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Waveshare ESP32-P4-Module-DEV-KIT-C

Waveshare ESP32-P4 Development Board Instruction Manual

Model: ESP32-P4-Module-DEV-KIT-C

1. INTRODUCTION

This manual provides essential information for the setup, operation, and maintenance of the Waveshare ESP32-P4 High-Performance Development Board. The ESP32-P4-Module-DEV-KIT-C is designed for multimedia and edge computing applications, featuring a 400MHz RISC-V dual-core processor, Wi-Fi 6, Bluetooth 5/BLE, and extensive peripheral support. This specific kit includes a 10-inch DSI Capacitive Touch Display and an RPi Camera (B).

The board offers comprehensive connectivity and rich human-machine interfaces, making it suitable for complex multimedia projects. It also incorporates advanced security features to ensure robust data protection.

2. PACKAGE CONTENTS

Verify that all items listed below are present in your package. Refer to the image for visual confirmation of the components included in the ESP32-P4-Module-DEV-KIT-C.

- ESP32-P4-Module-DEV-KIT-C Development Board x1
- 10.1-DSI-TOUCH-A 10-inch DSI Capacitive Touch Display x1
- RPi Camera (B) x1
- Speaker (8Ω 2W) x1
- Screws pack x1
- USB Type-A dual-plug cable x1
- USB Type-A to Type-C cable x1
- DSI cable x1
- FFC 15PIN cable x1
- FFC 22PIN cable (2PCS) x1
- 2PIN cable x1

ESP32-P4-Module Development Board

High-Performance Development Board Based On ESP32-P4 And ESP32-C6

Rich Human-Machine Interfaces



Figure 2.1: Contents of the ESP32-P4-Module-DEV-KIT-C package.

3. PRODUCT OVERVIEW

The Waveshare ESP32-P4 Development Board is a high-performance platform built around the ESP32-P4 and ESP32-C6 modules, offering robust capabilities for various embedded projects.

3.1 Key Features

- **High-Performance Processor:** Features a 400MHz RISC-V dual-core processor for enhanced performance.
- **Memory:** Up to 32MB PSRAM and 16MB Nor Flash for ample storage and processing.
- **Wireless Connectivity:** Supports Wi-Fi 6 and Bluetooth 5/BLE for versatile communication.
- **Rich Interfaces:** Includes MIPI-CSI (Camera), MIPI-DSI (Display), I2S, SPI, I2C, UART, USB 2.0 OTG, and more.
- **Ethernet with PoE:** Onboard RJ45 Ethernet with Power over Ethernet (PoE) functionality.
- **GPIO Header:** 40-pin GPIO header compatible with Raspberry Pi HATs.
- **Security:** Secure Boot, Flash Encryption, cryptographic accelerators, and TRNG for data security.
- **Multimedia Support:** Designed for multimedia applications with integrated image signal processor and H.264 encoder.



Figure 3.1: ESP32-P4-Module Development Board overview.

3.2 Integrated Modules

The board integrates the ESP32-P4-Module, which includes the ESP32-C6 for Wi-Fi 6 and Bluetooth 5/BLE connectivity, and 16MB Nor Flash.

Development Board Introduction

This product is a multimedia development board based on ESP32-P4 with integrated ESP32-C6, supports Wi-Fi 6 and Bluetooth 5 wireless connection. It features rich Human-Machine interfaces, including MIPI-CSI (with integrated Image Signal Processor), MIPI-DSI, SPI, I2S, I2C, LED PWM, MCPWM, RMT, ADC, UART, TWAI, etc. Additionally, it supports USB OTG 2.0 HS, onboard RJ45 Ethernet port with reserved PoE function header, and onboard 40PIN GPIO header which is compatible with some Raspberry Pi HATS, enabling a wider range of application adaptability.

The ESP32-P4 adopts a 400MHz dual-core RISC-V processor and supports up to 32MB PSRAM, featuring USB 2.0, MIPI-CSI/DSI, H.264 encoder, and other peripherals, meeting the needs for low-cost, high-performance, and low-power multimedia development. It also integrates the Digital Signature Peripheral and a dedicated Key Management Unit, ensuring secure data and operations. Specifically designed for high-performance and high-security applications, the ESP32-P4-Module-DEV-KIT meets the requirements of Human-Machine interaction, efficient edge computing, and IO expansion.

Key features include:

- High-performance MCU with RISC-V 32-bit dual-core and single-core processors
- 128 KB HP ROM, 16 KB LP ROM, 768 KB HP L2MEM, 32 KB LP SRAM, 8 KB TCM
- Powerful image and voice processing capability. Provides image and voice processing interfaces including JPEG Codec, Pixel Processing Accelerator, Image Signal Processor, H264 encoder
- 32MB PSRAM in the chip's package, with onboard 16MB Nor Flash
- Commonly used peripherals such as MIPI-CSI, MIPI-DSI, USB 2.0 OTG, Ethernet, SDIO 3.0 TF card slot, microphone, speaker header and RTC battery header, etc.
- Adapting 2*20 GPIO headers with 28 x remaining programmable GPIOs
- Security features: Secure Boot, Flash Encryption, cryptographic accelerators, and TRNG. Additionally, hardware access protection mechanisms help to enable Access Permission Management and Privilege Separation

Figure 3.2: ESP32-P4-Module for high performance.

Highly Integrated And Powerful Performance

Adopts ESP32-P4-Module, With Built-In ESP32-C6 And 16MB Nor Flash



The image shows a close-up of the ESP32-P4-Module chip. The chip is square with gold pins on all sides. It features the Espressif logo and the text: "ESP32-P4-Module", "SoC: ESP32-P4NRW32", "WiFi: 802.11 b/g/n/ax", and "Flash: 16MB".

Wi-Fi 6 And Bluetooth Support

Built-In ESP32-C6 Module To Extend 2.4GHz Wi-Fi 6 And Bluetooth 5/BLE For ESP32-P4, Using SDIO Interface Protocol For Communication, Stable Connection And Efficient Transmission.



The image shows the ESP32-P4-Module chip with icons for Wi-Fi 6 and Bluetooth 5/BLE. The text "2.4GHz Wi-Fi 6" and "Bluetooth 5/BLE" is displayed next to their respective icons. The chip itself is shown with the same text as in the previous image: "ESP32-P4-Module", "SoC: ESP32-P4NRW32", "WiFi: 802.11 b/g/n/ax", and "Flash: 16MB".

Figure 3.3: Wi-Fi 6 and Bluetooth 5/BLE support.

3.3 PoE Power Supply

The board includes a reserved PoE module header, allowing for power supply and network connection through a single Ethernet cable when connected to a compatible PoE module (not included).

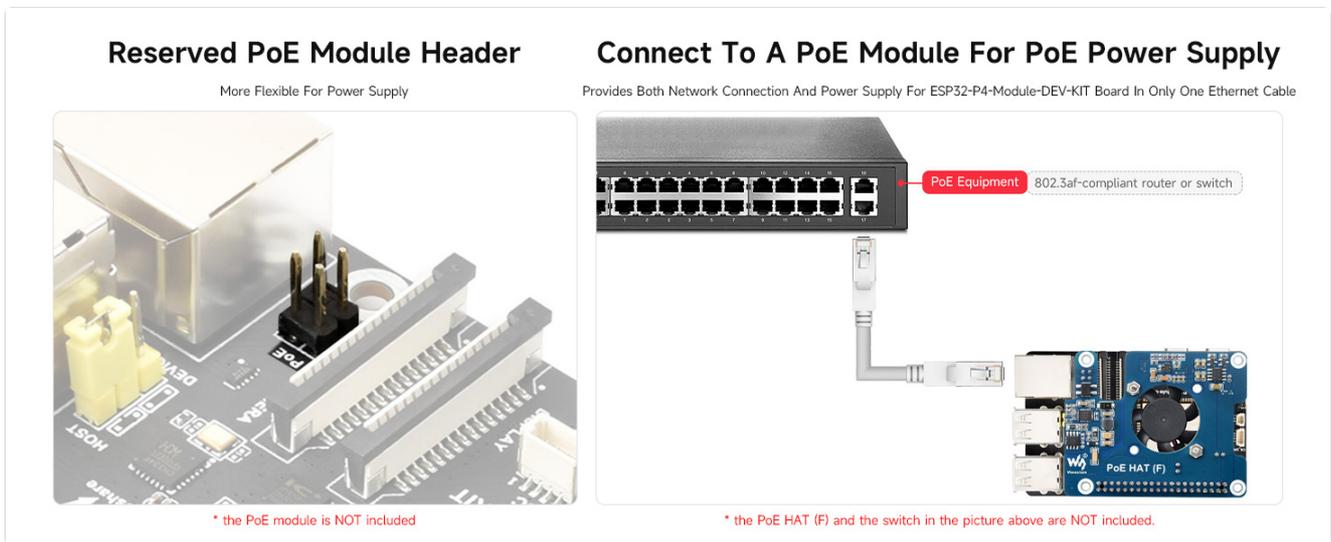


Figure 3.4: Reserved PoE module header.

4. BOARD LAYOUT AND PINOUT

Understanding the board's layout and pin definitions is crucial for proper connection and development.

4.1 What's On Board

The following diagram identifies key components and interfaces on the ESP32-P4-Module-DEV-KIT-C.

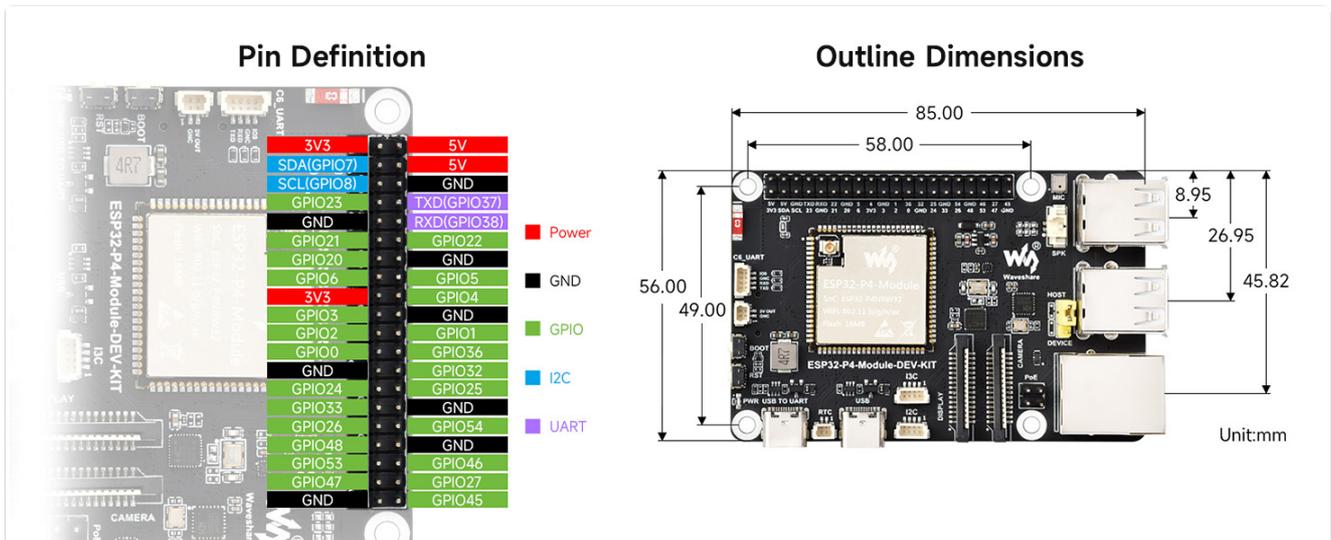


Figure 4.1: Labeled components of the ESP32-P4-Module-DEV-KIT-C.

4.2 Pin Definition and Outline Dimensions

The 40-pin GPIO header provides various power and data pins. Refer to the diagram for pin assignments and board dimensions.

Raspberry Pi Camera (B)

5MP | Manual Focus

Compatible With Raspberry Pi Series Boards



SENSOR	OV5647	CMOS SIZE	1/4inch
PIXELS	5MP	APERTURE	F2.0
FOCAL LENGTH	6mm	FIELD OF VIEW	60.6°
NIGHT VISION FUNCTION	Not support	FOCUSING	Manual Focus

Figure 4.2: Pin definitions and outline dimensions.

5. SETUP AND CONNECTION

This section guides you through connecting the various components of your ESP32-P4 development kit.

5.1 Kit Selection Overview

The ESP32-P4-Module-DEV-KIT is available in several configurations. This manual focuses on the 'C' kit, which includes the 10-inch DSI LCD and RPi Camera (B).

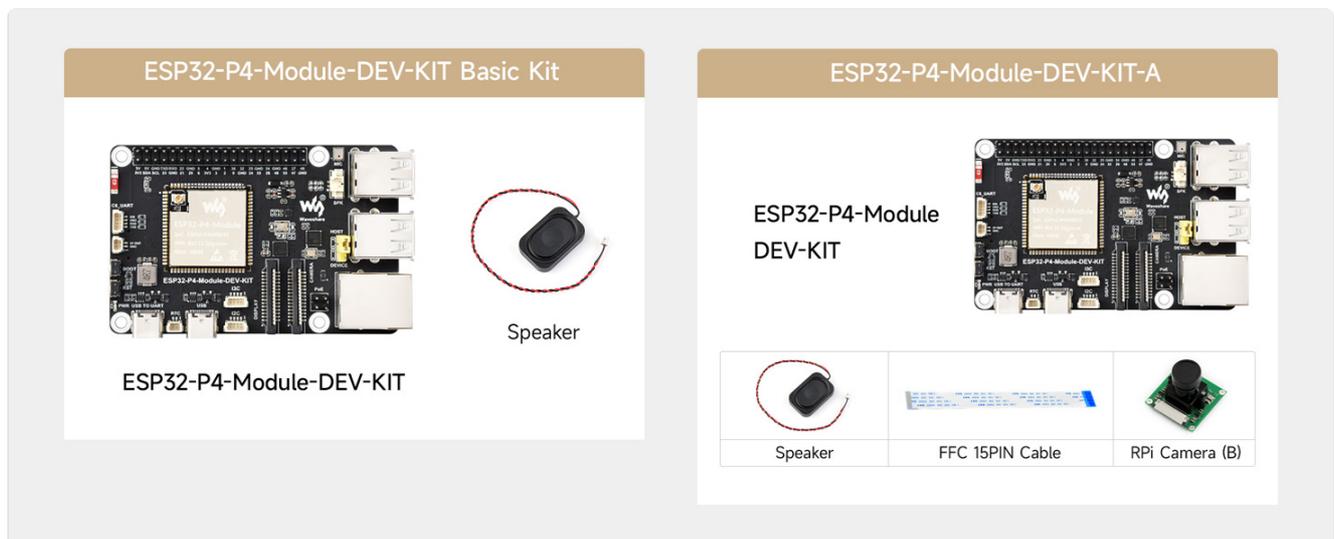


Figure 5.1: Overview of available kit configurations.

5.2 Connection Examples

Follow these general steps for connecting the display and camera to the development board:

1. **Connect the DSI Display:** Carefully connect the DSI cable from the 10.1-DSI-TOUCH-A display to the MIPI-DSI interface on the ESP32-P4 board. Ensure the cable is inserted correctly and secured.
2. **Connect the RPi Camera:** Attach the RPi Camera (B) to the MIPI-CSI interface on the development board using the provided FFC cable.
3. **Power Connection:** Connect the USB Type-A to Type-C cable to the Type-C UART connector on the board for power and programming.
4. **Speaker Connection:** Connect the 8Ω 2W speaker to the designated speaker header.

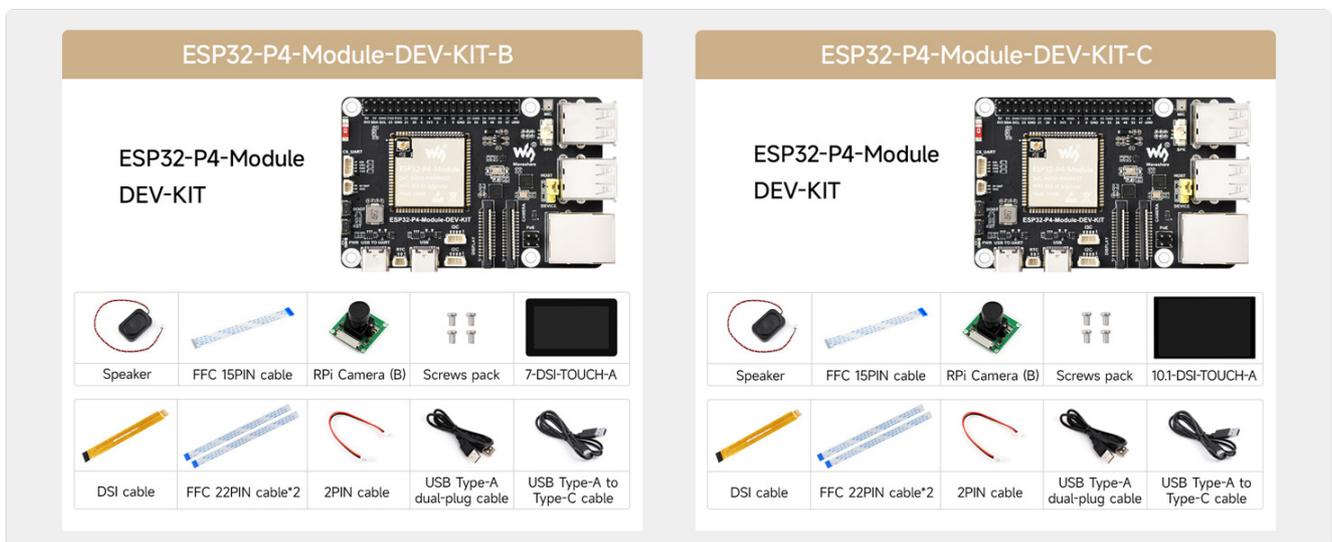


Figure 5.2: Example connections for the development kit.

6. OPERATING INSTRUCTIONS

After connecting all components, you can begin operating your ESP32-P4 Development Board. The board typically runs a Linux operating system and supports various development environments.

- **Power On:** Connect the Type-C USB cable to a power source. The power supply indicator LED should illuminate.
- **Software Development:** For detailed programming guides and examples, refer to the official Waveshare Wiki resources. This includes information on using ESP-IDF and potentially Arduino IDE for development.
- **Entering Download Mode:** Press and hold the BOOT button, then press the RST Reset button to enter download mode for flashing firmware.
- **USB OTG:** The USB OTG 2.0 high-speed ports can be switched between host and device via a jumper for expanded USB functionalities.

It is recommended to consult the Waveshare Wiki for the latest software, drivers, and specific programming instructions relevant to the ESP32-P4 and ESP32-C6 modules.

7. MAINTENANCE

Proper maintenance ensures the longevity and reliable operation of your ESP32-P4 Development Board.

- **Handling:** Always handle the board by its edges to avoid touching sensitive components. Use anti-static precautions when possible.
- **Cleaning:** Keep the board free from dust and debris. Use a soft, dry brush or compressed air for cleaning. Avoid liquid cleaners.
- **Storage:** Store the board in a dry, cool environment, away from direct sunlight and extreme temperatures.
- **Power Supply:** Use a stable and appropriate power supply (5V via Type-C or 5V header) to prevent damage.
- **RTC Battery:** If using a rechargeable RTC battery, ensure it is compatible and correctly installed.

8. TROUBLESHOOTING

This section addresses common issues you might encounter with the ESP32-P4 Development Board.

- **Board Not Powering On:**

- Ensure the USB Type-C cable is securely connected to both the board and a functional power source.
 - Verify the power source provides adequate voltage (5V).
- **Display Not Showing Image:**
 - Check the DSI cable connection between the board and the display. Ensure it is fully seated and oriented correctly.
 - Confirm that the software or firmware running on the ESP32-P4 is configured to output to the DSI display.
- **Camera Not Functioning:**
 - Inspect the FFC cable connection for the RPi Camera (B) to the MIPI-CSI interface.
 - Ensure the camera module is properly seated.
 - Verify that the software includes the necessary drivers and configurations for the camera.
- **Wi-Fi/Bluetooth Connectivity Issues:**
 - Check that the ESP32-C6 SMD Antenna is not obstructed.
 - Ensure your software has correctly initialized the Wi-Fi or Bluetooth modules and is attempting to connect to valid networks/devices.
- **Software/Firmware Upload Failure:**
 - Ensure the board is in download mode (press and hold BOOT, then press RST).
 - Verify that the correct drivers for the USB-UART bridge are installed on your computer.
 - Check your development environment settings for correct port selection and baud rate.

For more specific troubleshooting or advanced issues, refer to the [Waveshare Wiki](#) or community forums.

9. SPECIFICATIONS

Detailed technical specifications for the Waveshare ESP32-P4 Development Board and included components.

Feature	Specification
Brand	Waveshare
Model Name	ESP32-P4-Module-DEV-KIT-C
Processor	400MHz RISC-V Dual-Core (Espressif)
RAM	32MB PSRAM
Flash Memory	16MB Nor Flash
Wireless Connectivity	Wi-Fi 6, Bluetooth 5/BLE (via ESP32-C6)
Operating System	Linux
Interfaces	MIPI-CSI, MIPI-DSI, I2S, SPI, I2C, UART, USB 2.0 OTG, RJ45 Ethernet (PoE)
GPIO	40-pin header (Raspberry Pi HAT compatible)
SD Card Slot	SDIO 3.0 TF card slot

Feature	Specification
Item Weight	1.69 pounds (approx. 0.77 kg)
Package Dimensions	11.89 x 8.5 x 2.05 inches (approx. 30.2 x 21.6 x 5.2 cm)

9.1 DSI Capacitive Touch Display (10.1-DSI-TOUCH-A)

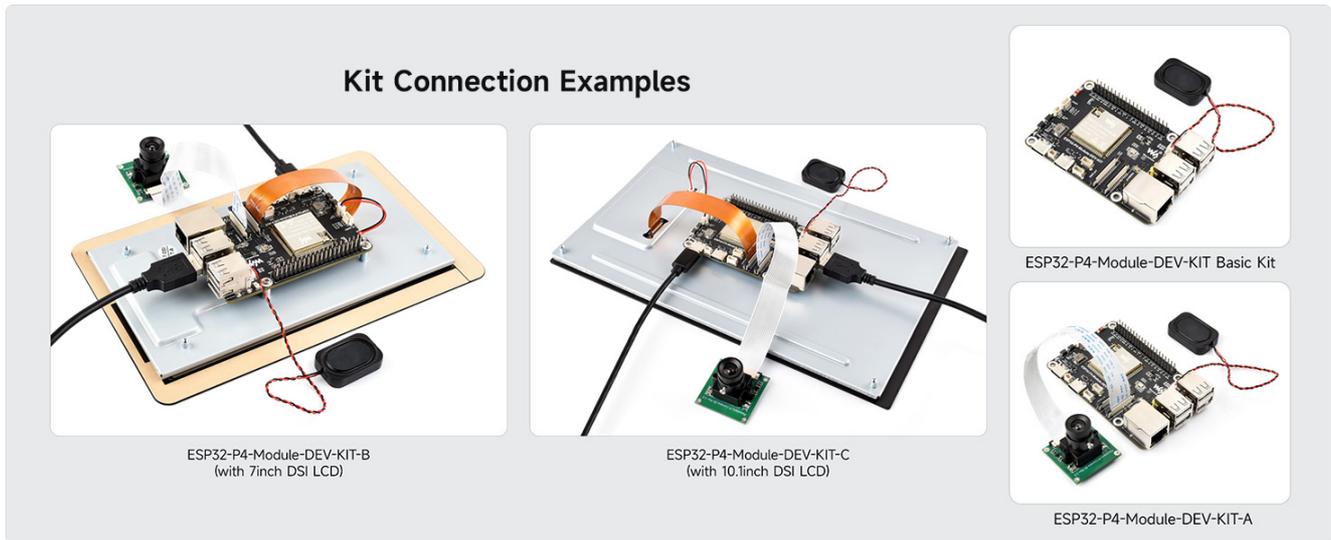


Figure 9.1: DSI Capacitive Touch Display specifications.

9.2 RPi Camera (B)

DSI Capacitive Touch Display Comparison

Optional For DSI Capacitive Touch Display, IPS Screen, Optical Bonding Toughened Glass Panel, With 178° Wide Viewing Angle. Supports 10-Point Touch, Provides Clear Image And Excellent Visual Experience

7-DSI-TOUCH-A

10.1-DSI-TOUCH-A

MODEL	7-DSI-TOUCH-A	10.1-DSI-TOUCH-A
RESOLUTION	720 × 1280 (H×V)	800 × 1280 (H×V)
COMMUNICATION INTERFACE	MIPI 2-lane	
BRIGHTNESS	450cd/m ² (supports customization for 1000cd/m ² high brightness version)	400cd/m ² (supports customization for 1000cd/m ² high brightness version)
TOUCH CHIP	GT9271	
OUTLINE DIMENSION	120.24mm × 189.32mm	147.0mm × 239.0mm
DISPLAY AREA	88.0mm × 155.0mm	135.96mm × 217.18mm
PIXEL PITCH	0.12075mm × 0.12075mm	0.1175mm × 0.1088mm
CONTRAST RATIO	800:1	
OPERATION TEMPERATURE	0°C-60°C	

* the DSI LCD is only included in the ESP32-P4-Module-DEV-KIT-B and ESP32-P4-Module-DEV-KIT-C.

Figure 9.2: RPi Camera (B) specifications.

10. SUPPORT AND RESOURCES

For further technical documentation, software examples, and community support, please visit the official Waveshare Wiki. The Wiki provides comprehensive resources to assist with your development projects.

Waveshare Wiki: <https://www.waveshare.com/wiki>