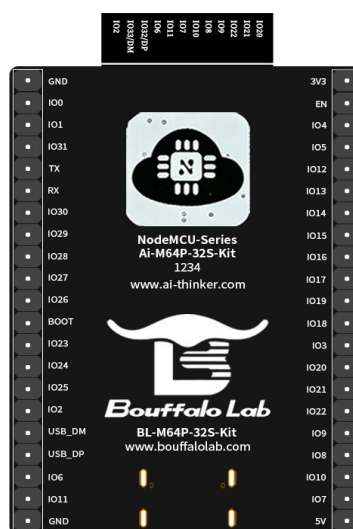
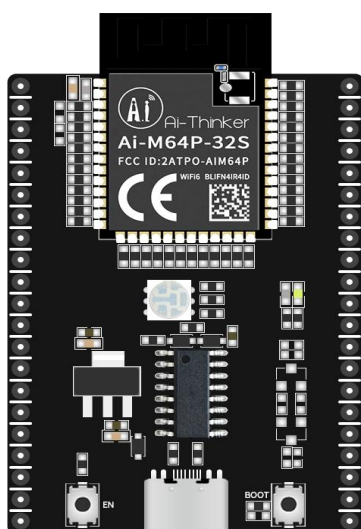


Ai-M64P-32S-Kit Specification



Product Series: Wi-Fi Series

Product Model: Ai-M64P-32S-Kit

Version: V1.0.2

Copyright: ©2026

Document Language: English

Release Date: 2026-07-15

Confidentiality Level: Public Document

Manufacturer: Shenzhen Ai-Thinker Technology Co., Ltd.

Keywords: Ai-M64P-32S-Kit, BL616CL, Wi-Fi 6, BLE 5.3, RISC-V, Low Power, IoT, Smart Home, Type-C Power Supply

Document Revision History

Version	Date	Created / Revised Content	Prepared by	Approved by
V1.0.0	2026-06-01	First edition	Qian Zekai	Xu Hong
V1.0.1	2026-06-10	Corrected positions of warm/cool LEDs	Qian Zekai	Xu Hong
V1.0.2	2026-07-15	Removed DSP description	Qian Zekai	Xu Hong

Contents

1 Product Overview	5
1.1 Features	6
1.2 Application Scenarios	7
2 Key Specifications	8
2.1 Power Supply Selection	8
3 Electrical Characteristics	9
3.1 Recommended Operating Conditions	9
3.2 I/O DC Electrical Characteristics	9
3.3 Electrostatic Discharge	9
3.4 Wi-Fi RF Performance	10
3.5 BLE RF Performance	11
3.6 Power Consumption	12
4 Mechanical Specifications	13
4.1 Development Board Dimensions	13
5 LED and Button Description	14
6 Pin Definition	15
7 Schematic	19
8 Packaging Information	20
9 Contact Us	20
Disclaimer	21

List of Figures

Figure 1	Main Chip Architecture Diagram	5
Figure 2	ESD Protection Diagram	9
Figure 3	Development Board Dimensions	13
Figure 4	LED and Button Location	14
Figure 5	Pin Diagram	15
Figure 6	Schematic	19

List of Tables

Table 1	Key Specifications	8
Table 2	Recommended Operating Conditions	9
Table 3	I/O DC Electrical Characteristics	9
Table 4	Wi-Fi RF Performance	10
Table 5	BLE RF Performance	11
Table 6	Power Consumption	12
Table 7	LED and Button Function Description	14
Table 8	Pin Function Definition	15
Table 9	Packaging Information	20

1 Product Overview

The Ai-M64P-32S-Kit is a development board developed based on the Ai-M64P-32S module. The Ai-M64P-32S is a standardized wireless module based on the Bouffalo Lab BL616CL RF chip, specifically designed for ultra-low power, high-performance, and high-security IoT scenarios. The module fully retains the chip-level RF performance and full-function peripherals, and it undergoes rigorous RF matching and reliability verification with plug-and-play capability, significantly reducing the development barriers and mass-production risks of end products. The product features five core features: strong signal performance, low power consumption, high integration, security and reliability, and ultra-compact package, while also supporting backward compatibility.

Figure 1 shows the BL616CL main chip architecture.

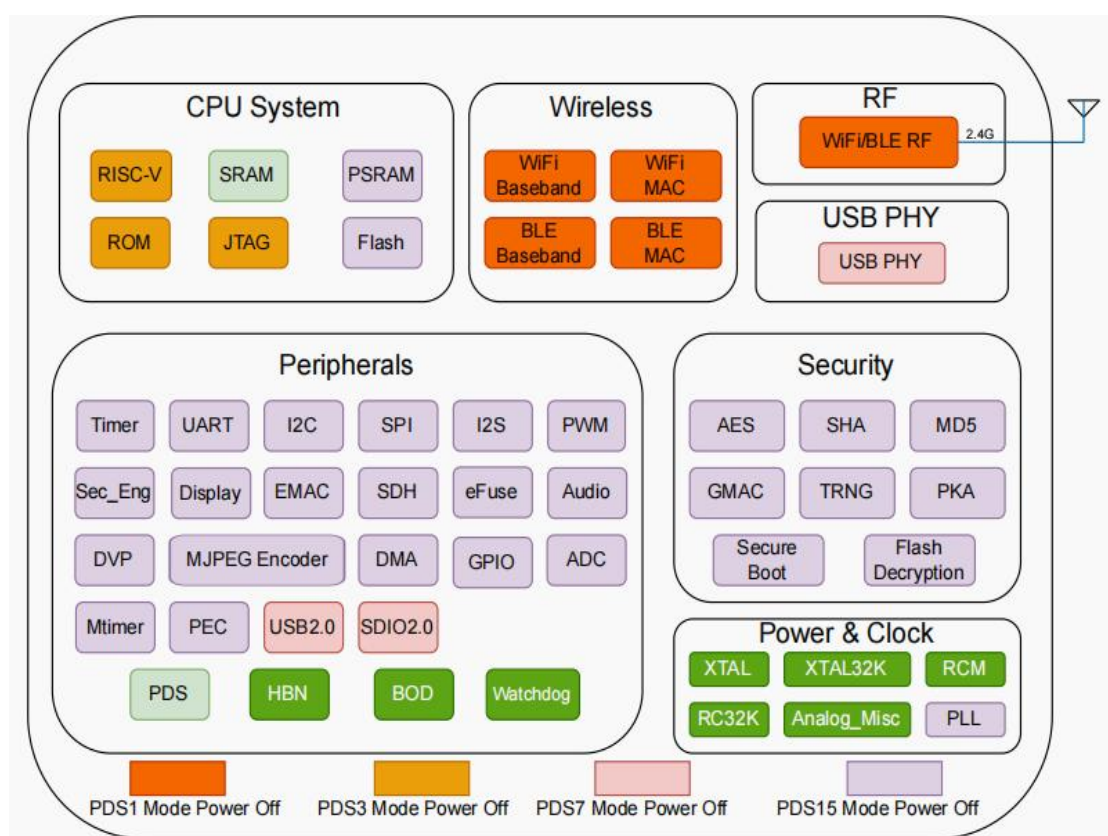


Figure 1 Main Chip Architecture Diagram

1.1 Features

MCU Subsystem

- 32-bit RISC-V CPU, up to 320MHz with FPU, supporting edge computing

Memory

- Built-in 388KB SRAM, 224KB OCRM, 160KB WRAM, 4KB HBN RAM. Optional 2/4/8MB Flash and 4/8MB PSRAM

Wi-Fi

- Supports Wi-Fi 6 (IEEE 802.11 b/g/n/ax), 20MHz bandwidth, 1T1R
- Full support for OFDMA, TWT, LDPC, STBC, Beamformee, RX diversity
- Transmit power: 23dBm@1Mbps
- Receiver sensitivity: -99dBm@1Mbps

Bluetooth

- Supports BLE 5.3, multi-rate: 2Mbps/1Mbps/500kbps/125kbps
- Receiver sensitivity: -99dBm@125kbps
- Supports multi-connection, advertising extensions, AOI/AOD, suitable for gateways and sensor nodes

Wi-Fi / BLE Coexistence

- Built-in chip-level coexistence engine, no external switch required, dual-mode TDD operation without interference
- Supports BLE-assisted Wi-Fi fast connection

Peripheral Interfaces

- Integrated USB2.0 HS, EMAC 10/100M, DVP camera, DBI display, MJPEG codec
- Rich peripherals: 3 × UART, 2 × I2C, 2 × SPI, 1 × I2S, 1 × PWM (4 channels), 1 × GPADC 16-bit (12 channels), 1 × Touch

Security & Encryption

- Supports secure boot, firmware encryption signature, TrustZone, AES/SHA/PKA/TRNG full hardware encryption

Operating Frequency Band

- 2.4GHz band: 2400 – 2483.5MHz

Power Consumption

- Supports PDS power-down sleep and HBN hibernation
- PDS mode: 45μA (Wi-Fi disconnected)
- HBN mode: 5μA

Physical Characteristics

- Package: DIP-42
- Board Dimensions (L × W): 53.50 × 38.10mm
- Antenna Type: On-board antenna
- Operating Temperature: -40 – 85°C (customizable to -40 – 105°C)
- Storage Environment: -40 – 125°C, < 90% RH
- On-board RGB LED, warm/cool dual-color LED, reset button, Flash button

Electrical Characteristics

- Three power supply methods: Type-C, 3V3 header pin, 5V header pin
- Supply Voltage: 3.3V or 5V
- Supply Current: > 500mA
- Available I/Os: 37 by default

Note: For features not marked, please refer to the Bouffalo BL616CL chip datasheet.

1.2 Application Scenarios

- Audio and Video Multimedia
- Internet of Things (IoT)
- Mobile Devices
- Smart Home
- Central Control Devices

2 Key Specifications

Table 1 summarizes the key electrical and physical parameters of the Ai-M64P-32S-Kit development board.

Table 1 Key Specifications

Model	Ai-M64P-32S-Kit
Package	DIP-42
Dimensions	53.50 × 38.10mm
Antenna Type	On-board antenna
Frequency Range	2400 – 2483.5MHz
Operating Temperature	-40 – 85°C
Storage Conditions	-40 – 125°C, <90% RH
Power Supply Range	Supply voltage: 3.3V or 5V; supply current >500mA
Available I/Os	37 by default
UART Rate	115200bps by default

2.1 Power Supply Selection

The Ai-M64P-32S-Kit supports three power supply modes:

- Type-C interface (recommended)
- 3V3 and GND pin header
- 5V and GND pin header

3 Electrical Characteristics

3.1 Recommended Operating Conditions

Table 2 lists the recommended operating electrical parameters of the Ai-M64P-32S-Kit development board. Operating outside these ranges may cause device damage.

Table 2 Recommended Operating Conditions

Parameter	Condition	Min	Typ	Max	Unit
Interface Power Supply	Type-C	4.5	5	5.3	V
Pin Header Power Supply	3V3	2.97	3.3	3.63	V
	5V	4.5	5	5.3	V

3.2 I/O DC Electrical Characteristics

Table 3 lists the I/O DC characteristics of the Ai-M64P-32S-Kit development board. These parameters are mainly used for external interface level matching and GPIO circuit design.

Table 3 I/O DC Electrical Characteristics

Symbol	Parameter	Min	Typ	Max	Unit
VIH	High-level Input Voltage	2	-	-	V
VIL	Low-level Input Voltage	-	-	0.8	V
VOH	High-level Output Voltage	-	$0.9 \times VCC$	-	V
VOL	Low-level Output Voltage	-	$0.1 \times VCC$	-	V

3.3 Electrostatic Discharge

Figure 2 shows the ESD protection diagram. Ai-M64P-32S-Kit is an ESD-sensitive device and requires special precautions during handling.



Figure 2 ESD Protection Diagram

3.4 Wi-Fi RF Performance

Table 4 lists the Wi-Fi RF performance parameters of the Ai-M64P-32S module. RF performance parameters are measured under typical test conditions. Actual performance may be affected by the antenna, power supply, PCB layout, test environment, and other factors.

Table 4 Wi-Fi RF Performance

Description	Typ			Unit
Frequency Range	2400 – 2483.5			MHz
Output Power				
Mode	Min	Typ	Max	Unit
802.11b, 11Mbps	-	19	23	dBm
802.11g, 54Mbps	-	18	20	dBm
802.11n, HT20 (MCS7)	-	18	19	dBm
802.11ax, HE20 (MCS9)	-	16	17	dBm
Receiver Sensitivity				
Mode	Min	Typ	Max	Unit
802.11b, 1Mbps	-99	-	-	dBm
802.11b, 11Mbps	-90	-	-	dBm
802.11g, 6Mbps	-93	-	-	dBm
802.11g, 54Mbps	-78	-	-	dBm
802.11n, HT20 (MCS7)	-76	-	-	dBm
802.11ax, HE20 (MCS9)	-69	-	-	dBm

3.5 BLE RF Performance

Table 5 lists the BLE RF performance parameters of the Ai-M64P-32S module. RF performance parameters are measured under typical test conditions. Actual performance may be affected by the antenna, power supply, PCB layout, test environment, and other factors.

Table 5 BLE RF Performance

Description	Typ			Unit
Frequency Range	2400 – 2483.5			MHz
Output Power				
Rate Mode	Min	Typ	Max	Unit
1Mbps	-	10	15	dBm
2Mbps	-	10	15	dBm
Receiver Sensitivity				
Rate Mode	Min	Typ	Max	Unit
1Mbps Sensitivity@30.8% PER	-99	-	-	dBm
2Mbps Sensitivity@30.8% PER	-97	-	-	dBm

3.6 Power Consumption

Table 6 lists the power consumption data of the Ai-M64P-32S module in different modes. The following power consumption data are measured under a 3.3V power supply and 25°C ambient temperature.

- The P_{OUT} power for all transmit modes is measured at the antenna interface.
- All transmission data are measured at 100% duty cycle in continuous transmit mode.

Table 6 Power Consumption

Mode	Min	Avg	Max	Unit
TX 802.11b, 11Mbps, $P_{OUT} = +23\text{dBm}$	-	435	-	mA
TX 802.11g, 54Mbps, $P_{OUT} = +20\text{dBm}$	-	352	-	mA
TX 802.11n, MCS7, $P_{OUT} = +19\text{dBm}$	-	338	-	mA
TX 802.11ax, MCS9, $P_{OUT} = +17\text{dBm}$	-	290	-	mA
RX 802.11b, Packet Length 1500 bytes	-	84.5	-	mA
RX 802.11g, Packet Length 1500 bytes	-	84.5	-	mA
RX 802.11n, Packet Length 1500 bytes	-	84.5	-	mA
RX 802.11ax, Packet Length 1500 bytes	-	84.5	-	mA
PDS (Tickless 3), Wi-Fi Disconnected	-	45	-	μA
PDS (Tickless 3), Wi-Fi Connected	-	256	-	μA
PDS (Tickless 10), Wi-Fi Disconnected	-	45	-	μA
PDS (Tickless 10), Wi-Fi Connected	-	90	-	μA
HBN Mode	-	5	-	μA

4 Mechanical Specifications

4.1 Development Board Dimensions

Figure 3 shows the outline dimensions of the Ai-M64P-32S-Kit development board. The outline dimensions ($L \times W$) are $53.50 \times 38.10\text{mm}$. The dimensional tolerance is $\pm 0.20\text{mm}$.

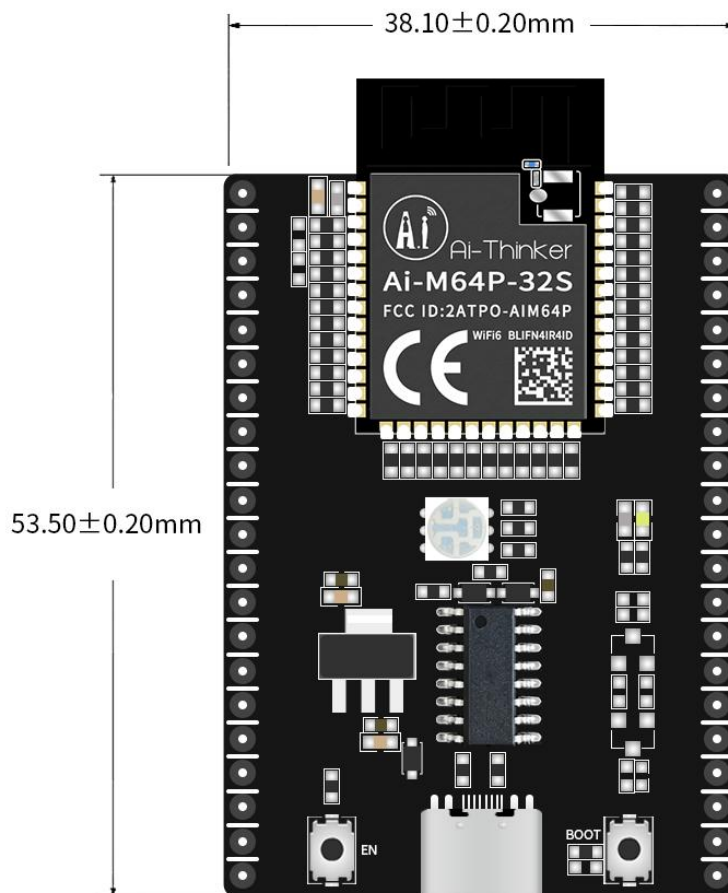


Figure 3 Development Board Dimensions

5 LED and Button Description

Figure 4 shows the onboard layout of LED indicators and buttons for the Ai-M64P-32S-Kit development board.

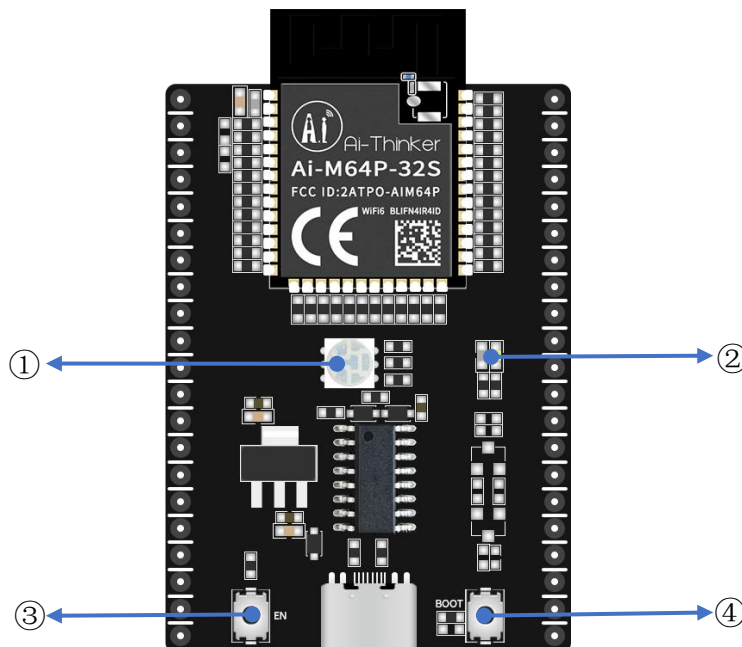


Figure 4 LED and Button Location

Table 7 provides the detailed functional definitions of the LED indicators and buttons on the Ai-M64P-32S-Kit development board.

Table 7 LED and Button Function Description

No.	Function Description
①	RGB LED (The red LED is connected to IO14, the green LED is connected to IO15, and the blue LED is connected to IO16. Active high.)
②	LED. (The left warm LED is connected to IO28, and the right cool LED is connected to IO27. Active high.)
③	Reset button
④	Flash button. When flashing firmware, press and hold the flash button first, then briefly press the reset button at the same time.

6 Pin Definition

Figure 5 shows the top and bottom views of the Ai-M64P-32S-Kit development board's pin layout, with a total of 42 pins exposed.

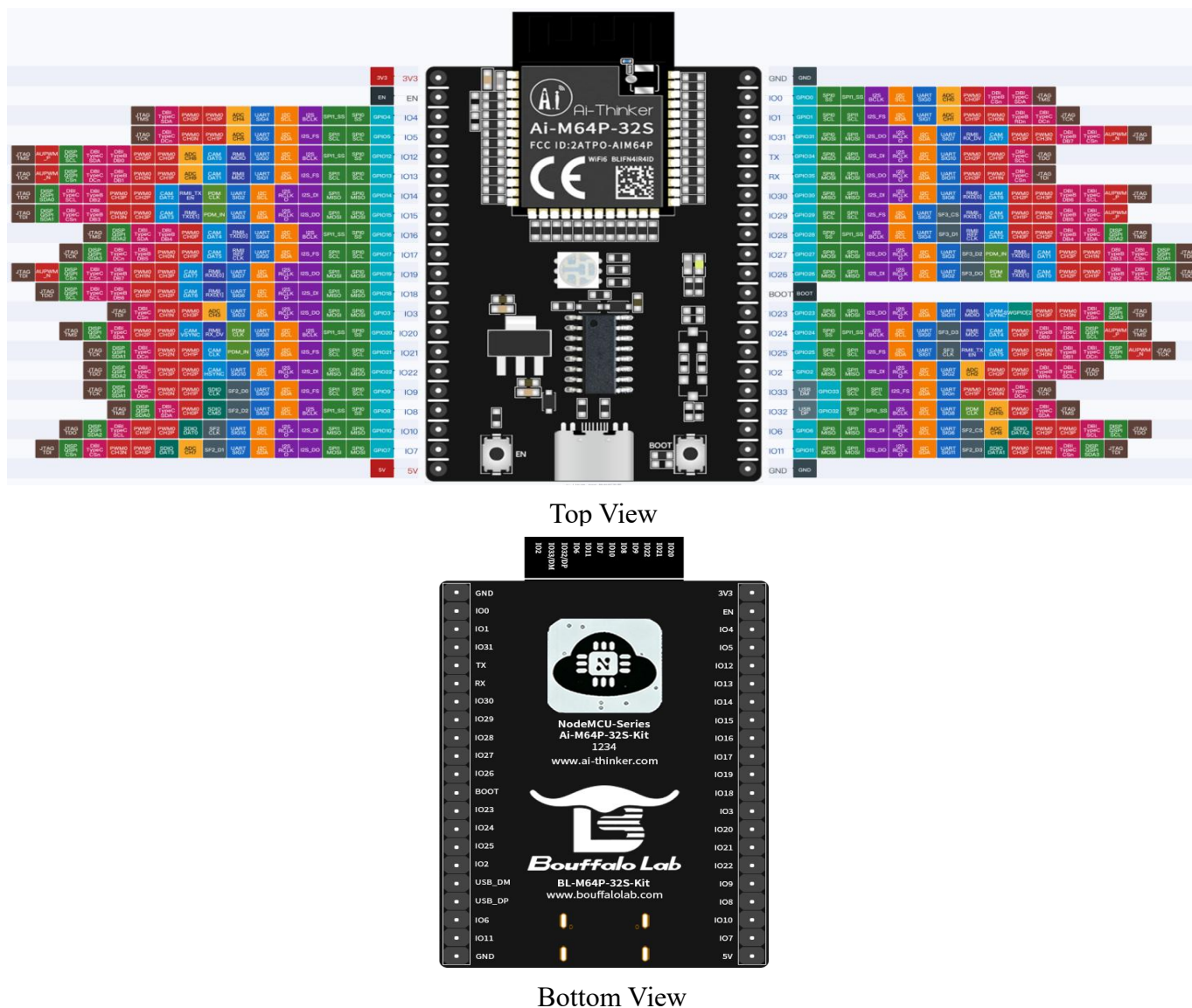


Figure 5 Pin Diagram

Table 8 defines the pin functions of the Ai-M64P-32S-Kit development board, including pin number, pin name, and function description.

Table 8 Pin Function Definition

No.	Name	Function
1	3V3	3.3V power supply; supply current recommended >500mA
2	EN	Default chip enable pin, active-high

3	IO4	GPIO4/SPI0_SS/SPI1_SS/I2S_BCLK/I2C_SCL/UART_SIG4/ADC_CH4/PWM0_CH0P/PWM0_CH2P/DBI_TypeC_SDA/JTAG_TMS (Default available. This IO is shared with the module's internal 32.768kHz crystal input pin. If the module is customized with an internal mounted 32.768kHz crystal, this IO is NC.)
4	IO5	GPIO5/SPI0_SCLK/SPI1_SCLK/I2S_FS/I2C_SDA/UART_SIG5/ADC_CH5/PWM0_CH1P/PWM0_CH2N/DBI_TypeC_DCn/JTAG_TCK (Default available. This IO is shared with the module's internal 32.768kHz crystal output pin. If the module is customized with an internal mounted 32.768kHz crystal, this IO is NC.)
5	IO12	GPIO12/SPI0_SS/SPI1_SS/I2S_BCLK/I2C_SCL/UART_SIG0/RMII_MDIO/CAM_DAT0/ADC_CH8/PWM0_CH0P/PWM0_CH2P/DBI_TypeB_DB0/DBI_TypeC_SDA/DISP_QSPI_SCL/AUPWM_P/JTAG_TMS
6	IO13	GPIO13/SPI0_SCLK/SPI1_SCLK/I2S_FS/I2C_SDA/UART_SIG1/RMII_MDC/CAM_DAT1/ADC_CH9/PWM0_CH1P/PWM0_CH2N/DBI_TypeB_DB1/DBI_TypeC_DCn/DISP_QSPI_CSn/AUPWM_N/JTAG_TCK
7	IO14	GPIO14/SPI0_MISO/SPI1_MISO/I2S_DI/I2S_RCLK_O/I2C_SCL/UART_SIG2/PDM_CLK/RMII_TX_EN/CAM_DAT2/PWM0_CH2P/PWM0_CH3P/DBI_TypeB_DB2/DBI_TypeC_SCL/DISP_QSPI_SDA0/JTAG_TDO
8	IO15	GPIO15/SPI0_MOSI/SPI1_MOSI/I2S_DO/I2S_RCLK_O/I2C_SDA/UART_SIG3/PDM_IN/RMII_TXD[1]/CAM_DAT3/PWM0_CH3P/PWM0_CH3N/DBI_TypeB_DB3/DBI_TypeC_CSn/DISP_QSPI_SDA1/JTAG_TDI
9	IO16	GPIO16/SPI0_SS/SPI1_SS/I2S_BCLK/I2C_SCL/UART_SIG4/RMII_TXD[0]/CAM_DAT4/PWM0_CH0P/DBI_TypeB_DB4/DBI_TypeC_SDA/DISP_QSPI_SDA2/JTAG_TMS
10	IO17	GPIO17/SPI0_SCLK/SPI1_SCLK/I2S_FS/I2C_SDA/UART_SIG5/RMII_REF_CLK/CAM_DAT5/PWM0_CH1P/PWM0_CH0N/DBI_TypeB_DB5/DBI_TypeC_DCn/DISP_QSPI_SDA3/JTAG_TCK
11	IO19	GPIO19/SPI0_MOSI/SPI1_MOSI/I2S_DO/I2S_RCLK_O/I2C_SDA/UART_SIG7/RMII_RXD[0]/CAM_DAT7/PWM0_CH3P/PWM0_CH1N/DBI_TypeB_DB7/DBI_TypeC_CSn/DISP_QSPI_CSn/AUPWM_N/JTAG_TDI
12	IO18	GPIO18/SPI0_MISO/SPI1_MISO/I2S_DI/I2S_RCLK_O/I2C_SCL/UART_SIG6/RMII_RXD[1]/CAM_DAT6/PWM0_CH2P/PWM0_CH1P/DBI_TypeB_DB6/DBI_TypeC_SCL/DISP_QSPI_SCL/AUPWM_P/JTAG_TDO
13	IO3	GPIO3/SPI0_MOSI/SPI1_MOSI/I2S_DO/I2S_RCLK_O/I2C_SDA/UART_SIG3/ADC_CH3/PWM0_CH3P/PWM0_CH1N/DBI_TypeB_DCn/DBI_TypeC_CSn/JTAG_TDI (Default unavailable. This IO is internally connected to the module DC-DC for low-power use. If low power is not required and this IO needs to be used, please contact Ai-Thinker for customization.)
14	IO20	GPIO20/SPI0_SS/SPI1_SS/I2S_BCLK/I2C_SCL/UART_SIG8/PDM_CLK/RMII_RX_DV/CAM_VSYNC/PWM0_CH0P/PWM0_CH2P/DBI_TypeC_SDA/DISP_QSPI_SDA0/JTAG_TMS
15	IO21	GPIO21/SPI0_SCLK/SPI1_SCLK/I2S_FS/I2C_SDA/UART_SIG9/PDM_IN/CAM_CLK/PWM0_CH1P/PWM0_CH2N/DBI_TypeC_DCn/DISP_QSPI_SDA1/JTAG_TCK

16	IO22	GPIO22/SPI0_MISO/SPI1_MISO/I2S_DI/I2S_RCLK_O/I2C_SCL/UART_SIG10/CAM_HSYNC/PWM0_CH2P/PWM0_CH3P/DBI_TypeC_SCL/ DISP_QSPI_SDA2/JTAG_TDO
17	IO9	GPIO9/SPI0_SCLK/SPI1_SCLK/I2S_FS/I2C_SDA/UART_SIG9/SF2_D0 /SDIO_CLK/PWM0_CH1P/PWM0_CH0N/DBI_TypeC_DcN/DISP_QSPI _SDA1/JTAG_TCK (Default available. This IO is shared with the module's internal Flash pin. If the module is customized with internal mounted Flash, this IO is NC.)
18	IO8	GPIO8/SPI0_SS/SPI1_SS/I2S_BCLK/I2C_SCL/UART_SIG8/SF2_D2/SD IO_CMD/PWM0_CH0P/DBI_TypeC_SDA/DISP_QSPI_SDA0/JTAG_T MS (Default available. This IO is shared with the module's internal Flash pin. If the module is customized with internal mounted Flash, this IO is NC.)
19	IO10	GPIO10/SPI0_MISO/SPI1_MISO/I2S_DI/I2S_RCLK_O/I2C_SCL/UART _SIG10/SF2_CLK/SDIO_DAT0/PWM0_CH2P/PWM0_CH1P/DBI_Type C_SCL/DISP_QSPI_SDA2/JTAG_TDO (Default available. This IO is shared with the module's internal Flash pin. If the module is customized with internal mounted Flash, this IO is NC.)
20	IO7	GPIO7/SPI0_MOSI/SPI1_MOSI/I2S_DO/I2S_RCLK_O/I2C_SDA/UART _SIG7/SF2_D1/ADC_CH7/SDIO_DAT3/PWM0_CH3P/PWM0_CH3N/D BI_TypeC_CSn/DISP_QSPI_CSn/JTAG_TDI (Default available. This IO is shared with the module's internal Flash pin. If the module is customized with internal mounted Flash, this IO is NC.)
21	5V	5V power supply; supply current recommended >500mA
22	GND	Ground
23	IO0	GPIO0/SPI0_SS/SPI1_SS/I2S_BCLK/I2C_SCL/UART_SIG0/ADC_CH0/ PWM0_CH0P/DBI_TypeB_CSn/DBI_TypeC_SDA/JTAG_TMS
24	IO1	GPIO1/SPI0_SCLK/SPI1_SCLK/I2S_FS/I2C_SDA/UART_SIG1/ADC_C H1/PWM0_CH1P/PWM0_CH0N/DBI_TypeB_RDn/DBI_TypeC_DcN/JT AG_TCK
25	IO31	GPIO31/SPI0_MOSI/SPI1_MOSI/I2S_DO/I2S_RCLK_O/I2C_SDA/UAR T_SIG7/RMII_RX_DV/CAM_DAT7/PWM0_CH3P/PWM0_CH3N/DBI_ TypeB_DB7/DBI_TypeC_CSn/AUPWM_N/JTAG_TDI
26	TX	GPIO34/SPI0_MISO/SPI1_MISO/I2S_DI/I2S_RCLK_O/I2C_SCL/UART _SIG10/PWM0_CH2P/PWM0_CH1P/DBI_TypeC_SCL/JTAG_TDO
27	RX	GPIO35/SPI0_MOSI/SPI1_MOSI/I2S_DO/I2S_RCLK_O/I2C_SDA/UAR T_SIG11/PWM0_CH3P/PWM0_CH1N/DBI_TypeC_CSn/JTAG_TDI
28	IO30	GPIO30/SPI0_MISO/SPI1_MISO/I2S_DI/I2S_RCLK_O/I2C_SCL/UART _SIG6/RMII_RXD[0]/CAM_DAT6/PWM0_CH2P/PWM0_CH3P/DBI_Ty peB_DB6/DBI_TypeC_SCL/AUPWM_P/JTAG_TDO
29	IO29	GPIO29/SPI0_SCLK/SPI1_SCLK/I2S_FS/I2C_SDA/UART_SIG5/SF3_C S/RMII_RXD[1]/CAM_DAT3/PWM0_CH1P/PWM0_CH2N/DBI_TypeB _DB5/DBI_TypeC_DcN/DISP_QSPI_SDA3/JTAG_TCK
30	IO28	GPIO28/SPI0_SS/SPI1_SS/I2S_BCLK/I2C_SCL/UART_SIG4/SF3_D1/R MII_REF_CLK/CAM_DAT2/PWM0_CH0P/PWM0_CH2P/DBI_TypeB_

		DB4/DBI_TypeC_SDA/DISP_QSPI_SDA2/JTAG_TMS
31	IO27	GPIO27/SPI0_MOSI/SPI1_MOSI/I2S_DO/I2S_RCLK_O/I2C_SDA/UART_SIG3/SF3_D2/PDM_IN/RMII_TXD[0]/CAM_DAT1/PWM0_CH3P/PWM0_CH1N/DBI_TypeB_DB3/DBI_TypeC_CSn/DISP_QSPI_SDA1/JTAG_TDI
32	IO26	GPIO26/SPI0_MISO/SPI1_MISO/I2S_DI/I2S_RCLK_O/I2C_SCL/UART_SIG2/SF3_D0/PDM_CLK/RMII_TXD[1]/CAM_DAT0/PWM0_CH2P/PWM0_CH1P/DBI_TypeB_DB2/DBI_TypeC_SCL/DISP_QSPI_SDA0/JTAG_TDO
33	BOOT	BOOT: NC by default. If required, please contact the business representative for control. GPIO36/SPI0_SS/SPI1_SS/I2S_BCLK/I2C_SCL/UART_SIG0/PWM0_CH0P/PWM0_CH2P/DBI_TypeB_DCN/JTAG_TMS
34	IO23	GPIO23/SPI0_MOSI/SPI1_MOSI/I2S_DO/I2S_RCLK_O/I2C_SDA/UART_SIG11/RMII_MDIO/CAM_VSYNC/SWGPI0[23]/PWM0_CH3P/PWM0_CH3N/DBI_TypeC_CSn/DISP_QSPI_SDA3/JTAG_TDI
35	IO24	GPIO24/SPI0_SS/SPI1_SS/I2S_BCLK/I2C_SCL/UART_SIG0/SF3_D3/RMII_MDC/CAM_DAT4/PWM0_CH0P/DBI_TypeB_DB0/DBI_TypeC_SDA/DISP_QSPI_SCL/AUPWM_P/JTAG_TMS
36	IO25	GPIO25/SPI0_SCLK/SPI1_SCLK/I2S_FS/I2C_SDA/UART_SIG1/SF3_CLK/RMII_TX_EN/CAM_DAT5/PWM0_CH1P/PWM0_CH0N/DBI_TypeB_DB1/DBI_TypeC_DCN/DISP_QSPI_CSn/AUPWM_N/JTAG_TCK
37	IO2	GPIO2/SPI0_MISO/SPI1_MISO/I2S_DI/I2S_RCLK_O/I2C_SCL/UART_SIG2/ADC_CH2/PWM0_CH2P/PWM0_CH1P/DBI_TypeB_WRn/DBI_TypeC_SCL/JTAG_TDO (Default unavailable. This IO is internally connected to the module DC-DC for low-power use. If low power is not required and this IO needs to be used, please contact Ai-Thinker for customization.)
38	IO33/DM	USB_DM/GPIO33/SPI0_SCLK/SPI1_SCLK/I2S_FS/I2C_SDA/UART_SIG9/PDM_IN/ADC_CH11/PWM0_CH1P/PWM0_CH0N/DBI_TypeC_DCN/JTAG_TCK
39	IO32/DP	USB_DP/GPIO32/SPI0_SS/SPI1_SS/I2S_BCLK/I2C_SCL/UART_SIG8/PDM_CLK/ADC_CH10/PWM0_CH0P/DBI_TypeC_SDA/JTAG_TMS
40	IO6	GPIO6/SPI0_MISO/SPI1_MISO/I2S_DI/I2S_RCLK_O/I2C_SCL/UART_SIG6/SF2_CS/ADC_CH6/SDIO_DAT2/PWM0_CH2P/PWM0_CH3P/DBI_TypeC_SCL/DISP_QSPI_SCL/JTAG_TDO
41	IO11	GPIO11/SPI0_MOSI/SPI1_MOSI/I2S_DO/I2S_RCLK_O/I2C_SDA/UART_SIG11/SF2_D3/SDIO_DAT1/PWM0_CH3P/PWM0_CH1N/DBI_TypeC_CSn/DISP_QSPI_SDA3/JTAG_TDI (Default available. This IO is shared with the module's internal Flash pin. If the module is customized with internal mounted Flash, this IO is NC.)
42	GND	Ground

Note: Both BOOT and the test point on the back can be used as Bootstrap. If the level is high at the moment of power-on, the module enters flashing/download mode. If the level is low at the moment of power-on, the module boots normally. The module is internally pulled low by default.

7 Schematic

Figure 6 shows the schematic of Ai-M64P-32S-Kit development board, including all functional subcircuits such as power supply, USB-to-UART, module, LEDs, buttons, RF, and peripheral interfaces.

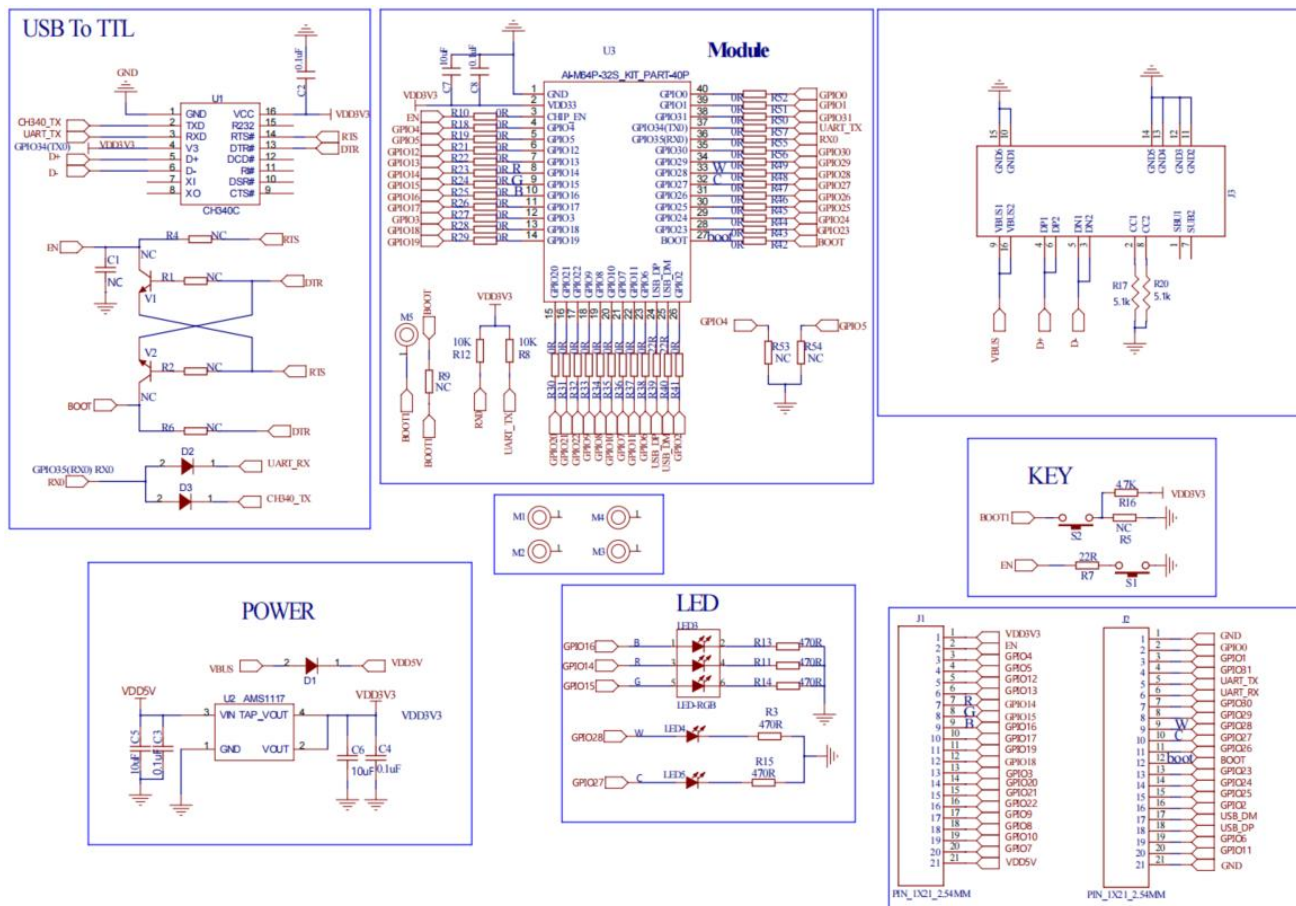


Figure 6 Schematic

8 Packaging Information

Table 9 shows the packaging information for the Ai-M64P-32S-Kit development board.

Table 9 Packaging Information

Packing List	Packaging Method	Quantity per Bag (ESD Bag)	Quantity per Bag (Sealed Bag)
Ai-M64P-32S-Kit	Foam + ESD bag	1pcs	20pcs

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WeChat Mini Program



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