WT9932S31-TINY User Guide

2026-10-21

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Notice

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Revision History

Version	Date	Changed By	Changes
V1.0	2026/10/08	Kirto	Document created
V1.1	2026/10/21	Iris	Corrected document metadata, resource paths and usage instructions; removed the cover subtitle, updated the document date and corrected the development board image size; reordered related documentation and added Espressif's official Get Started guide

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1. Development Board Overview

1.1 Development Board Introduction

WT9932S31-TINY is a compact development board based on the WT0132S31-S1 module and powered by the Espressif ESP32-S31. It features a four-layer PCB design and measures only 54 × 28 mm, making it suitable for embedded applications and prototyping where space is limited. ESP32-S31 features a dual-core RISC-V processor running at up to 320 MHz and supports 2.4 GHz Wi-Fi 6, Bluetooth Low Energy, Bluetooth Classic, Zigbee and Thread, enabling device control, image processing and IoT applications using multiple protocols. The development board includes an onboard DVP camera FPC connector for connecting a camera for image capture and vision application development. GPIO pins are broken out to pin headers that support breadboard connections, making it easy to add sensors and other peripherals. The board also features an RGB indicator LED and two USB Type-C ports, FUSB and HUSB, making it suitable for IoT devices, image capture and vision prototyping.

1.2 Product Features

1. **High Performance, Compact Size**: Based on the WT0132S31-S1 module, the board features an Espressif ESP32-S31 dual-core RISC-V processor running at up to 320 MHz and supports multiple wireless communication protocols, including Wi-Fi 6. It uses a four-layer PCB design and measures only **54 × 28 mm**.
2. **Flexible DVP and GPIO Expansion**: The onboard DVP camera FPC connector is compatible with the corresponding connector on Espressif's official S31 development board. Below the connector are **pads for a 2×9 dual-row surface-mount pin header with a 2.54 mm pitch, not populated by default**. When DVP is not used, you can solder a pin header onto these pads and use the associated signal pins as general-purpose GPIO. The board's pin headers support breadboard connections for convenient prototyping.
3. **Extensive Onboard Peripherals**: The board features a **push-pull SD card slot supporting 4-bit mode** for data logging and file storage; **BOOT and EN buttons** for firmware downloading and reset operations; and an **RGB indicator LED** for multicolor status indication and interactive effects.
4. **Comprehensive Power Supply Design**: The FUSB and HUSB USB Type-C ports use power-path combining and reverse-current protection, with FUSB taking priority when both ports are connected. The pin headers provide **5 V and 3.3 V (DC-DC)**, while the DVP expansion pin header pads additionally provide **1.5 V and 2.8 V (LDO)** to power different peripherals.
5. **Open-Source Hardware and Software**: The hardware design is open source on the Lichuang platform, and the software code is open source on GitHub, facilitating learning, reference, modification and further development.

6. **Mechanical Mounting Features**: Mounting features along the board edges support the use of screws, retaining plates or custom bases, making it suitable for integration into enclosures and complete devices.

1.3 Development Board Image

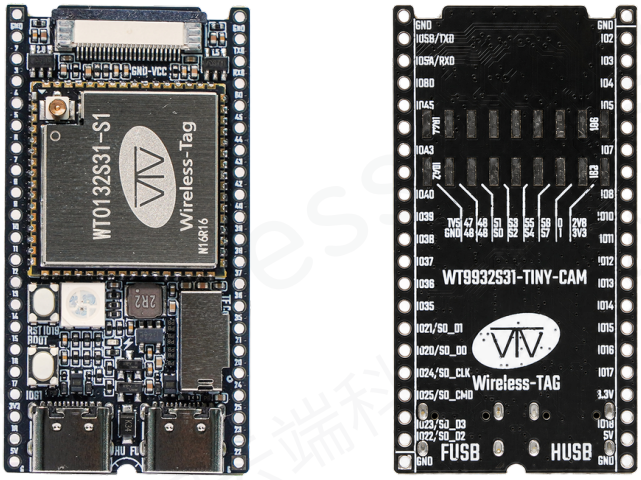


Figure 1 – Development Board Image

2. Hardware Reference

2.1 Functional Block Diagram

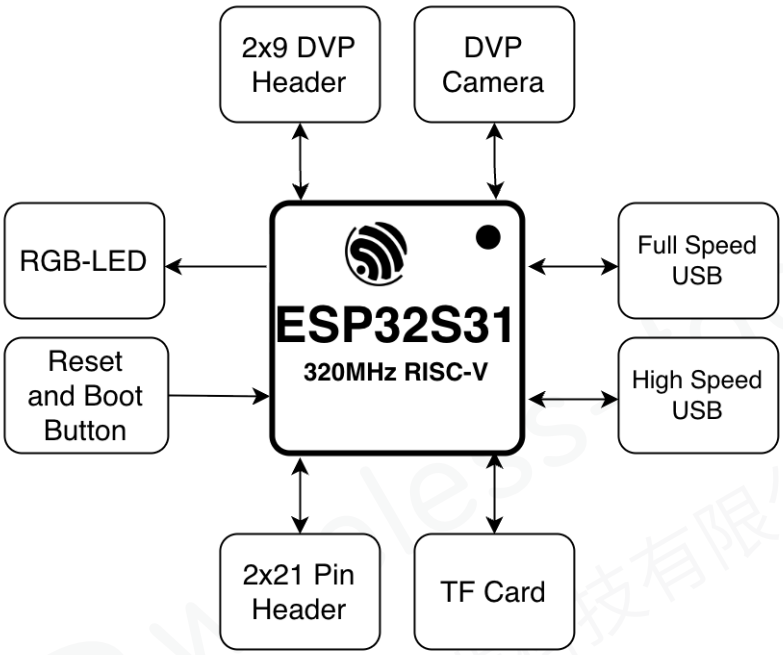


Figure 2 – Functional Block Diagram

2.2 Hardware Peripherals

Peripheral Name	Description
WS2812	Single-wire RGB LED connected to IO19.
RESET Button	Used to reset the board
BOOT Button	Used to manually enter firmware download mode; connected to IO61.
FUSB	Full-speed USB for power supply and firmware downloading/updating.
HUSB	High-speed USB.
DVP	0.5 pitch, 24pin FPC connector.
TF Card	Push-pull TF card socket supporting four-bit mode.

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2.3 Component Overview

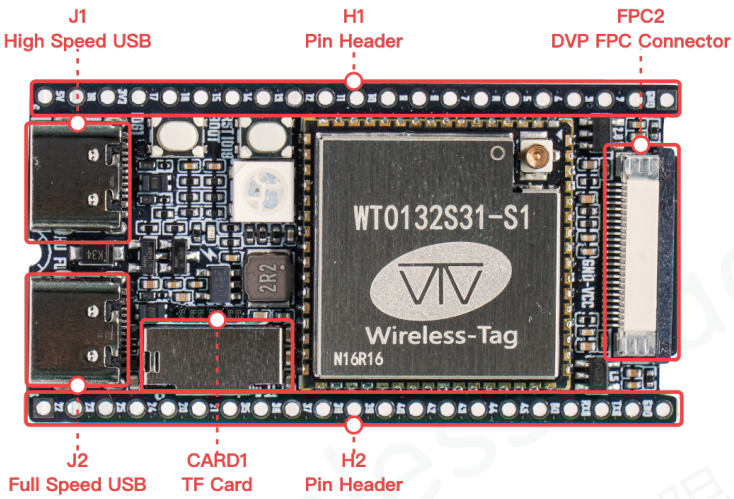


Figure 3 – Front-Side Connectors and Components

Ref.	Component Name	Description
J1	USB 2.0 Type-C Interface	High-speed USB 2.0 typeC interface. Cannot supply power to external devices.
H1	Pin Header Interface	All available GPIO pins are broken out to the pin header
FPC2	DVP FPC Connector	DVP FPC connector with the OV3660 pinout
J2	USB 2.0 Type-C Interface	Full-speed USB 2.0 typeC interface for firmware flashing and JTAG debugging.
CARD1	TF Card	Push-pull TF card socket supporting 4-bit mode
H2	Pin Header Interface	All available GPIO pins are broken out to the pin header

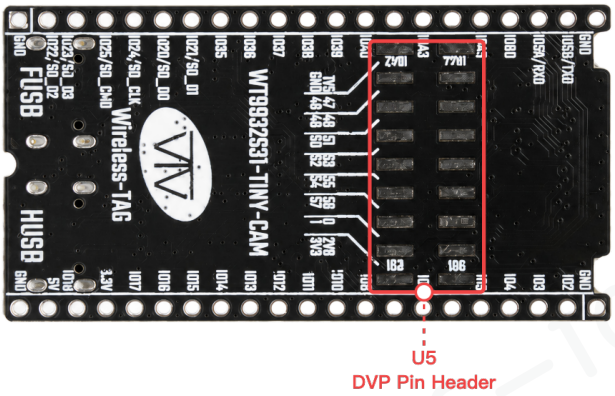


Figure 4 – Back-Side Connectors and Components

Ref.	Component Name	Description
U5	2.54mm pitch 2x9 right-angle surface-mount pin header (not populated)	Breaks out the DVP pins and power supplies; when DVP is not used, the pin header can be used for general-purpose IO

2.4 Connector Footprints

Interface Description	Connector Footprints	Notes
Pin Header Interface	HDR-TH_21P-P2.54-V-M	Pitch compatible with perfboard/breadboard
DVP FPC Connector Interface	FPC-SMD_AFC07-S24FCA-00	Check the FPC pinout carefully to avoid shorting GND and VCC
TF Card Interface	TF-SMD_TF-021B-H265	Front-side push-pull TF card socket
DVP Pin Header Interface	HDR-SMD_18P-P2.54-H-M-R2-C18-LS17.0	Not populated at the factory

2.5 Interface Descriptions

[H1]Pin Header Interface

The connector is a 21 pin through-hole soldered pin header with a 2.54mm pitch.

For detailed pin functions, refer to the official manual

The pinout is as follows:

No.	Pin	Description	Voltage Range	Notes
1	GND	Power ground	0V	
2	IO2	General-purpose input/output pin	0V/3.3V	
3	IO3	General-purpose input/output pin	0V/3.3V	
4	IO4	General-purpose input/output pin	0V/3.3V	
5	IO5	General-purpose input/output pin	0V/3.3V	
6	IO6	General-purpose input/output pin	0V/3.3V	
7	IO7	General-purpose input/output pin	0V/3.3V	
8	IO8	General-purpose input/output pin	0V/3.3V	
9	IO9	General-purpose input/output pin	0V/3.3V	
10	IO10	General-purpose input/output pin	0V/3.3V	

No.	Pin	Description	Voltage Range	Notes
11	IO11	General-purpose input/output pin	0V/3.3V	
12	IO12	General-purpose input/output pin	0V/3.3V	
13	IO13	General-purpose input/output pin	0V/3.3V	
14	IO14	General-purpose input/output pin	0V/3.3V	
15	IO15	General-purpose input/output pin	0V/3.3V	
16	IO16	General-purpose input/output pin	0V/3.3V	
17	IO17	General-purpose input/output pin	0V/3.3V	
18	3.3V	3.3V power output	3.3V	Do not use as a power input
19	IO18	General-purpose input/output pin	0V/3.3V	
20	5V	5V power output	5V	Do not use as a power input
21	GND	Power ground	0V	

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[H2]Pin Header Interface

The connector is a 21 pin through-hole soldered pin header with a 2.54mm pitch.

For detailed pin functions, refer to the official manual

The pinout is as follows:

No.	Pin	Description	Voltage Range	Notes
1	GND	Power ground	0V	
2	IO58	General-purpose input/output pin	0V/3.3V	UART0 TX pin by default
3	IO59	General-purpose input/output pin	0V/3.3V	UART0 RX pin by default
4	IO60	General-purpose input/output pin	0V/3.3V	
5	IO45	General-purpose input/output pin	0V/3.3V	
6	IO44	General-purpose input/output pin	0V/3.3V	
7	IO43	General-purpose input/output pin	0V/3.3V	
8	IO42	General-purpose input/output pin	0V/3.3V	
9	IO40	General-purpose input/output pin	0V/3.3V	
10	IO39	General-purpose input/output pin	0V/3.3V	
11	IO38	General-purpose input/output pin	0V/3.3V	
12	IO37	General-purpose input/output pin	0V/3.3V	
13	IO36	General-purpose input/output pin	0V/3.3V	
14	IO35	General-purpose input/output pin	0V/3.3V	
15	IO21	General-purpose input/output pin	0V/3.3V	SD card D1 pin
16	IO20	General-purpose input/output pin	0V/3.3V	SD card D0 pin
17	IO24	General-purpose input/output pin	0V/3.3V	SD card CLK pin
18	IO25	General-purpose input/output pin	0V/3.3V	SD card CMD pin
19	IO23	General-purpose input/output pin	0V/3.3V	SD card D3 pin
20	IO22	General-purpose input/output pin	0V/3.3V	SD card D2 pin
21	GND	Power ground	0V/3.3V	

[J1][J2]USB Power Supply Interfaces

USB2.0 Type-C interfaces for firmware downloading/power supply. J2 is a full-speed USB2.0 interface with a maximum theoretical speed of **12Mbps**, J1 is a high-speed USB2.0 interface with a maximum theoretical speed of **480Mbps**.

[CARD1]TF Card Interface

Push-pull TF card interface:

No.	Pin	Description	Voltage Range	Notes
1	IO22	DATA2 in four-bit SDIO mode	0V/3.3V	
2	IO23	DATA3 in four-bit SDIO mode	0V/3.3V	
3	IO25	CMD in four-bit SDIO mode	0V/3.3V	
4	VCC	SD card power supply	3.3V	
5	IO24	CLK in four-bit SDIO mode	0V/3.3V	
6	GND	Power ground	0V	
7	IO20	DATA0 in four-bit SDIO mode	0V/3.3V	
8	IO21	DATA1 in four-bit SDIO mode	0V/3.3V	

[FPC2]DVP FPC Connector Interface

Slide-lock, bottom-contact, 24Pin, 0.5mm pitch The pin definitions are as follows:

No.	Pin	Description	Voltage Range	Notes
1	NC	Not connected; leave floating	/	
2	3.3V	3.3V power output	3.3V	
3	Y4	Camera parallel image data Y4	0V/3.3V	MCU IO48, input
4	Y3	Camera parallel image data Y3	0V/3.3V	MCU IO47, input
5	Y5	Camera parallel image data Y5	0V/3.3V	MCU IO49, input
6	Y2	Camera parallel image data Y2	0V/3.3V	MCU IO46, input
7	Y6	Camera parallel image data Y6	0V/3.3V	MCU IO50, input

No.	Pin	Description	Voltage Range	Notes
8	PCLK	Camera pixel clock for sampling image data	0V/3.3V	MCU IO54, input
9	Y7	Camera parallel image data Y7	0V/3.3V	MCU IO51, input
10	GND	Power and signal reference ground	0V	
11	Y8	Camera parallel image data Y8	0V/3.3V	MCU IO52, input
12	XMCLK	Camera external master clock input	0V/3.3V	MCU IO55, output
13	Y9	Camera parallel image data Y9	0V/3.3V	MCU IO53, input
14	2.8V	2.8V camera power supply pin	2.8V	
15	1.5V	Camera digital core power supply pin	1.5V	
16	HREF	Camera line-valid signal indicating that the current line data is valid	0V/3.3V	MCU IO57, input
17	PWDN	Camera standby control input, active high	0V/3.3V	Default pull-down
18	VSYNC	Camera frame synchronization signal for identifying image frame boundaries	0V/3.3V	MCU IO56, input
19	RESET	Camera hardware reset input, active low	0V/3.3V	Default pull-up
20	I2C_SCL	Camera SCCB configuration bus clock	0V/3.3V	MCU IO1, output;
21	GND	Power and signal reference ground	0V	
22	I2C_SDA	Camera SCCB configuration bus data	0V/3.3V	MCU IO0, bidirectional;
23	GND	Power and signal reference ground	0V	
24	NC	Not connected; leave floating	/	

[U5] DVP Pin Header Interface

2.54mm pitch 2x9 right-angle surface-mount pin header (not populated) The pinout is as follows:

No.	Pin	Description	Voltage Range	Notes
1	2.8V	2.8V power supply pin	2.8V	
2	3.3V	3.3V power supply pin	3.3V	
3	IO0	General-purpose input/output pin	0V/3.3V	Camera SCCB data, CAM_I2C_SDA
4	IO1	General-purpose input/output pin	0V/3.3V	Camera SCCB clock, CAM_I2C_SCL
5	IO56	General-purpose input/output pin	0V/3.3V	Camera frame synchronization signal, DVP_VSYNC
6	IO57	General-purpose input/output pin	0V/3.3V	Camera line-valid signal, DVP_HREF
7	IO55	General-purpose input/output pin	To be confirmed	Camera external master clock input, DVP_XMCLK
8	IO54	General-purpose input/output pin	0V/3.3V	Camera pixel clock, DVP_PCLK
9	IO53	General-purpose input/output pin	0V/3.3V	Camera parallel data DVP_Y9
10	IO52	General-purpose input/output pin	0V/3.3V	Camera parallel data DVP_Y8
11	IO51	General-purpose input/output pin	0V/3.3V	Camera parallel data DVP_Y7
12	IO50	General-purpose input/output pin	0V/3.3V	Camera parallel data DVP_Y6
13	IO49	General-purpose input/output pin	0V/3.3V	Camera parallel data DVP_Y5
14	IO48	General-purpose input/output pin	0V/3.3V	Camera parallel data DVP_Y4

No.	Pin	Description	Voltage Range	Notes
15	IO47	General-purpose input/output pin	0V/3.3V	Camera parallel data DVP_Y3
16	IO46	General-purpose input/output pin	0V/3.3V	Camera parallel data DVP_Y2
17	1.5V	1.5V power supply pin	1.5V	
18	GND	Power and signal reference ground	0V	

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3. Schematic

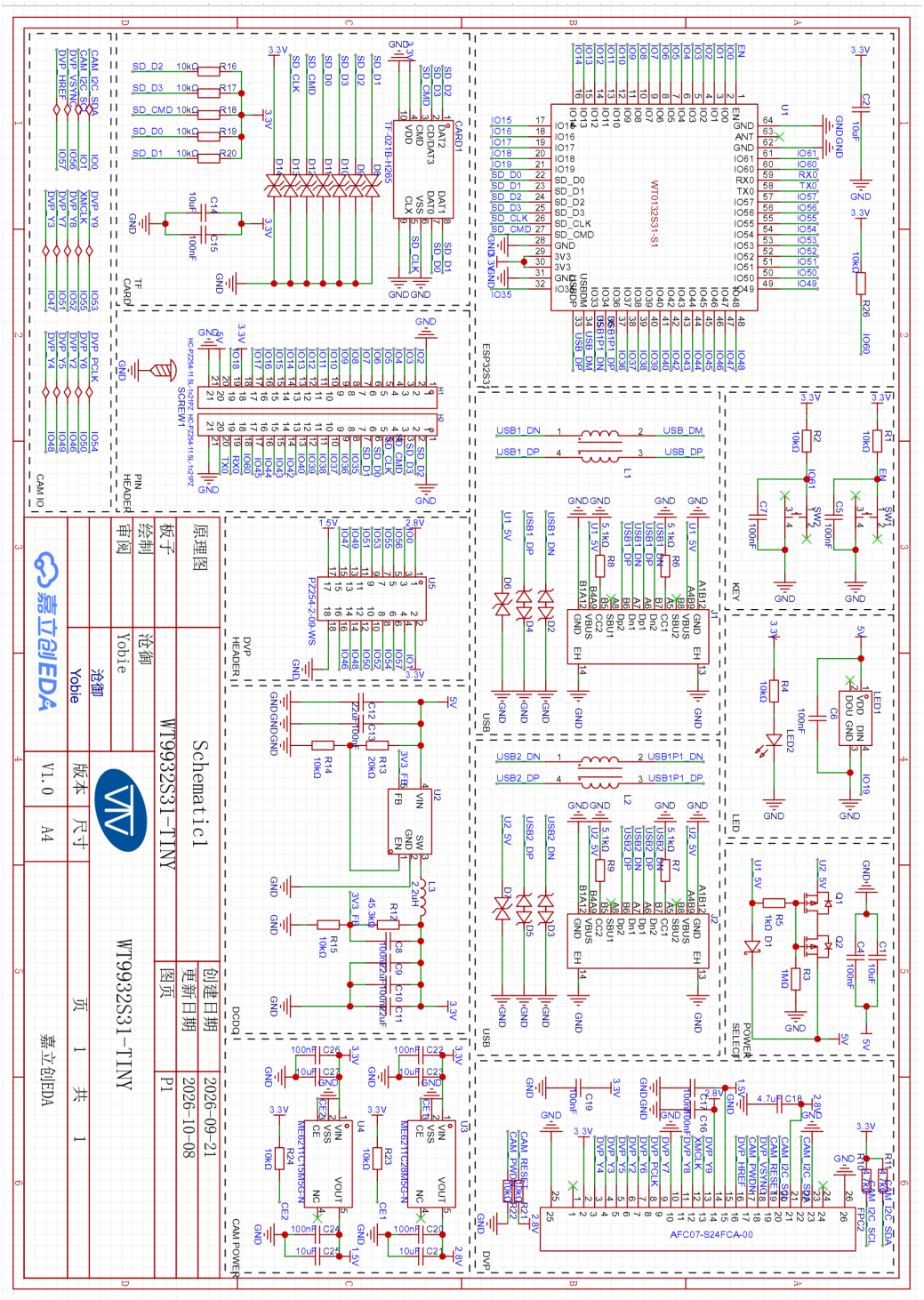


Figure 5 – Schematic

4. Mechanical Support

4.1 PCBA Dimensions

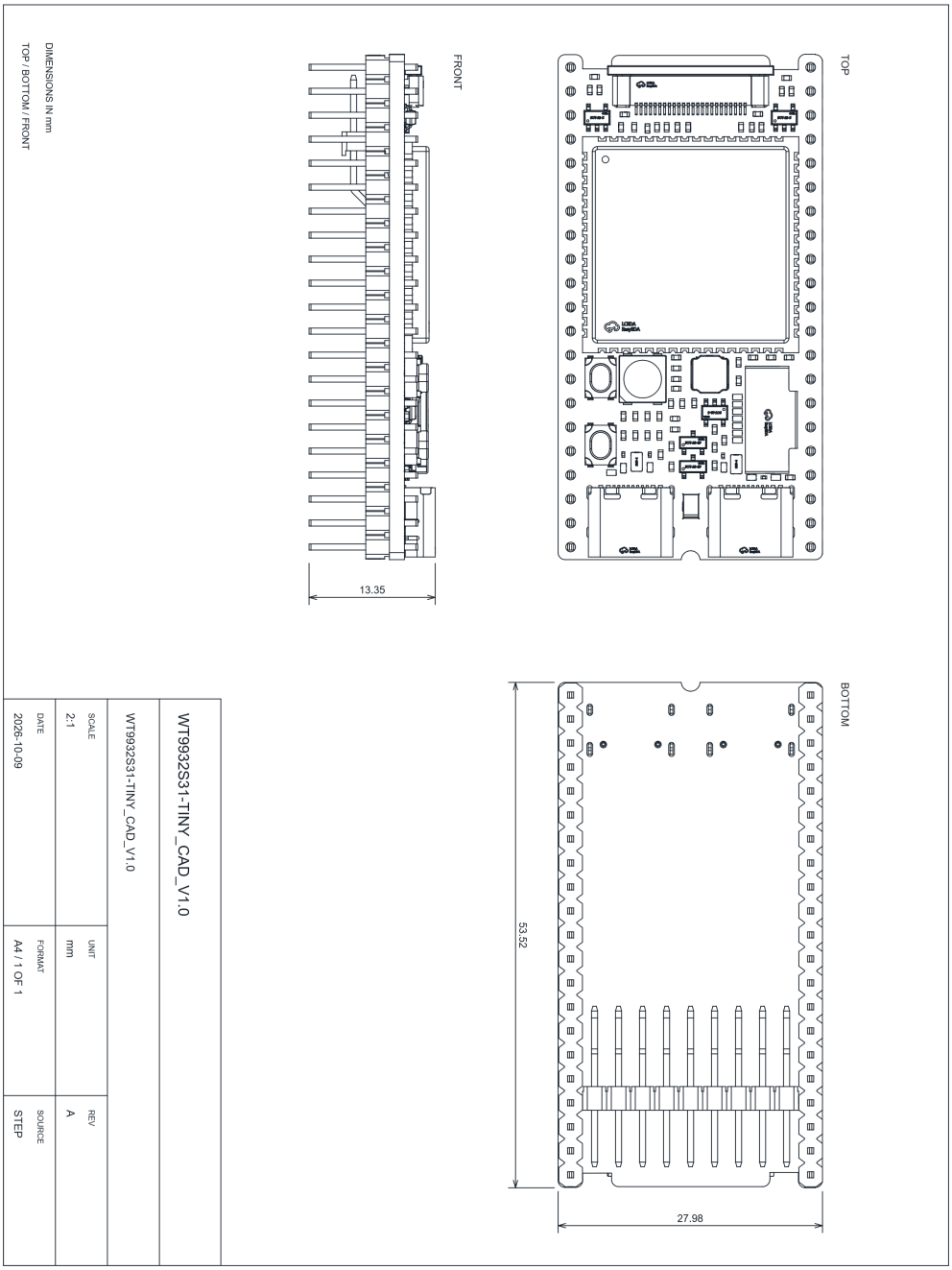


Figure 6 – Main Board Dimensions

5. Usage Instructions

5.1 Preparation

Complete the following preparations before using the hardware.

Hardware Preparation:

1. **WT9932S31-TINY Development Board** × 1 *Required; the core hardware device for this product.*
2. **USB-C Data Cable** × 1 *Required for powering the development board or connecting it to a computer. An original or high-quality cable is recommended to ensure a stable power supply.*
3. **FPC Antenna** × 1 *Required, for signal gain*
4. **Micro SD Memory Card** × 1 *Optional, for storage*
5. **WTDK-CAM-2145 Camera** × 1 *Optional, for image capture*



Figure 7 – Hardware Preparation

> **Tip**: When powering the board from a computer's USB port, the port should provide at least 5V@1A. Insufficient power may prevent the device from starting properly.

Software Preparation:

1. Install Git. Click here for installation instructions
2. Use the ESP-IDF Installation Manager (EIM) to install ESP-IDF, the build tools and the associated toolchains. The manager supports multiple operating systems. Click here for installation instructions.
3. Use **git clone** to clone the BSP repository provided for the hardware: https://github.com/Wireless-TAG-Maker/WT_BSP.git

> Note: 1. Our development kit uses the ESP32-S31 chip and requires release version V6.0 or later. 2. If you use windows, we recommend a Windows+WSL development setup. In the esp-idf installation documentation linked above, follow the 【Install ESP-IDF and the Toolchain on Linux】section to set up the environment.

5.2 Hardware Connections

Connect the hardware as shown below. Connect one end of the USB-C data cable to the development board and the other end to the computer. The indicator LED lights up when the device is powered on.

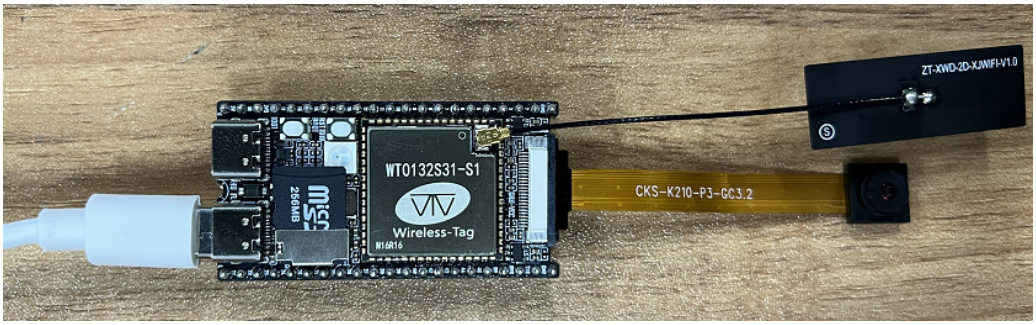


Figure 8 – Hardware Preparation

> If a Micro SD memory card is inserted, it will obscure the power indicator LED. You will not be able to see the LED's status when viewing the board from above; check it from the side instead.

5.3 User Guide

Before starting, make sure the【Software Preparation】section above has been completed. Here, we begin with the BSP repository provided for the hardware.

Choose a directory for the BSP project, then clone the repository:

```
mkdir -p ~/work
cd ~/work
git clone https://github.com/Wireless-TAG-Maker/WT_BSP.git
cd WT_BSP
```

You should normally be on the main branch. All subsequent examples assume that the repository is located at:

```
~/work/WT_BSP
```

> You may use a different directory during development. Simply replace the paths in the documented commands with your actual paths.

Do not modify the main branch directly; create a new branch for subsequent modifications and experiments:

```
git switch -c my_branch
```

To switch branches and pull updates later, use the following commands:

```
git switch main
git pull --ff-only origin main
```

> Whenever possible, keep custom applications outside the WT_BSP repository or on a separate Git branch. This allows you to synchronize official updates through the main branch later, reducing the risk of conflicts with your application code. When working in a team, also record the verified WT_BSP commit so that other developers can reproduce the same build environment.

5.3.1 Start Verification with a Simple Example

After each WT_BSP update, we recommend building the minimal blink example first to confirm that ESP-IDF, the BSP and the board selection tool are working correctly:

```
cd ~/work/WT_BSP/examples/get-started/blink

# Notes:
# 1. set-board is our custom setup command. After running it, you can use
    build, flash and monitor.
```

```
# 2. set-board simplifies board configuration. Do not use idf.py set-target unless you understand the setup performed by set-board.
# 3. When prompted, select the number corresponding to your development board.
~/work/WT_BSP/examples/get-started/blink$ idf.py set-board
...
Supported boards in this example:
0: WT9932C2-TINY (esp32c2)
1: WT9932C3-TINY (esp32c3)
2: WT9932C5-TINY (esp32c5)
3: WT9932C61-TINY (esp32c61)
4: WT9932P4-TINY (esp32p4)
5: WT9932P4C61-TINY (esp32p4)
6: WT9932P4X-TINY (esp32p4)
7: WT9932S31-TINY (esp32s31)

Please select the target board by entering the corresponding number.
Enter board number:  # Enter the number corresponding to your development board.
7 # For WT9932S31-TINY, enter 7 and press Enter to continue.
Target changed from esp32p4 to esp32s31; running idf.py fullclean # set-board also generates board presets for the current project; it automatically runs fullclean when switching to a board with a different target chip.
Executing action: fullclean
Executing action: remove_managed_components
Done
Generated sdkconfig.board
Generated sdkconfig.board.Kconfig
Updated build/sdkconfig
Selected WT9932S31-TINY (esp32s31)
Done

# Then build the project.
~/work/WT_BSP/examples/get-started/blink$ idf.py build
```

> The same procedure applies to all subsequent BSP examples.

After the build succeeds, you can flash the firmware. Use a USB-C data cable to connect the board's FUSB port to a USB port on the PC:

```
idf.py -p <COM> flash
```

> **Tip**: If you encounter an issue after connecting FUSB If the following occurs: the COM port on the computer keeps appearing and disappearing, and the UART connection also appears intermittently in the serial terminal software. Try the following: 1. Press and hold the BOOT button on the development board, then 2. Press and release the RESET button, and finally release the BOOT button. This manually puts the hardware into firmware download mode.

After the firmware is flashed successfully, the RGB LED on the development board changes color once every second:

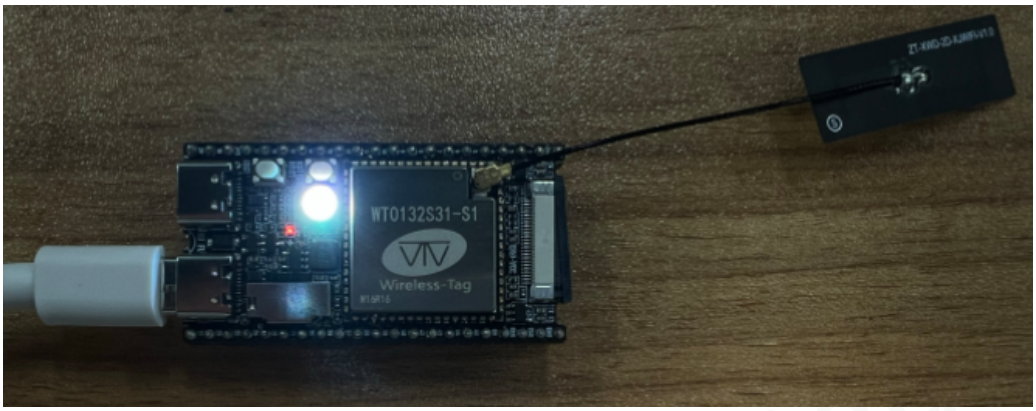


Figure 9 – Hardware Preparation

Open the serial port to view the following log:

```
I (27) boot: ESP-IDF v6.1 2nd stage bootloader
I (28) boot: compile time Oct 10 2026 10:33:18
I (28) boot: Multicore bootloader
I (30) boot: chip revision: v0.0
I (30) boot: efuse block revision: v0.1
I (34) boot.esp32s31: SPI Speed      : 80MHz
I (38) boot.esp32s31: SPI Mode       : DIO
I (42) boot.esp32s31: SPI Flash Size : 16MB
I (46) boot: Enabling RNG early entropy source...
I (50) boot: Partition Table:
I (53) boot: ## Label            Usage          Type ST Offset   Length
I (59) boot:  0 nvs              WiFi data        01 02 00009000 00006000
I (66) boot:  1 phy_init         RF data          01 01 0000f000 00001000
I (72) boot:  2 factory          factory app      00 00 00010000 00100000
I (80) boot: End of partition table
I (82) esp_image: segment 0: paddr=00010020 vaddr=40030020 size=0d254h (
  53844) map
I (100) esp_image: segment 1: paddr=0001d27c vaddr=2f000000 size=02d9ch (
  11676) load
I (104) esp_image: segment 2: paddr=00020020 vaddr=40000020 size=21548h
  (136520) map
I (128) esp_image: segment 3: paddr=00041570 vaddr=2f002d9c size=0ad24h (
  44324) load
I (139) esp_image: segment 4: paddr=0004c29c vaddr=2f00db00 size=02cf8h (
  11512) load
I (146) boot: Loaded app from partition at offset 0x10000
I (147) boot: Disabling RNG early entropy source...
I (156) cpu_start: Multicore app
I (165) cpu_start: GPIO 59 and 58 are used as console UART I/O pins
I (166) cpu_start: Pro cpu start user code
I (166) cpu_start: cpu freq: 320000000 Hz
I (168) app_init: Application information:
```

```
I (171) app_init: Project name:     blink
I (175) app_init: App version:      73b219b
I (179) app_init: Compile time:     Oct 10 2026 10:33:12
I (184) app_init: ELF file SHA256:  895ce1f04...
I (188) app_init: ESP-IDF:          v6.1
I (192) efuse_init: Min chip rev:     v0.0
I (196) efuse_init: Max chip rev:     v0.99
I (200) efuse_init: Chip rev:         v0.0
I (204) heap_init: Initializing. RAM available for dynamic allocation:
I (210) heap_init: At 2F012270 len 00068D40 (419 KiB): RAM
I (215) heap_init: At 2F07AFB0 len 000041C0 (16 KiB): RAM
I (220) heap_init: At 2E000000 len 00007FE8 (31 KiB): RTCRAM
I (227) spi_flash: detected chip: generic
I (229) spi_flash: flash io: dio
I (233) sleep_gpio: Configure to isolate all GPIO pins in sleep state
I (239) sleep_gpio: Enable automatic switching of GPIO sleep configuration
I (254) main_task: Started on CPU0
I (254) main_task: Calling app_main()
I (264) blink: Initializing Wireless-Tag BSP
I (264) button: IoT Button Version: 4.2.1
I (264) wt_bsp_sdmmc: Initializing on-chip LDO channel 1 for SD card
I (274) wt_bsp_sdmmc: On-chip LDO initialized successfully
```

6. Related Documentation

Document Name	Link	Description
Wireless-tag Official WIKI	Official Documentation Center	Entry point for development board documentation and resources
ESP32-S31 ESP-IDF Programming Guide	Official Chinese Documentation	ESP32-S31 development environment setup, project development, driver API and system features
Espressif Official Get Started (ESP32-S31)	Official English Documentation	ESP32-S31 environment installation and configuration, building, flashing and serial monitoring of the first project
ESP32-S31 Series Datasheet	Official Chinese PDF	Chip features, pin definitions, multiplexed functions, power supply requirements, electrical characteristics and package dimensions
ESP32-S31 Technical Reference Manual	Official Chinese PDF	Operating principles and register descriptions for memory, the GPIO matrix, LCD/Camera and other peripherals
ESP32-S31 Hardware Design Guidelines	Official Chinese Documentation	Design requirements for power supply, reset, crystal oscillators, RF, memory and peripheral interfaces
ESP32-S31 PCB Layout Design Guidelines	Official Chinese Documentation	Placement and routing requirements for power supply, crystal oscillators, RF, Flash, PSRAM, USB and other components
ESP32-S31 Series Chip Errata	Official Chinese Documentation	Known issues, affected scope and workarounds for each chip revision

7. Contact Us

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- WeChat Official Account QR Code



Figure 10 – WeChat Official Account QR Code