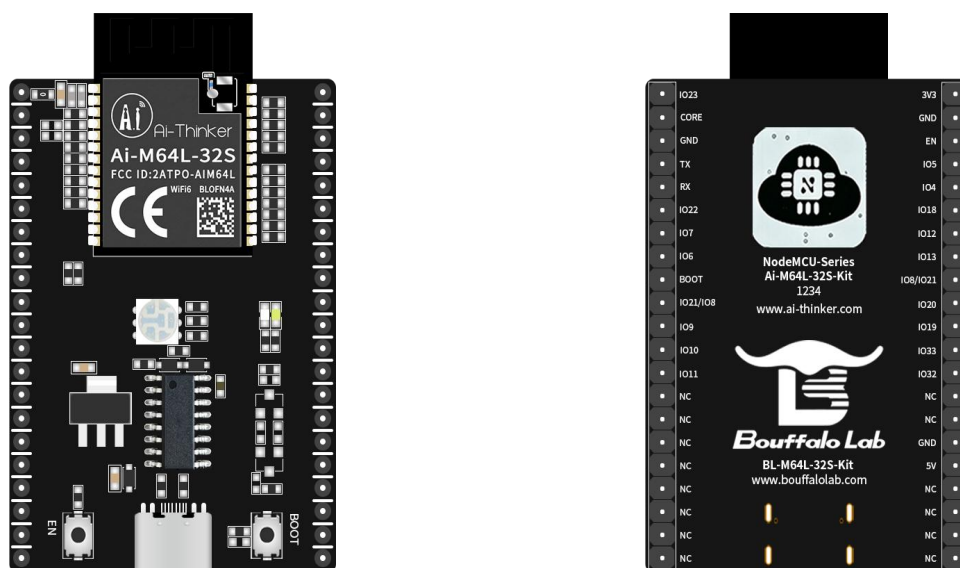


Ai-M64L-32S-Kit Specification



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1 Product Overview

The Ai-M64L-32S-Kit is a development board developed based on the Ai-M64L-32S module. The Ai-M64L-32S module 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 has 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.

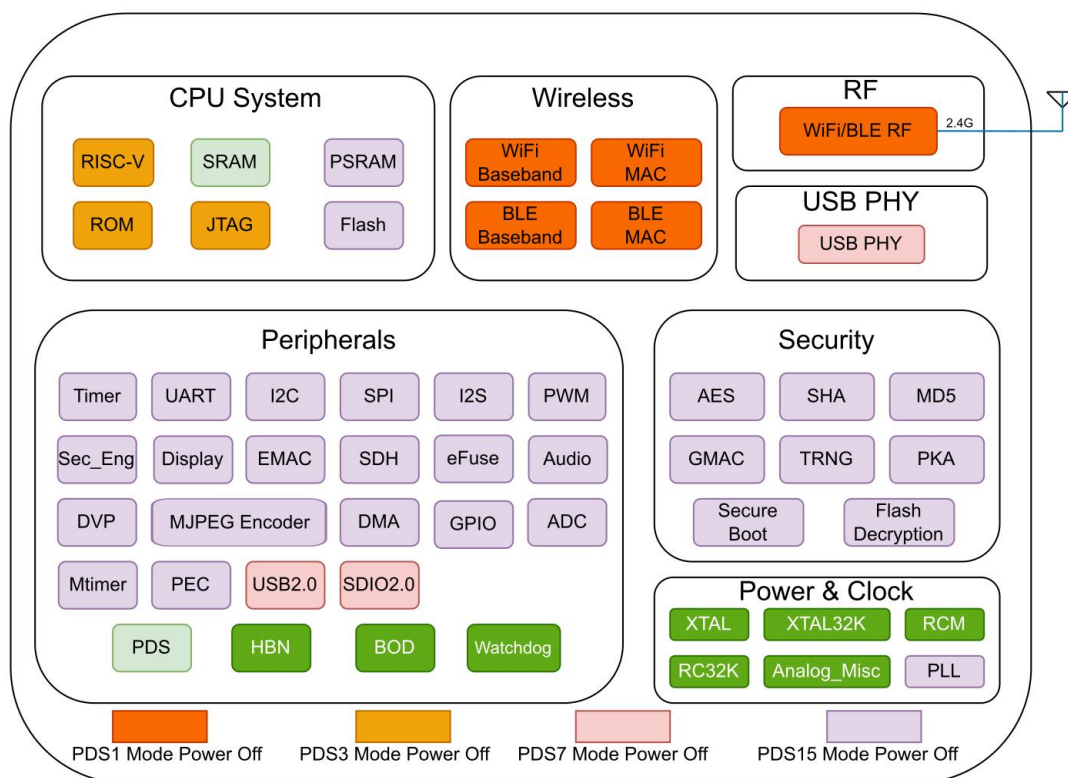


Figure 1 Main Chip Architecture Diagram

1.1 Features

Wireless

- 2.4 GHz RF transceiver, protocol rates from MCS0 to MCS9
- Wi-Fi 6 (IEEE 802.11b/g/n/ax), 20MHz bandwidth, 1T1R
- Bluetooth® 5.3, multi-rate: 2Mbps/1Mbps/500kbps/125kbps
- Wi-Fi/BLE coexistence, supports BLE-assisted Wi-Fi fast connection
- Supports LDPC, STBC, Beamformee, DL/UL OFDMA, MU-MIMO, TWT (Target Wake Time), SR (Spatial Reuse), DCM (Dual Carrier Modulation), ER (Extended Range)
- Supports aggregation (AMPDU, AMSDU), immediate block ACK, fragmentation and defragmentation
- Supports RX diversity
- Supports IEEE 802.11e QoS WMM (Wi-Fi Multimedia), IEEE 802.11w PMF (Protected Management Frames)
- STA, SoftAP, STA+SoftAP, and Sniffer modes
- Integrated RF balun, PA/LNA, supports external PA/LNA

Microcontroller Subsystem

- 32-bit RISC-V CPU, supports RISC-V RV32IMAFCP instruction set
- Dynamic frequency from 1MHz to 320MHz
- Integrated FPU

Memory

- 388KB SRAM
- 224KB OCRAM
- 160KB WRAM
- 4KB HBN RAM
- BL616CL chip embedded with 2/4/8MB Flash (optional)
- Supports external Flash expansion (customized)

Security

- Secure boot (supports firmware encryption & signing)
- Supports Anti-Rollback
- XIP On-The-Fly AES Decryption (OTFAD)
- Supports TrustZone
- AES-ECB/CBC/CTR/GMAC/XTS modes
- MD5, SHA-1/224/256/384/512
- TRNG (True Random Number Generator)
- PKA (Public Key Accelerator) for RSA/ECC
- Total 1024 bits eFuse

Peripherals

- USB, UART, I2C, SPI, PWM, GPTimer, Watchdog, ADC, etc.

Operating Frequency Band

- 2.4GHz band: 2400 – 2483.5MHz

Power Consumption

- Supports PDS power-down sleep and HBN hibernation
- Receive current: 72.18mA
- Transmit current: TX 802.11ax, MCS9, POUT=+17dBm: 276.84mA (average, 100% duty cycle)

Physical Characteristics

- Package: DIP-42
- Development board dimensions (L × W): 53.50 × 38.10mm
- Antenna type: Onboard antenna
- Operating temperature: -40 – 85°C
- Storage conditions: -40 – 125°C, < 90% RH
- On-board RGB LED, warm/cool dual-color LED, reset button, Flash button

Electrical Characteristics

- Three power supply modes: Type-C, 3V3 header pin, 5V header pin

- Supply Voltage: 3.3V or 5V
- Supply Current: > 500mA
- Available I/Os: 15 GPIOs exposed by default (up to 21 GPIOs)

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

1.2 Application Scenarios

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

2 Key Specifications

Table 1 summarizes the key electrical and physical parameters of the Ai-M64L-32S-Kit development board.

Table 1 Key Specifications

Model	Ai-M64L-32S-Kit
Package	DIP-42
Dimensions	53.50 × 38.10mm
Antenna Type	Onboard 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	15 by default (up to 21 GPIOs exposed)
UART Rate	115200bps by default
Security	WPS/WEP/WPA/WPA2/WPA3
Flash	4MByte by default (up to 16MByte supported)

2.1 Power Supply Selection

The Ai-M64L-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-M64L-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-M64L-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-M64L-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-M64L-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
2.4GHz Harmonic Suppression RBW/VBW (1MHz/3MHz)				
Mode	Min	Typ	Max	Unit
2450MHz@23dBm@2nd Harmonic	-	-48	-	dBm
2450MHz@23dBm@3rd Harmonic	-	-47.5	-	dBm

3.5 BLE RF Performance

Table 5 lists the BLE RF performance parameters of the Ai-M64L-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
2.4GHz Harmonic Suppression RBW/VBW (1MHz/3MHz)				
Mode	Min	Typ	Max	Unit
2450MHz@15dBm@2nd Harmonic	-	-48	-	dBm
2450MHz@15dBm@3rd Harmonic	-	-47.5	-	dBm

3.6 Power Consumption

Table 6 lists the power consumption data of the Ai-M64L-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, $P_{OUT} = +23\text{dBm}$	-	389.87	-	mA
TX 802.11g, 54Mbps, $P_{OUT} = +20\text{dBm}$	-	314.11	-	mA
TX 802.11n, MCS7, $P_{OUT} = +19\text{dBm}$	-	293.78	-	mA
TX 802.11ax, MCS9, $P_{OUT} = +17\text{dBm}$	-	276.84	-	mA
RX 802.11b, Packet Length 1500 bytes	-	72.18	-	mA
RX 802.11g, Packet Length 1500 bytes	-	72.18	-	mA
RX 802.11n, Packet Length 1500 bytes	-	72.18	-	mA
RX 802.11ax, Packet Length 1500 bytes	-	72.18	-	mA

4 Mechanical Specifications

4.1 Development Board Dimensions

Figure 3 shows the outline dimensions of the Ai-M64L-32S-Kit development board. The outline dimensions ($L \times W$) are $53.50 \times 38.10\text{mm}$. The dimensional tolerance is $\pm 0.20\text{mm}$.

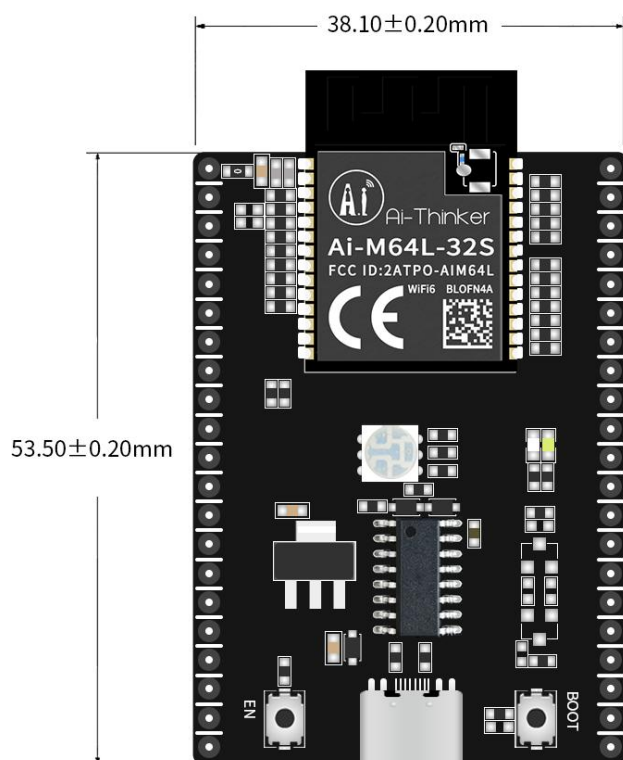


Figure 3 Development Board Dimensions

5 LED and Button Description

Figure 4 shows the onboard layout of LED indicators and buttons for the Ai-M64L-32S-Kit development board.

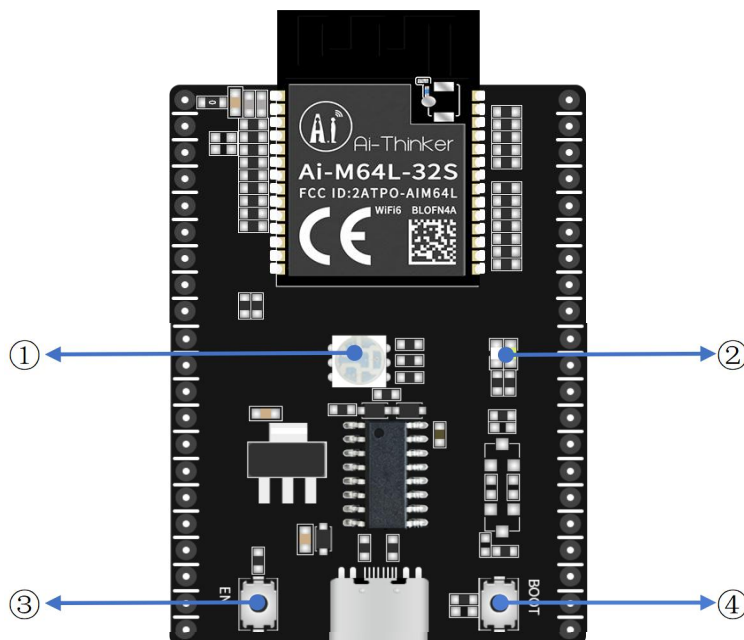


Figure 4 LED and Button Location

Table 7 provides the detailed functional definitions of the LED indicators and buttons on the Ai-M64L-32S-Kit development board.

Table 7 LED and Button Function Description

No.	Function Description
①	RGB LED (The red LED is connected to IO19, the green LED is connected to IO22, and the blue LED is connected to IO18. Active high.)
②	LED (The left warm LED is connected to IO23, and the right cool LED is connected to IO13. 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-M64L-32S-Kit development board's pin layout, with a total of 42 pins exposed.

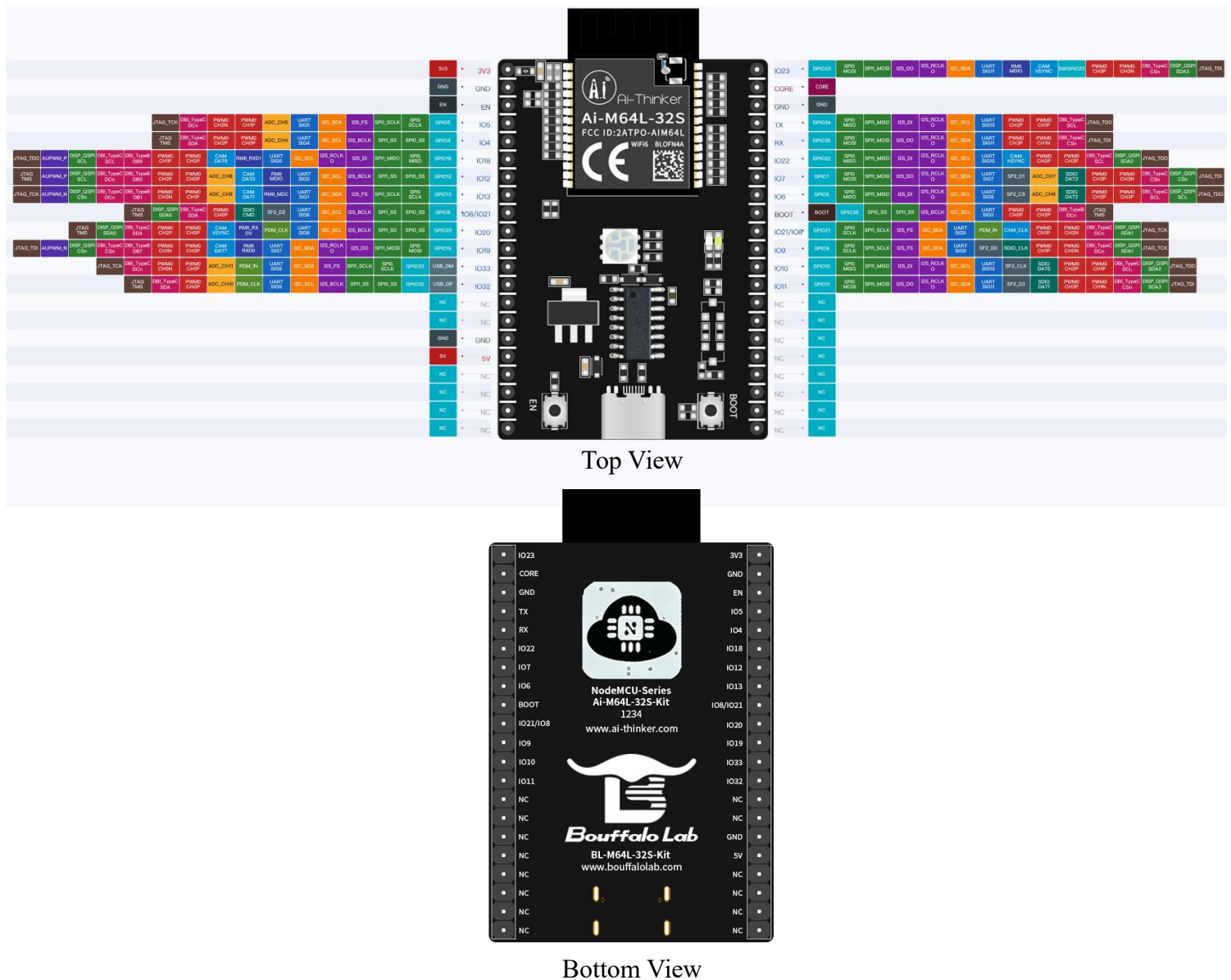


Figure 5 Pin Diagram

Table 8 defines the pin functions of the Ai-M64L-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, current recommended to be above 500mA

2	GND	Ground
3	EN	Chip enable by default; active high
4	IO5	GPIO5/SPI0_SCLK/SPI1_SCLK/I2S_FS/I2C_SDA/UART_SIG5/ADC_CH5/PWM0_CH1P/PWM0_CH2N/DBI_TypeC_DCn/JTAG_TCK (Available by default. Shared with the module's internal 32.768kHz crystal pin and internal DC-DC control pin. This I/O pin is NC if an integrated 32.768kHz crystal or integrated DC-DC is customized.)
5	IO4	GPIO4/SPI0_SS/SPI1_SS/I2S_BCLK/I2C_SCL/UART_SIG4/ADC_CH4/PWM0_CH0P/PWM0_CH2P/DBI_TypeC_SDA/JTAG_TMS (Available by default. Shared with the module's internal 32.768kHz crystal input pin. This I/O pin is NC if an integrated 32.768kHz crystal is customized.)
6	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
7	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
8	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_CS_n/AUPWM_N/JTAG_TCK
9	IO8/IO21	GPIO8/SPI0_SS/SPI1_SS/I2S_BCLK/I2C_SCL/UART_SIG8/SF2_D2/SDIO_CMD/PWM0_CH0P/DBI_TypeC_SDA/DISP_QSPI_SDA0/JTAG_TMS (Not available by default because it is shared with module's internal Flash pins. This I/O is available on module versions with on-chip Flash. IO8 and IO21 can be swapped by customization; please contact Ai-Thinker if this option is required.)
10	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
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_CS_n/DISP_QSPI_CS_n/AUPWM_N/JTAG_TDI
12	IO33	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
13	IO32	USB_DP/GPIO32/SPI0_SS/SPI1_SS/I2S_BCLK/I2C_SCL/UART_SIG8/PDM_CLK/ADC_CH10/PWM0_CH0P/DBI_TypeC_SDA/JTAG_TMS
14	NC	No connection
15	NC	No connection
16	GND	Ground

17	5V	5V power supply, current recommended to be above 500mA
18	NC	No connection
19	NC	No connection
20	NC	No connection
21	NC	No connection
22	NC	No connection
23	NC	No connection
24	NC	No connection
25	NC	No connection
26	NC	No connection
27	NC	No connection
28	NC	No connection
29	NC	No connection
30	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_CS _n /DISP_QSPI_SDA3/JTAG_TDI (Not available by default because it is shared with module's internal Flash pins. If this I/O pin is required, please contact Ai-Thinker to customize a module with on-chip Flash.)
31	IO10	GPIO10/SPI0_MISO/SPI1_MISO/I2S_DI/I2S_RCLK_O/I2C_SCL/UART_SIG10/SF2_CLK/SDIO_DAT0/PWM0_CH2P/PWM0_CH1P/DBI_TypeC_SCL/DISP_QSPI_SDA2/JTAG_TDO (Not available by default because it is shared with module's internal Flash pins. If this I/O pin is required, please contact Ai-Thinker to customize a module with on-chip Flash.)
32	IO9	GPIO9/SPI0_SCLK/SPI1_SCLK/I2S_FS/I2C_SDA/UART_SIG9/SF2_D0/SDIO_CLK/PWM0_CH1P/PWM0_CH0N/DBI_TypeC_DC _n /DISP_QSPI_SDA1/JTAG_TCK (Not available by default because it is shared with module's internal Flash pins. If this I/O pin is required, please contact Ai-Thinker to customize a module with on-chip Flash.)
33	IO21/IO8	GPIO21/SPI0_SCLK/SPI1_SCLK/I2S_FS/I2C_SDA/UART_SIG9/PDM_IN/CAM_CLK/PWM0_CH1P/PWM0_CH2N/DBI_TypeC_DC _n /DISP_QSPI_SDA1/JTAG_TCK (Available by default. IO21 and IO8 may be swapped by customization; please contact Ai-Thinker if this option is required.)

34	BOOT	BOOT/GPIO36/SPI0_SS/SPI1_SS/I2S_BCLK/I2C_SCL/UART_SIG0/PWM0_CH0P/PWM0_CH2P/DBI_TypeB_DCn/JTAG_TMS (Only available on module version with suffix “A” on the shield cover marking, exposed to the module edge castellated pads)
35	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 (Not available by default because it is shared with module’s internal Flash pins. If this I/O pin is required, please contact Ai-Thinker to customize a module with on-chip Flash.)
36	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/DBI_TypeC_CSn/DISP_QSPI_CSn/JTAG_TDI (Not available by default because it is shared with module’s internal Flash pins. If this I/O pin is required, please contact Ai-Thinker to customize a module with on-chip Flash.)
37	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
38	RX	GPIO35/SPI0_MOSI/SPI1_MOSI/I2S_DO/I2S_RCLK_O/I2C_SDA/UART_SIG11/PWM0_CH3P/PWM0_CH1N/DBI_TypeC_CSn/JTAG_TDI
39	TX	GPIO34/SPI0_MISO/SPI1_MISO/I2S_DI/I2S_RCLK_O/I2C_SCL/UART_SIG10/PWM0_CH2P/PWM0_CH1P/DBI_TypeC_SCL/JTAG_TDO
40	GND	Ground
41	CORE	Internal core-voltage input. (Floating by default. For an ultra-low-power module, a DC-DC circuit needs to be configured on this pin. For detailed solutions, please contact Ai-Thinker.)
42	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
Note: Both BOOT and the test point on the back of the module can be used as Bootstrap. When the voltage is high at power-up, the module enters programming mode; when the voltage is low at power-up, the module boots normally. The internal default level of the module is low.		

7 Schematic

Figure 6 shows the schematic of Ai-M64L-32S-Kit development board, including all functional subcircuits such as power supply, USB-to-UART, module, LEDs, buttons, RF, and peripheral interfaces.

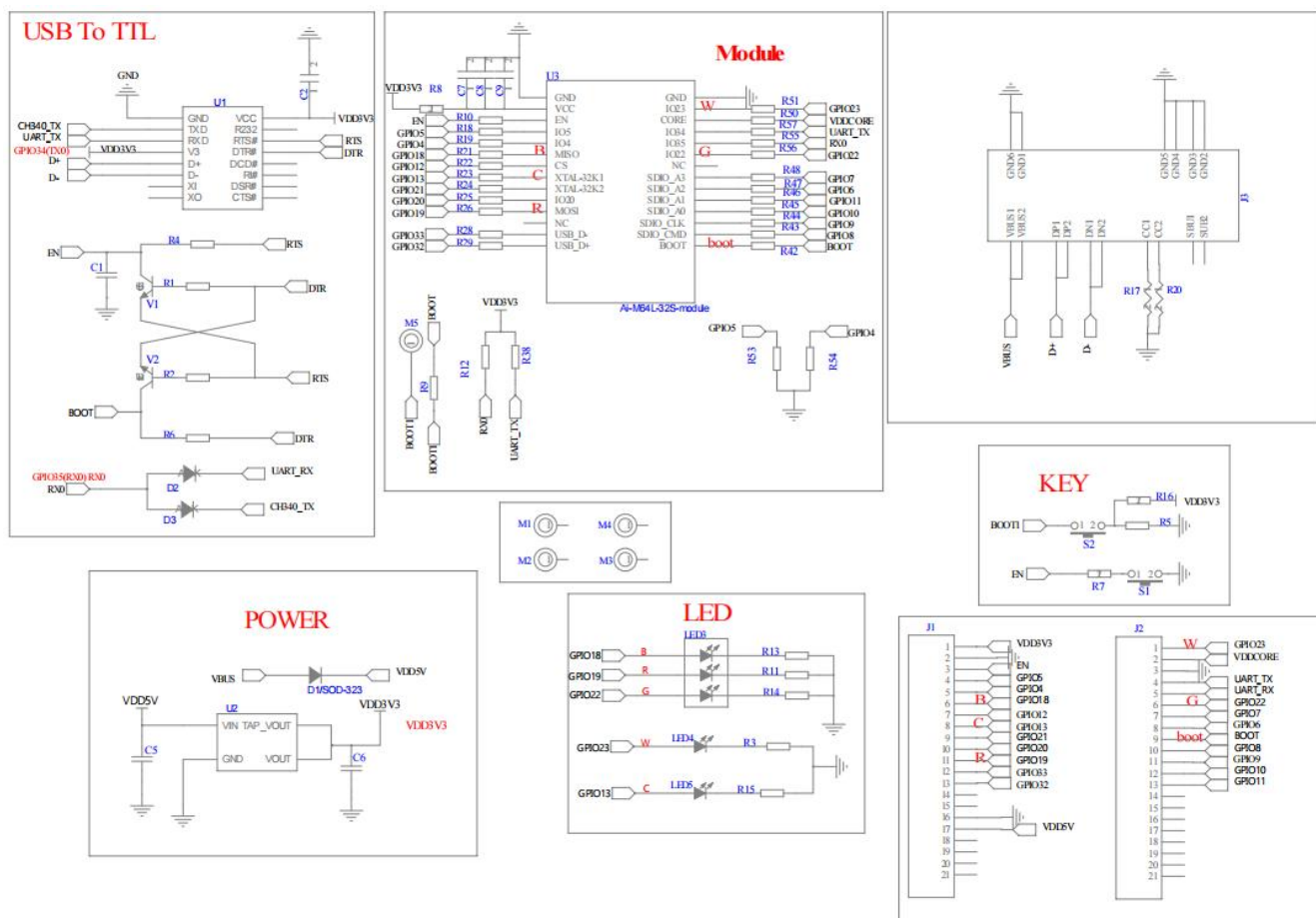


Figure 6 Schematic

8 Packaging Information

Table 9 shows the packaging information for the Ai-M64L-32S-Kit development board.

Table 9 Packaging Information

Packing List	Packaging Method	Quantity per Bag (ESD Bag)	Quantity per Bag (Sealed Bag)
Ai-M64L-32S-Kit	Foam + ESD bag	1pcs	20pcs

9 Contact Us

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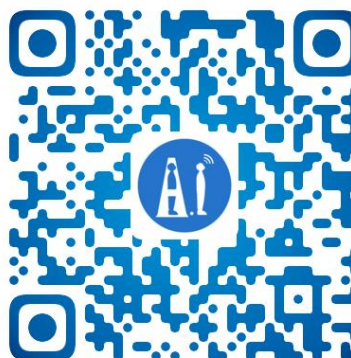
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WeChat Mini Program



WeChat Official Account

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