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Waveshare RP2350-Zero

Waveshare RP2350-Zero Mini Development Board User Manual

Model: RP2350-Zero

1. INTRODUCTION

The Waveshare RP2350-Zero Mini Development Board is a compact and powerful microcontroller board designed for embedded projects. It is based on the Raspberry Pi RP2350A microcontroller, featuring a unique dual-core and dual-architecture design with an Arm Cortex-M33 processor and a Hazard 3 RISC-V processor. This board offers impressive processing capabilities in a small form factor, making it suitable for a wide range of applications from robotics and automation to IoT and wearable devices. Its compatibility with existing Raspberry Pi Pico resources and software facilitates ease of development.

2. PACKAGE CONTENT

Verify that your package contains the following item:

- RP2350-Zero Mini Development Board x1

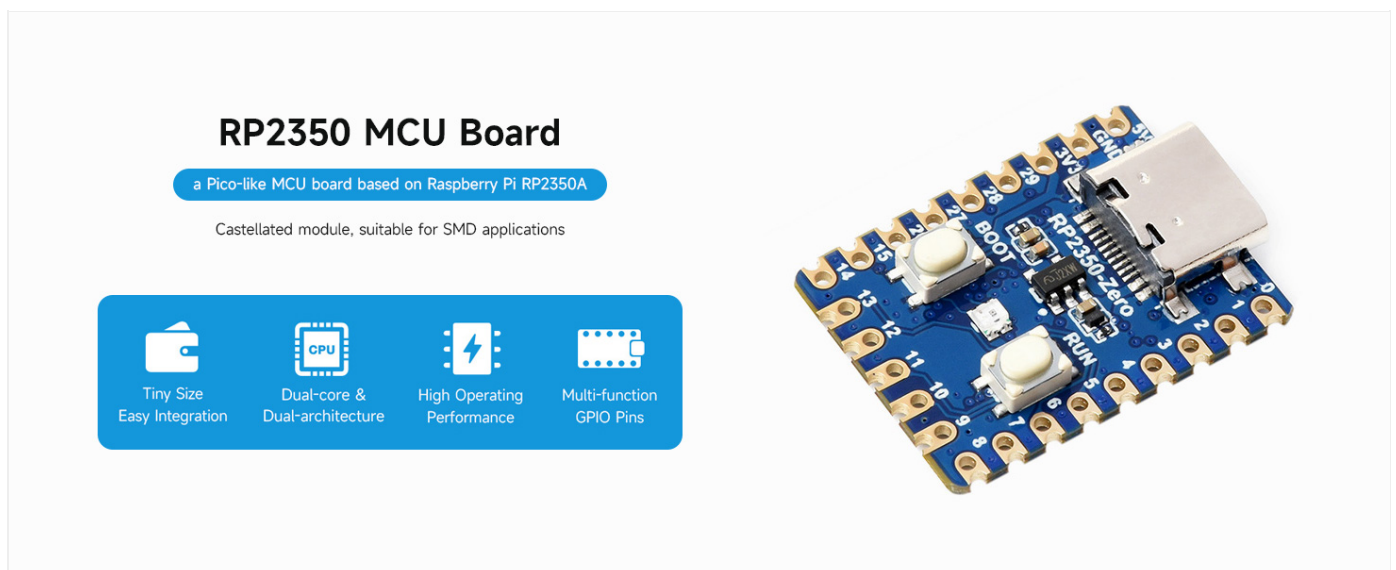


Figure 2.1: Package content, showing one RP2350-Zero board.

The image above displays the RP2350-Zero Mini Development Board, which is the primary component included in the package.

3. PRODUCT OVERVIEW

The RP2350-Zero is a Pico-like MCU board based on the Raspberry Pi RP2350A. It is designed as a castellated module, making it suitable for Surface Mount Device (SMD) applications. Key features include its tiny size for easy integration, dual-core and dual-architecture processing, high operating performance, and multi-function GPIO pins.

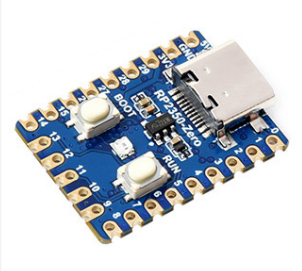
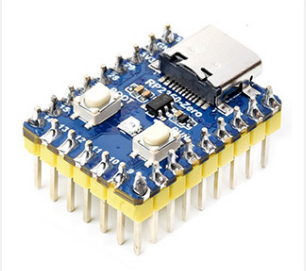
Board Specifications	Version Options
<ul style="list-style-type: none">• RP2350A microcontroller chip designed by Raspberry Pi in the United Kingdom• Adopts unique dual-core and dual-architecture design: dual-core Arm Cortex-M33 processor and dual-core Hazard 3 RISC-V processor, flexible clock running up to 150 MHz• 520KB of SRAM, and 4MB of on-board Flash memory• Type-C connector, keeps it up to date, easier to use• Castellated module allows soldering directly to carrier boards• USB 1.1 with device and host support• Low-power sleep and dormant modes• Drag-and-drop programming using mass storage over USB• 29 × multi-function GPIO pins (20× via edge pinout, others via solder points)• 2 × SPI, 2 × I2C, 2 × UART, 4 × 12-bit ADC, 24 × controllable PWM channels• Accurate clock and timer on-chip• Temperature sensor• Accelerated floating-point libraries on-chip• 12 × Programmable I/O (PIO) state machines for custom peripheral support	<div><p>RP2350-Zero without pinheader</p></div> <div><p>RP2350-Zero-M with pre-soldered pinheader</p></div>

Figure 3.1: Overview of the RP2350 MCU Board and its main features.

This image illustrates the compact design and core capabilities of the RP2350-Zero board, emphasizing its suitability for various embedded projects.

4. BOARD SPECIFICATIONS

The RP2350-Zero Mini Development Board incorporates the following technical specifications:

- **Microcontroller Chip:** RP2350A, designed by Raspberry Pi (UK).
- **Processor Architecture:** Dual-core design with an Arm Cortex-M33 processor and a Hazard 3 RISC-V processor.
- **Clock Frequency:** Up to 150 MHz.
- **Memory:** 520KB Static RAM (SRAM) and 4MB on-board Flash memory.
- **Connectivity:** USB Type-C connector, supporting USB 1.1 (device and host).
- **Mounting:** Castellated module for direct soldering onto carrier boards.
- **Power Modes:** Low-power sleep and dormant modes.
- **Programming:** Drag-and-drop programming via USB mass storage.
- **GPIO Pins:** 29 multi-functional GPIO pins (20 via edge pinout, others via solder points).
- **Peripherals:**
 - 2 × SPI interfaces
 - 2 × I2C interfaces
 - 2 × UART interfaces
 - 4 × 12-bit Analog-to-Digital Converters (ADC)
 - 16 × controllable PWM channels
- **Timing:** Accurate clock and on-chip timer.
- **Sensors:** Integrated temperature sensor.

- **Libraries:** Accelerated floating-point libraries on-chip.
- **PIO:** 12 Programmable I/O (PIO) state machines for custom peripheral support.

Figure 4.1: Detailed list of the RP2350-Zero board's technical specifications.

The image provides a visual summary of the key specifications, reinforcing the capabilities of the RP2350A microcontroller.

5. PINOUT DIAGRAM AND GPIO

The RP2350-Zero features 29 multi-function GPIO pins, offering extensive configuration options for flexible development and integration. These pins support various functions including digital I/O, SPI, I2C, UART, ADC, and PWM.

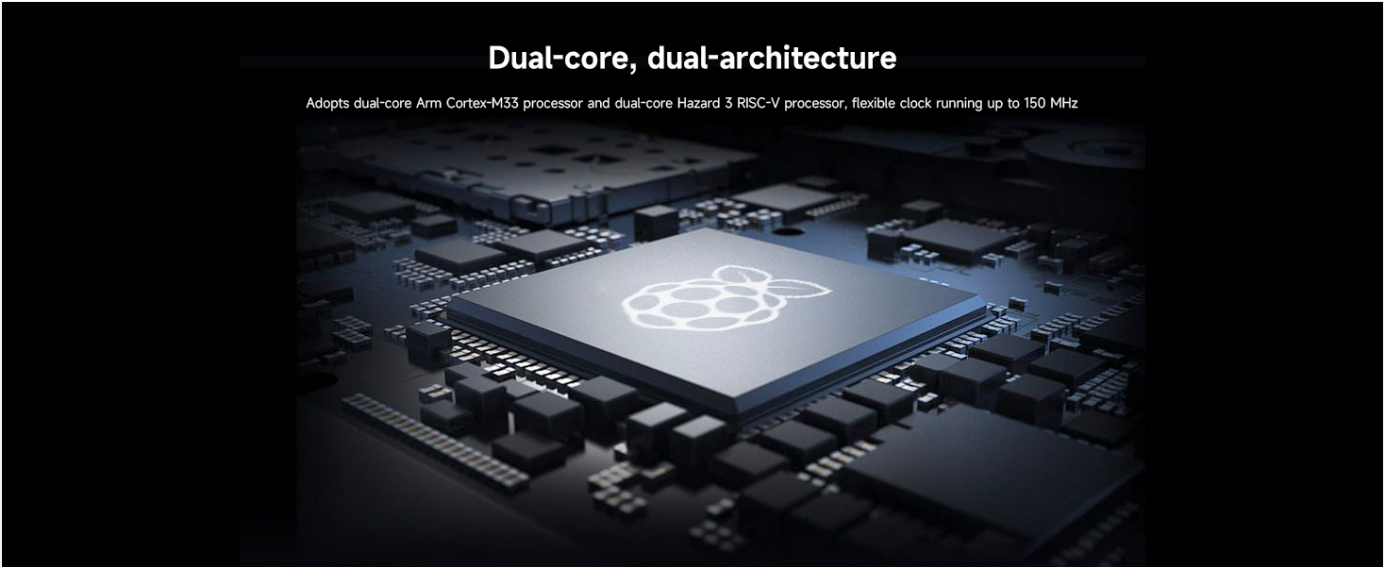


Figure 5.1: Pinout diagram illustrating the functions of the 29 multi-function GPIO pins.

This diagram is crucial for understanding how to connect peripherals and integrate the board into custom circuits, showing power, ground, UART, SPI, I2C, ADC, and PWM pin assignments.

6. ON-BOARD COMPONENTS AND DIMENSIONS

This section identifies the key components on the RP2350-Zero board and provides its physical dimensions.

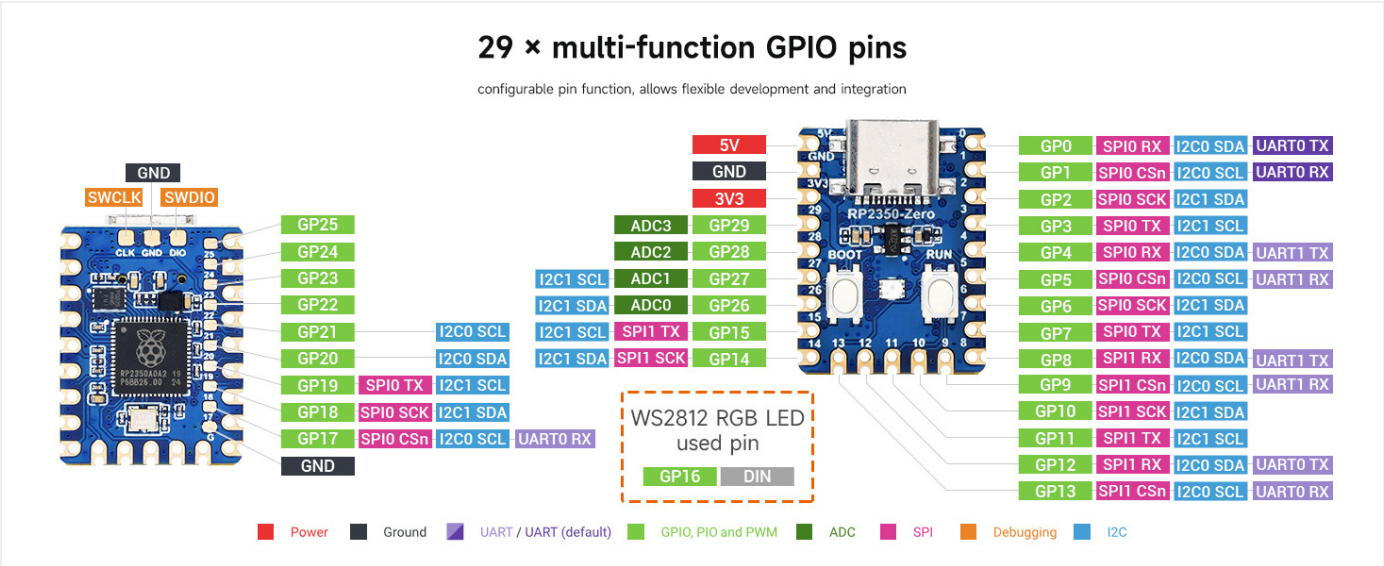


Figure 6.1: Identification of key components on the RP2350-Zero board.

The diagram above points out important features such as the USB Type-C connector for programming and power, the BOOT and RUN buttons for device control, and the RP2350A microcontroller chip.

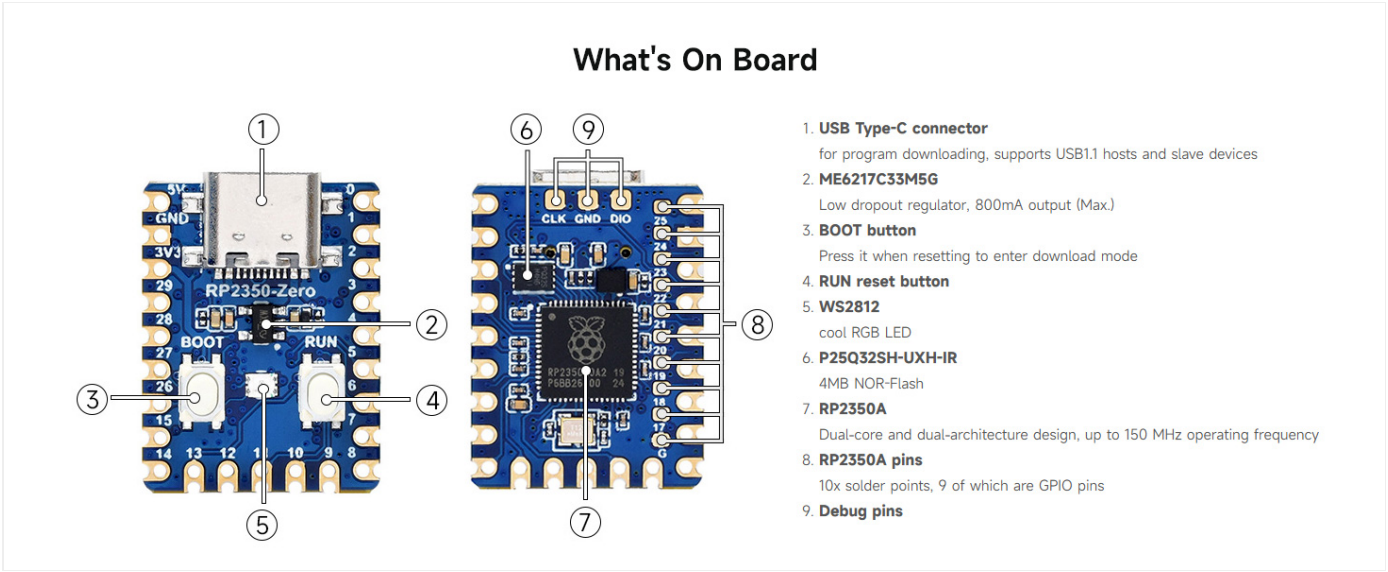


Figure 6.2: Physical dimensions of the RP2350-Zero board.

This technical drawing provides the exact measurements of the board, essential for integration into custom enclosures or PCBs.

7. PINHEADER OPTIONS

The RP2350-Zero is available in different configurations regarding pinheaders, allowing for flexibility in mounting and application.

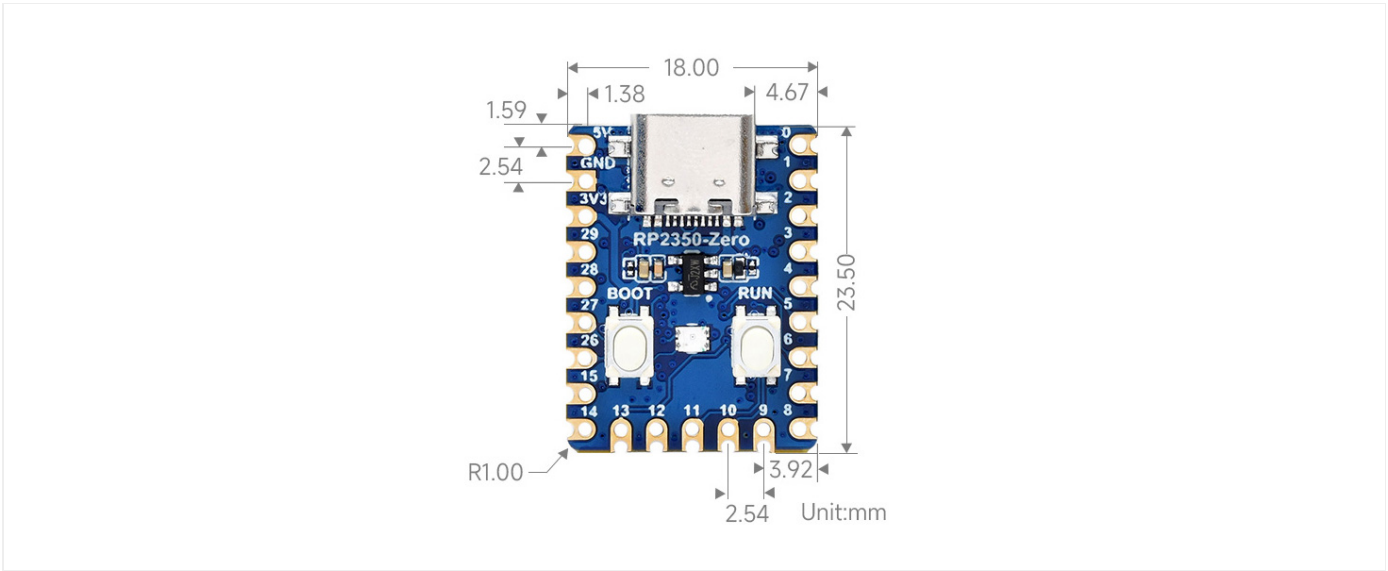


Figure 7.1: RP2350-Zero board versions with and without pinheaders.

The image illustrates the standard RP2350-Zero (without pinheaders, ideal for direct soldering) and the RP2350-Zero-M (with pre-soldered pinheaders for breadboard compatibility or socket mounting).

8. SOFTWARE SUPPORT

The RP2350-Zero supports various programming environments, including C/C++ and MicroPython, providing

comprehensive SDKs, development resources, and tutorials to assist users in getting started.

For **C/C++ development**, the official Raspberry Pi Pico C SDK can be utilized. This SDK allows for development from the command line or within popular integrated development environments such as Visual Studio Code and Eclipse.

For **MicroPython**, a full implementation of the Python 3 programming language is available, designed to run directly on embedded hardware like the Raspberry Pi Pico. This provides an accessible entry point for rapid prototyping and development.

The board's dual-core, dual-architecture design, incorporating an Arm Cortex-M33 processor and a Hazard 3 RISC-V processor, allows for flexible clock speeds up to 150 MHz, enabling diverse programming approaches and efficient execution of complex tasks.

9. SETUP

To begin using your Waveshare RP2350-Zero Mini Development Board, follow these general setup steps:

1. **Connect to Computer:** Use a USB Type-C cable to connect the RP2350-Zero board to your computer. The board should appear as a mass storage device.
2. **Install Drivers (if necessary):** For some operating systems, specific USB drivers might be required. Refer to the official Raspberry Pi Pico documentation or Waveshare's product wiki for detailed driver installation instructions.
3. **Install Development Environment:**
 - For **C/C++ development**, install the Raspberry Pi Pico SDK. Integrated Development Environments (IDEs) like Visual Studio Code or Eclipse can be used.
 - For **MicroPython development**, install a MicroPython or CircuitPython firmware. Tools like Thonny IDE are commonly used for flashing and programming.
4. **Flash Firmware:**
 - To enter bootloader mode, press and hold the **BOOT** button while connecting the USB cable, then release the **BOOT** button. The board will appear as a removable drive (RPI-RP2).
 - Drag and drop the appropriate firmware (.uf2 file) onto the RPI-RP2 drive. The board will automatically reboot and run the new firmware.
5. **Verify Connection:** After flashing, the board should be recognized by your development environment, allowing you to upload and run programs.

For detailed, up-to-date setup guides and specific software versions, always consult the official Waveshare product wiki for the RP2350-Zero.

10. OPERATING INSTRUCTIONS

Once the RP2350-Zero is set up with your chosen development environment and firmware, you can begin programming and operating it.

1. **Power On:** Connect the board to a power source via the USB Type-C port. The board will power on and execute the loaded program.
2. **Upload Programs:**
 - In C/C++ environments, compile your code and upload it to the board, often through the USB interface.
 - In MicroPython/CircuitPython, use your IDE (e.g., Thonny) to connect to the board's serial port and upload your Python scripts.
3. **Resetting the Board:** Press the **RUN** button to reset the board and restart the currently loaded program.
4. **Interacting with GPIO:** Connect external components (sensors, LEDs, motors) to the GPIO pins as per your

project's requirements and the pinout diagram (Figure 5.1). Control these components through your programmed code.

5. **USB Host/Device Functionality:** Utilize the USB 1.1 capabilities for connecting to other USB devices (as a host) or appearing as a USB device (e.g., HID, serial port) to a computer.

Always ensure proper wiring and power supply when connecting external components to avoid damage to the board or peripherals.

11. MAINTENANCE

Proper care and maintenance will ensure the longevity and reliable operation of your RP2350-Zero board.

- **Handling:** Handle the board by its edges to avoid touching components, especially the pins, which can be sensitive to static electricity.
- **Storage:** Store the board in an anti-static bag when not in use, in a dry environment, away from extreme temperatures.
- **Cleaning:** If necessary, gently clean the board with a soft, dry brush or compressed air to remove dust. Avoid using liquids or abrasive materials.
- **Power Supply:** Always use a stable 5V power supply via the USB-C port. Ensure the current draw of connected peripherals does not exceed the board's capabilities (800mA max from LDO regulator).
- **Firmware Updates:** Regularly check the Waveshare wiki for firmware updates to benefit from bug fixes and new features.

12. TROUBLESHOOTING

This section addresses common issues you might encounter with the RP2350-Zero board.

- **Board Not Recognized by Computer:**
 - Ensure the USB Type-C cable is fully inserted and functional.
 - Try a different USB port or cable.
 - Verify that the board is in bootloader mode (hold BOOT button while connecting USB).
 - Check for necessary USB drivers on your operating system.
- **Firmware Flashing Issues:**
 - Ensure you are using the correct .uf2 firmware file for the RP2350-Zero. Firmware for RP2040 or RP2400 devices may not be compatible.
 - Confirm the board is in bootloader mode (RPI-RP2 drive appears).
 - Try re-downloading the firmware file to ensure it's not corrupted.
- **Program Not Running:**
 - After flashing, press the **RUN** button to restart the program.
 - Check your code for errors in your development environment.
 - Ensure all external connections are correct and stable.
- **Serial Port Not Detected (MicroPython/CircuitPython):**
 - Some users have reported issues with MicroPython serial port detection on certain versions. Consider using CircuitPython as an alternative, which has shown better compatibility in some cases.
 - Ensure your IDE is configured to connect to the correct serial port.

- **Unexpected Behavior:**
 - Verify power supply stability.
 - Check for short circuits or incorrect wiring on your breadboard or custom PCB.
 - Consult the Waveshare wiki and community forums for similar issues and solutions.

13. DETAILED SPECIFICATIONS

Feature	Detail
Brand	Waveshare
Model Name	RP2350-Zero Mini
Processor	Raspberry Pi RP2350A (Dual-core Arm Cortex-M33 & Hazard 3 RISC-V)
CPU Speed	Up to 150 MHz
RAM	520KB SRAM
Flash Memory	4MB (on-board)
Connectivity Technology	USB Type-C (USB 1.1 Device/Host)
GPIO Pins	29 multi-functional (20 via edge, others via solder points)
Peripherals	2x SPI, 2x I2C, 2x UART, 4x 12-bit ADC, 16x PWM channels, 12x PIO state machines
Operating System Support	Linux (for development host), MicroPython, CircuitPython, C/C++ SDK
Item Weight	0 ounces (very light)
Package Dimensions	2.76 x 1.97 x 0.87 inches
Manufacturer	Waveshare

14. WARRANTY AND SUPPORT

For technical support, detailed documentation, and the latest resources, please refer to the official Waveshare product wiki for the RP2350-Zero Mini Development Board. This resource provides comprehensive guides, examples, and community support.

Information regarding specific warranty terms is typically provided at the point of purchase or on the manufacturer's official website. Please consult your retailer or the Waveshare website for warranty details.

Online Resources: [Waveshare Official Website](#)

