Version number:Ver 0.1.2

LoRa AIOT Dev Kit
Product Specifications

2026/03/16

Version V0.1.2

Change Log(Reversion Record)

Date (Date)	Version (Rev)	Notes (Change Description)	Author (Author)
2025-08-15	Ver0.1.0	Draft Product Specifications	Wu Chaoqun
2025-12-31	Ver0.1.1	Update the product image table and some of the content	Gong Rui
2026-03-16	Ver0.1.2	Update the I/O Expansion Chip description.	Gong Rui

Catalog(**catalog**)

1 Product Overview

1.1 Product name

LoRa AIOT Dev Kit

1.2 Product model

DEVK1.0

1.3 Product Overview

This product serves as the first AIoT hardware development platform for IoT engineers and smart hardware developers; it is a hardware solution designed to facilitate developers in debugging software functions, expanding peripheral modules and testing software performance;

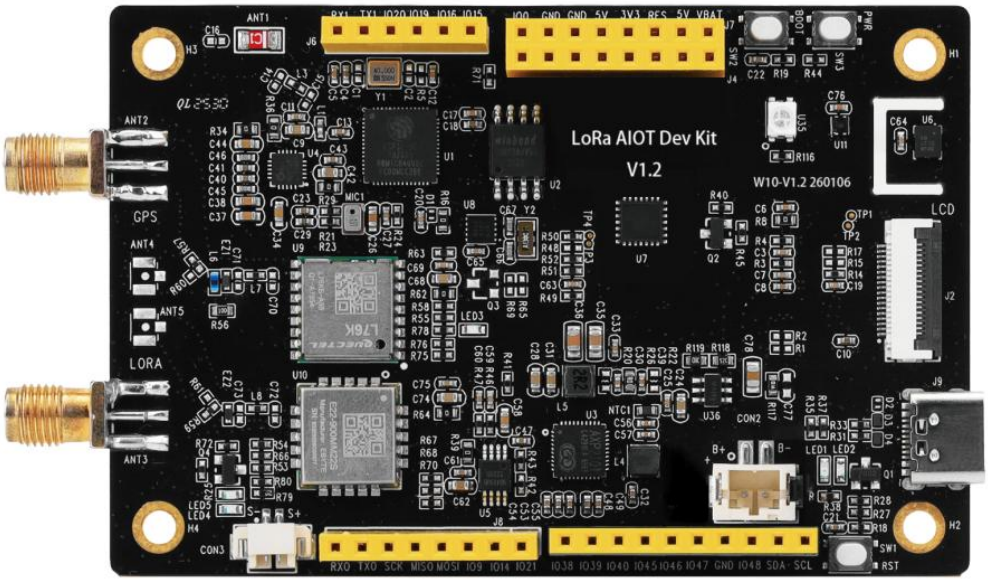
The product utilises the currently mainstream ESP32-S3 processor, paired with LoRa and GPS modules. It integrates the WiFi, Bluetooth and LoRa communication standards commonly used in the Internet of Things, supports the 850–930 MHz frequency band and the LoRaWAN protocol, and is compatible with Mesh networks, meeting the requirements of scenarios such as smart cities and industrial control.

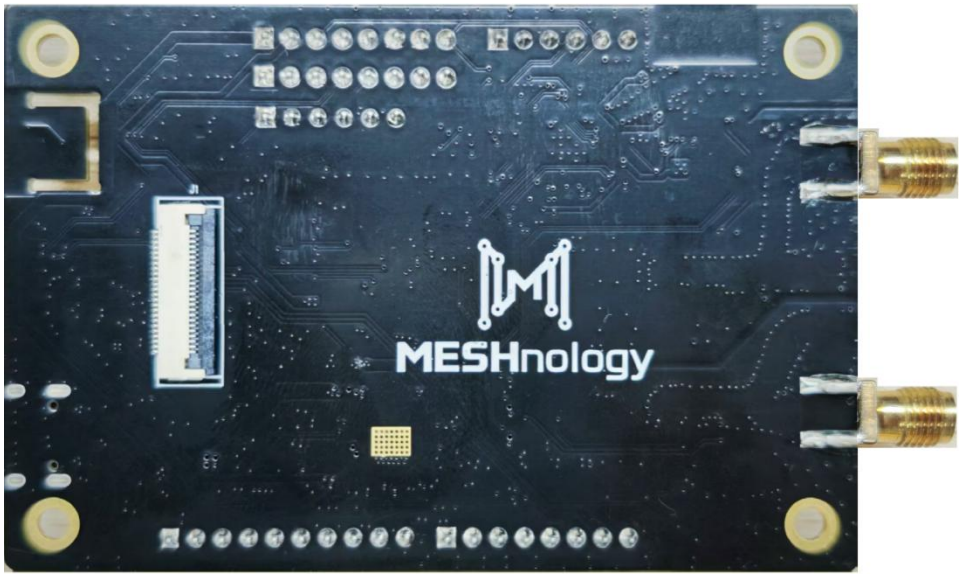
1.4 Product positioning

This product is primarily designed to provide an IoT development kit for IoT engineers, smart hardware engineers, open-source hardware enthusiasts, tech-savvy individuals in North America, and university IoT programming courses. It offers a hardware development platform supporting Wi-Fi, Bluetooth and LoRa communication technologies. Furthermore, as the product is designed to the Arduino UNO standard interface, it is compatible with Arduino peripheral modules and expansion boards, offering developers greater flexibility;

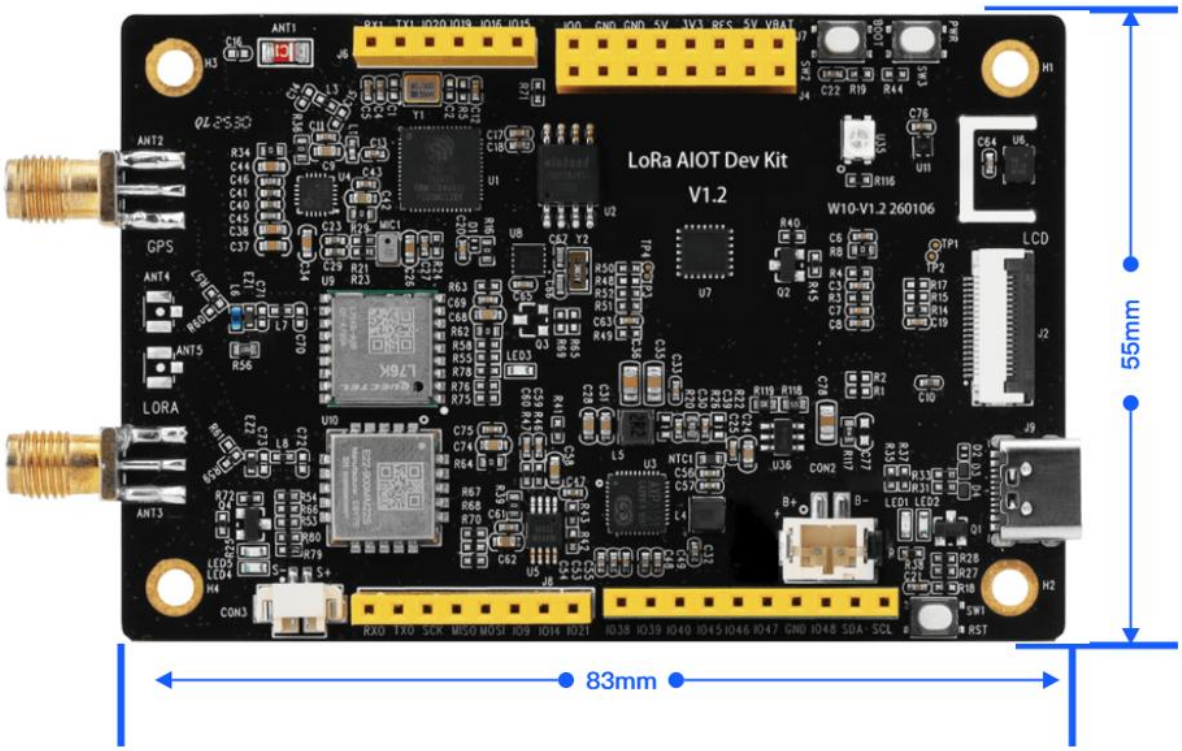
Target audience: IoT engineers, smart hardware engineers, open-source hardware enthusiasts, tech-savvy men in North America, and university students with an interest in programming.

1.5 **Product illustration**





1.6 **Dimension diagram**



1.7 **Hardware specifications**

Function category	Function description
Product name	LoRa AIOT Dev Kit
Power supply interface	USB TYPE-C 5V/3A
main control chip	ESP32-S3R8 Xtensa® 32-bit LX7 dual-core microprocessor, clocked at up to 240 MHz
LoRa module	The EBYTE E22-900MM22S supports the 850–930 MHz frequency band and the LoRaWAN protocol
GPS module	The Quectel L76K supports multiple satellite systems, including GPS, GLONASS, BDS and QZSS
LCD	Supports a 3.5-inch capacitive touchscreen with an FPC (SPI+I2C) interface, 320×480 resolution and 262K colours
	Supports a 3.5-inch TFT display with an Arduino (LCD) interface, resolution 320×480
	Supports a 1.54-inch ISP full-view SPI interface display with a resolution of 240×240 and full-colour RGB
	Supports a 1.3-inch OLED LCD display with an SPI interface, 128×64 resolution, and full-colour RGB
	Supports a 1.47-inch TFT LCD display with an SPI interface, resolution 172 ×320, full-colour RGB
Camera	Supports OV2640 2-megapixel cameras
	Supports the OV5640 5-megapixel camera
Audio codecs	ES8311 low-power audio codec chip, 24-bit, supporting sampling rates from 8 to 96 kHz

Temperature and humidity sensor	SHT41 Temperature: 0−75 °C, accuracy ±0.2 °C; Humidity: 0−100%, accuracy ±2%
IMU sensor	QMI8658 6-axis MEMS IMU chip, integrating a 3-axis gyroscope and a 3-axis accelerometer
RTC (Real-Time Clock)	The PCF85063 RTC calendar chip has extremely low power consumption, with a standby current of just 0.25 μA
Power management	The AXP2101 is a highly integrated PMIC featuring four built-in DC-DC converters and one battery monitor
IO expansion port	Compatible with the Arduino interface, featuring 2 UART ports, 1 ADC port, 1 SPI port and 1 I2C port
Debugging interface	1 x JTAG port
USB port	1 USB 2.0 communication port, primarily utilising the USB CDC function
Button	1 reset button, 1 BOOT button
Storage	External 16MB SPI Flash
Number of board layers	4th floor
Board material	RF-4 (fibreglass board)
Weight per board	30.8g
Spacing between mounting holes	73.80*45.00mm
Board dimensions	83.40*55.00mm
Operating temperature	-40℃~85℃
FCC ID	2BRTY-DEVK
Product Certification	FCC、CE、RoHs

2 Product Features

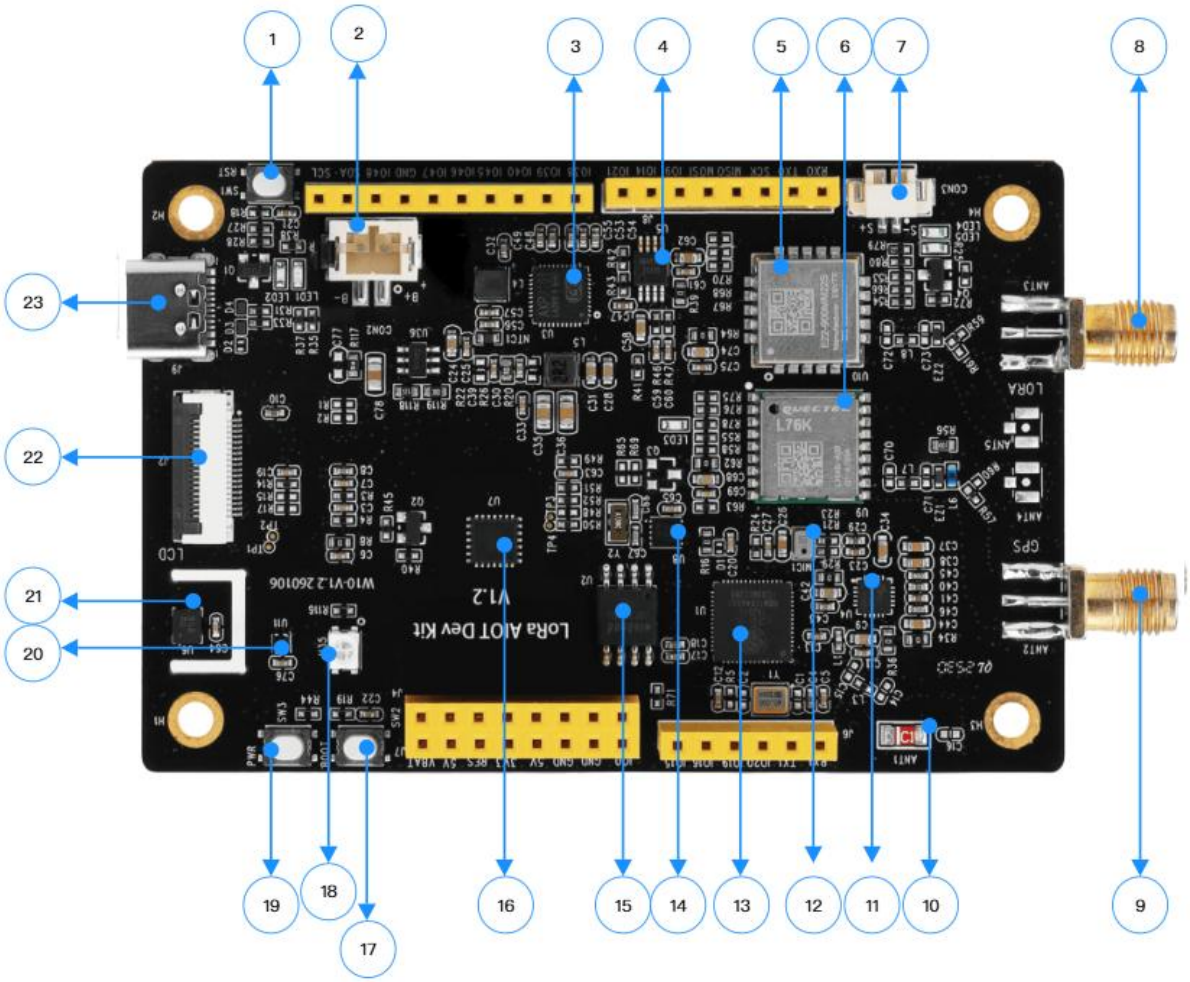
2.1 Overview of Features

This product utilises a processor based on the Xtensa® 32-bit LX7 dual-core architecture, with a clock speed of up to 240 MHz and significantly higher floating-point performance than processors based on the ARM Cortex-M33 architecture; it features mainstream LoRa SX1262 and GPS L76K modules on board, making it highly convenient for use and expansion in wireless communication and outdoor positioning applications; Furthermore, the board is equipped with an audio codec chip and power amplifier components; when used in conjunction with a display, it enables the straightforward implementation of XiaoZhi AI voice dialogue and chat functions. The board also features temperature and humidity sensors, as well as inertial sensors, allowing for flexible use in environmental monitoring and motion control applications. Additionally, the board incorporates an RTC (Real-Time Clock) chip, enabling the transmission of timestamped data during communication to ensure the timeliness and accuracy of the data;

2.2 Product Features

1. Features an Xtensa® 32-bit LX7 dual-core processor with a clock speed of up to 240 MHz, and built-in Wi-Fi and BLE functionality;
2. Integrated with LoRa and GPS modules, it effortlessly meets communication and data logging requirements in areas without network coverage, as well as outdoor positioning and tracking needs;
3. Equipped with an on-board IMU and temperature and humidity sensors, it enables motion detection and environmental monitoring functions, and, when paired with wireless connectivity, facilitates synchronisation and data upload;
4. The on-board RTC clock chip enables clock, alarm and perpetual calendar functions, and can also serve as a timestamp reference for wireless communications;
5. Equipped with an audio codec chip and compatible with mainstream LCD and OLED displays, it enables easy implementation of AI-powered voice intercom and chat functions;
6. Equipped with a camera interface, it supports OV2640 and OV5640 cameras, enabling the capture, display and upload of images and video;
7. Equipped with a lithium battery port, this product can be powered and operated normally even when not connected to a USB source;
8. Expansion I/O compatible with the Arduino interface, capable of supporting various modules and accessories for Arduino;

2.3 **Introduction to Resources**



Reference number	Resource description
1	RESET button: Press to restart the device; used for fault recovery and to restart the programme
2	PH2.0 lithium battery interface, connected to a 3.7V lithium battery via a PH2.0_2PIN connector
3	The AXP2101 power management IC handles power distribution, voltage regulation and power consumption control, ensuring a stable power supply to the device
4	The NS4150B audio amplifier delivers an output power of up to 2.8W under a 4Ω load, with a maximum output of 3W.
5	Ebit E22 - 900MM22S LoRa module, based on the SX1262 chip, operating in the 850–930 MHz band, with a maximum transmission power of 22 dBm.
6	The Quectel L76K GPS module supports multiple satellite systems, including GPS, GLONASS, BDS and QZSS.
7	PH1.25 speaker connector: a connector for audio output, supporting speakers with a maximum power rating of 3W.
8	SMA connector, for connecting a LoRa 850–930 MHz antenna.
9	SMA connector, for connecting an active GPS antenna.
10	A surface-mounted ceramic antenna that enables the transmission and reception of wireless signals (Wi-Fi, Bluetooth) and operates without the need for an external antenna.

11	The ES8311 is a low-power audio codec chip that processes audio signals (encoding and decoding), enabling devices to record and play back audio.
12	Microphone, used to capture audio signals for recording and voice interaction.
13	The ESP32, powered by the S3R8 core, is a system-on-chip (SoC) that integrates Wi-Fi and Bluetooth functionality. It operates at a frequency of 240 MHz and features 8 MB of pseudo-static random-access memory (PSRAM) for expanded storage.
14	The PCF85063 RTC clock chip provides an accurate time reference, enabling devices to function as real-time clocks.
15	W25Q128JVSIQ 16MB NOR flash memory chip.
16	The MCP23017 is a 16-bit I²C serial bus I/O expansion chip that supports a wide voltage range of 1.8V to 5.5V and features interrupt outputs, weak pull-up and configuration registers.
17	The BOOT button, which is used to select the boot mode, is often used in conjunction with the reset button to flash firmware onto the device.
18	3030 0.6W multicoloured LED
19	PWR power button, used to switch the device on and off.
20	The QMI8658 six-axis inertial measurement unit (IMU) comprises a three-axis gyroscope (for measuring angular velocity) and a three-axis accelerometer (for measuring acceleration).
21	The SHT41 temperature and humidity sensor features an I²C interface and offers high accuracy (±0.1°C/±1.5% RH), low power consumption and a compact size (2.5 ×2.5×0.9 mm).
22	3.5-inch LCD display FPC connector, featuring integrated SPI, I²C and SDIO interfaces
23	Type-C port, used for powering the device and data transfer.

2.4 **Features**

2.4.1 SOC Features

Component name	Classification by characteristics	Product Features
ESP32 - S3	Processor performance	It features an Xtensa® 32-bit LX7 dual-core processor with a clock speed of up to 240 MHz. Single-core performance reaches 613.86 CoreMark, whilst dual-core performance reaches 1181.60 CoreMark. It supports SIMD instructions and a single-precision floating-point unit (FPU), as well as AI instruction acceleration, enabling it to handle complex computational and real-time control tasks with ease.
	Storage resources	Featuring 384KB of ROM, 512KB of SRAM and 16KB of RTC SRAM, with 8MB of built-in PSRAM and support for external Flash memory, it meets the requirements for multitasking and large-scale data caching.
	Wireless communication	Supports dual-mode wireless communication via 2.4GHz Wi-Fi and Bluetooth® Low Energy (Bluetooth® LE). Wi-Fi supports the IEEE 802.11 b/g/n protocols, with 20 MHz and 40 MHz channel bandwidths on the 2.4 GHz band, and data rates of up to 150 Mbps; Bluetooth supports Bluetooth 5 and Bluetooth mesh, with data rates of 125 Kbps, 500 Kbps, 1 Mbps and 2 Mbps.
	Peripheral ports	Features 45 GPIO pins and supports a variety of digital interfaces, including 4×SPI, 1×LCD interface, 1×DVP

		camera interface, an LED PWM controller, 1× full-speed USB OTG, 1× USB Serial/JTAG controller, 1× SDIO host interface, a general-purpose DMA controller, 1× TWAI® controller, 2× 12-bit SAR ADCs, and 1× temperature sensor, amongst others.
	Safety features	It supports secure boot and flash encryption, and features a built-in hardware encryption accelerator, including a random number generator (RNG) and digital signature capabilities. It also incorporates a 'World Controller' peripheral, providing two fully isolated execution environments to ensure data security.
	Low-power management	It features a power management unit with five power consumption modes and an integrated ultra-low-power coprocessor (ULP), comprising an ULP-RISC-V coprocessor and an ULP-FSM coprocessor. With a current draw as low as 10μA in deep sleep mode, it is ideal for battery-powered devices.

2.4.2 LoRa Features

Component name	Classification by characteristics	Product Features
SX1262	Communication performance	- Transmission power: up to +22 dBm (high-efficiency integrated power amplifier) - Receiver sensitivity: as low as –148 dBm - Maximum link budget: 170 dB - Interference immunity: 88 dB of interference immunity at 1 MHz offset; 19 dB of co-channel rejection in LoRa mode - Modulation schemes: Supports FSK, GFSK, MSK, GMSK, LoRa and long-range FHSS - Data rates: Programmable up to 62.5 kbps in LoRa mode and up to 300 kbps in FSK mode
	Low-power characteristics	- The active receiver draws just 4.6 mA of current, making it suitable for battery-powered applications
	Highly integrated	- Integrates a DC-DC converter and an LDO, reducing the number of external components and lowering system costs and PCB footprint
	Packed with features	- Built-in bit synchroniser (for clock recovery) - Features automatic channel activity detection (CAD) and ultra-fast AFC
	Wide frequency coverage	- Covers a continuous frequency range from 150 MHz to 960 MHz, supporting the major global Sub-GHz ISM bands
	in compliance with regulatory requirements	- Complies with the physical layer requirements of the LoRaWAN specification; - Complies with radio regulations such as ETSI EN 300 220, FCC CFR 47 Part 15, and ARIB T-108 in China and Japan

2.4.3 GPS Features

Component name	Classification by characteristics	Product Features
L76K	Satellite system support	Supports GPS, BDS, GLONASS and QZSS multi-satellite systems, enabling both multi-system combined positioning and single-system independent positioning
	Assisted positioning function	Supports AGNSS functionality
	Built-in components	Built-in low-noise amplifier (LNA) and surface acoustic wave filter
	Key features	Provides users with a fast, accurate and high-performance positioning experience
	Layout method	Configuration is carried out via NMEA commands or a binary protocol; the default baud rate is 9600 bps.

2.4.4 IMU Features

Component name	Classification by characteristics	Product Features
QMI8658	Sensor type	6-axis inertial measurement unit, integrating a 3-axis gyroscope and a 3-axis accelerometer
	Gyroscope noise	The QMI8658C has a figure of merit of 15 mdps/√Hz, whilst the QMI8658A has a figure of merit of 13 mdps/√Hz
	Accelerometer noise	QMI8658C is 200 μg/√Hz, and QMI8658A is 150 μg/√Hz
	Dynamic range	The gyroscope ranges from ±16°/s to ±2048°/s, and the accelerometer ranges from ±2g to ±16g
	Interface type	Supports MIPI™ I3C, I2C and 3-wire or 4-wire SPI
	Directional accuracy	When used in conjunction with the XKF3 9D sensor fusion, pitch and roll accuracy is ±3°, and yaw / heading accuracy is ±5°
	FIFO	1536-byte FIFO, which can be used to buffer sensor data in order to reduce system power consumption
	Programmable features	The accelerometer and gyroscope sensors feature signal processing paths, digitally programmable data rates and filtering; they support digitally programmable sampling rates and filters

2.4.5 RTC Features

Component name	Classification by characteristics	Product Features
PCF85063	Timer function	Based on a 32.768 kHz quartz crystal, it displays the year, month, day, day of the week, hour, minute and second; the time format supports both 12-hour and 24-hour notation
	Communication interfaces	I²C bus interface, with a maximum data rate of 400 kbit/s
	Operating voltage	0.9V - 5.5V

	Clock output	Programmable clock output, with selectable frequencies of 32.768 kHz, 16.384 kHz, 8.192 kHz, 4.096 kHz, 2.048 kHz, 1.024 kHz and 1 Hz
	Frequency adjustment	Features a programmable offset register for fine-tuning the clock
	Interrupt functionality	Supports one-minute and half-minute interruptions
	Other features	Oscillator stop detection function, Power-On Reset (POR), alarm function, countdown timer

2.4.6 IO Features

Component name	Classification by characteristics	Product Features
MCP23017	I/O Expansion	Includes 16 configurable I/O pins, divided into two groups: PORTA (GPA0–GPA7) and PORTB (GPB0–GPB7), which are set to input mode by default;
	Operating Voltage	Wide input voltage range: 1.8 V to 5.5 V (-40 °C to +85 °C); 2.7 V to 5.5 V (-40 °C to +85 °C); 4.5 V to 5.5 V (-40 °C to +125 °C)
	Standby Current	Low-power design: maximum 1 µA at -40°C to +85°C; maximum 3 µA at 4.5 V to 5.5 V and +85°C to +125°C
	Communication Interfaces	Supports high-speed I²C communication with selectable baud rates of 100 kHz, 400 kHz and 1.7 MHz; supports Byte mode and Sequential mode, with the address pointer capable of being automatically incremented or fixed
	Interrupt Outputs	Equipped with dual interrupt pins (INTA and INTB), which can be configured to operate independently or in conjunction with a logical OR function; supports three output modes: active-high, active-low and open-drain; interrupt sources can be set to pin level changes or mismatches with the default value in the DEFVAL register
	I/O Port Characteristics	Supports input polarity reversal (configured via the IPOLA/IPOLB registers); an internal 100 kΩ weak pull-up resistor can be enabled (typical pull-up current of 75 µA at VDD = 5 V); pins support bidirectional data transmission and are in a high-impedance state when configured as inputs
	Output Drivers	The maximum sink current for a single output pin is 25 mA, and the maximum source current is 25 mA; the low output voltage is ≤0.6 V (IOL = 8.0 mA, VDD = 4.5 V), and the high output voltage is ≥VDD − 0.7 V (IOH = −3.0 mA, VDD = 4.5 V)
	ESD Protection	All pins are ESD-protected, with a human body model (HBM) rating of 4 kV and a machine model (MM) rating of 400 V.
	Register Configuration	Includes 22 independent registers (11 pairs of register sets); core configuration registers include: IODIRA/B (I/O direction), GPINTENA/B (interrupt enable), DEFVALA/B (interrupt default values), INTCONA/B (interrupt control), IOCON (device configuration), etc.; Supports BANK bit switching for register mapping mode (0 for continuous addressing, 1 for port-based addressing)

	Hardware address	Equipped with three hardware address pins (A0, A1 and A2), it supports the daisy-chaining of up to eight devices on a single I²C bus, enabling multi-device expansion
	Reset function	An external RESET pin is provided; the reset pulse must be at least 1 μs in duration. Upon reset, all registers revert to their default values and the I/O pins are set to input mode by default.
	Bus load	I²C bus capacitive load: maximum 400 pF in 100 kHz/400 kHz mode, maximum 100 pF in 1.7 MHz mode; the SDA pin supports slew rate control
	Packaging specifications	28-pin multi-package options: PDIP (300 mil), SOIC (300 mil), SSOP, QFN (6×6 mm), suitable for various installation scenarios
	Environmental characteristics	Operating temperature range: -40°C to +125°C; storage temperature range: -65°C to +150°C; maximum total power consumption: 700 mW; suitable for industrial environments

2.4.7 PMIC Features

Component name	Classification by characteristics	Product Features
AXP2101	Input voltage range	Supports a wide input voltage range from 4.5V to 20V;
	Output channels	Includes multiple DC-DC converters and LDO regulators, providing a wide range of power supply output options:
	Output current capacity	- Multiple synchronous buck DC-DC converters (e.g. DCDC1, DCDC2, etc.), with adjustable output voltage
	Charge management	- Multi-channel LDOs, with fixed or adjustable output voltages
	Power control	Output capabilities vary by channel; for example, the main DC-DC converters can provide higher currents (e.g. 3A/4A) to meet the power requirements of the core processor, whilst LDOs typically provide currents in the range of several hundred mA
	Protection functions	Built-in lithium battery charge management module, supporting multiple charge current settings and featuring charge protection functions (over-voltage, over-current, over-temperature, etc.)
	Low-power features	Supports multiple power control methods, including enable pin control and I²C interface configuration, enabling power sequencing management and dynamic voltage regulation;
	Interfaces and communication	Integrated overvoltage protection (OVP), undervoltage protection (UVP), overcurrent protection (OCP) and overtemperature protection (OTP), ensuring stable and safe system operation;

2.4.8 Audio Features

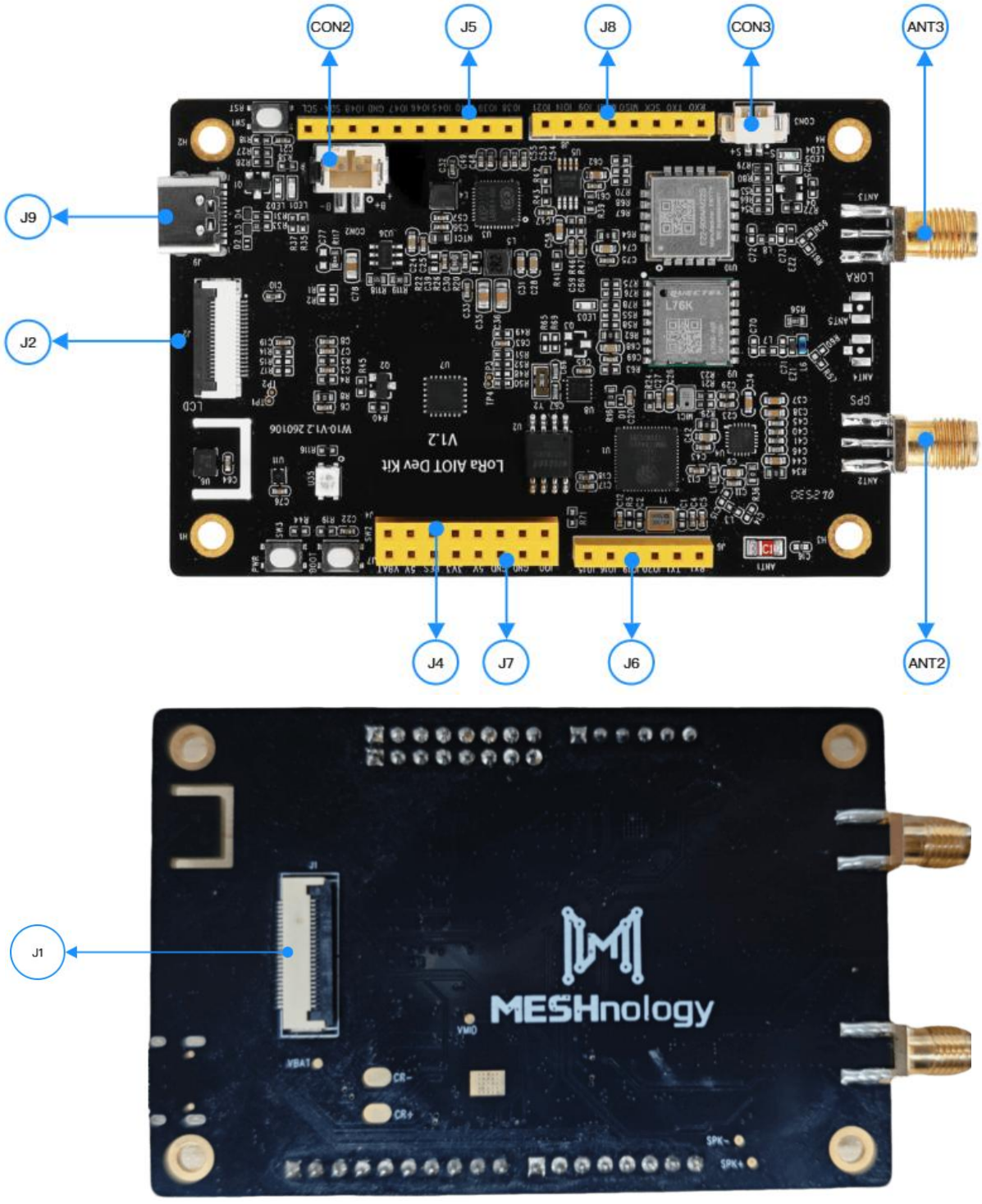
Component name	Classification by characteristics	Product Features
ES8311	Audio input	Supports microphone input (MIC IN) and line input (LINE IN), with configurable gain;

	Audio output	Supports headphone output (HP OUT) and line output (LINE OUT), with volume control;
	Sampling rate	Supports a range of sampling rates, typically covering 8 kHz to 48 kHz, to meet the requirements of various audio applications;
	Resolution	Supports digital audio resolutions such as 16-bit and 24-bit, providing high audio precision;
	Signal-to-noise ratio (SNR)	Both microphone input and output channels feature a high signal-to-noise ratio, typically exceeding 90dB, ensuring audio quality;
	Power consumption	Low-power design with multiple operating modes (such as normal mode and sleep mode), suitable for battery-powered devices;
	Interfaces	Supports the I²S digital audio interface for transmitting audio data to the host controller; supports the I²C control interface for configuring chip parameters;
	Audio features	Some models may incorporate basic audio processing functions, such as volume control and mute control

2.4.9 Sensor Features

Component name	Classification by characteristics	Product Features
SHT41	Measurement range	Temperature: -40°C to 125°C; Humidity: 0% RH to 100% RH
	Measurement accuracy	Temperature: ±0.2°C; Humidity: ±1.8% RH
	Supply voltage range	1.08 V to 3.6 V
	Average supply current	0.4 μA (at a measurement rate of 1 Hz)
	Standby current	80 nA
	Communication interface	I²C
	Response time	Humidity: 4 s (at 63% RH); Temperature: 2 s (at 63% RH)

2.5 **Hardware Interfaces**



2.5.1 IO Extension interface

J5：Interface definitions from left to right

No.	Name	Type	Function
1	SCL	I/O	GPIO41, CLK_OUT1, MTDI
2	SDA	I/O	GPIO42, MTMS
3	GPIO48	I/O	GPIO48, SPICLK_N
4	GND	G	Ground
5	GPIO47	I/O	GPIO47, SPICLK_P
6	GPIO46	I/O	GPIO46
7	GPIO45	I/O	GPIO45
8	GPIO40	I/O	GPIO40, CLK_OUT2, MTDO
9	GPIO39	I/O	GPIO39, CLK_OUT3, SUBSPICS1, MTCK
10	GPIO38	I/O	GPIO38, FSPIWP, SUBSPIWP

J8：Interface definitions from left to right

No.	Name	Type	Function
1	GPIO21	I/O	GPIO21
2	GPIO14	I/O	GPIO14, TOUCH14, ADC2_CH3, FSPIDQS, SUBSPIWP, FSPIWP
3	GPIO9	I/O	GPIO9, TOUCH9, ADC1_CH8, SUBSPIHD, FSPIHD
4	MOSI	I/O	GPIO13, TOUCH13, ADC2_CH2, FSPIIO7, SUBSPIQ, FSPIQ
5	MISO	I/O	GPIO11, TOUCH11, ADC2_CH0, FSPIIO5, SUBSPID, FSPID
6	SCK	I/O	GPIO12, TOUCH12, ADC2_CH1, FSPIIO6, SUBSPICLK, FSPICLK
7	TX0	I/O	GPIO43, U0TXD, CLK_OUT1
8	RX0	I/O	GPIO44, U0RXD, CLK_OUT2

J7：Interface definitions from left to right

No.	Name	Type	Function
1	VBAT	P	Input 3.7~4.2V, Battery positive terminal input
2	5V	P	Output 5.0V, power supply for external sensor
3	RES	I	CHIP_PU, Connect to RST switch
4	3V3	P	Output 3.3V, power supply for external sensor
5	5V	P	Output 5.0V, power supply for external sensor
6	GND	G	Ground
7	GND	G	Ground
8	IO0	I/O	GPIO0

J6：Interface definitions from left to right

No.	Name	Type	Function
1	IO15	I/O	GPIO15, U0RTS, ADC2_CH4, XTAL_32K_P
2	IO16	I/O	GPIO16, U0CTS, ADC2_CH5, XTAL_32K_N
3	IO19	I/O	GPIO19, U1RTS, ADC2_CH8, CLK_OUT2, USB_D
4	IO20	I/O	GPIO20, U1CTS, ADC2_CH9, CLK_OUT1, USB_D+
5	TX1	I/O	GPIO17, U1TXD, ADC2_CH6
6	RX1	I/O	GPIO18, U1RXD, ADC2_CH7, CLK_OUT3

2.5.2 USB Interface

J9：USB Type-C port, supporting a maximum power output of 5V/3A, compatible with PD fast chargers.

2.5.3 CAM FPC Interface

J1：Top-down interface definition

No.	Name	Type	Function
1	NC	NC	Reserved
2	AGND	P	Analog Ground
3	TWI_SDA	I/O	SCCB communication data signal.
4	AVDD2.8V	P	power supply for a 2.8V analog circui
5	TWI_CLK	I	SCCB communication clock signal.
6	RESET	I	Reset signal (active low)

7	CAM_VSYNC	O	Frame synchronization signal output.
8	CAM_PWDN	I	Power-down enable (active high).
9	CAM_HREF	O	Line synchronization signal output.
10	DVDD1.5V	P	Power supply for a 1.5V digital circuit.
11	DOVDD2.8V	P	power supply for a 2.8V digital circui.
12	CAM_D7	O	8-bit data output.
13	CAM_XCLK	I	Basic working clock input pin of OV5640.
14	CAM_D6	O	8-bit data output.
15	GND	G	Module ground wire
16	CAM_D5	O	8-bit data output.
17	CAM_PCLK	O	Pixel clock output.
18	CAM_D4	O	8-bit data output.
19	CAM_D0	O	8-bit data output.
20	CAM_D3	O	8-bit data output.
21	CAM_D1	O	8-bit data output.
22	CAM_D2	O	8-bit data output.
23	VCC3V3	P	Module power supply pin, connected to 3.3V power supply.
24	GND	G	Module ground wire.

2.5.4 LCD Extension interface

J4：Interface definitions from left to right

No.	Name	Type	Function
1	GND	G	Ground
2	VCC	P	3.3V power input
3	CLK	I/O	SPI bus clock pin
4	MOSI	I/O	SPI bus data pin
5	RES	I/O	OLED reset pin
6	DC	I/O	Data or command switch pin
7	CS	I/O	SPI bus choose pin
8	BL	I/O	Backlight control pin

2.5.5 LCD FPC Interface

J2：Top-down interface definition

No.	Name	Type	Function
1	3.3V	P	3.3V power input for LCD display.
2	LCD_BL	I	LCD backlight control from PWM.
3	GND	G	Ground
4	SCLK	I	SPI communication SCLK pin
5	MOSI/SD_CMD	I	SPI communication MOSI pin /SDIO communication CMD pin
6	MISO/SD_DAT0	O	SPI communication MISO pin / SDIO communication DAT0 pin
7	LCD_DC	I	Data/command pin for LCD, low level indicates command, high level indicates data.
8	LCD_TP_RST	I	Reset pin for LCD and TP, active at low level.
9	LCD_CS	I	Chip select pin for LCD, active at low level.
10	SD_CS/SD_DAT3	I/O	Chip select pin for Micro SD / SDIO communication DAT3 pin
11	SD_DAT2	I/O	SDIO communication DAT2 pin
12	LCD_TP_RST	I	Reset pin for LCD and TP, active at low level
13	TP_SCL	I	I2C communication Clock pin for TP
14	TP_SDA	I/O	I2C communication Data pin for TP
15	TP_INT	O	Touch Interrupt pin for TP
16	SD_DAT1	I/O	SDIO communication DAT1 pin
17	NC	/	Reserved
18	NC	/	Reserved

2.5.6 SMA Interface

ANT3: Connect an SMA male-to-female LoRa 850–930 MHz whip antenna or external antenna

ANT2: Connect an SMA male-to-female GPS active antenna

2.5.7 Lithium-ion battery interface

CON2：Top-down interface definition

No.	Name	Type	Function
1	GND	G	Ground
2	VBAT+	P	Input 3.7~4.2V, Battery positive terminal input

2.5.8 Speaker connections

CON3：Interface definitions from left to right

No.	Name	Type	Function
1	SPK+	A	Audio output positive pole
2	SPK-	A	Audio output Negative pole

2.6 **Performance Indicators**

Device type	Component name	Performance indicators
Main SoC	ESP32-S3	Processor: Xtensa® 32-bit LX7 microprocessor, with a maximum operating frequency of 240 MHz. Memory: 512KB of on-board SRAM, with support for external SPI flash and PSRAM. Communication interfaces: Supports Wi-Fi 4 (802.11b/g/n), Bluetooth 5 (BLE) and Bluetooth Mesh, with multiple UART, SPI, I2C and other interfaces. Security features: Built-in hardware security module, supporting security functions such as encryption and authentication.
LoRa modules	SX1262	Supported frequency bands: Supports the 137–1020 MHz band. Transmit power: Maximum output power up to 22 dBm. Receiver sensitivity: Up to -148 dBm. Modulation schemes: Supports LoRa, FSK, GFSK and other modulation schemes. Communication interface: SPI interface. Operating bands: EU868 / US915 / AU915 / AS923 / KR920 / IN865.
GPS modules	L76K	Reception bands: GPS – L1 C/A, GLONASS – L1, BDS – B1I, QZSS – L1 C/A Supported satellite systems: GPS, GLONASS, BDS and QZSS Sensitivity: Acquisition: -147 dBm, Tracking: -161 dBm, Reacquisition: -162 dBm Horizontal positioning accuracy: 2.0 m Speed accuracy: 0.1 m/s (without assistance) Acceleration accuracy: 0.1 m/s² (without assistance) Time to First Fix (TTFF): With AGNSS enabled, 5.5 s for cold start and 2 s for warm start; with AGNSS disabled, 30 s for cold start and 2 s for warm start
IMU modules	QMI8658	Sensor type: 6-axis inertial measurement unit (3-axis gyroscope + 3-axis accelerometer).

		Gyroscope performance: Noise density as low as 15 mdps/√Hz, with a dynamic range of ±16°/s to ±2048°/s. Accelerometer performance: Noise density of 200 μg/√Hz, with a dynamic range of ±2g to ±16g.
RTC modules	PCF85063	Accuracy: Typical accuracy at 25°C is ±20 to ±50 ppm. Low power consumption: Low supply current of 0.22 μA. Communication protocol: I²C protocol, with a maximum data rate of 400 kbit/s. Features: Includes a programmable alarm, countdown timer and interrupt output.
I/O expansion modules	MCP23017	I/O Ports: 16-bit general-purpose bidirectional I/O expansion, divided into two groups (PORTA and PORTB), configured as inputs by default, with support for internal weak pull-up. Communication Protocol: I²C protocol, with data rates of 100 kHz, 400 kHz and 1.7 MHz; three hardware address pins support daisy-chaining of up to eight devices. Low Power Consumption: Maximum standby current of 1 μA at room temperature, 3 μA in high-temperature environments. Interrupt Function: Dual interrupt pins, supporting multi-mode configuration and two interrupt trigger sources. Operating Voltage: Wide voltage range of 1.8 V to 5.5 V, suitable for a temperature range of -40 °C to +125 °C. Core configuration: 22 registers, supporting flexible configuration such as I/O direction and polarity inversion.
PMIC modules	AXP2101	Input voltage range: 3.9V to 5.5V. Charging function: 100mA–1A linear charger, CV accuracy ±0.5%. Output channels: Supports 16-channel power output, comprising 5 DC-DC channels and 11 LDO channels. Communication interfaces: Supports TWSI and RSB interfaces. Protection functions: Features overvoltage protection, overcurrent protection and overtemperature protection.
Audio codecs	ES8311	Audio interfaces: Supports I2S, left-aligned, right-aligned and other audio interface formats. Sampling rate: Supports sampling rates from 8 kHz to 96 kHz. Signal-to-noise ratio: Typical value of 98 dB. Power consumption: Features a low-power mode, making it suitable for battery-powered devices.
Temperature and humidity sensors	SHT41	Measurement range: Temperature range: -40°C to 125°C; humidity range: 0% RH to 100% RH. Accuracy: Temperature accuracy: ±0.2°C (-40°C to 125°C); humidity accuracy: ±1.8% RH (5% RH to 95% RH). Communication interface: I²C interface. Power consumption: Low-power design, suitable for battery-powered devices.
Power amplifier modules	NS4150	Output power: 3W (5V supply, 4Ω load). Operating voltage range: 3.0V to 5.25V. Total harmonic distortion: 0.1% (0.5W output power, 3.6V supply). Efficiency: up to 90%. Protection features: built-in overcurrent protection, over-temperature protection and under-voltage protection.
Silicon microphones	LMA2718T381	Polar pattern: Omnidirectional. Operating voltage: 1.6 V to 3.6 V. Operating current: 120 μA.

		Signal-to-noise ratio: 60 dB.
Storage modules	W25Q128	Storage capacity: 128 Mbit (16 MB). Operating voltage: 2.7 V to 3.6 V. Interfaces: Supports standard SPI, 2-wire SPI, 4-wire SPI and QPI interfaces; SPI clock frequency up to 104 MHz. Erase/program cycles: Over 100,000. Data retention: Over 20 years.

2.7 **Specifications**

Key specifications	Description	minimum value	typical value	maximum value	unit
Supply voltage	USB port supply voltage	3.9	5.0	5.5	V
Operating current	Total operating current	0.16	228	1024	mA
Operating power consumption	Total power consumption	0.62	1140	5632	mW
Lithium battery voltage	Lithium battery supply voltage	3.0	3.7	4.2	V
RTC battery voltage	RTC battery supply voltage	2.0	3.0	3.0	V
Speaker power	External speaker power	0.5	2.8	3.0	W
LoRa	Operating frequency band	850	-	930	MHz
	Transmit power	-9	-	22	dBm
	Transmit rate	0.018	-	62.5	Kbps
	Transmit current	-	120	-	mA
	Receive current	-	10	-	mA
	Receive sensitivity	-147	-146	-145	dBm
	Blocking power	-	-	10	dBm
	Transmission range	-	-	6	km
WiFi	Operating frequency band	2412	-	2484	MHz
	Transmit power	18	-	21	dBm
	Transmit rate	1	-	150	Mbps
	Transmit current	286	-	340	mA
	Operating current	88	-	91	mA
	Receiver sensitivity	-98.4	-	-71.4	dBm
BLE	Operating frequency band	2402	-	2480	MHz
	Transmit power	-24	0	20	dBm
	Transmit rate	0.125	-	2	mA
	Transmit current	-	-	380	mA
	Operating current	-	-	95	mA
	Receiver sensitivity	-104.5	-	-93.5	dBm
GPS	Receive band	GPS：L1 C/A；GLONASS：L1；BDS：B1I；QZSS：L1 C/A			MHz
	Receive current	-	29	-	mA
	Receive sensitivity	-162	-160	-147	dBm
	Number of tracking channels	-	-	32	CH
	Update rate	1	1	5	Hz
	UART baud rate	9600	9600	115200	bps
	Cold start positioning time	5.5	7.8	30	s
	Hot start positioning time	2	2	-	s

	Horizontal positioning accuracy	2.0	-	-	m
	Velocity accuracy	0.1	-	-	m/s
	Acceleration accuracy	0.1	-	-	m/s^2
	Timing accuracy	30	-	-	ns
ES8311	Sampling rate	8	-	96	kHz
	Signal-to-noise ratio	105	110	115	dB
Operating temperature	Operating temperature range	-40	25	85	℃

3 About Us

We are a high-tech enterprise specialising in the research, development, production and sale of core IoT modules. With many years of experience in the ESP series module sector, we are committed to providing highly reliable, high-performance IoT hardware solutions to customers worldwide.

3.1 Key strengths

Technical Capabilities: We have a dedicated hardware R&D team with in-depth expertise in the Espressif ESP32-S3 chip technology. We possess end-to-end development capabilities, from module design to firmware optimisation, and our products undergo rigorous reliability testing and compatibility verification.

Quality Assurance: We adhere to industrial-grade manufacturing standards, utilising high-quality components and precision manufacturing processes. All modules undergo high and low-temperature testing, ageing tests and RF performance calibration to ensure stable operation in a wide range of complex environments.

Support Services: We provide comprehensive technical documentation, development example code and one-to-one technical consultation services. We support OEM/ODM customisation requirements and respond swiftly to clients' product iteration and functional adaptation needs.

3.2 Areas of application

Our products are widely used in smart home, industrial automation, smart agriculture, healthcare, wearable devices and IoT gateways, providing customers with one-stop 'hardware + software' IoT solutions to support the digital transformation and upgrading of industries.。

3.3 Contact us

Technical support: support@xxx.com (Weekdays 9:00–18:00, rapid response)

Business enquiries: business@xxx.com

Official website: www.xxx.com

3.4 Release Notes

This module forms the core framework of the LoRa AIoT Dev Kit Product Specification V0.1.1; the content will be continuously optimised in line with product updates and user feedback.

FCC warning:

Any Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

Note: This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:

(1) This device may not cause harmful interference, and

(2) this device must accept any interference received, including interference that may cause undesired operation.

These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

-Reorient or relocate the receiving antenna.

-Increase the separation between the equipment and receiver.

-Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.

-Consult the dealer or an experienced radio/TV technician for help.

This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance 20cm between the radiator & your body.