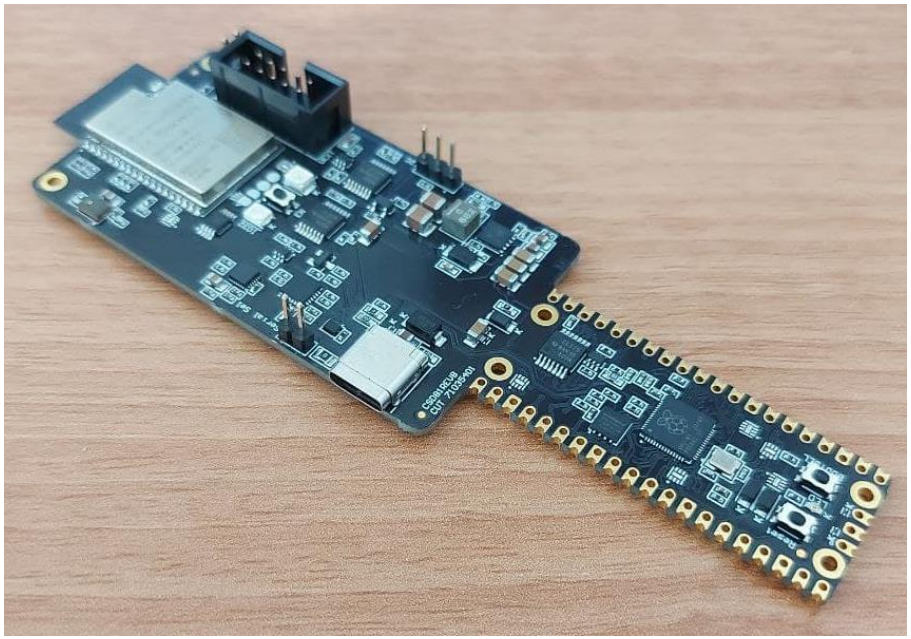
Smart Edge Computing

User Manual



UDOO KEY

Developer board with ESP32-WROVER-E module
and RP2040 microcontroller

SECO

REVISION HISTORY

Revision	Date	Note	Ref
1.0	03 August 2021	First Release.	RB
1.1	14 October 2021	Updated board name	RB
1.2	15 October 2021	Global review: Minor corrections and tables new format introduced	SB
1.3	25 October 2021	FW Setup chapter updated	TM
1.4	12 November 2021	Identification label updated	LT
1.5	13 December 2021	Updated images	RB
1.6	02 February 2022	Updated Identification Label and P/N Description	RB

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Every effort has been made to ensure the accuracy of this manual. However, SECO S.p.A. accepts no responsibility for any inaccuracies, errors or omissions herein. SECO S.p.A. reserves the right to change precise specifications without prior notice to supply the best product possible.

For further information on this module or other SECO products, but also to get the required assistance for any and possible issues, please contact us using the dedicated web form available at http://www.seco.com (registration required).

Our team is ready to assist.

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Chapter 1. . INTRODUCTION

- Warranty
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- Installation
- Admissible environmental conditions
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1.1 Warranty

This product is subject to the Italian Law Decree 24/2002, acting European Directive 1999/44/CE on matters of sale and warranties to consumers.

The warranty on this product lasts for 1 year.

Under the warranty period, the Supplier guarantees the buyer assistance and service for repairing, replacing or credit of the item, at the Supplier's own discretion.

Shipping costs that apply to non-conforming items or items that need replacement are to be paid by the customer.

Items cannot be returned unless previously authorized by the supplier.

The authorization is released after completing the specific form available on the web-site https://support.seco.com/. The RMA authorization number must be put both on the packaging and on the documents shipped with the items, which must include all the accessories in their original packaging, with no signs of damage to, or tampering with, any returned item.

The error analysis form identifying the fault type must be completed by the customer and has must accompany the returned item.

If any of the above-mentioned requirements for the RMA is not satisfied, the item will be shipped back and the customer will have to pay any and all shipping costs.

Following a technical analysis, the supplier will verify if all the requirements, for which a warranty service applies, are met. If the warranty cannot be applied, the Supplier will calculate the minimum cost of this initial analysis on the item and the repair costs. Costs for replaced components will be calculated separately.

1.2 Information and assistance

What do I have to do if the product is faulty?

SECO S.p.A. offers the following services:

- SECO website: visit http://www.seco.com to receive the latest information on the product. In most cases it is possible to find useful information to solve the problem.
- SECO Sales Representative: the Sales Rep can help to determine the exact cause of the problem and search for the best solution.
- SECO Help-Desk: contact SECO Technical Assistance. A technician is at disposal to understand the exact origin of the problem and suggest the correct solution.

  E-mail: technical.service@seco.com

  Fax (+39) 0575 340434
- Repair centre: it is possible to send the faulty product to the SECO Repair Centre. In this case, follow this procedure:
  - Returned items must be accompanied by a RMA Number. Items sent without the RMA number will be not accepted.
  - Returned items must be shipped in an appropriate package. SECO is not responsible for damages caused by accidental drop, improper usage, or customer neglect.

Note: Please have the following information before asking for technical assistance:

- Name and serial number of the product;
- Description of Customer's peripheral connections;
- Description of Customer's software (operating system, version, application software, etc.);
- A complete description of the problem;
- The exact words of every kind of error message encountered.

1.3 RMA number request

To request an RMA number, please visit SECO's web-site. On the home page, please select "Online RMA" and follow the procedure described.

An RMA Number will be sent within 1 working day (only for on-line RMA requests).

1.4 Safety

The UDOO KEY system uses only extremely-low voltages.

While handling the system, please use extreme caution to avoid any kind of risk or damages to electronic components.



Always switch the power off, and unplug the power supply unit, before handling the board and/or connecting cables or other boards.

Avoid using metallic components - like paper clips, screws and similar - near the board when connected to a power supply, to avoid short circuits due to unwanted contacts with other board components.

If the board has become wet, never connect it to any external power supply unit or battery.

Check carefully that all cables are correctly connected and that they are not damaged.

1.5 Electrostatic discharges

The UDOO KEY system, like any other electronic product, is an electrostatic sensitive device: high voltages caused by static electricity could damage some or all the devices and/or components on-board.



Whenever handling an UDOO KEY System, ground yourself through an anti-static wrist strap. Placement of the board on an anti-static surface is also highly recommended.

1.6 RoHS compliance

The UDOO KEY system is designed using RoHS compliant components and is manufactured on a lead-free production line. It is therefore fully RoHS compliant.

1.7 FCC certification

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions:

(1) This device may not cause harmful interference, and

(2) this device must accept any interference received, including interference that may cause undesired operation.

NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.



Warning!
All changes or modifications to the equipment not explicitly approved by SECO S.p.A. could impair the equipment's functionalities and could void the warranty

- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

To comply with FCC RF exposure compliance requirements, a separation distance of at least 20 cm must be maintained between the antenna of this device and all nearby persons.

SECO S.p.A.
Model: VD81
FCC ID: 2AC7Z-ESP32WROVERE

1.8 Waste Disposal

Electrical equipment no longer in use must not be thrown away with normal municipal waste. The substances and materials it contains must be disposed of separately in an appropriate manner.

The device must be disposed correctly as it is a waste of electric and electronic equipment (WEEE).

1.9 Manufacturer Identification

Manufacturer: SECO S.p.A.

Address: via Achille Grandi, 20
52100 Arezzo – Italy
Tel. +39 0575 26979

1.10 Identification Label

The device is equipped with an identification label which is placed on the bottom of the device. On the label are written all the device's identification data that must be communicated to SECO S.p.A. if necessary:



VD81 is the board model, XXXX-XXXX-CX is the configuration key which indicates the configuration of the system, according to the scheme indicated at chapter 2.5.

Warning! Do not remove or replace the identification label.

1.11 Installation

UDOO KEY shall be placed on a flat surface. This surface must be dry and non-conductive.

1.12 Admissible environmental conditions

The installation and usage environment must NOT show:

- Exposure to environmental temperatures out of the range 0°C ÷ +60°C
- Exposure to zones at height over 2000 above sea level
- Exposure to corrosive flue gases
- Exposure to excessive dust
- Exposure to abrasive powder
- Exposure to oil vapours
- Exposure to explosive gas or powders mixtures
- Exposure to salty air
- Exposure to vibrations, impacts or shocks
- Exposure to weather elements or dripping
- Exposure to non-usual transportation or storage conditions
- Exposure to fast or high thermal gradients (more than 5K/h)
- Presence of nuclear radiations.



Caution!
Environmental conditions that differ from those specified may seriously damage the device. Positioning the device in environments that do not correspond to those indicated shall render the warranty null and void for the parts to be replaced.
SECO S.p.A. shall not be held liable if these instructions are not respected.

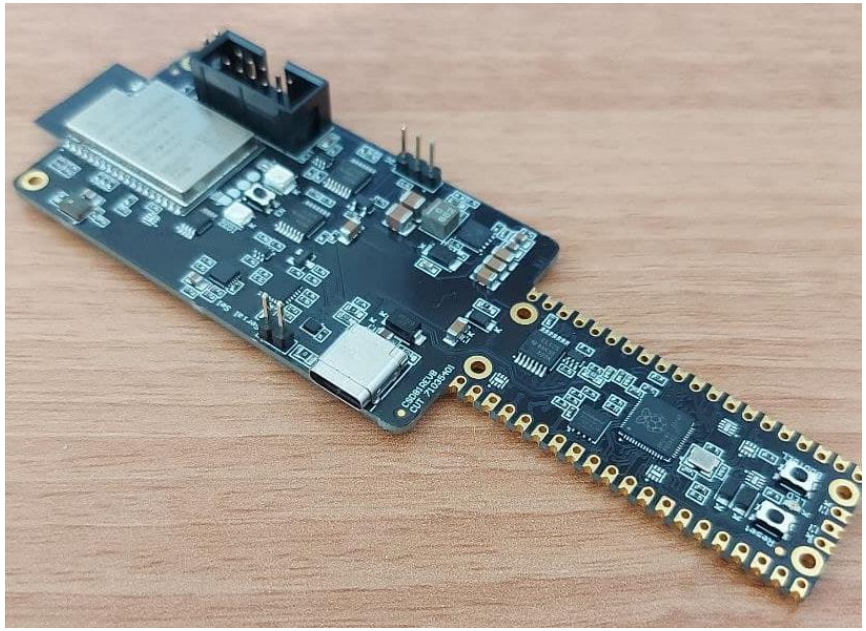
1.13 Pictograms

The device and the manual are provided with symbols, as indicated in the table below:

PICTOGRAM	DESCRIPTION
	CE Marking
	Warning! Read the manual before use
	WEEE/RAEE Indicates the separate collection of electronic and electrical equipment according to Directive 2012/19/EU.
	Symbol used to identify important warnings for the safety of the user and/or of the device

Chapter 2.
OVERVIEW

- Introduction
- Technical specifications
- Electrical specifications
- Mechanical specifications
- P/N Description



2.1 Introduction

UDOO KEY is a non-boxed module with a form factor of just 130 x 40 x 10.9 mm based on an ESP32-WROVER-E module of Espressif and an RP2040 microcontroller made by Raspberry Pi Foundation.

ESP32-WROVER-E is a powerful, generic WiFi-BT-BLE MCU module that targets a wide variety of applications, ranging from low-power sensor networks to the most demanding tasks, such as voice encoding, music streaming and MP3 decoding. This module is provided with an PCB antenna.

ESP32-WROVER-E features a 16 MB external SPI flash and an additional 8 MB SPI Pseudo static RAM (PSRAM).

The core of the module is the ESP32-D0WD-V3 chip. The embedded chip is designed to be scalable and adaptive. There are two CPU cores that can be individually controlled, and the CPU clock frequency is adjustable from 80 MHz to 240 MHz. The chip has also a low-power co-processor that can be used instead of the CPU to save power while performing tasks that do not require much computing power, such as monitoring of peripherals.

The integration of Bluetooth, Bluetooth LE and Wi-Fi ensure that a wide range of applications can be targeted and that the module is all-around: using Wi-Fi allows a large physical range and direct connection to the Internet through a Wi-Fi router, while using Bluetooth allows the user to conveniently connect to the phone or broadcast low energy beacons for its detection. The sleep current of the ESP32 chip is less than 5 µA, making it suitable for battery-powered and wearable electronics applications. The module supports a data rate of up to 150 Mbps, 802.11b at 13.5dBm, and 802.11g/n at 18.5 dBm of output power to the antenna to ensure the widest physical range. As such the module does offer industry-leading specifications and the best performance for electronic integration, range, power consumption, and connectivity. Secure (encrypted) over the air (OTA) upgrade is also supported, so that users can upgrade their products even after their release, at minimum cost and effort.

RP2040 microcontroller is a new released chip from Raspberry Pi Foundation that integrates two ARM Cortex-M0+ CPUs that can be run up to 133MHz, features 264kB of on-chip SRAM and up to 16MB of off-chip Flash memory. This microcontroller can be used for machine learning, motor control, audio and so on.

UDOO KEY offers the possibility to use these two microcontrollers (ESP32-WROVER-E and RP2040) independently or combine its main features together to realize infinite new applications.

A particular feature available on this board, among other things, is the possibility to program RP2040 by the ESP32-WROVER-E via dedicated SWD bus. This feature is interesting because made possible to take advantage from a wireless connectivity of ESP32-WROVER-E to download a new firmware for RP2040.

This board can be powered by $+5V_{DC}$ via USB Type-C connector and is suitable for IoT applications.

Please refer to following chapter for a complete list of all peripherals integrated and characteristics.

2.2 Technical specifications

Module

Espressif ESP32-WROVER-E Module

Flash

16 MB

PSRAM

8 MB

Peripherals

UART, SPI, I2C, Blue LED, Yellow LED, SWD to RP2040, SPK0838HT4H-1 Microphone

Networking

WiFi: 802.11 b/g/n (802.11n up to 150 Mbps)

Bluetooth: Bluetooth v4.2 BR/EDR and BLE specification

RF Power

WiFi: 20 dBm

BT:13.7 dBM

Modulation type

ESP32: GFSK, OFDM

Communication protocols

802.11 b/g/n, BluetoothLE

Frequency bands

2400 ÷ 2483.5 MHz

Bandwidth

BT / BLE: 1 MHz (79 channels) / 2 MHz (40 channels)

Module

Raspberry Pi RP2040

Flash

8 MB

SRAM

264 kB

Peripherals

UART, SPI, I2C, Green LED

Power Supply

$+5V_{DC}$

Common peripherals

ICM-20948 IMU sensor

Operating temperature

0°C ÷ +60°C

Dimensions

130 x 40 x 10.9 mm

2.3 Electrical specifications

The UDOO KEY board can be supplied with +5V_{DC}.

This voltage can be supplied through a standard USB Type-C (CN1).

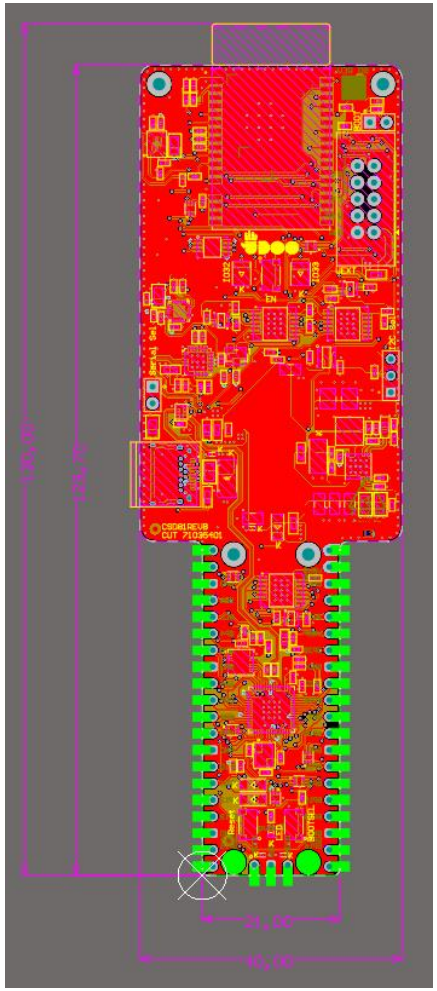
This board is provided of a 2.5A 32V_{DC} fuse to protect itself from overcurrent injection.

Power In USB Type-C Connector – CN1	
Pin	Signal
A4	+5V_{DC}
A9	+5V_{DC}
B4	+5V_{DC}
B9	+5V_{DC}
A1	GND
A12	GND
B1	GND
B12	GND
G1	GND
G2	GND

2.4 Mechanical specifications

The dimensions are 130 x 40 x 10.9 mm.

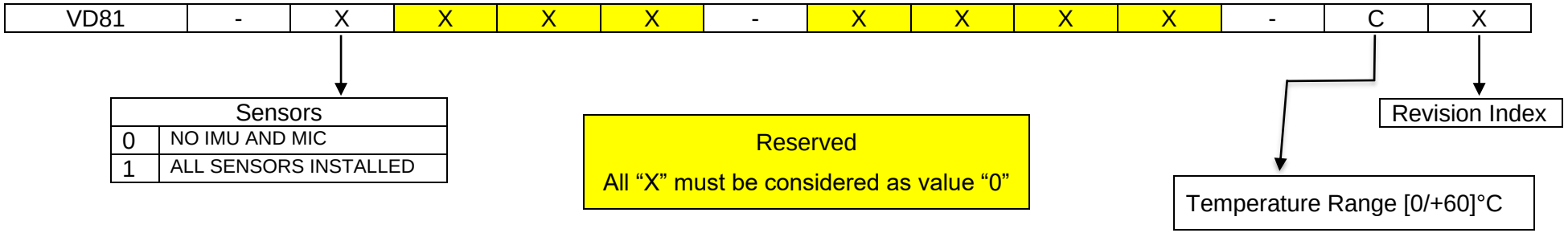
The printed circuit of the internal board is made of four layers, one of them is ground plane, for disturbance rejection.



2.5 P/N Description

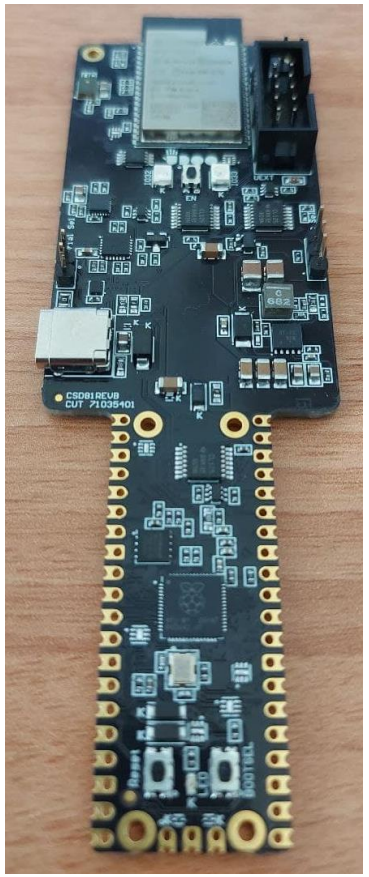
The UDOO KEY system is available in two possible variants, each one integrating different system's options.

All the possible options are summarized in the system part number (VD81-xxxx-xxxx-Cx), according to the following scheme:



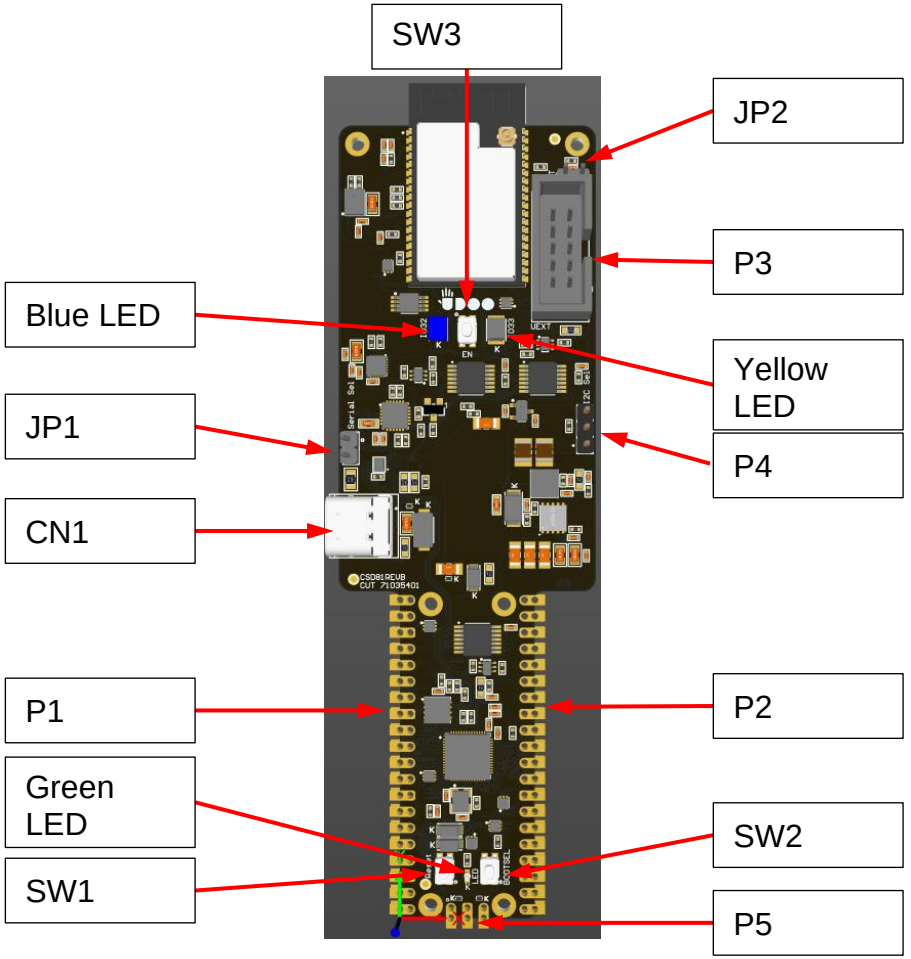
Chapter 3.
CONNECTORS/BUTTONS/LEDS

- Introduction
- Connectors overview
- Connectors description



3.1 Introduction

On UDOO KEY board, there are several connectors located on the lower and upper part. Moreover, there are two hardware reset buttons and three user's LEDs.



Please be aware that, depending on the configuration purchased, the appearance of the system could be slightly different from the above picture.

3.2 Connectors overview

Name	Description	Name	Description
CN1	USB Type-C connector	JP1	USB select jumper
P1, P2	External connectors to RP2040	JP2	Boot Mode ESP32-WROVER-E
P3	External connector to ESP32-WROVER-E	SW1, SW2, SW3	Switch buttons
P4	I2C select jumper	D12, D17, D18	LEDs
P5	External SWD to RP2040		

3.3 Connectors description

3.3.1 USB Type-C connector CN1

The UDOO KEY System can be powered by an external power supply +5V_{DC} (max 2.5A) via USB Type-C connector. This connector power up both ESP32-WROVER-E module, RP2040 and all peripherals connected on.

On this same connector, it is also available an USB 2.0 Port which can be used for programming of RP2040 or ESP32 (via an UART-to-USB bridge). The selection can be made using dedicated jumper JP4, according to the following table:

USB routing selection Jumper – JP4	
Jumper Position	Microcontroller connected
Not placed	ESP32
Placed	RP2040

3.3.2 External RP2040 connectors (P1&P2)

Connectors P1 and P2 are used to provide customers an easy solution to connect external peripherals to RP2040.

To use these two connectors, it is needed to solder two 20-pin headers on P1 and P2 or solder castellated holes in a proper manner.

These connectors offers the following possibilities:

RP2040 Connector P1						
Pin nr.	**Pin Name**	**SPI Interface**	**UART**	**I2C**	**PWM**	**SIO/PIO**
1	N.C.				---	
2	N.C.				---	
3	GND				Power GND	
4	RPI_SDA	SPI0_SCK	UART0_CTS	I2C1_SDA	PWM1_A	SIO/PIO0/PIO 1
5	RPI_SCL	SPI0_TX	UART0_RTS	I2C1_SCL	PWM1_B	SIO/PIO0/PIO 1

6	GP4	SPI0_RX	UART1_TX	I2C0_SDA	PWM2_A	SIO/PIO0/PIO1
7	GP5	SPI0_CSn	UART1_RX	I2C0_SCL	PWM2_B	SIO/PIO0/PIO1
8	GND				Power GND	
9	GP6	SPI0_SCK	UART1_CTS	I2C1_SDA	PWM3_A	SIO/PIO0/PIO1
10	GP7	SPI0_TX	UART1_RTS	I2C1_SCL	PWM3_B	SIO/PIO0/PIO1
11	GP8	SPI1_RX	UART1_TX	I2C0_SDA	PWM4_A	SIO/PIO0/PIO1
12	GP9	SPI1_CSn	UART1_RX	I2C0_SCL	PWM4_B	SIO/PIO0/PIO1
13	GND				Power GND	
14	GP10	SPI1_SCK	UART1_CTS	I2C1_SDA	PWM5_A	SIO/PIO0/PIO1
15	GP11	SPI1_TX	UART1_RTS	I2C1_SCL	PWM5_B	SIO/PIO0/PIO1
16	GP12	SPI1_RX	UART0_TX	I2C0_SDA	PWM6_A	SIO/PIO0/PIO1
17	GP13	SPI1_CSn	UART0_RX	I2C0_SCL	PWM6_B	SIO/PIO0/PIO1
18	GND				Power GND	
19	GP14	SPI1_SCK	UART0_CTS	I2C1_SDA	PWM7_A	SIO/PIO0/PIO1
20	GP15	SPI1_TX	UART0_RTS	I2C1_SCL	PWM7_B	SIO/PIO0/PIO1

RP2040 Connector P2						
Pin nr.	**Pin Name**	**SPI Interface**	**UART**	**I2C**	**PWM**	**SIO/PIO**
1	GP16	SPI0_RX	UART0_TX	I2C0_SDA	PWM0_A	SIO/PIO0/PIO 1
2	GP17	SPI0_CSn	UART0_RX	I2C0_SCL	PWM0_B	SIO/PIO0/PIO 1
3	GND				Power GND	
4	GP18	SPI0_SCK	UART0_CTS	I2C1_SDA	PWM1_A	SIO/PIO0/PIO 1
5	GP19	SPI0_TX	UART0_RTS	I2C1_SCL	PWM1_B	SIO/PIO0/PIO 1
6	GP20	SPI0_RX	UART1_TX	I2C0_SDA	PWM2_A	SIO/PIO0/PIO 1
7	GP21	SPI0_CSn	UART1_RX	I2C0_SCL	PWM2_B	SIO/PIO0/PIO 1
8	GND				Power GND	
9	GP22	SPI0_SCK	UART1_CTS	I2C1_SDA	PWM3_A	SIO/PIO0/PIO 1
10	/RPI_RESET				RP2040 Reset	
11	GP26	SPI1_SCK	UART1_CTS	I2C1_SDA	PWM5_A	SIO/PIO0/PIO 1
12	GP27	SPI1_TX	UART1_RTS	I2C1_SCL	PWM5_B	SIO/PIO0/PIO 1
13	GND				Power GND	
14	GP28	SPI1_RX	UART0_TX	I2C0_SDA	PWM6_A	SIO/PIO0/PIO 1
15	ADC_VREF				A/D Reference Voltage	
16	3V3				+3.3V_{DC} (315mA)	

17	N.C.	---
18	GND	Power GND
19	VSYS	+5V_{DC} filtered from USB Type-C (500mA)
20	VBUS	+5V_{DC} raw from USB Type-C (500mA)

3.3.3 External connector to ESP32-WROVER-E (P3)

P3 is a 2.54mm pitch 2x4 poles connector, type MOLEX 70246-1004 or equivalent, that can be used as external interface of ESP32 microcontroller.

This connector offers the following possibilities:

- 1x SPI interface
- 1x I2C interface
- 1x UART interface

ESP 32 External Connector- P3					
Pin nr.	**Pin Name**	**GPIO**	**I2C Interface**	**SPI**	**UART**
1	3V3		3.3V output, 150mA Max		
2	GND		Power GND		
3	EXT_UART2_TX	GPIO13			UART2_TX
4	EXT_UART2_RX	GPIO26			UART2_RX
5	ESP32_SCL	GPIO21	SCL		
6	ESP32_SDA	GPIO18	SDA		
7	SPI_MISO	GPIO35		SPI_MISO	
8	SPI_MOSI	GPIO12		SPI_MOSI	
9	SPI_SCK	GPIO14		SPI_SCK	
10	SPI_CS#	GPIO15		SPI_CS#	

3.3.4 IMU Sensor I2C management selector (P4)

This 3-pins header is used to select which microcontroller (RP2040 or ESP32) can communicate to the onboard IMU sensor via I2C bus.

By placing a jumper on the header, it is possible to make a selection as described in the following table:

JP4 Jumper	
Jumper Position	Microcontroller connected
Not placed	ESP32 (Default)
1-2	RP2040
2-3	ESP32

3.3.5 RP2040 External Serial Wire Debug (P5)

The Serial Wire Debug interface is available on a 1x3 poles connector.

By using this header is possible program and debug RP2040 microcontroller externally.

The following table show the pin configuration:

SWD interface – P5	
Pin nr.	Function
1	SWCLK
2	GND
3	SWDIO

3.3.6 ESP32 Boot Mode selection jumper - JP2

Jumper JP2 is used to allow the programming of ESP32-WROVER-E module as described in the following table:

ESP32 Boot Mode Selection Jumper – JP2	
Jumper Position	ESP 32 Boot Mode
Not placed	Boot Mode OFF
Placed	Boot Mode On

Only when the jumper is placed (i.e. closed) it is possible to program ESP32-WROVER-E module via USB communication.

3.3.7 Buttons / LED

On the board, there are three pushbuttons:

- SW1 (RPI_RST_SW), must be used to restart the RP2040 microcontrolle
- SW2 (BOOTSEL), must be pushed to program directly RP2040
- SW3 (ESP32_RST), must be used to restart ESP32-WROVER-E module.

There are also three LEDS onboard.

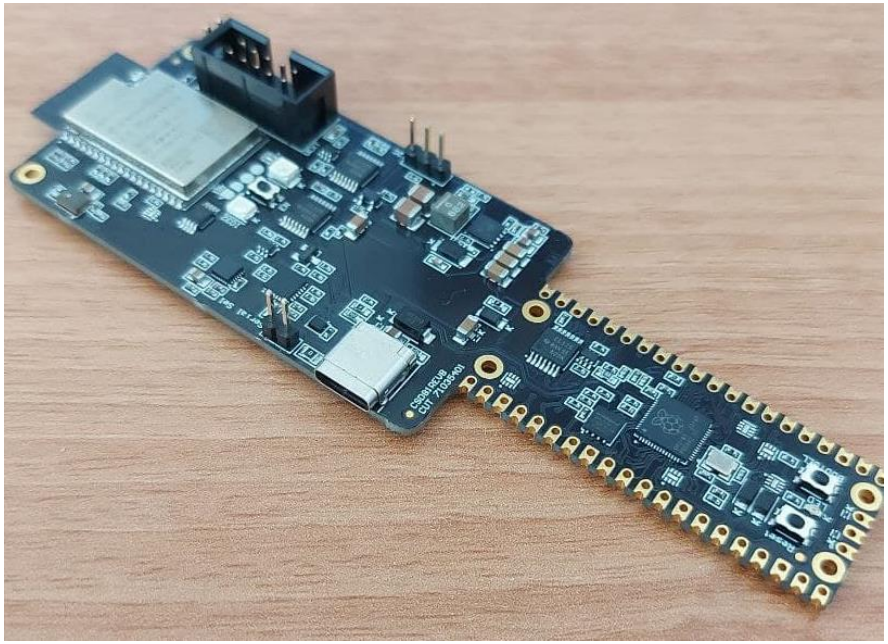
Green LED (D12 - RP2040 user’s led) customizable behaviour by user.

Blue LED (D17 – ESP32 user’s led) customizable behaviour by user.

Yellow LED (D18 – ESP32 user’s led) customizable behaviour by user.

Chapter 4.
FW SETUP

- Development Environment
- Firmware Download



4.1 Development Environment

In this section and in the next one you can find how to create your own firmware and load it on the device.

4.1.1 RP2040 Development Environment

All the software documentation you need to create a new firmware project and use the RP2040 chip is contained in the official Raspberry Pi Documentation pages.

You can start from Getting started from Raspberry Pi Pico.

Although all pages of the documentation are important, we would like to point out some useful links to start with the development of your own project.

Here you can find how to Quick start your own project.

4.1.2 ESP32 Development Environment

All the software documentation you need to create a new firmware project and use the ESP32 chip is contained in the official Espressif's documentation pages.

You can start from the Get Started page and continue by carefully reading all the documentation provided by Espressif.

Although all pages of the documentation are important, we would like to point out some useful links to start with the development of your own project.

Here you can find how to Setting up Development Environment.

This page shows how to Creating Your Project while at these links you can see how to Configure and Build Your Project.

4.2 Firmware Download

Below is a brief description of the steps to be carried out for loading and testing the firmware.

4.2.1 How to flash RP2040

- Close JP1 Jumper
- Connect USB to USB-C from Host PC to VD81 board
- Keep old press SW2 button meanwhile click SW1 button
- New USB block device /dev/sda1 should appear on your Host PC
- Drag and drop the .uf2 binay file into USB block device as suggested by rp2040 documentation
- Wait for the copy to complete: after that, the microcontroller will reset itself automatically and the new firmware will run

4.2.2 How to flash ESP32

- If present, remove JP1 Jumper
- Connect USB to USB-C from Host PC to VD81 board
- Close JP2 Jumper
- Reset ESP32 using SW3
- New serial device /dev/ttyUSB0 should appear on your Host PC
- Flash board as suggested by esp-idf documentation
- Reset ESP32 using SW3 to run new firmware



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