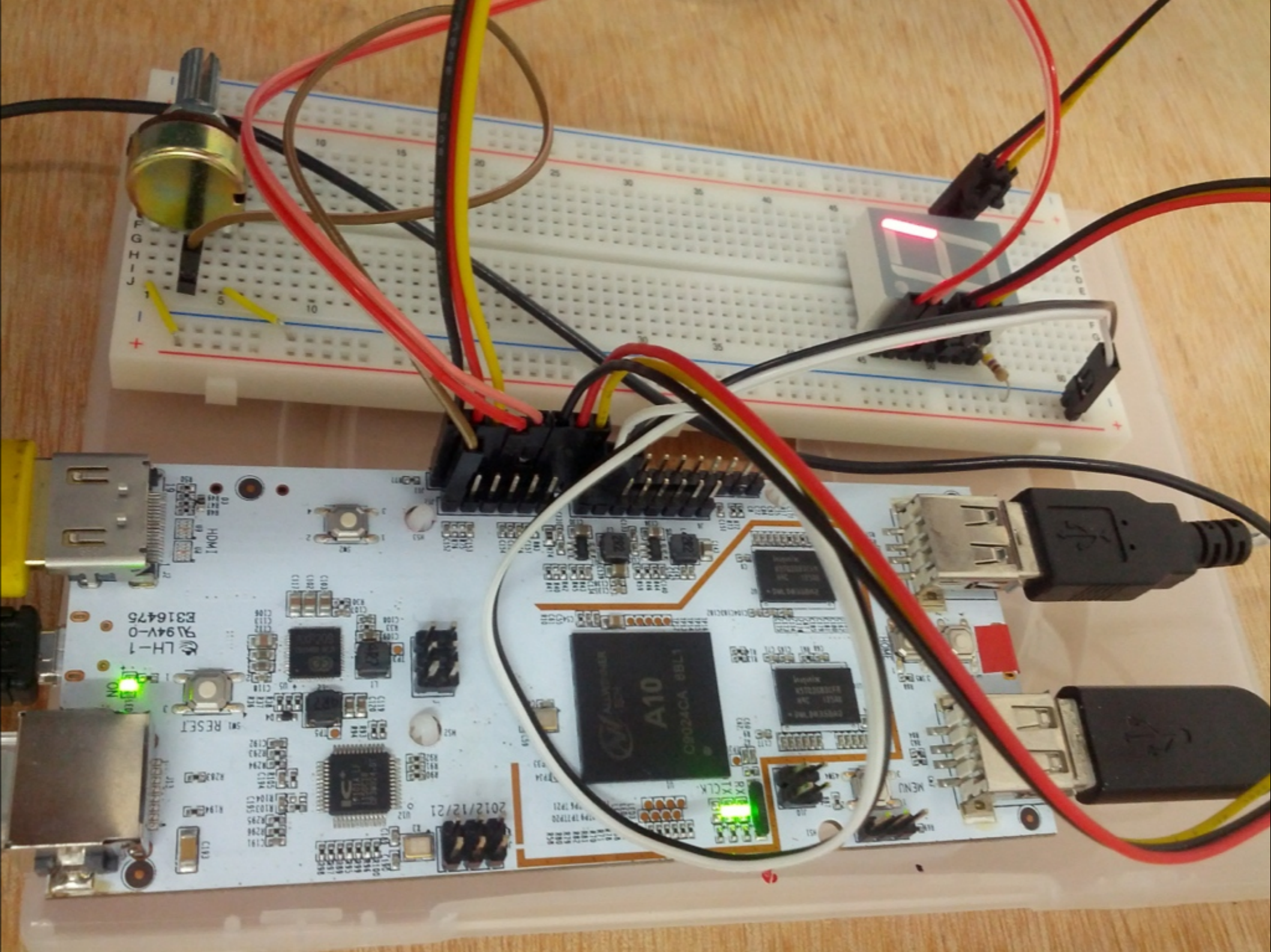
A10


pinos físicos
J12
J11
J9
J8
ADC
12 bits
ADC
6 bits
A5
A4
A3
A2
A1
A0
5V in
gnd
gnd
5 V
3.3 V
reset
5 V
0 RXD
1 RXD
2
3 ~ PWM0
4
5 ~ PWM1
6 ~ PWM2
7
8
9 ~ PWM3
10 ~ CS / PWM4
11 ~ MOSI / PWM5
12 MISO
13 SCLK
gnd
ARef
SDA
SCL
analog in
~ pino PWM: total 6
UART
SPI
I²C

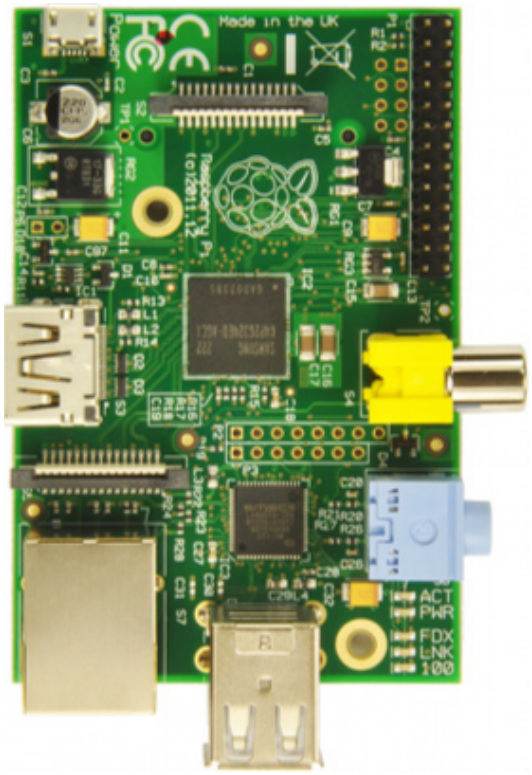
DOJO COM PCDUINO



GAROA
HACKER CLUBE


A10
HDMI
RESET
LH-1
94V-0
2012/12/21

RASPBERRY Pi

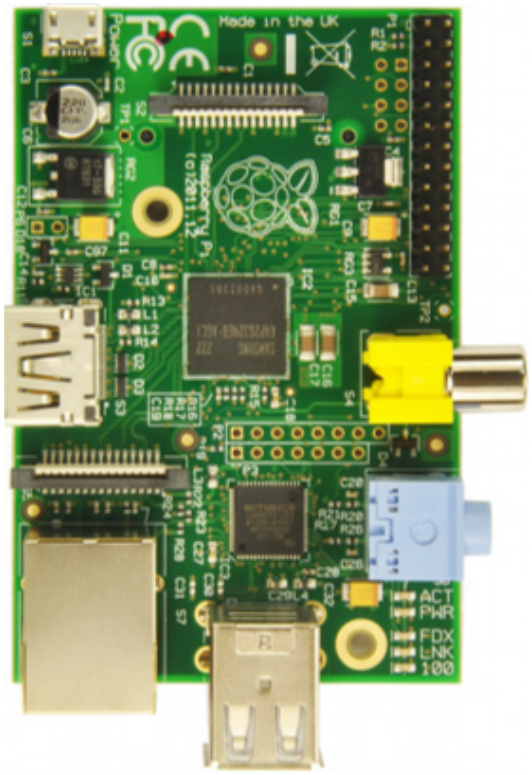


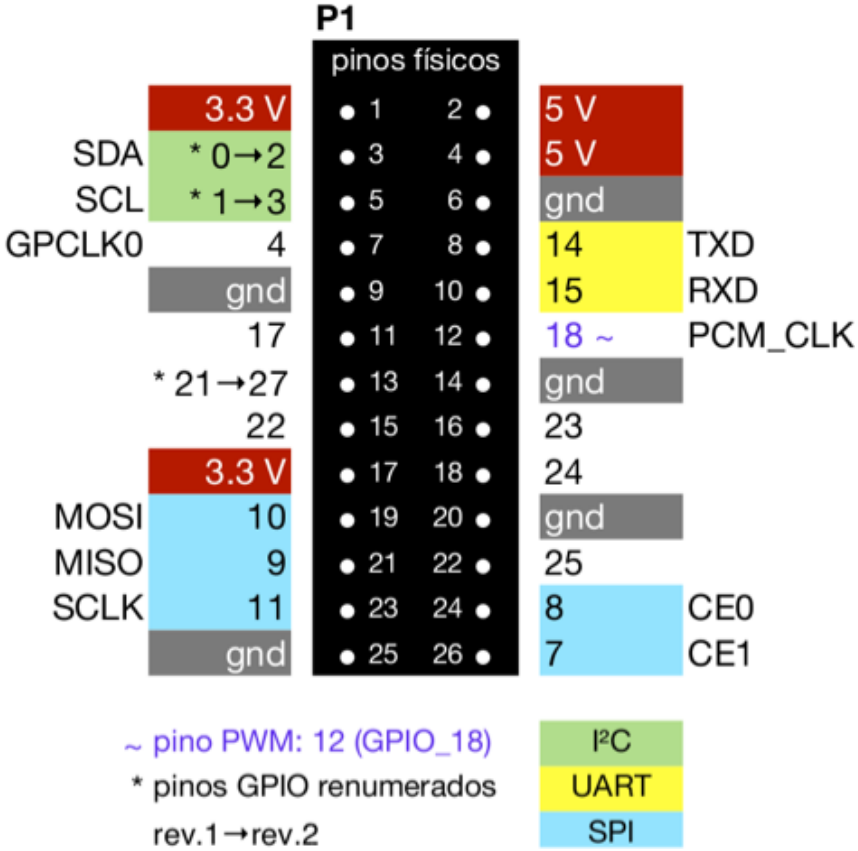
	Raspberry Pi mod. B
SoC	Broadcom BCM2835
CPU	ARM11 (ARMv6)
GPU	VideoCore IV
clock	700 MHz
SO	GNU/Linux (vários)
RAM	512 MB
Flash onboard	✘
SD card	SD
GPIO	17 (+4 no P5)
PWM	1
ADC	✘
USB client	✘
USB host	2
Ethernet	10/100
Wifi	✘
HDMI	HDMI
video composto	RCA
audio	HDMI + plug 3.5mm
preço USD	35
Arduinos	1.0
open hardware	✘

GAROA HACKER CLUBE

RASPBERRY Pi

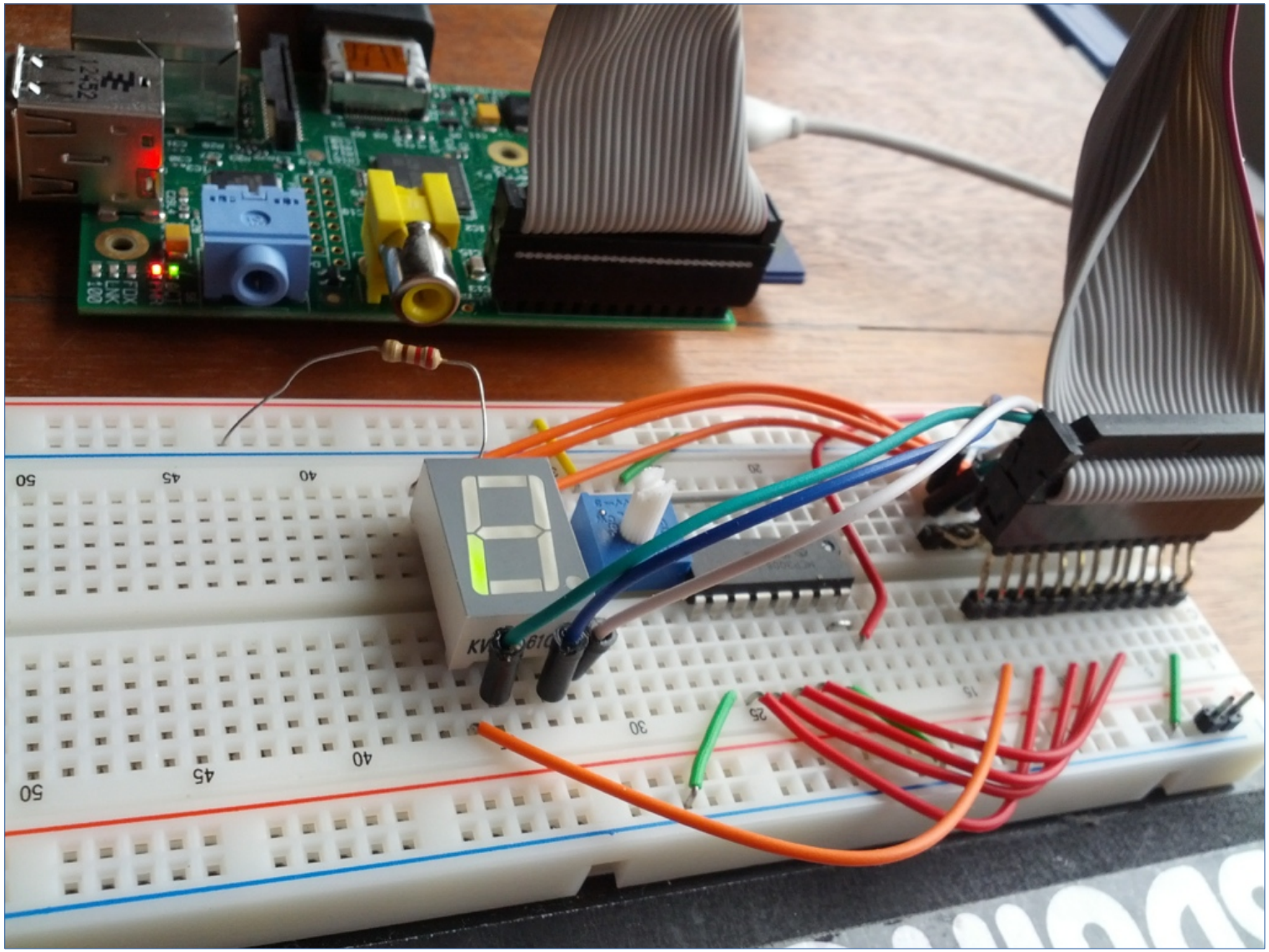
P1



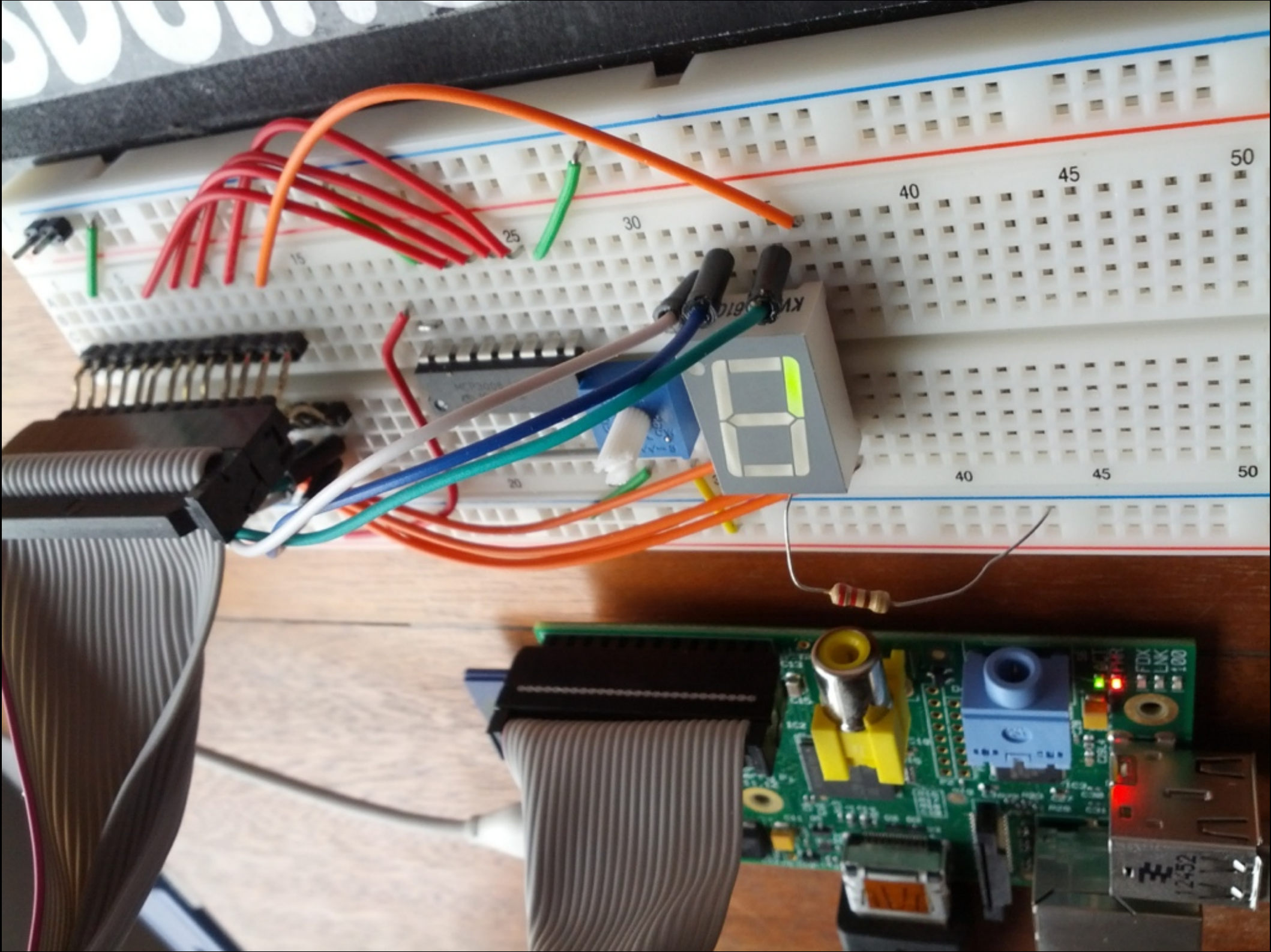


GAROA HACKER CLUBE

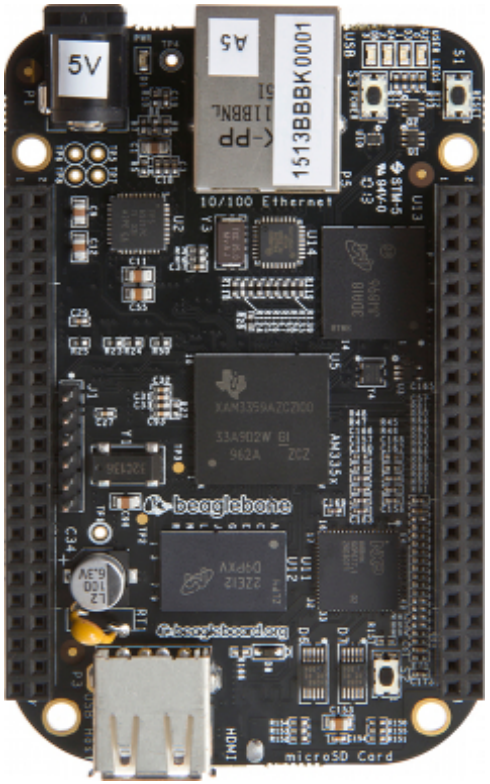
DOJO COM RASPBERRY Pi



GAROA
HACKER CLUBE


50
45
40
30
25
15
20
FDX
LNK
100

BEAGLEBONE BLACK



	Beaglebone Black
SoC	Texas Instruments Sitara AM335x
CPU	ARM Cortex A8 (ARMv7 + NEON SIMD)
GPU	PowerVR SGX 530
clock	1 GHz
SO	GNU/Linux (vários) Android
RAM	512 MB
Flash onboard	2 GB
SD card	micro-SD
GPIO	66
PWM	8
ADC	7
USB client	1
USB host	1
Ethernet	10/100
Wifi	✘
HDMI	micro-HDMI
video composto	✘
audio	via HDMI
preço USD	45
Arduinos	1.3
open hardware	✔

GAROA HACKER CLUBE

BEAGLEBONE BLACK

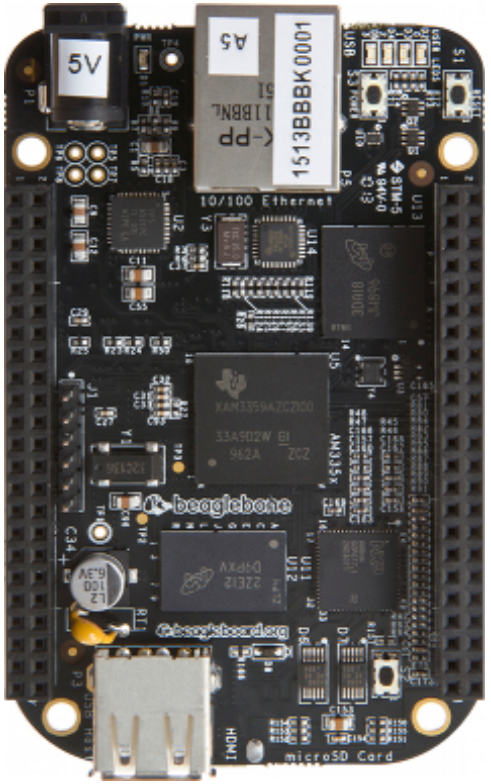
P9

	pinos físicos		
gnd	1	2	gnd
3.3 V	3	4	3.3 V
VDD 5 V	5	6	5 V VDD
SYS 5 V	7	8	5 V SYS
PWR_BUT	9	10	SYS_RESETn
UART4_RXD	11	12	1-28
UART4_TXD	13	14	EHRPWM1A ~
1-16	15	16	EHRPWM1B ~
I2C1_SCL	17	18	I2C1_SDA
I2C2_SCL	19	20	I2C2_SDA
UART2_TXD	21	22	UART2_RXD
1-17	23	24	UART1_TXD
* 3-21	25	26	UART1_RXD
3-19	27	28	SPI1_CS0 ~
SPI1_D0	29	30	SPI1_D1
SPI1_SCLK	31	32	VADC
AIN4	33	34	AGND
AIN6	35	36	AIN5
AIN2	37	38	AIN3
AIN0	39	40	AIN1
² CLKOUT2, 3-20	41	42	0-7 ~, 3-18 ²
gnd	43	44	gnd
gnd	45	46	gnd

x-yy pino GPIOX_YY
~ pino PWM: 14, 16, 28, 42² (0-7)
* em uso: oscilador audio HDMI
² pino físico ligado a dois pinos lógicos

analog input
I²C
UART
SPI
misc.

P9 P8



P8

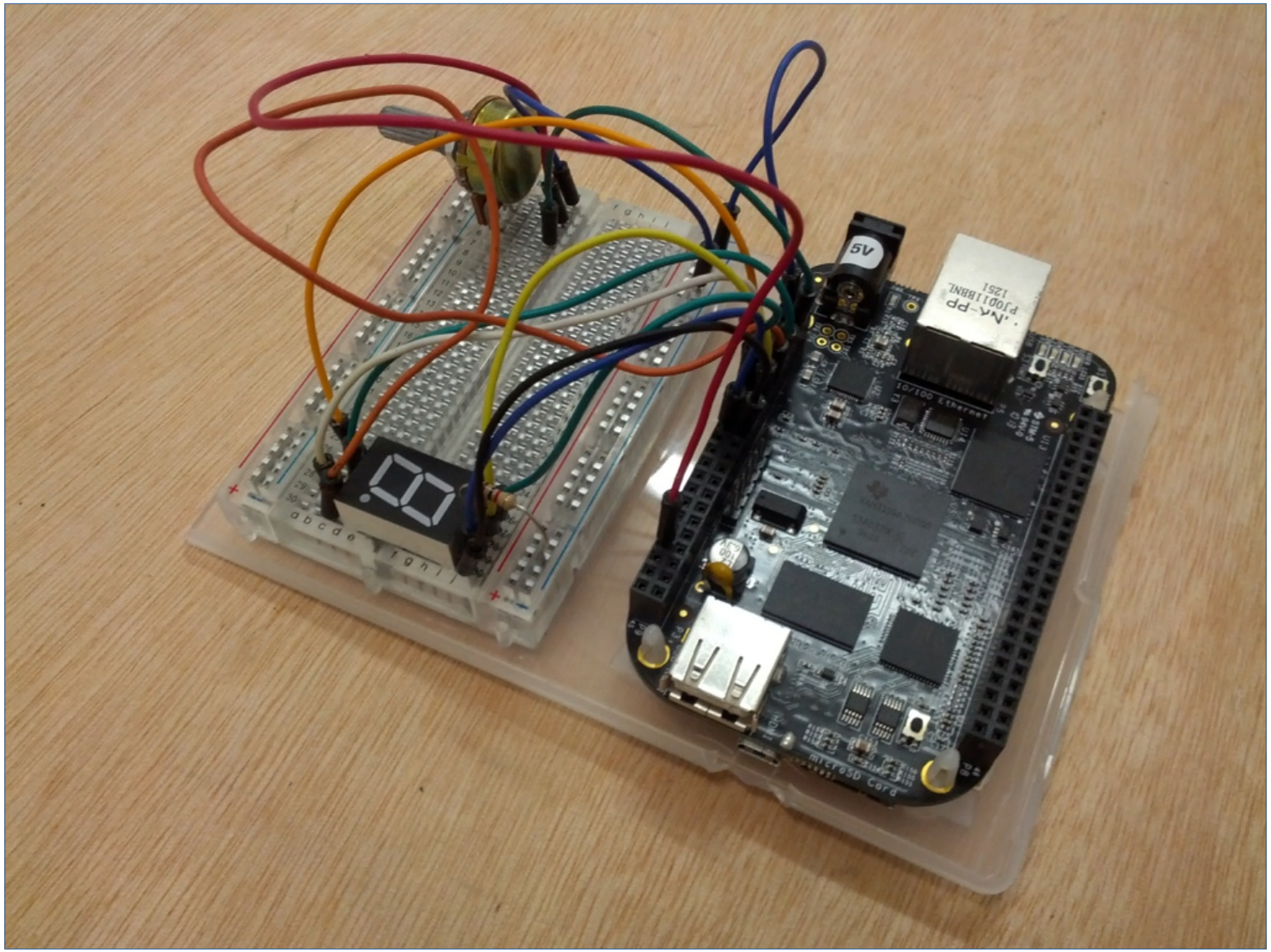
	pinos físicos		
gnd	1	2	gnd
1-6	3	4	1-7
1-2	5	6	1-3
TIMER4	7	8	TIMER7
TIMER5	9	10	TIMER6
1-13	11	12	1-12
~ EHRPWM2B	13	14	0-26
1-15	15	16	1-14
0-27	17	18	2-1
~ EHRPWM2A	19	20	1-31
1-30	21	22	1-5
1-4	23	24	1-1
1-0	25	26	1-29
2-22	27	28	2-24
2-23	29	30	2-25
UART5_CTSN	31	32	UART5_RTSN
UART4_RTSN	33	34	UART3_RTSN
UART4_CTSN	35	36	UART3_CTSN
UART5_TXD	37	38	UART5_RXD
2-12	39	40	2-13
2-10	41	42	2-11
2-8	43	44	2-9
2-6	45	46	2-27

x-yy pino GPIOX_YY
~ pino PWM: 13, 19

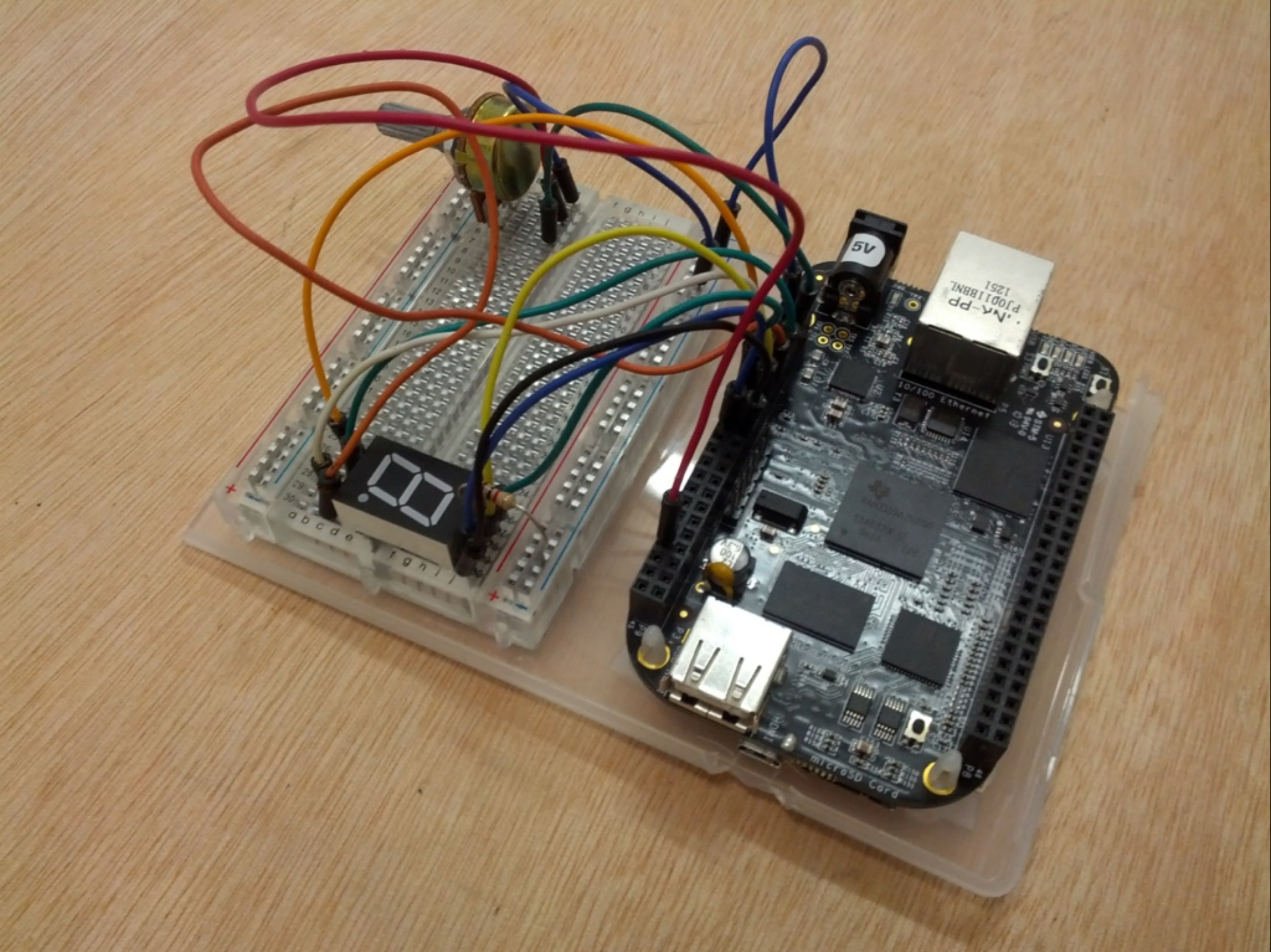
UART
timers

GAROA HACKER CLUBE

DOJO COM BBB



GAROA
HACKER CLUBE


5V
10/100 Ethernet
MICROSD Card

PROGRAMANDO PINOS

- Quase todas essas placas são programáve em **Python**
- Python embarcado, naquelas que rodam **GNU/Linux** embarcado
- Python em **outro** computador, controlando remotamente
  - ex: **Arduino** via serial com protoco **Firmata** e biblioteca **pyFirmata**

GAROA HACKER CLUBE

```
import time, os

GPIO_PATH = os.path.normpath('/sys/devices/virtual/misc/gpio/')
ADC_PATH = os.path.normpath('/proc/')

INPUT = LOW = "0"
OUTPUT = HIGH = "1"

def pin_mode(pin, mode):
    with open(GPIO_PATH+'mode/gpio%s' % pin, 'w') as f:
        f.write(mode)

def digital_write(pin, value):
    with open(GPIO_PATH+'pin/gpio%s' % pin, 'w') as f:
        f.write(str(value))

def analog_read(pin):
    with open(ADC_PATH+'adc%d' % pin) as f:
        f.seek(0)
        return int(f.read(16).split(':')[1])

def setup():
    for i in range(18):
        pin_mode(i, OUTPUT)
        digital_write(i, LOW)

setup()
while True:
    for i in [0, 1, 7, 5, 4, 2]:
        digital_write(i, 1)
        delay = analog_read(5)/4096.0
        time.sleep(delay)
        digital_write(i, 0)
```

PCDUINO

GAROA HACKER CLUBE

RASPBERRY Pi

```
import atexit
import time
import RPi.GPIO as GPIO
import spi

# executar cleanup ao sair
atexit.register(GPIO.cleanup)

# usar numeração lógica dos pinos
GPIO.setmode(GPIO.BCM)

DISPLAY = [17, 4, 9, 11, 7, 27, 22, 10]

SPI_CLK = 18
SPI_MISO = 23
SPI_MOSI = 24
SPI_CS = 25
conversor_ad = spi.Mcp3008(SPI_CLK, SPI_MISO, SPI_MOSI, SPI_CS)

CANAL_POTENCIOMETRO = 1

for led in DISPLAY[:6]:
    GPIO.setup(led, GPIO.OUT)
    GPIO.output(led, 0)

while True:
    for led in DISPLAY[:6]:
        GPIO.output(led, 1)
        atraso = conversor_ad.read(CANAL_POTENCIOMETRO)/1000.0
        time.sleep(atraso)
        GPIO.output(led, 0)
```

GAROA HACKER CLUBE

BEAGLEBONE BLACK

```
import Adafruit_BBIO.GPIO as GPIO
import Adafruit_BBIO.ADC as ADC

ADC.setup()

from time import sleep
pinos = [16, 21, 22, 13, 12, 11]

for pino in pinos:
    GPIO.setup("P9_" + str(pino), GPIO.OUT)

while True:
    for pino in pinos:
        GPIO.output("P9_" + str(pino), GPIO.HIGH)
        tempo = ADC.read('P9_39')
        print tempo
        sleep(tempo)
        GPIO.output("P9_" + str(pino), GPIO.LOW)
```

GAROA HACKER CLUBE

PiNGO

NOSSA SOLUÇÃO

OBJETOS BÁSICOS

- API orientada a objetos
- Classes:
  - pingo.Board (placa)
    - pingo.rpi.RaspberryPi
    - pingo.arduino.ArduinoFirmata
    - ...
  - pingo.Pin (pino)
    - pingo.DigitalPin
    - pingo.AnalogPin
    - ...

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HACKER CLUBE