



Mmm...  
Smells like Chips!

Diana Gastrin, RS2022

# WHO AM I?



אוניברסיטת בן-גוריון  
Gurion University  
of the Negev

B.Sc. in Computer Science



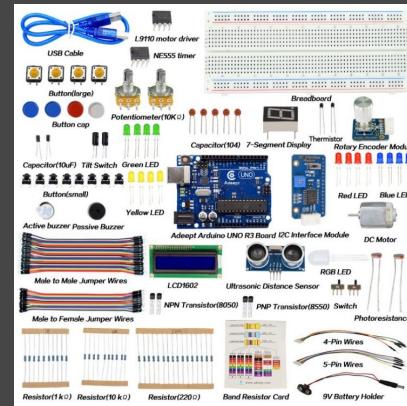
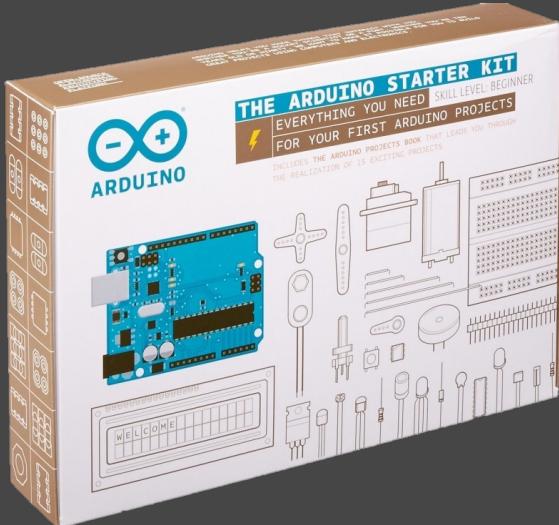
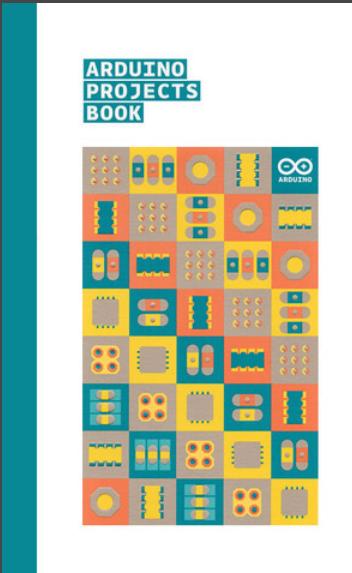
Software Developer



Side projects



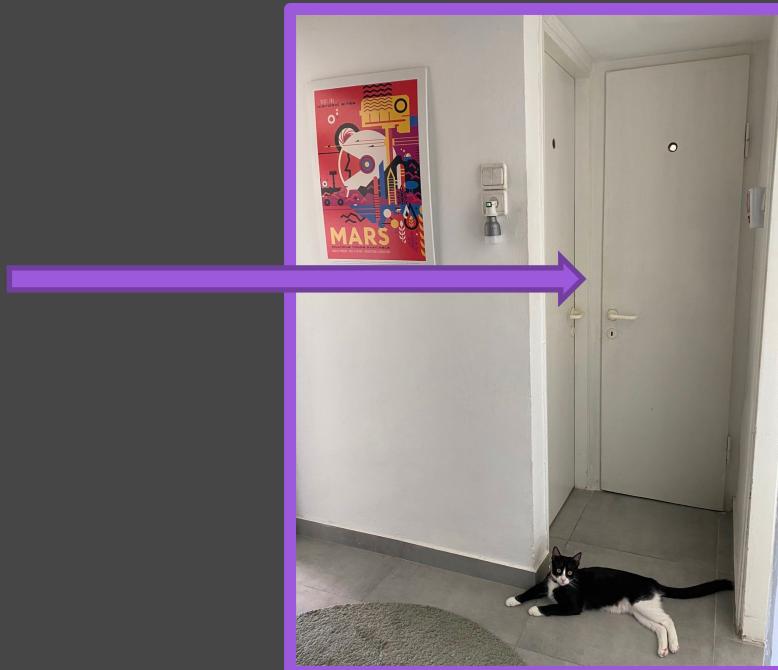
# Arduino Starter Kit



# The Problem



# The Problem



# The Problem



# The Pookimeter



# The Pookimeter

1

**What**

is a Pookimeter?



2

**Hardware parts**

build it from scratch



3

**Software parts**

Code and Burn



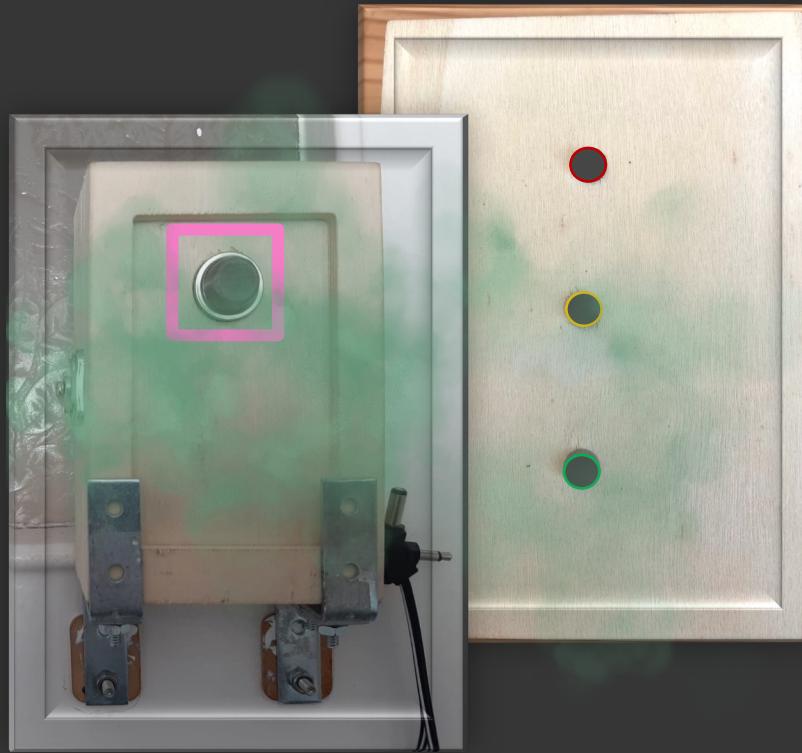
4

**Debug**

Offline and Online



# What is a Pookimeter



# What is a Pookimeter

Calibration mode **ON / OFF**

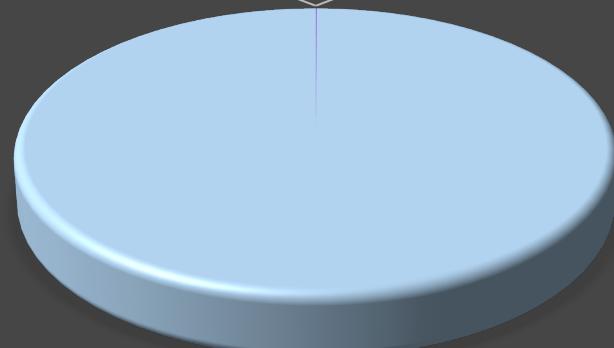


Set *min* and *max* va

# Human Gas Extraction

Methane, 1.87

Co2, 417

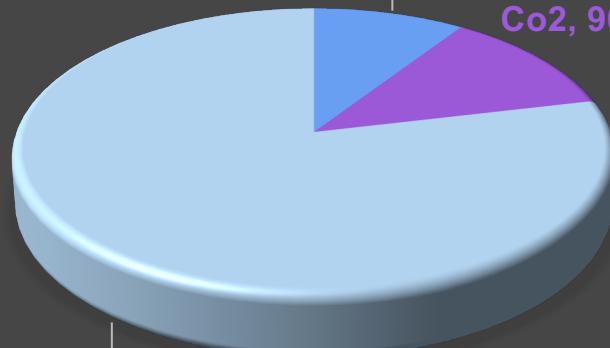


Clean Air

Nitrogen, 780840

Methane, 70000

Co2, 90000



Pooked Air

Nitrogen, 590000



# Demo



Danse Macabre by Kevin MacLeod is licensed under a Creative Commons Attribution 4.0 license. <https://creativecommons.org/licenses/by/4.0/>  
Source: <http://incompetech.com/music/royalty-free/index.html?collection=005> Artist: <http://incompetech.com/>

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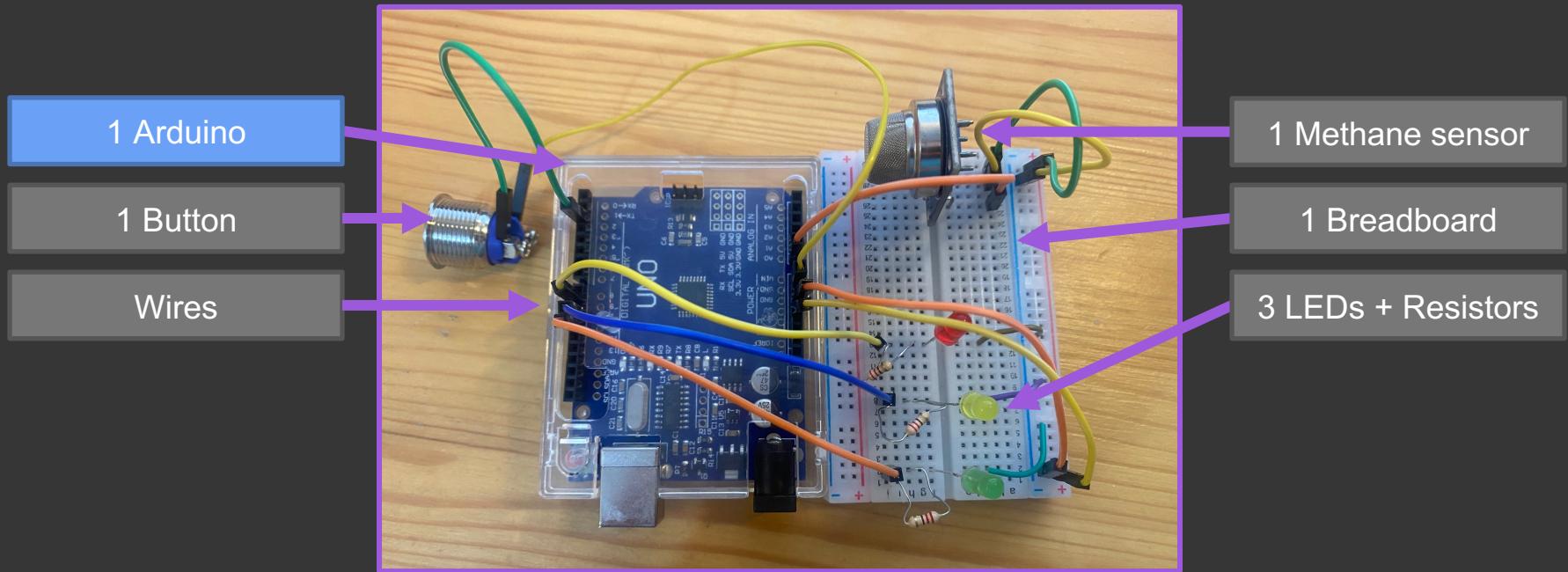
4

**Debug**

Offline and Online

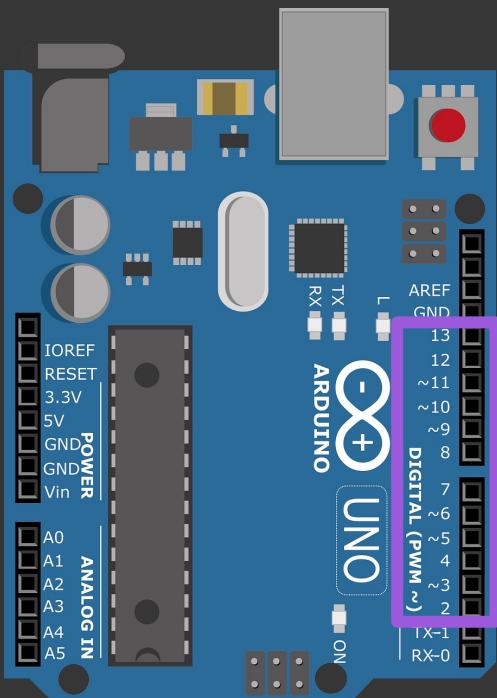


# Hardware parts

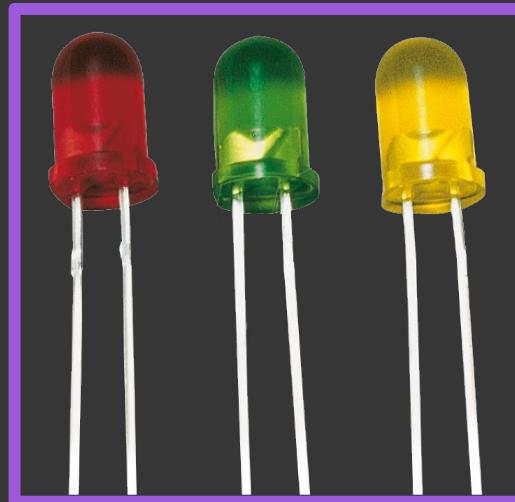


Version 1

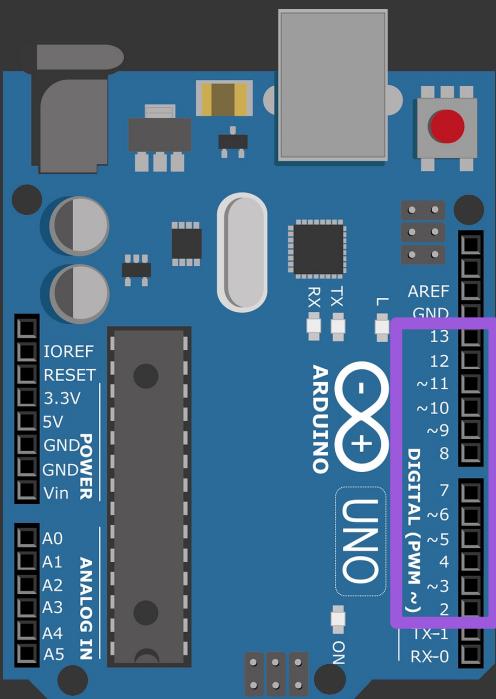
# Hardware parts



3 Digital Pins



# Hardware parts



Digital Pull-up resistor Pin

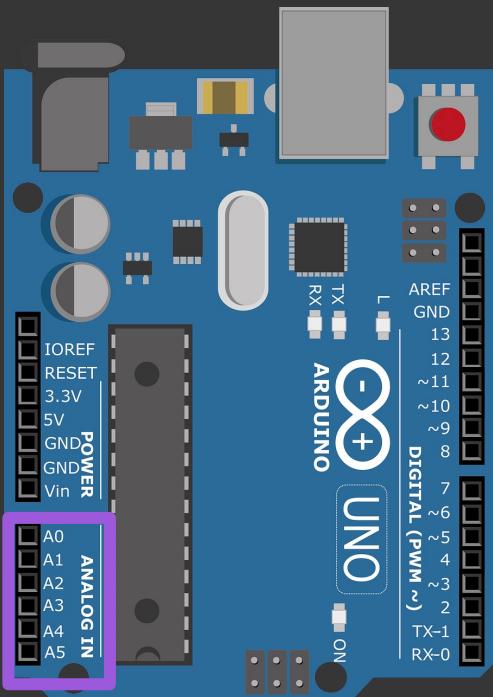
Pressed

Not Pressed

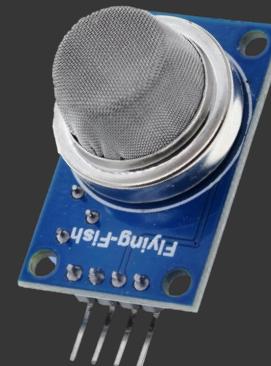
Low (0)

High (1)

# Hardware parts



1 Analog Pin

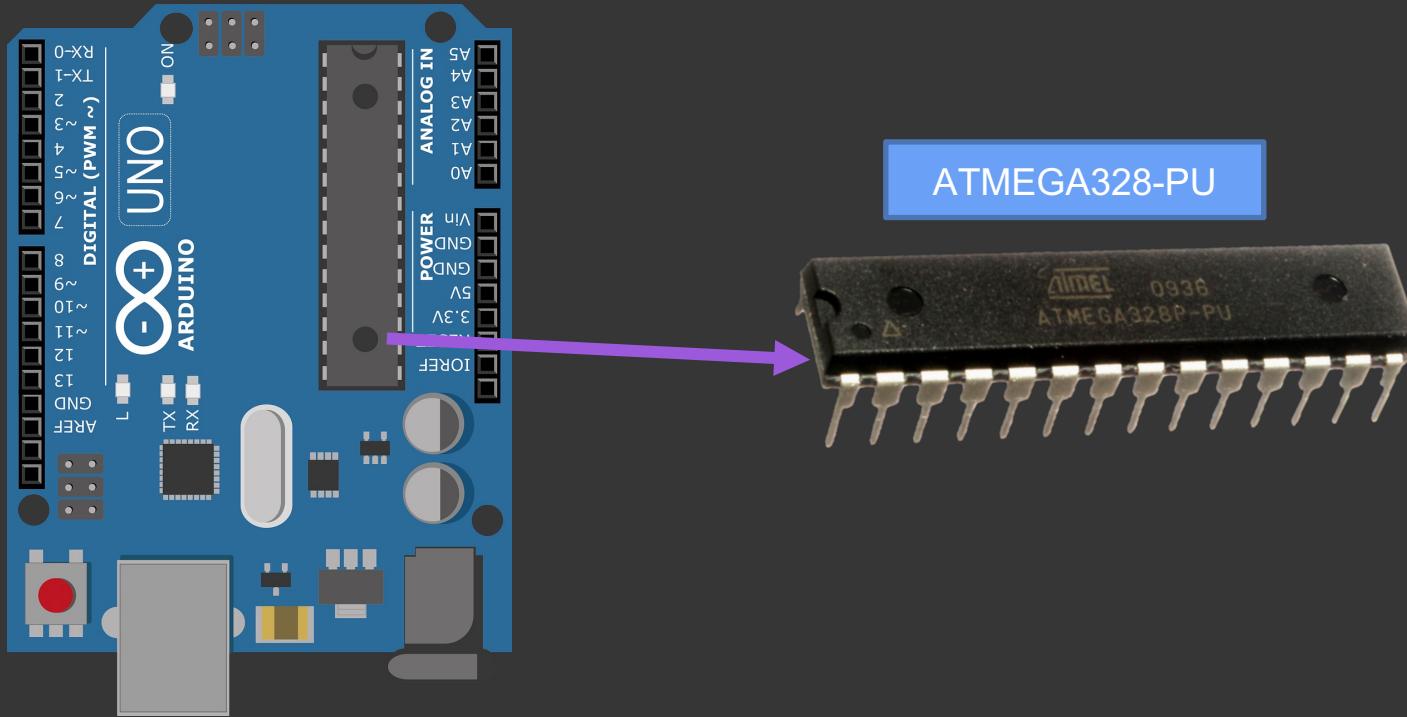


0 - 1023

1	0	1	1	1	0	1	0	1	1
---	---	---	---	---	---	---	---	---	---

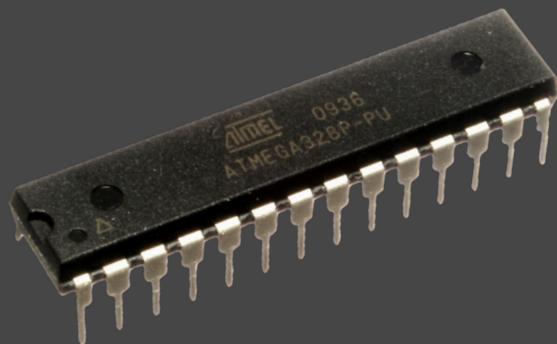
Cheaper  
and  
Smaller

# Hardware parts Microcontroller



# Hardware parts Microcontroller

ATMEGA328-PU



4  
Digital

PIC12F683

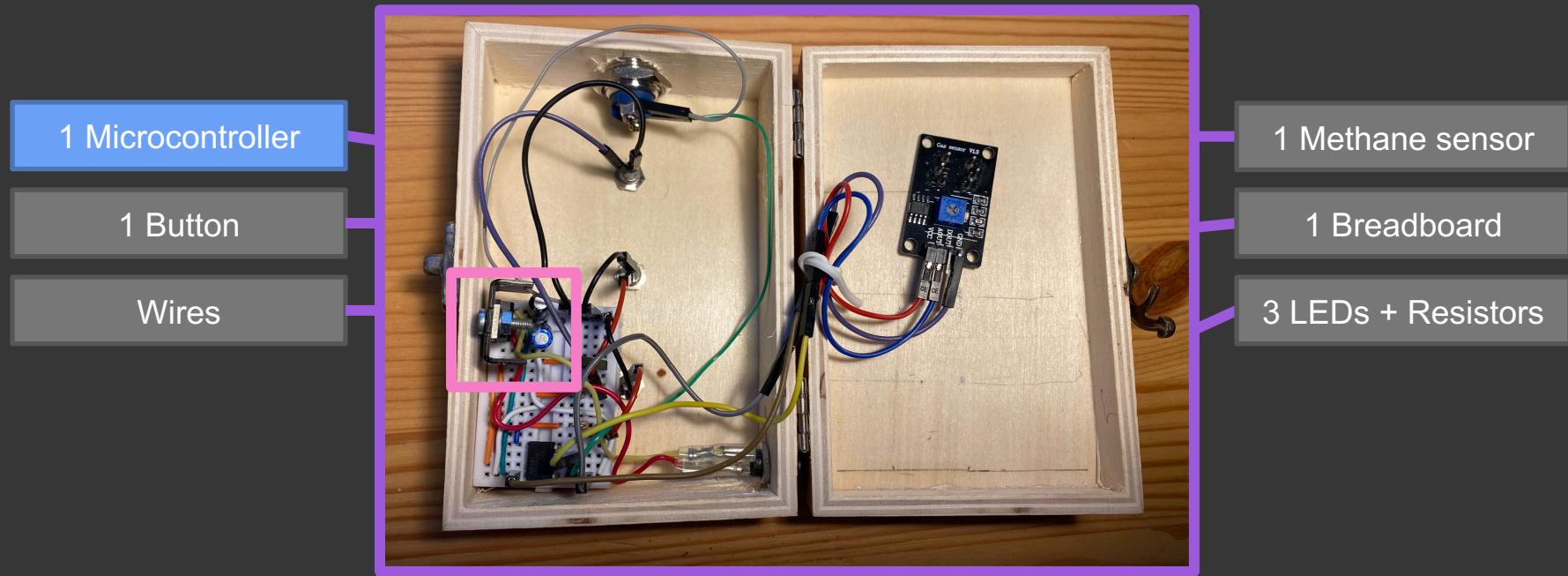


1  
Analog

# Pookimeter V2



# Hardware parts



Version 2

# Hardware parts Power supplier v1

Convert to 5v



9v



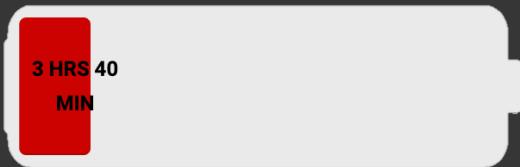
# Battery life

**Battery Capacity**

550 mAh ▾

**Device Consumption**

150 mA ▾



# Hardware parts Power supplier v2

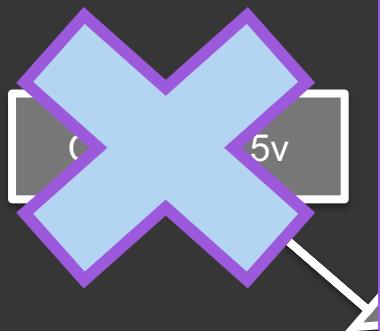
Convert to 5v



9v



# Hardware parts Power supplier v3

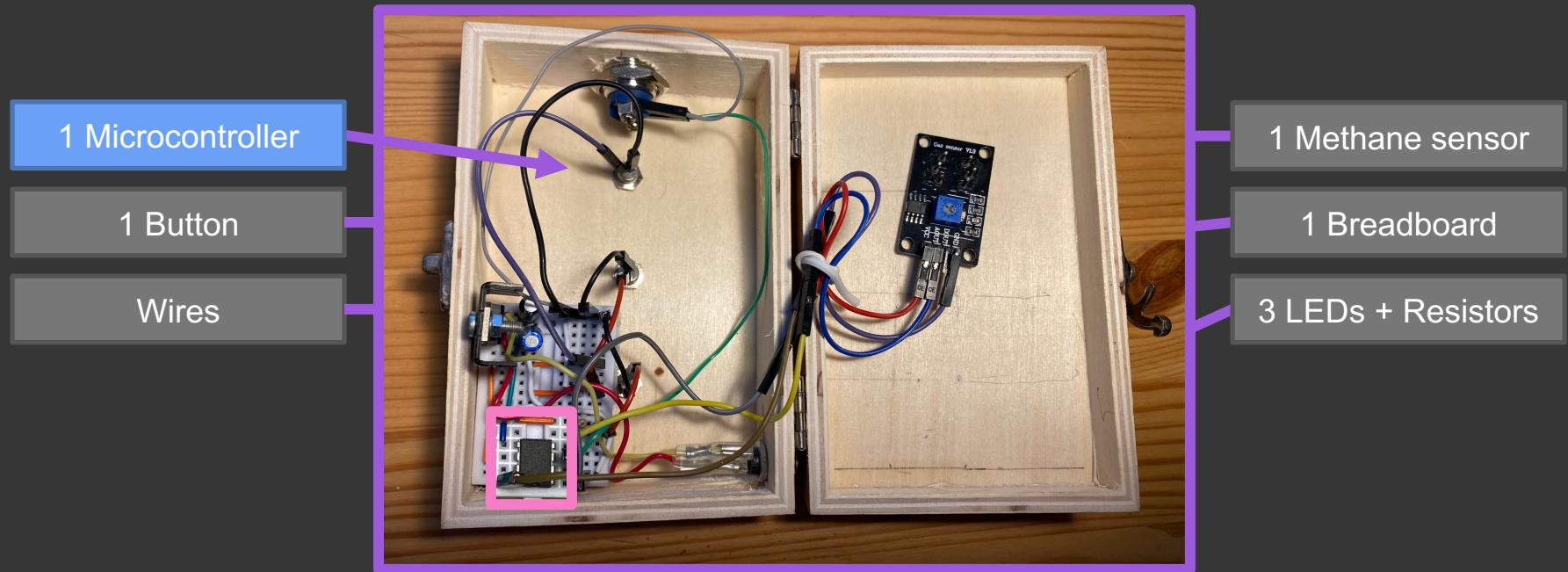


5v

USB 2.0

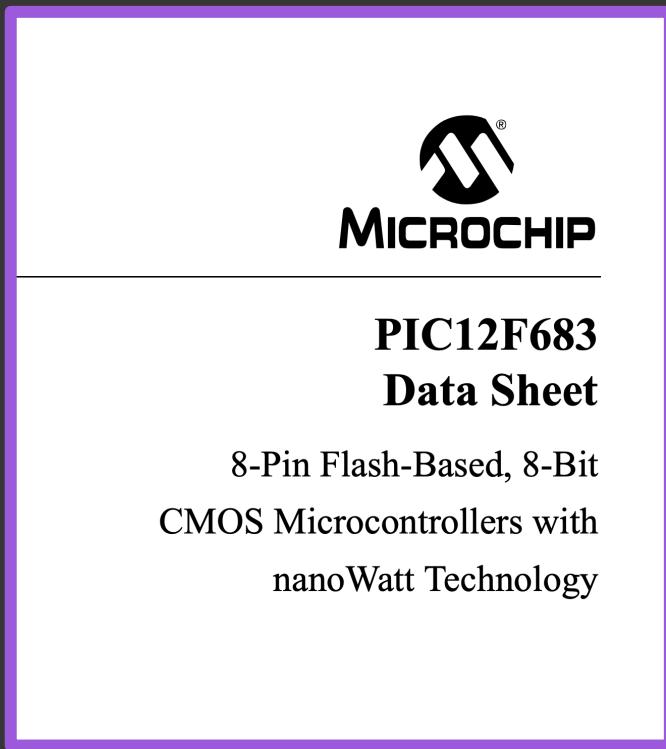


# Hardware parts



Version 2

# Microcontroller PIC12F683

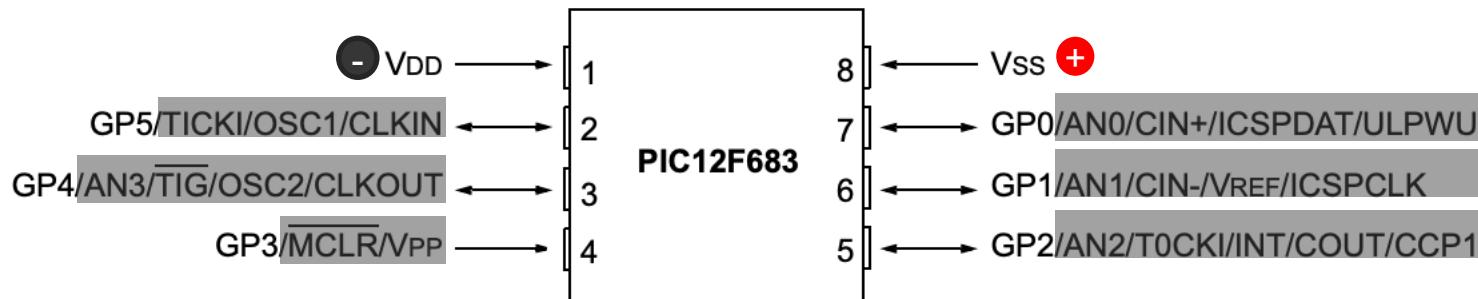


PIC12F683



# Microcontroller PIC12F683 I/O Ports

## 8-Pin Diagram (DFN)



# Microcontroller PIC12F683 I/O Ports

TABLE 1: 8-PIN SUMMARY

I/O	Pin	Analog	Comparators	Timer	CCP	Interrupts	Pull-ups	Basic
GP0	7	AN0	CIN+	—	—	IOC	Y	ICSPDAT/ULPWU
GP1	6	AN1/VREF	CIN-	—	—	IOC	Y	ICSPCLK
GP2	5	AN2	COUT	T0CKI	CCP1	INT/IOC	Y	—
GP3 <sup>(1)</sup>	4	—	—	—	—	IOC	Y <sup>(2)</sup>	MCLR/VPP
GP4	3	AN3	—	$\overline{T1G}$	—	IOC	Y	OSC2/CLKOUT
GP5	2	—	—	T1CKI	—	IOC	Y	OSC1/CLKIN
—	1	—	—	—	—	—	—	VDD
—	8	—	—	—	—	—	—	Vss

Note 1: Input only.

2: Only when pin is configured for external MCLR.

# Microcontroller PIC12F683 I/O Ports

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GP1	6	AN1/VREF	CIN-	—	—	IOC	Y	ICSPCLK
GP2	5	AN2	COUT	T0CKI	CCP1	INT/IOC	Y	—
GP3 <sup>(1)</sup>	4	—	—	—	—	IOC	Y <sup>(2)</sup>	MCLR/VPP
GP4	3	AN3	—	T1G	—	IOC	Y	OSC2/CLKOUT
GP5	2	—	—	T1CKI	—	IOC	Y	OSC1/CLKIN
—	1	—	—	—	—	—	—	VDD
—	8	—	—	—	—	—	—	Vss

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# Microcontroller PIC12F683 I/O Ports

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GP2	5	AN2	COUT	T0CKI	CCP1	INT/IOC	Y	—
GP3 <sup>(1)</sup>	4	—	—	—	—	IOC	Y <sup>(2)</sup>	MCLR/VPP
GP4	3	AN3	—	T1G	—	IOC	Y	OSC2/CLKOUT
GP5	2	—	—	T1CKI	—	IOC	Y	OSC1/CLKIN
—	1	—	—	—	—	—	—	VDD
—	8	—	—	—	—	—	—	Vss

Note 1: Input only.

2: Only when pin is configured for external MCLR.

Methane Sensor



Push Button



# Pookimeter V3

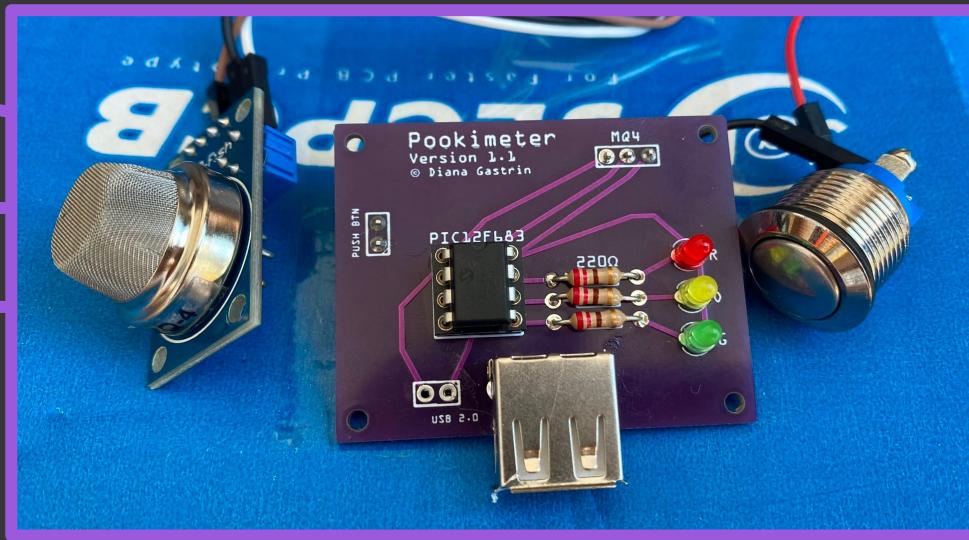


# Hardware parts PCB

1 Microcontroller

1 Button

Wires



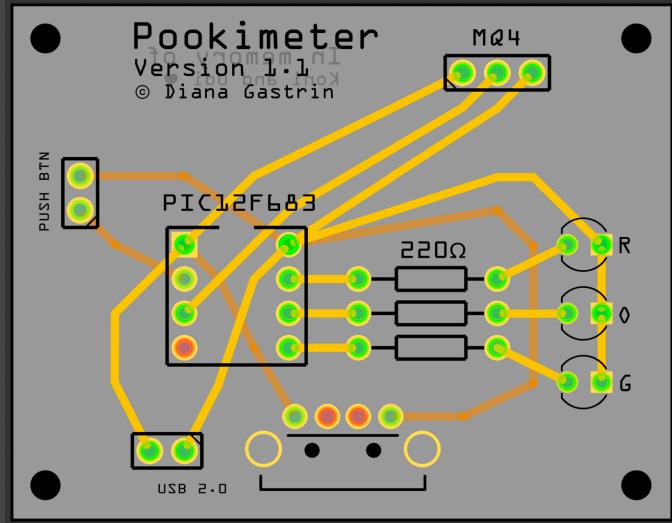
1 Methane sensor

1 Breadboard

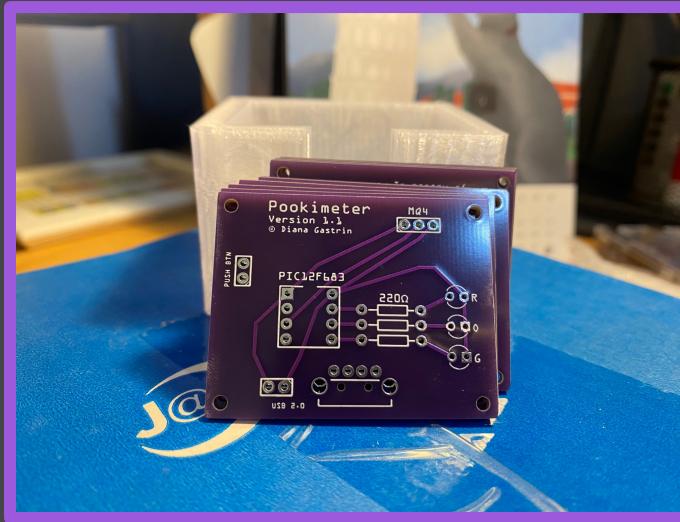
3 LEDs + Resistors

Version 3

# Creating a PCB

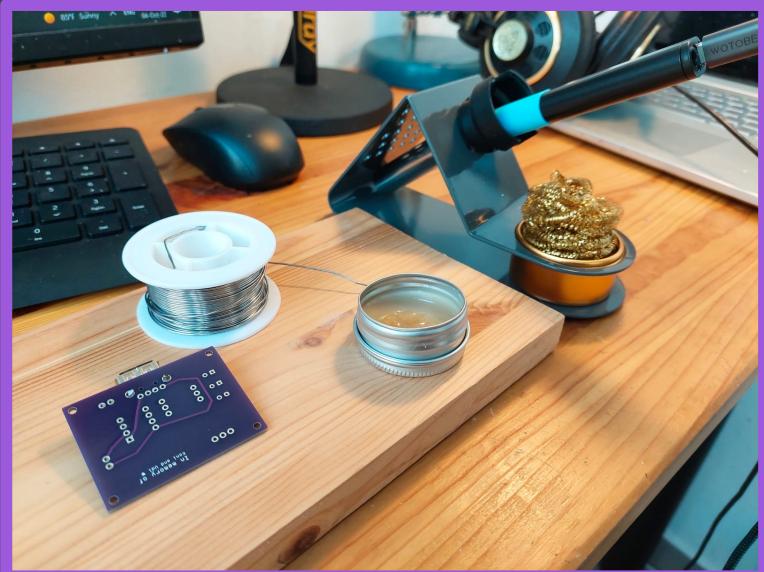


fritzing



J@LC JLCPBCB

# Creating a PCB



Soldering



Case printing



# The Pookimeter

1

**What**

is a Pookimeter?



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**Hardware parts**

build it from scratch



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Code and Burn



4

**Debug**

Offline and Online



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# Code



# IDE and Compiler



IDE

Compiler

# Code

```
void setup() {}
```

```
void loop() {}
```

# Code

```
void setup() {}
```

```
void loop() {}
```

# Code

```
void setup() {}
```

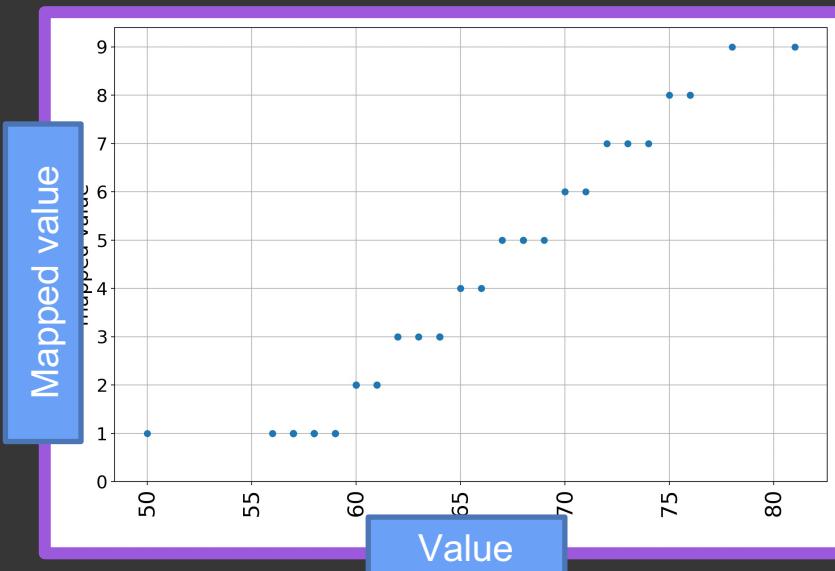
```
void loop() {}
```

# LOOP Methane Sensor value

```
void loop() {  
    while (1) {  
        // check if the analog-to-digital is ready  
        → if (ADCON0bits.GO_nDONE) {  
            continue;  
        }  
  
        → value = analogRead(METHANE_PIN);  
        ...  
    }  
}
```

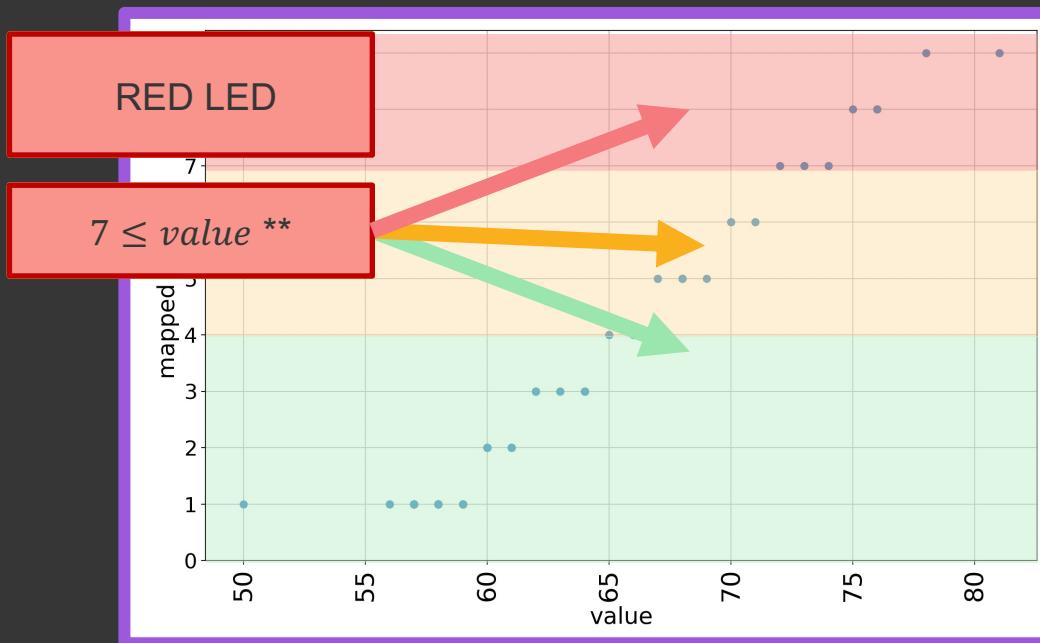
# LOOP Map value to 0 - 9

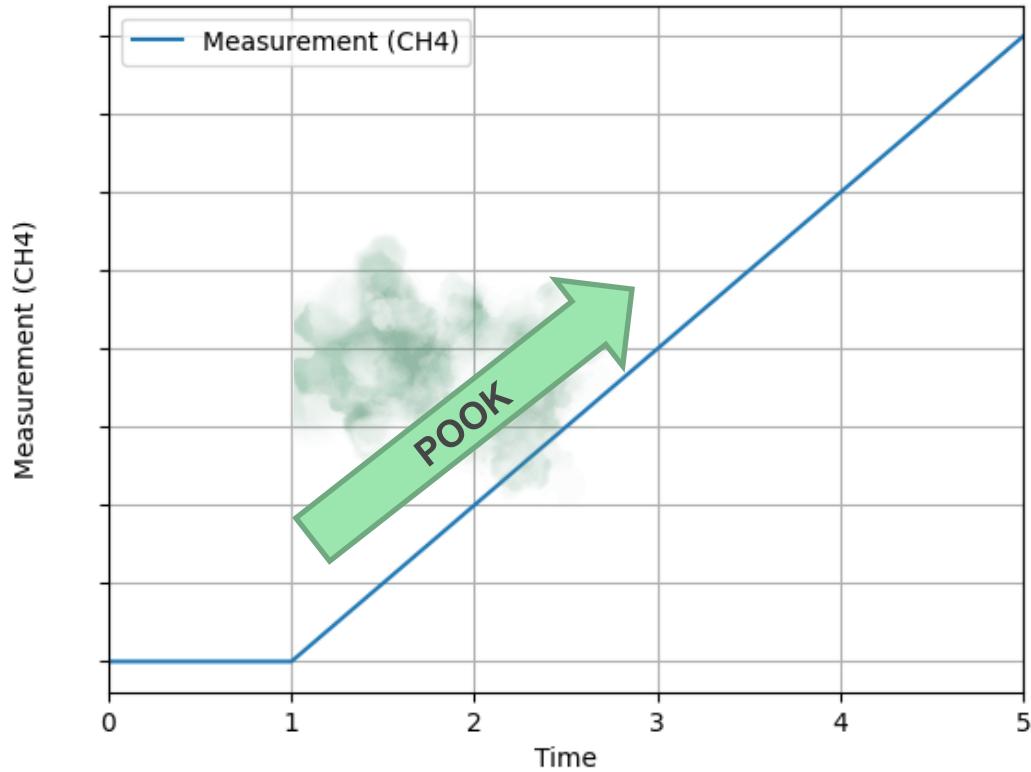
```
value = analogRead(METHANE_PIN);  
mapped_value = map(value, min, max, 0, 9);
```

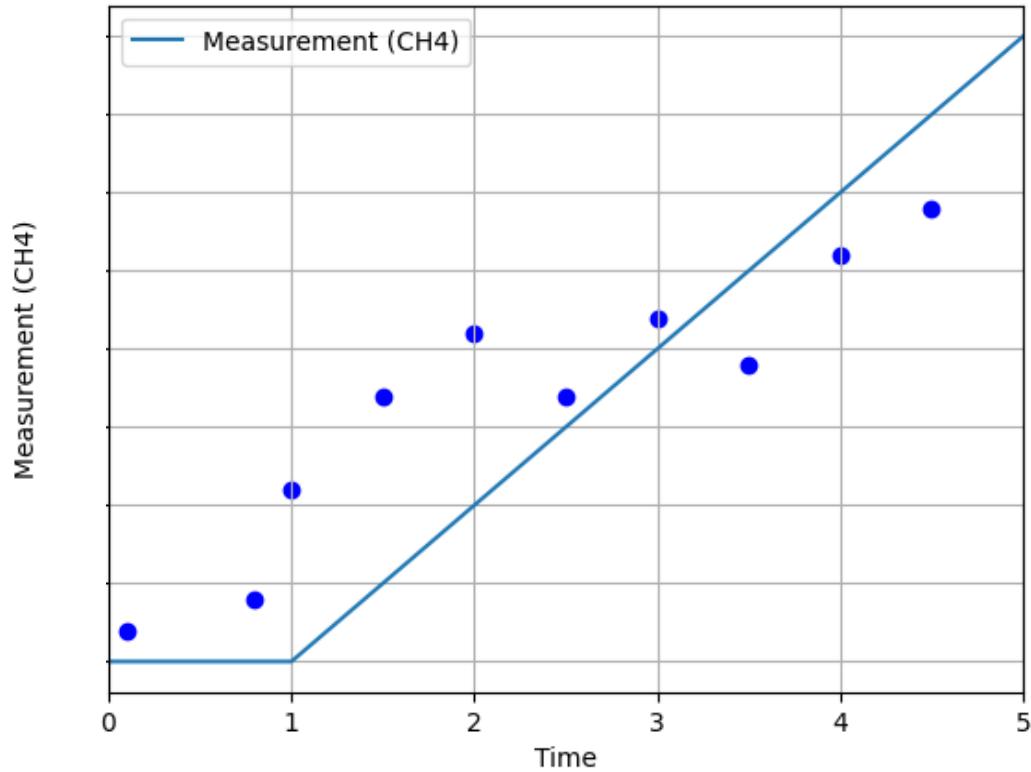


# LOOP Map value to 0 - 9

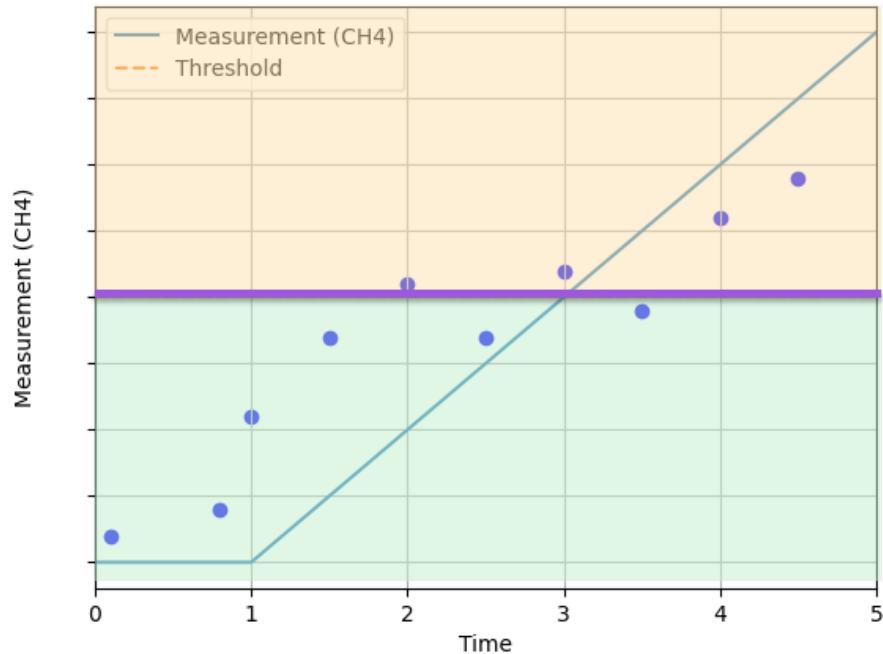
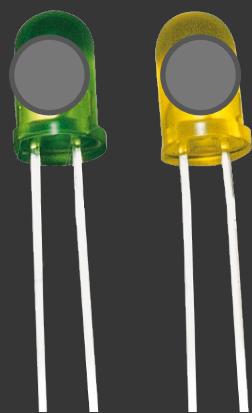
```
value = analogRead(METHANE_PIN);  
mapped_value = map(value, min, max, 0, 9);
```



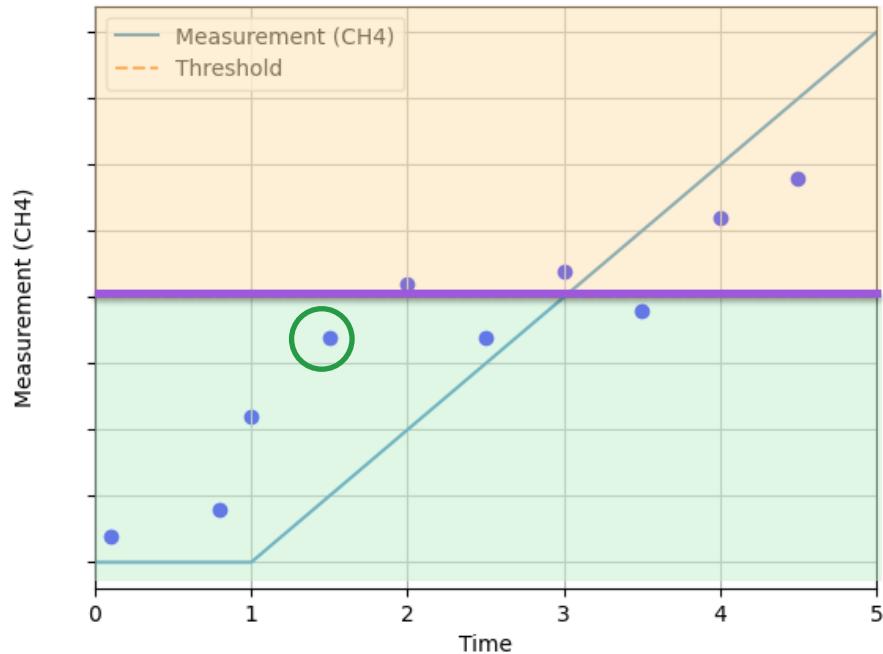
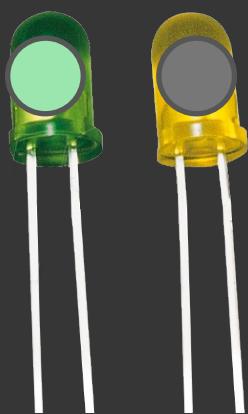




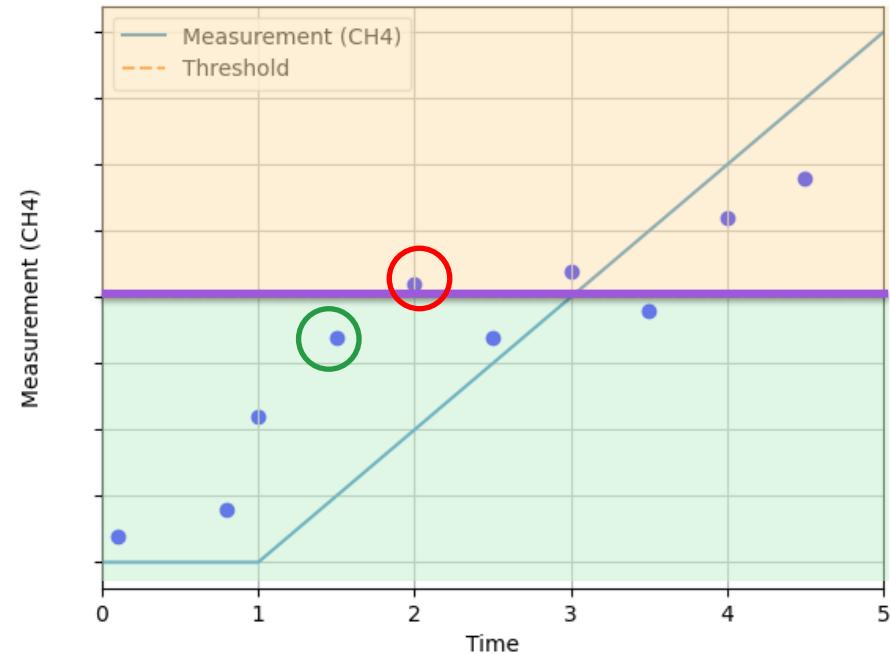
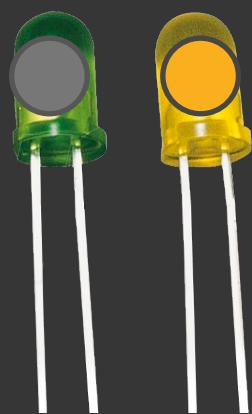
# Issue



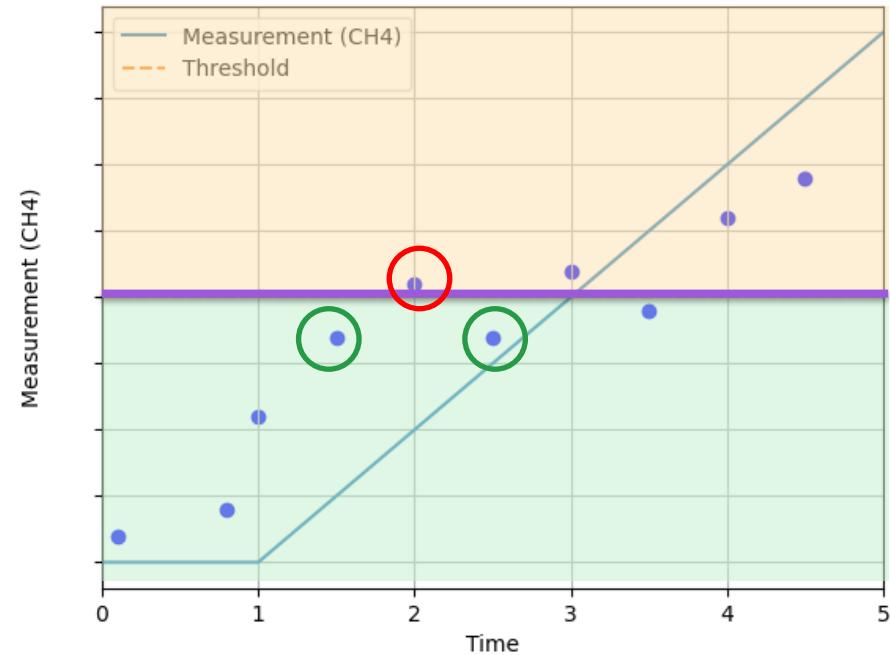
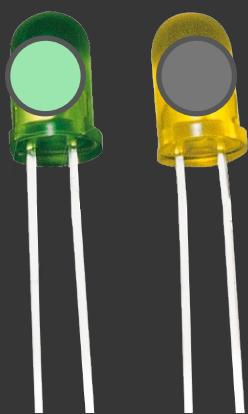
# Issue



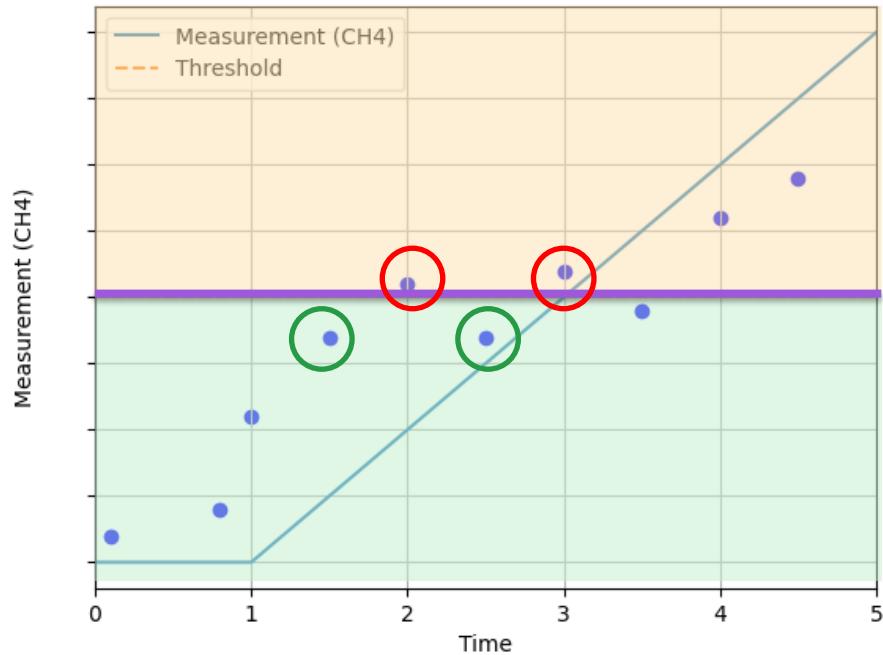
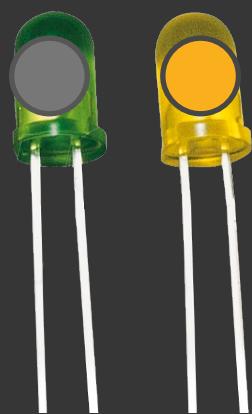
# Issue



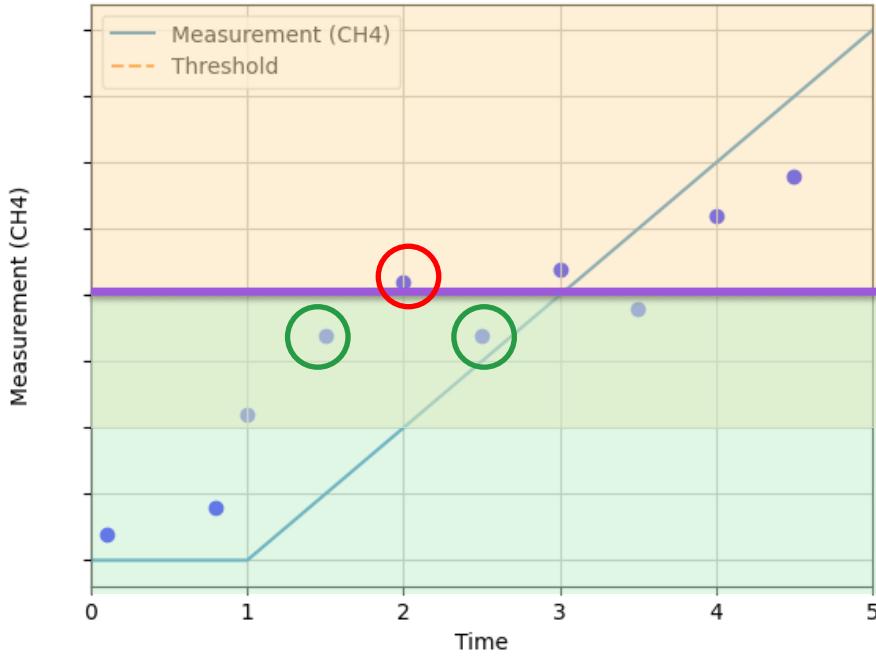
# Issue



# Issue

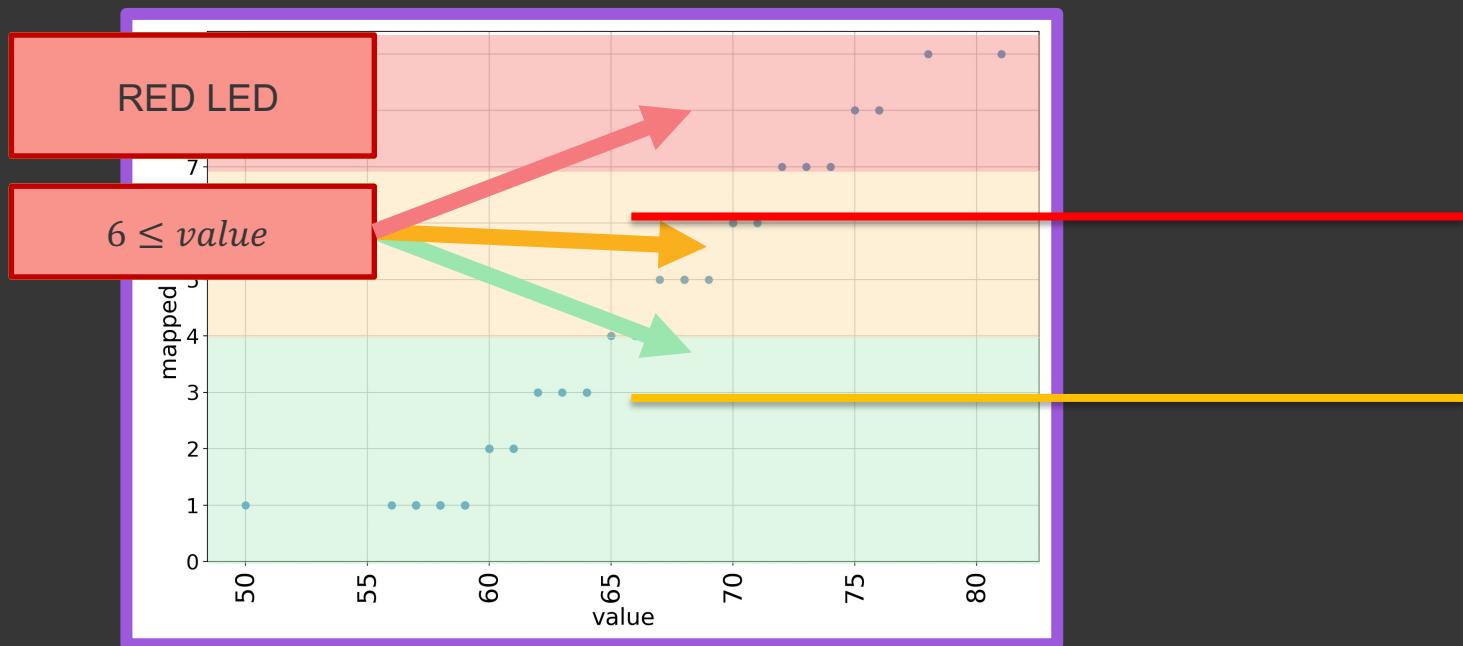


# Solution A Hysteresis

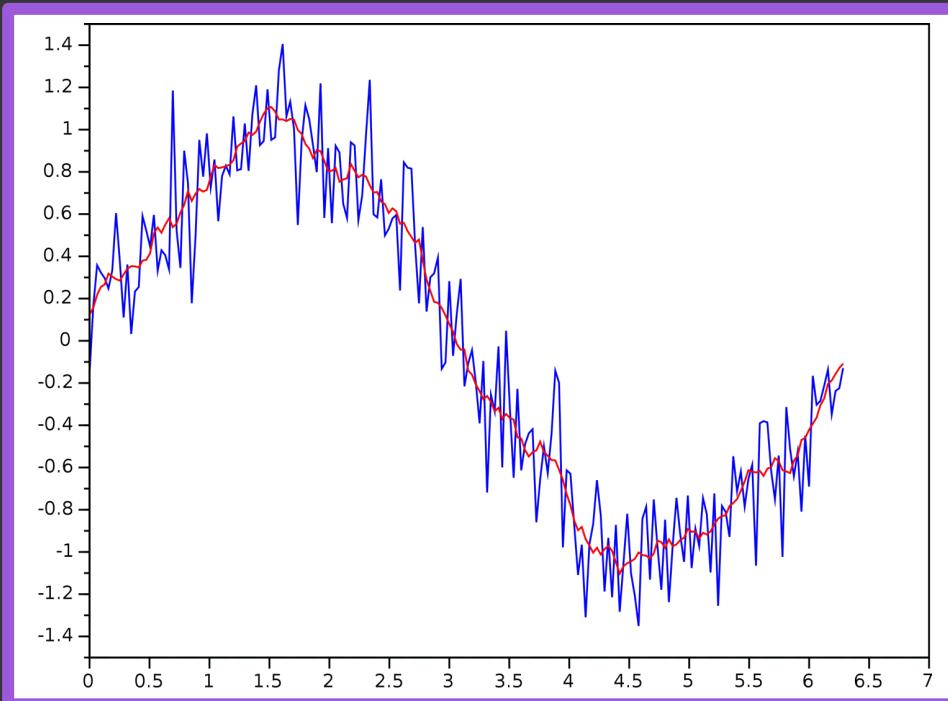


# LOOP Map value to 0 - 9

```
value = analogRead(METHANE_PIN);  
mapped_value = map(value, min, max, 0, 9);
```



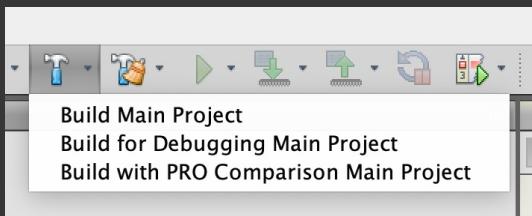
# Solution B Moving Average



# Burn the code

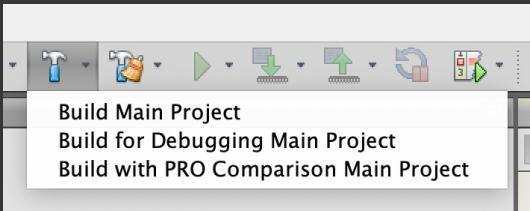
# Burn the code

HEX file



# Burn the code

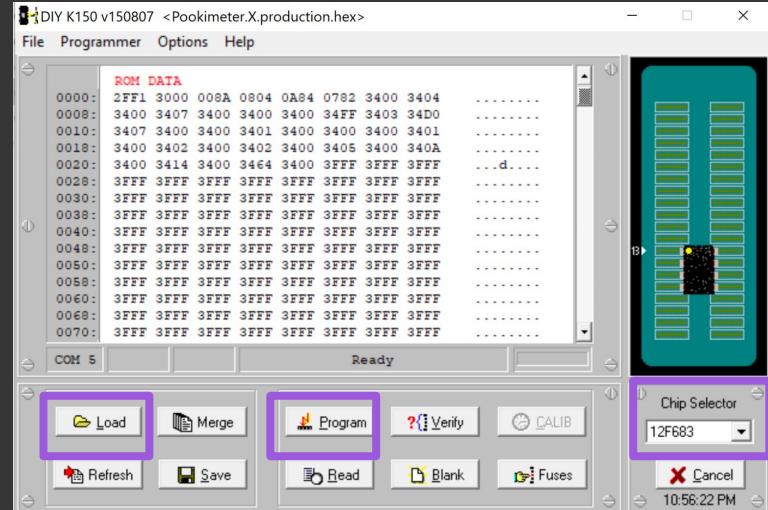
HEX file



K150 PIC Programmer



K150 PIC Driver



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Code and Burn



4

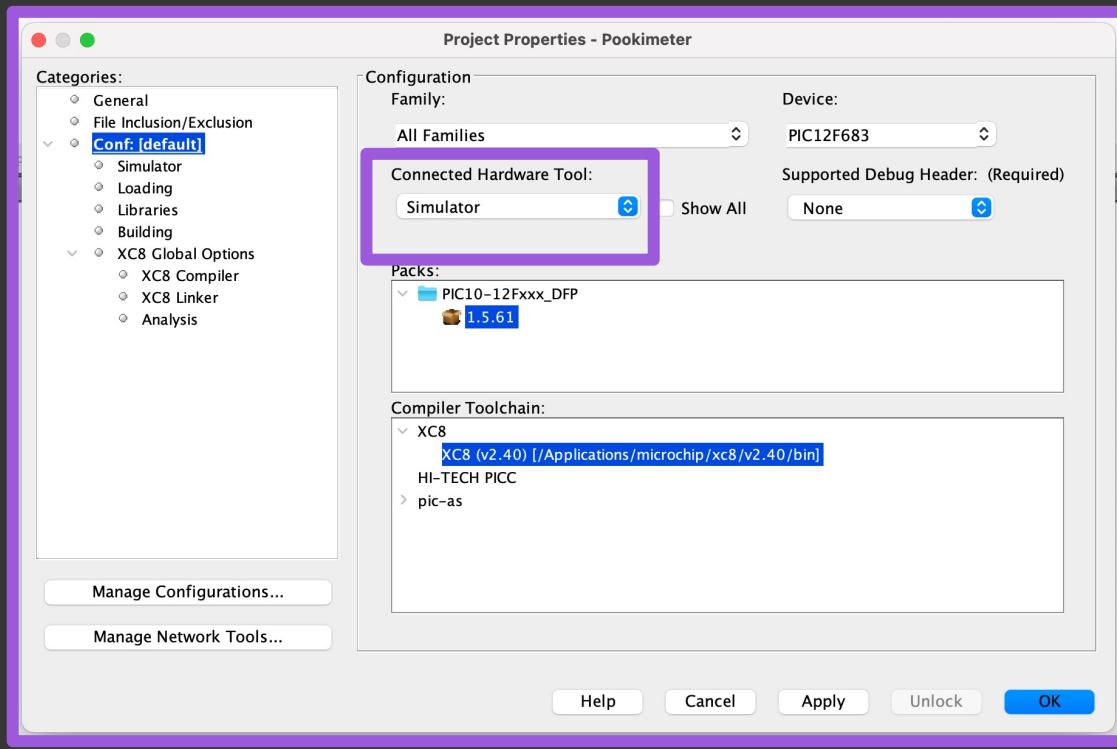
**Debug**

Offline and Online

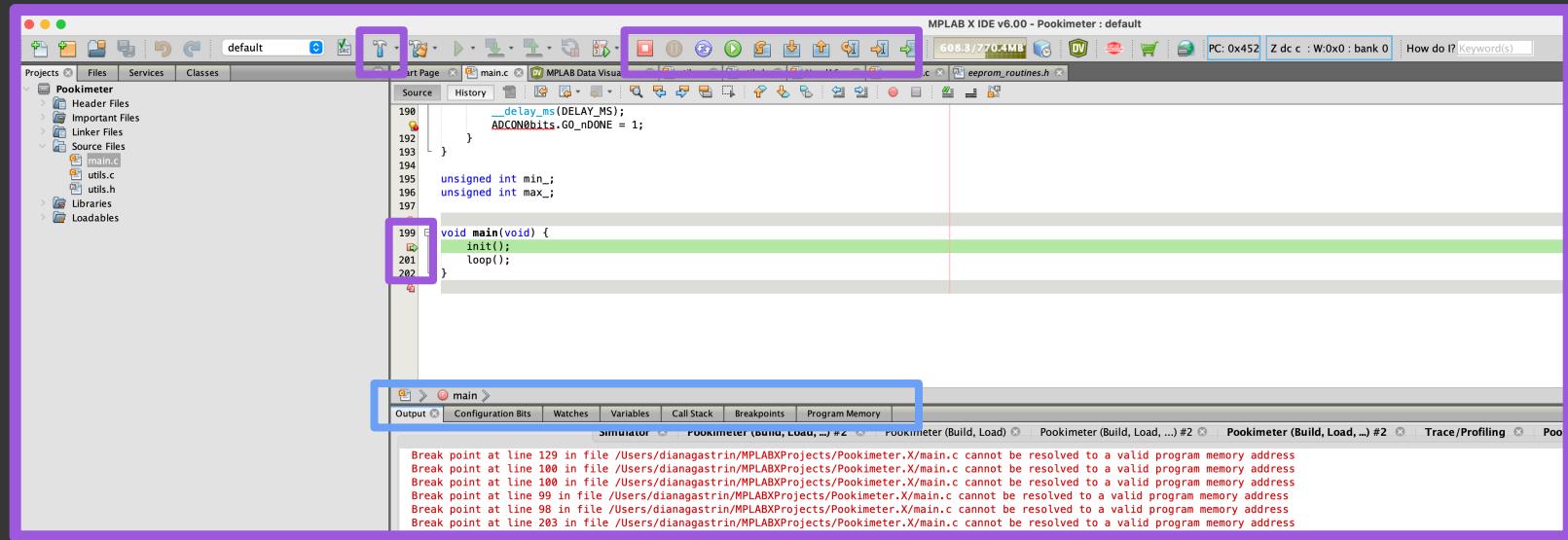


# Offline debug

# Offline Debug



# Offline Debug



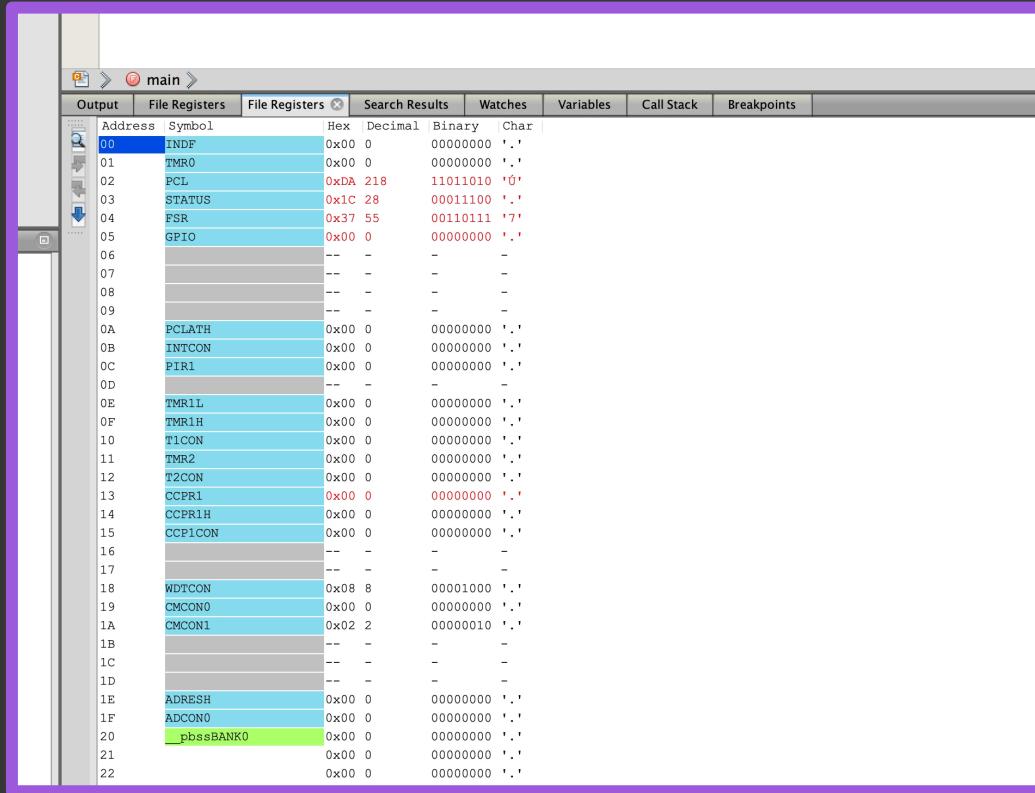
# PIC12F683 Data Memory

Address	Symbol	Hex	Decimal	Binary	Char
0F	TMR1H	0x00 0	00000000	00000000	'.'
10	T1CON	0x00 0	00000000	00000000	'.'
11	TMR2	0x00 0	00000000	00000000	'.'
12	T2CON	0x00 0	00000000	00000000	'.'
13	CCPR1	0x00 0	00000000	00000000	'.'
14	CCPR1H	0x00 0	00000000	00000000	'.'
15	CCP1ICON	0x00 0	00000000	00000000	'.'
16		-- -	-	-	-
17		-- -	-	-	-
18	WDTCON	0x08 8	00001000	00000000	'.'
19	CMCON0	0x00 0	00000000	00000000	'.'
1A	CMCON1	0x02 2	00000010	00000000	'.'
1B		-- -	-	-	-
1C		-- -	-	-	-
1D		-- -	-	-	-
1E	ADRESH	0x00 0	00000000	00000000	'.'
1F	ADCONO	0x00 0	00000000	00000000	'.'
20	pbs BANK0	0x00 0	00000000	00000000	'.'
21		0x00 0	00000000	00000000	'.'
22		0x00 0	00000000	00000000	'.'
23		0x00 0	00000000	00000000	'.'
24		0x00 0	00000000	00000000	'.'
25		0x00 0	00000000	00000000	'.'
26		0x00 0	00000000	00000000	'.'
27		0x00 0	00000000	00000000	'.'
28		0x00 0	00000000	00000000	'.'
29		0x00 0	00000000	00000000	'.'
2A	_mapped_value	0x00 0	00000000	00000000	'.'
2B		0x00 0	00000000	00000000	'.'
2C	_pressed_counter	0x00 0	00000000	00000000	'.'
2D		0x00 0	00000000	00000000	'.'
2E	_max_calibrated	0x00 0	00000000	00000000	'.'
2F		0x00 0	00000000	00000000	'.'
30	_min_calibrated	0x00 0	00000000	00000000	'.'
31		0x00 0	00000000	00000000	'.'
32	_calibration_counter	0x00 0	00000000	00000000	'.'
33		0x00 0	00000000	00000000	'.'

Special function  
registers (SFR)

General purpose  
registers (GPR)

# Offline Debug



The screenshot shows a debugger interface with a purple border. The title bar says "main". The menu bar includes "File", "Registers", "File Registers", "Search Results", "Watches", "Variables", "Call Stack", and "Breakpoints". The main window displays a memory dump table with columns: Address, Symbol, Hex, Decimal, Binary, and Char.

Address	Symbol	Hex	Decimal	Binary	Char
00	INDF	0x00 0	00000000	0000000000000000	'.'
01	TMR0	0x00 0	00000000	0000000000000000	'.'
02	PCL	0xDA 218	11011010	0101101101101010	'0'
03	STATUS	0x1C 28	00011100	0001110000000000	'.'
04	FSR	0x37 55	00110111	0011011101101101	'7'
05	GPIO	0x00 0	00000000	0000000000000000	'.'
06		-- -	-	-	
07		-- -	-	-	
08		-- -	-	-	
09		-- -	-	-	
0A	PCLATH	0x00 0	00000000	0000000000000000	'.'
0B	INTCON	0x00 0	00000000	0000000000000000	'.'
0C	PIR1	0x00 0	00000000	0000000000000000	'.'
0D		-- -	-	-	
0E	TMR1L	0x00 0	00000000	0000000000000000	'.'
0F	TMR1H	0x00 0	00000000	0000000000000000	'.'
10	T1CON	0x00 0	00000000	0000000000000000	'.'
11	TMR2	0x00 0	00000000	0000000000000000	'.'
12	T2CON	0x00 0	00000000	0000000000000000	'.'
13	CCPR1	0x00 0	00000000	0000000000000000	'.'
14	CCPR1H	0x00 0	00000000	0000000000000000	'.'
15	CCP1ICON	0x00 0	00000000	0000000000000000	'.'
16		-- -	-	-	
17		-- -	-	-	
18	WDTCON	0x08 8	00001000	0000100000000000	'.'
19	CMCON0	0x00 0	00000000	0000000000000000	'.'
1A	CMCON1	0x02 2	00000010	0000001000000000	'.'
1B		-- -	-	-	
1C		-- -	-	-	
1D		-- -	-	-	
1E	ADRESH	0x00 0	00000000	0000000000000000	'.'
1F	ADCON0	0x00 0	00000000	0000000000000000	'.'
20	_pbssBANK0	0x00 0	00000000	0000000000000000	'.'
21		-- -	-	-	
22		-- -	-	-	

# Online debug

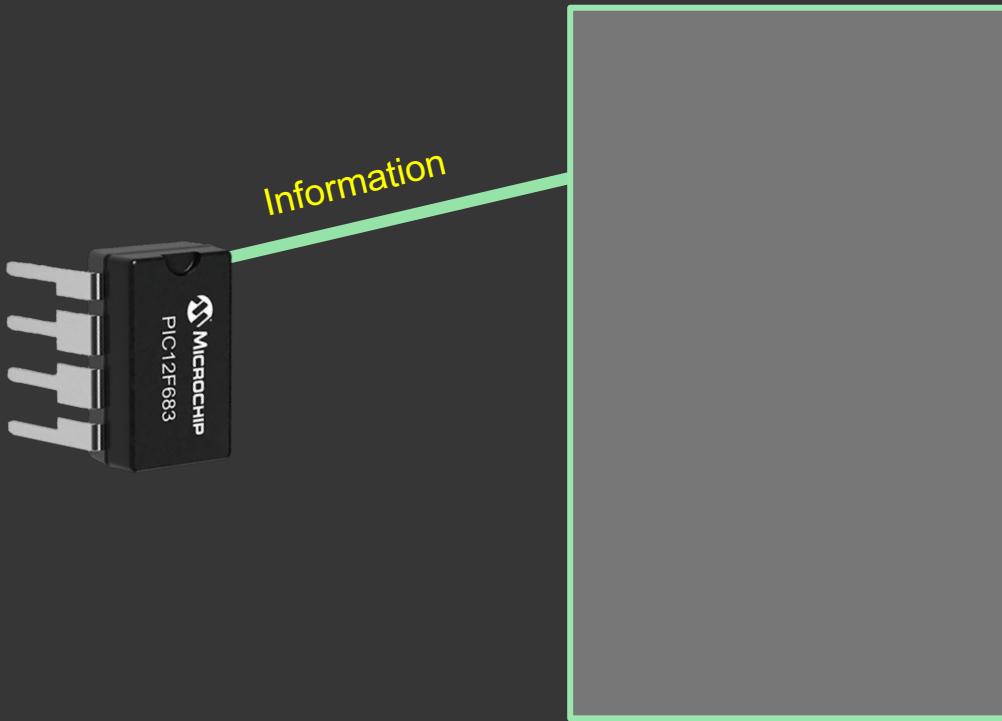
# Online debug

See the  
current  
values in  
the code

Do beautiful  
graphs with  
the data

Understand  
the data

# Online debug

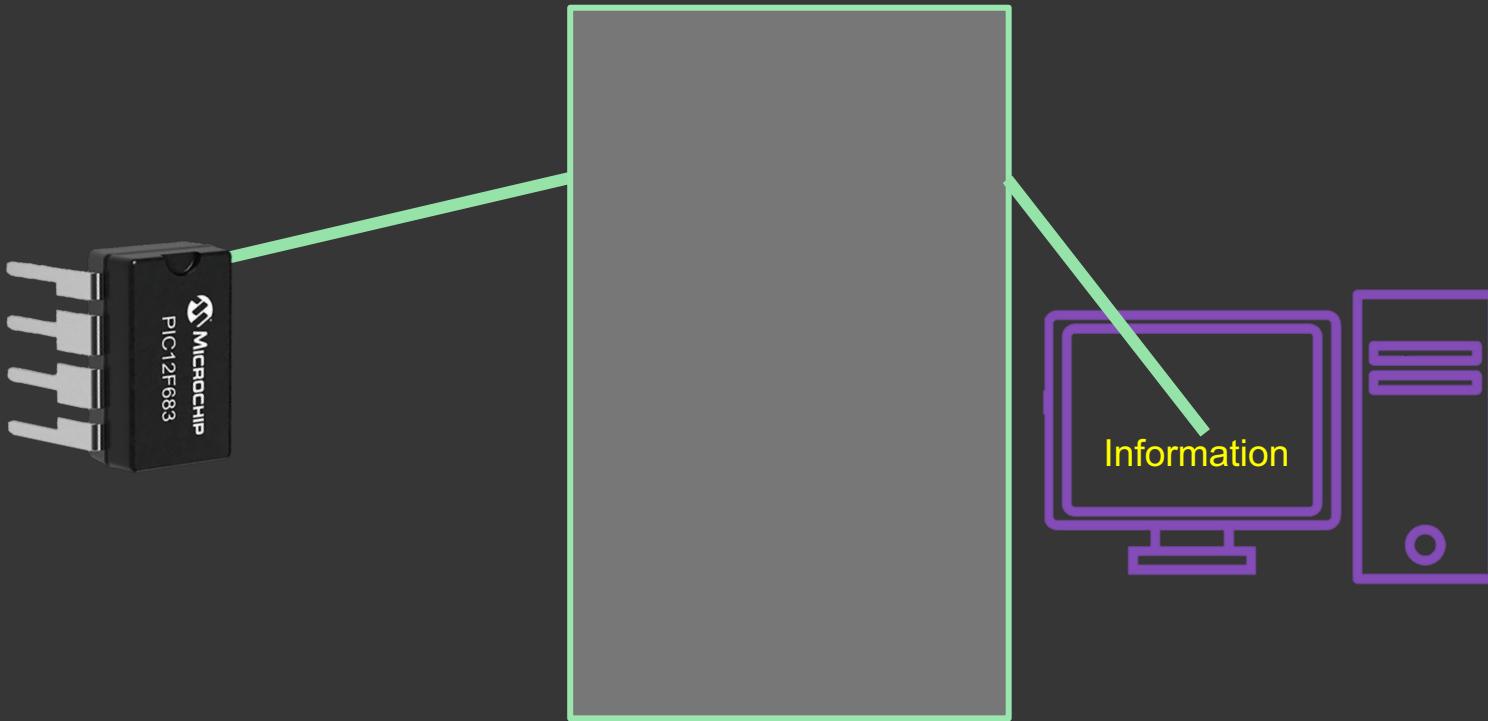


# Online debug

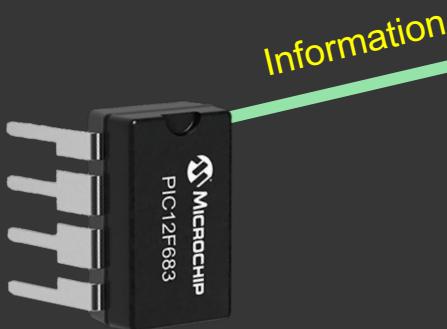


Information

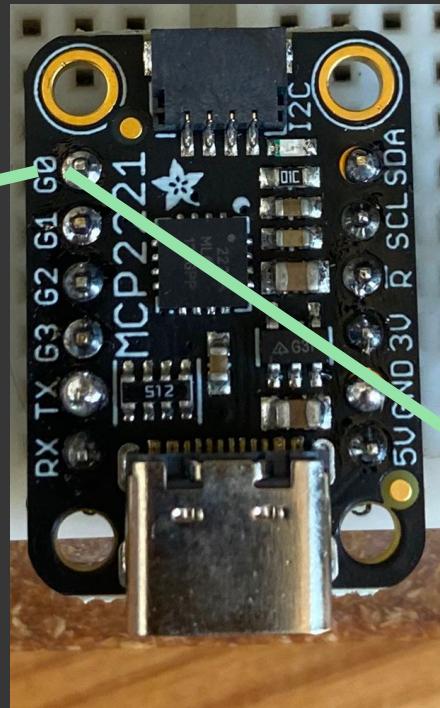
# Online debug



# Online debug



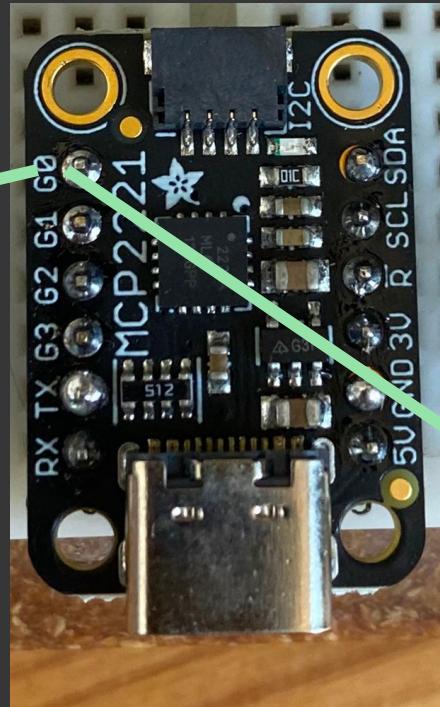
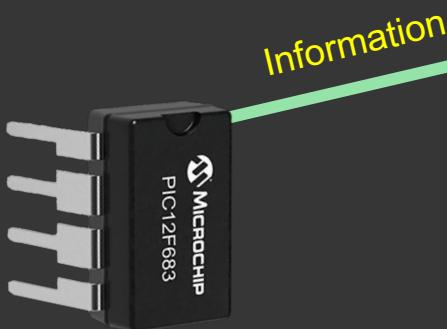
Information



MCP2221  
(Adafruit)



# Online debug



MCP2221  
(Adafruit)

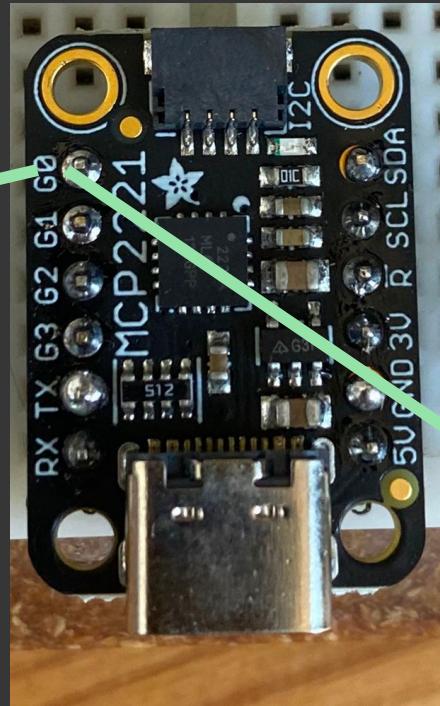


# Online debug



Asynchronous  
serial protocol

Information



MCP2221  
(Adafruit)



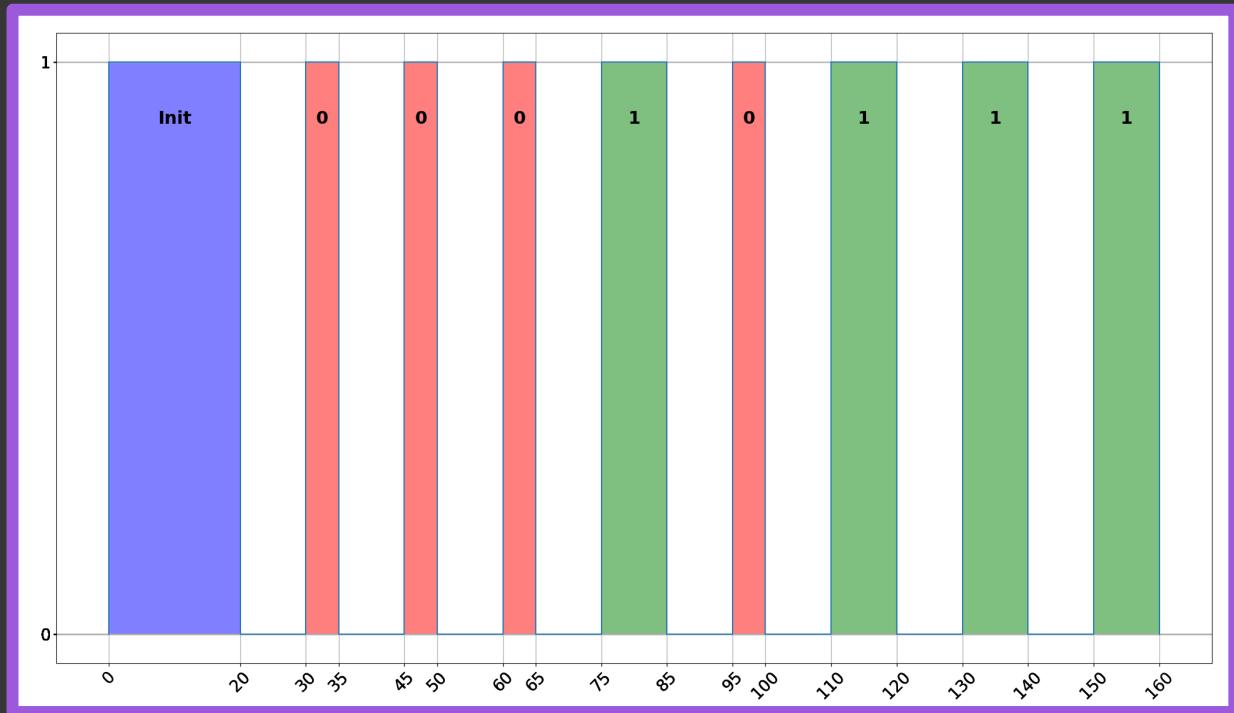
# Online debug

Send 23  
(00010111)

20 ms init

5 ms for 0

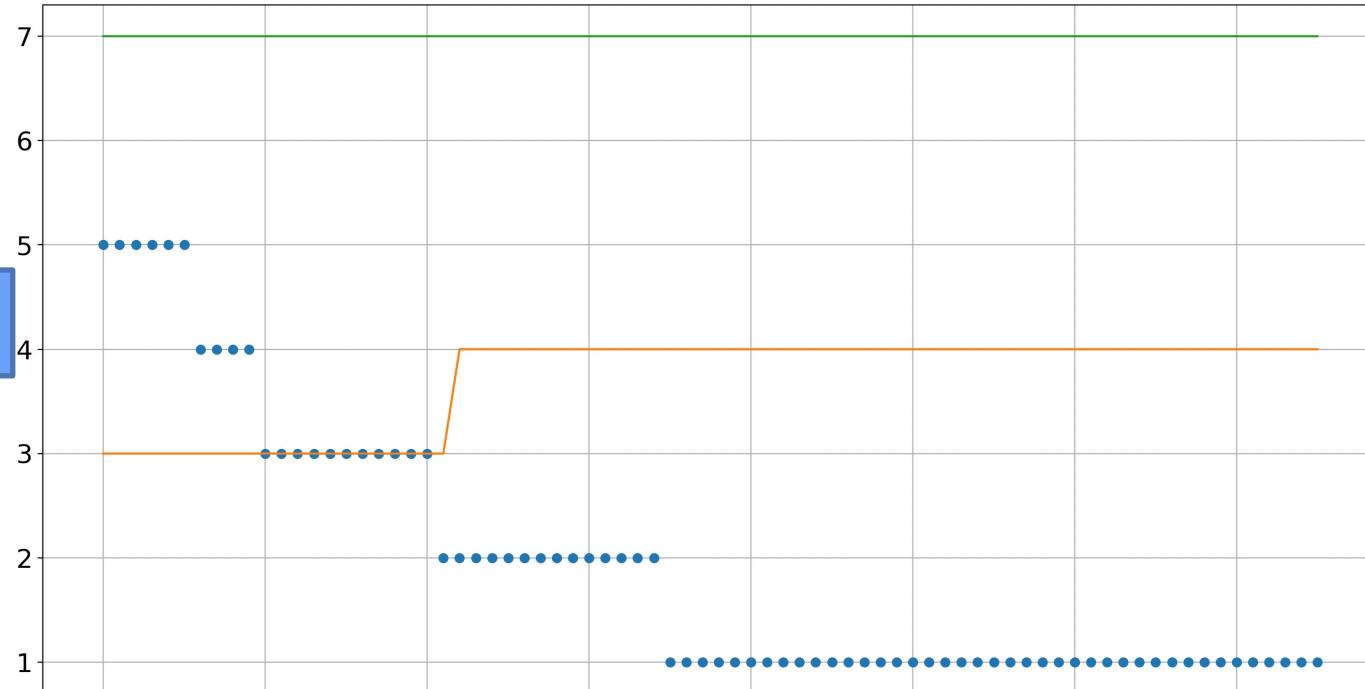
10 ms for 1



# Online debug

Mapped  
value

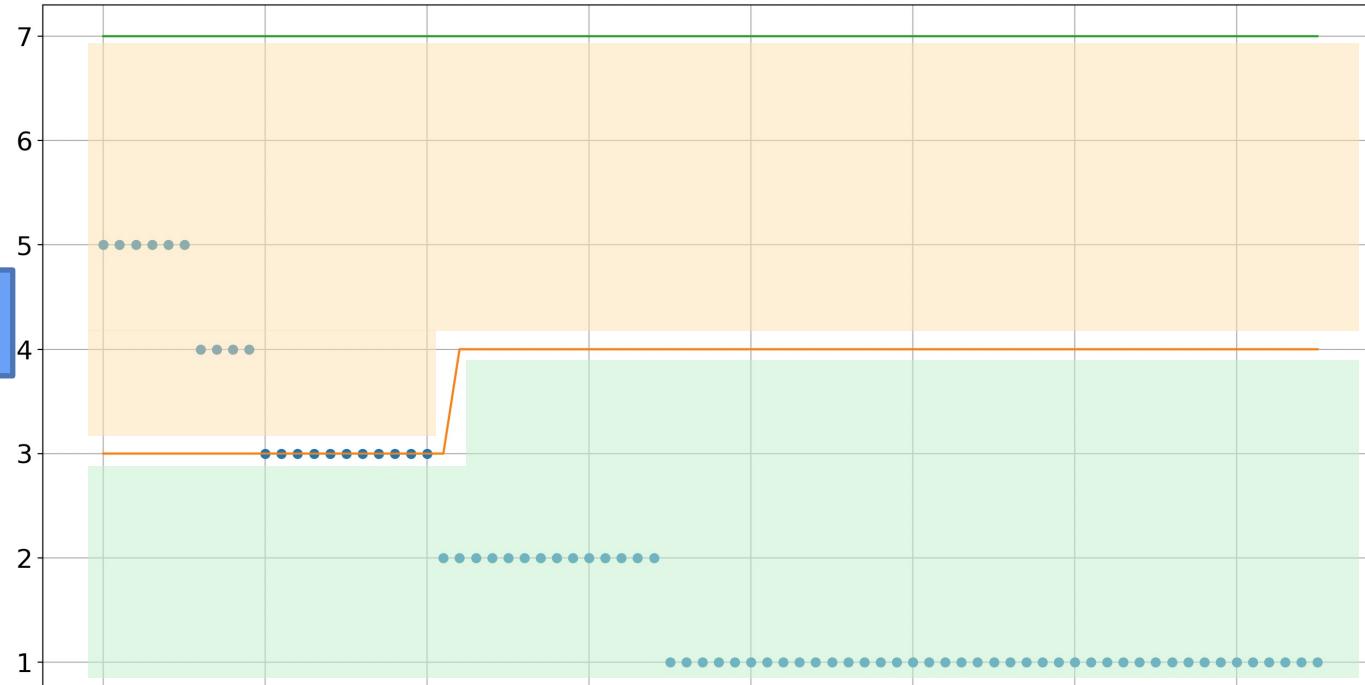
Time



# Online debug

Mapped  
value

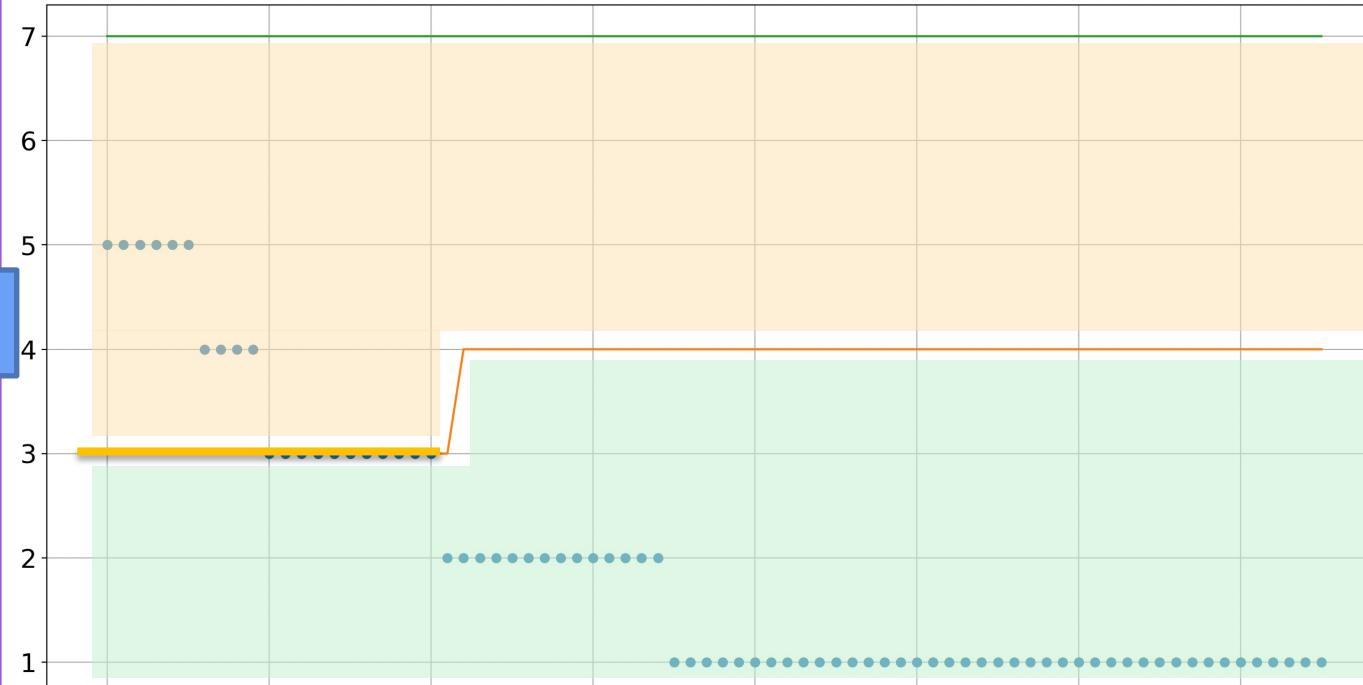
Time



# Online debug

Mapped value

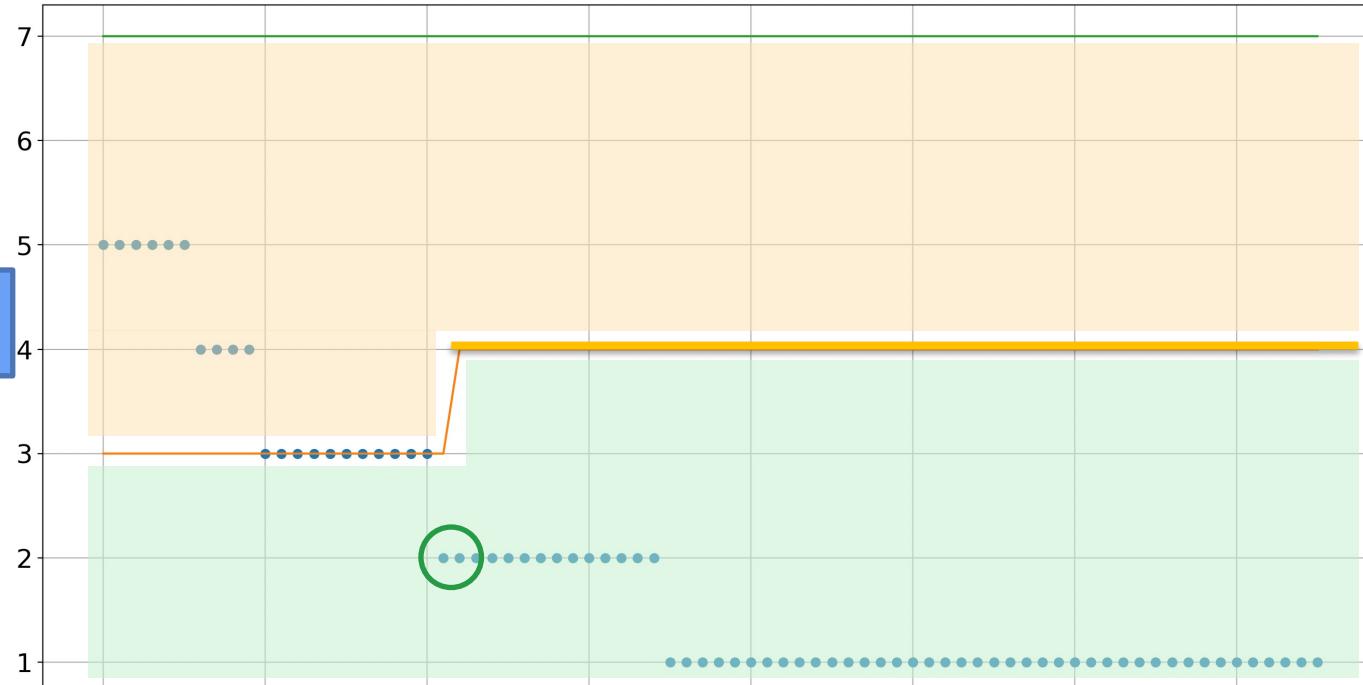
Time



# Online debug

Mapped  
value

Time



# The Pookimeter

1

**What**

is a Pookimeter?



2

**Hardware parts**

build it from scratch



3

**Software parts**

Code and Burn



4

**Debug**

Offline and Online



# One more thing...



# Thanks!



@gastrin\_diana