



Specification of AFW121Tx Wi-Fi Module

V1.2

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Patent statements

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Introduction

AFW121Tx is the fifth generation of small-volume embedded Wi-Fi module developed by 99 Internet of Things by adopting SoC solution of Realtek, built-in ARM Cortex-M4 processing core. It has large storage (FLASH: 1MB ROM: 512KB) (FLASH: can be 128MB), operation space (SRAM: 256KB) and abundant peripheral resources, so after the professional optimization, it can meet the demands of a variety of embedded Wi-Fi wireless communication applications.

1 Basic parameters

1.1 Main performance parameters

- ARM Cortex-M4 processing core, basic frequency of 62.5MHz
- Single supply of 3.3V DC
- Package: AFW121T small size of 22×18mm
- AF-W123T small size of 30×22mm

1.2 Peripheral resources

Peripheral resources	AFW122T	AFW123T
GPIOs	11	33
UARTs	2(1x HS/ 1x Std for log)	3(2x HS/ 1x Std for log)
SPI	2	2
I2C	2	2
PWM	5	8
USB-device	0	1
Programming device interface	JTAG/SWD	JTAG/SWD
WDG	1	1
IIS	0	1
RTC	1	1
ADC	2 (1*Vbat 1thermal)	4 (1*Vbat/1*thermal/2Normal)



1.3 Wi-Fi parameters

- Standard: 802.11 b/g/n 1x1
- Transmitting power: 11b: 17dBm / 11g: 15dBm / 11n: 13dBm
- Receiving sensitivity: 11b: -93dBm / 11g: -91dBm / 11n: -85dBm
- Communication rate: 11Mbps @11b / 54Mbps @11g / 150Mbps @11n
- Working mode: STA、AP、STA+AP
- Hardware encryption: WPA/WPA2
- Antenna: outer antenna, IPEX antenna interface, onboard antenna
- Power consumption: Deep sleep: 7uA Standby:50uA
Run mode: 120mA

1.4 Product characteristics

- Complete Internet of Things solution (SDK, cloud service, APP)
- Supporting the complete secondary development of AT+ application set
- Supporting the secondary development of C-SDK
- Supporting OTA wireless upgrading
- Supporting low-frequency low-power consumption mode, supporting wake-up, connecting and data packet transmission within 2ms
- Supporting functions of Simple Configuration intelligent networking, Airkiss WeChat distribution network
- Providing fast connecting + softap distribution network app “99link” (app-SDK can be provided)
- Industrial application design, 2-layer PCB design, guarantee of performance consistency
- Complying with FCC/CE standard and RoHS standard



1.5 Software characteristics

- Built-in IPV4/IPV6 protocol stack
- Built-in FreeRTOS management system
- Supporting HTTP / HTTPS (SSL) encryption
- Supporting Baidu cloud, Amazon, Jingdong cloud, Ali cloud
- Being able to support customized private cloud or user private cloud
- Supporting the secondary development, flexible and convenient secondary integration



2 General

Characteristics

- Supporting IEEE802.11B/G/N standard, the integration of ARM-CM4F, WLAN MAC/RF/Baseband PHY, compatible with the device of 802.11b/g in working mode of 802.11n
- The maximum transmission rate reaches 72.2Mbps when using bandwidth of 20MHZ, and reaches 150Mbps for bandwidth of 40MHZ
- Supporting RAM read protection
- Digital signature for the firmware to ensure its integrity and legitimacy and to prevent being replaced or tampered in the OTA process
- Being able to apply for the keys for customers, save the device certificate issued from the cloud which can identify the corresponding device connectivity to prevent illegal, non-security device access to the server
- The device can be connected to the cloud to

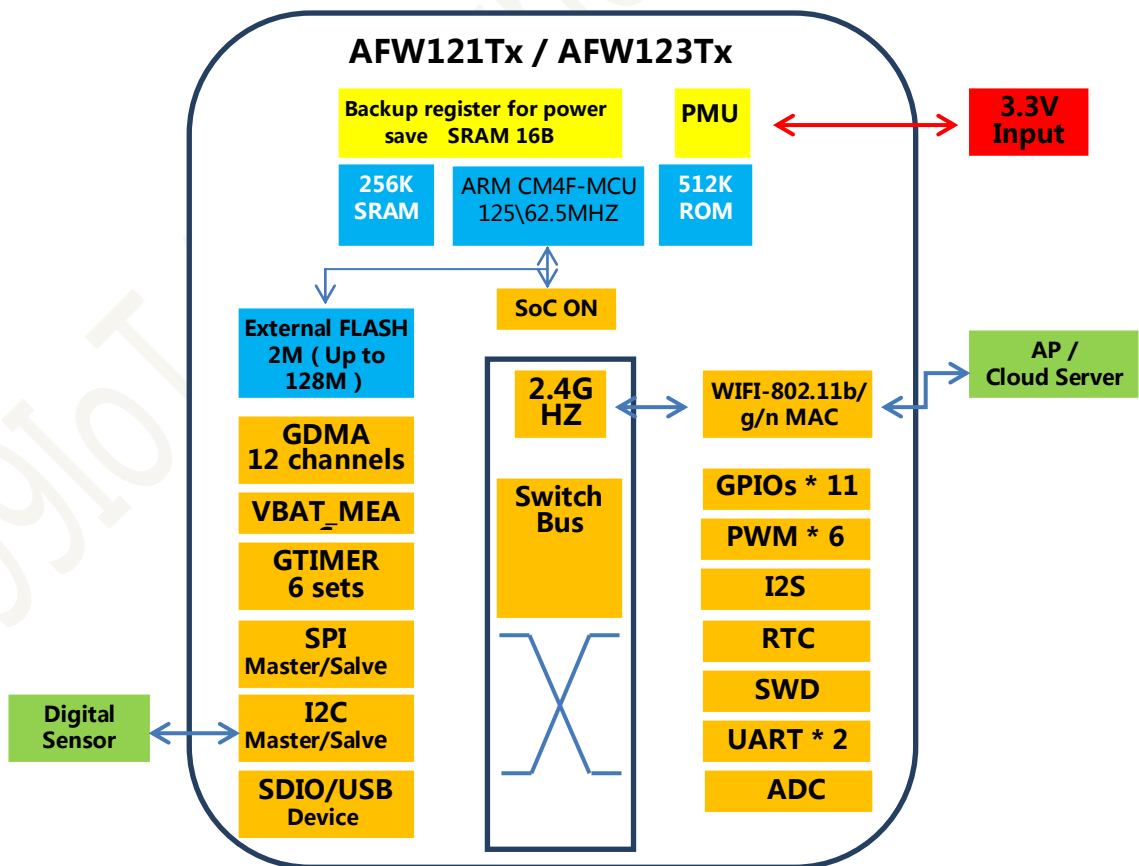
prevent code and data acquisition

Applications

- Intelligent lighting
- Intelligent socket
- Industrial control
- Remote device monitoring
- Internet of Things applications
- Thermal printer
- LED control card
- Electronic scales

Module type

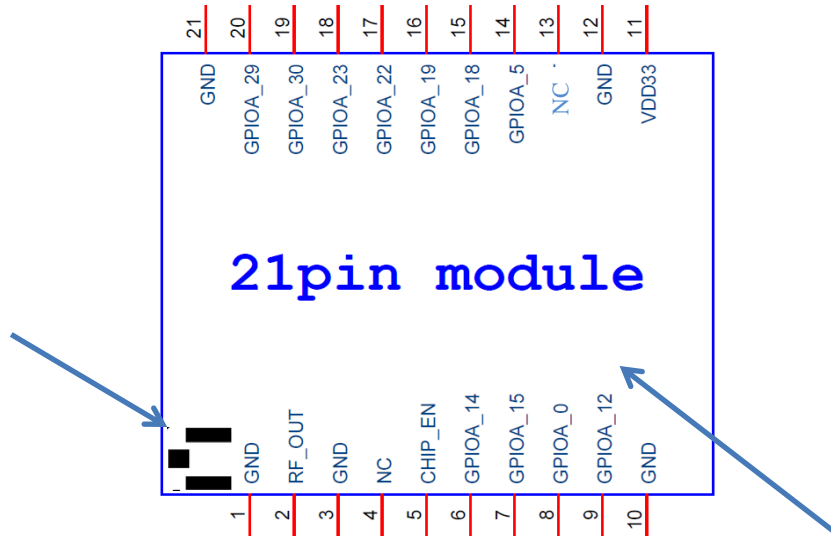
Module name	Module description
AFW121TI	PCB onboard antenna
AFW121TO	IPEX outer antenna



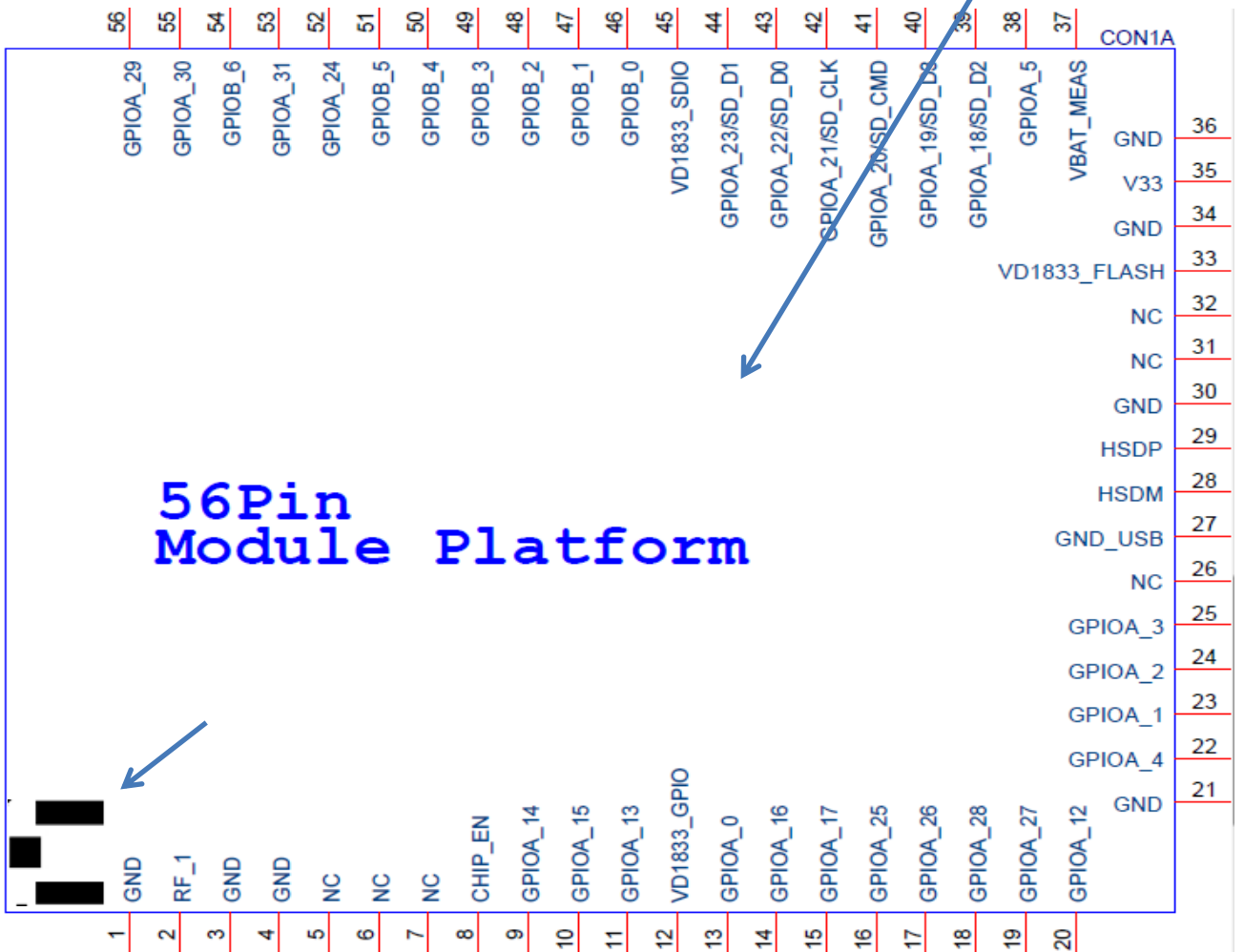


3 Pin arrangement and function

AFW121T : 22*18mm



AFW123T : 30*20mm





3.1 Pin definition

AFW123T

Pin	Name/ main function	Type	Optional functions	Other functions
1	GND			
2	Wi-Fi-ANTENA			
3	GND			
4	GND			
5	NC			
6	NC			
7	NC			
8	CHIP_EN(RESET)	I		
9	GPIOA_14	I/O	PWM0/ SWD_CLK	
10	GPIOA_15	I/O	PWM1/ SWD_DATA	
11	GPIOA_13	I/O	PWM4	
12	VDD33_GPIO	I		
13	GPIOA_0		PWM2/EXT_32K/WL_LED	
14	GPIOA_16	I/O	UART2_Log_RXD/PWM1/RTC_OUT	
15	GPIOA_17	I/O	UART2_Log_TXD/PWM2	
16	GPIOA_25	I/O	UART1_RXD	
17	GPIOA_26	I/O	UART1_TXD	
18	GPIOA_28	I/O	I2C1_SCL	
19	GPIOA_27	I/O	I2C_SDA	
20	GPIOA_12	I/O	PWM3	
21	GND			
22	GPIOA_4	I/O	UART0_TXD / SPI1_MOSI/ SPI0_MOSI / I2C_SDA	
23	GPIOA_1	I/O	UART0_RXD / SPI1_CLK / SPI0_CLK / I2C0_SCL	
24	GPIOA_2	I/O	UART0_CTS / SPI1_CS / SPI0_CS / I2C_SDA	
25	GPIOA_3	I/O	UART0_RTS / SPI1_MISO SPS_LDO_SEL / SPI0_MISO / I2C1_SCL	
26	NC			
27	GND_USB			
28	HSDM			
29	HSDP			
30	GND			
31	NC			
32	NC			
33	VDD33_FLASH			



34	GND			
35	VCC33			
36	GND			
37	VBAT_MEAS			
38	GPIOA_5	I/O	SDIO_SIDEHAND_INT/ PWM4	
39	GPIOA_18	I/O	UART0_RXD/SPI1_CLK /SPI0_CLK / I2C1_SCL / SD_D2/ TIMER4_TRIG/ I2S_MCK	
40	GPIOA_19	I/O	UART0_CTS/SPI1_CS/SPI0_CS I2C0_SDA/SD_D3/TIMER5_TRIG I2S_SD_TX	
41	GPIOA_20	I/O	SD_CMD / I2S_SD_RX	
42	GPIOA_21	I/O	SD_CLK / PWM3 / I2S_CLK	
43	GPIOA_22	I/O	UART0_RTS / SPI1_MISO/ SPI0_MISO / I2C0_SCL SD_D0 / PWM5 / I2S_WS	
44	GPIOA_23	I/O	UART0_TXD/ SPI1_MOSI/ SPI0_MOSI / I2C1_SDA SD_D1 / PWM0	
45	VDD33_SDIO			
46	GPIOB_0	I/O	SPI0_CS/ SPI1_CS	
47	GPIOB_1	I/O	SPI0_CLK / SPI1_CLK	
48	GPIOB_2	I/O	SPI0_MISO/ SPI1_MISO	
49	GPIOB_3	I/O	SPI0_MOSI/ SPI1_MOSI	
50	GPIOB_4	I/O	SWD_CLK / I2S_MCK	
51	GPIOB_5	I/O	SWD_DATA/ I2S_SD_TX	
52	GPIOA_24	I/O	I2S_SD_RX	
53	GPIOA_31	I/O	I2S_CLK	
54	GPIOB_6	I/O	I2S/WS	
55	GPIOA_30	I/O	UART2_Log_TXD/ I2C0_SDA/ PWM3 / RTC_OUT	
56	GPIOA_29	I/O	UART2_Log_RXD / I2C0_SCL PWM4	

Note:

1. PIN55, 56 are for input and output port when Wi-Fi debugs LOG information.
2. PIN 55 of module AFW123Tx needs to be pulled up to 3.3V externally, or floating, or to ensure that power-on time isn't low level.
3. Please keep CHIP_EN or other pins floating if they are not used.

**AFW122T**

Pin	Name/ main function	Type	Optional functions	Other functions
1	GND			
2	Wi-Fi-ANTENA			
3	GND			
4	NC/GND			
5	CHIP_EN(RESET)	I	Power ON \ OFF	Reset
6	GPIOA_14	I/O	PWM0/ SWD_CLK	
7	GPIOA_15	I/O	PWM1/ SWD_DATA	
8	GPIOA_0	I/O	PWM2/EXT_32K/WL_LED	
9	GPIOA_12	I/O	PWM3	
10	GND			
11	VDD33			
12	GND			
13	VBAT_MEAS			
14	GPIOA_5	I/O	SDIO_SIDEHAND_INT/ PWM4	
15	GPIOA_18	I/O	UART0_RXD/SPI1_CLK /SPI0_CLK / I2C1_SCL / SD_D2/TIMER4_TRIG/ I2S_MCK	
16	GPIOA_19	I/O	UART0_CTS/SPI1_CS/SPI0_CS I2C0_SDA/SD_D3/TIMER5_TRIG I2S_SD_TX	
17	GPIOA_22	I/O	UART0_RTS / SPI1_MISO/ SPI0_MISO / I2C0_SCL SD_D0 / PWM5 / I2S_WS	
18	GPIOA_23	I/O	UART0_TXD/ SPI1_MOSI/ SPI0_MOSI / I2C1_SDA SD_D1 / PWM0	
19	GPIOA_30	I/O	UART2_Log_TXD/ I2C0_SDA/ PWM3 / RTC_OUT	
20	GPIOA_29	I/O	UART2_Log_RXD / I2C0_SCL PWM4	
21	GND			

Note:

- PIN19, 20 are for input and output port when Wi-Fi debugs LOG information.
- PIN 19 of module AFW121Tx needs to be pulled up to 3.3V externally, or floating, or to ensure that power-on time isn't low level.
- Please keep CHIP_EN or other pins floating if they are not used.



4 Electrical characteristics

4.1 Rated limit

Symbol	Parameter	Minimum value	Representative value	Maximum value	Unit
VDD33	Supply voltage	3.0	3.3	3.6	V
VIO_IN	Pin input voltage	3.0	3.3	3.6	V

Symbol	Parameter	Maximum value	Unit
I _{VDD}	Rated current for 3.3V	450	mA
I _{DD-IO}	Total rated current of I/O pin	200	mA
I _{DD-IO-3.3}	Total rated current of 3.3V I/O pin	50	mA
I _{IO}	Pull-up current of I/O pin	20	mA
	Output current of I/O pin	20	mA

4.2 Working condition

Symbol	Parameter	Minimum value	Representative value	Maximum value	Unit
V _{DD}	Supply voltage range	3.0	3.3	3.6	V
V _{DD-IO}	Voltage range by IO supply	1.62	1.8~3.3	3.6	V
V _{A1.2}	Voltage range by 1.2V core supply	1.08	1.2	1.32	V

Symbol	Parameter	Condition	Representative value	unit
I _{PK}	Peak operating current	Connecting transmission	162	mA
I _{STB}	Standby current	Deep sleep	5.5	uA



4.3 I/O pin characteristic

4.3.1 Pin input level

Symbol	Parameter	Condition	Minimum value	Maximum value	Unit
V_{IL}	Input low level	$3.0V \leq V_{DD} \leq 3.6V$	—	0.8	V
V_{IH}	Input high level	$3.0V \leq V_{DD} \leq 3.6V$	$0.7V_{DD}$	—	V

4.3.2 Pin output level

Symbol	Parameter	Condition	Minimum value	Maximum value	Unit
V_{OL}	Output low level	$I_{IO} = +8mA$ $3.0V \leq V_{DD} \leq 3.6$	—	0.4	V
V_{OH}	Output high level		$V_{DD} - 0.4$	—	V
V_{OL}	Output low level	$I_{IO} = +20mA$ $3.0V \leq V_{DD} \leq 3.6$	—	1.3	V
V_{OH}	Output high level		$V_{DD} - 1.3$	—	V

4.4 ESD performance

Symbol	Parameter	Condition	Grade	Maximum value	Unit
$V_{ESD} - HB$	ESD voltage (HBM)	$T_{AMB} = +25^{\circ}C$ (JESD22 - A114)		2000	V
$V_{ESD} - CD$	ESD voltage (CDM)	$T_{AMB} = +25^{\circ}C$ (JESD22 - C101)		500	V



5 Power mode and power consumption

5.1 Summary of power mode and representative power consumption parameters

Power mode	Power consumption		
	Representative value	Maximum value	Unit
Deep Sleep Mode	7	7	uA
Deep Standby Mode	50	70	uA
Sleep Power Gate	100	120	uA
Sleep Clock Gate	300	350	uA
Run mode	120	300	mA

5.2 Description of power mode

5.2.1 Start-up and description of power mode

Deep Sleep Mode

CHIP_EN base pin is kept at high level, entering Deep Sleep Mode via API interface command.

Deep Standby Mode

CHIP_EN base pin is kept at high level, entering Deep Standby Mode via API interface command.

Sleep Power Gate

Turning off power domain, including Cortex-M4 kernel and system clock, the system needs no restarting after wake-up.

Sleep Clock Gate

Sleep mode turn off system clock. System is not required to restart after wakeup



5.2.2 Functional status

Mode	Deep Sleep	Deep Standby	Sleep Power	Sleep Clock
Cortex-M4	OFF	OFF	OFF	ON
System	OFF	OFF	OFF	OFF
SRAM	OFF	OFF	ON	ON
Peripherals	OFF	OFF	ON	ON
Backup	OFF	ON	ON	ON
RTC	OFF	ON	ON	ON
low	ON	ON	ON	ON
Wake pin	ON	ON	ON	ON
System	ON	ON	ON	ON

5.2.3 Wake-up type

Mode	Deep Sleep Mode	Deep Standby Mode	Sleep Power Gate	Sleep Clock Gate
Wake pin	GPIOA_5 GPIOA_18 GPIOA_22 GPIOA_23	GPIOA_5 GPIOA_18 GPIOA_22 GPIOA_23	GPIOA_5 GPIOA_18 GPIOA_22 GPIOA_23	GPIOA_5 GPIOA_18 GPIOA_22 GPIOA_23
Low precision timer	YES	YES	YES	YES
RTC	———	YES	YES	YES
System timer	———	YES	YES	YES
Peripherals	———	———	GPIO_interrupt wlan ADC UART I2C SDIO/GSPI	GPIO_interrupt wlan ADC UART I2C SDIO/GSPI



6 Temperature and humidity characteristics

6.1 Temperature

Working temperature : -20 to 85 °C

Storage temperature : -55 to 125 °C

Junction temperature : 0 to 125 °C (temperature inside semiconductor component)

6.2 Humidity

Ambient humidity : relative humidity MAX 95%, no condensation

7 RF characteristics

7.1 Basic parameters

Parameter	Index
Working frequency	2.412 - 2.472GHz
Wi-Fi standard	IEEE 802.11 b/g/n
Modulation mode	802.11b : DSSS or CCK ; 802.11g : OFDM ; 802.11n : OFDM (MIMO-OFDM technique)
Communication rate	11Mbps @802.11b ; 54Mbps @802.11g ; 150Mbps @802.11n
Antenna type	Onboard antenna or outer antenna (IPEX antenna socket)



7.2 Performance requirements of outer antenna

- Frequency band : 2400~2500MHz
- Antenna gain $\geq 3\text{dBi}$: antenna of 3dBi does good to the signal within 5 meters and the pond-shape in which it sends out signal is similar to the shape of two brackets ().
- Impedance of 50 ohm : 50 ohm in practical application takes account of voltage withstanding, power transmission and consumption, etc.
- Standing-wave ratio ≤ 2 : refers to whether the antenna matches the radio transmitting station, equaling to 1 means no emission of radio wave to antenna, greater than 1 means parts of the radio waves are reflected back.

7.3 TX test parameters

7.3.1 Transmission characteristics of IEEE802.11b

Parameter characteristics of CCK_11M in IEEE802.11b mode

Channel	Power(dBm)	EVM (dB)	FreqErr(ppm)
1	16.31dBm	-21.3dB	-0.07ppm
7	16.26dBm	-21.42dB	-0.11ppm
13	16.12dBm	-21.43dB	-0.16ppm

7.3.2 Transmission characteristics of IEEE802.11g

Parameter characteristics of OFDM_54M in IEEE802.11 mode

Channel	Power(dBm)	EVM (dB)	FreqErr(ppm)
1	14.71dBm	-32dB	-0.88ppm
7	14.52dBm	-30.93dB	-1.10ppm
13	15.09dBm	--33dB	-0.97ppm



7.3.3 Transmission characteristics of IEEE802.11n HT20

Parameter characteristics of HT20MHZ-MCS7 in IEEE802.11n mode

Channel	Power(dBm)	EVM (dB)	FreqErr(ppm)
1	13.75dBm	-35dB	-0.40ppm
6	13.28dBm	-34.42dB	-0.57ppm
11	13.38dBm	-34.93dB	-0.46ppm

7.3.4 Transmission characteristics of IEEE802.11n HT40

Parameter characteristics of HT40MHZ-MCS7 in IEEE802.11n mode

Channel	Power(dBm)	EVM (dB)	FreqErr(ppm)
3	13.46dBm	-34dB	-0.55ppm
7	13.14dBm	-34.96dB	-0.63ppm
11	13.06dBm	-34.98dB	-0.47ppm

7.4 RX test parameters

7.4.1 Receiving sensitivity characteristics of IEEE802.11b

Receiving sensitivity parameter characteristics of 11MHZ in IEEE802.11b mode (bandwidth 20M)

Channel	Pwr(dBm)
1	-90dBm
7	-91dBm
13	-87dBm

7.4.2 Receiving sensitivity characteristics of IEEE802.11g

Receiving sensitivity parameter characteristics of 54MHZ in IEEE802.11g mode (bandwidth 20M)

Channel	Pwr(dBm)
1	-77dBm
7	-76dBm
13	-76dBm

7.4.3 Receiving sensitivity characteristics of IEEE802.11n

Receiving sensitivity parameter characteristics of HT20-MSC7 in IEEE802.11n mode (bandwidth 20M)

Channel	Pwr(dBm)
1	-73dBm
6	-72dBm
11	-74dBm

7.4.4 Receiving sensitivity characteristics of IEEE802.11n

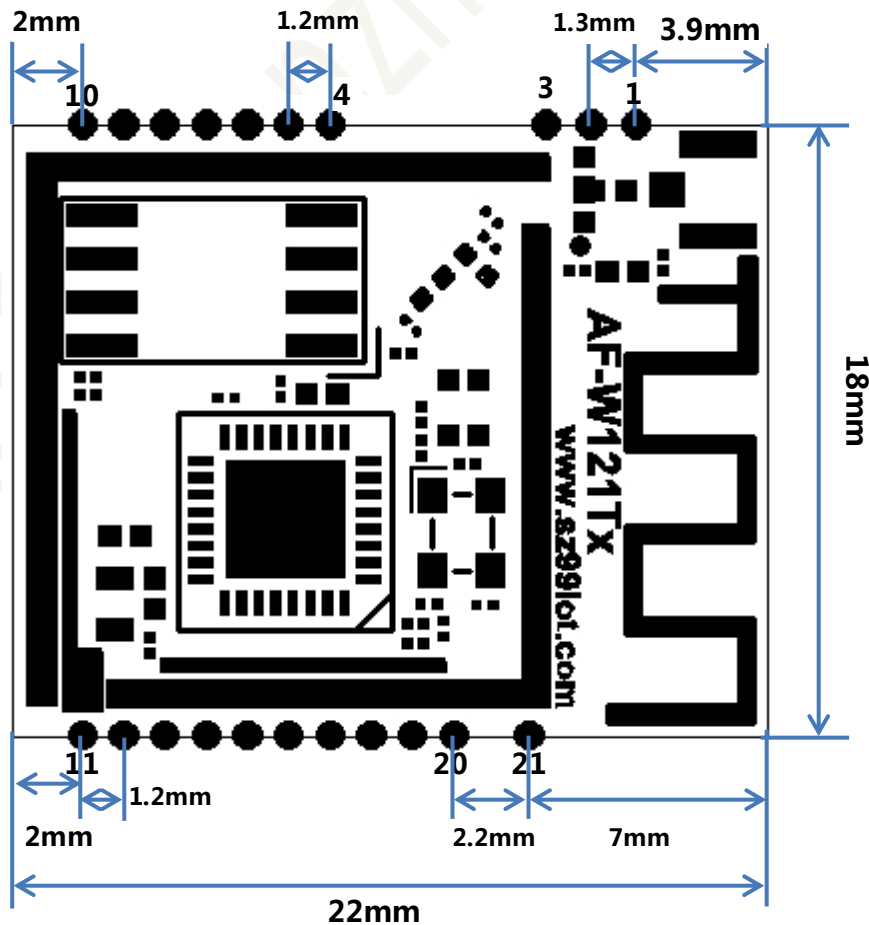
Receiving sensitivity parameter characteristics of HT40-MSC7 in IEEE802.11n mode (bandwidth 40M)

Channel	Pwr(dBm)
3	-69dBm
7	-68dBm
11	-69dBm

8 External dimensions, description of antenna matching type

8.1 AFW121Tx

8.1.1 External dimensions: 22 x 18 x 3.0 mm

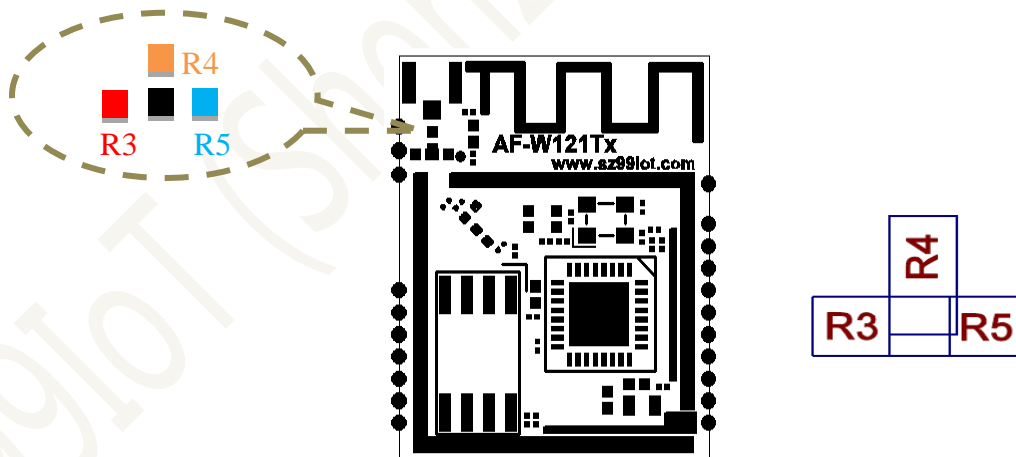
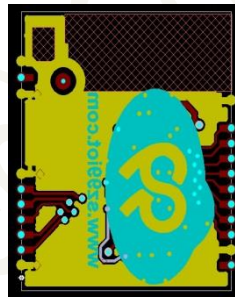


Dimension description:

Pin pad itself consists of semi-hole and rectangular bottom pad with hole diameter of 0.86mm, and rectangular width of 0.8mm.

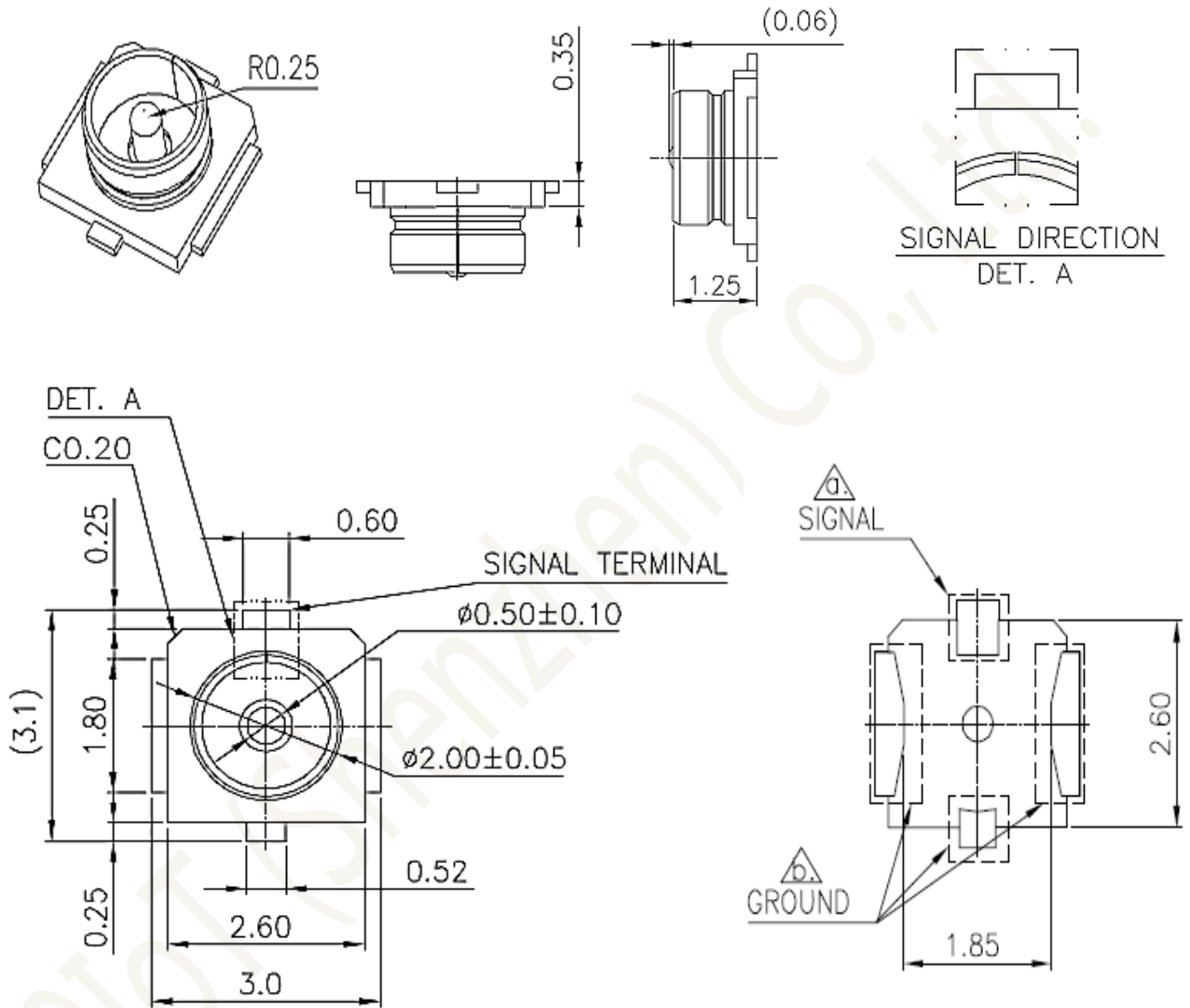
Pin	Description
1、 2、 3	The distance between centers of pins is 1.3mm
4、 5、 6、 7、 8、 9、 10	The distance between centers of pins is 1.2mm
11、 12、 13、 14、 15、 16、 17、 18、 19、 20	The distance between centers of pins is 1.2mm

8.1.2 Description of antenna matching type



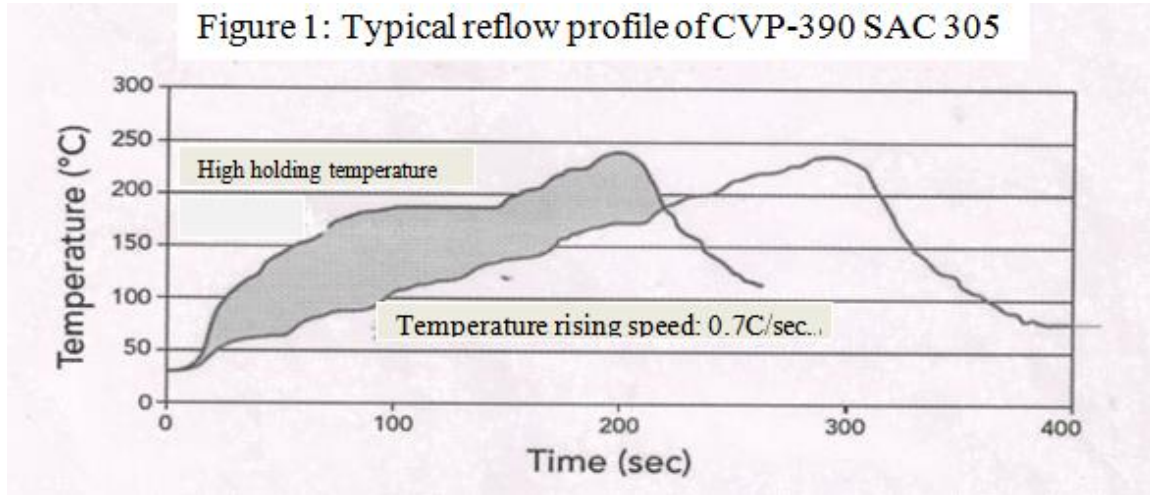
Module type	Antenna type	Gated resistance
AFW121TO	External antenna (through IPEX pedestal)	R4
AFW121TI	PCB onboard antenna	R5

9 Specification of IPEX pedestal

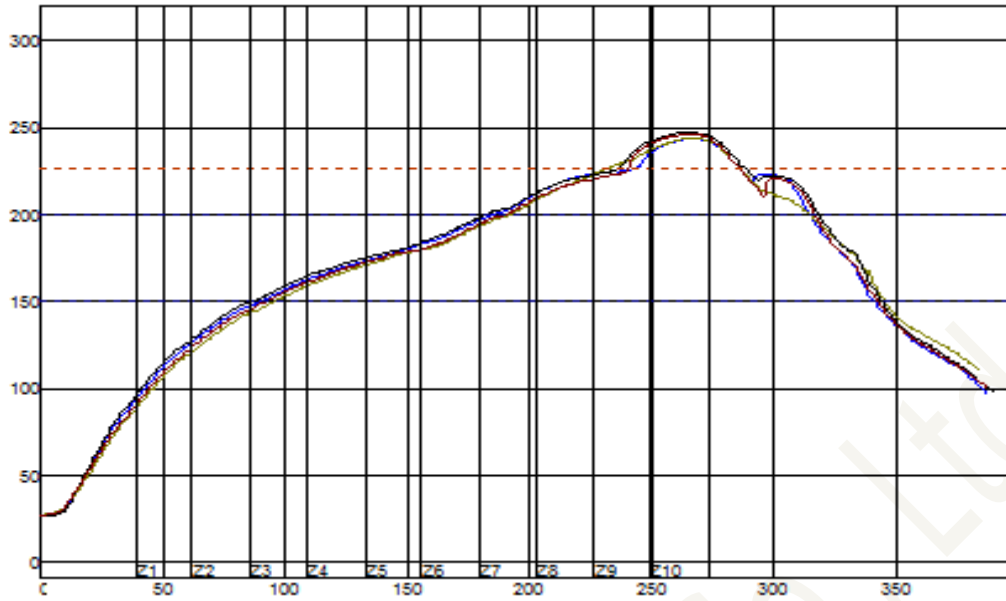


10 Thermal reflow profile

The reflow is suggested to be no more than twice



Advice on reflow profile		
Parameter	Recommended value	Other information
Reflow gas	Air or nitrogen	
SAC305, SAC405 SACX Plus™ 0807	Melting range of 217-225°C	
SACX Plus™ 0307	Melting range of 217-225°C	
Setting zone	Recommended remaining duration	Extending window
40°C -225°C	2:30-4:30min	Less than 5:00min
170°C -225°C	0:30-2:00min	Less than 2:30min
120°C -225°C	1:25-3:00min	Less than 3:30min
Temperature above liquidus point (217-225°C)	45-90sec	Not recommended
Peak temperature	235-245°C	Compatible with most common surface treatments (Entek HT, Entek OM, Alpha Star, ENIG, SACX HASL)
Cooling rate of welding spot from 170°C	1-6°C/sec	Maintaining the recommended speed helps prevent surface rupture.



The above recommended values are for SAC305 alloy only, please operate other alloys according to their liquidus point temperature.



Updating description of historical versions

Revision	Release Data	Summary
V1.0	2017/03/05	First draft
V1.1	2017/04/25	Adding type, hardware flow chart
V1.2	2017/06/10	Adding description of power mode, RF characteristics, external dimensions, IPEX specification

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