



 **iLabel**

**AFM431T**  
Dalian IfLabel Technology Co., LTD

## General Description

AFM431T is a dual-band embedded Wi-Fi + Bluetooth module, which is composed of a highly integrated Realtek radio frequency chip RTL8722DM and a few peripheral devices. The chip is built in with 802.11a/b/g/n Wi-Fi wireless protocol and Bluetooth standard protocol. Built-in ARM Cortex-M4F and Cortex-M0 processing core, with large capacity (Flash :2MB) storage space (Flash: up to 128MB), running space (SRAM:512KB+PSRAM:4MB) and rich peripheral resources, MCU carries RTOS system platform and LWIP protocol. By encapsulating and optimizing SDK, MCU can meet a variety of embedded wireless communication applications.

## Basic parameters

### 1.1 Main performance parameters

ARM Cortex-M4 and Cortex-M0 processing core, main frequency 200MHz

3.3V DC single power supply

Packaging: stamp hole small size: length × width × thickness 37×27×2.8mm

### 1.2 WLAN and Bluetooth parameters

Antenna: external antenna, IPEX antenna interface, onboard antenna

Power consumption:

Power Mode: 50mA

Deep Sleep Mode: 40uA

### 2.4G WI-FI:

Standard: 802.11a /b/g/n 1x1

Transmitting power: 11A (54M):14dBm / 11B (11M):18dBm / 11G (54M):16dBm / 11N (MCS7):15dBm

Receiving sensitivity: 11B (11M) : -92dBm / 11G (54M) : -83dBm / 11N (MCS7) : -76dBm

Communication rate: 11Mbps @11b / 54Mbps @11g / 150Mbps @11n

Working mode: STA, AP, STA+AP

Encryption: AES/WPA/WPA2

### 5G WI-FI

Standard: 802.11a 1x1

Transmitting power: 11A (54M) : 16dBm / 11A (HT20-MCS7) : 15dBm / 11A (HT40-MCS7) : 15dBm

Receiving sensitivity: 11A (54M) : -76dBm/ 11A (HT20-MCS7) : -73.7dBm / 11A (HT40-MCS7) : 71.3dBm

### **Bluetooth 5.0:**

Standard: GAP, GATT

BLE Output Power: Average Power (4 ~ 8dBm)

Carrie Freq. Offset & Drift: < 20 KHZ

Modulation Characteristics: Delta F1 AVG (450 ~ 550 kHz)

Encryption: SM (Security Manager)

### **1.3 Product Features**

Complete Internet of Things solution (underlying development, cloud service, APP)

Support secondary development of AT+ application set

Support secondary development of C-SDK packages

Support OTA wireless upgrades

Support Bluetooth intelligent networking and Airkiss WeChat network function

FCC/CE certified, RoHS compliant

### **1.4 Software Features**

Built-in IPv4 / IPv6 stack

Built-in Free RTOS system

Support low power BLE 5.0

Supports HTTP/HTTPS (SSL) encryption

Support Ayla cloud, Amazon cloud, Jingdong cloud, Ali cloud

Support custom private cloud or user private cloud docking

Support secondary development, secondary integration

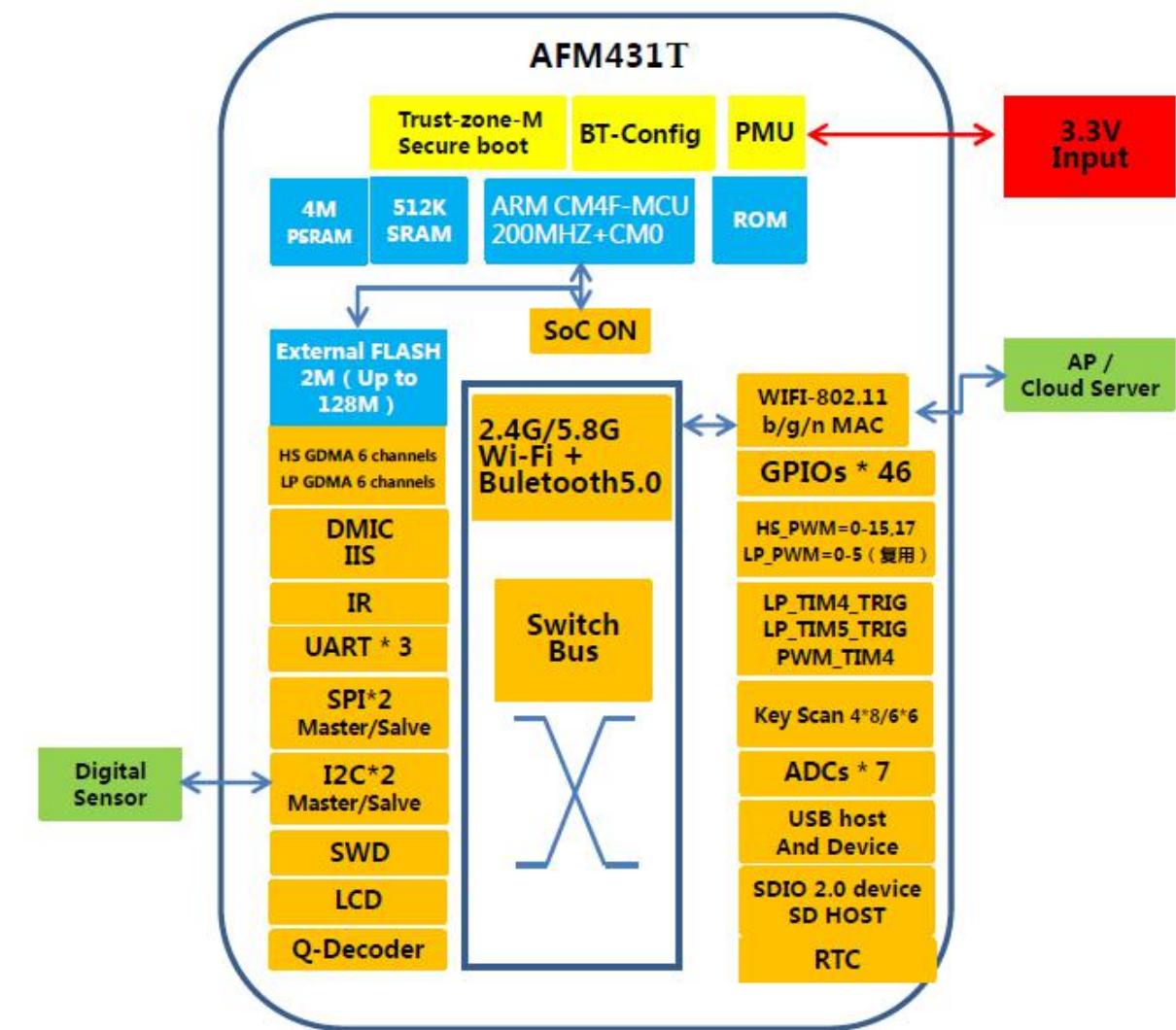
## 2. Module Framework

### Application

Intelligent lighting  
Smart socket  
Industrial control  
Smart home appliances  
Internet of Things Applications  
Thermal printer  
LED control card  
Bluetooth control device

### Module model

Part No.	Description
AFM431TI	PCB onboard antenna
AFM431TO	IPEX external antenna



### 3. Module PIN Definition

#### 3.1 PIN Definition

NO.	Name	I/O	Type	Function
1	GND		P(1)	
2	PA9		I/O	
3	PA10		I/O	
4	PA11		I/O	
5	PA12	GPIOA_12	I/O	LP_UART_TXD,SPI1_MOSI,HS_PWM0, LP_PWM0,I2S_MCLK,KEY_ROW0,GPIO[0]
6	PA13	GPIOA_13	I/O	LP_UART_RXD,SPI1_MISO,HS_PWM1, LP_PWM1,I2S_SD_TX1,KEY_ROW1,GPIO[1]
7	PA14	GPIOA_14	I/O	LP_UART_RTS,SPI1_CLK, I2S_SD_TX2,RTC_OUT,KEY_ROW2,GPIO[2]
8	PA15	GPIOA_15	I/O	LP_UART_CTS,SPI1_CS,RTC_EXT_32K, KEY_ROW3,KEY_COL6,GPIO[3]
9	PA16	GPIOA_16	I/O	HS_UART0_RTS,SPI0_MOSI, KEY_ROW4,KEY_COL5,
10	PA17	GPIOA_17	I/O	HS_UART0_CTS,SPI0_MISO, KEY_ROW6,KEY_COL3
11	PA18	GPIOA_18	I/O	HS_UART0_TXD,SPI0_CLK,JTAG_CLK, RTC_OUT,KEY_ROW5,KEY_COL4
12	PA19	GPIOA_19	I/O	HS_UART0_RXD,SPI0_CS,JTAG_TRST, KEY_COL2,LCD_D0
13	PA20	GPIOA_20	I/O	LCD_D1
14	PA21	GPIOA_21	I/O	HS_UART0_TXD,HS_USI_UART_RTS, KEY_ROW7
15	PA22	GPIOA_22	I/O	HS_UART0_RXD,HS_USI_UART_CTS
16	PA23	GPIOA_23	I/O	HS_USI_UART_TXD,HS_UART0_RTS,LCD_D2, HS_USI_I2C_SCL,HS_PWM2,LP_PWM2
17	PA24	GPIOA_34	I/O	HS_USI_UART_RXD,HS_UART0_CTS,LCD_D3, HS_USI_I2C_SDA,HS_PWM3,LP_PWM3
18	PA27	GPIOA_27	I/O	LP_UART_RTS,SWD_DATA
19	PA31	GPIOA_31	I/O	LP_I2C_SCL,LCD_D4
20	PB0	GPIOB_0	I/O	LP_I2C_SDA,LCD_D5
21	PA30	GPIOA_30	I/O	HS_USI_SPI_CLK,HS_PWM7,LP_PWM1, LCD_D6,VBUS_OTG(PX_IGNORE)
22	PA28	GPIOA_28	I/O	LP_UART_CTS,HS_USI_SPI_CS,HS_PWM6, LP_PWM0,LCD_D7,RREF(PX_IGNORE)

23	GND		P	
24	PA26	GPIOA_26	I/O	LP_UART_TXD,HS_USI_SPI_MISO,IR_RX, LP_I2C_SDA,KEY_COL0,LCD_D8,HS_PWM5, LP_PWM5,HSDP(PX_IGNORE)
25	PA25	GPIOA_25	I/O	LP_UART_RXD,HS_USI_SPI_MOSI,IR_TX, LP_I2C_SCL,KEY_COL1,LCD_D9,HS_PWM4, LP_PWM4,HSDM(PX_IGNORE)
26	GND		P	
27	PB2	GPIOB_2	I/O	LP_UART_RXD,DMIC_DATA,SGPIO, PCM_CLK,HS_TIM5_TRIG,ADC_5
28	PB1	GPIOB_1	I/O	LP_UART_TXD,DMIC_CLK, SGPIO_OUT,HS_TIM4_TRIG,ADC_4
29	PB3	GPIOB_3	I/O	SWD_CLK,PCM_SYNC,ADC_6
30	PB4	GPIOB_4	I/O	SPI1_MOSI,RTC_EXT_32K,HS_PWM8, LP_PWM2,I2S_SD_TX1,ID_OTG(PX_IGNORE), JTAG_TDI,PCM_IN,HS_TIM4_TRIG,ADC_0
31	PB5	GPIOB_5	I/O	SPI1_MISO,RTC_OUT,LP_I2C_SCL, HS_PWM9,LP_PWM3,I2S_SD_TX2, JTAG_TDO,PCM_OUT,HS_TIM5_TRIG,ADC_1
32	PB6	GPIOB_6	I/O	SPI1_CLK,LP_TIM4_TRIG, LP_I2C_SDA,JTAG_TMS,ADC_2
33	PB7	GPIOB_7	I/O	SPI1_CS,LP_TIM5_TRIG, HS_PWM17,LP_PWM5,ADC_3
34	Vbat_MEAS	ADC-PIN	A <sup>(5)</sup>	
35	GND		P	
36	VD1833 <sup>(3)</sup>		P	
37	GND		P	
38-41	NC		NC	
42	GND		P	
43	PB18	GPIOB_18	I/O	HS_UART0_RXD,HS_USI_UART_RTS, SPI0_MOSI,SPI_CS,SD_D2,HS_PWM10, LP_PWM4,SWD_CLK,LCD_D14,
44	PB19	GPIOB_19	I/O	HS_UART0_TXD,HS_USI_UART_CTS, SPI0_MISO,SPI_DATA1,SD_D3,HS_PWM11, LP_PWM5,SWD_DATA,I2S_SD_TX0,LCD_D15,
45	PB20	GPIOB_20	I/O	HS_USI_UART_RXD,HS_UART0_CTS,SPI0_CL, SPI_DATA0,HS_USI_I2C_SCL,SD_CMD, HS_PWM12,LP_PWM0,I2S_CLK, LCD_VSYNC_TE,
46	PB21	GPIOB_21	I/O	HS_USI_UART_RXD,HS_UART0_RTS,SPI0_CS, SPI_CLK,HS_USI_I2C_SDA,SD_CLK, HS_PWM13,LP_PWM1,I2S_WS, LCD_RS,QDEC_IDX

47	PB22	GPIOB_22	I/O	LP_TIM4_TRIG,IR_RX,SPI_DATA3,SD_D0, HS_PWM14,LP_PWM2,I2S_SD_RX,LCD_RD, ID_OTG(PX_IGNORE),QDEC_PHB,SGPIO_OUT
48	PB23	GPIOB_23	I/O	LP_TIM5_TRIG,IR_TX,SPI_DATA2,SD_D1, HS_PWM15,LP_PWM3,I2S_MCLK, LCD_WR,QDEC_PHA,SGPIO_OUT,EXT_32K
49	GND		P	
50-51	NC		NC	
52	PB29	GPIOB_29	I/O	IR_RX,I2S_CLK,SGPIO
53	PB28	GPIOB_28	I/O	LCD_CS,
54	PB30	GPIOB_30	I/O	
55	PB31	GPIOB_31	I/O	IR_TX,I2S_WS,QDEC_PHA,SGPIO
56	PA0	GPIOA_0	I/O	I2S_SD_RX,QDEC_IDX,SGPIO
57	PA4	GPIOA_4	I/O	I2S_WS,QDEC_PHA
58	PA2	GPIOA_2	I/O	I2S_CLK,QDEC_PHB,SGPIO_OUT
59	PA1	GPIOA_1	I/O	I2S_SD_TX0,
60	PA5	GPIOA_5	I/O	SD_WP
61	PA6	GPIOA_6	I/O	SD_CD
62	GND		P	
63	CHIP_EN <sup>(2)</sup> ( RESET )		I	Hardware reset pin (low level effective, internal pull up resistor 100K)
64	PA7 <sup>(4)</sup>	GPIOA_7	O	LOG_UART_TXD 1: Boot from Flash 0: Download image from UART
65	PA8 <sup>(4)</sup>	GPIOA_8	I	LOG_UART_RXD
66	GND		P <sup>(1)</sup>	

#### Description:

1. P represents the power pin, I/O represents the input and output pins, and CHIP\_EN is the module hardware reset pin, which does not clear the Wi-Fi distribution network information.

2, CHIP\_EN pin if not used to remain suspended, other pins are not used to remain suspended.

3, PIN13 3.3V, 1.8V power input pin:

4. PIN64 and PIN65 are the input and output ports for the module to download the program and debug LOG information.

\* When using UART to download the program, you need to connect the PIN64 series with 1K resistor short to GND to enter download mode.

\* During normal use, the user's bottom plate is reserved for test points.

5. A stands for ADC analog input pin

## 4. Electrical characteristics

### 4.1 Rated limit value

Symbol	Parameter	Min.	Typ.	Max.	Unit
VD33	Power supply voltage	3.0	3.3	3.6	V
VIO_IN	Pin input voltage	0.99	1.8-3.3	3.6	V

Symbol	Parameter	Max.	Unit
I <sub>VDD</sub>	3.3V rated current	450	mA
I <sub>DD-IO</sub>	I/O pin total constant current	200	mA
I <sub>DD-IO-3.3</sub>	3.3V I/O pin total constant current	50	mA
I <sub>IO</sub>	PIN input current	20	mA
	PIN output current	20	mA

### 4.2 Working condition

Symbol	Parameter	Condition	Typ.	Unit
I <sub>PK</sub>	Peak working current	To connect to send	150	mA
I <sub>STB</sub>	Standby current	Deep sleep	20	uA

### 4.3 IO PIN characteristic

#### 4.3.1 Pin input level

Symbol	Parameter	Condition	Min.	Max.	Unit
V <sub>IL</sub>	Input low level	3.0V≤VDD≤3.6V	-	0.8	V
V <sub>IH</sub>	Input high level	3.0V≤VDD≤3.6V	2.0	-	V

#### 4.3.2 Pin output level

Symbol	Parameter	Condition	Min.	Max.	Unit
V <sub>OL</sub>	Input low level	I <sub>IO</sub> =+20mA 3.0V≤VDD≤3.6V	-	0.4	V
V <sub>OH</sub>	Input high level		2.4	-	V

#### 4.3.2 ESD performance

Symbol	Parameter	Condition	Grade	Max.	Unit
VESD-HB	ESD Voltage (HBM)	TAMB=25°C (JESD22-A114)		2000	V
VEDS-CD	ESD Voltage (CDM)	TAMB=25°C (JESD22-C101)		500	V

## 5. Power mode and power consumption

### 5.1 Power mode and typical consumption parameters

Power mode	Power consumption		
	Typ.	Max.	Unit
Deep Sleep Mode	10	20	uA
Deep Standby Mode	70	190	uA
Power mode	50	80	mA
3.3v UDP Performance	20.35	39.30	mA

### 5.2 Functional Status

Mode	Deep Sleep Mode	Deep Standby Mode
Cortex-M4 core	OFF	OFF
System Clock	OFF	OFF
SRAM	OFF	OFF
Peripherals	OFF	OFF
Backup register	OFF	OFF
low precision timer	ON	ON
Wake pin	ON	ON
System timer	--	ON

## 6. RF Character

### 6.1 WI-FI Basic Parameter

Parameter	Description
Working Frequency	2.412–2.484GHz CH1~CH14
WI-FI Standard	IEEE 802.11 b/g/n
Communication Interface	UART, SDIO, SPI
Modulation Method	802.11a : OFDM 802.11b : DSSS/CCK ; 50mW/MHz 802.11g: OFDM; 40mW/MHz 802.11n : OFDM ( MIMO-OFDM Tech ) 28mW/MHz
Communication Rate	54Mbps @802.11a; 11Mbps @802.11b; 54Mbps @802.11g; 72Mbps @802.11n;
Type of Antenna	On-board antenna (gain 2dBi) or external antenna (IPEX antenna socket)

## 6.2 Bluetooth Basic Parameter

Parameter	Description
Working Frequency	2.402–2.480GHz 79 channels
Wi-Fi Standard	Bluetooth V5.0 of 1, 2 and 3 Mbps.
Communication Interface	UART
Modulation Method	DPSK, DQPSK
Communication Rate	1Mbps @ BER=0.1%, -86dBm; 2Mbps @ BER=0.01%, -86dBm; 3Mbps @ BER=0.01%, -80dBm;
Type of Antenna	On-board antenna (gain 2dBi) or external antenna (IPEX antenna socket)

## 6.3 Antenna performance requirements

Spectrum from 2400 to 2500 MHZ

Antenna gain  $\geq$  3DBI: 3DBI antenna can be within 5 meters of very good signal, it is in the shape of a pond

Outgoing signal, like two parentheses ()

Impedance 50 ohm: In practical application, the match of 50 ohm takes into account the advantages of voltage resistance, power transmission and loss

Standing wave ratio  $\leq 2$ : indicates whether the antenna and the radio transmitter match, equal to 1, indicates the radio wave to the antenna

No reflection at all, greater than one, which means some of the waves are reflected back

## 6.4 TX Parameter

### 6.4.1 IEEE802.11b transmission feature

IEEE802.11b mode CCK\_11M parameter characteristics

Channel	Power(dBm)	EVM (dB)	FreqErr(ppm)
1	18.2dBm	-23.3dB	-0.07ppm
7	18.1dBm	-23.42dB	-0.11ppm
13	18.11dBm	-23.43dB	-0.16ppm

### 6.4.2 IEEE802.11g transmission characteristics

IEEE802.11g mode OFDM\_54M parameter features

Channel	Power(dBm)	EVM (dB)	FreqErr(ppm)
1	15.51dBm	-35.77dB	-0.3ppm
7	15.50dBm	-35.83dB	-0.16ppm
13	15.19dBm	-35.65dB	-0.27ppm

#### 6.4.3 IEEE802.11n HT20/HT40 transmission characteristics

IEEE802.11n mode HT20/ HT40MHz -MCS7 parameter characteristics

Channel	Power(dBm)	EVM (dB)	FreqErr(ppm)
1	14.65dBm/14.75dBm	-35dB/-35.3dB	-0.15ppm
6	14.55dBm/14.35dBm	-34.72dB/-34.8dB	-0.27ppm
11	14.60dBm/14.70dBm	-34.93dB/-34.9dB	-0.25ppm

#### 6.4.4 5G IEEE802.11a transmission feature

IEEE802.11a mode OFDM\_54M parameter characteristics

Channel	Power(dBm)	EVM (dB)	FreqErr(ppm)
44	15.8dBm	-31.4dB	-0.27ppm
60	15.95dBm	-32.00dB	-0.21ppm
120	16.02dBm	-31.8dB	-0.36ppm
165	16.1dBm	-32.8dB	-0.16ppm

#### 6.4.5 5G IEEE802.11a transmission feature

IEEE802.11a mode HT20\_MCS7 parameter characteristics

Channel	Power(dBm)	EVM (dB)	FreqErr(ppm)
48	14.7dBm	-31.4dB	-0.27ppm
64	15.95dBm	-32.00dB	-0.21ppm
144	16.02dBm	-31.8dB	-0.36ppm
177	16.1dBm	-32.8dB	-0.16ppm

#### 6.4.6 5G IEEE802.11a transmission feature

IEEE802.11a mode HT40\_MCS7 parameter characteristics

Channel	Power(dBm)	EVM (dB)	FreqErr(ppm)
38	15.1dBm	-32.6dB	0.07ppm
54	14.95dBm	33.10dB	0.31ppm
102	14.85dBm	-33.3dB	-0.14ppm
151	14.83 dBm	-32.8dB	-0.18ppm

## 6.5 RX Parameter

IEEE802.11b receiving sensitivity characteristics	IEEE802.11g receiving sensitivity characteristics
IEEE802.11b mode 11MHz receiving sensitivity parameter characteristics	IEEE802.11g mode 54MHz receiving sensitivity parameter characteristics
20 m (bandwidth)	20 m (bandwidth)

Channel	Pwr(dBm)
1	-91dBm
7	-93dBm
13	-87dBm

Channel	Pwr(dBm)
1	-82dBm
7	-82dBm
13	-83dBm

IEEE802.11n receiving sensitivity characteristics

IEEE802.11n mode HT20/HT40-MCS7 receiving sensitivity parameter characteristics

20 m / 40 m (bandwidth)

Channel	Pwr(dBm)
1	-91dBm
7	-93dBm
13	-87dBm

IEEE802.11a receiving sensitivity characteristics

Data Rate	Channel	Pwr(dBm)
OFDM-54M	36	-76dBm
HT20-MCS7	52	-73dBm
HT40-MCS7	100	-71dBm
OFDM-54M	116	-76.7dBm
HT20-MCS7	132	-72.8dBm
HT40-MCS7	149	-71.2dBm
HT40-MCS7	165	-71.8dBm

## 7. Work timing

### 7.1 Power sequence

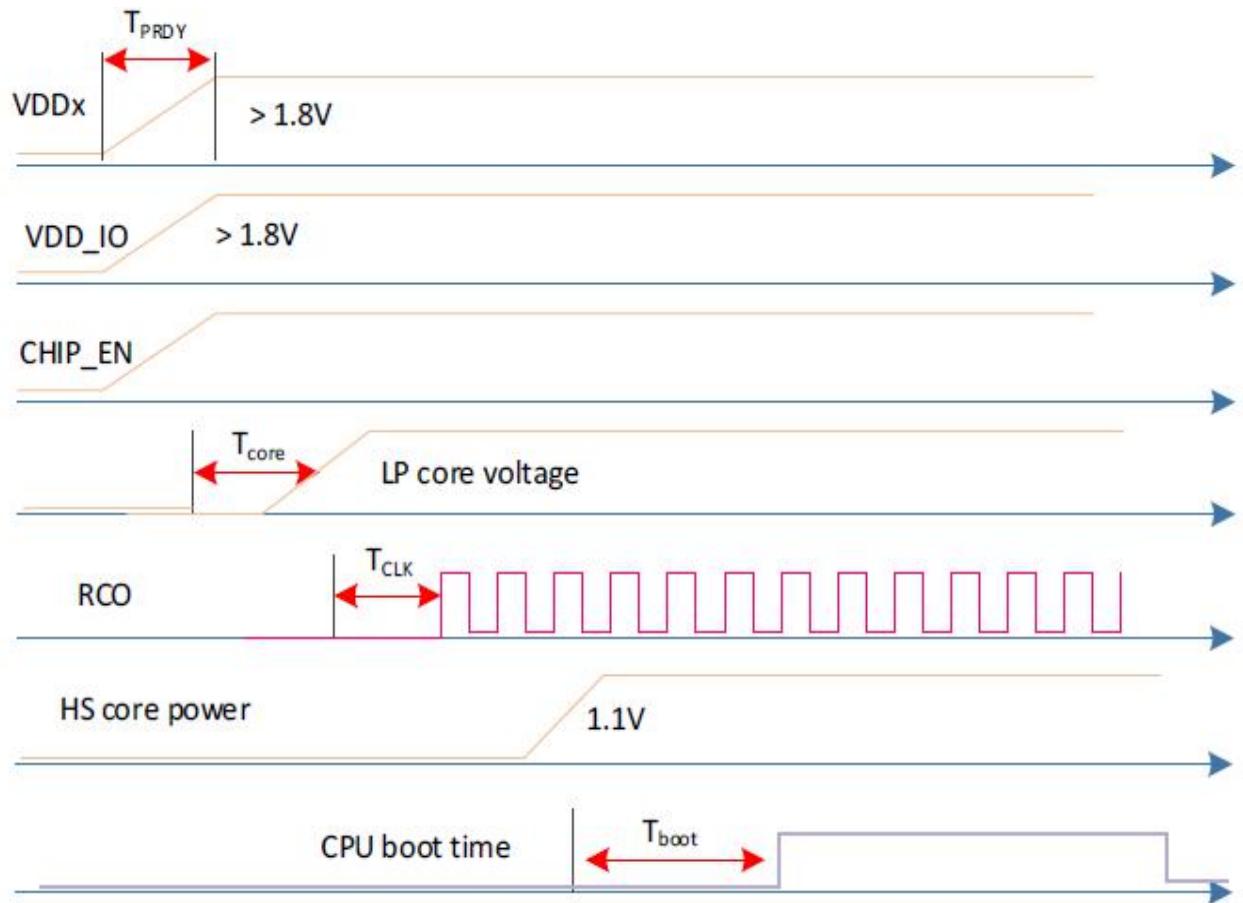


Fig 7-1 Timing sequence of power on or resuming from deepsleep

## 7.2 Shutdown sequence

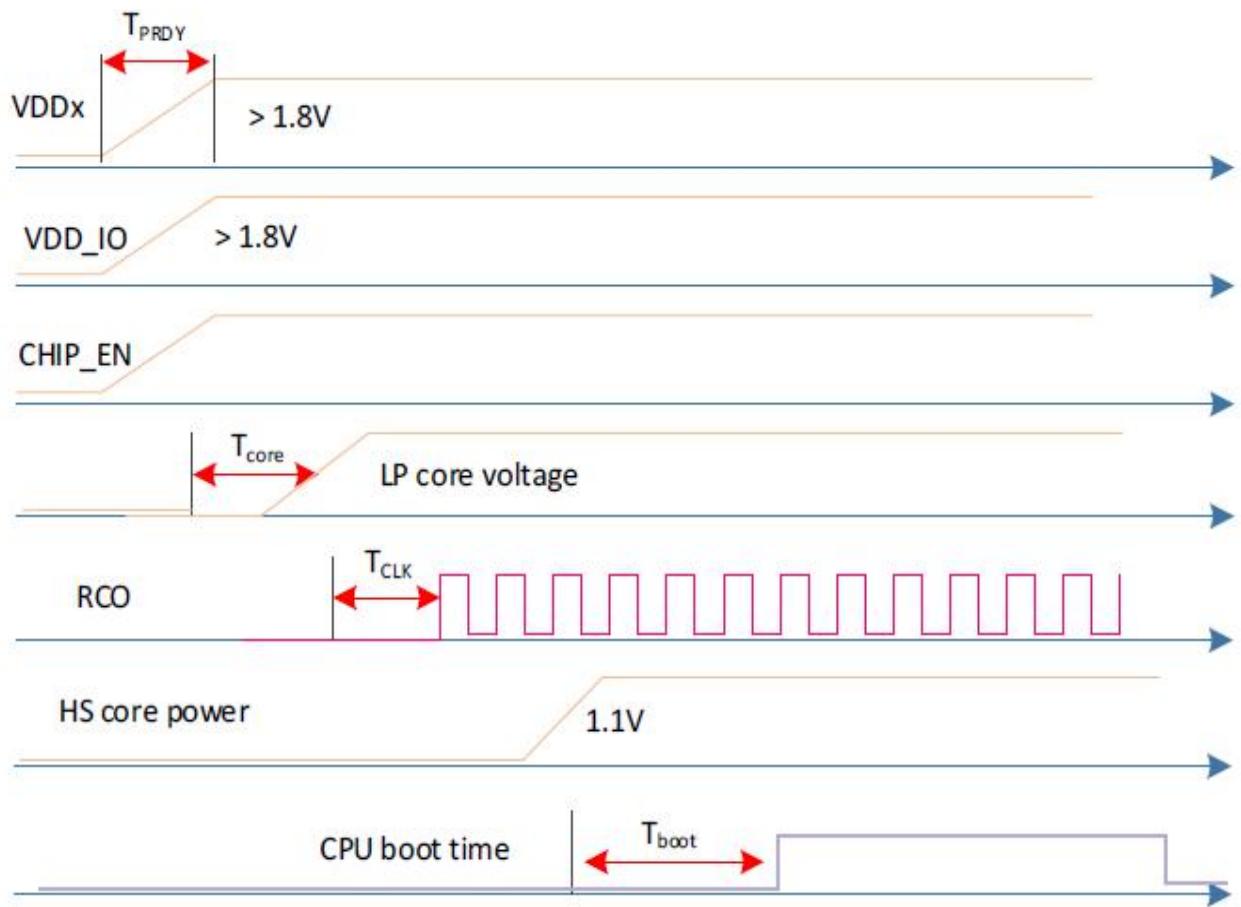


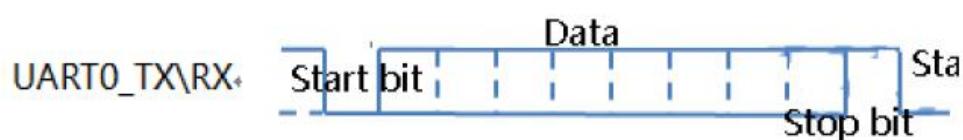
Fig 7-1 Timing sequence of power on or resuming from deepsleep

## 7.2 UART

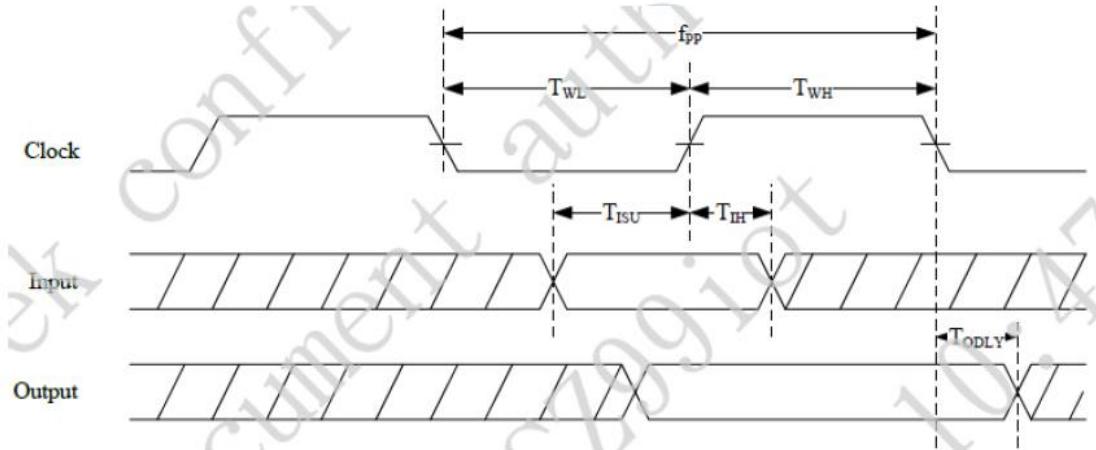
Normal no-data transmission state



Data transfer status

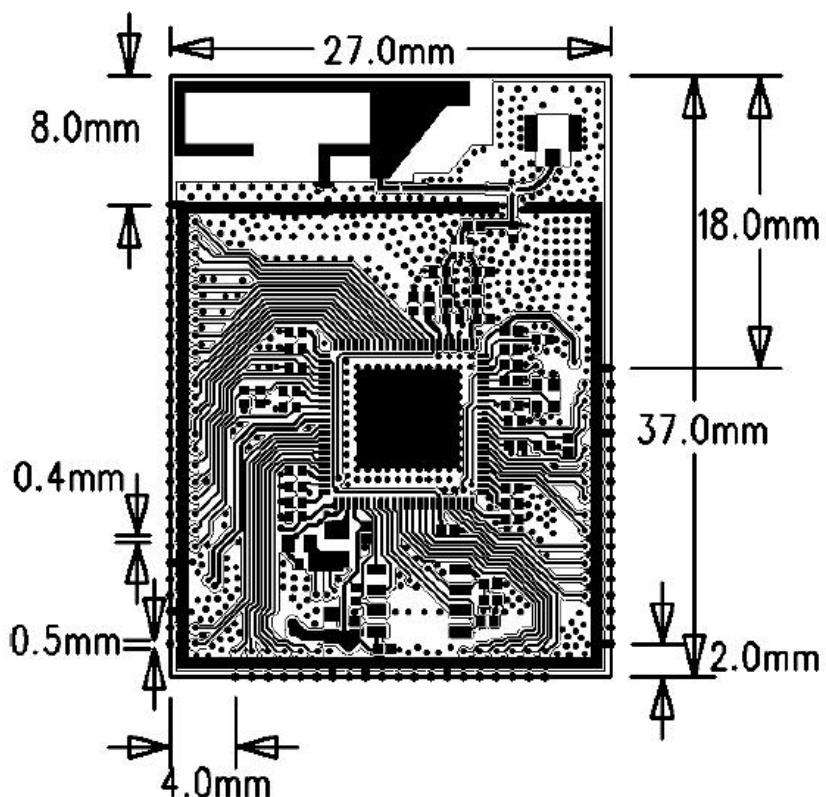


### 7.3 SDIO device

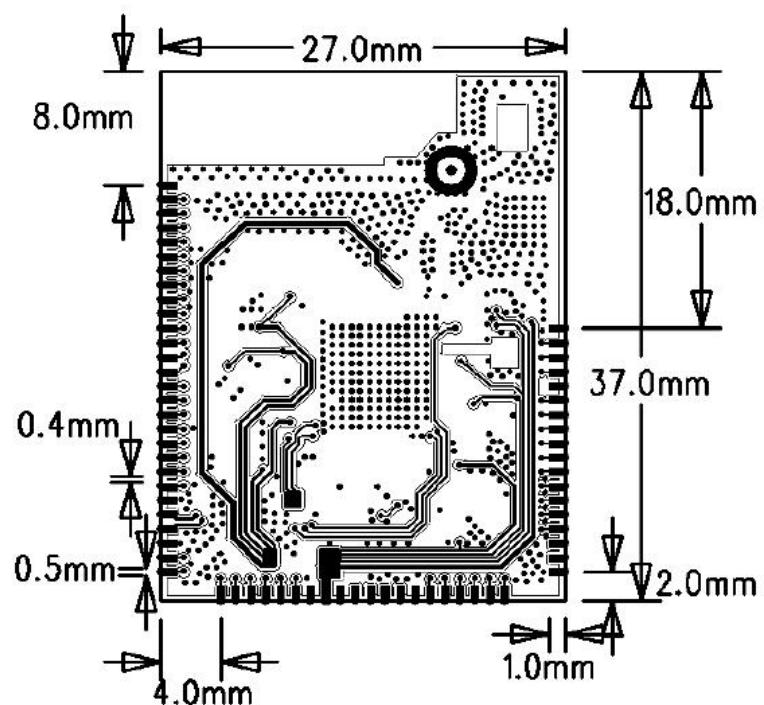


NO	Parameter	MODE	MIN	MAX	Unit
$f_{PP}$	Clock Frequency	Default	0	25	MHz
		HS	0	50	MHz
$T_{WL}$	Clock Low Time	DEF	10	—	ns
		HS	7	—	Ns
$T_{WH}$	Clock High Time	DEF	10	—	ns
		HS	7	—	ns
$T_{ISU}$	Input Setup Time	DEF	5	—	ns
		HS	6	—	ns
$T_{IH}$	Input Hold Time	DEF	5	—	ns
		HS	2	—	ns
$T_{ODLY}$	Output Delay Time		—	14	ns

### 8. Outline Dimension



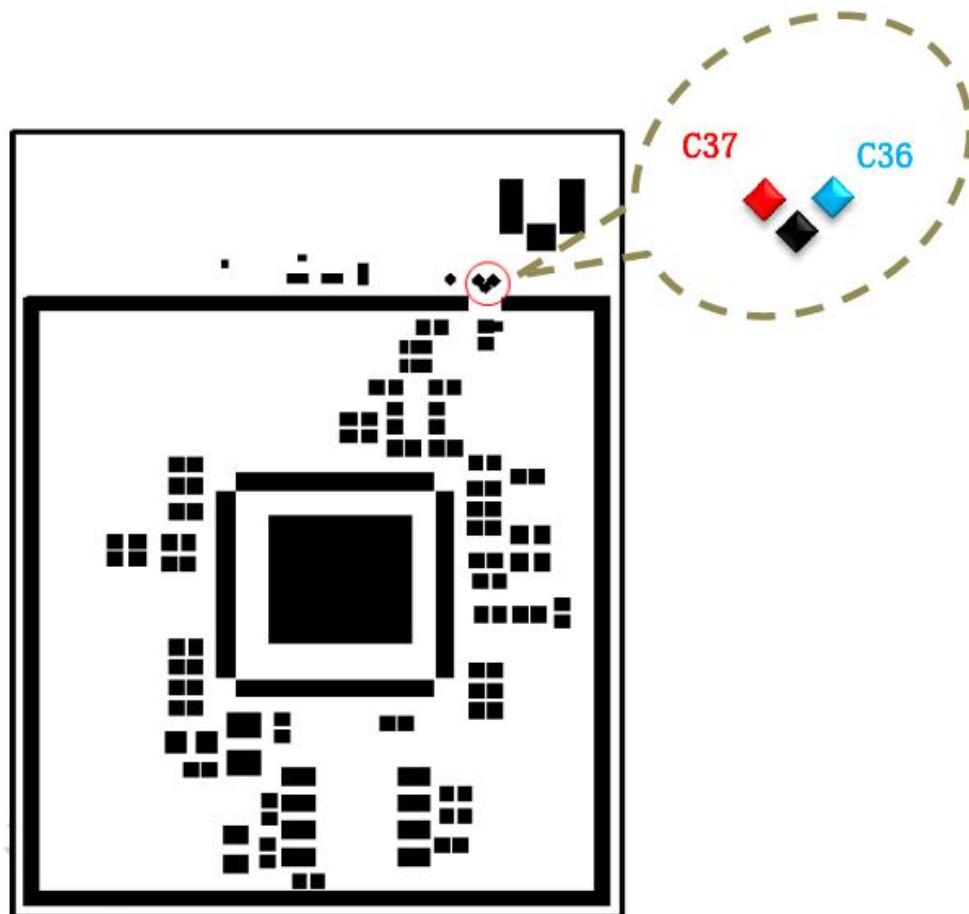
TOP



BOTTOM

### Size specification

The Pin foot pad itself consists of a half hole and a rectangular bottom pad with a hole diameter of 0.5mm and a rectangular width of 0.8mm, PIN Pitch:1.0 mm (PIN1-PIN66)



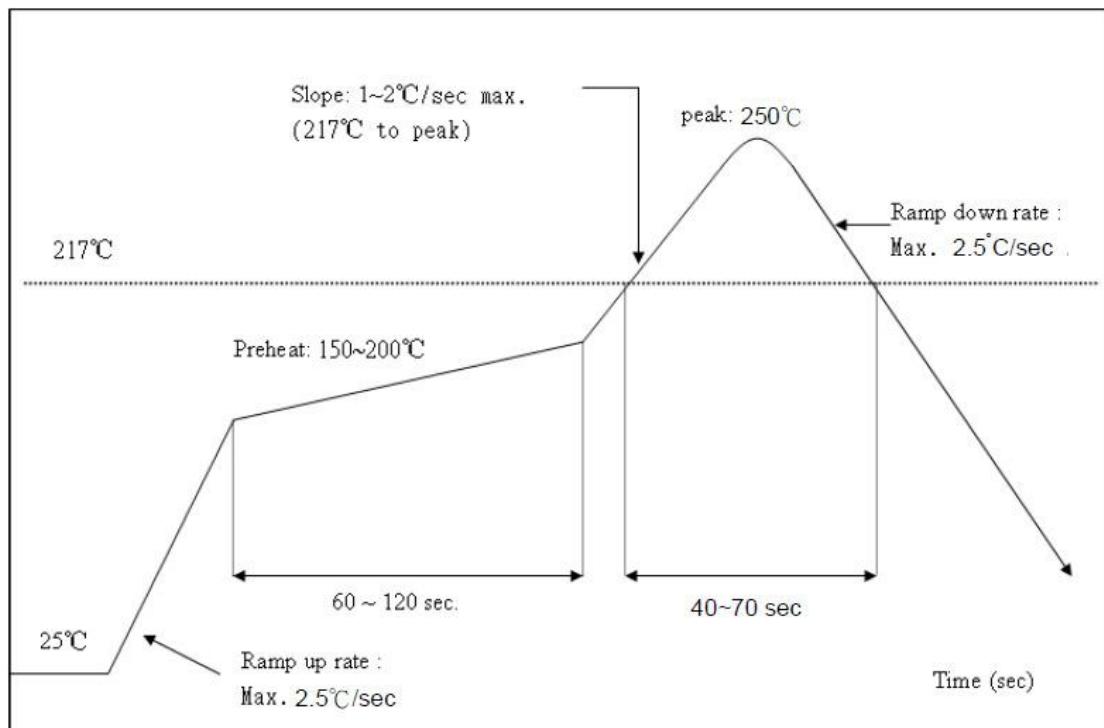
Part No.	Description	Resistance
AFM431TI	PCB onboard antenna	C36
AFM431TO	IPEX external antenna	C37

### 9 Production Guide

#### 9.1 Recommended furnace temperature curve

Referred to IPC/JEDEC standard.

Peak Temperature:<250°C. Number of Times: ≤2 times



## 9.2 Storage conditions of factory modules

- A, moisture-proof bag must be stored at temperature < 30°C, humidity < 85%RH.
- B. The shelf life of dry packaged products should be 6 months from the date of sealing the package.
- Note:
- A. In the whole process of production, operators at all stations must wear electrostatic rings.
  - B. Strictly prevent the module from being stained with water or dirt during operation.