

**SPA-MW21xx-x**

# **Wireless Audio Module Datasheet**



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**SUNPLUS Technology Co., Ltd.** [www.sunplus.com](http://www.sunplus.com)

No.19, Innovation 1st Road, Hsinchu Science Park 30076, Taiwan, ROC

T: +886-3-5786005 F: +886-3-5786006

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## Table of Content

|                                                 |           |
|-------------------------------------------------|-----------|
| <b>1. Introductions</b>                         | <b>2</b>  |
| <b>2. Key Features</b>                          | <b>3</b>  |
| <b>3. Applications</b>                          | <b>4</b>  |
| <b>4. Module Pin Assignments</b>                | <b>5</b>  |
| 4.1 Module Package Outline                      | 5         |
| SPA-MW21F3-M                                    | 5         |
| SPA-MW21F3-E                                    | 7         |
| 4.2 Module PCB Pin Outline                      | 9         |
| SPA MW21F3-M                                    | 9         |
| SPA- MW21F3-E                                   | 10        |
| 4.3 Module Pin Type Definitions                 | 11        |
| 4.4 Tx Module Pinout Descriptions               | 11        |
| 4.5 Rx Module Pinout Descriptions               | 12        |
| 4.6 Soldering Specification                     | 13        |
| <b>5. Performance</b>                           | <b>15</b> |
| 5.1 Audio Specification (I2S to I2S), Fs=48KHz  | 15        |
| 5.2 Audio Specification (I2S to I2S), Fs=96KHz  | 15        |
| 5.3 Audio Specification (I2S to I2S), Fs=192KHz | 15        |
| 5.4 Channel Synchronization                     | 15        |
| <b>6. Electrical Characteristic</b>             | <b>16</b> |
| 6.1 Operation Condition                         | 16        |
| 6.2 Digital IO DC Characteristic                | 16        |
| 6.3 WLAN 5G band RF Characteristic              | 16        |
| 6.4 BLE 2.4G band RF Characteristic             | 16        |
| 6.5 Power Consumption                           | 16        |
| <b>7. AC Characteristics</b>                    | <b>17</b> |
| 7.1 I2C Characteristics                         | 17        |
| 7.2 I2S Characteristics                         | 17        |
| <b>8. Module Part No. Description</b>           | <b>19</b> |
| <b>9. Version History</b>                       | <b>20</b> |
| Add SPA-MW21M1-E information                    | 20        |
| Add Storage condition                           | 20        |

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## 1. Introductions

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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.

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## 2. Key Features

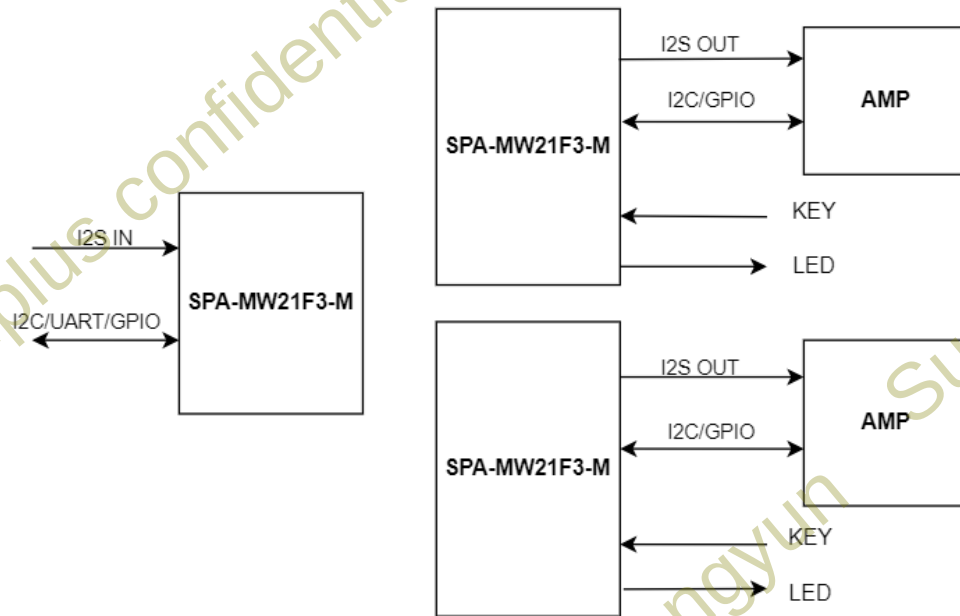
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- Low audio latency
- Low audio jitter
- Lossless audio transmission
- Maximum transmission bandwidth/channels
  - ◆ 8ch@44.1/48KHz, 24bit
  - ◆ 4ch@96KHz, 24bit
  - ◆ 2ch@192KHz, 24bit
- Support 8ch I2S in/out with rich configurations
  - ◆ master/slave 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



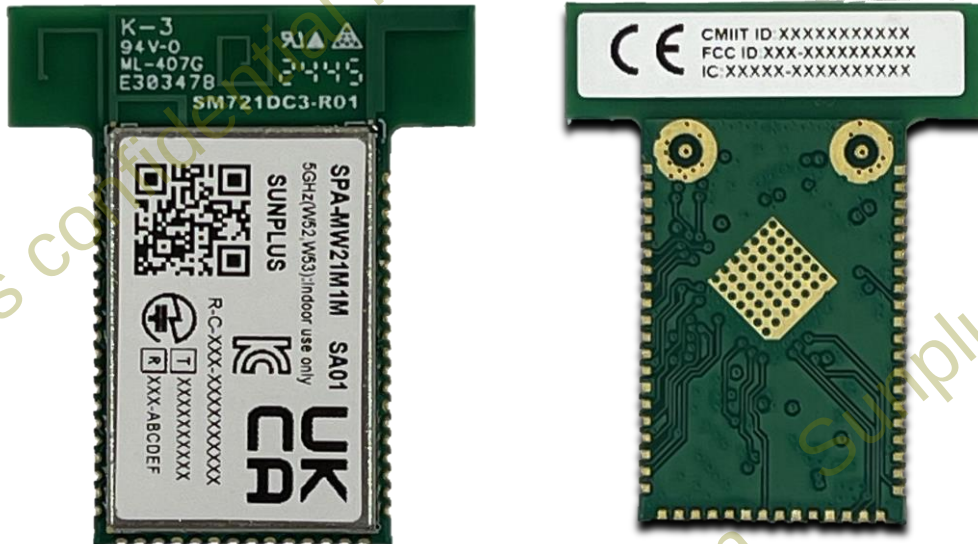
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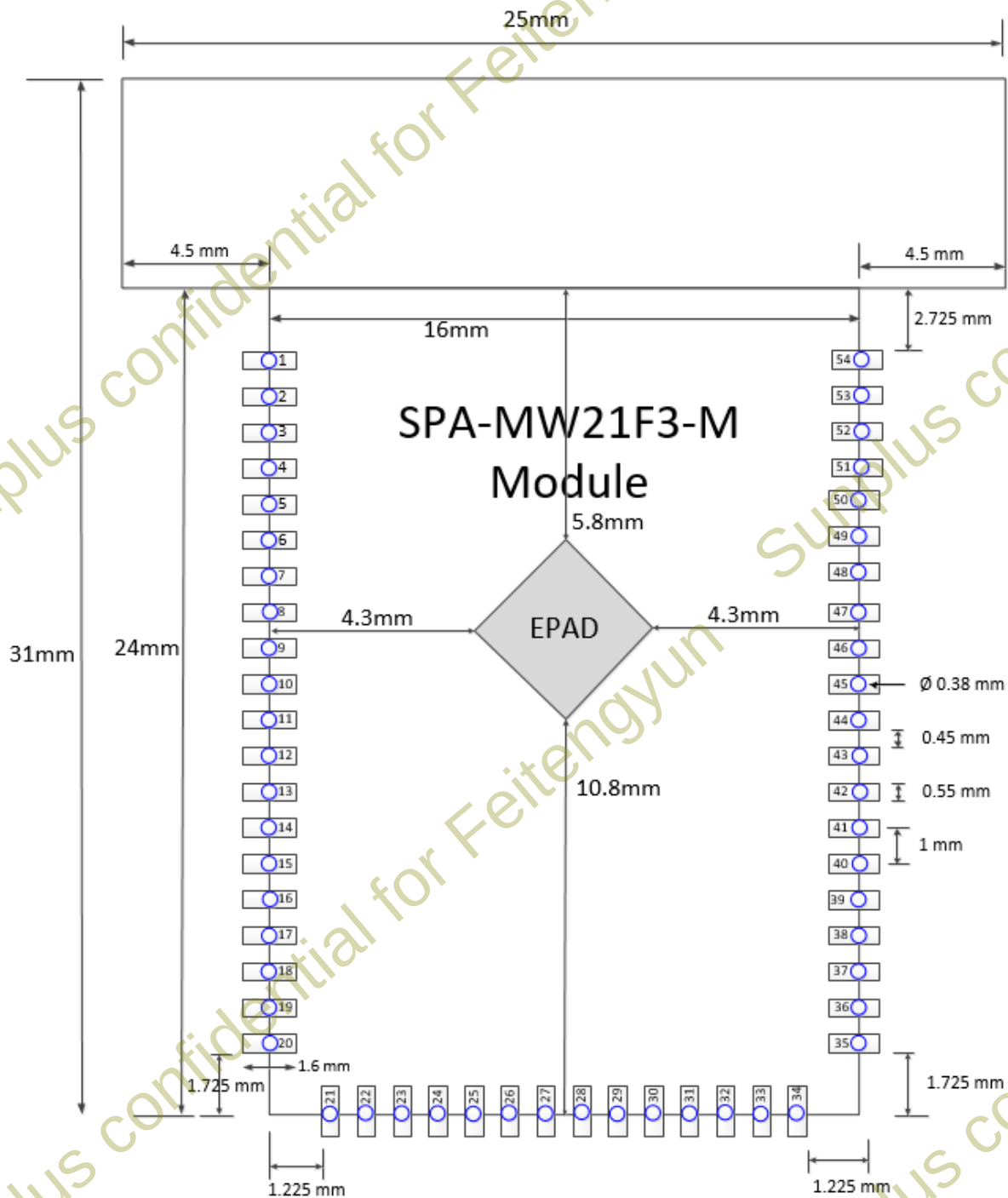
## 4. Module Pin Assignments

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### 4.1 Module Package Outline

#### SPA-MW21F3-M



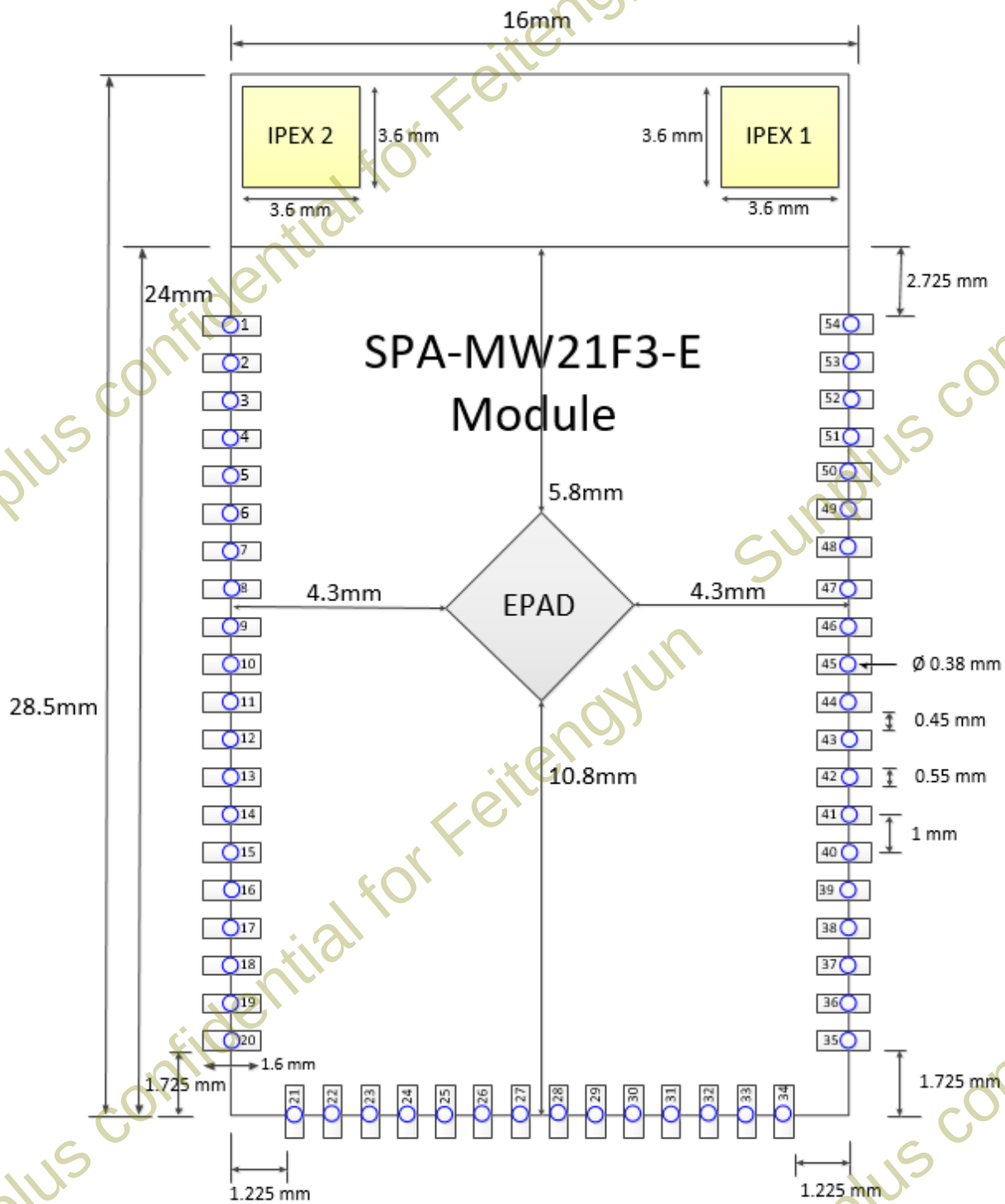


SPA-MW21F3-E



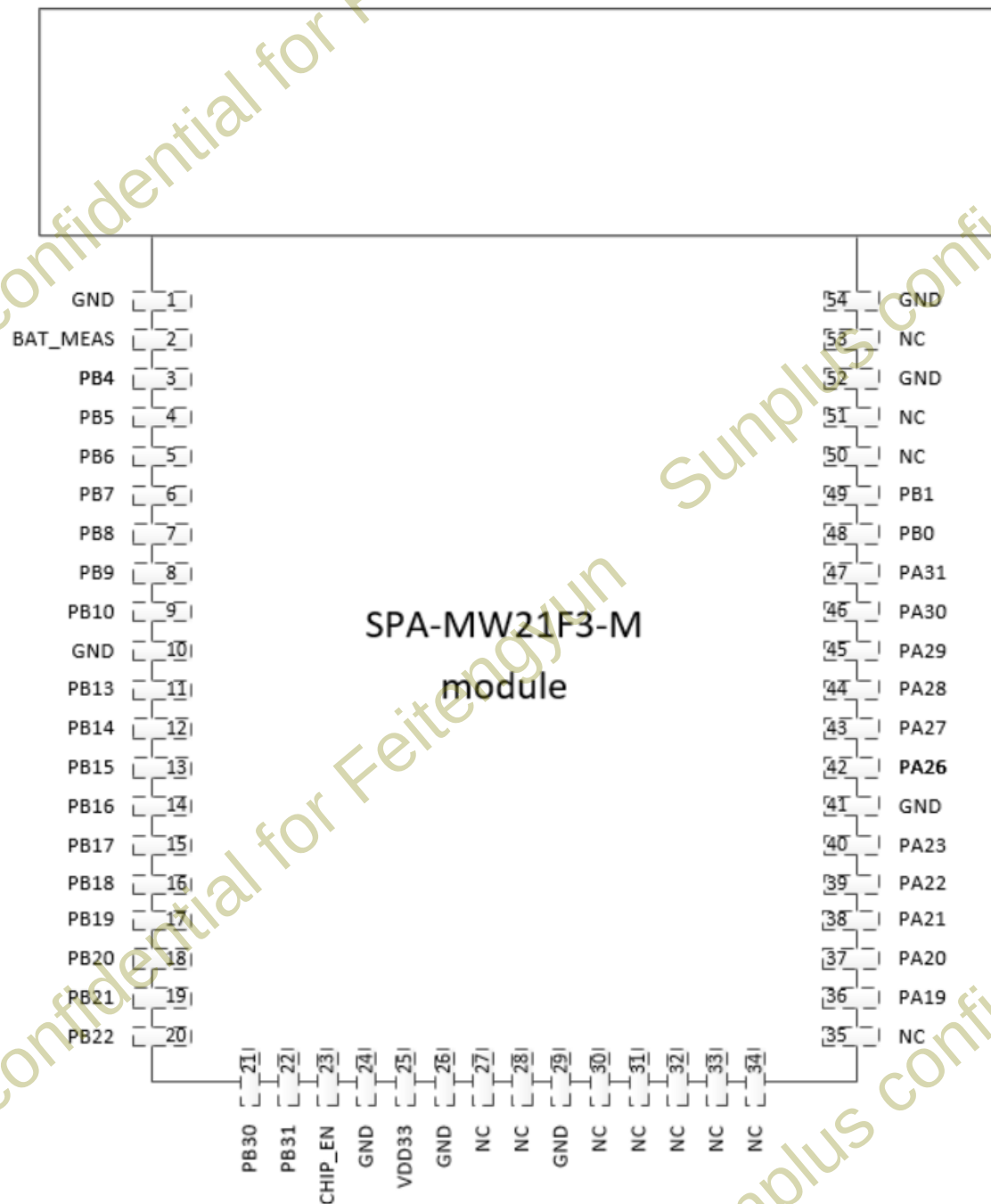
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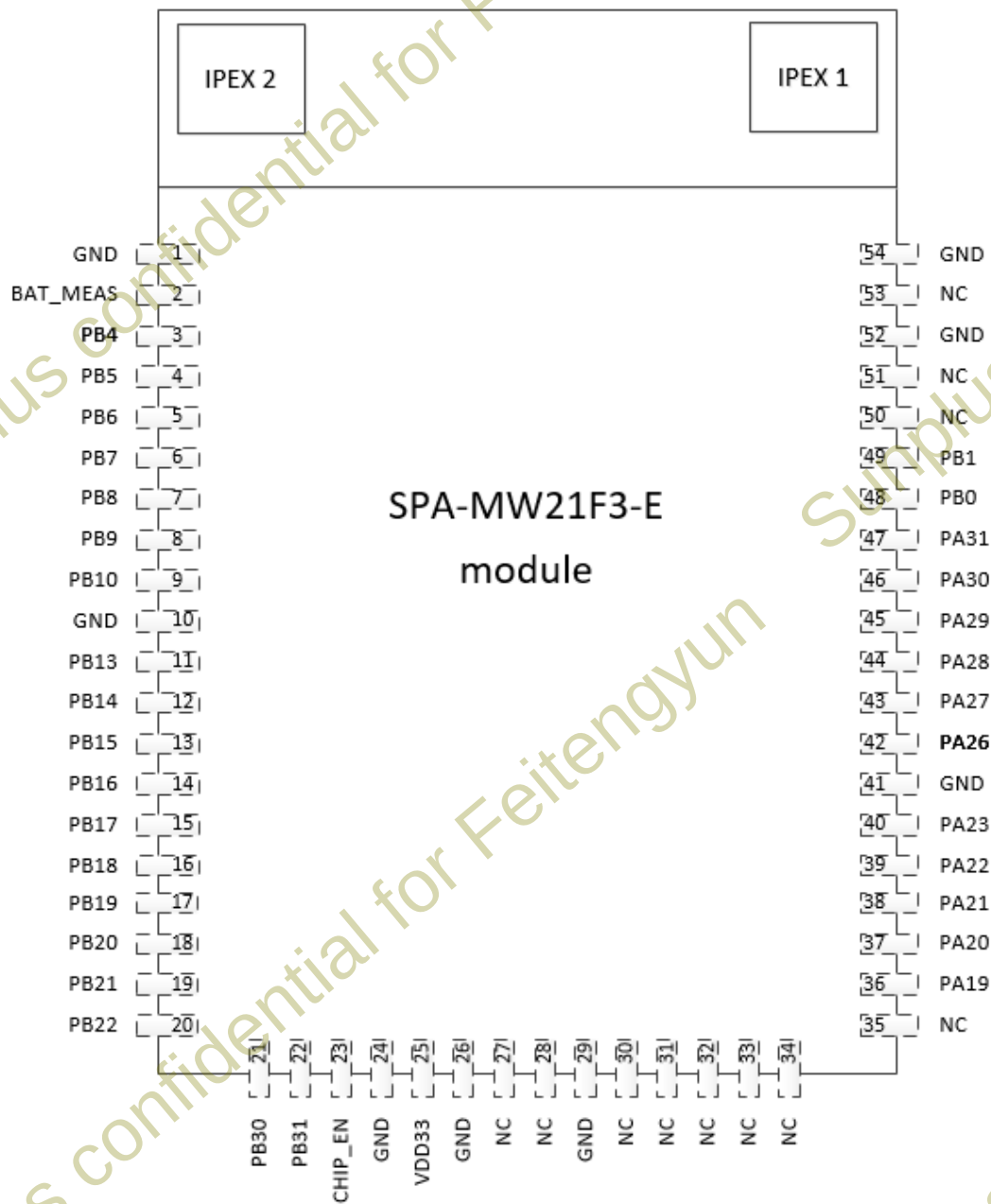


4.2 Module PCB Pin Outline

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)

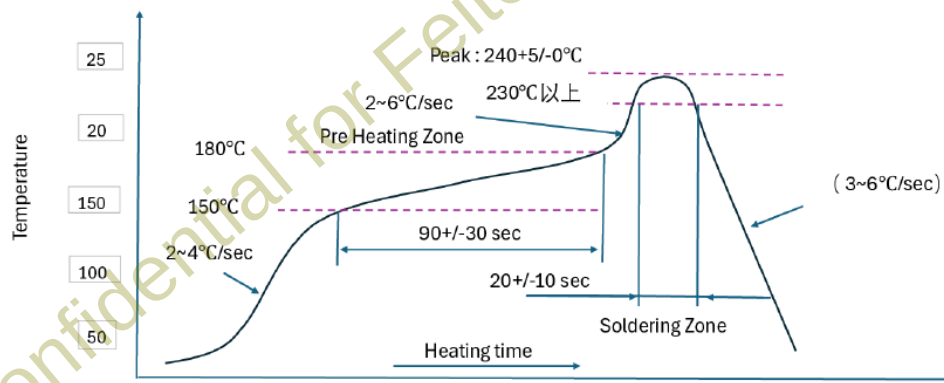


**Figure 8 Reflow Temperature profile:**



## 5. Performance

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

| Parameter          | Condition                             | Min.   | Typ.   | Max.   | Unit |
|--------------------|---------------------------------------|--------|--------|--------|------|
| SNR(A)             | 1kHz, -60dB<br>20kHz LPF & A-weighted |        | 144.5  |        | dB   |
| THD+N              | 1kHz, 0dB<br>20kHz LPF                |        | -141.5 |        | dB   |
| Frequency response | Sweep FR: 20Hz~24KHz                  | -0.005 |        | +0.005 | dB   |
| Dynamic Range(A)   | 1kHz, -60dB<br>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<br>20kHz LPF & A-weighted |        | 147.3  |        | dB   |
| THD+N              | 1kHz, 0dB<br>20kHz LPF                |        | -141.5 |        | dB   |
| Frequency response | Sweep FR: 20Hz~48KHz                  | -0.005 |        | +0.005 | dB   |
| Dynamic Range(A)   | 1kHz, -60dB<br>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<br>20kHz LPF & A-weighted |        | 150.3  |        | dB   |
| THD+N              | 1kHz, 0dB<br>20kHz LPF                |        | -141.5 |        | dB   |
| Frequency response | Sweep FR: 20Hz~96KHz                  | -0.005 |        | +0.005 | dB   |
| Dynamic Range(A)   | 1kHz, -60dB<br>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 <sub>DD</sub> | External supply voltage       | 2.97 | 3.3  | 3.63 | V    |
| T <sub>a</sub>  | Ambient operating temperature | 0    | -    | 70   | °C   |
| T <sub>a</sub>  | Storage temperature           | -40  | 25   | 85   | °C   |

### 6.2 Digital IO DC Characteristic

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

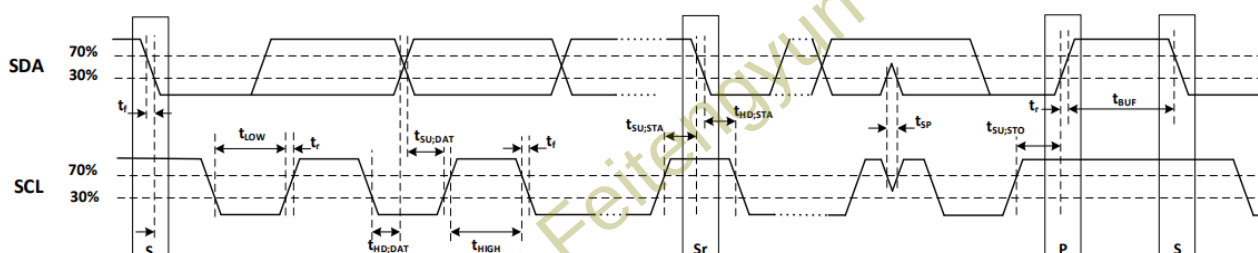
| Operating mode   | Condition         | Min. | Typ. | Max. | Unit |
|------------------|-------------------|------|------|------|------|
| Tx module active | Tx EVM v1.1, 1T8R | -    | 370  | -    | mA   |
| Rx module active | Rx EVM v1.1, 1T8R | -    | 65   | -    | mA   |
| Tx module sleep  | Tx EVM 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<br>(Cb=400pF max.) |      | Fast mode<br>(Cb=400pF max.) |      | Unit |
|---------------------|--------------------------------------------------|----------------------------------|------|------------------------------|------|------|
|                     |                                                  | Min.                             | Max. | Min.                         | Max. |      |
| F <sub>SCL</sub>    | SCL clock frequency                              | -                                | 100  | -                            | 400  | kHz  |
| t <sub>HD;STA</sub> | Hold time START condition                        | 4                                | -    | 0.6                          | -    | μs   |
| t <sub>LOW</sub>    | Low period of the SCL clock                      | Programmable                     |      | Programmable                 |      | μs   |
| t <sub>HIGH</sub>   | High period of the SCL clock                     |                                  |      |                              |      | μs   |
| t <sub>r</sub>      | Raise time of both SDA and SCL signals           | -                                | 1000 | 20                           | 300  | ns   |
| t <sub>f</sub>      | Fall time of both SDA and SCL signals            | -                                | 300  | 12                           | 300  | ns   |
| t <sub>SU;STA</sub> | Set-up time for a repeated START condition       | 4.7                              | -    | 0.6                          | -    | μs   |
| t <sub>HD;DAT</sub> | Data hold time                                   | 0                                | -    | 0                            | -    | μs   |
| t <sub>SU;DAT</sub> | Data set-up time                                 | 0.25                             | -    | 0.1                          | -    | μs   |
| t <sub>SU;STO</sub> | Set-up time for STOP condition                   | 4                                | -    | 0.6                          | -    | μs   |
| t <sub>VD;DAT</sub> | Data valid time                                  | -                                | 3.45 | -                            | 0.9  | μs   |
| t <sub>VD;ACK</sub> | Data valid acknowledge time                      | -                                | 3.45 | -                            | 0.9  | μs   |
| t <sub>BUF</sub>    | Bus free time between a STOP and START condition | 4.7                              | -    | 1.3                          | -    | μs   |

I2C timing data

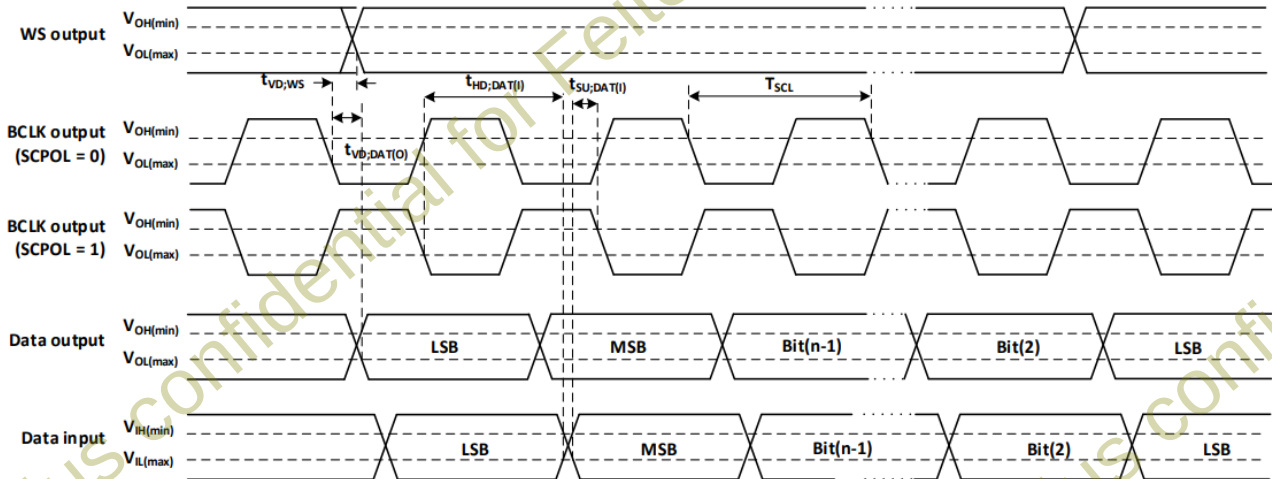


I2C AC timing diagram

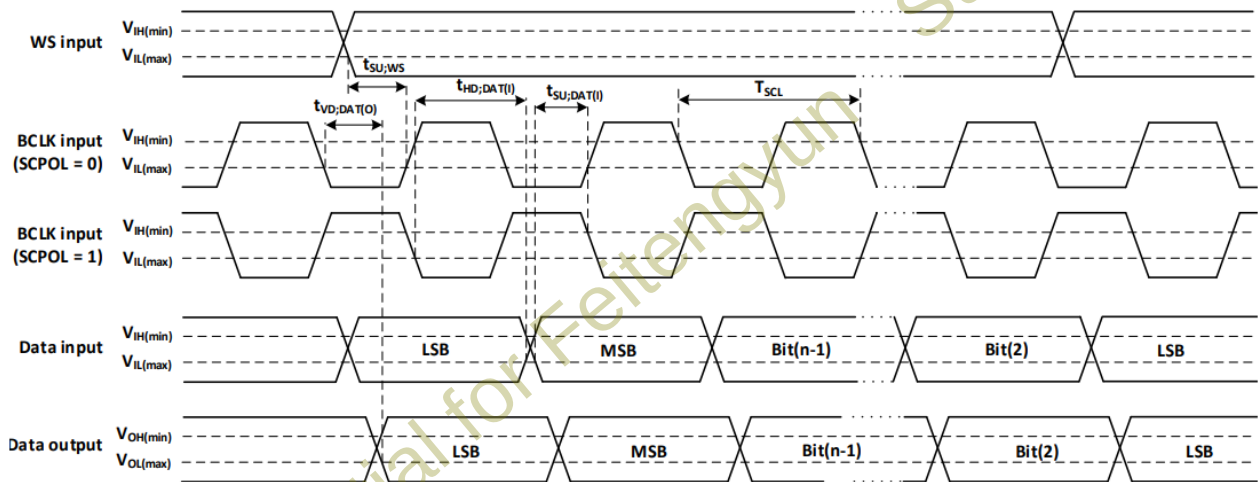
### 7.2 I2S Characteristics

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

## I2S timing data

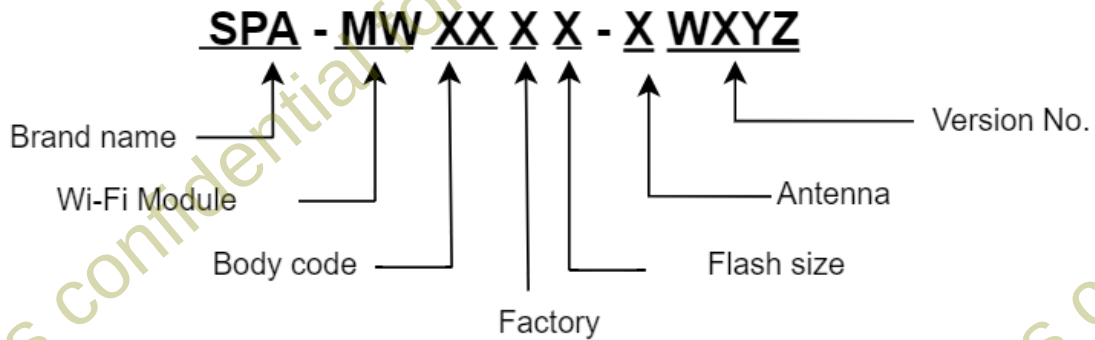


## I2S (Master) AC timing diagram



## 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<br>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                                    |

## **warning**

### **Federal Communication Commission Interference Statement**

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 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 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.

**FCC Caution:** Any changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate this equipment.

### **IMPORTANT NOTE:**

FCC Radiation Exposure Statement:

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.

This device and its antenna(s) must not be co-located with any other transmitters except in accordance with FCC multi-transmitter product procedures.

Referring to the multi-transmitter policy, multiple-transmitter(s) and module(s) can be operated simultaneously without C2PC.

This module is intended for OEM integrator. The OEM integrator is responsible for the compliance to all the rules that apply to the product into which this certified RF module is integrated.

Additional testing and certification may be necessary when multiple modules are used.

### **List of applicable FCC rules**

This module has been tested and found to comply with 15.247,15.407 requirements for Modular Approval.

The modular transmitter is only FCC authorized for the specific rule parts (i.e., FCC transmitter rules) listed on the grant, and that the host product

manufacturer is responsible for compliance to any other FCC rules that apply to the host not covered by the modular transmitter grant of certification. If the grantee markets their product as being Part 15 Subpart B compliant (when it also contains unintentional-radiator digital circuitry), then the grantee shall provide a notice stating that the final host product still requires Part 15 Subpart B compliance testing with the modular transmitter installed.

### **USERS MANUAL OF THE END PRODUCT:**

In the users manual of the end product, the end user has to be informed to keep at least 20cm separation with the antenna while this end product is installed and operated. The end user has to be informed that the FCC radio-frequency exposure guidelines for an uncontrolled environment can be satisfied. The end user has to also be informed that any changes or modifications not expressly approved by the manufacturer could void the user's authority to operate this equipment. If the size of the end product is smaller than 8x10cm, then additional FCC part 15.19 statement is required to be available in the users manual: This device complies with Part 15 of 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.

### **LABEL OF THE END PRODUCT:**

The final end product must be labeled in a visible area with the following " Contains TX FCC ID: 2BSO7-SPAMW21XXE1 ". If the size of the end product is larger than 8x10cm, then the following FCC part 15.19 statement has to also be available on the label: This device complies with Part 15 of 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.

**This module is intended for OEM integrators only. Per FCC KDB 996369 D03 OEM Manual v01 guidance, the following conditions must be strictly followed when using this certified module:**

**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, FCC Part 15.407.

**2.3 Summarize the specific operational use conditions**

The module is typically used 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**

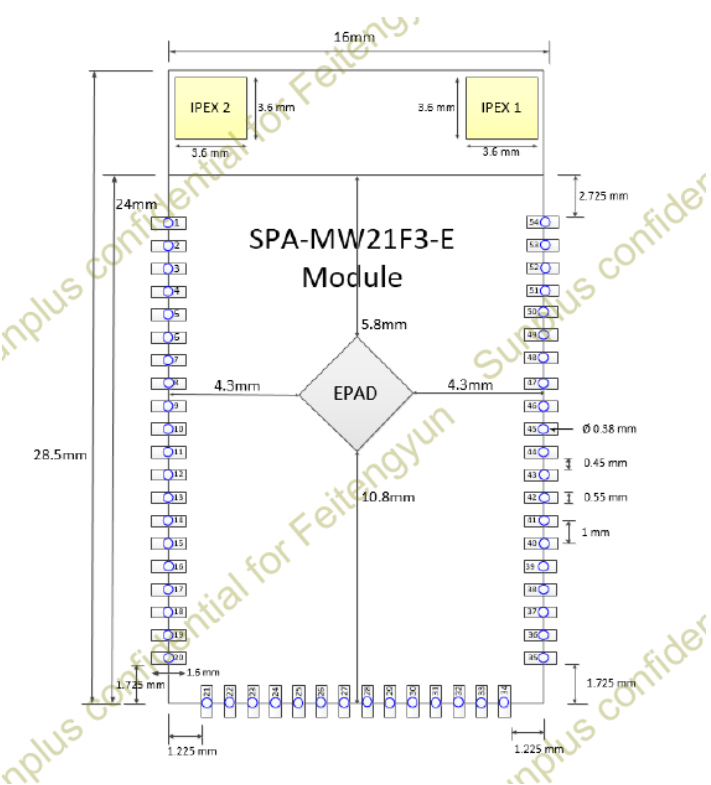
Not applicable.

**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.

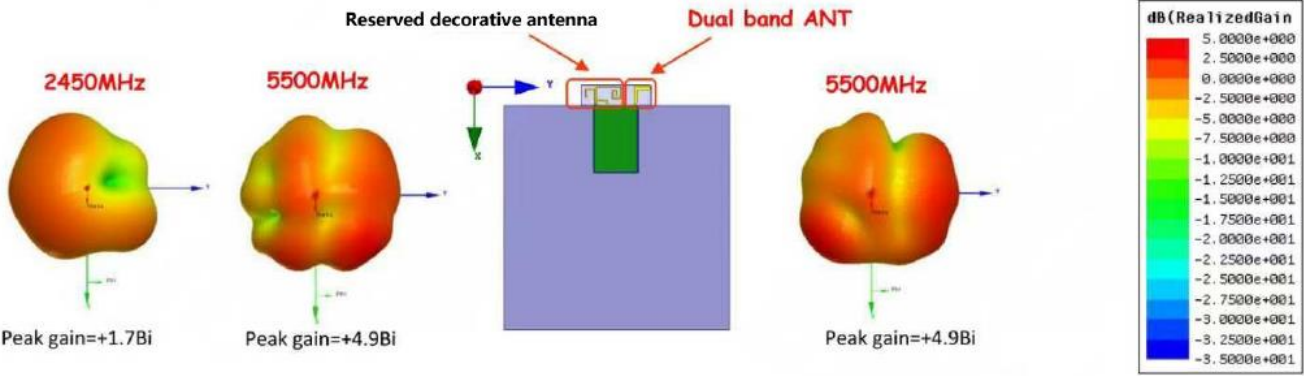
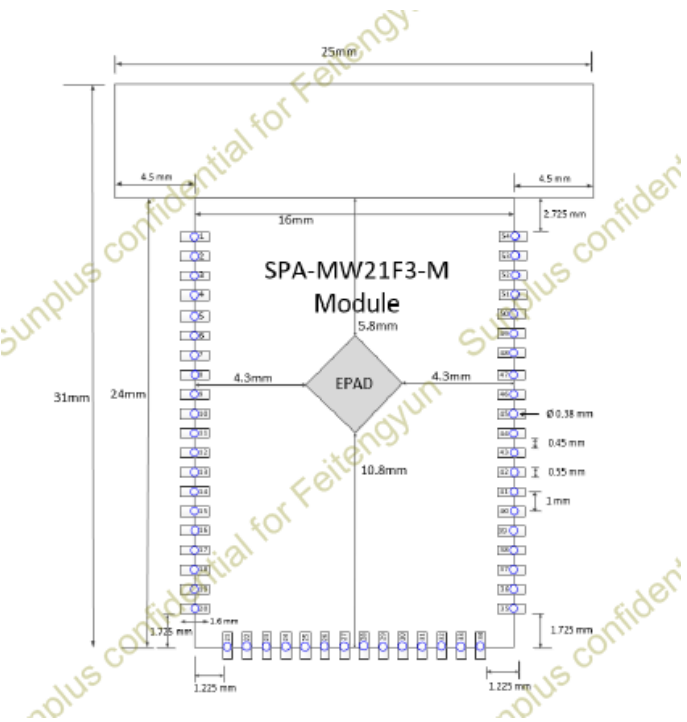
**2.7 Antennas**

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 External antenna must be meet the following requirements.



| Frequency  | Efficiency | Efficiency . dB | Frequency  | Gain . dB |
|------------|------------|-----------------|------------|-----------|
| 2400000000 | 45%        | -3.49           | 2400000000 | 4.22      |
| 2410000000 | 44%        | -3.61           | 2410000000 | 4.19      |
| 2420000000 | 44%        | -3.60           | 2420000000 | 4.21      |
| 2430000000 | 44%        | -3.54           | 2430000000 | 4.56      |
| 2440000000 | 43%        | -3.65           | 2440000000 | 4.43      |
| 2450000000 | 43%        | -3.66           | 2450000000 | 4.44      |
| 2460000000 | 43%        | -3.69           | 2460000000 | 4.28      |
| 2470000000 | 44%        | -3.54           | 2470000000 | 4.35      |
| 2480000000 | 46%        | -3.41           | 2480000000 | 4.50      |
| 2490000000 | 45%        | -3.47           | 2490000000 | 4.55      |
| 2500000000 | 45%        | -3.48           | 2500000000 | 4.46      |
| 5150000000 | 44%        | -3.54           | 5150000000 | 5.94      |
| 5200000000 | 43%        | -3.67           | 5200000000 | 5.83      |
| 5250000000 | 43%        | -3.64           | 5250000000 | 4.88      |
| 5300000000 | 43%        | -3.67           | 5300000000 | 4.77      |
| 5350000000 | 43%        | -3.67           | 5350000000 | 5.11      |
| 5400000000 | 42%        | -3.77           | 5400000000 | 5.53      |
| 5450000000 | 41%        | -3.88           | 5450000000 | 5.24      |
| 5500000000 | 41%        | -3.88           | 5500000000 | 5.45      |
| 5550000000 | 42%        | -3.79           | 5550000000 | 5.59      |
| 5600000000 | 41%        | -3.83           | 5600000000 | 5.51      |
| 5650000000 | 42%        | -3.79           | 5650000000 | 4.99      |
| 5700000000 | 41%        | -3.83           | 5700000000 | 4.50      |
| 5750000000 | 42%        | -3.78           | 5750000000 | 3.54      |
| 5800000000 | 43%        | -3.71           | 5800000000 | 3.54      |
| 5850000000 | 44%        | -3.56           | 5850000000 | 3.58      |

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 PCB antenna must be meet the following requirements.



## 2.8 Label and compliance information

The final end product must be labeled in a visible area with the following: "Contains

FCC ID: **2BS07-SPAMW21XXE1**". 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 show 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 multiradio and combined equipment