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Waveshare ESP32-P4 Pico Development Board User Manual

Model: ESP32-P4 Pico Dev Board

1. PRODUCT OVERVIEW

The Waveshare ESP32-P4 Pico Development Board is a multimedia development board based on the ESP32-P4 module. It integrates a variety of Human-Machine interfaces and common peripherals, making it suitable for diverse application development. The board features a 400MHz dual-core RISC-V processor, supports up to 32MB PSRAM, and includes USB 2.0, MIPI-CSI/DSI, and H.264 encoder capabilities. It also incorporates security features like Digital Signature Peripheral and Key Management Unit for secure operations.



Image 1.1: Overview of the ESP32-P4 Pico Development Board, showcasing its compact design and various interfaces.

2. KEY FEATURES

- **High-Performance MCU:** Features RISC-V 32-bit dual-core and single-core processors.
- **Memory:** Includes 128 KB HP ROM, 16 KB LP ROM, 768 KB HP L2MEM, 32 KB LP S-RAM, 8 KB TCM, 32MB PSRAM (in-package), and onboard 32MB Nor Flash.
- **Image and Voice Processing:** Provides interfaces for JPEG Codec, Pixel Processing Accelerator, Image Signal Processor, and H.264 encoder.
- **Common Peripherals:** MIPI-CSI, MIPI-DSI, USB 2.0 OTG, SDIO 3.0 TF card slot, microphone, and speaker header.
- **GPIO Headers:** Adapts 2*20 GPIO headers with 27 remaining programmable GPIOs.
- **Security Features:** Secure Boot, Flash Encryption, cryptographic accelerators, TRNG, Access Permission Management, and Privilege Separation.



Image 2.1: Detailed view of the board's core components, including the ESP32-P4 chip and 32MB Nor Flash memory.

3. BOARD LAYOUT AND PIN DEFINITION

Understanding the board's layout and pin assignments is crucial for proper integration and development. The following diagram illustrates the key components and their corresponding pin functions.



Image 3.1: Detailed diagram of the ESP32-P4 Pico Development Board, indicating component locations and pin definitions.

Component Identification:

1. ESP32-P4NRW32: The main ESP32-P4 chip with 32MB PSRAM.
2. 32MB Nor Flash: Onboard flash memory for program storage.
3. Display Interface: MIPI-DSI (2-lane), supports 6 / 7 / 8 / 10.1 inch DSI screens.
4. Camera Interface: MIPI-CSI (2-lane), supports OV5647 camera, etc.
5. USB Type-C Port: For power supply, program burning, and debugging.
6. Onboard Microphone.
7. Speaker Header: MX1.25 2P connector, supports 8Ω 2W speaker.
8. 4PIN USB Header: USB OTG 2.0 High Speed interface.
9. BOOT Button: Press it when powering on or resetting to enter download mode.
10. RST Button: Reset button.
11. Power Supply Indicator.
12. TF Card Slot: SDIO 3.0 interface protocol.

Pin Definition:

The pinout diagram provides details for Power, Ground, and System Control pins, along with various GPIOs. Refer to the diagram for specific pin assignments when connecting peripherals.

4. SETUP GUIDE

1. **Initial Power Connection:** Connect the ESP32-P4 Pico Development Board to your computer using a USB Type-C cable. Ensure the power supply indicator lights up.
2. **Driver Installation:** Depending on your operating system, you may need to install USB-to-serial drivers. Refer to the official Espressif documentation or Waveshare's online resources for specific driver requirements.
3. **Development Environment Setup:** Install the ESP-IDF (Espressif IoT Development Framework) or a compatible IDE (e.g., PlatformIO, Arduino IDE with ESP32-P4 support). Follow the official setup guides for your chosen environment.
4. **Connect Peripherals:** If using external components like displays, cameras, or speakers, connect them to the appropriate MIPI-CSI, MIPI-DSI, or speaker headers as indicated in the "Board Layout and Pin Definition" section.
5. **TF Card Insertion:** If using a TF card, insert it into the TF card slot.

5. OPERATING INSTRUCTIONS

1. **Programming the Board:**
 - Open your chosen development environment (e.g., ESP-IDF, PlatformIO).

- Select the correct board target (ESP32-P4).
 - Write or load your application code.
 - To upload code, press and hold the **BOOT** button, then press the **RST** button, and release both. This puts the board into download mode.
 - Initiate the upload process from your development environment.
2. **Debugging:** Utilize the USB Type-C port for serial communication and debugging output. Most IDEs provide a serial monitor feature.
 3. **Peripheral Usage:** Refer to the ESP-IDF documentation and specific library examples for programming the MIPI-CSI, MIPI-DSI, USB OTG, and other integrated peripherals.

6. MAINTENANCE

- **Handling:** Handle the board by its edges to avoid touching components, especially when powered. Electrostatic discharge can damage sensitive components.
- **Cleaning:** If necessary, gently clean the board with a soft, dry brush or compressed air. Avoid using liquids or abrasive materials.
- **Storage:** Store the board in an anti-static bag in a dry, cool environment when not in use.
- **Firmware Updates:** Regularly check for firmware and ESP-IDF updates to ensure optimal performance and access to the latest features and bug fixes.

7. TROUBLESHOOTING

- **Board Not Detected:**
 - Ensure the USB Type-C cable is securely connected to both the board and your computer.
 - Verify that the necessary USB-to-serial drivers are installed correctly.
 - Try a different USB port or cable.
- **Code Upload Failure:**
 - Confirm the board is in download mode (press and hold BOOT, then RST, then release both).
 - Check that the correct serial port is selected in your development environment.
 - Ensure your code compiles without errors.
- **Peripheral Not Functioning:**
 - Double-check all wiring connections according to the pin definition diagram.
 - Verify that the peripheral is correctly initialized and configured in your code.
 - Consult the peripheral's datasheet and relevant ESP-IDF examples.
- **Unexpected Behavior:**
 - Review your code for logical errors.
 - Use the serial monitor to check for error messages or debug output.
 - Ensure adequate power supply for the board and any connected peripherals.

8. SPECIFICATIONS

Feature	Detail
Brand	Waveshare
Model Name	ESP32-P4 Pico Dev Board
Chipset Type	ESP32-P4
Compatible Processors	RISC-V
RAM Memory Technology	PSRAM (32MB in-package)
Flash Memory	32MB Nor Flash (onboard)
Main Power Connector Type	40-Pin (GPIO headers)
Interfaces	MIPI-CSI, MIPI-DSI, USB 2.0 OTG, SDIO 3.0, I2S, I2C, SPI, UART, TWAI, etc.
Dimensions	Refer to "Outline Dimensions" diagram for detailed measurements.



Image 8.1: Outline dimensions of the ESP32-P4 Pico Development Board.

9. PACKAGE CONTENT

The standard package for the ESP32-P4 Pico Development Board includes the following items:

- ESP32-P4-Pico x1
- 20PIN header x2



Image 9.1: Items included in the ESP32-P4 Pico Development Board package.

10. SUPPORT AND RESOURCES

For further assistance, detailed documentation, and development resources, please refer to the official Waveshare online resources. Technical support is available if you encounter any issues during development or operation.

- **Online Development Resources:** Visit the Waveshare official website for datasheets, schematics, example code, and tutorials.
- **Technical Support:** If you have any problems or require technical assistance, please contact Waveshare customer support.

