1. Product overview

The ESP32-P4-WIFI6-Touch-LCD-4B is a high-performance development board based on the ESP32-P4. It uses a dual-core plus single-core RISC-V architecture and includes a 4-inch, 720 × 720 IPS touch display. The board supports human-machine interfaces and embedded applications requiring display, connectivity, audio and camera functions.

The platform provides MIPI-CSI with an integrated image signal processor (ISP), MIPI-DSI for the display, and a USB 2.0 OTG High-Speed interface. The ESP32-P4 also integrates a digital-signature peripheral and a dedicated key-management unit.

Product identifiers

SKU	Product
31416	ESP32-P4-WIFI6-Touch-LCD-4B
31570	ESP32-P4-86-Panel-ETH-2RO

2. Main technical features

Block	Specification
HP processor	32-bit dual-core RISC-V; DSP and ISA extensions; FPU; up to 360 MHz
LP processor	32-bit single-core RISC-V; up to 40 MHz
Wireless coprocessor	ESP32-C6; Wi-Fi 6 and Bluetooth 5 / BLE functions expanded through SDIO
HP ROM	128 KB
LP ROM	16 KB
HP L2 memory	768 KB
LP SRAM	32 KB
TCM	8 KB
External / package memory	32 MB PSRAM stacked in package; 32 MB external NOR Flash
Display	4-inch IPS, 720 × 720 pixels, MIPI-DSI
Peripheral interfaces	MIPI-CSI, MIPI-DSI, USB 2.0 OTG, Ethernet PHY, SDIO 3.0 TF card slot, dual microphones with echo cancellation, speaker connector and RTC battery connector

3. Hardware version comparison

Version	Hardware characteristics
ESP32-P4-WIFI6-Touch-LCD-4B	Main board includes a 15-pin, 1.0 mm-pitch MIPI-CSI camera connector supporting 2-lane MIPI CSI cameras.
ESP32-P4-86-Panel-ETH-2RO	Main PCB does not have the MIPI-CSI camera connector fitted. It connects to the 86 Panel Bottom Board, which provides RJ45 Ethernet, RS485 and two relays.

Important: The two versions use different main-PCB assemblies and enclosure structures. They cannot share the same 86-type back box.

4. Onboard resources

No.	Resource / component	Description
1	ESP32-P4-Core	Integrates ESP32-P4NRW32 and 32 MB NOR Flash.
2	ESP32-C6-MINI-1U-H8	SDIO interface; adds Wi-Fi 6 and Bluetooth 5 (LE).
3	4-pin programming pads	2.54 mm pitch; used to flash firmware to the ESP32-C6 module.
4	MIPI-DSI LCD interface	Connection for the 4-inch MIPI display.
5	RTC battery header	For a rechargeable RTC battery only.
6	Onboard microphone	Microphone input and echo cancellation.
7	BOOT button	Press during power-up or reset to enter download mode.

No.	Resource / component	Description
8	Expansion header	2.0 mm pitch; connects the 86 Panel Bottom Board or external I/O.
9	RESET button	Board reset.
10	PWR LED	Power indicator.
11	USB Type-C OTG	USB 2.0 High-Speed OTG interface.
12	USB Type-C to UART	Power supply, programming and debugging.
13	ES7210 audio ADC	Works with the onboard acoustic echo-cancellation circuit for microphone input.
14	IP101 Ethernet PHY	10/100 Mbit/s Ethernet PHY.
15	ES8311 audio codec	Low-power audio encoding and decoding.
16	MIPI-CSI interface	15-pin, 1.0 mm pitch; 2-lane camera interface; only on the 4B version.
17	Speaker header	MX1.25 2-pin connector; supports an 8 Ω, 2 W speaker.
18	TF card slot	SDIO 3.0 interface.
19	RJ45 Ethernet	100 Mbit/s Ethernet port on the bottom board.
20	Relay indicators	Status indicators for the relay channels.
21	Power isolation module	Isolation circuitry on the bottom board.
22	Digital isolator	Digital signal isolation.
23	Optocoupler isolation	Optocoupler-based isolation.
24	Relays	Two relay channels.
25	Relay screw terminal	5.08 mm, 4-pin terminal.
26	RS485 screw terminal	RS485 connection.
27	Power screw terminal	Wide-range DC 6–30 V input.

5. Peripheral quick reference

The assignments below are taken from the main-board and 86 Panel Bottom Board schematics referenced by Waveshare.

Module	Device / function	Interface	GPIO / signal	Availability
LCD	4-inch 720 × 720 IPS	2-lane MIPI-DSI	RESET GPIO27; BL_EN GPIO33; BL_PWM GPIO26	Both versions
Touch	GT911, 5-point capacitive	I2C	SDA GPIO7; SCL GPIO8; RST GPIO23; TP_INT at TP2	Both
Camera	15-pin, 1.0 mm connector	2-lane MIPI-CSI + I2C	Dedicated CSI lanes; control bus GPIO7/GPIO8	4B only
Wireless	ESP32-C6-MINI-1U-H8	SDIO / control	GPIO6, 14, 16, 18–20, 22, 54	Both
MicroSD	TF card slot	4-bit SDIO	D0–D3 GPIO39–42; CLK GPIO43; CMD GPIO44; power GPIO45	Both
Audio output	ES8311 + NS4150B amplifier	I2C + I2S	I2C GPIO7/8; I2S GPIO9–13; amp control GPIO53	Both
Audio input	ES7210 dual-mic ADC	I2C + I2S/TDM	I2C address 0x40; data/clocks GPIO10–13	Both
Ethernet PHY	IP101	RMII	GPIO28–31, 34/35, 49–52	PHY both; RJ45 on 86 Panel
RS485	THVD1406DR / SP3485EEN	UART, auto direction	TXD GPIO47; RXD GPIO48	86 Panel only
Relays	Two optocoupler-isolated channels	GPIO	RELAY1 GPIO32; RELAY2 GPIO46	86 Panel only
USB OTG	Native ESP32-P4 USB 2.0 HS	USB	Dedicated USBD_P / USBD_N	Both
USB to UART	CH343P	UART	GPIO37 / GPIO38; DTR/RTS also control reset/download	Both

6. Pin definitions

General expansion header (P3)

Pin	Signal	Pin	Signal
1	3V3	2	5V
3	GPIO7 / I2C_SDA	4	GND
5	GPIO8 / I2C_SCL	6	GPIO37
7	GPIO2	8	GPIO38
9	GPIO3	10	GPIO20
11	GPIO4	12	GPIO21
13	GPIO5	14	GPIO22

Bottom board header (P2)

P2 carries Ethernet pairs and control signals between the main PCB and the 86 Panel Bottom Board.

Pin	Signal	Pin	Signal
1	ETH_TX_P / TD_P	2	5V
3	ETH_TX_N / TD_N	4	3V3
5	ETH_RX_P / RD_P	6	GPIO32 / RELAY1
7	ETH_RX_N / RD_N	8	GPIO46 / RELAY2
9	USB_IN1_P	10	GPIO47 / RS485_TXD
11	USB_IN1_N	12	GPIO48 / RS485_RXD
13	GND	14	GND

7. GPIO allocation

GPIO	Signal / connected device	Notes
2–5	P3 expansion header	General-purpose expansion pins.
6	ESP32-C6 IO2	Wireless coprocessor interface.
7	Shared I2C SDA	Touch, camera control, ES8311, ES7210; also exposed on P3.
8	Shared I2C SCL	Touch, camera control, ES8311, ES7210; also exposed on P3.
9	ES8311 DSDIN	Audio playback data.
10	ES8311 LRCK / ES7210 SDOUT1	Shared audio interface.
11	ES7210 SDOUT2	Microphone ADC data.
12	ES8311 ASDOUT / ES7210 LRCK	Shared audio interface.
13	ES8311 / ES7210 SCLK	Audio bit clock.
14	ESP32-C6 IO23	Wireless coprocessor interface.
16	ESP32-C6 IO22	Wireless coprocessor interface.
18	ESP32-C6 IO21	Wireless coprocessor interface.
19	ESP32-C6 IO20	Wireless coprocessor interface.
20	ESP32-C6 IO19 / P3	Shared with expansion header.
21	P3 expansion header	General-purpose expansion pin.
22	ESP32-C6 IO9 / P3	Shared with expansion header.
23	TP_RST	GT911 touch reset.
24 / 25	USB_IN1_P / USB_IN1_N	Routed to P2 through unpopulated series resistors.
26	LCD_BL_PWM	LCD backlight brightness control.
27	LCD_RESET	LCD reset.
28	IP101 CRS_DV / RX_DV	RMII.
29	IP101 RXD0	RMII.
30	IP101 RXD1	RMII.
31	IP101 MDC	RMII management clock.
32	RELAY1	P2; used by the 86 Panel Bottom Board.
33	BL_EN	LCD backlight boost enable.
34	IP101 TXD0	RMII.
35	IP101 TXD1 / BOOT button	Shared through the download-mode circuit.
37 / 38	CH343P UART / P3	Programming and debugging serial port; also exposed on P3.
39–42	MicroSD D0–D3	4-bit SDIO data bus.
43	MicroSD CLK	SDIO clock.
44	MicroSD CMD	SDIO command.
45	MicroSD power control	Controls SD1_VDD.
46	RELAY2	P2; used by the 86 Panel Bottom Board.
47 / 48	RS485 TXD / RXD	P2; used by the 86 Panel Bottom Board.
49	IP101 TXEN	RMII transmit enable.
50	IP101 REF_CLK	RMII reference clock.
51	IP101 RESET	Ethernet PHY reset.
52	IP101 MDIO	RMII management data.
53	PA_CTRL	NS4150B speaker amplifier control.
54	ESP32-C6 CHIP_PU	Wireless coprocessor reset / enable.

8. Usage notes

• GPIO7 and GPIO8 are shared by onboard I2C devices and the P3 header. Check for I2C address conflicts before adding another device.
• GPIO20, GPIO22, GPIO37 and GPIO38 are exposed on P3 but are already connected to onboard functions.
• GPIO32, GPIO46, GPIO47 and GPIO48 become relay and RS485 signals when the 86 Panel Bottom Board is connected.
• TP_INT is available at test point TP2 and is not connected to an ESP32-P4 GPIO in the referenced schematic.

9. Dimensions

The Waveshare page provides a mechanical drawing for the ESP32-P4-86-Panel-ETH-2RO assembly. The drawing specifies the following dimensions in millimetres: front width 86.50 mm, front height 86.50 mm, side depth 36.50 mm, with additional enclosure and mounting dimensions shown in the source drawing.

10. Development tools

Arduino may offer a gentler learning curve for beginners and hobbyists. ESP-IDF provides more advanced tooling and finer control over system behaviour, making it more suitable for complex projects and demanding applications.

Waveshare recommendation: Due to limited ESP32-P4 support on the Arduino platform, ESP-IDF is currently recommended.

ESP-IDF (Espressif IoT Development Framework) is Espressif's development framework for ESP-series chips. It is C-based and includes a compiler, debugger and flashing tool. Development can be performed from the command line or an IDE such as Visual Studio Code with the Espressif IDF extension. Waveshare recommends VS Code and refers users to its Working with ESP-IDF tutorial for setup instructions and example programs.

11. Source and related documentation

Main product page: https://docs.waveshare.com/ESP32-P4-WIFI6-Touch-LCD-4B
Resources: schematics, datasheets and example code are linked from the product page under "Resources".
Development guide: "Working with ESP-IDF" is linked from the product page.

This PDF is a formatted reference copy of the content available on the cited Waveshare documentation page. For revisions, schematics and implementation details, consult the live source page.