

# Introduction to MicroPython for Raspberry Pi Pico Part 1 - Hardware

Hamilton Python Users Group  
12 Dec 2022  
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Version 2 of the presentation. This corrects diagrams where the Pull-Up and Pull-Down resistors were swapped.

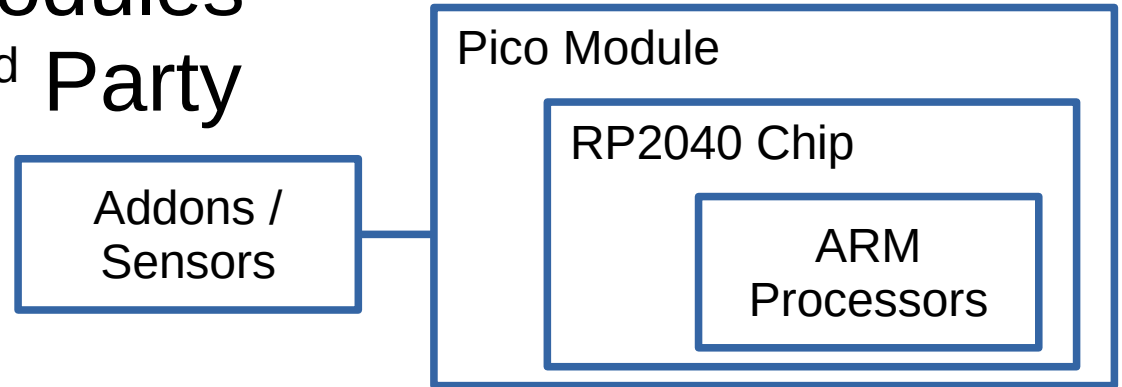
# MicroPython for Raspberry Pi Pico

## Hardware:

- ARM Cortex-M0+ Processor core
- Raspberry Pi RP2040 Microcontroller Chip
- Raspberry Pi Pico modules
- Pico Kits, Addons, 3<sup>rd</sup> Party

## Software:

- C / C++
- MicroPython



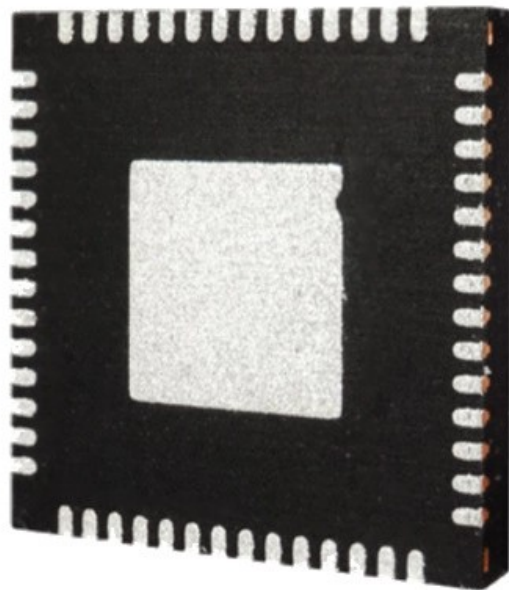
## ARM - Cortex-M0+

- ARM Holdings. Formerly “Acorn RISC Machines” and “Advanced RISC Machines”.
- ARM creates and licenses its technology as intellectual property.

### Cortex-M0+:

- 32-bit RISC ARM processor core
- Implements the ARMv6-M architecture
- Optimized superset of the Cortex-M0.
- Smallest ARM microcontrollers ,

# Raspberry Pi RP2040 Chip



PB Tech / Element14 ~\$1.66

Designed by Raspberry Pi Ltd.  
(~ not a Broadcom buy in)

- Dual ARM Cortex-M0+ @ 133MHz
- 264kB on-chip SRAM
- Support for up to 16MB of off-chip Flash memory via dedicated QSPI bus
- DMA controller
- Fully-connected AHB crossbar
- Interpolator and integer divider peripherals
- On-chip programmable LDO to generate core voltage of 1.1V
- 2 on-chip PLLs to generate USB and core clocks
- 30 GPIO pins, 4 of which can be used as analogue inputs

# RP2040

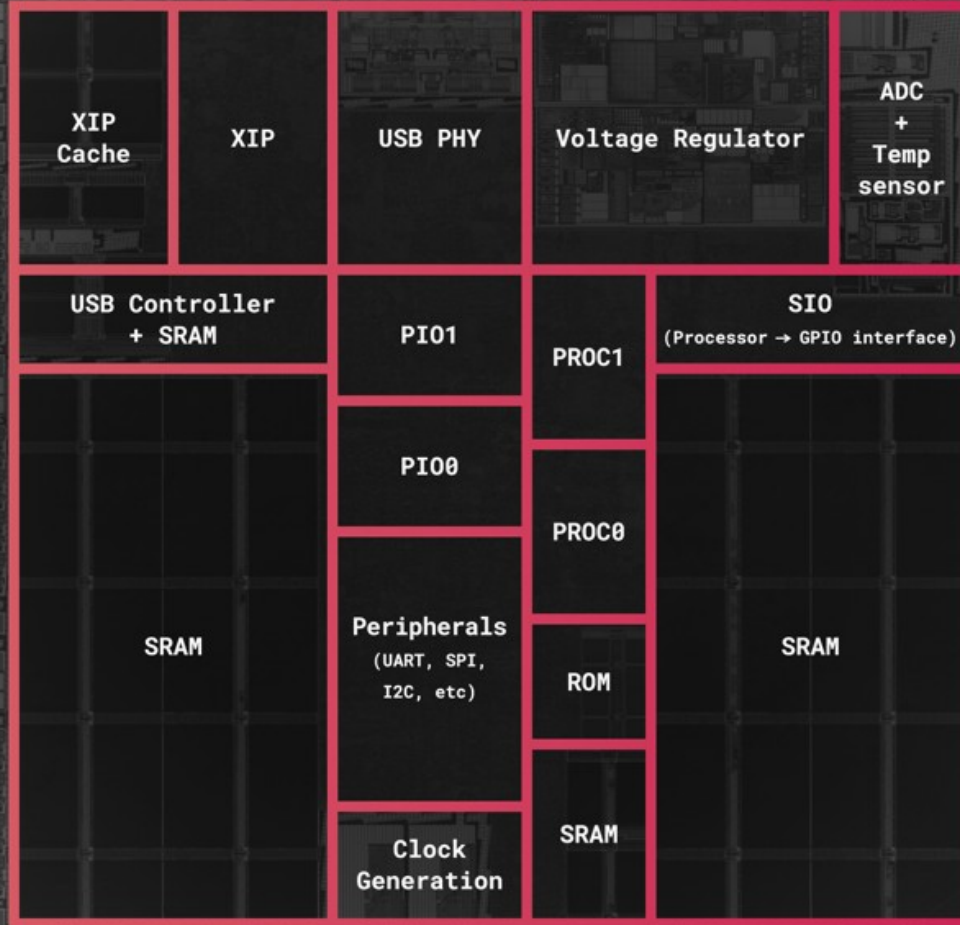
## Peripherals:

- 2 UARTs
- 2 SPI controllers
- 2 I2C controllers
- 16 PWM channels
- USB 1.1 controller and PHY, with host and device support
- 8 PIO state machines

### Abbreviations:

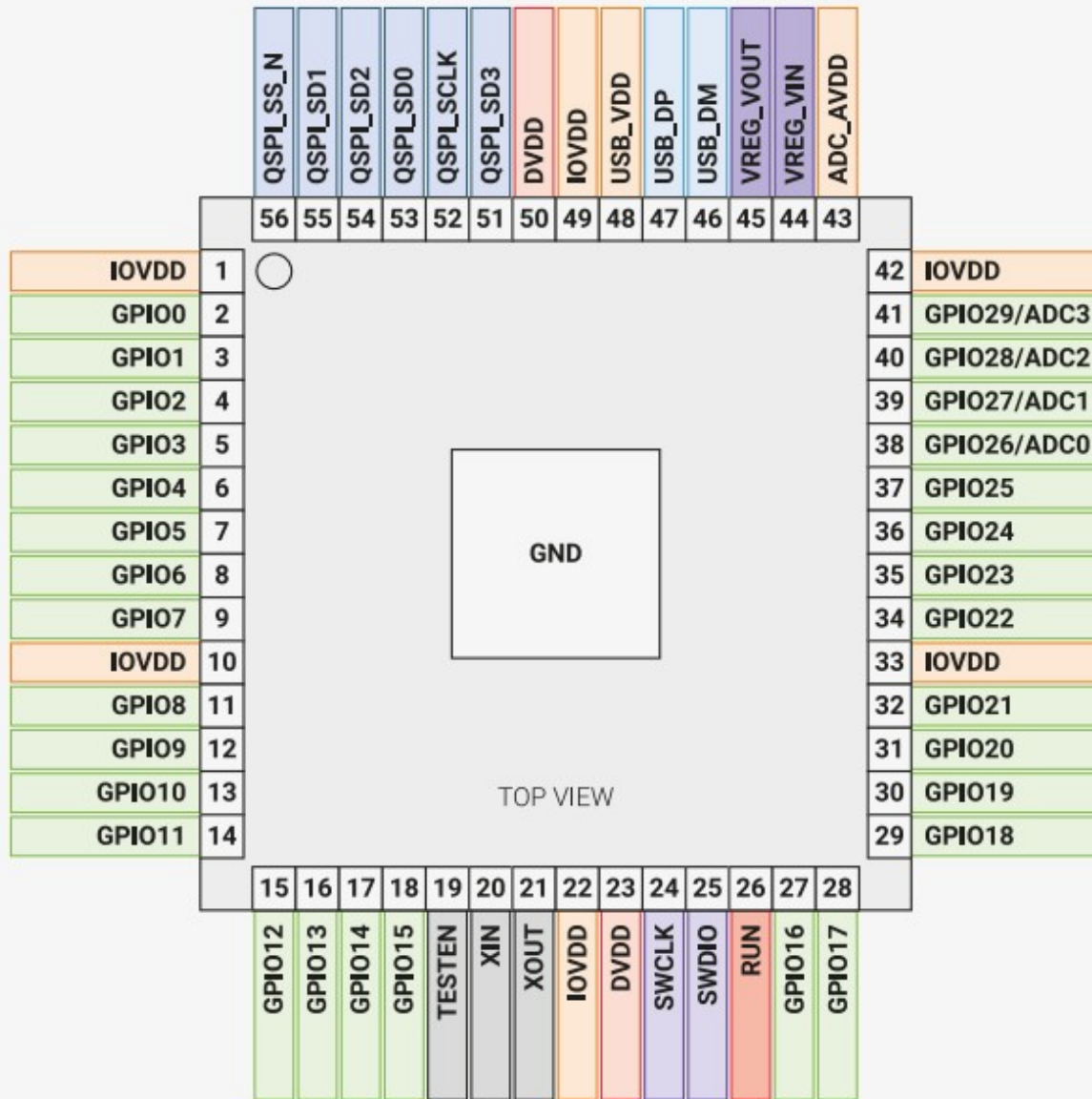
LDO Low DropOut Regulator  
AHB Advanced High Performance Bus  
PLL Phase Locked Loop  
SPI Serial Peripheral Interface  
GPIO General Purpose Input/Output  
PIO Programmable Input/Output  
PWM Pulse Width Modulation

# RP2040 Layout



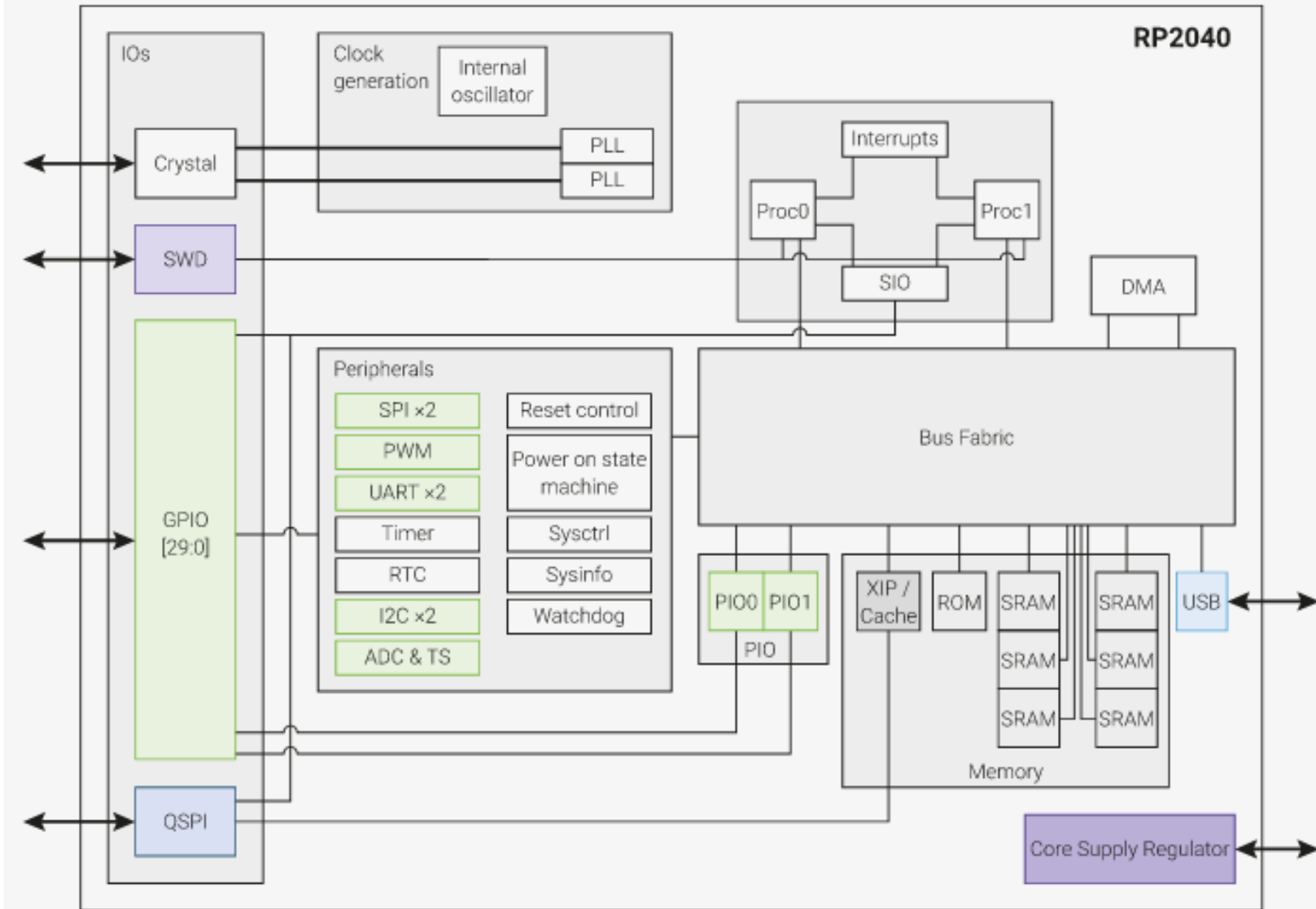
# RP2040 Chip

- 4 x 14 pin = 56 pins
- QFN-56 surface mount device
- 30 GPIO – 0 to 29
- 3.3V for the I/O
- 1.1V for the chip's digital core



QFN Quad Flat No-leads

# RP2040 Block Diagram





# RP2040 – Model Numbering Scheme

- Manufacturer – Raspberry Pi
- Number of processor cores (2)
- Loosely which type of processor (M0+)
- $\text{floor}(\log_2(\text{ram} / 16\text{k}))$
- $\text{floor}(\log_2(\text{nonvolatile} / 16\text{k}))$  or 0 if no onboard nonvolatile storage

```
>>> math.floor(math.log2(256000/16000))
```

4

RP 2 0 4 0

Raspberry Pi

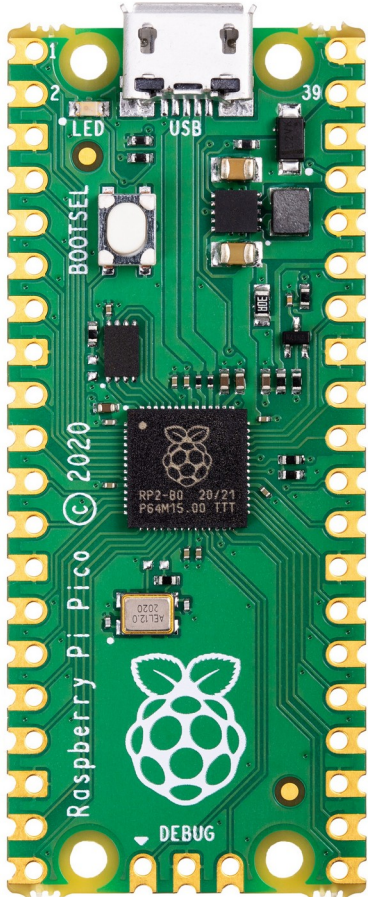
Number of cores

Type of core (e.g. M0+)

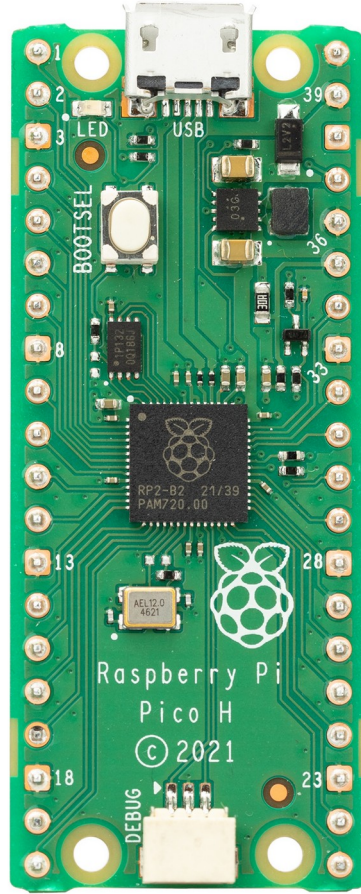
$\text{floor}(\log_2(\text{ram} / 16\text{k}))$

$\text{floor}(\log_2(\text{nonvolatile} / 16\text{k}))$

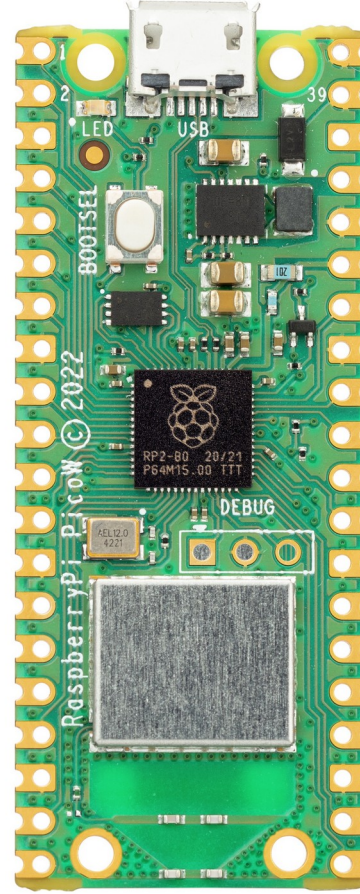
# Raspberry Pi Pico - family of RP2040-based boards



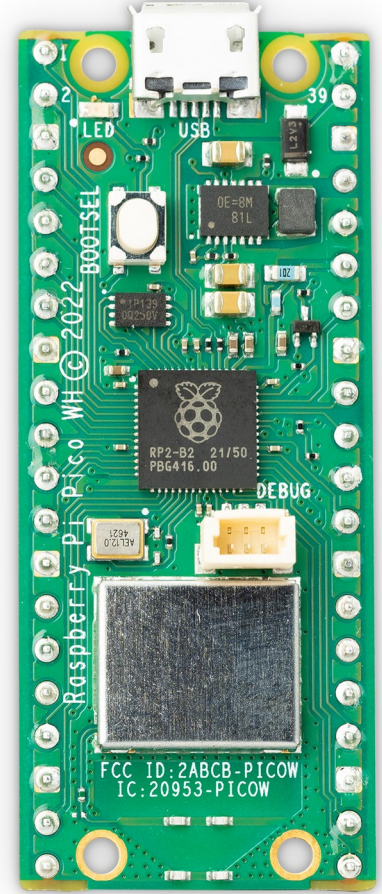
Pico \$8



Pico H \$10

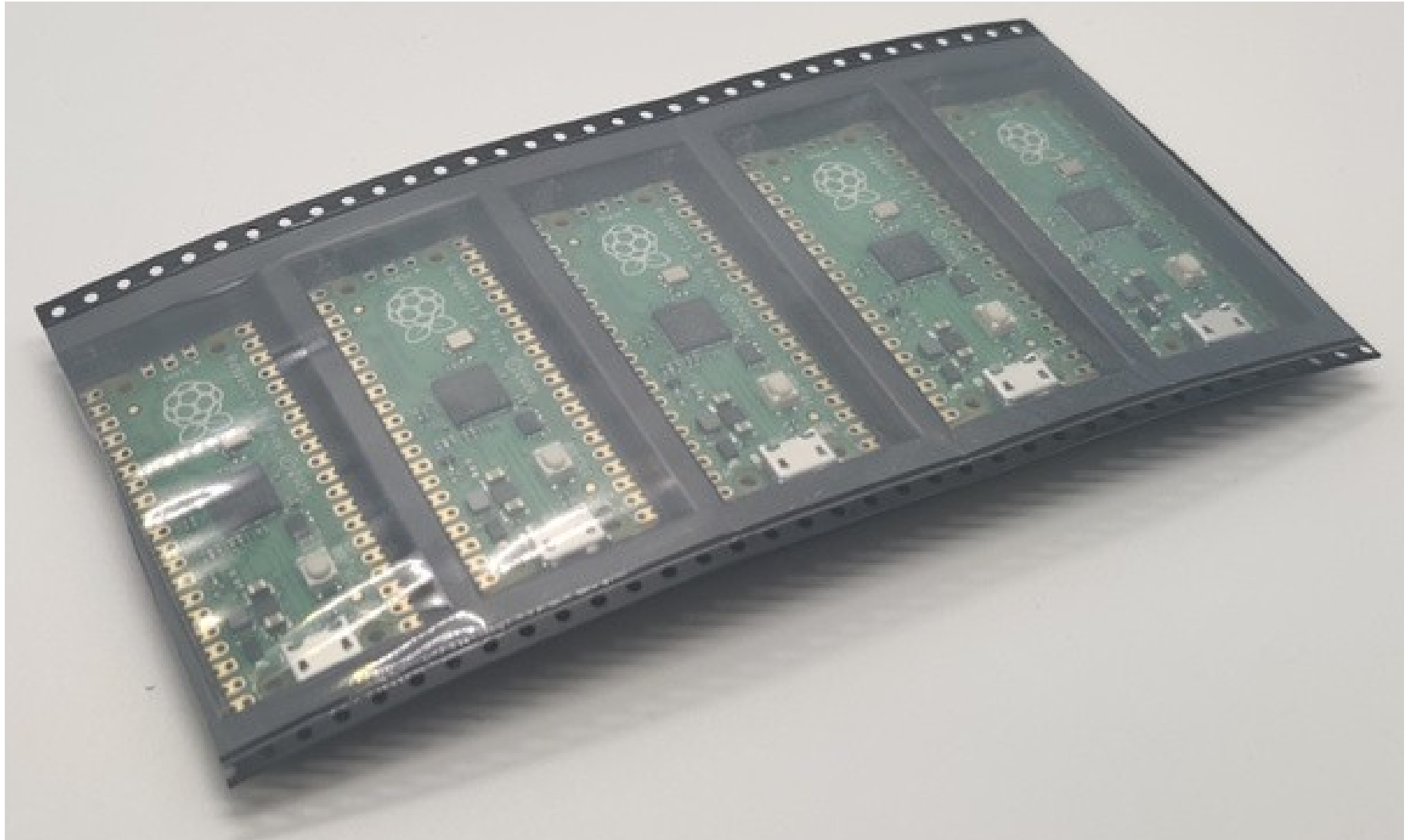


Pico W \$12



Pico WH ?

# Raspberry Pi Pico – 5 Pack.

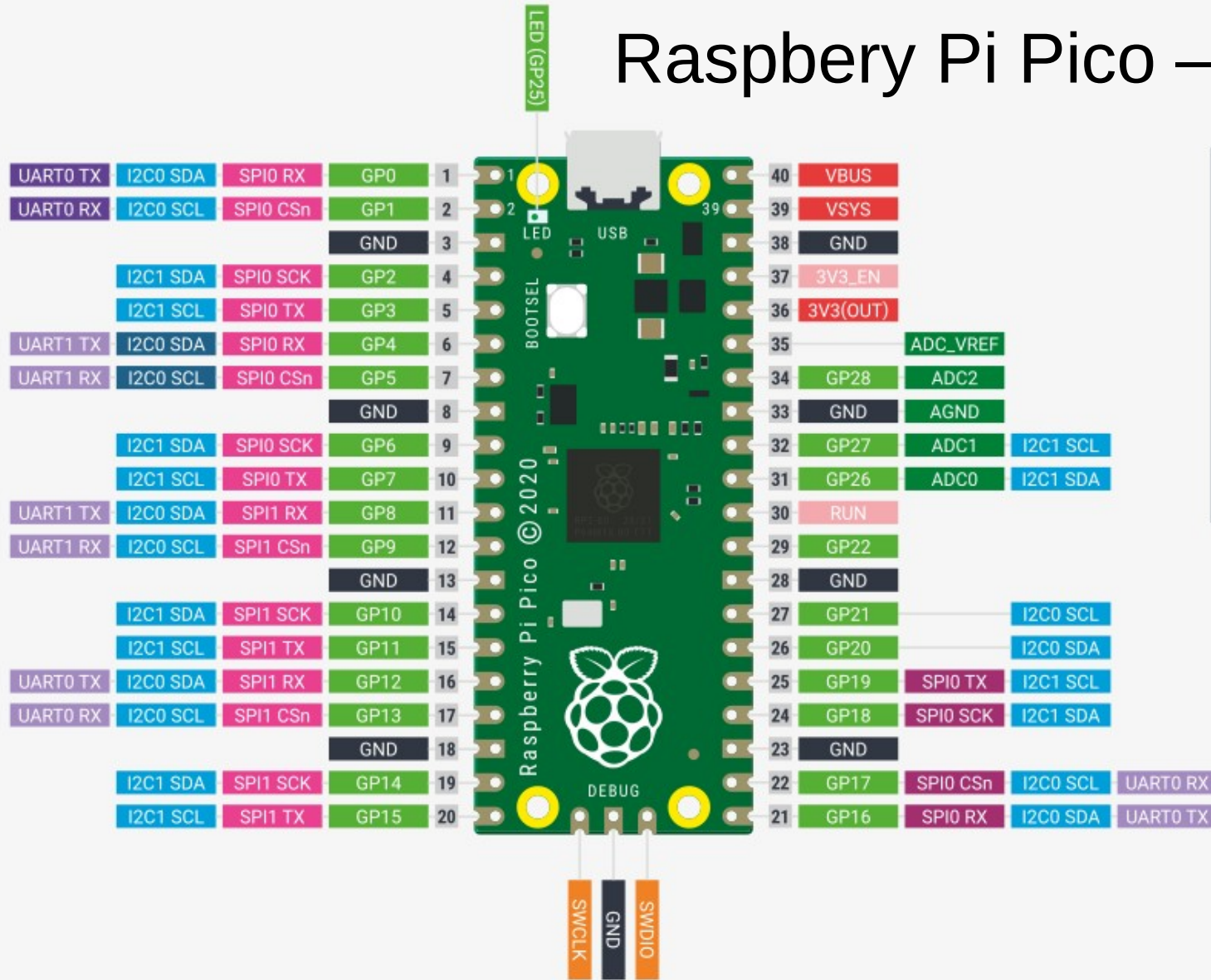


# Raspberry Pi Pico – On a roll

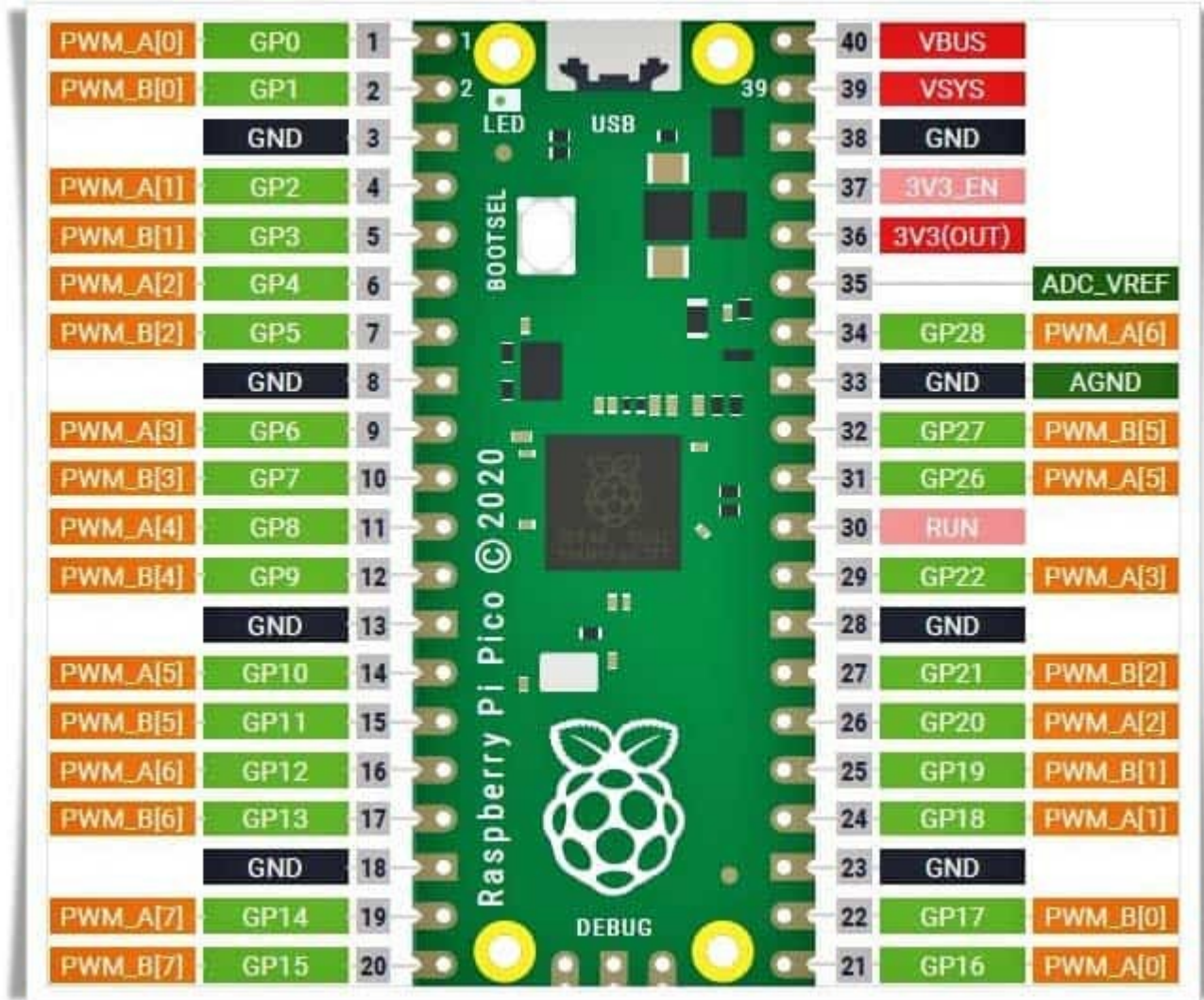




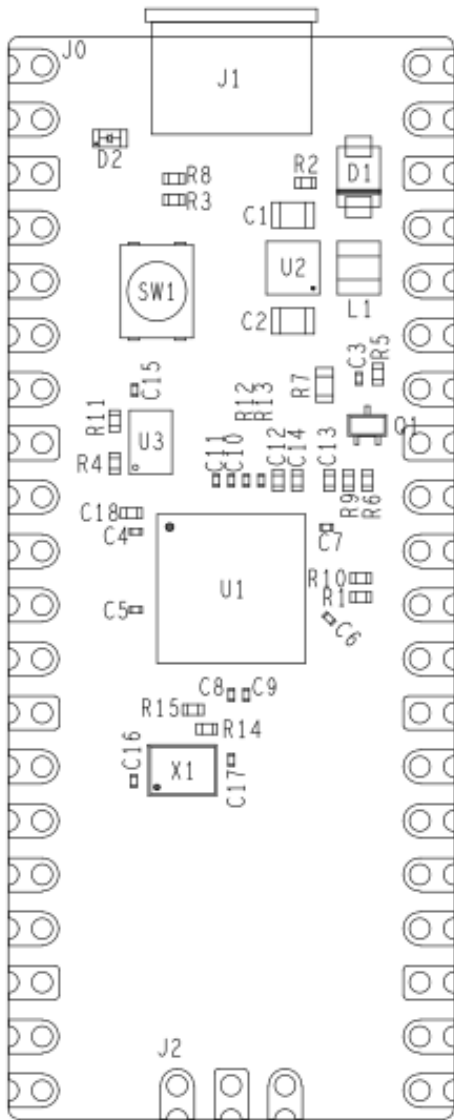
# Raspberry Pi Pico – connections



# Raspberry Pi Pico - family of RP2040-based boards



PWM



# Raspberry Pi Pico

Operating Temp Max85°C

Operating Temp Min-20°C

VBUS5V  $\pm$  10%.

VSYS Min 1.8V

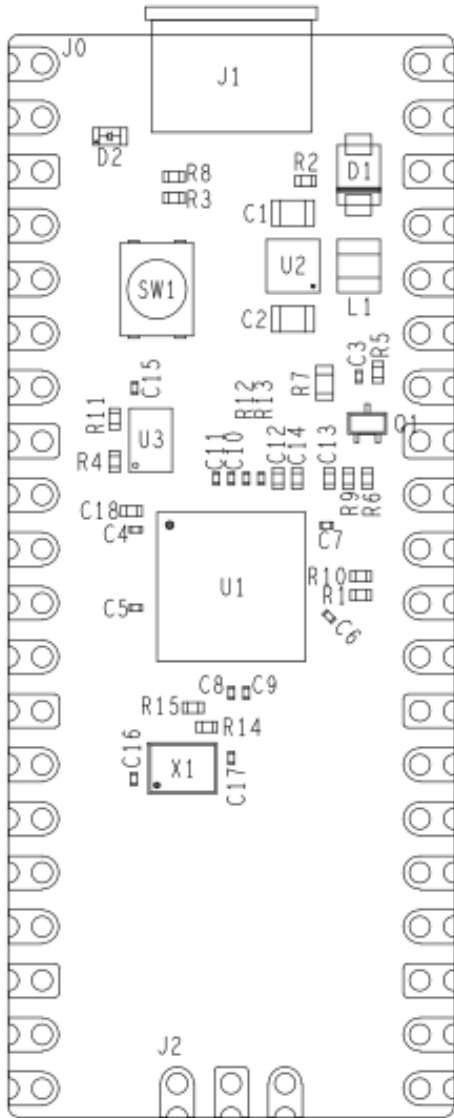
VSYS Max 5.5V

Current @5V < 100mA

## Current Sleep Mode @5V 1.4mA

Size 51mm x 21mm

	Model	Size	Vendor	Description
U1	RP2040	7x7	Raspberry Pi	32-bit dual ARM Cortex-M0+ microcontroller
U2	RT6150B-33GQW	2.5x2.5	Richtek	Buck-Boost Switching Regulator IC Positive Fixed 3.3V
U3	W25Q16J VUXIQ	2x3	Winbond	16M-bit 2M x 8 6ns
X1	12MHz	3.2x2.5	AEL	Crystal Oscillator



# Raspberry Pi Pico – Components

- 3 x ICs: RP2040, +3.3V Regulator, 2MB Flash
- 18 x Capacitors
- 1 x Crystal (12MHz)
- 2 x Diodes (1 x LED)
- 1 x Mosfet
- 1 x Inductor
- 15 x Resistors
- 1 x Switch
- 6 x Test Points

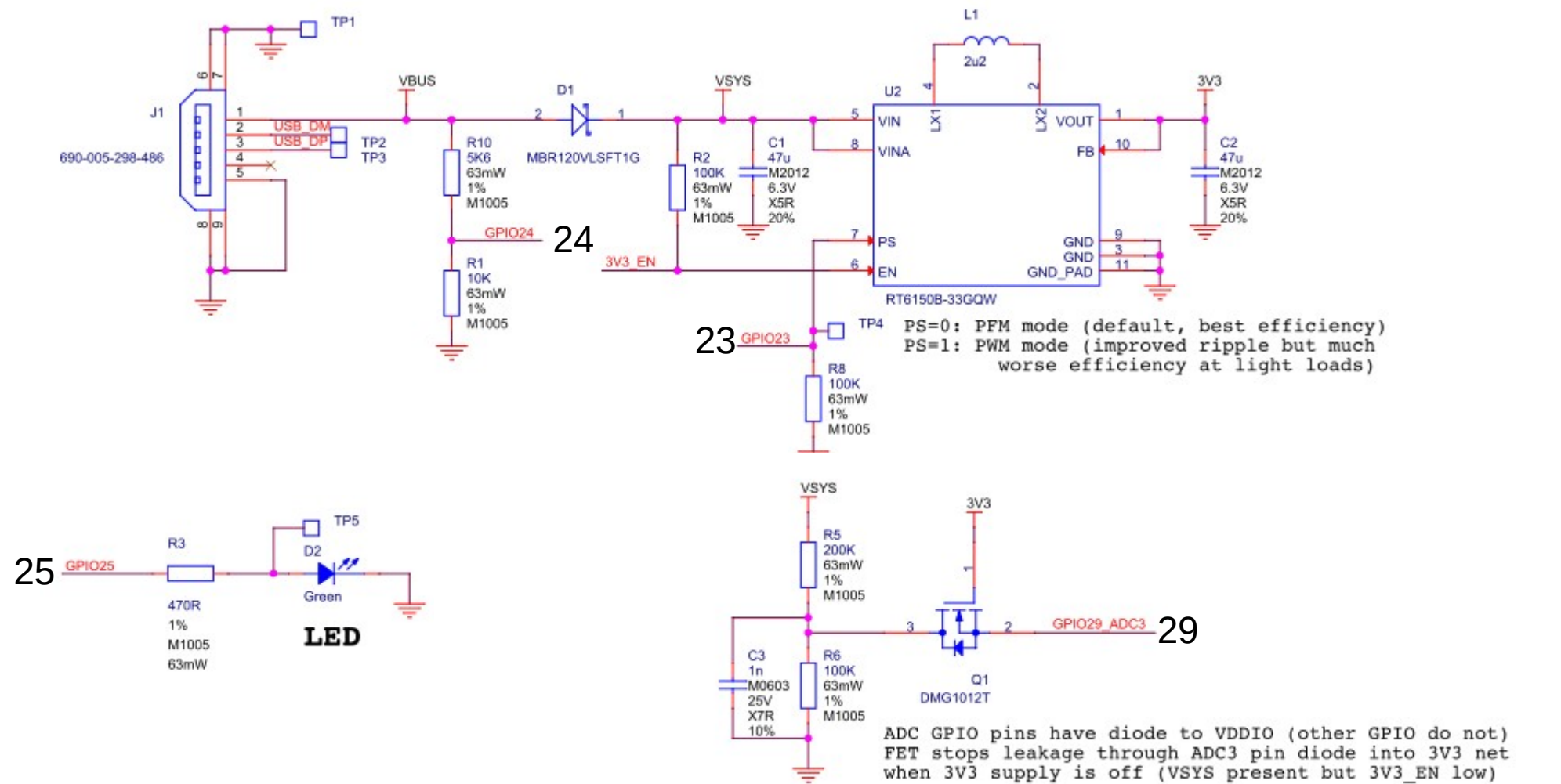


The image shows a detailed PCB layout for a Raspberry Pi Zero W. The layout includes various components such as the USB-C port, power management ICs, the main processor, and various passive components. The layout is color-coded and includes labels for components and their values. The components are arranged in a compact, efficient manner, typical of a high-density PCB design. The layout also includes a bill of materials table at the bottom, which lists the components and their quantities.

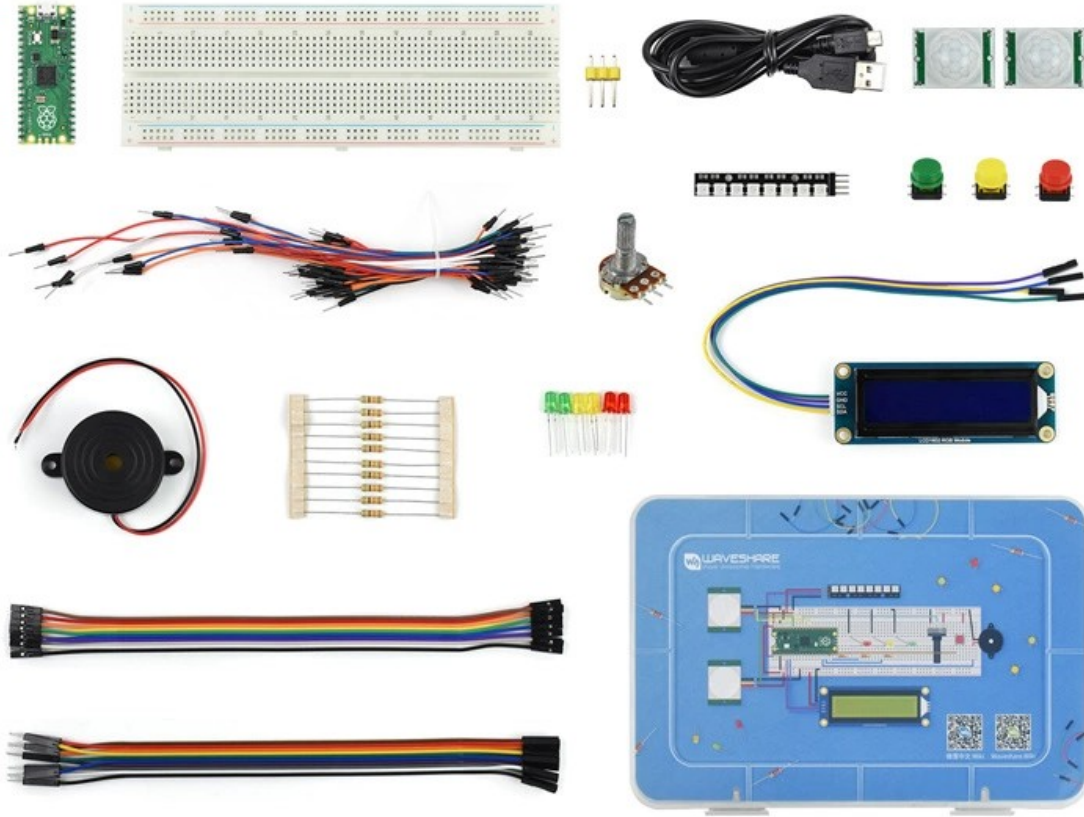
**COMPONENTS:**

- TP1, TP2, TP3, TP4, TP5, TP6, TP7, TP8, TP9, TP10, TP11, TP12, TP13, TP14, TP15, TP16, TP17, TP18, TP19, TP20, TP21, TP22, TP23, TP24, TP25, TP26, TP27, TP28, TP29, TP30, TP31, TP32, TP33, TP34, TP35, TP36, TP37, TP38, TP39, TP40, TP41, TP42, TP43, TP44, TP45, TP46, TP47, TP48, TP49, TP50, TP51, TP52, TP53, TP54, TP55, TP56, TP57, TP58, TP59, TP60, TP61, TP62, TP63, TP64, TP65, TP66, TP67, TP68, TP69, TP70, TP71, TP72, TP73, TP74, TP75, TP76, TP77, TP78, TP79, TP80, TP81, TP82, TP83, TP84, TP85, TP86, TP87, TP88, TP89, TP90, TP91, TP92, TP93, TP94, TP95, TP96, TP97, TP98, TP99, TP100, TP101, TP102, TP103, TP104, TP105, TP106, TP107, TP108, TP109, TP110, TP111, TP112, TP113, TP114, TP115, TP116, TP117, TP118, TP119, TP120, TP121, TP122, TP123, TP124, TP125, TP126, TP127, TP128, TP129, TP130, TP131, TP132, TP133, TP134, TP135, TP136, TP137, TP138, TP139, TP140, TP141, TP142, TP143, TP144, TP145, TP146, TP147, TP148, TP149, TP150, TP151, TP152, TP153, TP154, TP155, TP156, TP157, TP158, 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# Raspberry Pi Pico – RP2040 GPIO used by Pico



# Raspberry Pi Pico – addons / evaluation kits

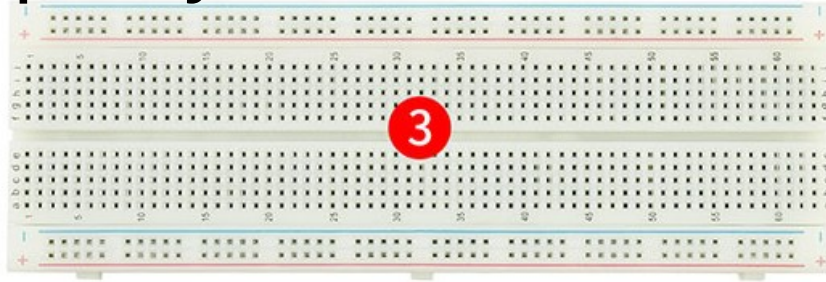


## Kit Contents:

- Raspberry Pi Pico With Header
- LCD1602 RGB Module
- PIR motion sensor
- 8-Bit WS2812 RGB LED
- Alarm
- Single-joint potentiometer
- Round buttons
- 5mm LED
- 330R resistors
- Breadboard and wires
- Jumper wires
- Plastic box

Basic Entry - Level Kit MicroPython Programming Learning Kit \$73

# Raspberry Pi Pico – addons / evaluation kits



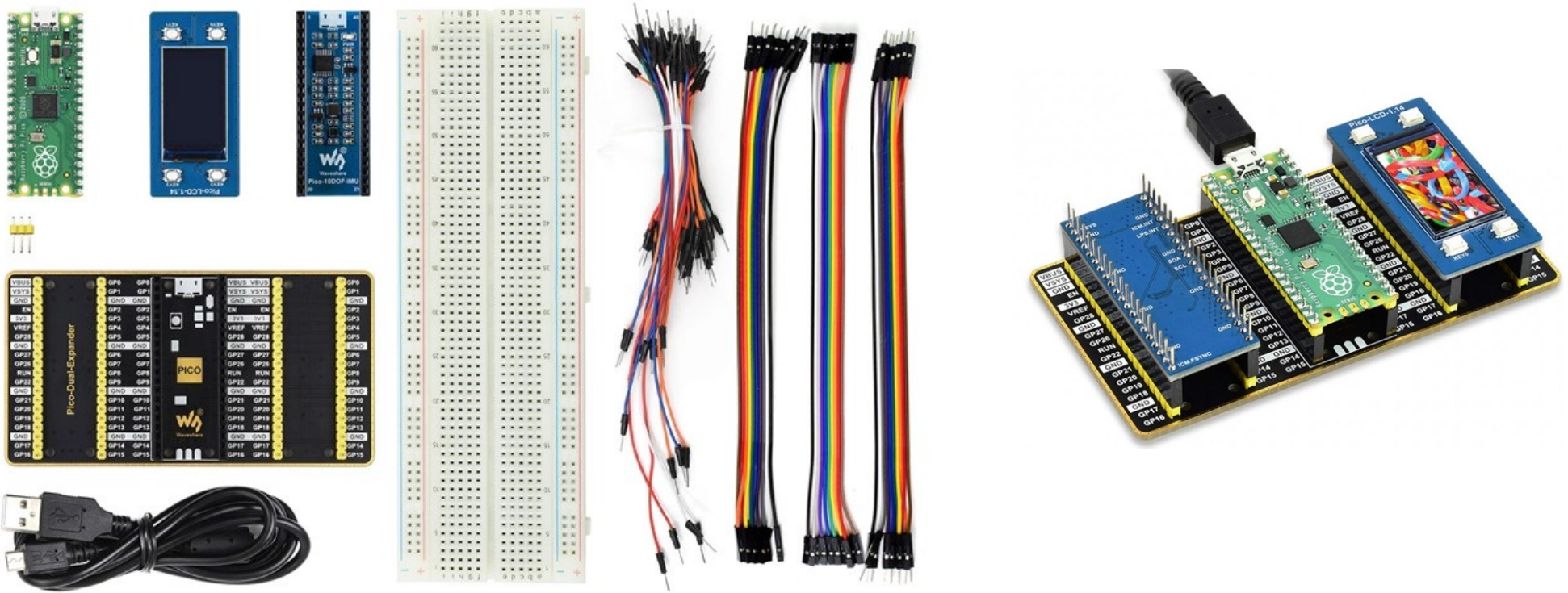
## Sensors:

- MQ-5 Gas
- Color
- Flame
- Hall
- Infrared Reflective
- Laser
- Moisture
- Rotation
- Sound
- Temperature-Humidity
- Tilt
- UV
- Liquid Level

Sensor Kit Development & Expansion Boards Kit Pack \$110

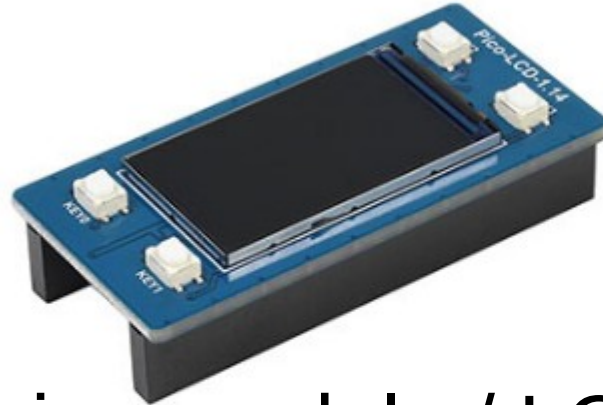
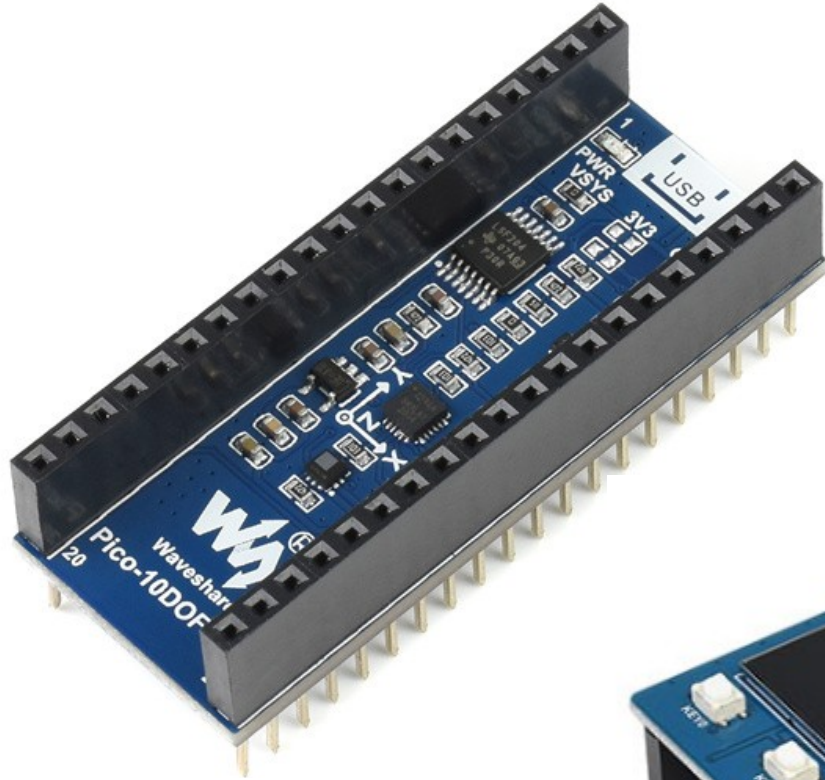


# Raspberry Pi Pico – addons / evaluation kits



Evaluation Kit Type B The Pico + Colour LCD + IMU Sensor + GPIO Expander \$100

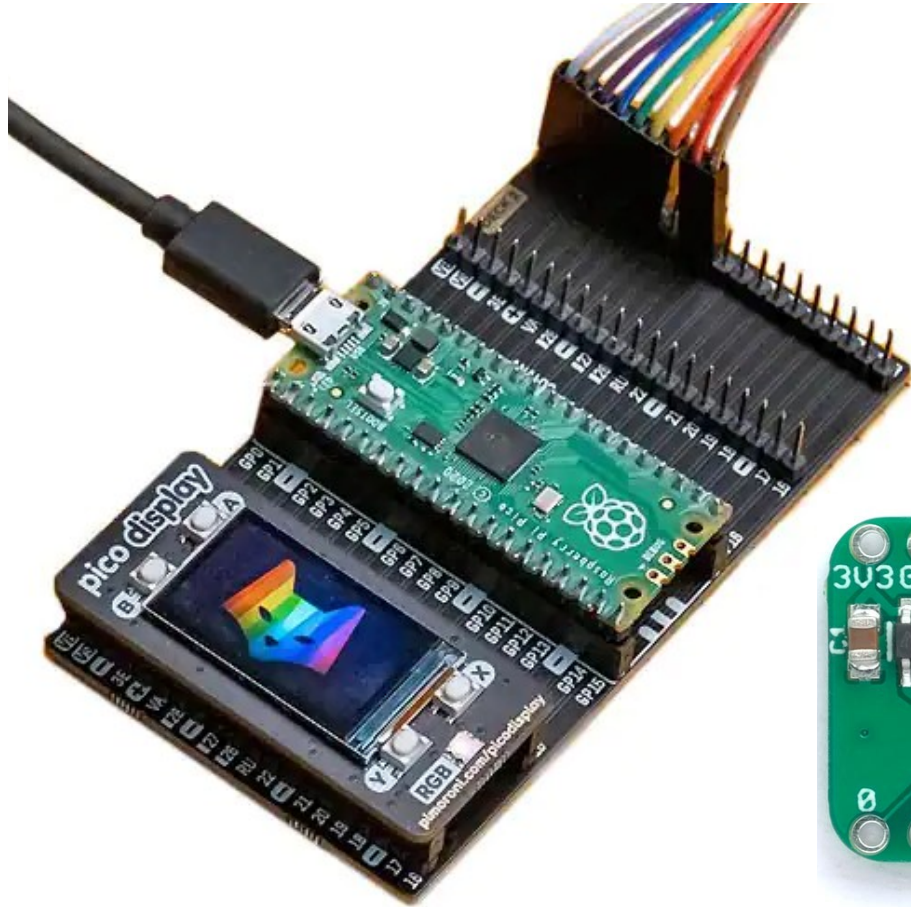
# Raspberry Pi Pico – addons / evaluation kits



## Sensor expansion module / LCD Displays



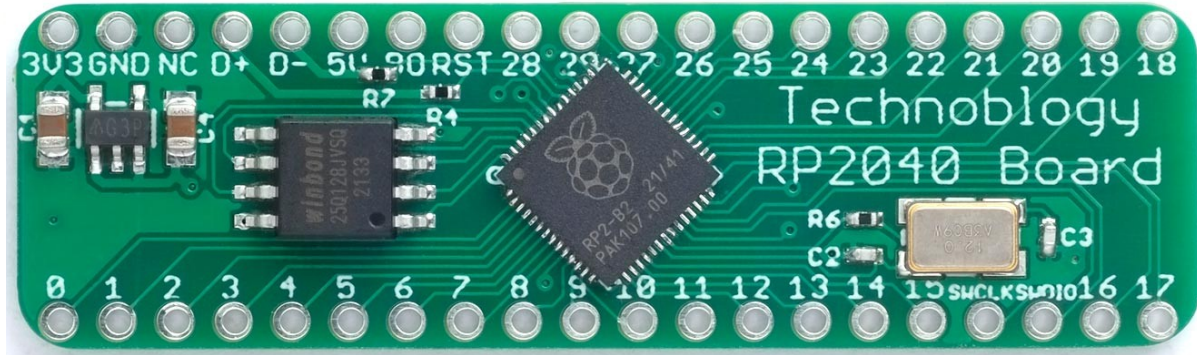
# Raspberry Pi Pico – addons 3<sup>rd</sup> Party



Manufacturer Pimoroni Ltd

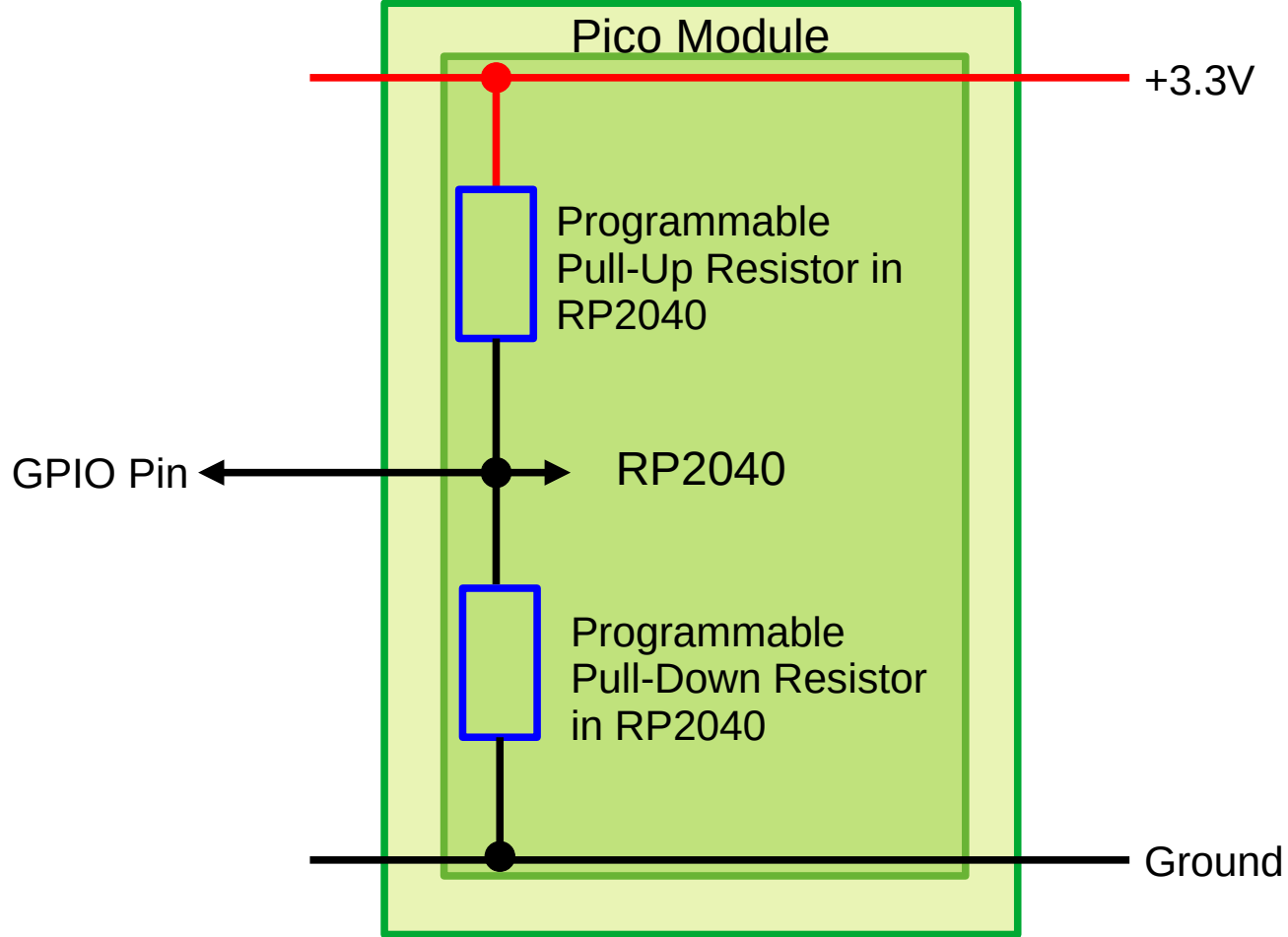
Manufacturer Product Number PIM556

Description PICO OMNIBUS (DUAL EXPANDER)



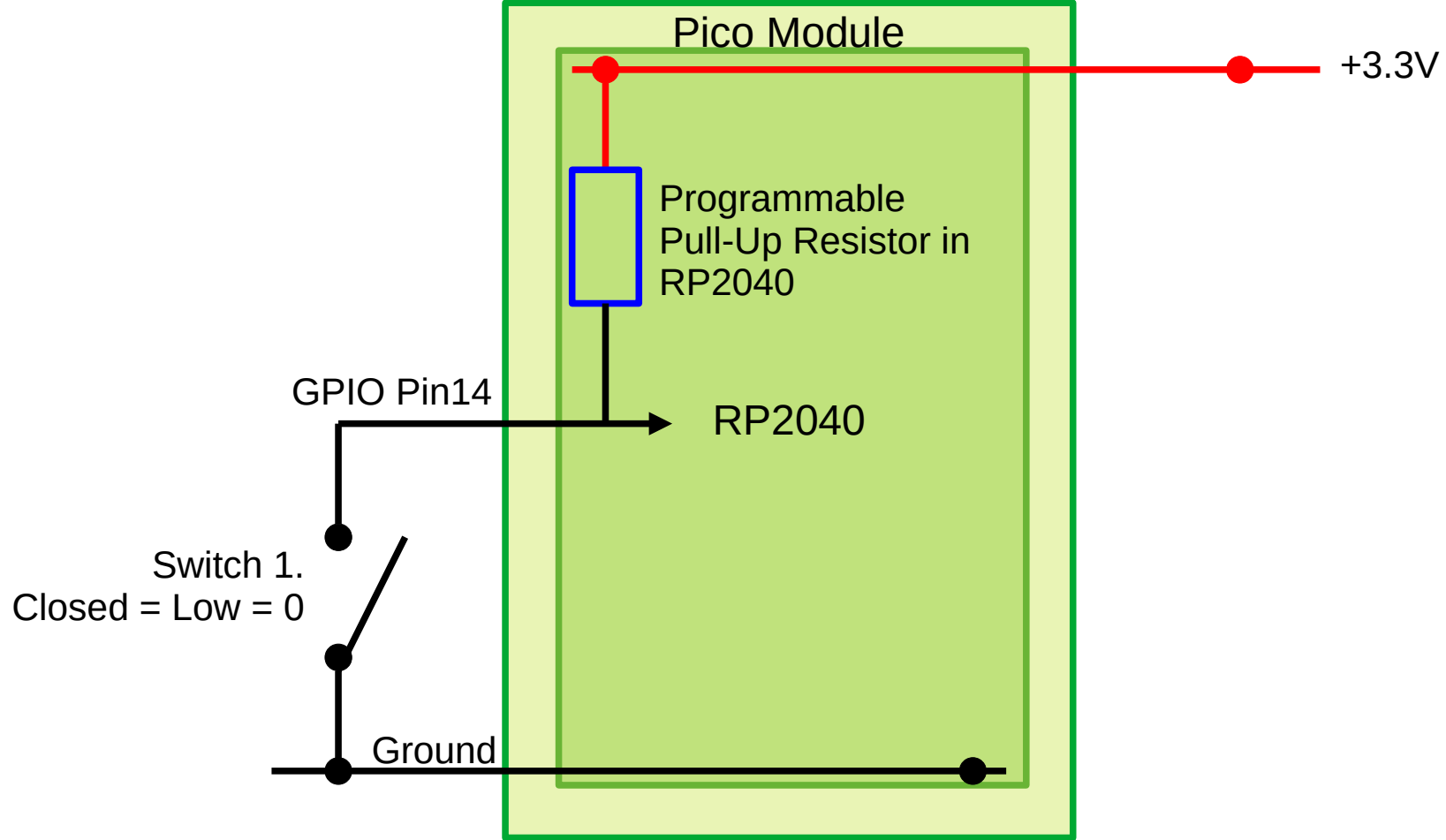
3<sup>rd</sup> Party 40pin Board – 30 x GPIO

# GPIO IN/OUT Circuits

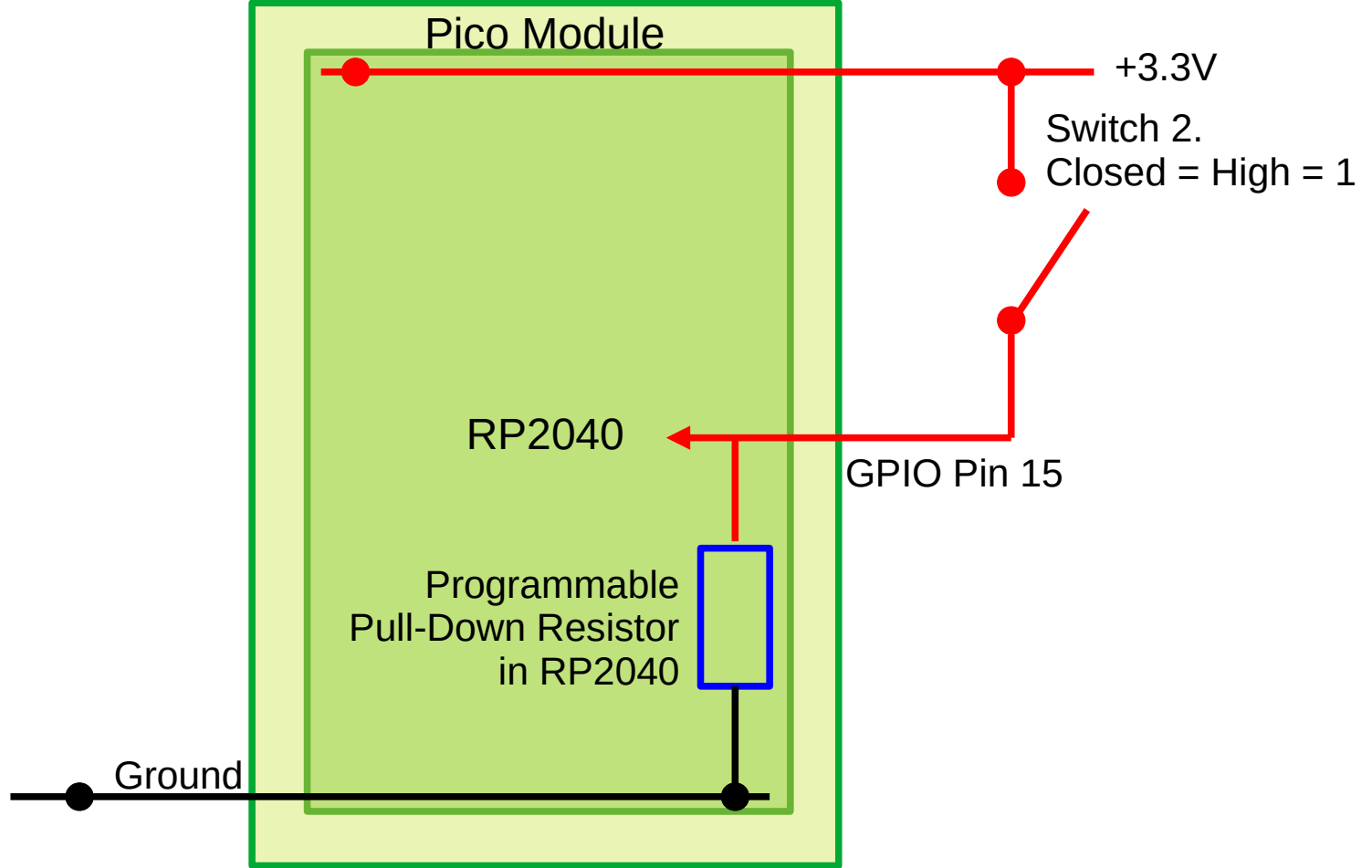




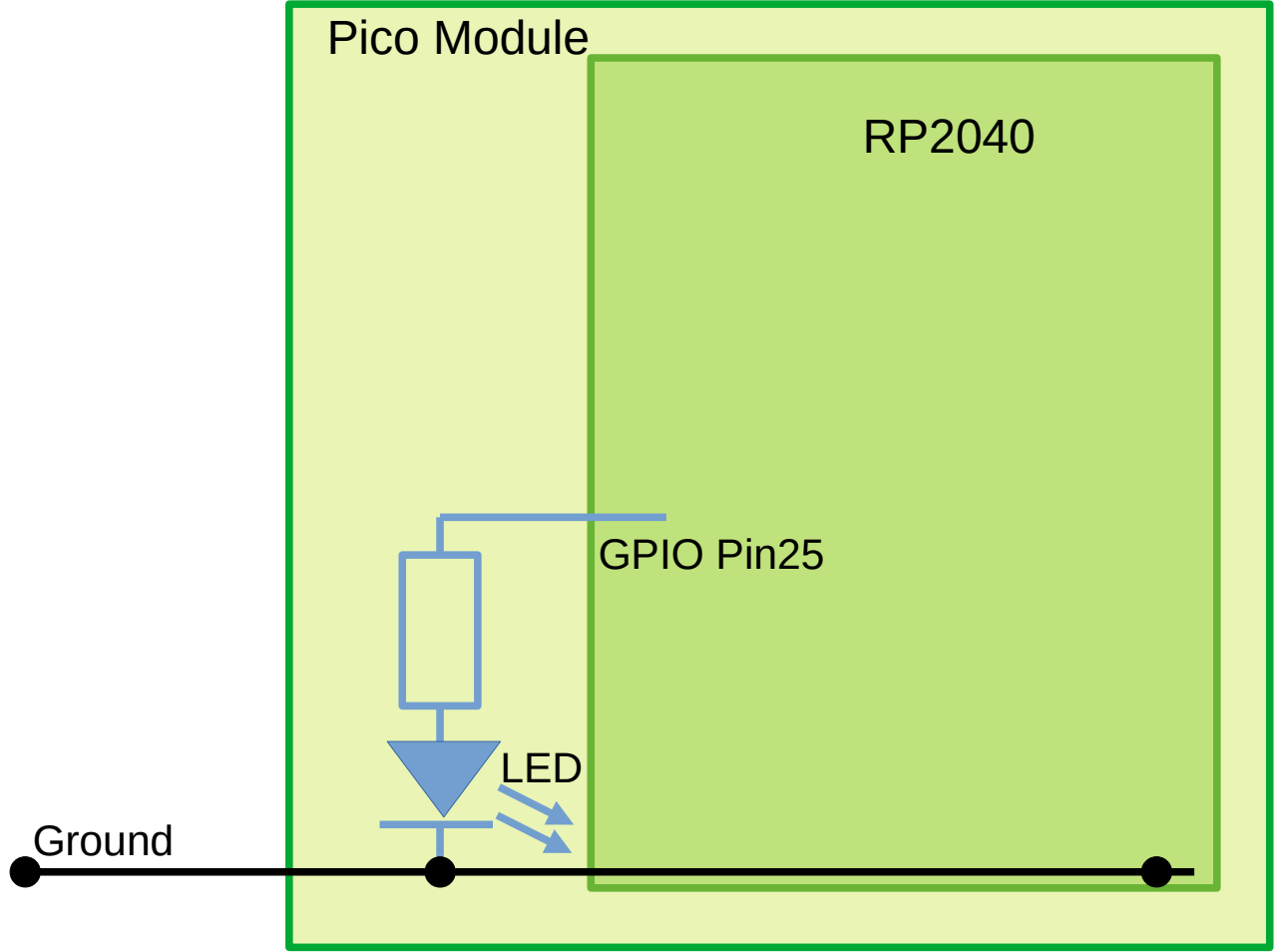
# GPIO Pin IN Pull-Up

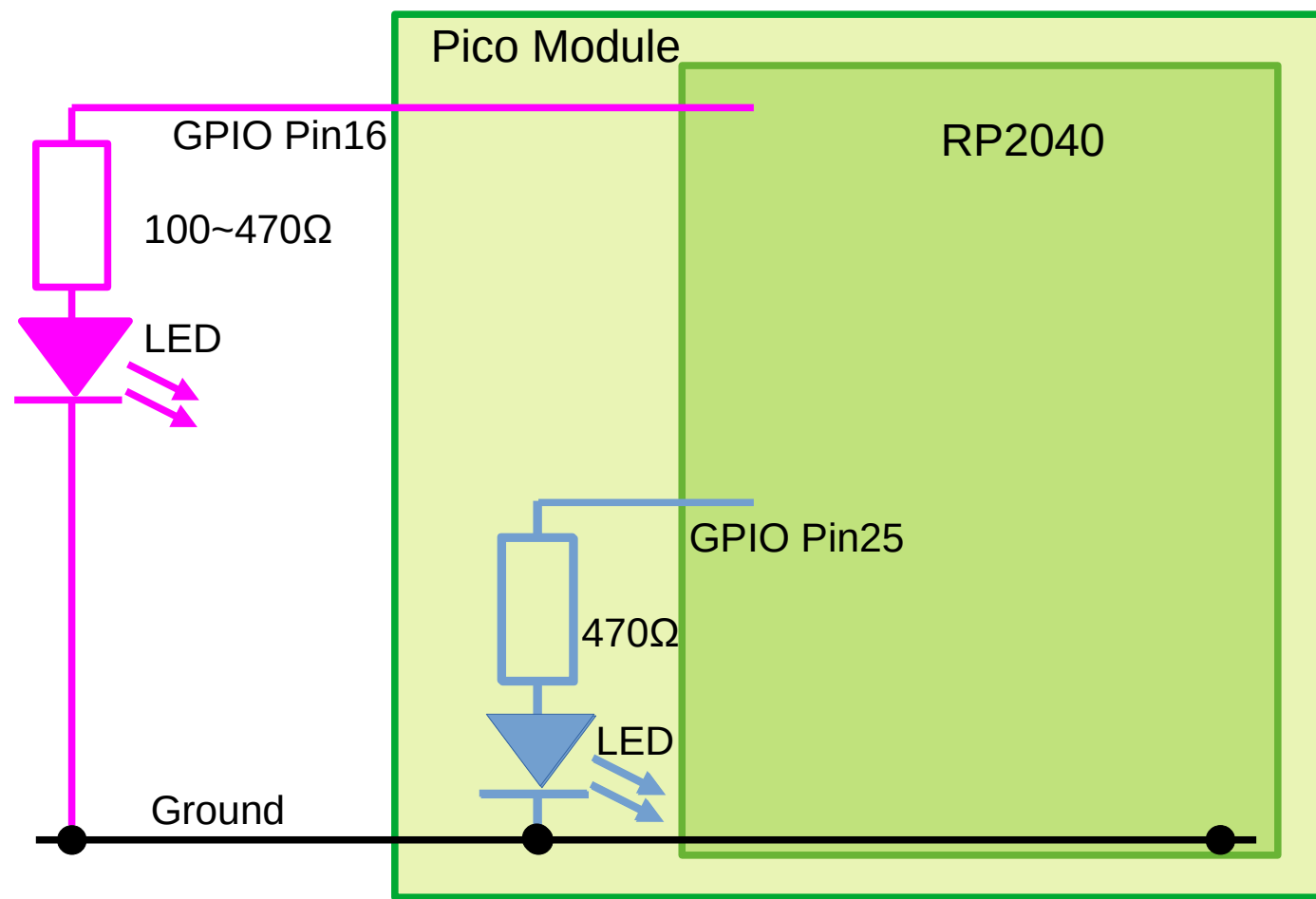


# GPIO Pin IN Pull-Down



# GPIO Pin OUT on Pico Module





GPIO Pin OUT  
on Pico Module.

GPIO Pin OUT  
External

Part 1 End.

Demo Hardware.