OSCORE Development Board Hardware Manual

> 💡 **Disclaimer**: This manual serves only as a reference for the OSCORE development board and does not constitute any express or implied warranty. Product design and specifications may be updated at any time without prior notice. Before using this product, please ensure that you have fully understood the relevant electrical safety regulations. The author shall not be held liable for any equipment damage or personal injury caused by improper use.

1. Product Overview

OSCORE is a high-performance robot control development board based on the **ESP32-S3-WROOM-1U-N16R8** module, integrating a 6-axis IMU (QMI8658A), a 3-axis magnetometer (QMC6309), CAN bus, Gigabit Ethernet, USB Hub, SBUS remote control receiver, PWM output, and encoder interface, suitable for embedded control scenarios such as mobile robots, drones, and smart cars.

> 📌 **Quick Overview of Core Parameters**: ESP32-S3 Dual-core Xtensa LX7 @ 240MHz | 16MB Flash / 8MB PSRAM | 5V@5A Main Power Supply | 9~26V Wide Voltage Input | Onboard 6+3 Axis IMU | CAN / Ethernet / USB Hub

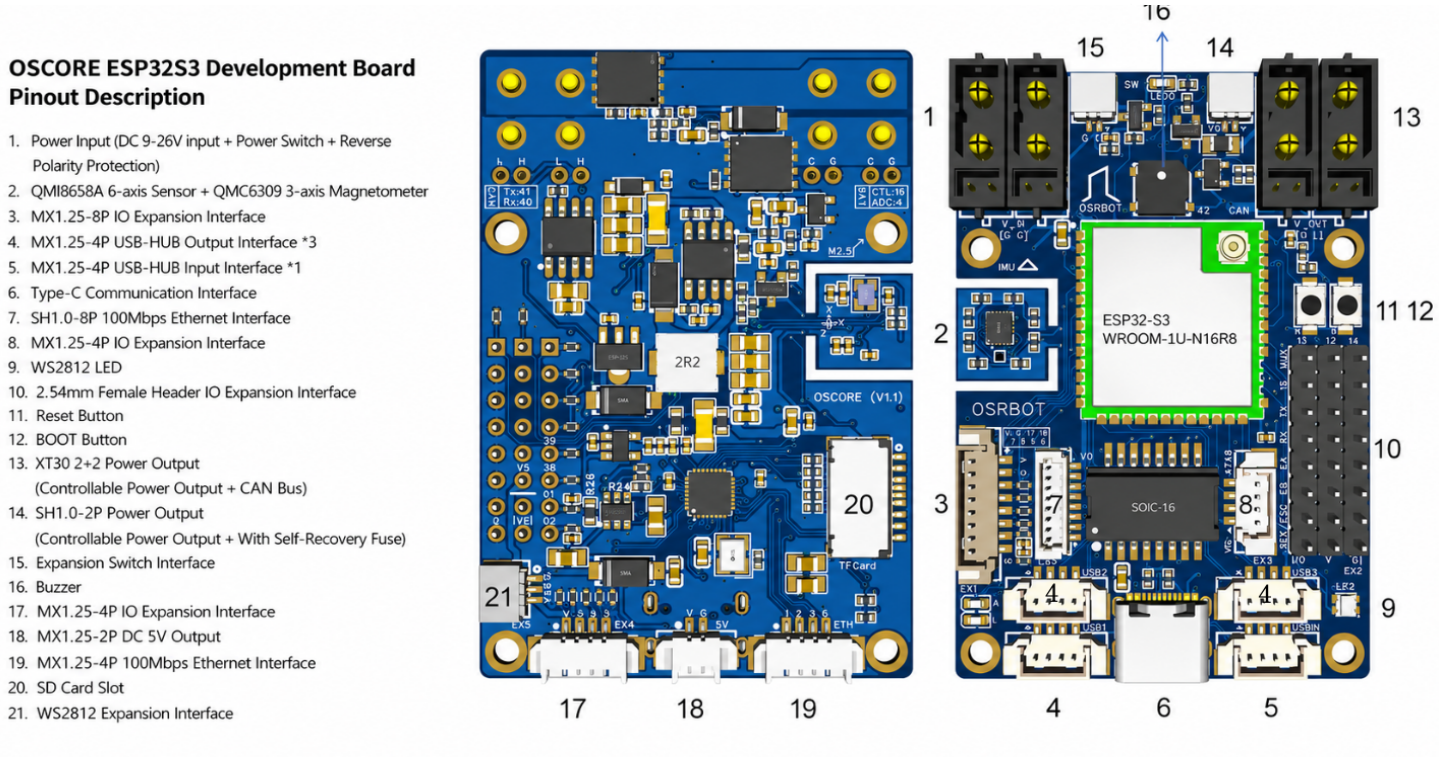
2. Item List

Serial Number	Item Name	Quantity	Remarks

1	OSCORE Development Board	1 piece	Welded Test
2	XT30 Power Cord	2 pieces	One male and one female
3	USB Type-C data cable	1 piece	Used for programming and debugging

3. Interface Overview

The following figure shows the front interface layout of the OSCORE development board, and the interface descriptions corresponding to each number are shown in the following table.



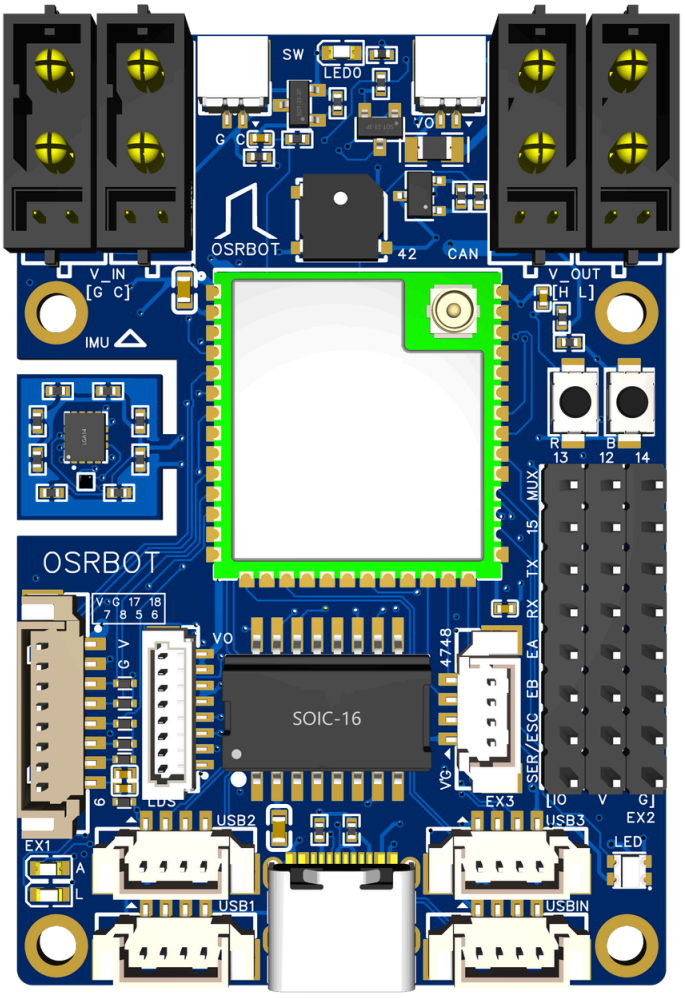
OSCORE development board interface layout diagram

3.1 Interface Comparison Table

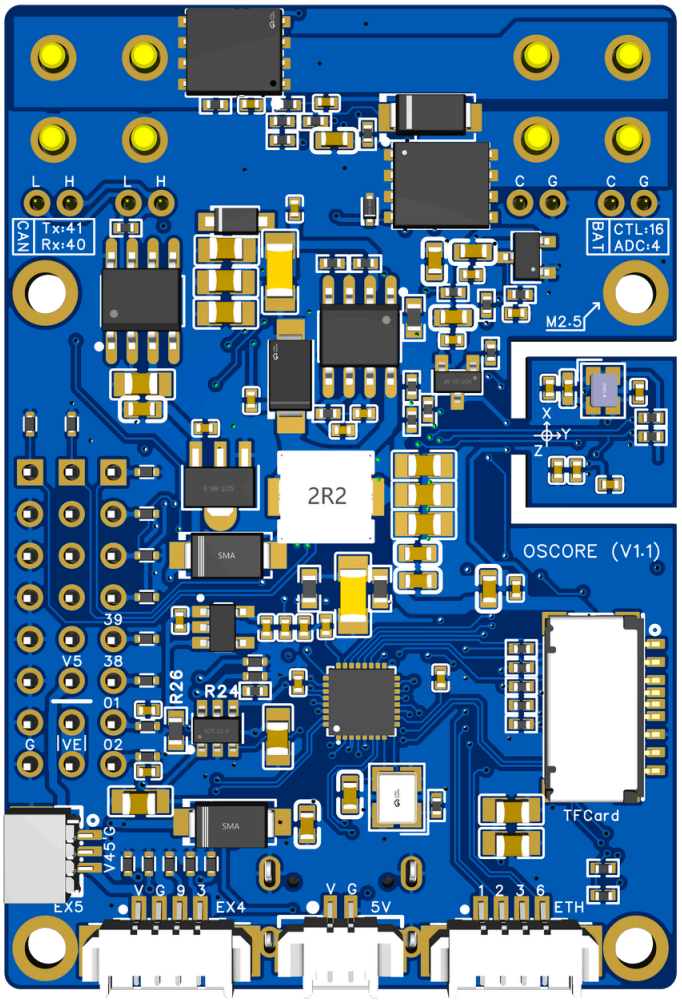
Interface Name	Type	Function Description	Remarks
DC Power Input	XT30 (2+2 PB-M)	Main power supply input, 9~26V	Built-in TPS54540 DC-DC
USB Type-C	Type-C 16P	Firmware Flashing, USB Communication, 5V Power	Extended via CH339F USB Hub

		Supply	
USB Hub Ports ×4	USB-A / Pin Header	Expand USB peripherals (cameras, USB flash drives, etc.)	CH339F 4 口 Hub
Ethernet	RJ45 (100M)	100Mbps Ethernet communication	HR641680E Network Transformer
MicroSD Card Slot	TF-123-ARP9H17	External TF Card Storage	via CH339F USB to SD
CAN Bus	Pin Header / Terminal	CAN 2.0 Communication	TJA1050T Transceiver
IO Expansion Pin Header	2.54mm Pin Header	Leads out the remaining GPIOs of ESP32-S3	含 SPI、I^2C、UART 等
WS2812 LED Interface	3P Pin Header / On-Board	Programmable RGB LED Control	5V Power Supply + Data Cable
Buzzer	Onboard	Active buzzer, controlled by IO42	3.3V Drive
RESET / BOOT Button	Touch Switch	Reset and Firmware Flashing Mode	Press BOOT + RESET to enter programming
IMU Sensor	QMI8658A + QMC6309	6-axis gyroscope/accelerometer + 3-axis magnetometer	I^2C Address: 0x6B / 0x7C
Power Output	XT30 (2+2 PB-M)	leads out VCC_5V / GND	for external power supply
ESP32-S3 Module	WROOM-1U-N16R8	Main Control MCU	External U.FL Antenna Interface
SBUS / PWM / Encoder	Pin Header	Remote control reception, servo/ESC control, encoder input	See the interface signal description for details

3.2 PCB Physical Diagram



OSCORE PCB front physical picture



OSCORE PCB back physical picture

4. Detailed Explanation of Functional Modules

4.1 主控 — ESP32-S3-WROOM-1U

Parameter	Specification
Chip Model	ESP32-S3-WROOM-1U-N16R8
CPU	Xtensa 32-bit LX7 双核 @ 240 MHz
Flash	16 MB (Quad SPI)
PSRAM	8 MB (Octal SPI)
Wireless	Wi-Fi 4 (802.11 b/g/n) + BLE 5.0
Antenna Interface	U.FL (IPEX) External Antenna
USB	USB OTG (via internal USB Serial/JTAG)

4.2 Power Supply System

OSCORE Support**Wide Voltage DC Input (9~26V)**, Outputting Stable Voltage through Two-Stage Power Conversion:

4.2.1 Power Supply Topology

Power Rail	Source	Voltage/Current	Usage
VCC_IN	XT30 或 Type-C	9~26V	Main power input (with reverse polarity protection)
VCC_5V_IO	TPS54540 DC-DC	5V / 5A	IO Peripheral Power Supply
VCC_5V	VCC_5V_IO + CTRL_A Switch	5V (Controlled)	USB Hub、CAN、WS2812 等
VCC_3V3	AMS1117-3.3 LDO	3.3V / 1A	ESP32-S3, IMU, buzzer, etc.
VCC_ESC	VCC_IN (through)	9~26V	ESC Power Supply Output

> 💡 **Precautions** : XT30 interface and Type-C interface **cannot be connected to different power sources simultaneously** . The input range of VCC_IN is 9~26V, and exceeding 26V may cause device damage. VCC_5V can control the MOSFET switch (CTRL_A/CTRL_B) through IO to implement peripheral power management.

4.2.2 Battery Voltage Detection

VCC_IN is connected to GPIO (IO_BAT_ADC) via a voltage divider network (R18 = 200k / R19 = 22k), and the battery voltage can be read via ADC. Voltage division ratio: V_ADC = VCC_IN × 22k / (200k + 22k) ≈ VCC_IN / 10.09.

4.3 USB and Expansion

4.3.1 Type-C Interface

The Type-C interface (16P) is used for firmware programming and USB communication. CC1/CC2 are grounded via 5.1k pull-down resistors, supporting standard USB-C power negotiation. USB 2.0 signals (DPU/DMU) are directly connected to ESP32-S3.

4.3.2 USB Hub 扩展 (CH339F)

The CH339F is a 4-port USB 2.0 Hub controller that expands the USB of ESP32-S3 into 4 USB-A interfaces, allowing simultaneous connection of peripherals such as cameras, USB flash drives,

and wireless network cards. The CH339F also provides SD card controller functionality, connecting to the MicroSD card slot via the SDIO interface.

Pin/Port	Signal	Description
DPU / DMU	USB Upstream	Connect to ESP32-S3 USB OTG
DP1~DP4 / DM1~DM4	USB Downstream ×4	4-port USB 2.0 downstream ports
SD_D0~D3 / SD_SCK / SD_CMD	SDIO	Connect to the MicroSD card slot
PWREN# / OVCUR#	Power Control	Downstream Port Power Enable / Overcurrent Detection
LED_ACT / LED_LINK	Indicates Output	Connect on-board LED2 / LED3

4.4 Ethernet

100Mbps Ethernet communication is achieved through the internal MAC of ESP32-S3 + HR641680E network transformer. Signal definition:

Signal Name	ESP32-S3 GPIO	Description
ETH_U_TXP / TXN	IO-related	Ethernet Differential Transmit Pair
ETH_U_RXP / RXN	IO-related	Ethernet Differential Receive Pair
ETH_RP / RN	IO-related	RMII Interface Receive
ETH_TP / TN	IO-related	RMII Interface Transmission

> 💡 **Hint**: When using the `esp_eth` driver of ESP-IDF, you need to enable Ethernet support in menuconfig and configure the corresponding GPIO mapping. HR641680E is a 1:1 network transformer, compatible with 10/100BASE-T.

4.5 IMU Inertial Measurement Unit

The OSCORE board is equipped with two types of IMU sensors, sharing a single I²C bus (IMU_SCL / IMU_SDA):

Sensor	Type	I²C Address	Measurement Range	Description
QMI8658A	6-axis IMU	0x6B	Gyro ±16~2048 dps / Acc ±2~16g	Integrated 3-axis gyroscope + 3-axis accelerometer
QMC6309	3-axis magnetometer	0x7C	±30 Gauss	Geomagnetic reference for 9-axis attitude fusion

💡 **Attitude Fusion Suggestion**: It is recommended to use Arduino's `Mahony` or `Madgwick` AHRS algorithm, combined with the 6-axis data of QMI8658A + the magnetometer data of QMC6309 to achieve 9-axis attitude calculation, which can obtain a drift-free heading angle.

4.6 CAN Bus

Component	Model/Pin	Description
Transceiver	TJA1050T	High-speed CAN transceiver, up to 1 Mbps
TX	TWAI_TX (ESP32-S3 GPIO)	CAN Transmit Data Line
RX	TWAI_RX (ESP32-S3 GPIO)	CAN Receive Data Line
CANH / CANL	Differential Bus Output	Standard CAN 2.0 Differential Signal
Terminal Resistance	120Ω (R39)	On-board optional CAN termination matching resistor

💡 **Usage Instructions**: The ESP32-S3 has a built-in TWAI (Two-Wire Automotive Interface) controller, which is compatible with the standard CAN 2.0. Simply use the `twai` driver

in ESP-IDF. The TJA1050T is powered by VCC_5V and is compatible with the 3.3V ESP32 I/O level (5V tolerant input).

4.7 SBUS / PWM / Encoder Interface

This area (No. 14) integrates the peripheral interfaces commonly used in robot control and is powered by VCC_5V_IO:

Signal	Direction	Description
SBUS_RX	Input	SBUS Remote Control Receiver Signal Input (UART RX)
SBUS_TX	Output	SBUS Remote Control Signal Output (UART TX)
ESC_PWM	Output	ESC PWM control signal output
SERVO_PWM	Output	Steering Gear PWM Control Signal Output
ENC_A / ENC_B	Input	Orthogonal Encoder A/B Phase Input

SBUS signals use the hardware UART of ESP32-S3 and support the inverted serial port (100kbps, 8E2, inverted logic) of the SBUS protocol.

4.8 WS2812 Programmable RGB LED

The board is equipped with 1 WS2812B-2020 LED (LED5), powered by VCC_5V and controlled by IO_WS2812 data. Additionally, a WS2812 output interface (IO_WS2812_DO) is provided, which can be cascaded with external LED strips.

💡 **Note** : The WS2812 data line operates at a 5V logic level, while the ESP32-S3 GPIO outputs a 3.3V level. In actual use, it can usually be driven normally. If signal instability occurs, it is recommended to add a 3.3V→5V level conversion to the data line.

4.9 MicroSD Card Slot

The MicroSD card is connected via the SDIO interface of CH339F and uses an independent 3.3V power supply (U7 LDO, 6V→3.3V, 600mA). All SDIO signal lines are pulled up to VCC_3V3 (10kΩ).

4.10 Buzzer

The onboard active buzzer is driven by ESP32-S3 IO42 through an NPN transistor and powered by VCC_3V3. Outputting PWM or level can produce sound.

5. Pin Mapping Table

The following lists the key function pin mappings of the ESP32-S3 module for reference only. For the complete pin definitions, please refer to the schematic diagram.

GPIO	Module Pin	Function	Remarks
IO0	27	BOOT Mode Selection	Enter the programming mode at low level
IO3	15	IMU Interrupt	QMI8658A INT1
IO9	17	External 32.768kHz crystal oscillator input	RTC Clock Source
IO35	28	ETH / OSPI	Ethernet RMII or PSRAM
IO36	29	ETH / OSPI	Ethernet RMII or PSRAM
IO37	30	ETH / OSPI	Ethernet RMII or PSRAM
IO42	35	Buzzer Control	High level active
IO46	16	WS2812 Data / LED	Programmable RGB LED Control
IO47	24	ETH / IMU Clock	to reuse
IO48	25	ETH / Status Indication	to reuse
RXD0	36	UART0 RX	Debug Serial Port Reception
TXD0	37	UART0 TX	Debug Serial Port Transmission

6. Electrical Parameters

6.1 Power Supply Parameters

Parameter	Minimum Value	Typical Value	Maximum Value
Input Voltage (VCC_IN)	9V	12~24V	26V
5V Output Current	—	—	5A
3.3V Output Current	—	—	1A
Battery Voltage Detection Range	9V	—	26V (voltage division ratio ≈1/10)

6.2 Working Environment

Parameter	Specification
Operating Temperature	-20°C ~ +70°C
Storage Temperature	-40°C ~ +85°C
Humidity	5% ~ 95% RH (no condensation)
PCB Size	(To be supplemented)

7. Version History

Version	Date	Revised Content	Author
V1.0	2026-05-28	Initial Release	—

(注：内容由 AI 生成，请谨慎参考)