- ESP32-S3，Xtensa® 32 bit LX7
- External PSRAM , FLASH
- Ultra-low power 10uA
- 2.4G WIFI，Bluetooth 5，Bluetooth mesh
- GPIO , ADC , TOUCH , PWM , I2C , SPI , RMT , I2S , UART , LCD，CAMERA，USB , JTAG
- 1* JST SH 1mm 4-Pin Socket, support I2C
- 1 * USB Type-C
- 1 * MX 1.25mm 2-Pin Socket，support charging
- 1 * Neopixel LED

ESP32-S3-DevKitC-1, BPI-Leaf-S3 Comparison

Dev Board	BPI-Leaf-S3	ESP32-S3-DevKitC-1
GPIO Pins	36	36
3.3v Pins	3	3
5v Pins	1	1
GND Pins	4	4
ARGB LEDs	1 on GPIO48	1 on GPIO48
Chip Internal USB	USB-C Connector x 1	MicroUSB Connector x 1
UART TTL to USB	None	CP2102-MicroUSB Connector x 1
External Battery Socket	3.7v Li-ion Battery dock	None
Battery Charging	500mA Charging Current	None
JST SH 1mm 4-Pin Socket	1	None

The amount, numeric order, and spacing of IO pins on BPI-Leaf-S3 are identical to the Espressif ESP32-S3-DevKitC-1.

The BPI-Leaf-S3 dev board no longer equips traditional UART TTL to USB converter chip and its dedicated USB port. This is due to the ESP32-S3 chip's internal USB function were improved, supporting CDC-ACM virtual serial port and JTAG interface, which is capable of software development and firmware management feature, that makes the external converter chip redundant.

Compared to ESP32-S3-DevKitC-1 dev board, the BPI-Leaf-S3 adds an external battery socket and a charging circuit, capable of charging the battery via USB. When a 3.7v battery is connected, unplugging the USB will not cause the program to break, making it fit for multiple applications.

BPI-Leaf-S3 dev board is equipped with an I²C 4 pin dock, this stabalizes connection to other I²C peripherals. This dock is not only restricted to I²C connection, any module that requires a 3.3v pin, a GND pin, one or two data pin can also be connected to the Leaf-S3 via this 4 pin dock.

Espressif ESP32-S3

ESP32-S3 is a dual-core XTensa LX7 MCU, capable of running at 240 MHz. Apart from its 512 KB of internal SRAM, it also comes with integrated 2.4 GHz, 802.11 b/g/n Wi-Fi and Bluetooth 5 (LE) connectivity that provides long-range support. It has 45 programmable GPIOs and supports a rich set of peripherals. Compared with ESP32, it supports larger, high-speed octal SPI flash, and PSRAM with configurable data and instruction cache.

What follows is a description of the most important features of ESP32-S3.

- Wi-Fi + Bluetooth 5 (LE) Wireless Connectivity: ESP32-S3 supports a 2.4 GHz Wi-Fi (802.11 b/g/n) with 40 MHz of bandwidth support. The Bluetooth Low Energy subsystem supports long range through Coded PHY and

advertisement extension. It also supports higher transmission speed and data throughput, with 2 Mbps PHY. Both Wi-Fi and BLE have superior RF performance that is maintained even at high temperatures.

- AI Acceleration Support: ESP32-S3 has additional support for vector instructions in the MCU, which provides acceleration for neural network computing and signal processing workloads. The software libraries for the above-mentioned optimized functions will become available very soon, in the form of updates to ESP-WHO and ESP-Skainet.

- Rich Set of IO Peripherals: ESP32-S3 has 44 programmable GPIOs, namely 10 more GPIOs than those of ESP32. ESP32-S3 supports all the commonly-used peripherals, such as SPI, I2S, I2C, PWM, RMT, ADC and UART, SD/MMC host and TWAITM. In total, 14 GPIOs can be configured as capacitive touch input for HMI applications. Apart from all these peripherals, however, ESP32-S3 is also equipped with an ultra-low-power (ULP) core that supports multiple low-power modes in a variety of such use-cases.

- Security:ESP32-S3 provides all the necessary security requirements for building securely connected devices, without requiring any external components. It supports AES-XTS-based flash encryption and RSA-based secure boot. In addition, ESP32-S3 has a digital signature peripheral and an HMAC module, which provide functionality that is similar to the hardware secure element, thus protecting the private or symmetric key from software attacks and identity theft. ESP32-S3 also has a "World Controller" peripheral that provides two fully-isolated execution
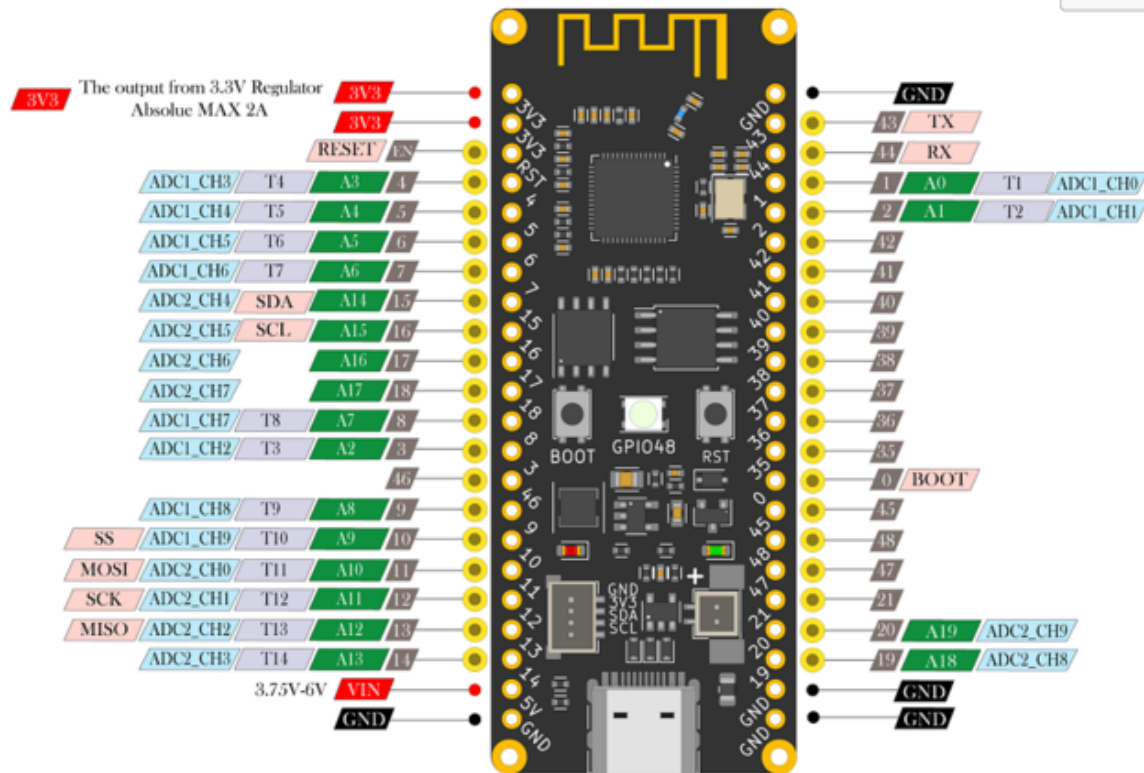
environments, which enable the implementation of a trusted-execution environment or a privilege-separation scheme.

Hardware

Hardware sketch map

Hardware Spec

BPI-Leaf-S3 Spec	
SoC	ESP32-S3，Xtensa® dual-core 32-bit LX7 microprocessor
Clock Frequency	240MHz MAX
Operating Temperature	-40℃~+85℃
Internal ROM	384 KB
Internal SRAM	512 KB

Onboard FLASH ROM	8MB
In-packge PSRAM	2MB
WIFI	IEEE 802.11 b/g/n，2.4Ghz，150Mbps
Bluetooth	Bluetooth 5，Bluetooth mesh
GPIO	BPI-Leaf-S3 has led out 36 available gpios
ADC	2 × 12-bit SAR ADCs, up to 20 channels
Touch Sensor	14
SPI	4
I2C	2
I2S	2
LCD	1 × LCD interface (8-bit ~16-bit parallel RGB, I8080 and MOTO6800)
CAMERA	1 × DVP 8-bit ~16-bit camera interface
UART	3
PWM	8 channels 14 bits
MCPWM	2
USB	1 × full-speed USB OTG，female Type-C socket
USB Serial/JTAG controller	1，CDC-ACM，JTAG
Temperature Sensor	1，ranging from -20 °C to 110 °C
SD/MMC	1 × SDIO host controller with 2 slots,SD 3.0,SD 3.01,SDIO 3.0,CE-ATA 1.1,MMC 4.41,eMMC 4.5,eMMC 4.51
TWAI® controller	1，compatible with ISO 11898-1 (CAN Specification 2.0)
General DMA controller (GDMA)	5 transmit channels and 5 receive channels
RMT	4 TX channels,4RX channels.Eight channels share a 384 x 32-bit RAM
Pulse Count Controller	4 independent pulse counters (units).Each unit consists of two independent channels
Timers	4 × 54-bit general-purpose timers. 1 × 52-bit system timer. 3 × watchdog timers
External crystal oscillator	40Mhz
RTC and LowPower Management	Power Management Unit (PMU) + Ultra-Low-Power Coprocessor(ULP)
Deep-sleep consumption current	10uA
Operating Voltage	3.3V
Input Voltage	3.3V~5.5V
Maximum discharge current	2A@3.3V DC/DC
USB charge	Support
Maximum charging current	500mA
Neopixel LED	1

Hardware Dimensions
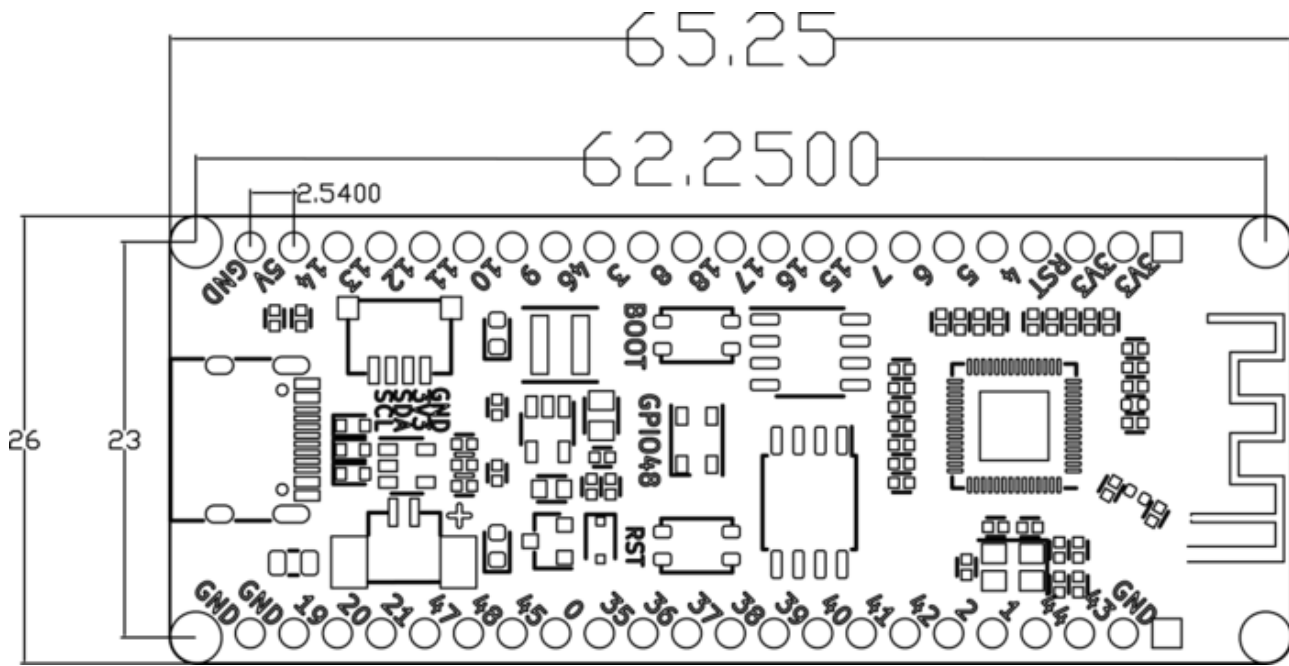
BPI-Leaf-S3 Dimensions	
Pin spacing	2.54mm
Mounting hole spacing	23mm/ 62.25mm
Mounting hole size	bore 2mm/outside 3mm
Motherboard size	26 × 65.25(mm)/1.02 x 2.57(inches)
board thickness	1.2mm

The pin spacing is breadboard compatible for easy application debugging.

Peripheral Pin Configurations

BPI-Leaf-S3 GPIO Pin define		
Peripheral Interface	Signal	Pin
ADC	ADC1_CH0~9	GPIO 1~10
	ADC2_CH0~9	GPIO 11~20
Touch sensor	TOUCH1~14	GPIO 1~14
JTAG	MTCK	GPIO 39
	MTDO	GPIO 40
	MTDI	GPIO 41
	MTMS	GPIO 42
UART	*The pins are assigned by default, and can be redefined to any GPIO*	
	U0RXD_in	GPIO 44
	U0CTS_in	GPIO 16
	U0DSR_in	any GPIO
	U0TXD_out	GPIO43
	U0RTS_out	GPIO 15
	U0DTR_out	any GPIO
	U1RXD_in	GPIO 18
	U1CTS_in	GPIO 20
	U1DSR_in	any GPIO
	U1TXD_out	GPIO 17
	U1RTS_out	GPIO 19
	U1DTR_out	any GPIO
	U2	any GPIO
I2C	any GPIO	
PWM	any GPIO	
I2S	any GPIO	
LCD	any GPIO	
CAMERA	any GPIO	
RMT	any GPIO	
SPI0/1	Used for FLASH and PSRAM	
SPI2/3	any GPIO	
Pulse counter	any GPIO	
USB OTG	D-	GPIO 19（on-chip PHY）
	D+	GPIO 20（on-chip PHY）
	VP	GPIO 42（external PHY）

	VM	GPIO 41 (external PHY)
	RCV	GPIO21 (external PHY)
	OEN	GPIO 40 (external PHY)
	VPO	GPIO 39 (external PHY)
	VMO	GPIO38 (external PHY)
	D-	GPIO 19 (on-chip PHY)
	D+	GPIO 20 (on-chip PHY)
USB Serial/JTAG	VP	GPIO 42 (external PHY)
	VM	GPIO 41 (external PHY)
	OEN	GPIO 40 (external PHY)
	VPO	GPIO 39 (external PHY)
	VMO	GPIO38 (external PHY)
SD/MMC	any GPIO	
MCPWM	any GPIO	
TWAI	any GPIO	
Neopixel LED	GPIO 48	

Software

Espressif ESP-IDF

ESP-IDF is the development framework for Espressif SoCs supported on Windows, Linux and macOS.

It is recommend that developers install ESP-IDF via IDE.

- GitHub: ESP-IDF Eclipse Plugin README
- ESP-IDF VSCode Extension | GitHub: README | youtube: Quick User Guide for the ESP-IDF VSCode Extension

Or install manually based on operating system:

- Standard Setup of Toolchain for Windows
- Standard Toolchain Setup for Linux and macOS

API:

- ESP-IDF API Reference Docs

- ESP-IDF API Guides

To enable your BPI-Leaf-S3 device to flash via USB-CDC.

There are two ways to enter Bootloader mode:

1. Connect it to the computer via USB, hold BOOT button, press RST button once, then release BOOT button.
2. Hold BOOT button while disconnected to power, connect to PC via USB, then release BOOT button.

The chip controls GPIO0 via BOOT button to choose between reset or cold boot.

Confirm the port of your BPI-Leaf-S3 device via device manager, it might display different port if you are on different modes.

MicroPython

Regardless of the programmer is a beginner or not, MicroPython is considered to be less difficult to develop than other MCU programming languages.

Its code is easy to understand compared to other programming languages, and it has various resources accumulated over the years by the open source community.

Just like Python, it has strong vitality and application value.

- Building MicroPython Operating Environment

- MicroPython Firmware Download

Forum resources

- BPI-Leaf-S3 OLED displays potentiometer voltage and progress bar
- BPI-Leaf-S3 with ESP32-S3, use potentiometer to control neopixel steplessly
- BPI-Leaf-S3 with ESP32-S3, use key interrupts to control neopixel
- BPI-Leaf-S3 with ESP32-S3 & microPython Neopixel show
- BPI-Leaf-S3 microPython getting started, blink LED on bread board
- BPI-Leaf-S3+MicroPython: Display Web Clock on OLED screen
- BPI-Leaf-S3+MicroPython:Use ADC measuring potentiometer to control the motor
- Banana Pi BPI-Leaf-S3 MicroPython with TB6612FNG PWM Motor

- Making IoT programming easy，using MicroPython on BPI-Leaf-S3

CircuitPython
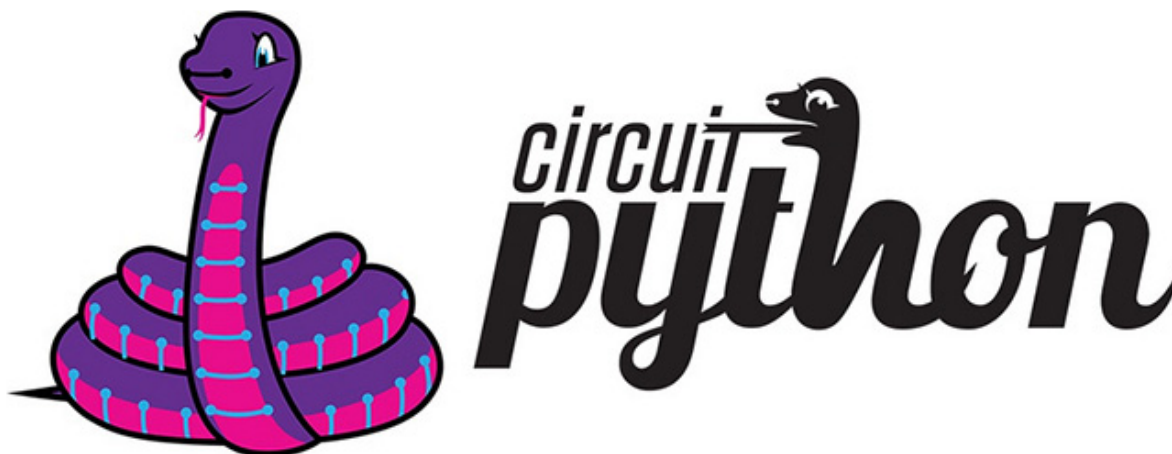
CircuitPython is a programming language designed to simplify experimenting and learning to code on low-cost microcontroller boards.

CircuitPython programming with Mu editor is the easiest way to get started. Install the software and connect the device to start using it.

BPI-Leaf-S3 CircuitPython Download Page

Mu Editor

How to install tinyUF2 firmware:

To enable your BPI-Leaf-S3 device to flash via USB-CDC.

Connect it to the computer via USB, hold BOOT button, press RST button once, then release BOOT button.

In the Install, Repair, or Update UF2 Bootloader section at the bottom of the page, follow its instructions to download and install tinyUF2 firmware.

How to install CircuitPython firmware：

Click the DOWNLOAD .UF2 NOW button on the right side of the page to download the firmware to the local, and then copy it to the disk in BPI-Leaf-S3 UF2 Bootloader mode, and it can be used after automatic reset.

Supported by the adafruit/circuitpython GitHub repository

https://github.com/adafruit/circuitpython/pull/6904

Supported by the adafruit/tinyuf2 GitHub repository

https://github.com/adafruit/tinyuf2/pull/196

Arduino

Arduino is an open source embedded software and hardware development platform for users to create interactive embedded projects.

- Arduino IDE download link | Install and configure the Arduino-ESP32 runtime environment
- GitHub: BPI-Leaf-S3 Arduino Getting Started
- Arduino-ESP32 APIs

Supported by the arduino-esp32 GitHub repository

https://github.com/espressif/arduino-esp32/pull/7345

The board has been merged into the master branch.

Resources

- BPI-Leaf-S3 schematic diagram PDF

- ESP32-S3 Datasheet

- ESP32-S3 Technical Reference Manual