

Documentation:

Electronics components used on IoT:

Microcontroller units:

1. Orange pi 5B :

The Orange Pi 5B is a powerful single-board computer designed to cater to a wide range of applications from simple DIY projects to advanced computing tasks. Equipped with the Rockchip RK3588 octa-core processor, it delivers robust performance with its four high-performance Cortex-A76 cores and four power-efficient Cortex-A55 cores.

With 16GB of high-speed LPDDR4 RAM, the Orange Pi 5B is capable of handling intensive multitasking and memory-demanding applications such as data analysis, video editing, and software development. The integrated ARM Mali-G610 MP4 GPU enhances the board's capability to support high-resolution video playback, 3D graphics rendering, and advanced image processing tasks.

The 32GB internal eMMC storage provides ample space for the operating system, applications, and user data. This can be further expanded using the microSD card slot, allowing for flexible storage solutions based on user needs.

Connectivity options on the Orange Pi 5B include Gigabit Ethernet for fast and reliable wired network connections, as well as Wi-Fi 6 and Bluetooth 5.0 for wireless communication with peripherals and IoT devices. The HDMI 2.1 port supports up to 8K video output, making it ideal for multimedia applications and high-definition displays.

Peripheral connectivity is well-supported with multiple USB ports, including a USB 3.0 port for high-speed data transfer, and a USB Type-C port for both power and data. The 40-pin GPIO header is compatible with the Raspberry Pi layout, allowing for easy integration with a wide range of sensors, actuators, and other accessories.

Designed with developers and hobbyists in mind, the Orange Pi 5B supports various operating systems including Orange Pi OS, Ubuntu, Debian, and Android, providing a versatile platform for different use cases. The board's compact size and robust feature set make it an excellent choice for embedded projects, home automation systems, media centers, and more.



Fig. Orange pi 5B

Processor

- **Model:** Rockchip RK3588
- **Architecture:** Octa-core 64-bit processor
 - 4x Cortex-A76 cores clocked at up to 2.2GHz
 - 4x Cortex-A55 cores clocked at up to 1.8GHz

Memory

- **RAM:** 16GB LPDDR4
 - High-speed, low-power consumption RAM
 - Suitable for multitasking, complex computations, and running multiple applications

Storage

- **Internal Memory:** 32GB eMMC
 - Embedded MultiMediaCard (eMMC) for reliable and fast storage
 - Expandable via microSD card slot

Graphics

- **GPU:** ARM Mali-G610 MP4
 - Supports 4K and 8K video decoding
 - Capable of 3D graphics rendering and high-definition multimedia processing

Networking

- **Ethernet:** Gigabit Ethernet port for high-speed wired network connectivity
- **Wi-Fi:** Integrated Wi-Fi 6 (802.11ax) for fast and reliable wireless connections
- **Bluetooth:** Bluetooth 5.0 for wireless peripherals and IoT connectivity

Display and Audio

- **HDMI:** HDMI 2.1 output
 - Supports up to 8K video output
 - HDR support for better color and contrast
- **MIPI-DSI:** Interface for connecting displays
- **Audio:** 3.5mm audio jack and HDMI audio output

Camera Interface

- **MIPI-CSI:** Camera interface for connecting camera modules
 - Supports high-resolution cameras for video and image capturing

Peripheral Interfaces

- **USB:**
 - 1x USB 3.0 Type-A port
 - 3x USB 2.0 Type-A ports
 - 1x USB Type-C port (power and data transfer)
- **GPIO:**
 - 40-pin GPIO header
 - Compatible with Raspberry Pi GPIO layout
 - Supports various interfaces like I2C, SPI, UART, PWM, and GPIO

Power Supply

- **Input Voltage:** 5V/4A via USB Type-C
 - Efficient power management for stable operation
 - Power supply with adequate amperage required to ensure reliable performance

Expansion

- **microSD Card Slot:** For additional storage and bootable operating systems
- **eMMC Module Socket:** For upgrading or replacing internal eMMC storage

Physical Dimensions

- **Dimensions:** 100mm x 60mm
 - Compact size for embedding in projects and applications
- **Weight:** Approximately 50g

Operating System Support

- **Supported OS:**
 - Orange Pi OS (Linux-based, optimized for Orange Pi hardware)
 - Ubuntu
 - Debian
 - Android

Additional Features

- **Cooling:** Heatsink and optional fan support for thermal management
- **RTC:** Real-Time Clock with battery backup
- **Debugging:** Serial console and JTAG for development and debugging

2. Raspberry Pi 4B:

The Raspberry Pi 4 Model B with 4GB RAM is a highly versatile single-board computer designed for developers, educators, and hobbyists. It features the powerful Broadcom BCM2711 quad-core Cortex-A72 processor running at 1.5GHz, which provides a significant performance boost over previous Raspberry Pi models.

The 4GB of high-speed LPDDR4-3200 SDRAM ensures that the Raspberry Pi 4B can handle multiple tasks simultaneously, making it suitable for more demanding applications such as software development, media center projects, and even light server use.

For storage, the Raspberry Pi 4B relies on a microSD card slot, which serves as the main boot and storage medium. Additionally, users can connect USB storage devices to the USB 3.0 and USB 2.0 ports for expanded storage options.

The integrated Broadcom VideoCore VI GPU supports 4K video playback at 60FPS and provides hardware-accelerated graphics, making the Raspberry Pi 4B ideal for multimedia applications. Dual micro-HDMI ports enable the connection of two monitors, supporting resolutions up to 4Kp60, which is perfect for desktop computing setups or digital signage.

Networking capabilities are robust with Gigabit Ethernet for high-speed wired connections and dual-band 802.11ac Wi-Fi for wireless networking. Bluetooth 5.0 support allows for easy connection to wireless peripherals and IoT devices.

The board features a 40-pin GPIO header, which is compatible with previous Raspberry Pi models, allowing for easy integration with a wide range of existing accessories and HATs. This makes the Raspberry Pi 4B a flexible platform for hardware prototyping, IoT projects, and automation systems.

The CSI and DSI ports enable the connection of the Raspberry Pi Camera Module and Raspberry Pi Display, respectively, which are useful for creating custom camera solutions or touchscreen interfaces.

Powering the Raspberry Pi 4B is straightforward with a 5V/3A USB Type-C power supply, ensuring stable and efficient operation. The compact form factor (85.6mm x 56.5mm) makes it easy to embed the board in various projects, while its lightweight design (approximately 46g) ensures it can be used in portable applications.

Supported operating systems include the official Raspberry Pi OS, which is optimized for the hardware, as well as other popular distributions like Ubuntu and Debian. This

broad OS support provides flexibility for different use cases, from educational environments to industrial applications.

In summary, the Raspberry Pi 4 Model B with 4GB RAM offers a powerful, flexible, and compact computing platform suitable for a wide range of applications, from basic desktop computing to advanced IoT and embedded projects. Its enhanced performance, extensive connectivity options, and robust community support make it an excellent choice for both beginners and experienced developers.

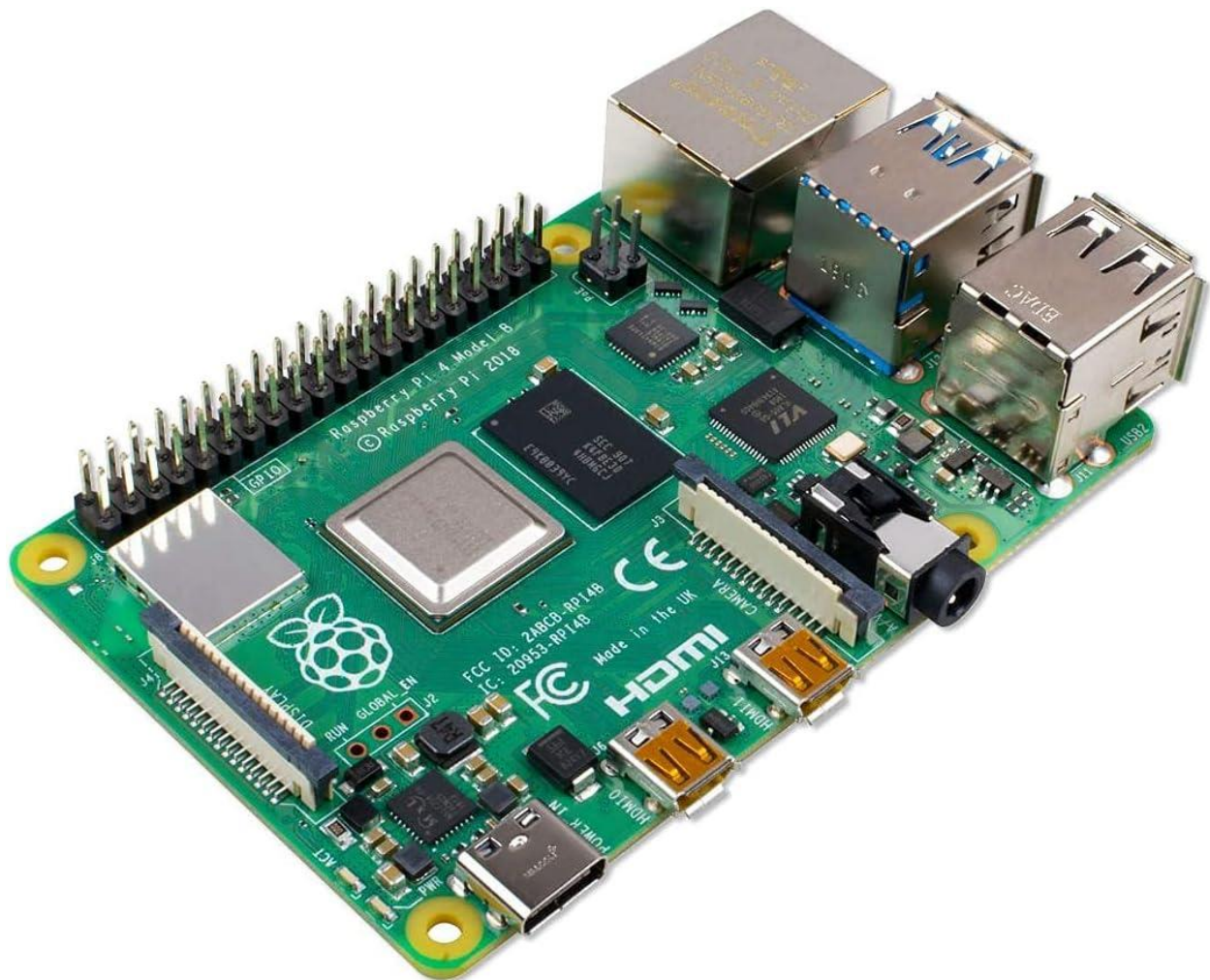


Fig. Raspberry pi 4B

Raspberry Pi 4 Model B Specifications

Processor

- **Model:** Broadcom BCM2711
- **Architecture:** Quad-core Cortex-A72 (ARM v8) 64-bit SoC
 - Clocked at 1.5GHz

Memory

- **RAM:** 4GB LPDDR4-3200 SDRAM
 - High-speed memory for smooth multitasking and application performance

Storage

- **External Storage:**
 - MicroSD card slot for operating system and data storage
 - USB storage devices supported via USB ports

Graphics

- **GPU:** Broadcom VideoCore VI
 - Supports OpenGL ES 3.0
 - Capable of 4K video playback at 60FPS (H.265 hardware decode)

Networking

- **Ethernet:** Gigabit Ethernet (1000 Mbps)
- **Wi-Fi:** 802.11ac wireless, dual-band (2.4GHz and 5.0GHz)
- **Bluetooth:** Bluetooth 5.0, BLE

Display and Audio

- **HDMI:** Dual micro-HDMI ports (up to 4Kp60 supported)
- **Video Output:** 4K display support via HDMI
- **Audio:**
 - 4-pole stereo audio and composite video port
 - HDMI audio output

Peripheral Interfaces

- **USB:**
 - 2x USB 3.0 ports
 - 2x USB 2.0 ports
- **GPIO:**
 - 40-pin GPIO header
 - Compatible with previous Raspberry Pi boards and accessories
 - Supports various interfaces like I2C, SPI, UART, PWM, and GPIO

Camera and Display Interfaces

- **CSI:** 2-lane MIPI CSI camera port
 - For connecting Raspberry Pi Camera Module and compatible camera devices
- **DSI:** 2-lane MIPI DSI display port
 - For connecting Raspberry Pi Display and compatible display devices

Power Supply

- **Input Voltage:** 5V/3A via USB Type-C
 - Efficient power management for stable operation
 - Power supply with adequate amperage required to ensure reliable performance

Expansion

- **microSD Card Slot:** For bootable operating systems and additional storage

Physical Dimensions

- **Dimensions:** 85.6mm x 56.5mm x 17mm
 - Compact size for embedding in projects and applications
- **Weight:** Approximately 46g

Operating System Support

- **Supported OS:**
 - Raspberry Pi OS (official)
 - Ubuntu
 - Debian
 - Other Linux distributions
 - Third-party OSes like LibreELEC for media center use

Additional Features

- **Cooling:** Optional heatsinks and fan support for thermal management
- **RTC:** Support via external modules connected to GPIO

3. ESP-32:

Detailed Description

The ESP32 is a powerful, low-cost microcontroller designed for a wide range of applications, particularly in IoT (Internet of Things), embedded systems, and wireless communication. It features a dual-core Tensilica Xtensa LX6 processor, which can operate at up to 240MHz, providing robust performance for various computing tasks.

With 520KB of SRAM and an additional 8KB of SRAM in the RTC, the ESP32 offers ample memory for most embedded applications. Flash memory is typically 4MB, but this can vary depending on the specific module used. External flash memory can also be added via the SPI interface.

The ESP32 excels in wireless communication, featuring integrated 802.11 b/g/n Wi-Fi and Bluetooth 4.2 (both classic BR/EDR and BLE). This dual connectivity makes it ideal for IoT applications where devices need to connect to the internet and communicate with other devices wirelessly.

One of the standout features of the ESP32 is its extensive range of peripheral interfaces. It includes 34 GPIO pins, multiple ADC and DAC channels, UART, SPI, I2C, I2S interfaces, PWM outputs, and capacitive touch sensors. This wide array of interfaces makes the ESP32 highly versatile for a variety of applications, from sensor data acquisition to audio processing.

The ESP32 is designed with power efficiency in mind. It supports various power-saving modes, including deep sleep, which consumes as little as 10 μ A. This makes it suitable for battery-operated devices where energy consumption is a critical concern.

For security, the ESP32 includes features like secure boot and flash encryption, as well as hardware acceleration for cryptographic algorithms (AES, SHA-2, RSA, ECC). This ensures that data and firmware running on the device are protected against unauthorized access and tampering.

The real-time clock (RTC) and timer capabilities allow the ESP32 to handle time-sensitive tasks and wake up from sleep modes based on predefined schedules or events, making it well-suited for time-critical applications.

In terms of development, the ESP32 is highly flexible. It is compatible with FreeRTOS, and developers can use the ESP-IDF (Espressif IoT Development Framework) for more advanced projects. For those familiar with Arduino, the ESP32 can also be programmed using the Arduino IDE, providing an easy-to-use environment for rapid prototyping. Additionally, the ESP32 supports other frameworks like MicroPython and Lua, catering to a wide range of development preferences.

Overall, the ESP32 microcontroller offers a combination of high performance, extensive connectivity options, and low power consumption, making it an ideal choice for a vast array of embedded and IoT applications.



Fig. Esp-32

ESP32 Specifications

Processor

- **Model:** Tensilica Xtensa LX6 Dual-Core
- **Architecture:** 32-bit
 - Dual-core processor (can be individually controlled)
 - Clock speed: up to 240MHz

Memory

- **RAM:**
 - 520KB SRAM
 - 8KB SRAM in RTC
- **Flash:** Typically 4MB (varies depending on the module and manufacturer)
 - External flash memory support via SPI

Storage

- **External Storage:**
 - MicroSD card support via SPI interface
 - SPI flash support

Networking

- **Wi-Fi:** 802.11 b/g/n
 - Supports 2.4 GHz Wi-Fi
 - WPA/WPA2 security
- **Bluetooth:**
 - Bluetooth v4.2 BR/EDR and BLE (Bluetooth Low Energy)

Peripheral Interfaces

- **GPIO:**
 - 34 programmable GPIO pins
- **ADC:**
 - 18 channels of 12-bit SAR ADC
- **DAC:**
 - 2 channels of 8-bit DAC
- **UART:**

- 3 UART interfaces
- **SPI:**
 - 4 SPI interfaces
- **I2C:**
 - 2 I2C interfaces
- **I2S:**
 - 2 I2S interfaces for audio
- **PWM:**
 - 16 channels of PWM
- **Touch Sensors:**
 - 10 capacitive touch sensor pins
- **Hall Sensor:**
 - Built-in Hall effect sensor

Power Management

- **Power Supply:**
 - Operating voltage: 2.2V to 3.6V
 - Deep sleep current: ~10μA
 - Light sleep current: ~0.8mA
 - Active mode: ~160mA

Clock

- **RTC:**
 - Real-time clock for deep sleep wake-up
 - Timer and wake-up interrupts

Security

- **Security Features:**
 - Secure boot
 - Flash encryption
 - Cryptographic hardware acceleration (AES, SHA-2, RSA, ECC, RNG)

Physical Dimensions

- **Dimensions:**
 - Varies by module (common modules like ESP-WROOM-32 are approximately 25.5mm x 18mm)

Operating System Support

- **Supported OS:**
 - Compatible with FreeRTOS (built-in)
 - Supports Arduino IDE
 - Other development frameworks: ESP-IDF, MicroPython, Lua

4. Arduino Uno:

Detailed Description

The Arduino Uno is a microcontroller board based on the ATmega328P microcontroller. It is one of the most popular and widely used boards in the Arduino family, known for its simplicity and ease of use. It is suitable for beginners and experienced developers alike, providing a robust platform for a wide range of projects.

Microcontroller

The ATmega328P is an 8-bit AVR microcontroller with a RISC architecture. It runs at 16 MHz and provides a balanced mix of performance and power efficiency. This microcontroller includes a variety of built-in peripherals and interfaces, making it versatile for various applications.

Memory

- **Flash Memory:** 32 KB of flash memory is available for storing your programs, with 0.5 KB occupied by the bootloader.
- **SRAM:** 2 KB of SRAM is used for runtime data storage.
- **EEPROM:** 1 KB of EEPROM is available for storing non-volatile data, which can be useful for saving configurations or sensor data that needs to persist between resets.

Power

The Arduino Uno can be powered either via the USB connection or an external power supply. The recommended input voltage range is 7-12V, but the board can handle up to 20V. The on-board voltage regulator ensures a stable 5V supply for the microcontroller and peripherals.

- **USB Power:** Connect the board to your computer using a USB Type-B cable.
- **External Power Supply:** Use a 2.1mm center-positive power plug to connect an external power source.

Input and Output

The Arduino Uno features 14 digital I/O pins, 6 of which can be used as PWM outputs. Additionally, it has 6 analog input pins with 10-bit resolution, which can read signals from sensors or potentiometers.

- **Digital I/O Pins:** These pins can be configured as either input or output, and can be used for digital reading and writing.
- **PWM Output:** 6 digital pins (3, 5, 6, 9, 10, and 11) support PWM, which allows for simulating analog output.
- **Analog Inputs:** 6 pins (A0 to A5) can read analog signals.

Interfaces

- **UART:** One serial interface for communication with other devices.
- **SPI:** One SPI interface for high-speed synchronous data transfer.
- **I2C:** One I2C interface for communication with peripherals and sensors.

Communication

The Arduino Uno includes a USB-to-serial converter, which allows for easy programming and communication with the host computer. This makes it straightforward to upload new sketches and receive data from the board.

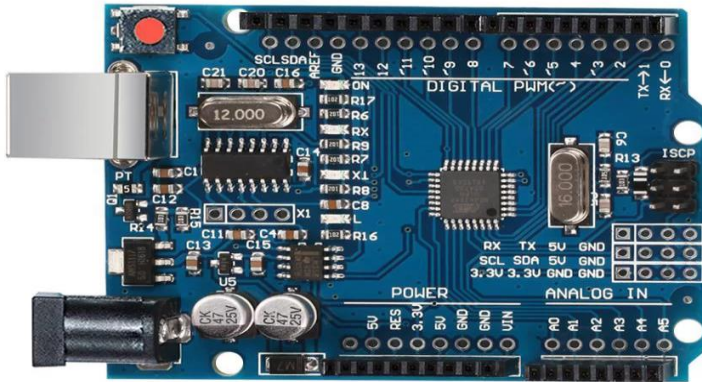


Fig. Arduino Uno

Physical Characteristics

The board's dimensions are 68.6 mm x 53.4 mm, and it weighs approximately 25 grams. This compact size makes it easy to integrate into various projects, from simple breadboard setups to more complex custom circuits.

Additional Features

- **ICSP Header:** The In-Circuit Serial Programming header allows for direct programming of the microcontroller.
- **Reset Button:** A physical reset button on the board allows for easy resetting of the microcontroller without disconnecting power.