

SPA-MW21xx-M

Wireless Audio Module Datasheet

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1. Introductions

The SPA-MW21F3-X is a high performance wireless audio transceiver module, operating in both 5.2GHz and 5.8GHz WiFi bands. It offers 10Mbps bandwidth for lossless audio data transmission and delivers a stunning audio quality, ideal for multi-channel and Hi-Res wireless audio applications.

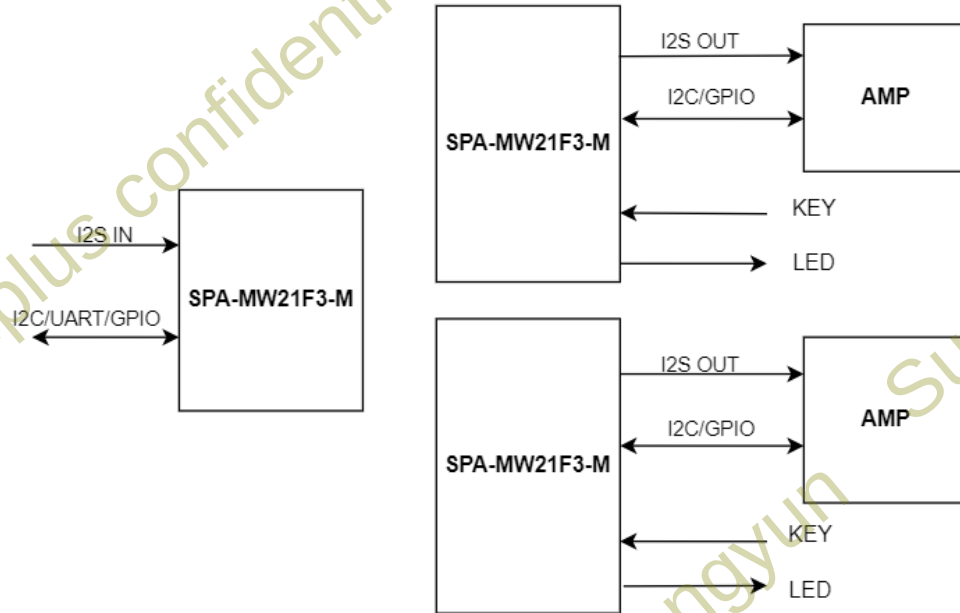


2. Key Features

- Low audio latency
- Low audio jitter
- Lossless audio transmission
- Maximum transmission bandwidth/channels
 - ◆ 8ch@44.1/48KHz, 24bit
 - ◆ 4ch@96KHz, 24bit
 - ◆ 2ch@192KHz, 24bit
- Support 8ch I2S in/out with rich configurations
 - ◆ master/slave mode
 - ◆ 16/24 bit
 - ◆ 44.1/48/96/192KHz sampling rate
- Radio frequency: 5.2G and 5.8G WiFi bands
- Dual antenna with diversity
- Adaptive channel selection algorithm
- Link distance up to 15m (w/o PA)
- Easy to integrate with MCUs, DSPs and amplifiers
- Bi-direction control channel
- Support OTA upgrade
 - ◆ upgrading time is less than 60 seconds for 1T8R system
- Low standby power consumption
- Small foot print

3. Applications

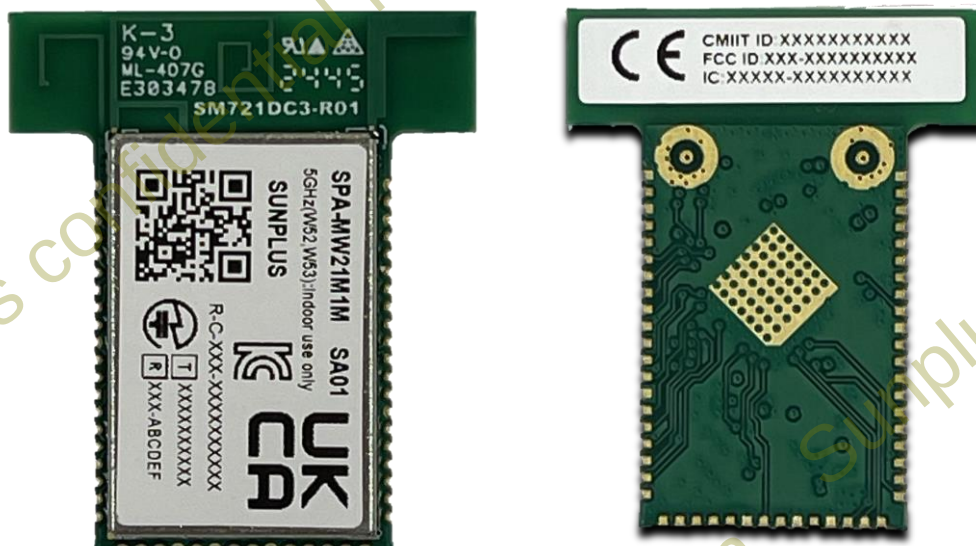
- Multi-channel wireless audio
- Hi-Res wireless audio

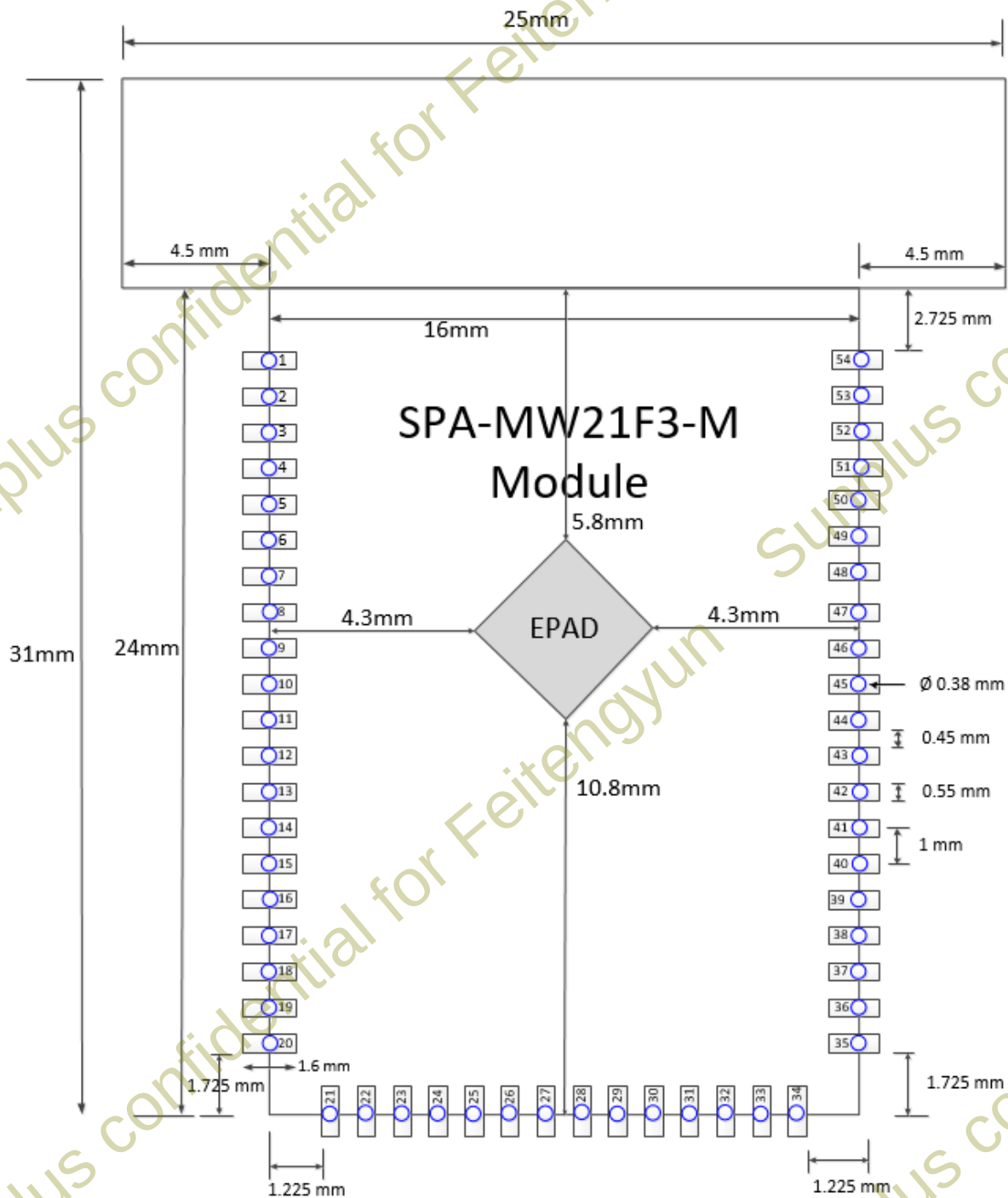


4. Module Pin Assignments

4.1 Module Package Outline

SPA-MW21F3-M



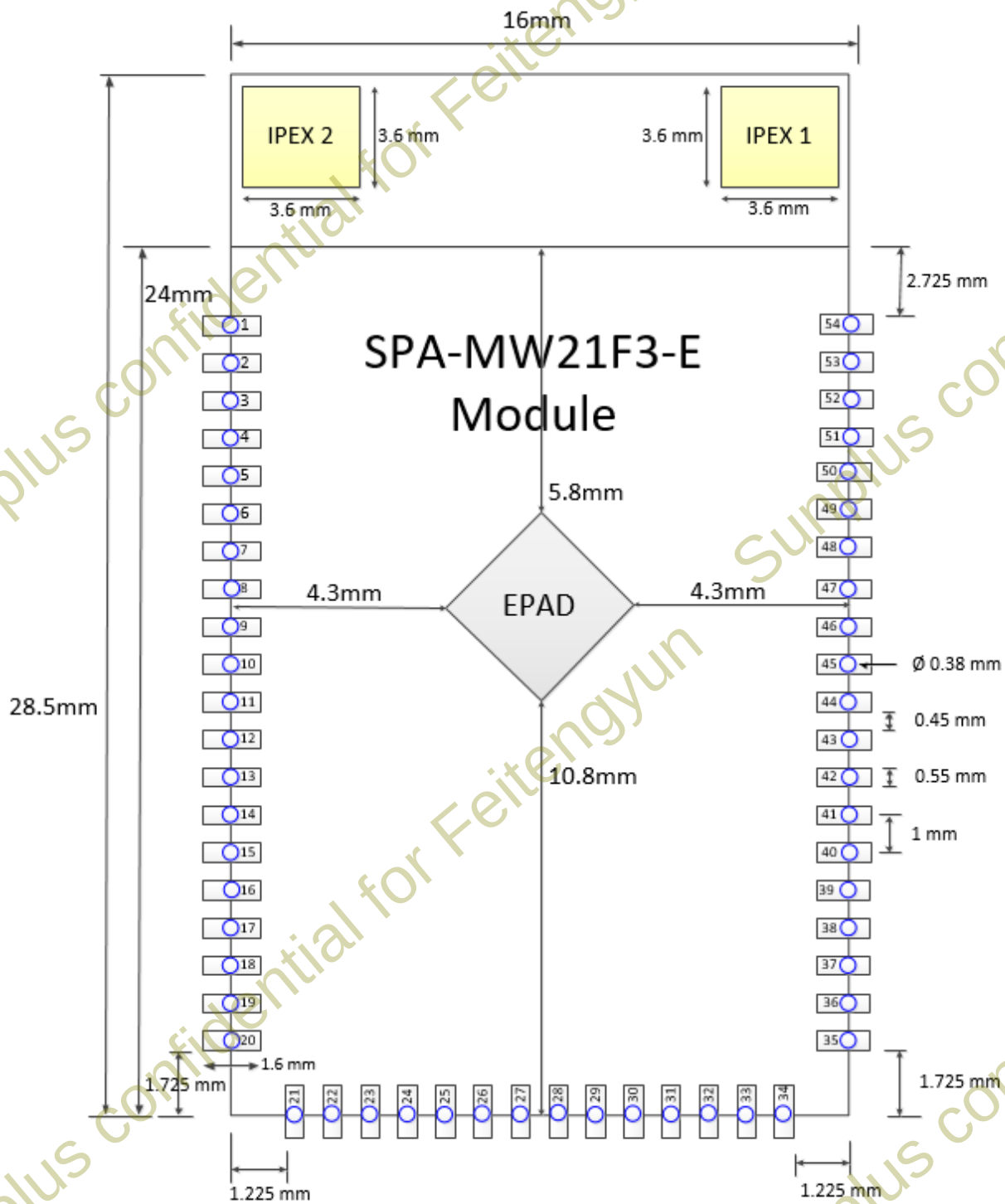


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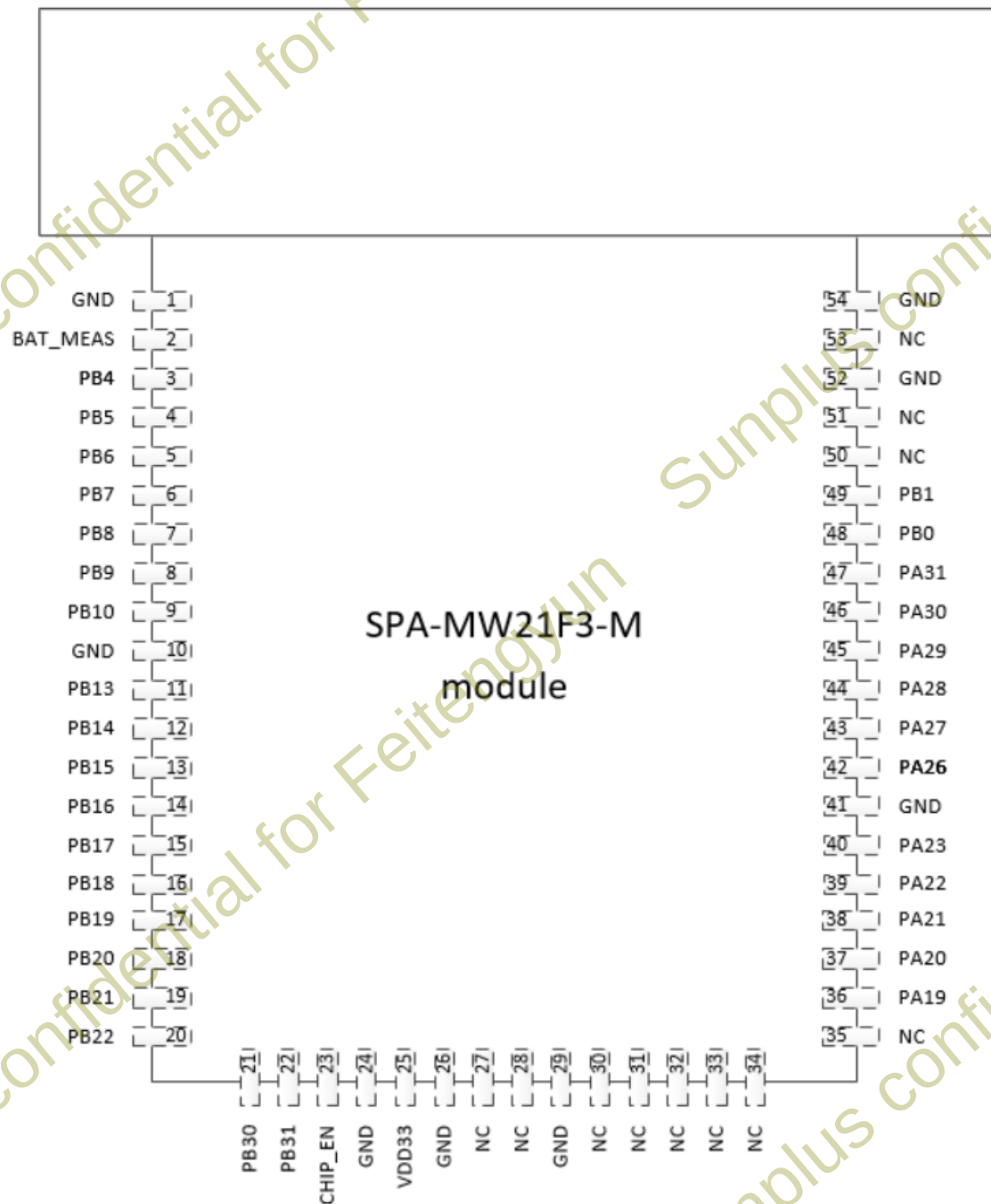
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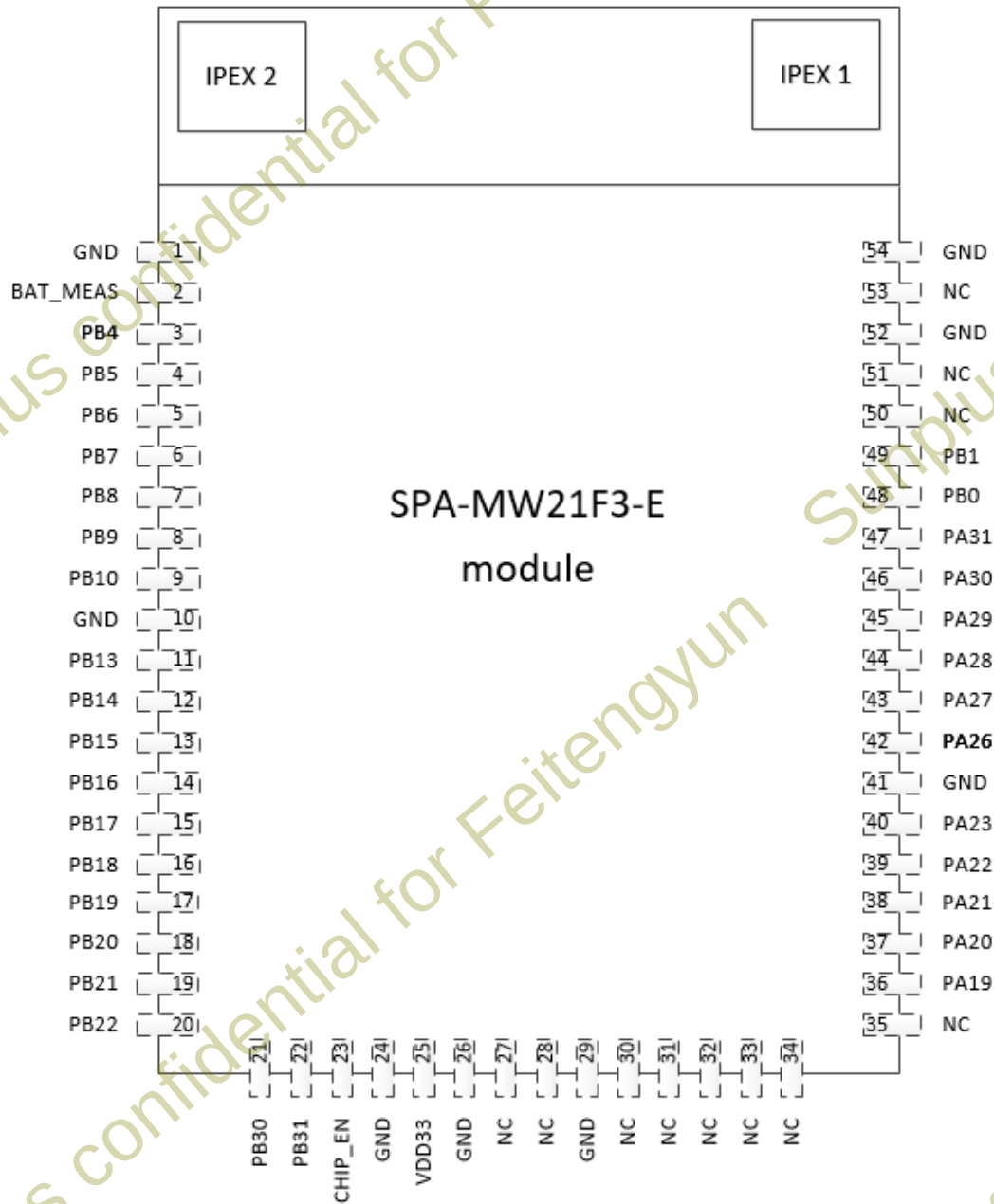


4.2 Module PCB Pin Outline

SPA MW21F3-M



SPA- MW21F3-E



4.3 Module Pin Type Definitions

Pin Type	Definition
3.3V-I/O	Digital Tristate Output with 3.3V tolerance Schmitt Trigger Input
PWR	Power pin
GND	Ground Pin

4.4 Tx Module Pinout Descriptions

PIN No.	PIN Name	PIN Type	GPIO	Description
1	GND	GND		Ground pin
2	NC	-		NC
3	UART_LOG_RX	3.3V-I/O	PB4	UART debug port
4	UART_LOG_TX	3.3V-I/O	PB5	UART debug port
5	FW_CFG_0	3.3V-I/O	PB6	Firmware configure pin 0
6	FW_CFG_1	3.3V-I/O	PB7	Firmware configure pin 1
7	FW_CFG_2	3.3V-I/O	PB8	Firmware configure pin 2
8	FW_CFG_3	3.3V-I/O	PB9	Firmware configure pin 3
9	PWM_LED1	3.3V-I/O	PB10	PWM LED control pin 1
10	GND	GND		Ground pin
11	PWM_LED2	3.3V-I/O	PB13	PWM LED control pin 2
12	I2C_SDA	3.3V-I/O	PB14	I2C data
13	I2C_SCL	3.3V-I/O	PB15	I2C clock
14	I2S_IN_D3	3.3V-I/O	PB16	Audio data 3 digital input
15	I2S_IN_D2	3.3V-I/O	PB17	Audio data 2 digital input
16	I2S_IN_D1	3.3V-I/O	PB18	Audio data 1 digital input
17	I2S_IN_D0	3.3V-I/O	PB19	Audio data 0 digital input
18	I2S_IN_BCK	3.3V-I/O	PB20	Audio data bit clock input
19	I2S_IN_LRCK	3.3V-I/O	PB21	Audio data word clock input
20	I2S_IN_MCK	3.3V-I/O	PB22	Audio data master clock output
21	WAKEUP_TX	3.3V-I/O	PB30	Wakeup Tx module
22	NC	-	PB31	NC
23	CHIP_EN	3.3V-I/O		Reset pin
24	GND	GND		Ground pin
25	VDD33	PWR		Power pin
26	GND	GND		Ground pin
27	NC	-	PA8	NC
28	NC	-	PA12	NC
29	GND	GND		Ground pin
30	NC	-	PA13	NC
31	NC	-	PA14	NC
32	NC	-	PA15	NC
33	NC	-	PA16	NC
34	NC	-	PA17	NC
35	NC	-	PA18	NC

PIN No.	PIN Name	PIN Type	GPIO	Description
36	I2S_O_MCK	3.3V-I/O	PA19	Audio data master clock output
37	I2S_O_LRCK	3.3V-I/O	PA20	Audio data word clock output
38	I2S_O_D1	3.3V-I/O	PA21	Audio data 1 digital output
39	I2S_O_D0	3.3V-I/O	PA22	Audio data 0 digital output
40	I2S_O_BCK	3.3V-I/O	PA23	Audio data bit clock output
41	GND	GND		Ground pin
42	I2S_O_D2	3.3V-I/O	PA26	Audio data 2 digital output
43	I2S_O_D3	3.3V-I/O	PA27	Audio data 3 digital output
44	TP	3.3V-I/O	PA28	Test Pin
45	TX_INT	3.3V-I/O	PA29	Tx interrupt to host
46	SWD_CLK	3.3V-I/O	PA30	SWD port
47	SWD_DATA	3.3V-I/O	PA31	SWD port
48	UART_TX	3.3V-I/O	PB0	UART control port
49	UART_RX	3.3V-I/O	PB1	UART control port
50	NC	-	PB2	NC
51	NC	-	PB3	NC
52	GND	GND		Ground pin
53	NC	-		NC
54	GND	GND		Ground pin

4.5 Rx Module Pinout Descriptions

PIN No.	PIN Name	PIN Type	GPIO	Description
1	GND	GND		Ground pin
2	NC	-		NC
3	UART_LOG_RX	3.3V-I/O	PB4	UART debug port
4	UART_LOG_TX	3.3V-I/O	PB5	UART debug port
5	CH_CFG_0	3.3V-I/O	PB6	Channel configure pin 0
6	CH_CFG_1	3.3V-I/O	PB7	Channel configure pin 1
7	CH_CFG_2	3.3V-I/O	PB8	Channel configure pin 2
8	CH_CFG_3	3.3V-I/O	PB9	Channel configure pin 3
9	PWM_LED1	3.3V-I/O	PB10	PWM LED control pin 1
10	GND	GND		Ground pin
11	PWM_LED2	3.3V-I/O	PB13	PWM LED control pin 2
12	I2C_SDA	3.3V-I/O	PB14	I2C data
13	I2C_SCL	3.3V-I/O	PB15	I2C clock
14	FW_CFG_0	3.3V-I/O	PB16	Firmware configure pin 0
15	FW_CFG_1	3.3V-I/O	PB17	Firmware configure pin 1
16	FW_CFG_2	3.3V-I/O	PB18	Firmware configure pin 2
17	FW_CFG_3	3.3V-I/O	PB19	Firmware configure pin 3
18	PAIR_KEY	3.3V-I/O	PB20	Pairing key
19	KEY1	3.3V-I/O	PB21	User key 1
20	KEY2	3.3V-I/O	PB22	User key 2
21	POWER_KEY	3.3V-I/O	PB30	Power key

PIN No.	PIN Name	PIN Type	GPIO	Description
22	NC	-		NC
23	CHIP_EN	3.3V-I/O		Reset pin
24	GND	GND		Ground pin
25	VDD33	PWR		Power pin
26	GND	GND		Ground pin
27	NC	-		NC
28	NC	-		NC
29	GND	-		Ground pin
30	NC	-		NC
31	NC	-		NC
32	NC	-		NC
33	NC	-		NC
34	NC	-		NC
35	NC	-		NC
36	I2S_O_MCK	3.3V-I/O	PA19	Audio data master clock output
37	I2S_O_LRCK	3.3V-I/O	PA20	Audio data word clock output
38	I2S_O_D1	3.3V-I/O	PA21	Audio data 1 digital output
39	I2S_O_D0	3.3V-I/O	PA22	Audio data 0 digital output
40	I2S_O_BCK	3.3V-I/O	PA23	Audio data bit clock output
41	GND	GND		Ground pin
42	I2S_O_D2	3.3V-I/O	PA26	Audio data 2 digital output
43	I2S_O_D3	3.3V-I/O	PA27	Audio data 3 digital output
44	/PA_RST	3.3V-I/O	PA28	Amp reset control
45	/PA_SD	3.3V-I/O	PA29	Amp shutdown/power down
46	SWD_CLK	3.3V-I/O	PA30	SWD port
47	SWD_DATA	3.3V-I/O	PA31	SWD port
48	/PA_FAULT	3.3V-I/O	PB0	Amp fault detection
49	AMP_PWR_EN	3.3V-I/O	PB1	Enable amp power
50	NC	-		NC
51	NC	-		NC
52	GND	GND		Ground pin
53	NC	-		NC
54	GND	GND		Ground pin

4.6 Soldering Specification

Solder Paste

Vendor: SMIC(Senju Metal Industry Co.,Ltd.)

Model No.: M705-GRN360-K2-V

Composition: Sn96.5/Ag3/Cu0.5

Powder size:Type-4(20~38 μ m)

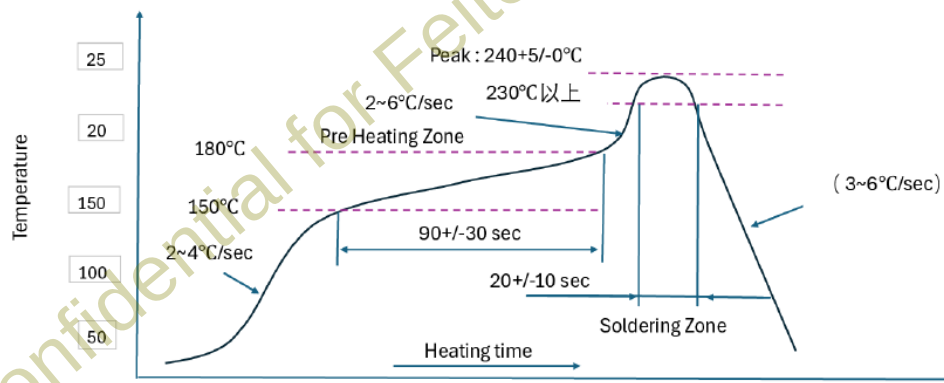


Figure 8 Reflow Temperature profile:



5. Performance

5.1 Audio Specification (I2S to I2S), Fs=48KHz

Parameter	Condition	Min.	Typ.	Max.	Unit
SNR(A)	1kHz, -60dB 20kHz LPF & A-weighted		144.5		dB
THD+N	1kHz, 0dB 20kHz LPF		-141.5		dB
Frequency response	Sweep FR: 20Hz~24KHz	-0.005		+0.005	dB
Dynamic Range(A)	1kHz, -60dB 20kHz LPF & A-weighted		144.5		dB
Latency	Pink noise		20.17		ms

5.2 Audio Specification (I2S to I2S), Fs=96KHz

Parameter	Condition	Min.	Typ.	Max.	Unit
SNR(A)	1kHz, -60dB 20kHz LPF & A-weighted		147.3		dB
THD+N	1kHz, 0dB 20kHz LPF		-141.5		dB
Frequency response	Sweep FR: 20Hz~48KHz	-0.005		+0.005	dB
Dynamic Range(A)	1kHz, -60dB 20kHz LPF & A-weighted		147.5		dB
Latency	Pink noise		20.15		ms

5.3 Audio Specification (I2S to I2S), Fs=192KHz

Parameter	Condition	Min.	Typ.	Max.	Unit
SNR(A)	1kHz, -60dB 20kHz LPF & A-weighted		150.3		dB
THD+N	1kHz, 0dB 20kHz LPF		-141.5		dB
Frequency response	Sweep FR: 20Hz~96KHz	-0.005		+0.005	dB
Dynamic Range(A)	1kHz, -60dB 20kHz LPF & A-weighted		150.5		dB
Latency	Pink noise		20.13		ms

5.4 Channel Synchronization

Parameter	Condition	Min.	Typ.	Max.	Unit
Channel synchronization	1T8R, 1KHz sine tone, Tx EVM Line-in to Rx EVM Line-out	-1	-	+1	°
Audio jitter	1T8R	-2.78	--	+2.78	μs



6. Electrical Characteristic

6.1 Operation Condition

Symbol	Parameter	Min.	Typ.	Max.	Unit
V _{DD}	External supply voltage	2.97	3.3	3.63	V
T _a	Ambient operating temperature	0	-	70	°C
T _a	Storage temperature	-40	25	85	°C

6.2 Digital IO DC Characteristic

Symbol	Parameter	Condition	Min.	Typ.	Max.	Unit
V _{IL}	I/O input low level voltage	V _{IO} =3.3V±10%	-0.3	-	0.8	V
V _{IH}	I/O input high level Voltage	V _{IO} =3.3V±10%	2	-	-	V
V _{OL}	I/O output low voltage	V _{IO} =3.3V±10%	-	-	0.15*V _{IO}	V
V _{OH}	I/O output high voltage	V _{IO} =3.3V±10%	0.85* V _{IO}	-	-	V

6.3 WLAN 5G band RF Characteristic

Parameter	Condition	Min.	Typ.	Max.	Unit
Frequency Range	Center channel frequency	5180	-	5825	MHz
Rx Sensitivity	HT20, MCS 7, 64-QAM rate 5/6	-	-74	-	dBm
	HT40, MCS 7, 64-QAM rate 5/6	-	-70.5	-	dBm
Tx Power	HT20, MCS 7, 64-QAM rate 5/6	-	15	-	dBm
	HT40, MCS 7, 64-QAM rate 5/6	-	15	-	dBm

6.4 BLE 2.4G band RF Characteristic

Parameter	Condition	Min.	Typ.	Max.	Unit
Frequency Range	Center channel frequency	2402	-	2480	MHz
Rx Sensitivity	PER < 30.8%	-	-99	-	dBm
Tx Power	At max. power output level	-	8	-	dBm

6.5 Power Consumption

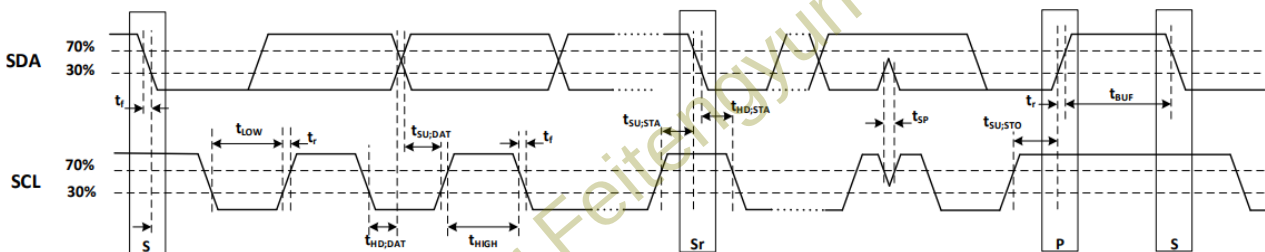
Operating mode	Condition	Min.	Typ.	Max.	Unit
Tx module active	Tx EVM v1.1, 1T8R	-	370	-	mA
Rx module active	Rx EVM v1.1, 1T8R	-	65	-	mA
Tx module sleep	Tx EVM v1.1, 1T8R	-	3	-	mA
Rx module sleep	Rx EVM v1.1, 1T8R	-	3	-	mA

7. AC Characteristics

7.1 I2C Characteristics

Symbol	Parameter	Standard mode (Cb=400pF max.)		Fast mode (Cb=400pF max.)		Unit
		Min.	Max.	Min.	Max.	
F _{SCL}	SCL clock frequency	-	100	-	400	kHz
t _{HD;STA}	Hold time START condition	4	-	0.6	-	μs
t _{LOW}	Low period of the SCL clock	Programmable		Programmable		μs
t _{HIGH}	High period of the SCL clock					μs
t _r	Raise time of both SDA and SCL signals	-	1000	20	300	ns
t _f	Fall time of both SDA and SCL signals	-	300	12	300	ns
t _{SU;STA}	Set-up time for a repeated START condition	4.7	-	0.6	-	μs
t _{HD;DAT}	Data hold time	0	-	0	-	μs
t _{SU;DAT}	Data set-up time	0.25	-	0.1	-	μs
t _{SU;STO}	Set-up time for STOP condition	4	-	0.6	-	μs
t _{VD;DAT}	Data valid time	-	3.45	-	0.9	μs
t _{VD;ACK}	Data valid acknowledge time	-	3.45	-	0.9	μs
t _{BUF}	Bus free time between a STOP and START condition	4.7	-	1.3	-	μs

I2C timing data

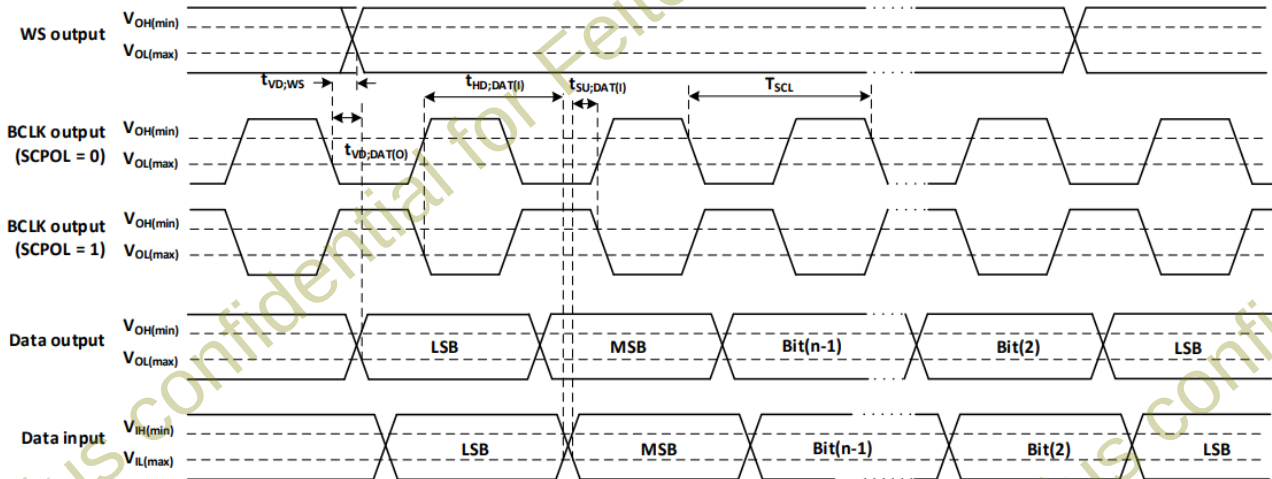


I2C AC timing diagram

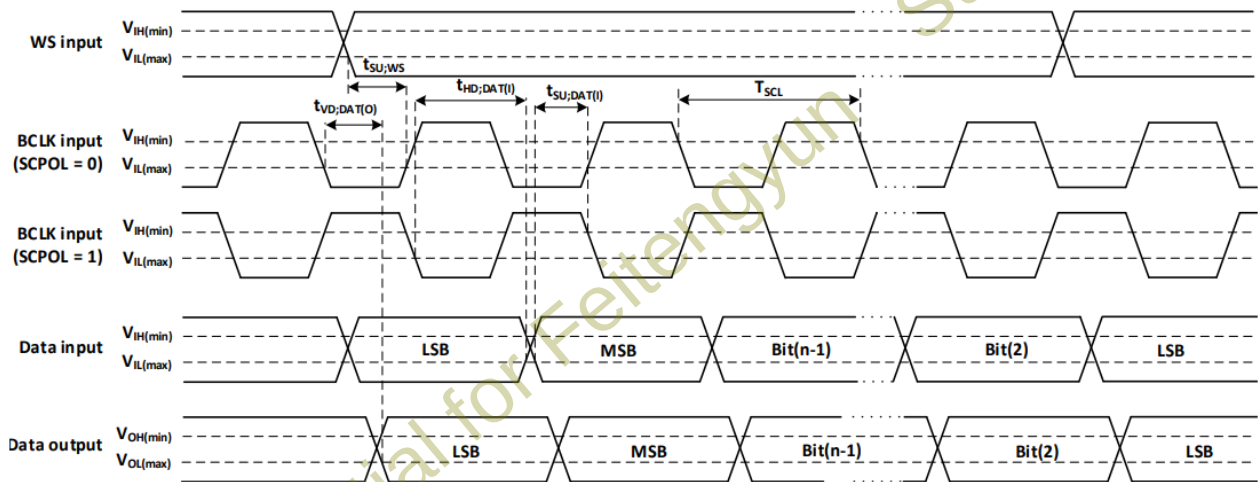
7.2 I2S Characteristics

Symbol	Parameter	Conditions	3.3V I/O (2.97V~3.6V)		Unit
			Min.	Max.	
T _{SCL}	I2S clock	Master	82	1953	ns
		Slave	82	1953	ns
Duty	Clock duty	Master	45	55	%
		Slave	35	65	%
t _{SU;DAT(I)}	Input data setup time	Master	8	-	ns
t _{SU;DAT(I)/t_{SU;WS}}	Input data/WS setup time	Slave	3	-	ns
t _{HD;DAT(I)}	Input data hold time	Master	0	-	ns
		Slave	3	-	ns
t _{VD;DAT(O)}	Output data valid time	Master	-5	5	ns
t _{VD;WS}	Output WS valid time	Master	-4	4	ns
t _{VD;DAT(O)}	Output data valid time	Slave	-	18	ns

I2S timing data

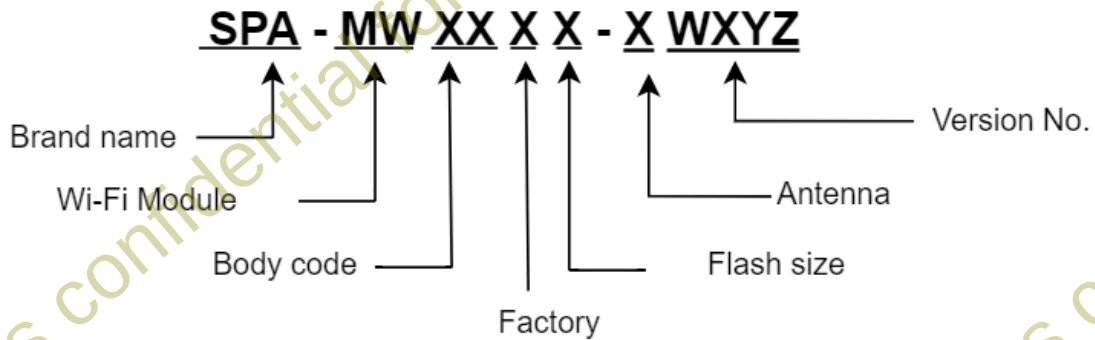


I2S (Master) AC timing diagram



I2S (Slave) AC timing diagram

8. Module Part No. Description



Brand name	SPA	
Wi-Fi Module	MW	
Body code	21	Wireless Audio
	30	Audio Streaming
Memory size	1	2Mbytes
	2	4Mbytes
	3	8Mbytes
	4	16 Mbytes
	5	32Mbytes
	6	64 Mbytes
	7	128Mbytes
	8	256Mbytes
Antenna	M	On module antenna
	B	External PCB antenna
	E	IPEX connector for external antenna
Version No.	W	Customer Name, Ex: S:Sunplus
	X	Project No.
	Y	Version No.
	Z	

9. Version History

Revision	Date	By	Remark
V1.0	2024/07/31	Ricky Liu	Initial
V1.01	2024/08/09	Ricky Liu	Update performance and characteristic data
V1.2	2024/08/12	Ricky Liu	Update information for new module with BLE antenna (HDK-SM721DC3-1V0)
V1.21	2024/08/26	Ricky Liu	Revised pin description
V1.22	2024/09/25	Ricky Liu	Update power consumption of standby mode
V1.23	2024/12/25	Ricky Liu	Revised module pin assignment
V1.3	2025/3/20	Ada	Add SPA-MW21M1-E information
V1.3.1	2025/4/2	Ada	Add Storage condition
V1.3.2	2025/4/29	Ada	Module part No. Description, Modify Module name
V1.3.3	2025/6/17	Cg.chen	Modify HT40 TX Power, add HT20 TX Power , RX sensitivity
V1.3.4	2025/6/27	Cg.chen	modify RX sensitivity value modify 4.1& 4.2 : module package
V1.4	2025/8/28	Ada	Add 4. 6 Soldering Specification
V1.4.1	2025/9/3	Ada	Modify Module Part No. description

This module is intended for OEM integrators only.
Integration instructions for host product manufacturers
according to KDB 996369 D03 OEM Manual v01
KDB 996369 D03 OEM Manual v01 rule sections:

2.2 List of applicable FCC rules

This module has been tested for compliance to FCC Part 15.247/15.407.

2.3 Summarize the specific operational use conditions

The module is typically use in industrial, household and general office / ITE and audio & video, EV charging system end-products. The product must not be co-located or operating in conjunction with any other antenna or transmitters.

2.4 Limited module procedures

not applicable

2.5 Trace antenna designs

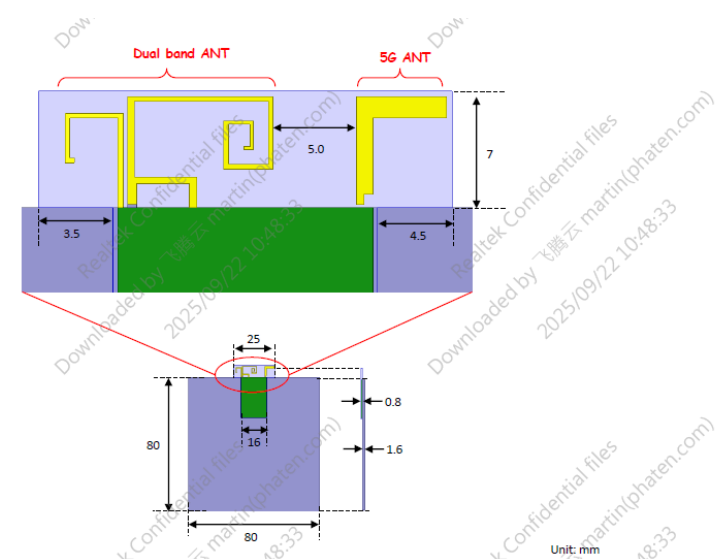
Not applicable.

2.6 RF exposure considerations

This equipment complies with FCC mobile radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with a minimum distance of 20cm between the radiator & your body. If the module is installed in a portable host, a separate SAR evaluation is required to confirm compliance with relevant FCC portable RF exposure rules.

2.7 Antennas

The following antennas have been certified for use with this module; antennas of the same type with equal or lower gain may also be used with this module. The antenna must be



6.2.1 WLAN ANT1						
Frequency [MHz]	XY Plane		ZY Plane		ZX Plane	
	Average Gain [dBi]	Peak Gain [dBi]	Average Gain [dBi]	Peak Gain [dBi]	Average Gain [dBi]	Peak Gain [dBi]
2412	-4.82	-3.16	-7.59	-3.03	-6.48	-4.42
2437	-4.68	-3.31	-7.17	-2.39	-6.15	-3.39
2442	-4.51	-3.18	-6.89	-2.68	-6.26	-3.28
2462	-4.47	-3.43	-6.74	-2.47	-5.89	-3.52
2472	-4.98	-3.65	-6.56	-2.35	-6.11	-3.17
5150	-11.87	-8.51	-2.51	1.90	-2.72	2.35
5200	-10.19	-7.79	-2.82	1.74	-2.26	2.79
5250	-8.22	-5.38	-2.47	1.59	-2.58	3.26
5300	-7.84	-6.04	-3.18	1.94	-2.75	2.02
5350	-7.75	-5.25	-2.87	1.57	-2.92	2.58
5470	-6.86	-4.85	-3.13	1.48	-2.64	3.16
5600	-6.02	-4.67	-3.29	1.62	-2.19	2.28
5725	-5.41	-3.78	-2.93	1.39	-1.68	3.29
5785	-6.29	-4.14	-2.95	1.21	-2.43	2.03
5850	-5.64	-3.27	-3.45	1.19	-2.21	2.52

6.2.2 WLAN ANT2						
Frequency [MHz]	XY Plane		ZY Plane		ZX Plane	
	Average Gain [dBi]	Peak Gain [dBi]	Average Gain [dBi]	Peak Gain [dBi]	Average Gain [dBi]	Peak Gain [dBi]
2412	-5.73	-4.46	-5.12	-0.74	-3.78	-0.73
2437	-5.25	-4.29	-4.68	0.21	-3.15	0.52
2442	-5.14	-4.47	-4.51	0.32	-2.89	0.91
2462	-5.27	-3.58	-4.29	0.58	-2.52	1.05
2472	-5.03	-3.67	-4.27	0.62	-2.45	1.49
5150	-2.19	-1.79	-3.54	1.71	-1.63	1.57
5200	-1.75	-1.13	-3.18	1.36	-1.98	1.32
5250	-1.51	-0.82	-3.28	1.73	-2.16	2.03
5300	-2.58	-1.05	-3.17	1.37	-2.29	0.94
5350	-2.57	-1.12	-3.04	1.03	-2.11	1.65
5470	-2.17	-0.83	-3.45	0.38	-2.68	1.14
5600	-4.13	-1.89	-4.25	-1.20	-3.76	0.69
5725	-3.89	-1.49	-4.13	0.71	-2.61	0.92
5785	-5.03	-2.84	-4.57	0.47	-3.82	-0.35
5850	-5.42	-3.28	-3.68	0.64	-3.57	1.87

6.2.3 BT ANT2						
Frequency [MHz]	XY Plane		ZY Plane		ZX Plane	
	Average Gain [dBi]	Peak Gain [dBi]	Average Gain [dBi]	Peak Gain [dBi]	Average Gain [dBi]	Peak Gain [dBi]
2402	-5.57	-3.80	-5.17	-0.98	-3.56	-0.40
2426	-4.98	-3.38	-4.78	-0.25	-3.04	0.36
2480	-4.40	-2.68	-4.56	0.27	-2.59	1.05

2.8 Label and compliance information

The final end product must be labeled in a visible area with the following: “Contains FCC ID: **2BS07-SPAMW21XXM**”. The grantee's FCC ID can be used only when all FCC compliance requirements are met. 2.9 Information on test modes and additional testing requirements

This transmitter is tested in a standalone mobile RF exposure condition and any co-located or simultaneous transmission with other transmitter(s) or portable use will require a separate class II permissive change re-evaluation or new certification.

2.10 Additional testing, Part 15 Subpart B disclaimer

Host manufacturer is responsible for compliance of the host system with module installed with all other applicable requirements for the system such as Part 15 B.

IMPORTANT NOTE: In the event that these conditions can not be met (for example certain laptop configurations or co-location with another transmitter), then the FCC authorization is no longer considered valid and the FCC ID can not be used on the final product. In these circumstances, the OEM integrator will be responsible for re-evaluating the end product (including the transmitter) and obtaining a separate FCC authorization.

Manual Information To the End User

The OEM integrator has to be aware not to provide information to the end user regarding how to install or remove this RF module in the user's manual of the end product which integrates this module.

The end user manual shall include all required regulatory information/warning as shown in this manual.

OEM/Host manufacturer responsibilities

OEM/Host manufacturers are ultimately responsible for the compliance of the Host and Module. The final product must be reassessed against all the essential requirements of the FCC rule such as FCC Part 15 Subpart B before it can be placed on the US market. This includes reassessing the transmitter module for compliance with the Radio and EMF essential requirements of the FCC rules. This module must not be incorporated into any other device or system without retesting for compliance as multi-radio and combined equipment

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.

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 equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. 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.