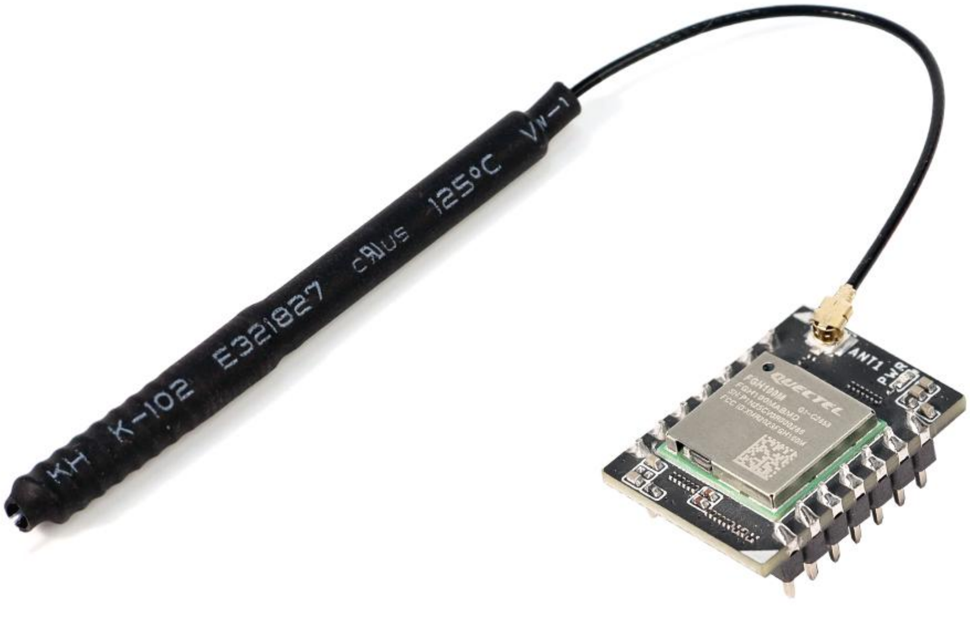
Wireless Module for Wi-Fi HaLow DataSheet

WiFi @ Wireless Module-Powered by Quectel

DataSheet

V1.0



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1 Overview

1.1 Product Description

The WIFI-HaLow Wireless Module is a Wi-Fi HaLow module compliant with the IEEE 802.11ah standard, specifically designed for next-generation IoT applications. Operating in the 850-950MHz Sub-1GHz frequency band, it seamlessly integrates three core advantages: long-distance transmission, low power consumption, and high penetration capability, effectively addressing the limitations of traditional Wi-Fi in coverage range and energy efficiency.

Supporting a maximum transmission rate of 32.5 Mbps, the module features robust security performance with support for advanced encryption protocols such as WPA3. Its standout characteristics lie in high integration and ease of use—effortlessly compatible with hardware like the CrowPanel Advanced series displays, it enables rapid development of human-machine interface (HMI) solutions integrated with long-range wireless communication capabilities, significantly simplifying the development process of IoT terminal products.

This module serves as an ideal choice for achieving low-power, wide-coverage wireless connectivity across diverse fields including smart homes, industrial automation, smart agriculture, and smart cities.

1.2 Core Features

- **Long-Range Coverage & Strong Penetration Capability:**Compliant with the IEEE 802.11ah standard, it operates in the 850-950MHz Sub-1 GHz frequency band. Boasting a communication distance of 500 meters in open environments, the module can effectively penetrate obstacles such as walls and trees, significantly expanding the coverage of IoT networks.
- **High-Speed Data Transmission:** Supports a maximum transmission rate of up to 32.5 Mbps under ideal conditions, meeting the requirements for high-speed data throughput.
- **Optimized Low Power Consumption Design:** Adopts an optimized power efficiency design, making it an ideal choice for battery-powered IoT applications sensitive to power consumption.
- **Robust Security Performance:** Implements comprehensive security features, supporting encryption algorithms including AES, SHA-256, SHA-384, and SHA-512, as well as the latest WPA3 security protocol to ensure communication security.
- **High Integration & Ease of Use:** Seamlessly compatible with hardware such as the CrowPanel Advanced series displays, enabling rapid development of human-machine interface (HMI) solutions integrated with long-distance wireless communication capabilities.

Figure 1: Compatible with CrowPanel Advance series screens

1.3 Application Fields

Scenario	Key Requirements	HaLow Solution
Smart Home	Long-distance appliance control, sensor data transmission, wall-penetrating coverage for all household devices	Leveraging the strong penetration of Sub-1 GHz band, it enables low-power, wall-penetrating connectivity for all household devices, supporting long-distance data transmission and control of multiple devices (e.g., sensors, smart appliances)
Industrial Automation	Long-distance communication between workshop equipment, low power consumption to meet the long-term monitoring needs of production line sensors	Star-shaped AP covers 500m, supports 8191 devices, features WPA3 security protection, and low latency adapts to real-time data transmission and device control of production line sensors
Agricultural IoT Monitoring	Coverage of fields/greenhouses, real-time transmission of soil moisture, temperature, humidity and other data	Strong penetration of Sub-1 GHz band and TWT (Target Wake Time) technology extend battery life, enabling low-power, long-distance data collection and transmission for devices in large-scale farmlands/greenhouses
Smart City & Smart Building	Supporting networking of building security, energy consumption monitoring and other devices, communication through building structures	Coexists with existing 2.4GHz Wi-Fi, with unified SSID and IP direct connection, meeting the networking needs of various terminals (cameras, lighting, access control, etc.) to penetrate building structures
Parks & Commercial Premises	Supporting networking of building security, energy consumption monitoring and other devices, communication through building structures	Coexists with existing 2.4GHz Wi-Fi, with unified SSID and IP direct connection, meeting the networking needs of various terminals (cameras, lighting, access control, etc.) to penetrate building structures
Environmental Monitoring Systems (GNSS, Environmental)	Realizing data collection of park security, commercial passenger flow, etc., covering open and indoor scenarios	With long-distance and multi-device access capabilities, it achieves wide-area coverage and data collection of security devices, passenger flow sensors, etc. in parks/commercial premises

2 Wi-Fi HaLow

2.1 Wi-Fi HaLow

Wi-Fi HaLow is a wireless technology based on the IEEE 802.11ah standard, operating in the sub-1 GHz frequency band. It is designed to address the low-power consumption and long-distance connectivity requirements in Internet of Things (IoT) applications. By offering longer transmission distance, lower energy consumption, and stronger signal penetration, it overcomes the limitations of traditional Wi-Fi in coverage range and power usage. Specifically developed for IoT devices, Wi-Fi HaLow is suitable for scenarios such as smart homes, industrial IoT, smart agriculture, and smart cities.

2.2 Wi-Fi Technology

Wi-Fi Technology Layers and Frequency Bands

From bottom to top, Wi-Fi encompasses a range of distinct wireless technologies.

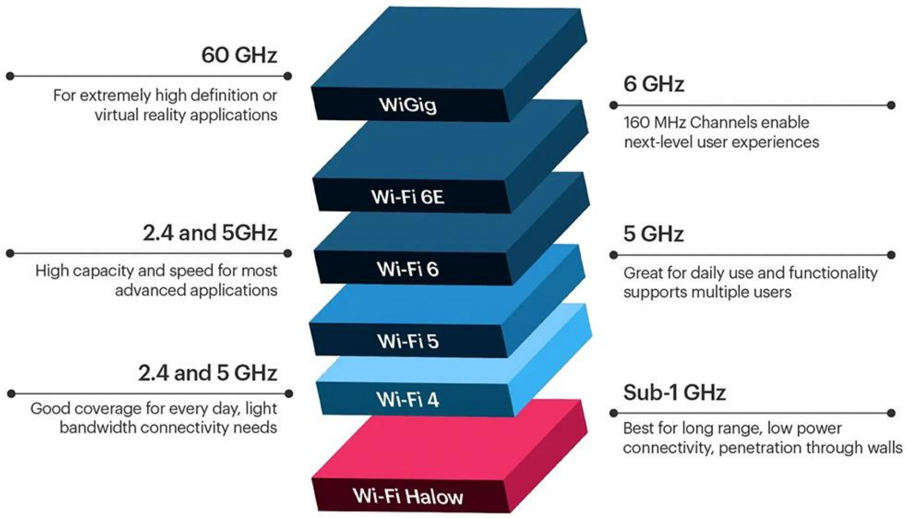

Figure 2: Wi-Fi Technology Layer Diagram

- Wi-Fi HaLow: Operates in the Sub-1 GHz frequency band, featuring long transmission distance, low power consumption, and strong wall-penetration capability. It is suitable for scenarios with low bandwidth requirements but a need for wide coverage or low power consumption, such as smart meters and remote sensors.
- Wi-Fi 4: Works in the 2.4 GHz and 5 GHz frequency bands, providing good coverage for daily light-bandwidth connections and meeting basic network needs like regular web browsing and simple video playback.
- Wi-Fi 5: Also based on the 2.4 GHz and 5 GHz frequency bands. Compared with Wi-Fi 4, it offers improved speed and efficiency, making it a "high-capacity, high-speed" technology that supports most advanced applications (e.g., high-definition video streaming and multi-user online office).
- Wi-Fi 6: Operates in the 5 GHz frequency band, emphasizing functionality for daily use. It supports multi-user concurrency and can maintain stable, high-speed connections in crowded network environments (such as shopping malls and office buildings).
- Wi-Fi 6E: Expands to the 6 GHz frequency band, leveraging 160 MHz channels to deliver "next-generation user experiences." It further increases bandwidth and speed, providing reliable support for immersive applications (e.g., 8K video streaming and cloud gaming).
- WiGig: Works in the 60 GHz frequency band, specifically designed for ultra-high-definition (UHD) or virtual reality (VR) applications. It enables transmission with extremely low latency and ultra-large bandwidth.

2.3 Wi-Fi HaLow System Architecture

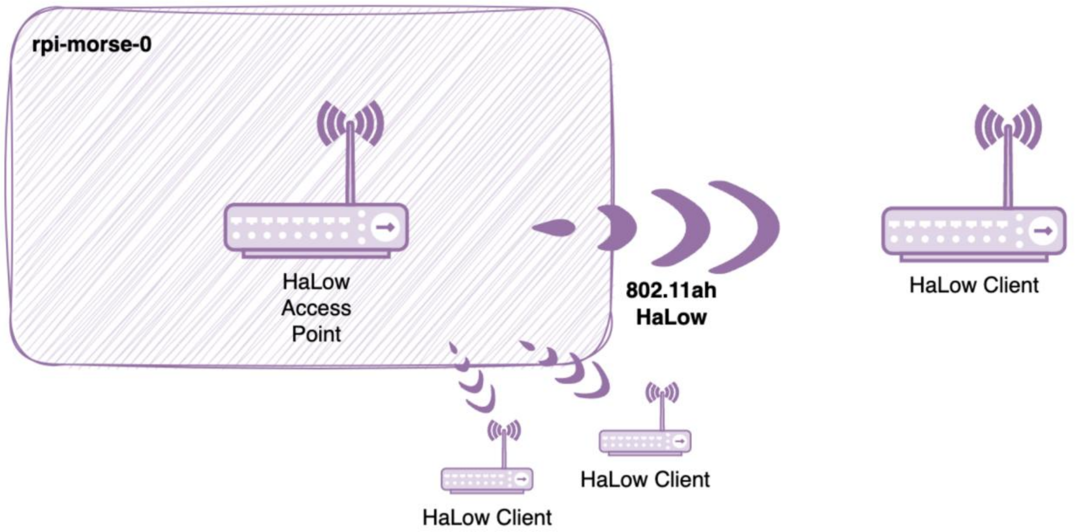

Figure 3:Wi-Fi HaLow System Architecture Diagram

Component	Name	Silkscreen
HaLow Access Point (AP)	As the core hub of the network, it manages connections for all access devices and undertakes data routing between devices and external networks.	A single access point theoretically supports up to 8192 devices and covers a range of approximately 500 meters, meeting the access requirements of high-density IoT devices.
HaLow Station (STA)	Refer to various IoT terminal devices, serving as the endpoints for data collection and operation execution.	Common devices include temperature and humidity sensors, smart home appliances, access controllers, etc. These devices connect to the network via the module and support the Target Wake Time (TWT) mechanism for sleep-mode energy saving.
Gateway	Acts as a bridge between the HaLow network and external networks such as Ethernet and cellular networks.	It resolves the protocol adaptation issue between HaLow and traditional networks, enabling data transmission from IoT terminals to the cloud or local area network (LAN) servers, and ensuring smooth cross-network communication.

3 Dimension Drawing

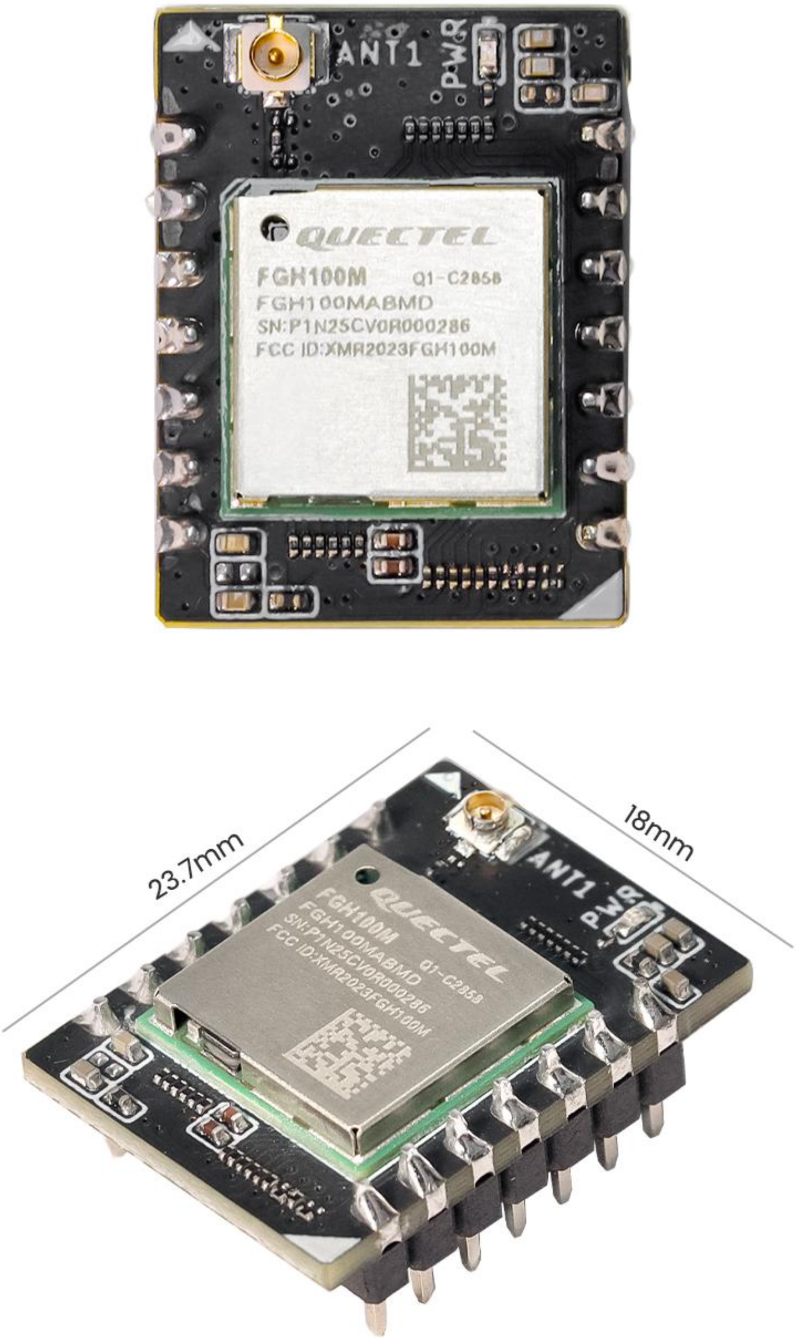

Figure 4:Dimension Drawing

4 System Block Diagram

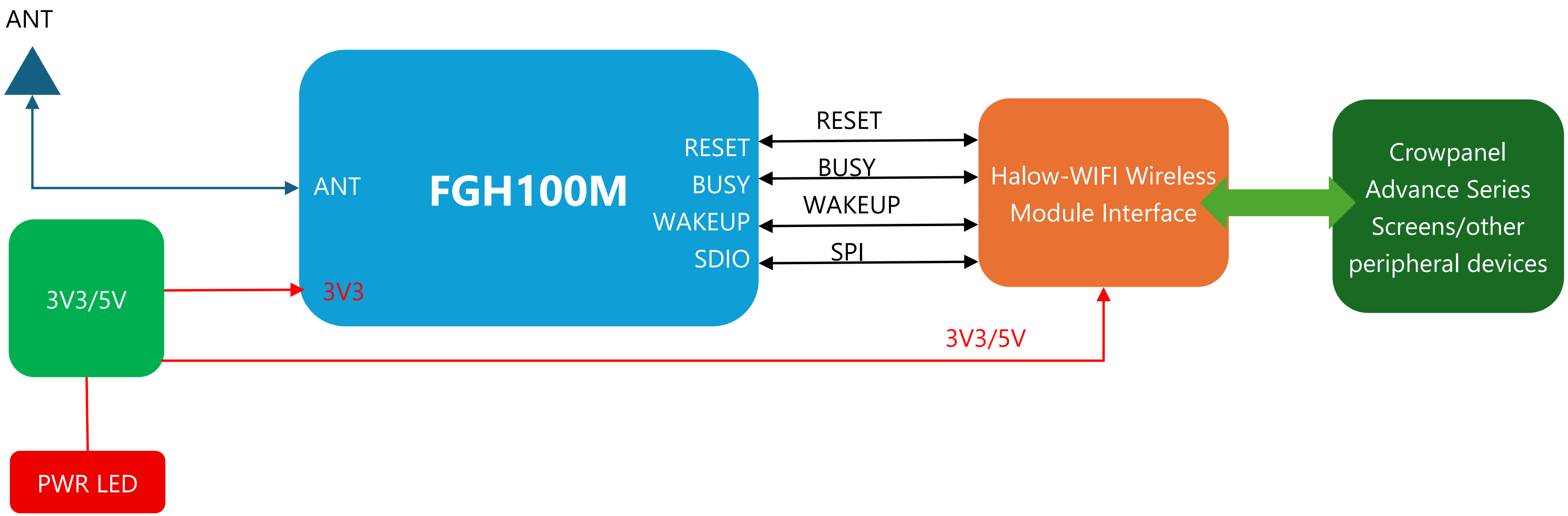

Figure 5: System Block Diagram

5 Hardware Overview

The hardware overview covers the interfaces, pin layout, and corresponding pin functions of the WIFI-HaLow module.

5.1 Indicator Light & Antenna Pin Functions

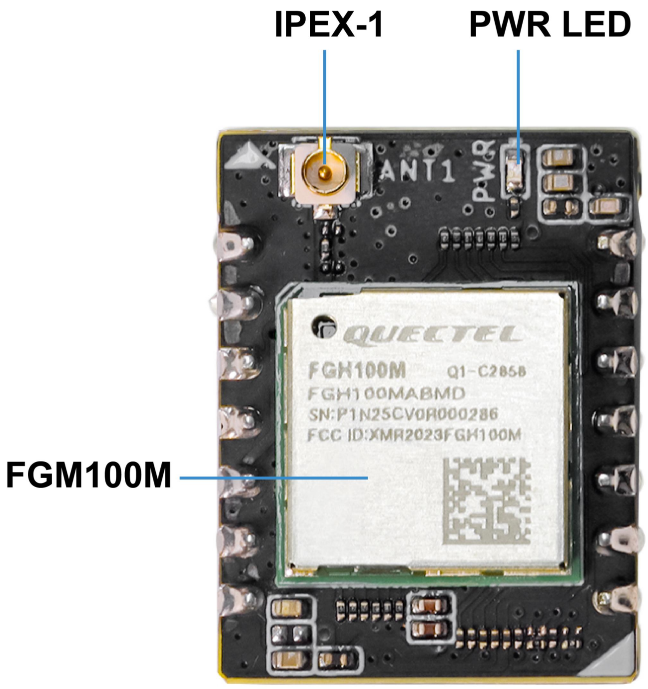

Figure 6:Module Functional Schematic Diagram

No.	Name	Silkscreen	Pin	Color	Description
1	Power Indicator Light	PWR	3V3	Red	Power indicator light; remains steadily lit in red when the power is turned on.
2	IPEX-1 Antenna Interface	ANT1	/	/	Connects to an 868MHz/915MHz antenna.

5.2 Pin Layout

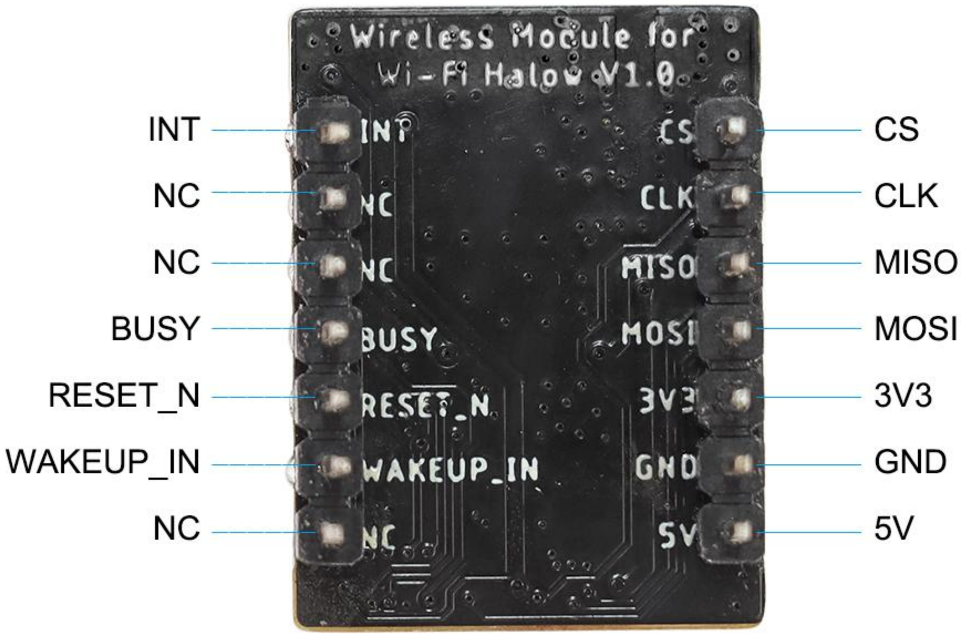

Figure 7:Module Pin Diagram

Pin Definitions:The following table presents the pin definitions and descriptions of the WIFI-HaLow Wireless Module:

Functional Descriptions of Left-Side Interface Pins:

No.	Pin No.	Type	Silkscreen	MCU Pin	Description
1	P$1	I/O	NC	/	Not connected
2	P$2	I/O	WAKEUP_IN	WAKEUP_IN	Low-power wake-up pin: Supports the host MCU to wake up the module, adapting to the low-power management requirements of IoT devices.
3	P$3	I/O	RESET_N	RESET_N	Module reset pin (active low): External triggering can restart the module, used for fault recovery or initial configuration.
4	P$4	I/O	BUSY	BUSY	Power-Saving Mode Pin
5	P$5	I/O	NC	/	Not connected
6	P$6	I/O	NC	/	Not connected
7	P$7	O	INT	SDOI_DATA1	Interrupt request pin (active low): When the module triggers specific events (e.g., successful Wi-Fi connection, completion of data reception), it sends an interrupt signal to the host to realize asynchronous communication.

Functional Descriptions of Right-Side Interface Pins:

No.	Pin No.	Type	Silkscreen	MCU Pin	Description
1	P$1	I/O	CS	SDIO_DATA3	Chip select signal for the synchronous serial interface.
2	P$2	I/O	CLK	SDIO_CLK	Clock signal for the synchronous serial interface; collaborates with CS, MOSI, and MISO to enable data transmission.
3	P$3	I/O	MISO	SDIO_DATA0	Master In/Slave Out (MISO) pin of the synchronous serial interface, utilized for data transmission
4	P$4	I/O	MOSI	SDIO_CMD	Master Out/Slave In (MOSI) pin of the synchronous serial interface, used for both command and data transmission.
5	P$5	I/O	3V3	/	3.3V power input.
6	P$6	I/O	GND	/	Ground pin, serving as the power circuit return path and signal reference ground.
7	P$7	O	5V	/	5V power input.

6 Module Specifications

No.	Item	Parameter	Specification
1	Core & Performance	Wi-Fi HaLow Module	FGH100M
2		Soc	MM6108 Chip
3		WLAN Protocol	IEEE 802.11ah
4		Wi-Fi Frequency Band	850-950MHz
5		Wi-Fi Antenna	1 × 1
6		Channel Width	1/2/4/8MHz
7		Wi-Fi Modulation Scheme	OFDM/ BPSK/ QPSK/ 16QAM/ 64QAM
8		Encryption Mode	AES、SHA-256、SHA-384、SHA-512、WPA3
9		Dimension	13.0mm×13.0mm×2.2mm
10		Maximum Output Power	21 dBm
11		Maximum Transmission Rate	32.5 Mbps
12	Wi-Fi Antenna Features	Characteristic Impedance	50Ω
13		Gain	2±1 dBi
14		Voltage Standing Wave Ratio (VSWR)	⩽ 2
15		Polarization	Linear Polarization
16		Directivity	Omnidirectional
17		Connection Method	IPEX
18		Antenna Material	Copper Tube + Spring
19	Electrical Characteristics	Tx Power	915Mhz:19.74dBm
20		Rx Power	915Mhz: 20.30dBm
21		Receive Sensitivity	-105dBm
22		Transmission Distance	500m
23		Power Supply Voltage	VBAT: 3.0~3.6 V, Typical Value 3.3 V
24		I/O Port Supply Voltage	VDD_IO: 1.8~3.6 V, Typical Values 1.8/3.3 V
25		FEM Power Supply Voltage	VDD_FEM: 3.0–3.6 V, Typical Value 3.3 V

26	Environmental Characteristics	Operating Temperature	-30℃~+85℃
27		Extended Temperature	-40℃~+85℃
28		Storage Temperature	-40℃~+95℃
29	Package Type	Dimension	23.7*18*1.6mm

7 Electrical Characteristics

7.1 Power Consumption Parameters

No.	State	Current	Power
1	Operating Status (5V)	48mA	240mW

7.2 Absolute Maximum Ratings

No.	Item	Description	Minimum	Maximum	Unit
1	V_{CC}	Supply Voltage	1.8	3.6	V

7.3 Normal Operating Conditions

No.	Item	Description	Minimum	Typical	Maximum	Unit
1	V_{CC}	Supply Voltage	3.0	3.3	3.6	V
2	Top	Operating Temperature	-40	-	+85	°C

8 Mechanical Characteristics

8.1 Module Dimensions

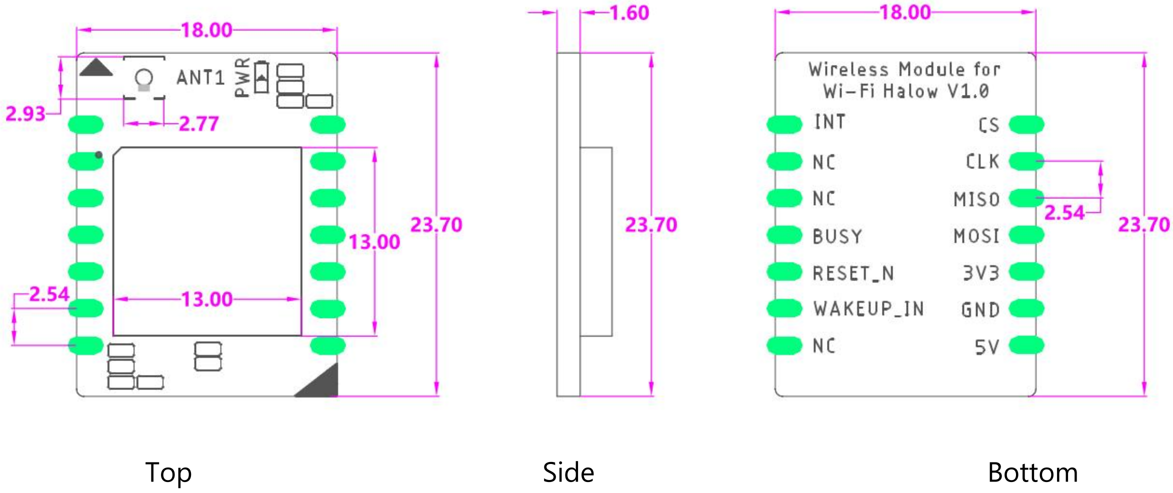

Figure 8: Outline Dimensions (Unit: mm)

8.2 Layout Recommendations

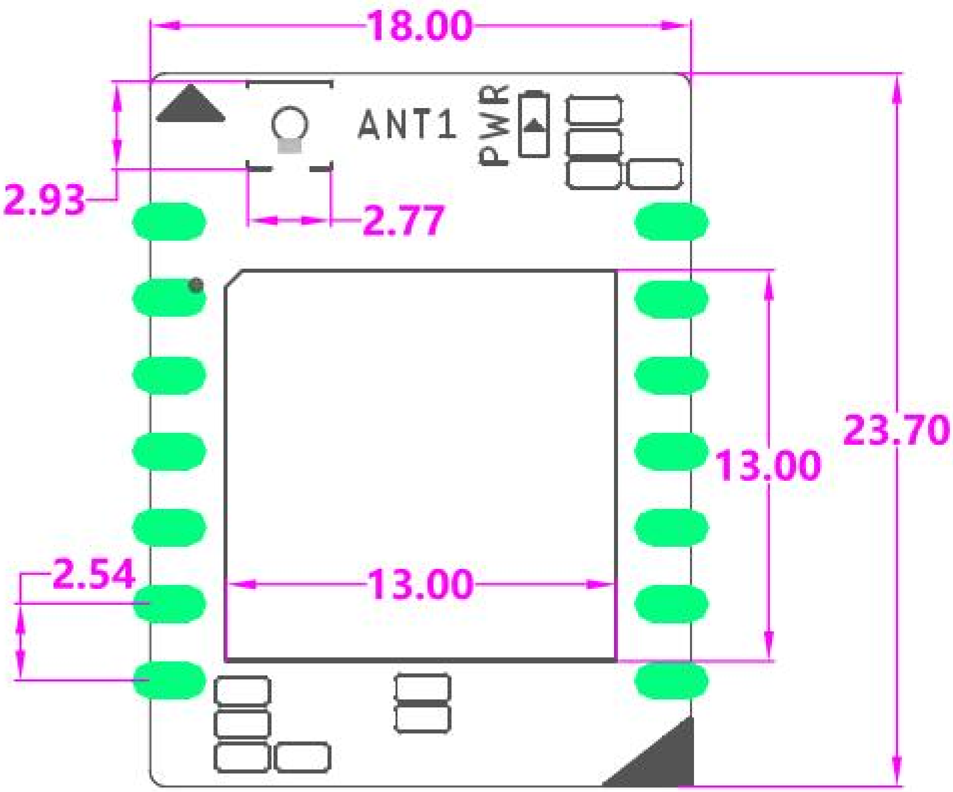

Figure 9:PCB Layout (Unit: mm)

9 Related Documents & Resources

- WIFI-HaLow Wireless Module Product Link
- FGH100M Datasheet

10 Revision History

Date	Version	Release Notes
2025/11/30	V1.0	Initial Release