Centre
de formació
i ocupació

Enginyers
Industrials de Catalunya

Curs pràctic de programació d'electrònica "embedded low-cost" per a la IoT

Curs pràctic de programació d'electrònica "embedded low-cost" per a la IoT

https://formacio.eic.cat/cursos/1123418

Grup de Treball IoT & Embedded Systems

Xavier Pi

Vicepresident GT IoT & Embedded Systems

Comissió Indústria 4.0 Enginyers de Catalunya

www.linkedin.com/in/xavierpi

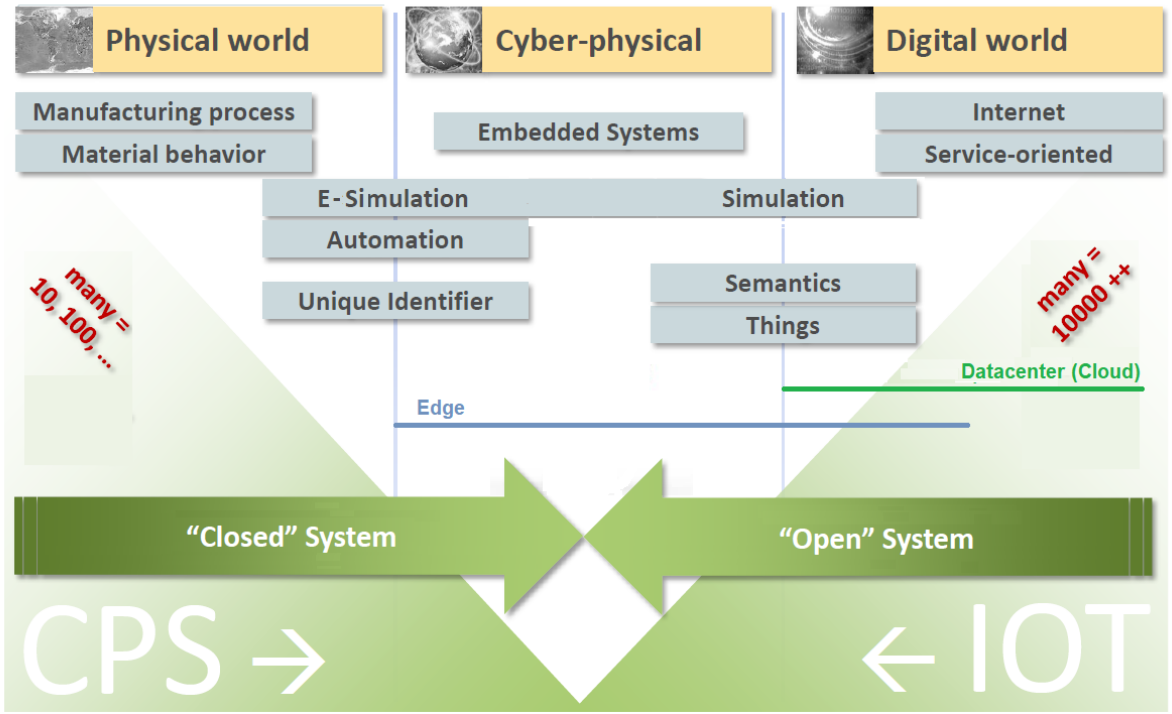
Índex

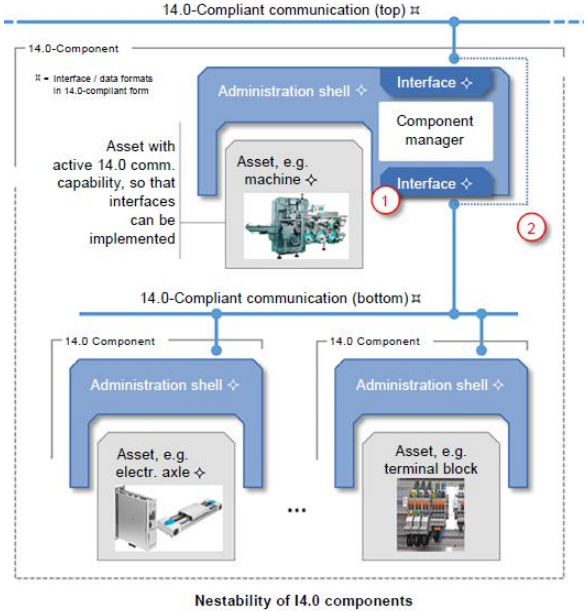
- Els embedded systems (Sistemes encastats)
- Elements centrals de la Indústria 4.0
- Exemples bàsics d’actuadors
- Exemples bàsics de sensòrica
- Internet de les coses
- Protocols de comunicacions IoT: MQTT i HTTP
- Cloud (núvol) i Edge
- Sensors i actuadors en entorns industrials

ELS EMBEDDED SYSTEMS

Elements centrals de la Indústria 4.0

Two Worlds coming together



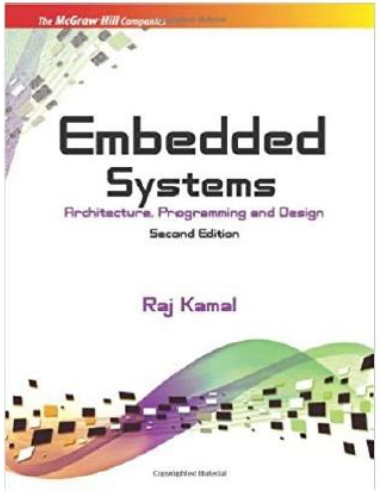


Nestability of I4.0 components

IEC PAS 63088

Tipus d'embedded systems

- Classificació del prof. Raj Kamal



  - Escala petita (Ex. Arduino)
  - Escala mitjana (Ex. ESP32)
  - Escala sofisticada (Ex. Raspberry Pi, Olimex)

Impacte del DiY en la recerca

Published: 06 April 2017

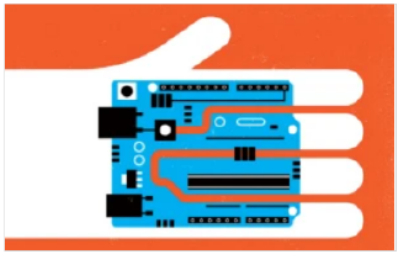
The DIY electronics transforming research

Daniel Cressey

Nature **544**, 125–126 (2017) | Cite this article

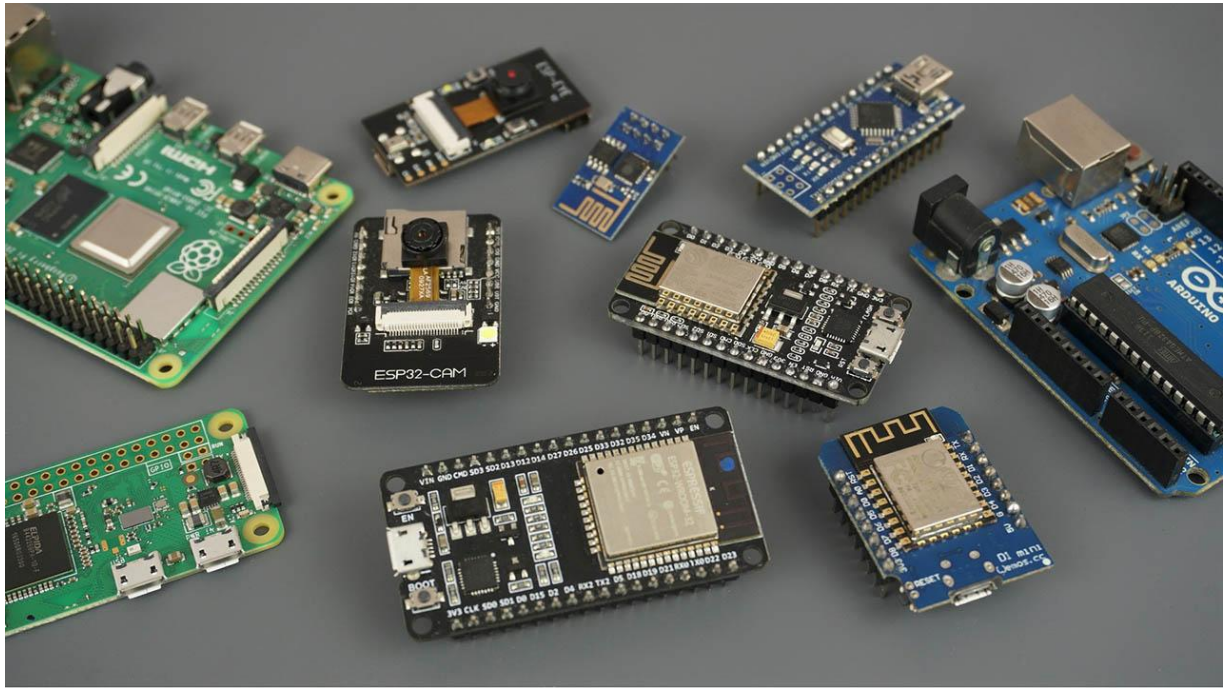
537 Accesses | **34** Citations | **336** Altmetric | Metrics

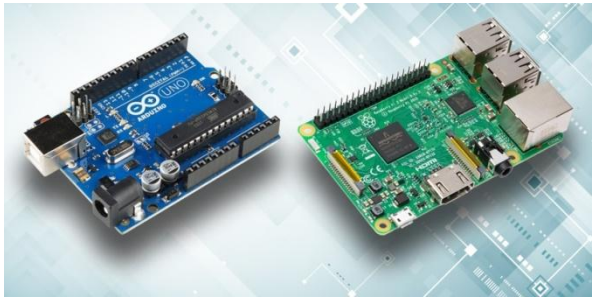
Cheap, stripped-down microcontrollers are allowing users to pack huge amounts of computing power into tiny spaces.



www.nature.com/articles/544125a

Impacte del DiY en la indústria

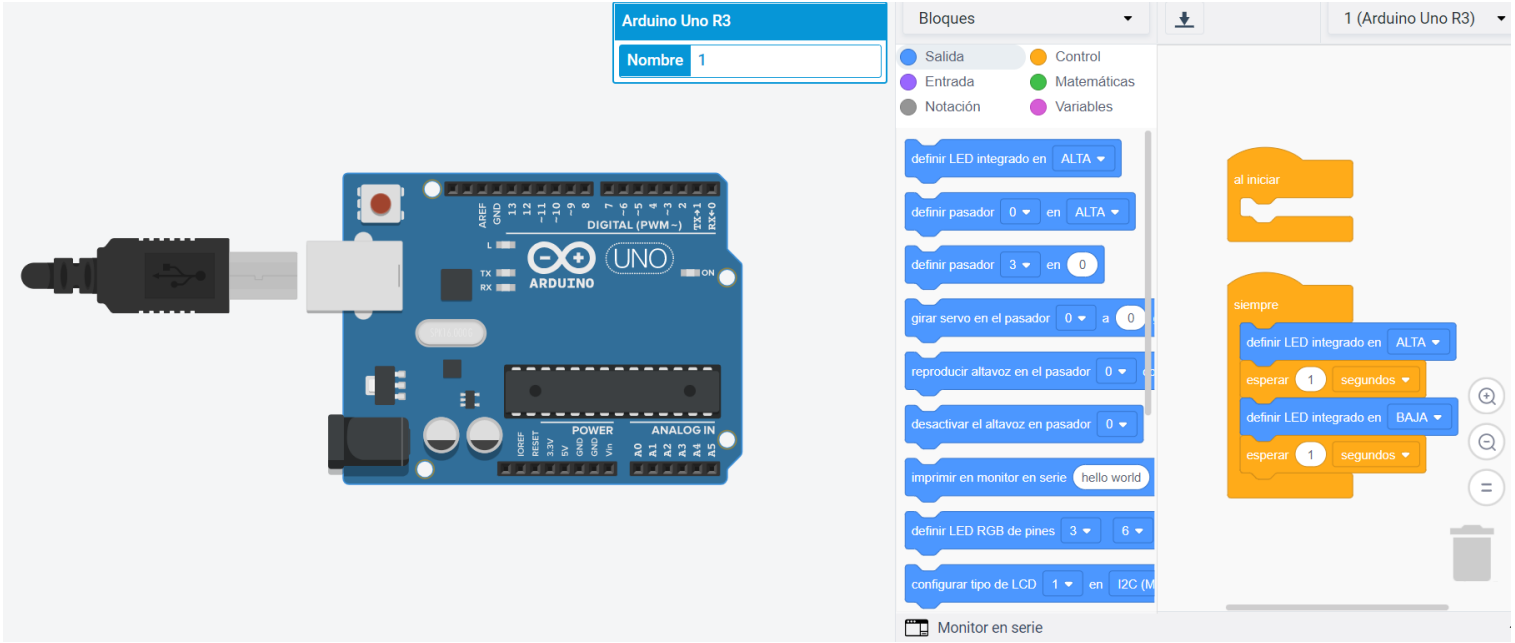




Proveïdors

- www.diotronic.com
- www.industrialshields.com
- www.amazon.com
- www.aliexpress.com

Llenguatges low-code de blocs (Blockly)



www.tinkercad.com

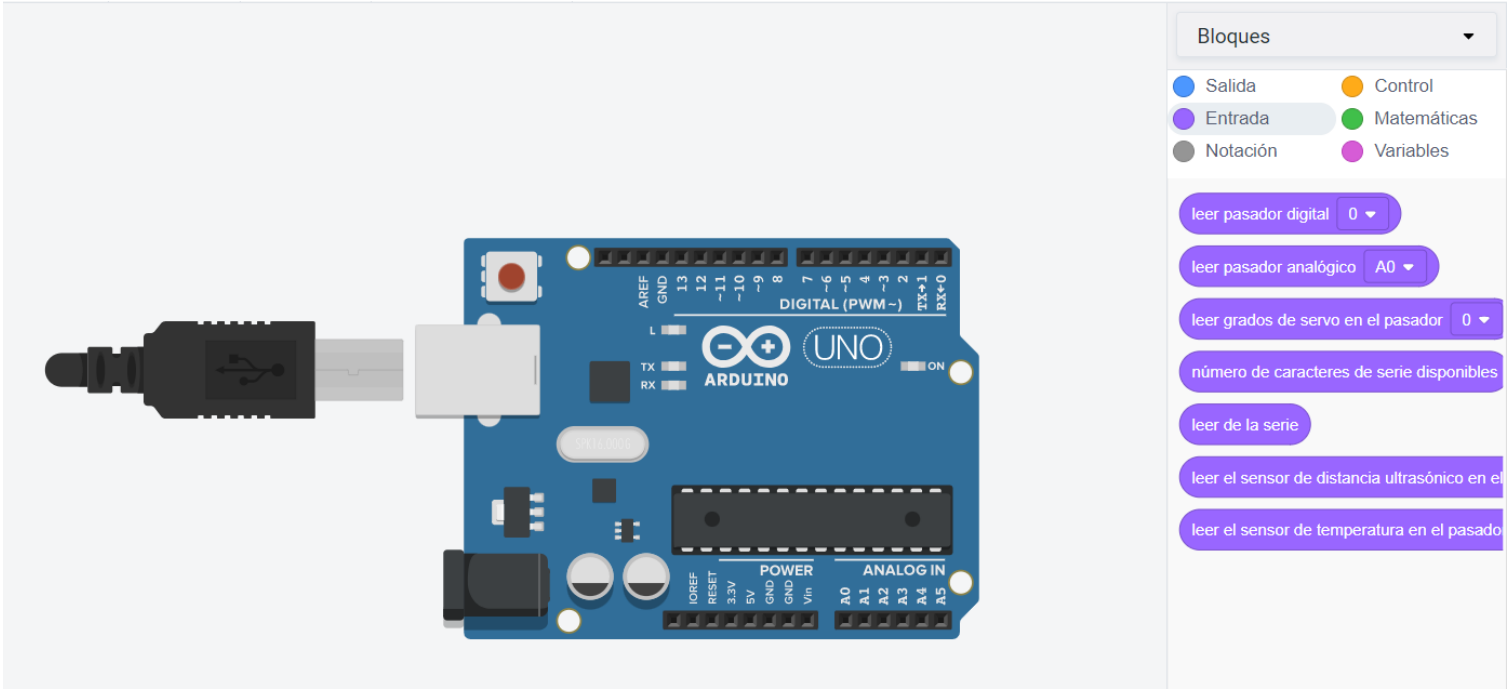
Arquitectura Super-Loop

(Atomatització industrial)

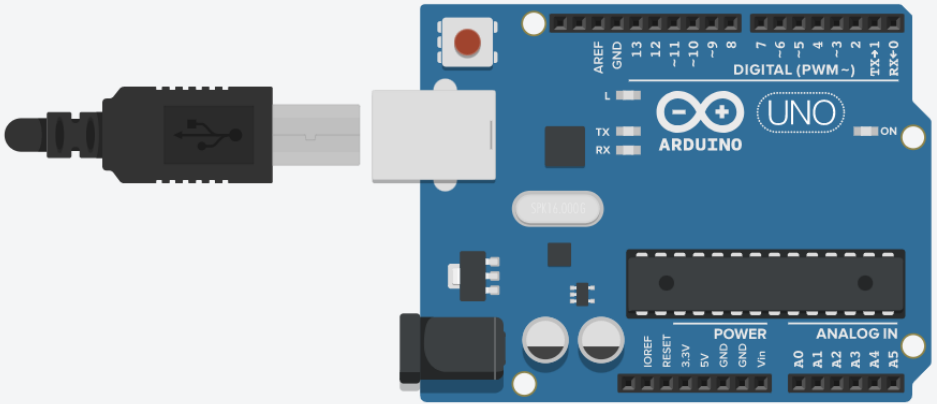
```
main() {
   setup();
   while (1) {
      loop();
   }
}
```

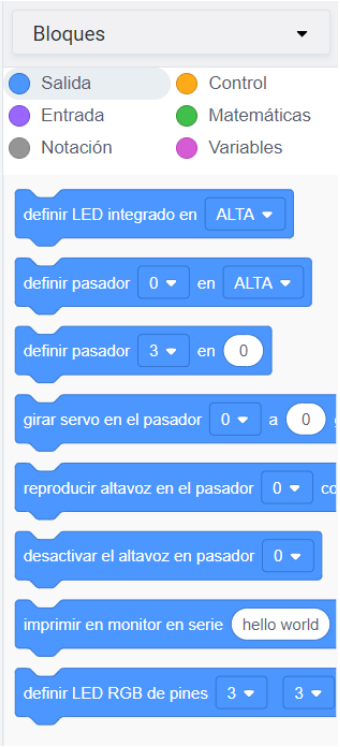
http://www.xavierpi.com/cursiotpract/3_0_To_4_0.png

Entrades analògiques i digitals



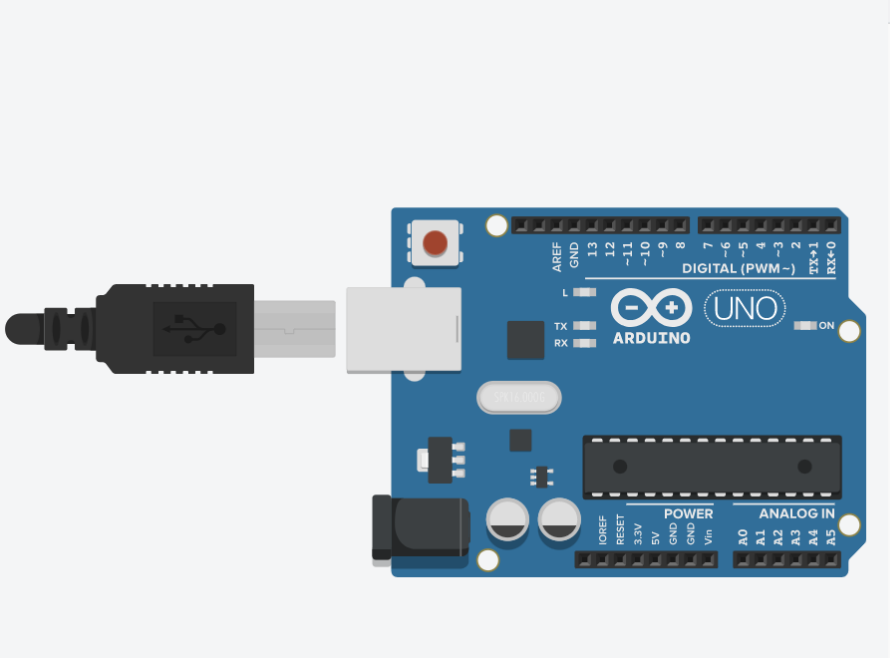
Sortides analògiques i digitals





EXEMPLES BÀSICS D'ACTUADORS

Control d'un led (blink)



definir LED integrado en ALTA
esperar 1 segundos
definir LED integrado en BAJA
esperar 1 segundos

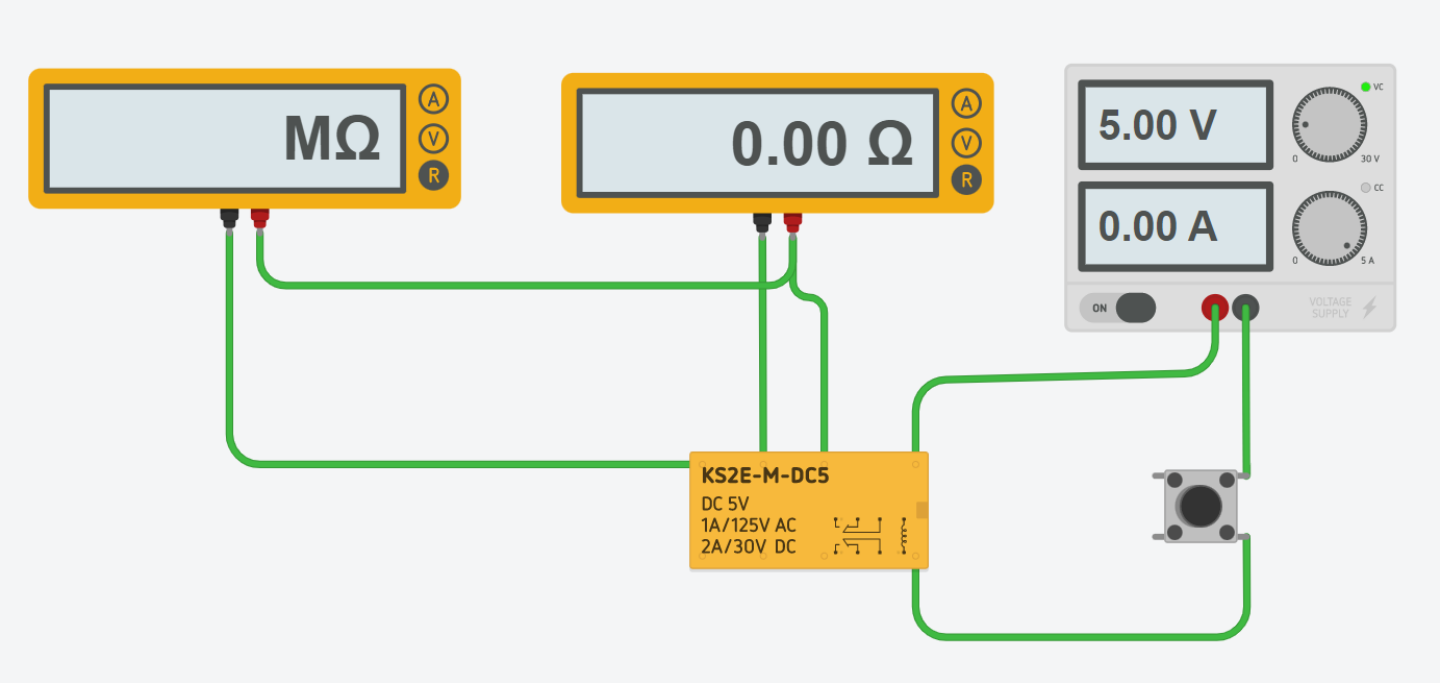
1 (Arduino Uno R3)

```
// C++ code
//
void setup()
{
  pinMode(LED_BUILTIN, OUTPUT);
}

void loop()
{
  digitalWrite(LED_BUILTIN, HIGH);
  delay(1000); // Wait for 1000 millisecond(s)
  digitalWrite(LED_BUILTIN, LOW);
  delay(1000); // Wait for 1000 millisecond(s)
}
```

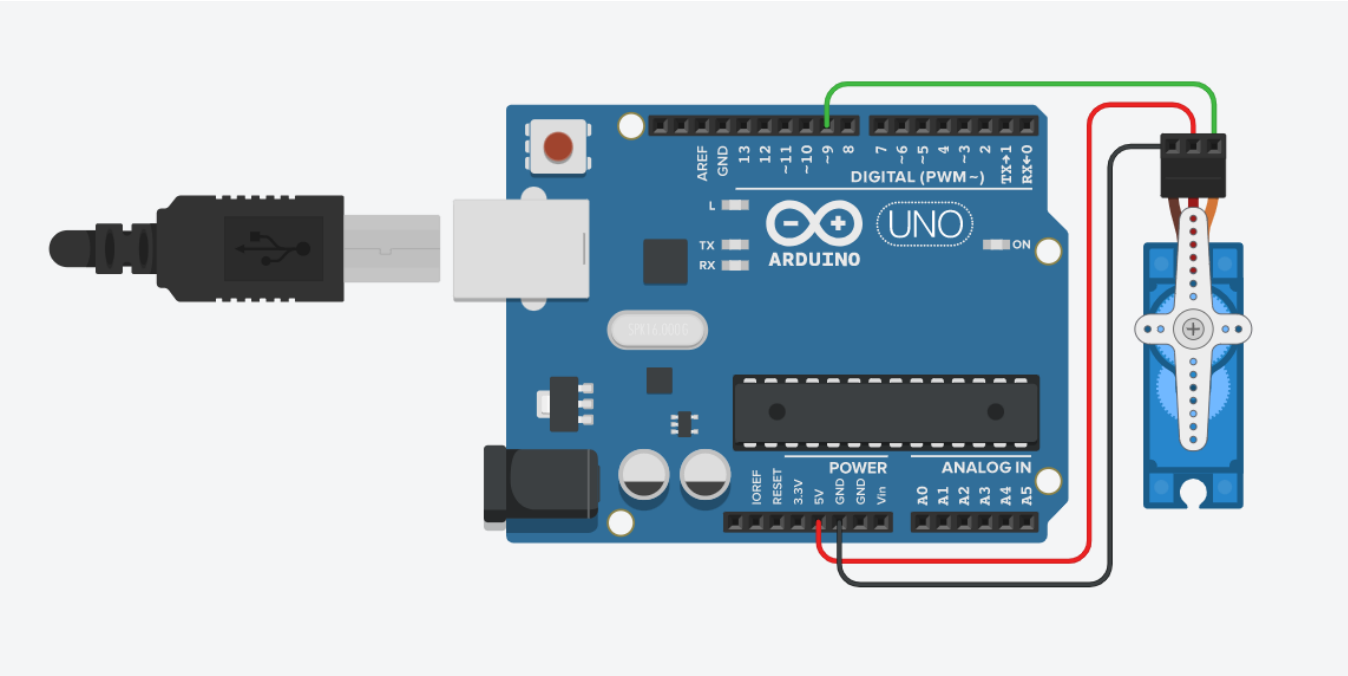
Exercici: Afegir un LED extern, amb la resistència corresponent.

Control d'un relé



https://www.tinkercad.com/things/1O4C6ZoLpdB

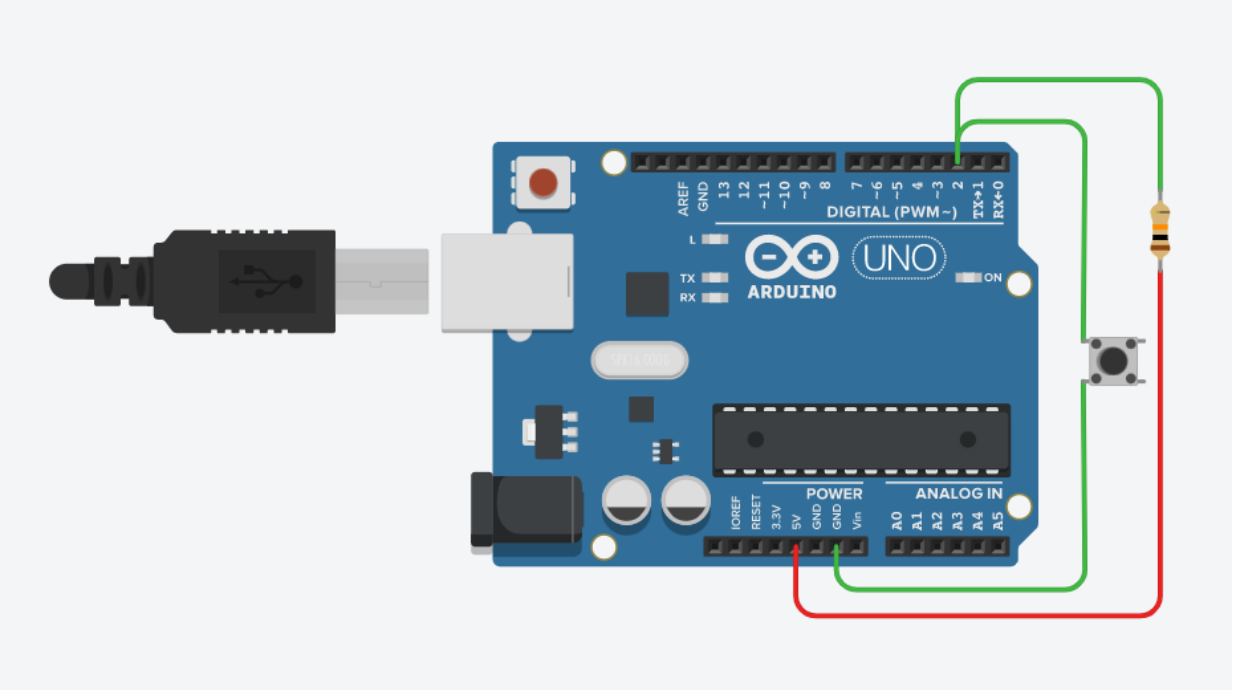
Control d'un servomotor



https://www.tinkercad.com/things/3NPIinNEm8D

EXEMPLES BÀSICS DE SENSÒRICA

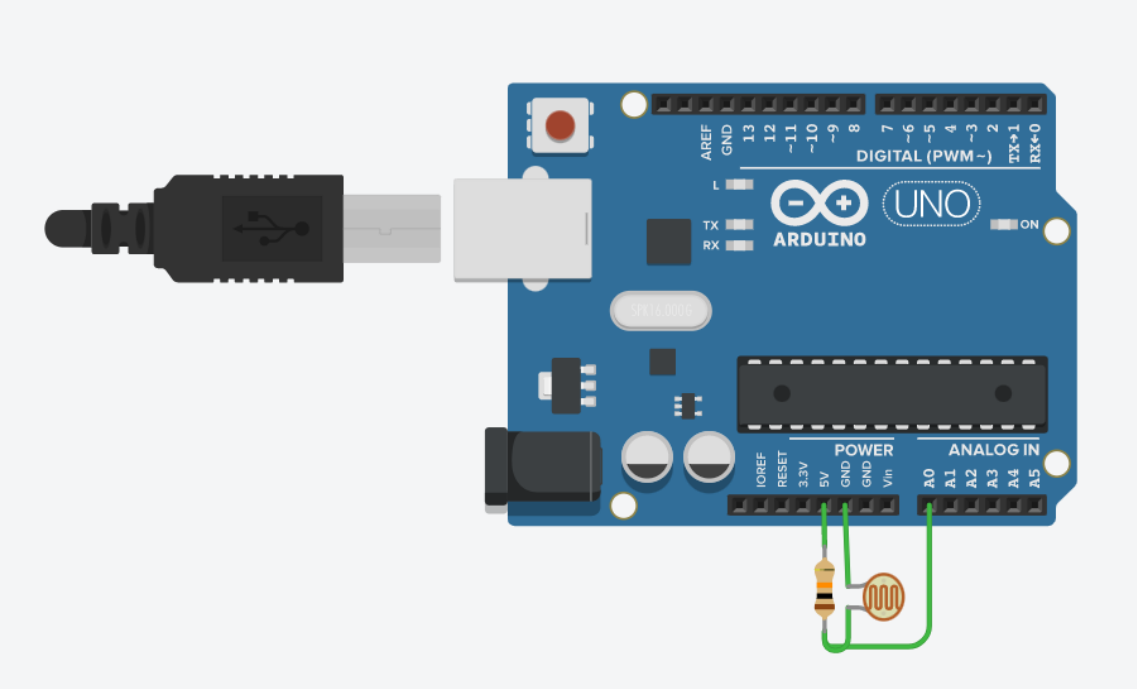
Detecció d'un final de carrera



(Noció de pull-up)

https://www.tinkercad.com/things/jcljb4UQUPd

Mesura d'un nivell de lluminositat



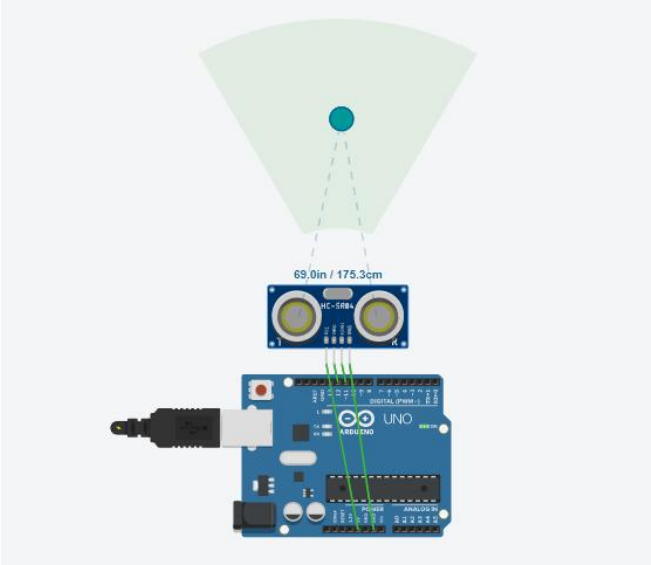
https://www.tinkercad.com/things/eZBCioTaA5V

Detecció d'un llindar de lluminositat

- Exercici:

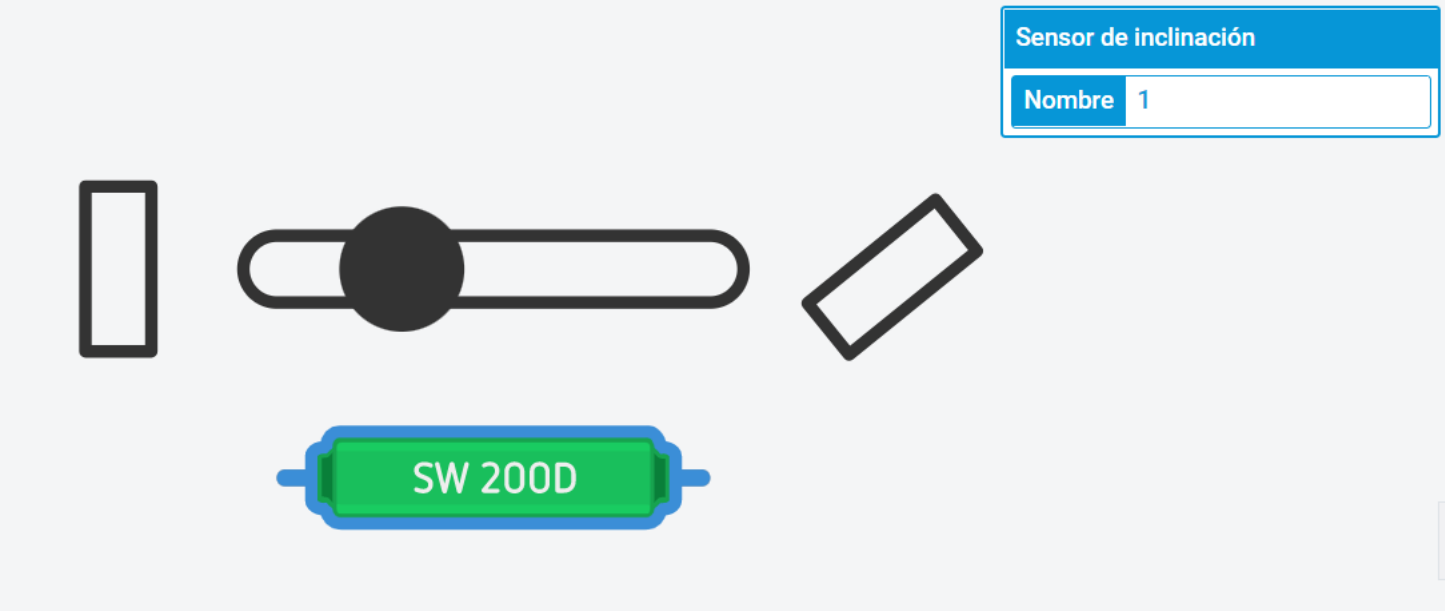
Ampliar l’exemple anterior per a encendre i apagar un LED si traspassa un valor llindar de lluminositat.

Mesura d'una distància



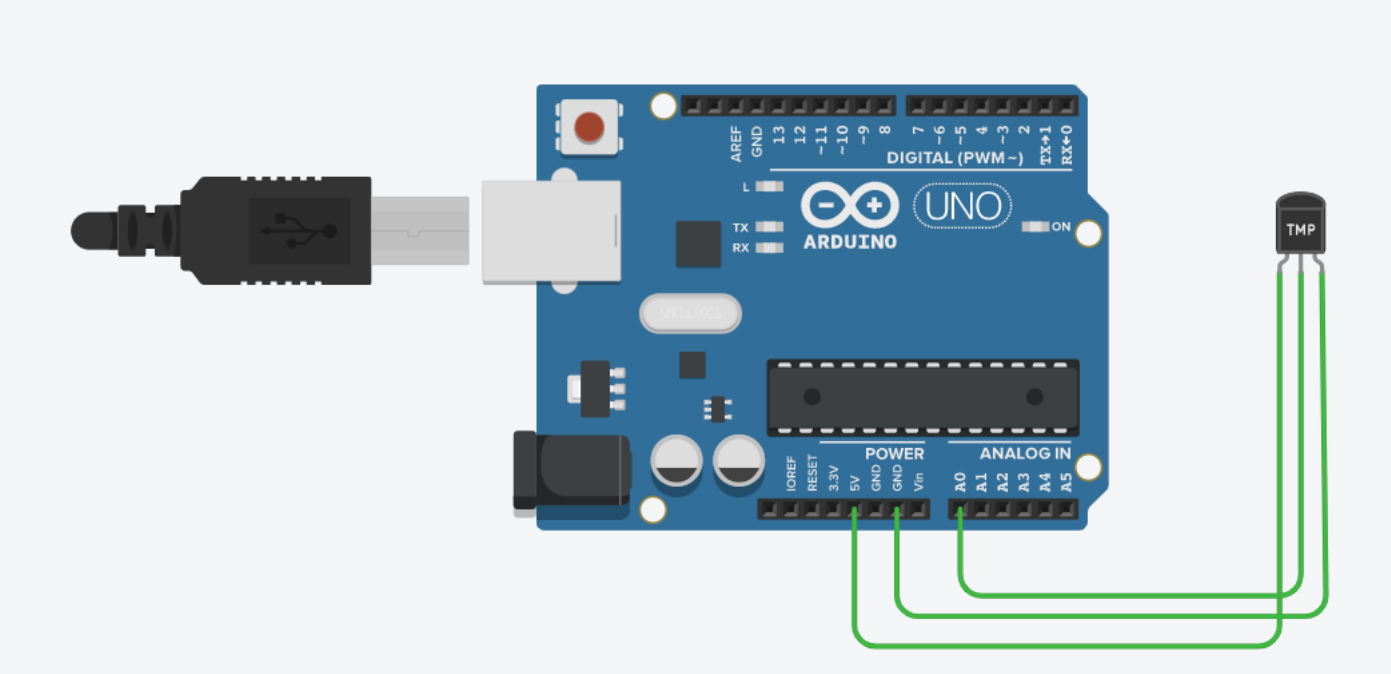
https://www.tinkercad.com/things/9l2rZw0cjLS

Mesura d'inclinacions (acceleracions)



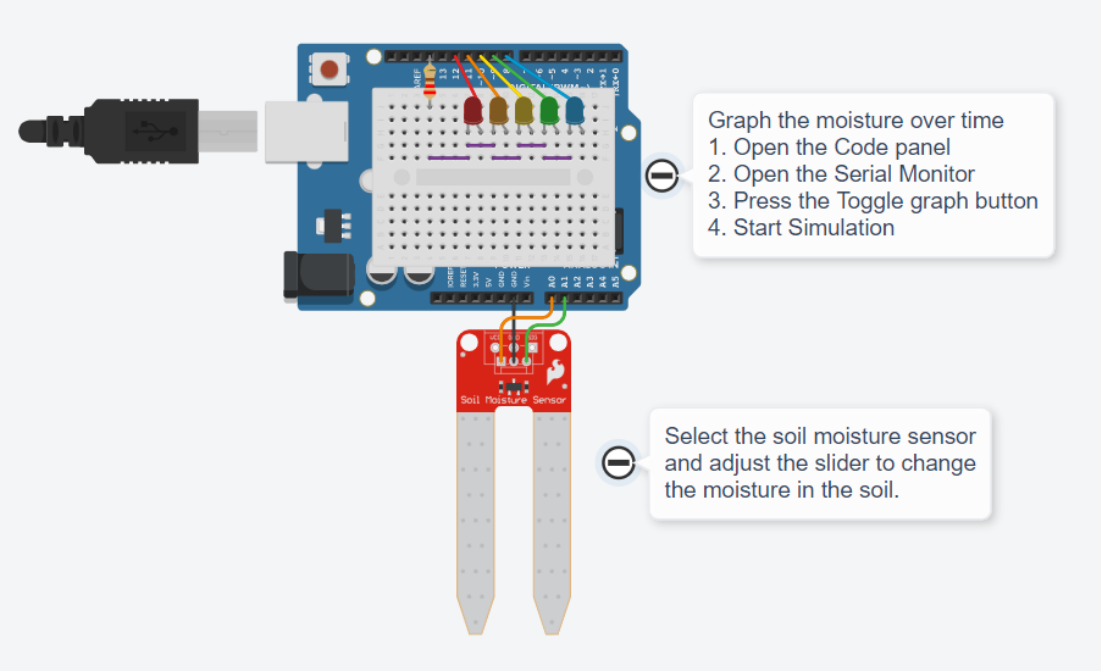
Exercici: Analitzar el funcionament amb el multímetre

Mesura temperatura



https://www.tinkercad.com/things/6M4rpEIlVrE

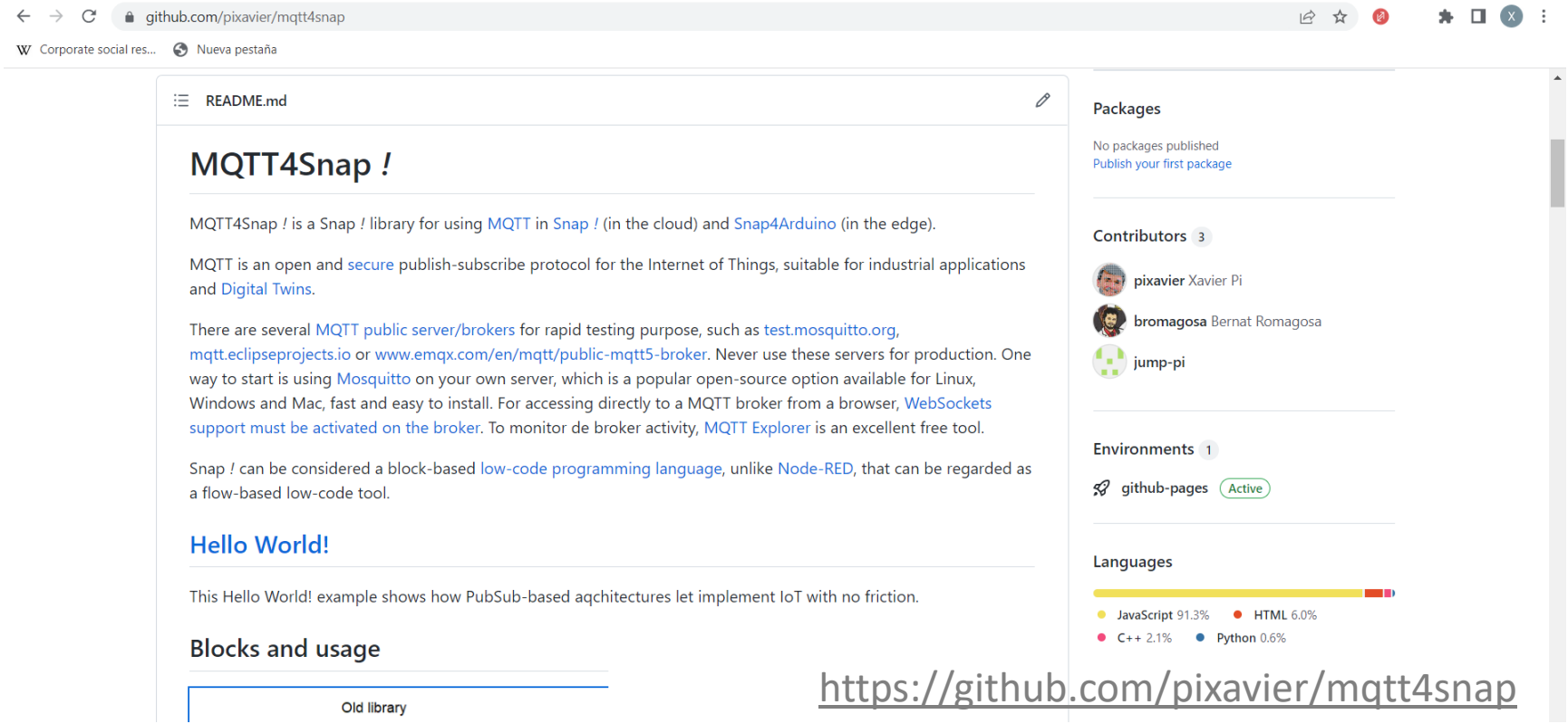
Mesura d'humitat



Moisture **Arduino Starter**. Exercici: Analitzar i entendre l'exemple.

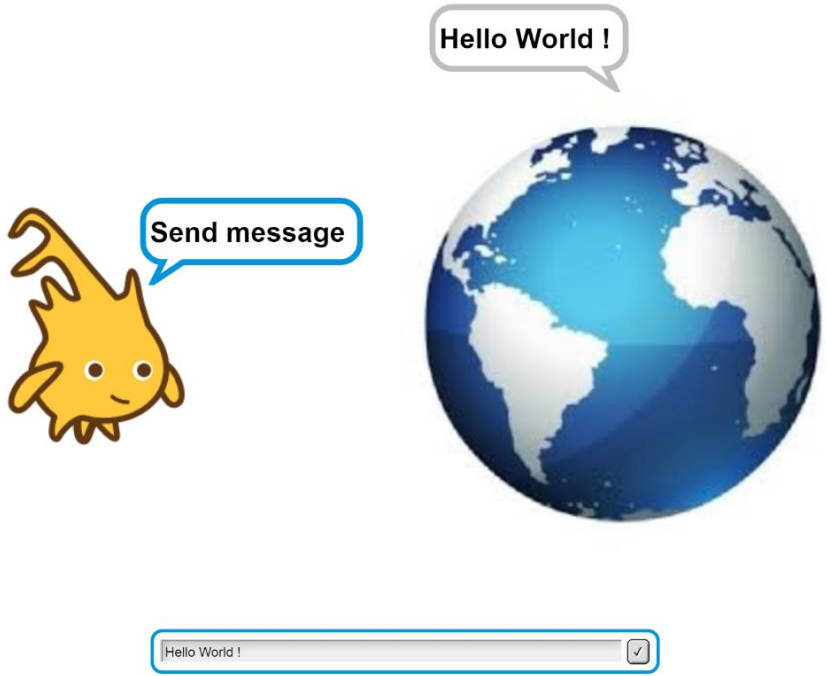
PROTOCOLS DE COMUNICACIONS IOT: MQTT I HTTP

Protocol MQTT. PubSub vs client-server



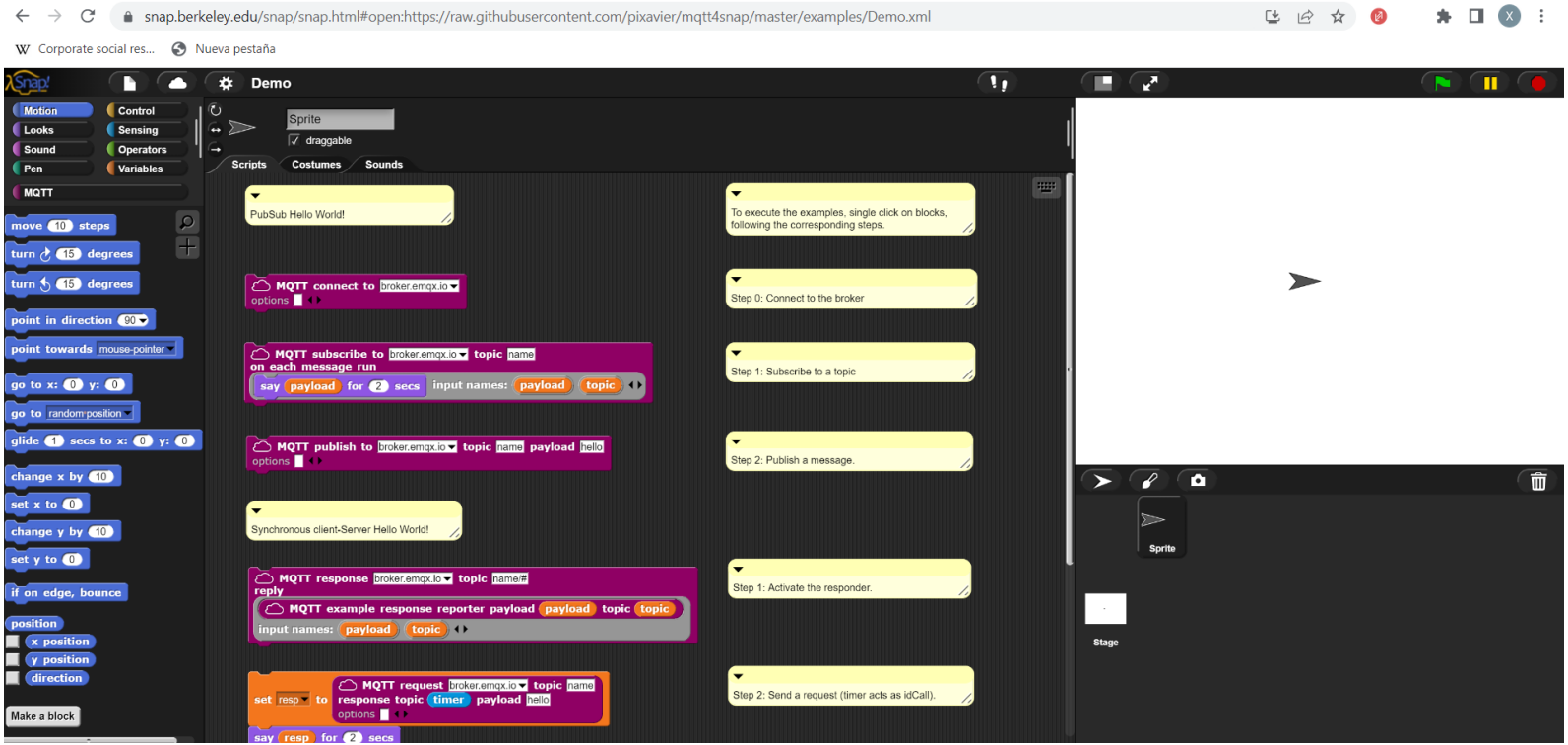
https://github.com/pixavier/mqtt4snap

Protocol MQTT: Hello World !



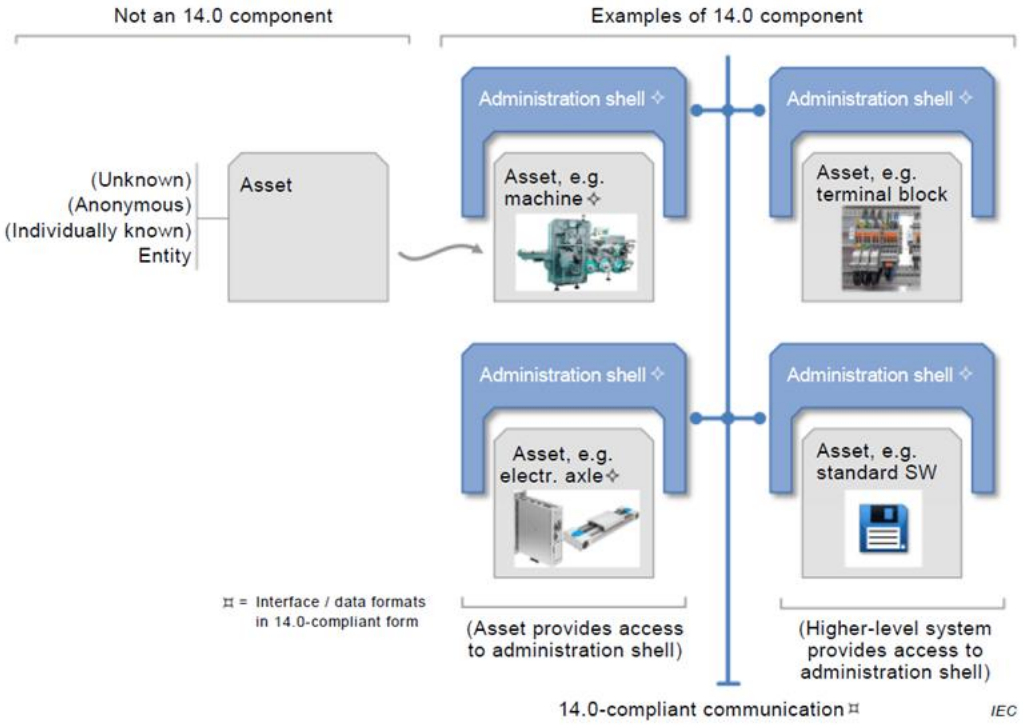
http://extensions.snap.berkeley.edu/snap/snap.html#run:http://raw.githubusercontent.com/pixavier/mqtt4snap/master/examples/HelloWorld.xml

Llenguatges low-code de blocs (Snap!, Scratch)



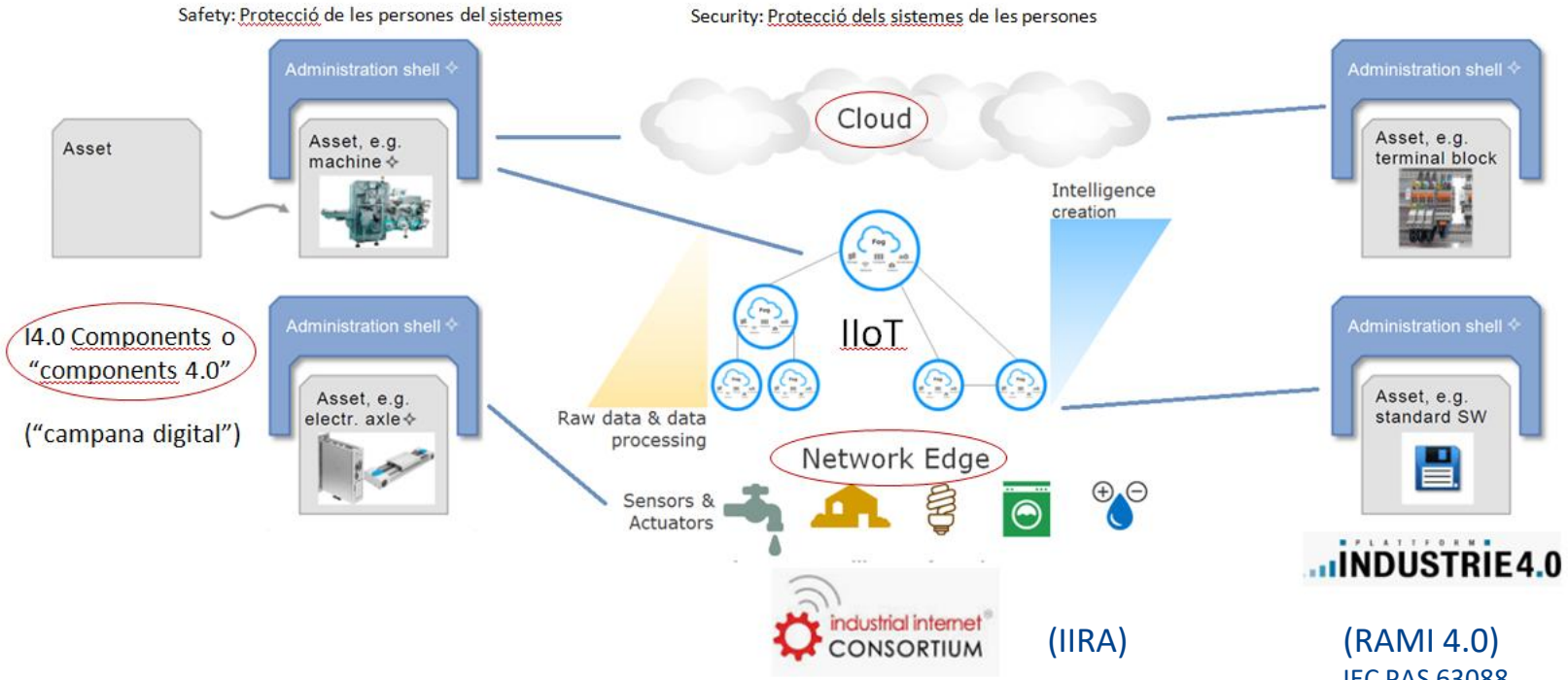
MQTT Demo

Noció de núvol. Cloud i Edge computing



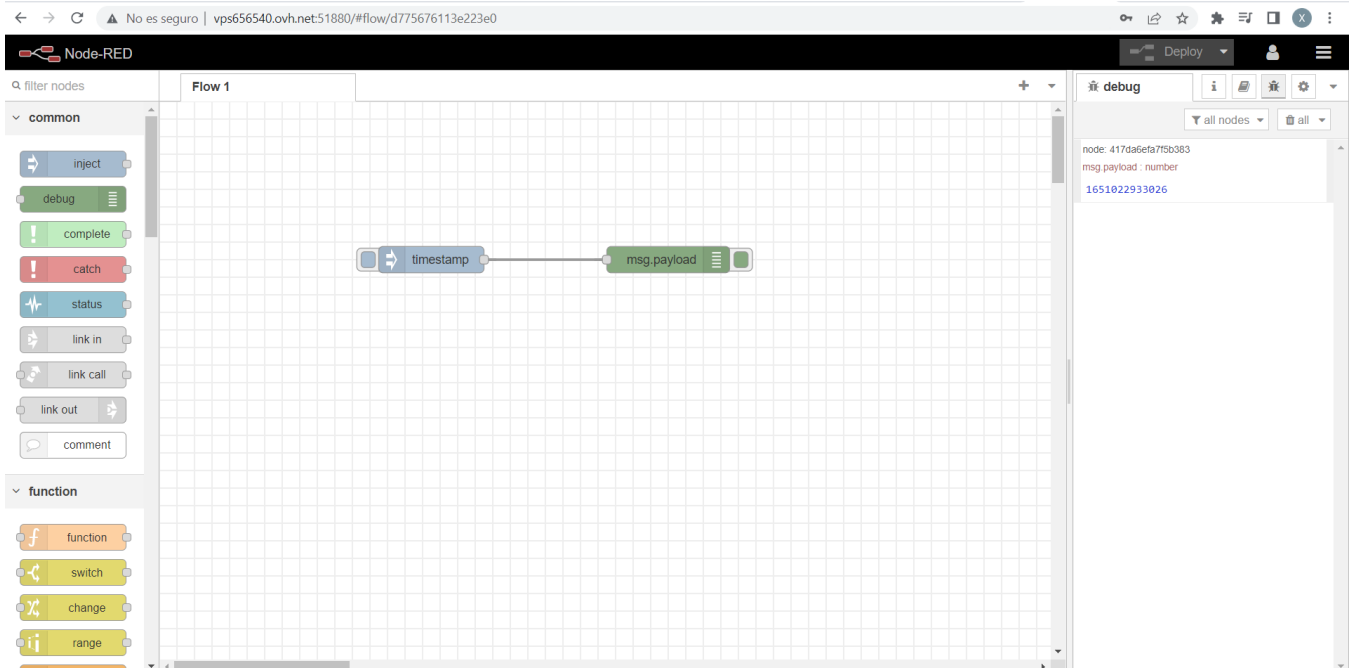
(RAMI 4.0)
IEC PAS 63088

Noció de núvol. Cloud i Edge computing



Llenguatges low-code de fluxos

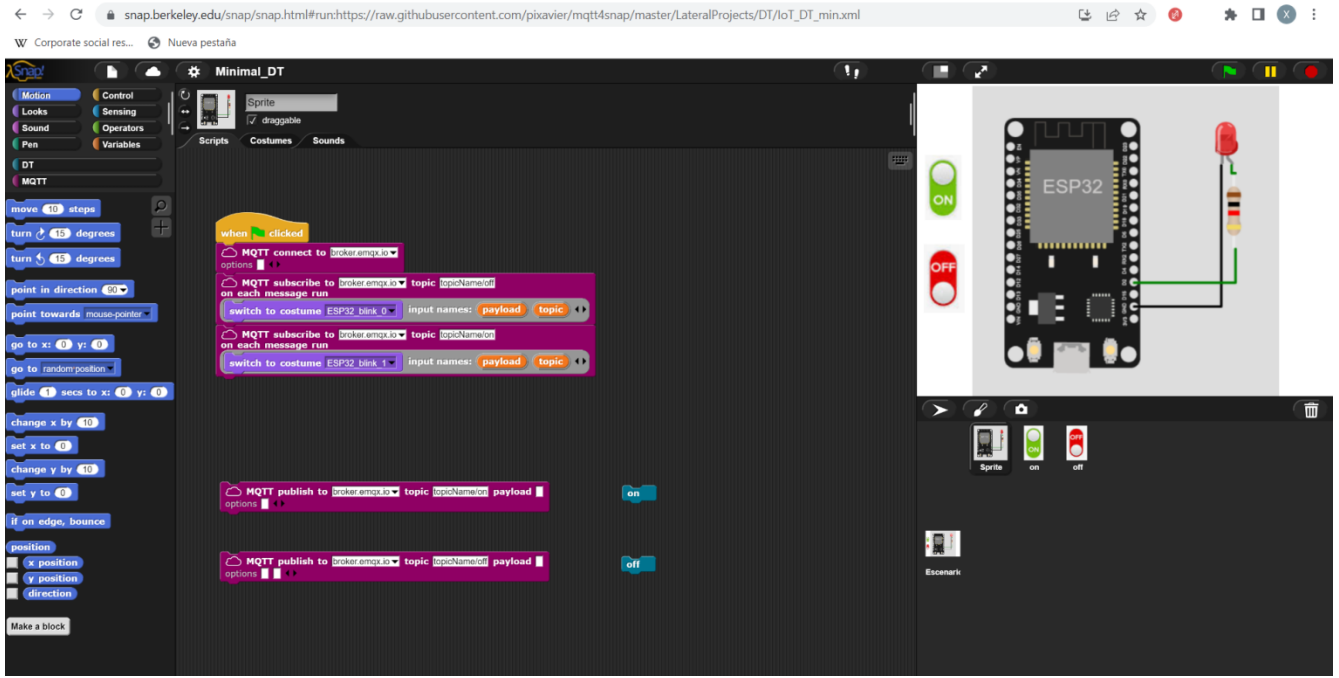
(Node-RED)



http://vps656540.ovh.net:5x880

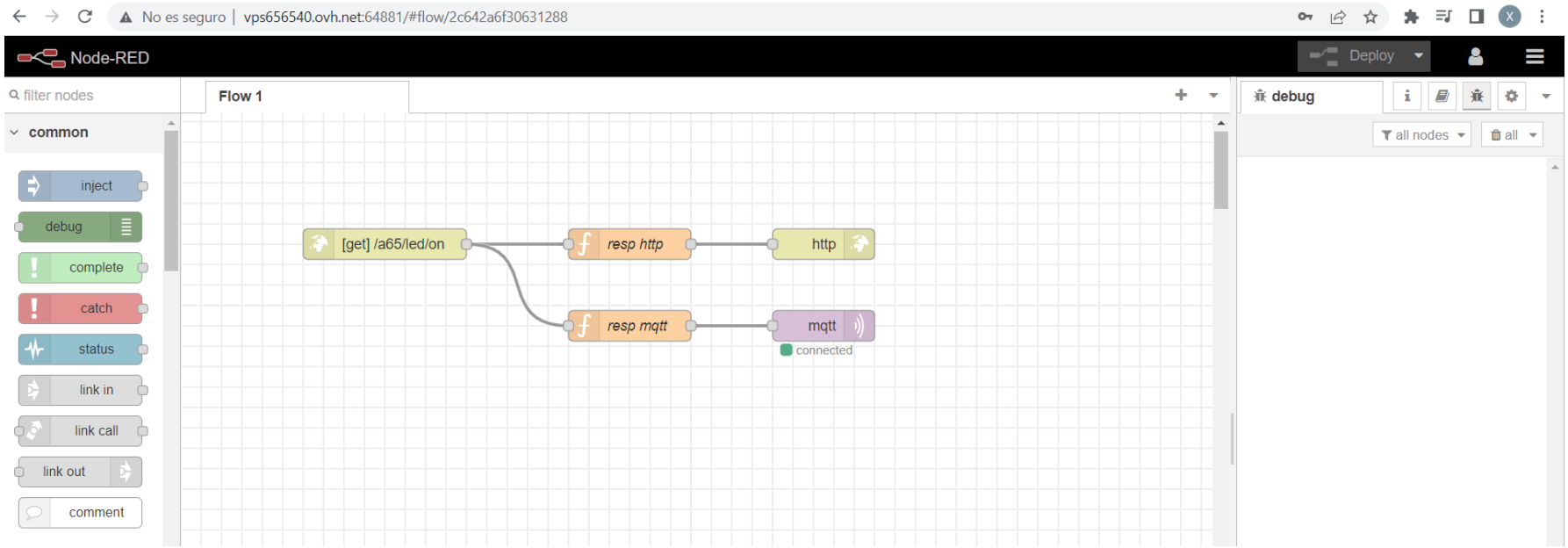
Connexió al núvol

Noció de Bessó Digital (Digital Twin)



https://snap.berkeley.edu/snap/snap.html#run:https://raw.githubusercontent.com/pixavier/mqtt4snap/master/LateralProjects/DT/IoT_DT_min.xml

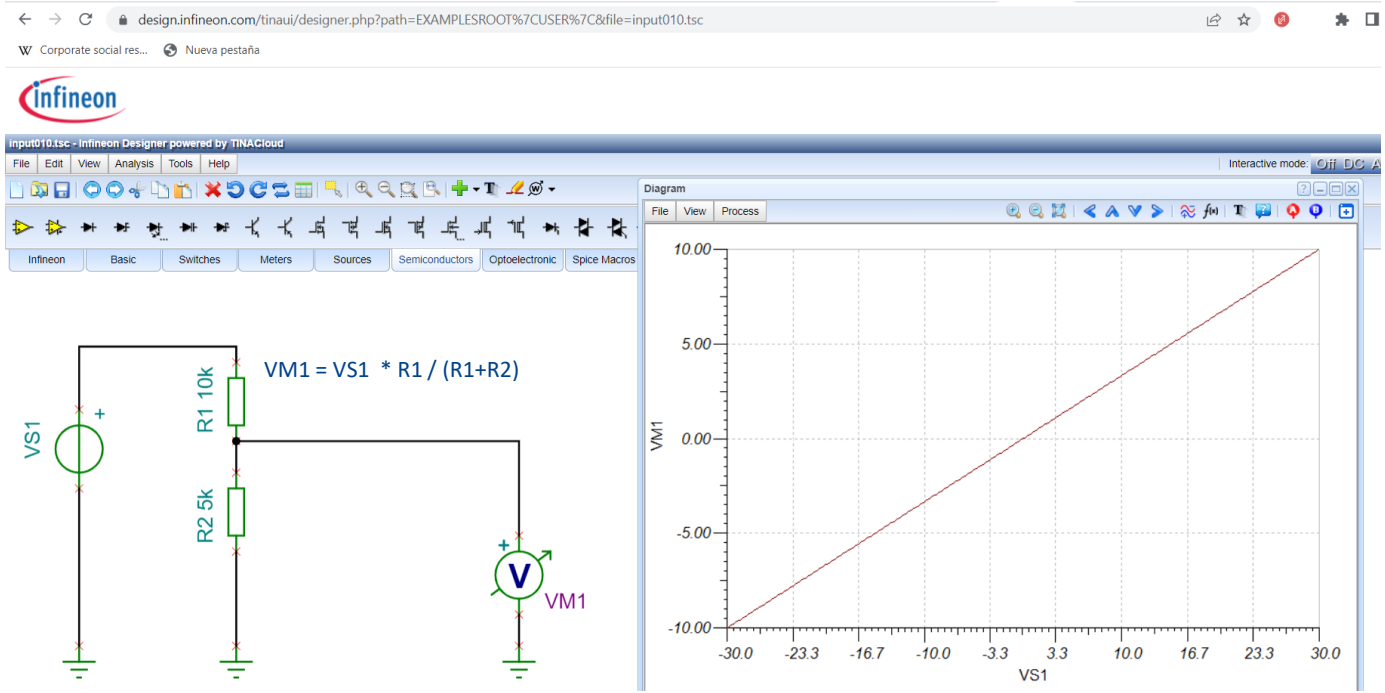
Protocol HTTP. Noció d'URL. Bridge HTTP-MQTT



http://vps656540.ovh.net:64881/a65/led/on

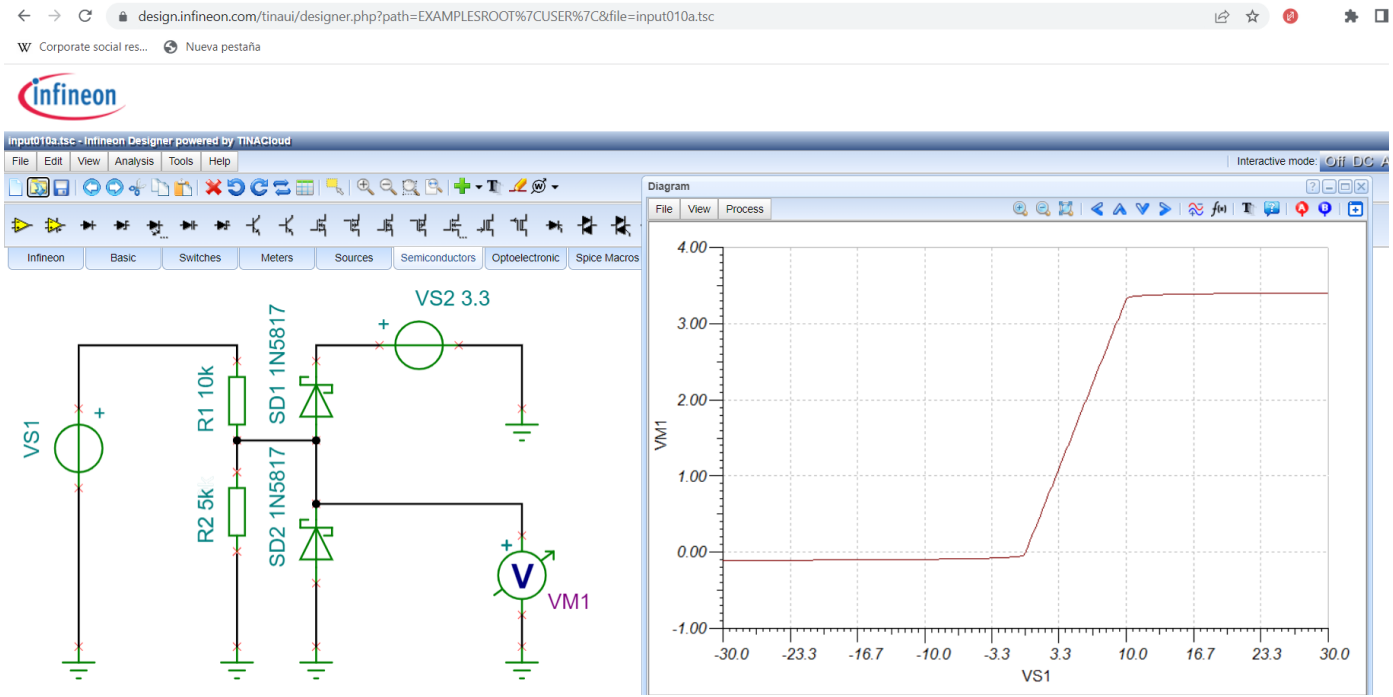
SENSORS I ACTUADORS EN ENTORNS INDUSTRIALS

Entrades analògiques i digitals.10V,24V

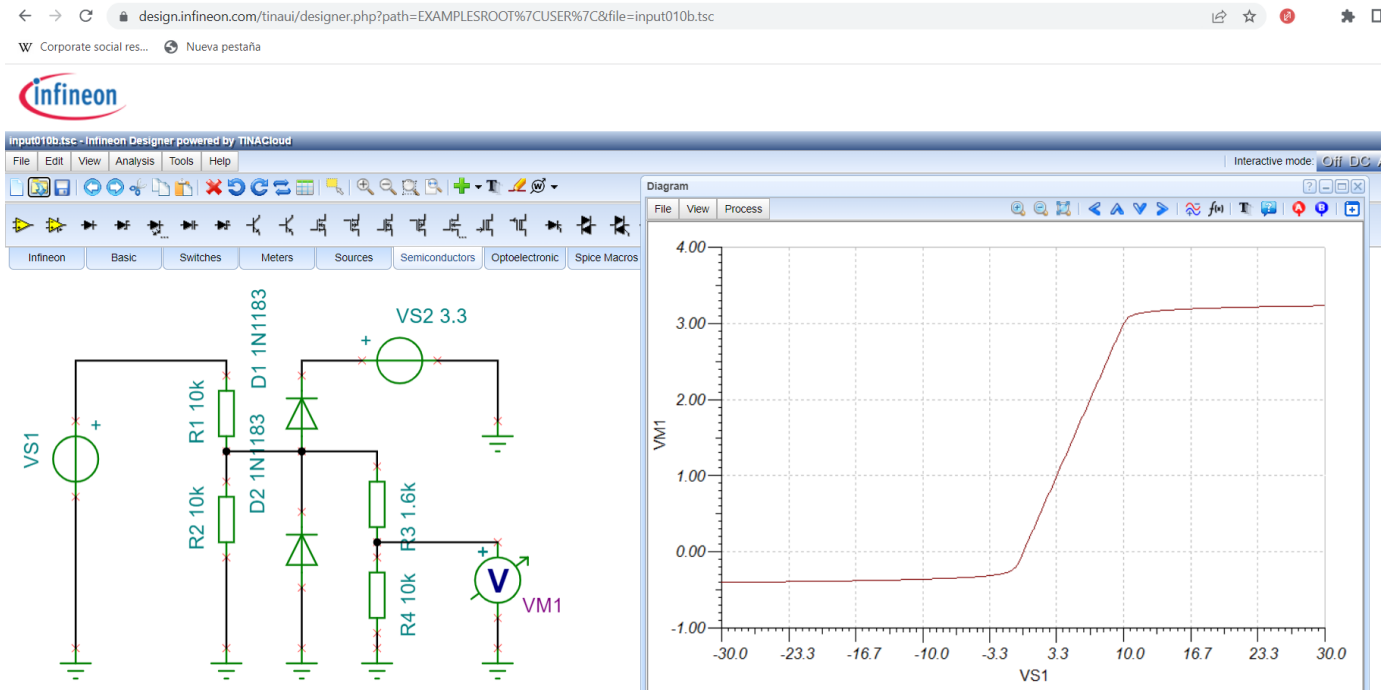


https://design.infineon.com/tinaui/designer.php?c=62266a588651e

Entrades analògiques i digitals.10V,24V

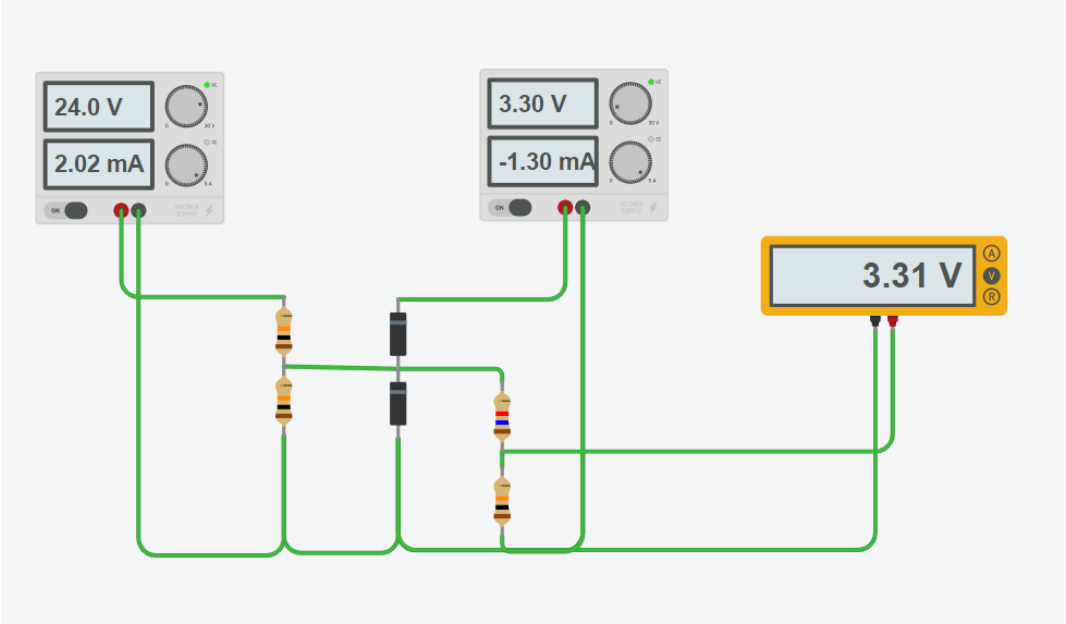


Entrades analògiques i digitals.10V,24V



https://design.infineon.com/tinaui/designer.php?c=63394a77db71b

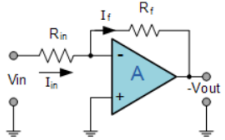
Entrades analògiques i digitals.10V,24V



https://www.tinkercad.com/things/428kNkFBRgR

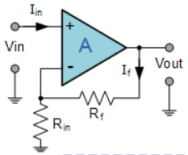
Sortides digitals 24V

Inverting Op-amp



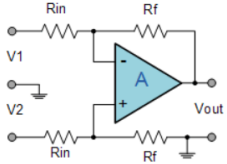
$$A = \frac{Vout}{Vin} = -\frac{Rf}{Rin}$$

Non-inverting Op-amp



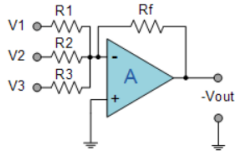
$$A = \frac{Vout}{Vin} = 1 + \frac{Rf}{Rin}$$

Differential Op-amp



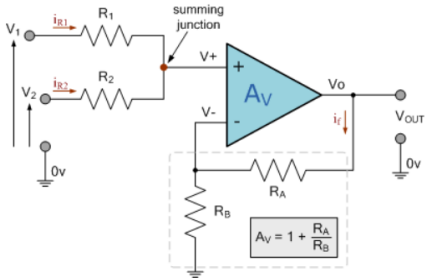
$$Vout = \frac{Rf}{Rin}(V2 - V1)$$

Inverting Summing Op-amp



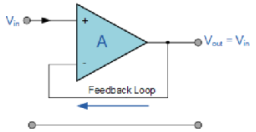
$$Vout = -\left(\frac{Rf}{R1}V1 + \frac{Rf}{R2}V2 + \frac{Rf}{R3}V3\right)$$

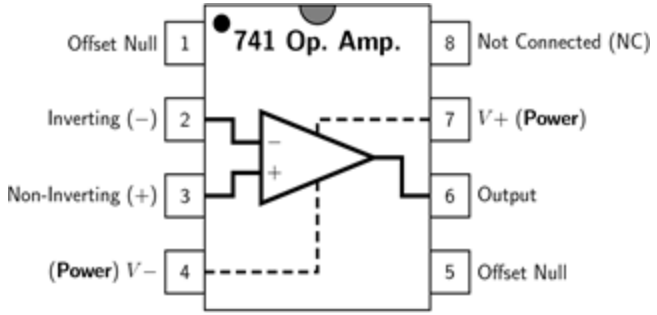
Non-inverting Summing Op-amp



Vout = (V1 + V2) AV / 2

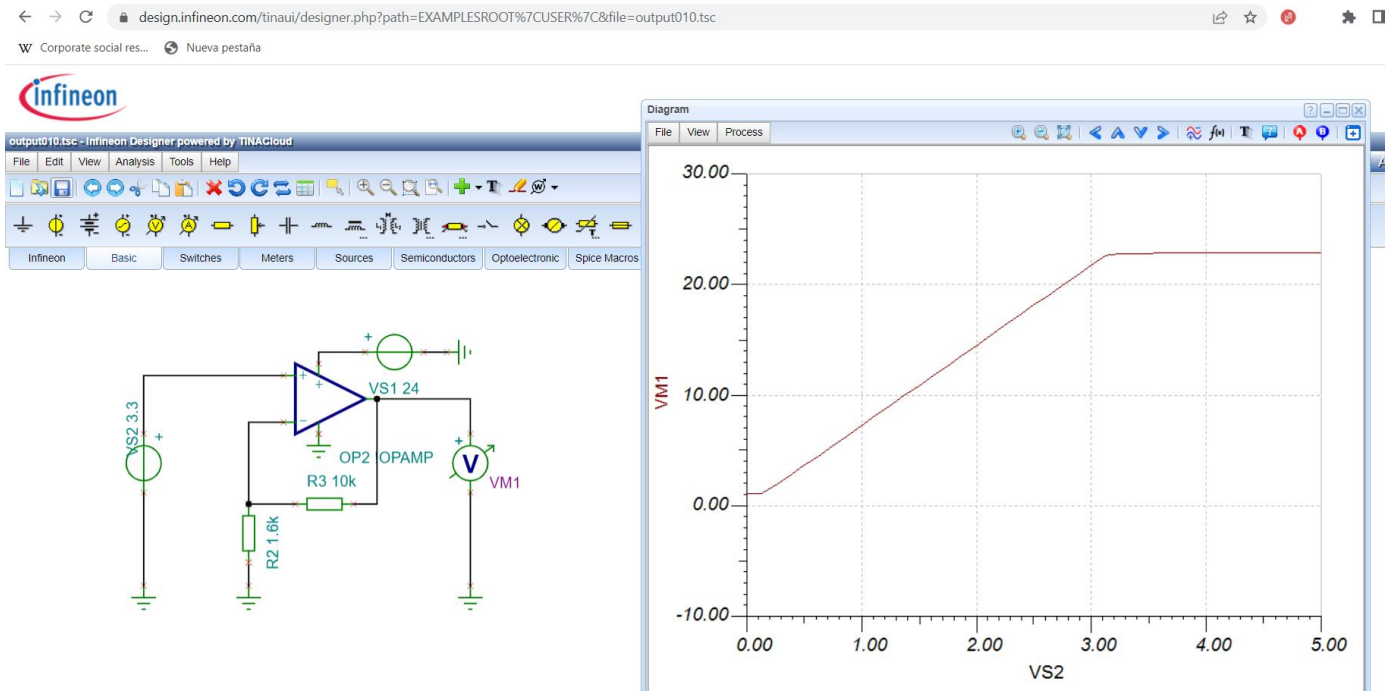
Voltage Follower





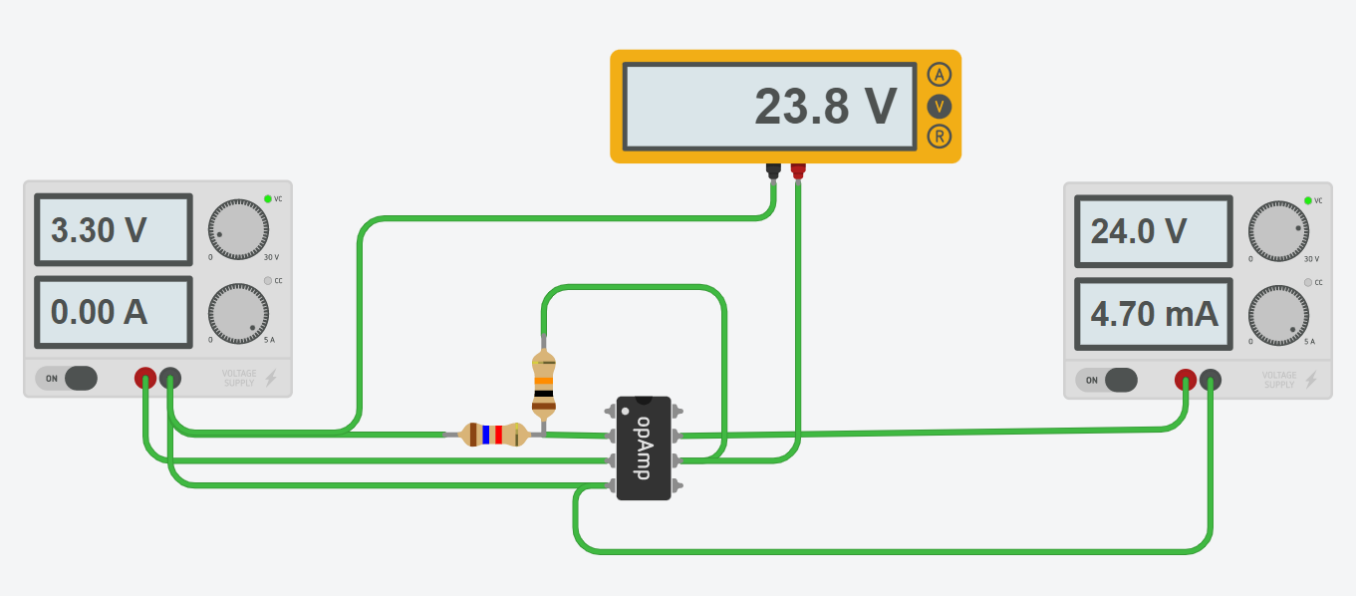
https://www.electronics-tutorials.ws/opamp/opamp_3.html

Sortides digitals 24V



https://design.infineon.com/tinaui/designer.php?c=633969e35341e

Sortides digitals 24V



https://www.tinkercad.com/things/2QMMBjVqQFp

Gràcies !

Xavier Pi

xpi@enginyers.net

https://www.eic.cat/content/gt-embedded-systems-iot

www.comissioindustria40.cat

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Industrials de Catalunya