BPI-Leaf-S3

Banana Pi Leaf is a series of low-powered microcontrollers designed for IoT development.

It supports 2.4 GHz Wi-Fi and Bluetooth® LE dual-mode wireless communication, the peripheral is compatible with low-power hardware design, and the power consumption is only 10uA in deep sleep mode.

The main controller supports two power supply inputs: USB and external 3.7V lithium battery, both can be inter-changable freely. The battery could also be charged while USB is plugged in. Compact size, various interface, easy to use, and can be directly applied to low-power IoT projects.

In terms of programming, the Leaf-S3 supports ESP-IDF, Arduino, micropython and other methods.

The IO pins on BPI-Leaf-S3 are identical to the Espressif ESP32-S3-DevKitC-1, developers can add peripherals that are supported by DevKitC-1 onto the BPI-Leaf-S3, and can also combine it onto a breadboard.

Key Features

- 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* 4pin I2C connector
- 1 * USB Type-C
- 1 * 2pin battery connector，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
I²C 4Pin Dock	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
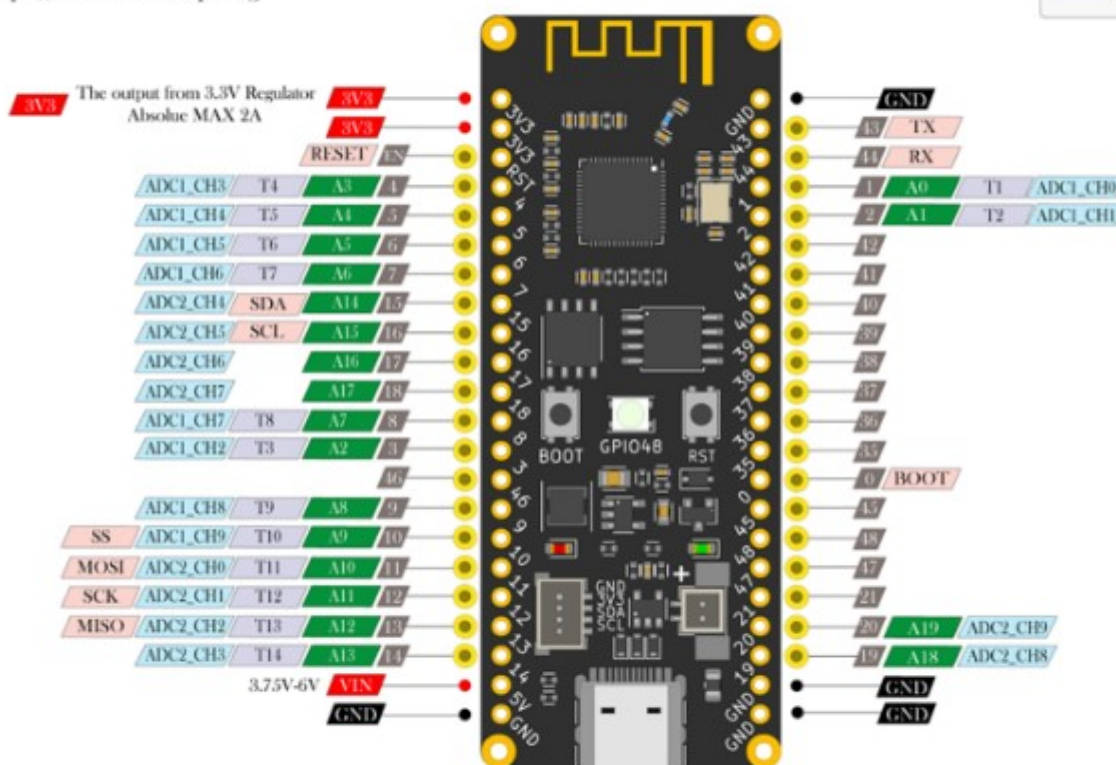
Hardware Spec

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	320 KB
Onboard FLASH ROM	4MB
On-chip 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
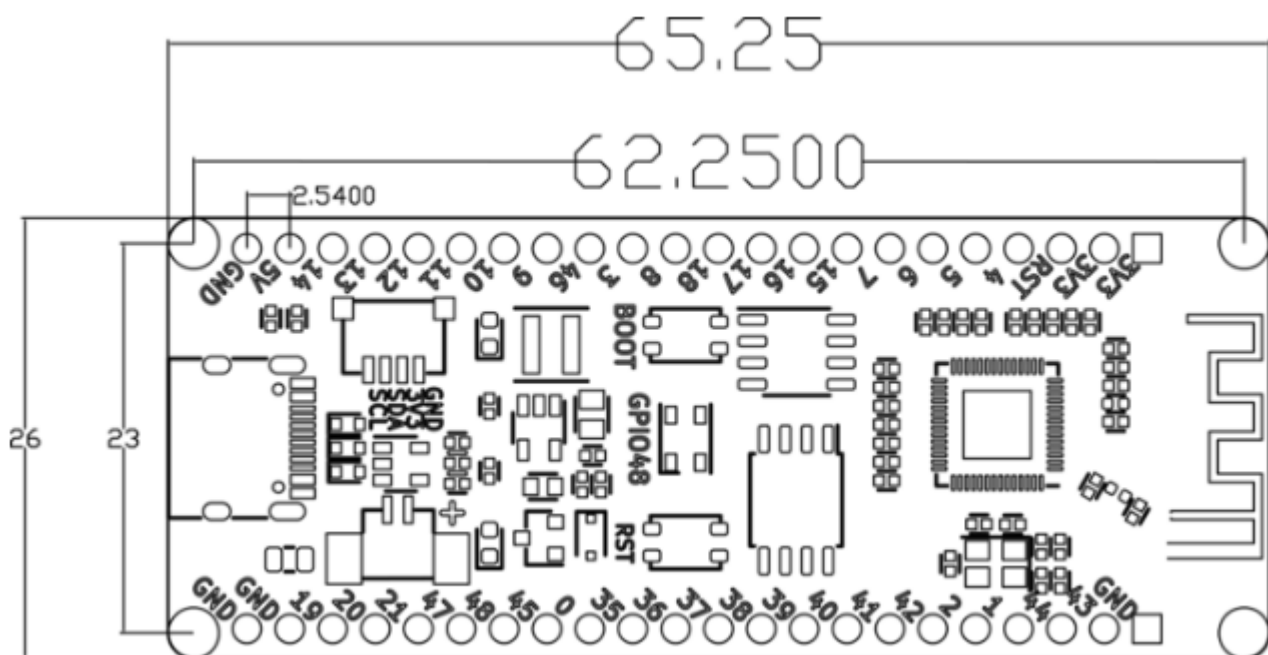
BPI-Leaf-S3 Dimensions	
Pin spacing	2.54mm
Mounting hole spacing	23mm/ 62.25mm
Mounting hole size	bore 2mm/outside 3mm

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）
USB Serial/JTAG	D-	GPIO 19（on-chip PHY）
	D+	GPIO 20（on-chip PHY）
	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