# BM81SPK02NB6

## Bluetooth 3.0 EDR Wireless Speaker Module

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**Version:1.0**
**8/21/2013**

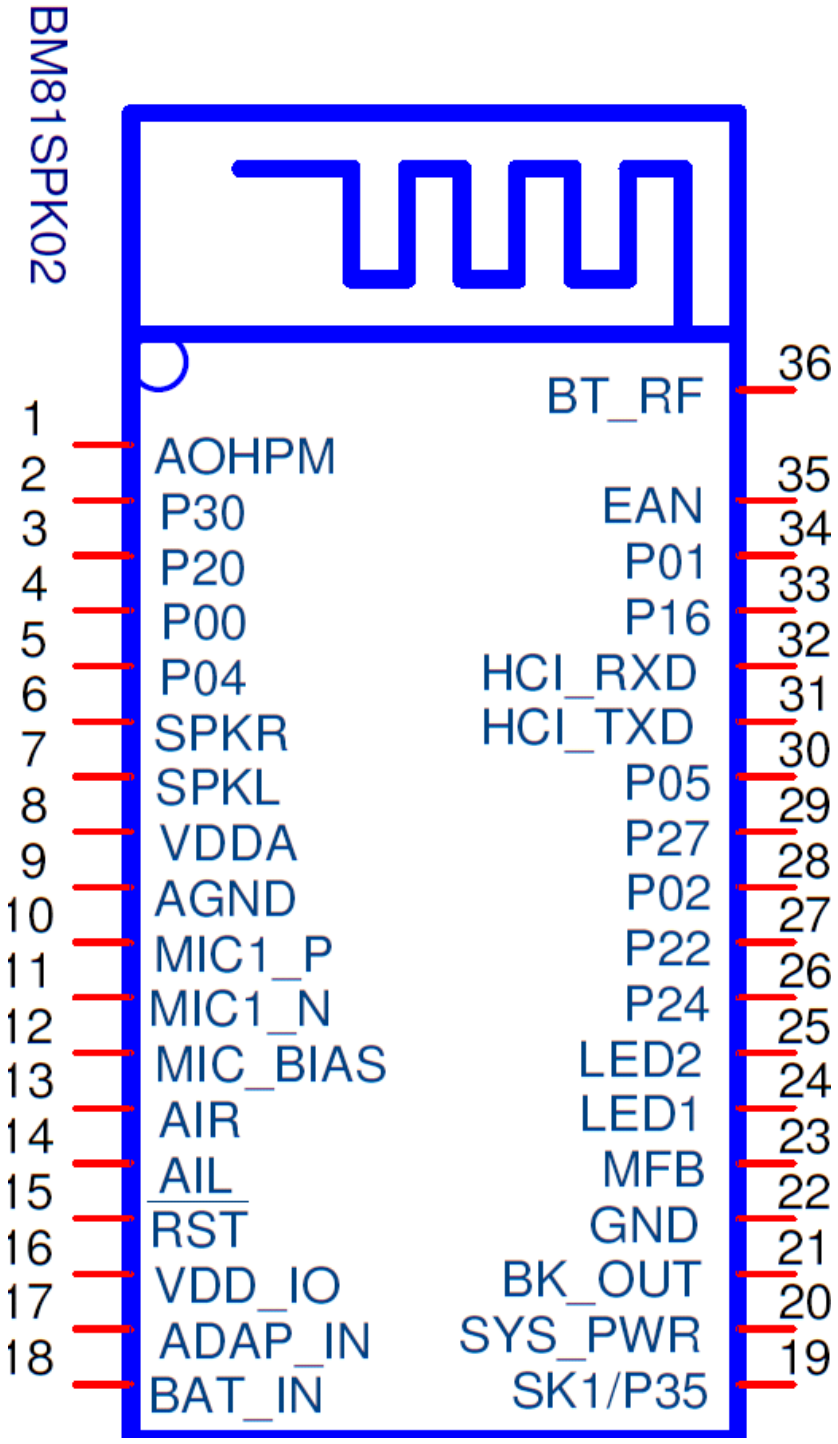
## Product Description

The ISSC BM81SPK02 is a highly integrated Bluetooth 3.0 EDR stereo module, designed for high data rate, short-range wireless communication in the 2.4 GHz ISM band. With the ISSC Bluetooth stack and profile, the ISSC BM81SPK02 provides a low power and ultra-low cost Bluetooth 3.0+EDR solution for wireless voice/audio applications.

## Features

- Main Chip: ISSC IS1681S
- Bluetooth 3.0 EDR compliant
- Max. +4dBm Class 2 output power
- Receiver Sensitivity: GFSK typical -90dBm, π/4 PSK typical -91dBm, 8DPSK typical -83dBm
- Piconet and Scatter net support
- HCI UART interface
- CVSD, A-law, μ-law CODEC algorithms for voice applications
- SBC decode for Bluetooth audio streaming
- Build-in High performance stereo audio codec
- Microphone input and audio line-in support
- Build-in audio mux/gain control for line-in audio signal
- Cap-less/single end headphone driver
- Audio DAC: 94dB SNR
- Build in Max. 350mAH Li-ion battery charger
- HSP, HFP, A2DP, AVRCP profile support
- 3.3V operating voltage
- ROM version: 32Kb EEPROM
- 35 pins for DIP module, 36pins for SMT module (with additional 36th pin antenna port for external antenna option)
- Size: 15mm x29mm
- Build-in PCB Antenna
- RoHS compliant

## Device Pinout Diagram



## Pin Definition

| Pin No. | I/O | Name | Description |
|---|---|---|---|
| 1 | AP | AOHPM | Headphone common mode output/sense input. Cap-less application only. |
| 2 | P | P30 | GPIO, default pull-high input<br>Line-in detection, 1: no line-in detected; 0: line-in detected |
| 3 | I/O | P20 | GPIO, default pull-high input<br>System Configuration, H: Application L: Baseband(IBDK Mode) |
| 4 | I/O | P00 | GPIO, default pull-low input.<br>Slide Switch Detector |
| 5 | I/O | P04 | GPIO, default pull-high input<br>Audio AMP Enable |
| 6 | AO | SPKR | R-channel analog headphone output, for cap-less and single-ended applications both |
| 7 | AO | SPKL | L-channel analog headphone output, for cap-leass and single-ended application both |
| 8 | AP | VDDA | Reserve for external cap to fine tune audio frequency response |
| 9 | AP | AGND | Audio ground |
| 10 | AI | MIC1_P | Mic 1 mono differential analog positive input |
| 11 | AI | MIC1_N | Mic 1 mono differential analog negative input |
| 12 | AP | MIC_BIAS | Microphone biasing voltage |
| 13 | AI | AIR | Stereo analog line in, R-channel |
| 14 | AI | AIL | Stereo analog line in, L-channel |
| 15 | I/O | RST_N | System Reset Pin |
| 16 | P | VDDIO | VDDIO pin, for calibration only<br>Do not add external power to this pin |
| 17 | P | ADAP_IN | Power adaptor input |
| 18 | P | BAT_IN | Battery input |
| 19 | I/O | SK1/P35 | Default SAR input for battery detection<br>This pin can be re-defined as GPIO P35 |
| 20 | P | SYS_PW | System Power Output |
| 21 | P | BK_OUT | Buck feedback sense pin |

| | | | |
|---|---|---|---|
| 22 | P | GND | Digital ground |
| 23 | P | MFB | Multi-Function Push Button key<br>Combined Play/Pause key when A2DP enabled. |
| 24 | P | LED1 | LED Driver 1 |
| 25 | P | LED2 | LED Driver 2 |
| 26 | I/O | P24 | GPIO, default pull-high input<br>System Configuration, H: Boot Mode |
| 27 | I/O | P22 | GPIO, default pull-low input.<br>External LDO enable |
| 28 | I/O | P02 | GPIO, default pull-high input<br>PLAY/PAUSE button |
| 29 | I/O | P27 | GPIO, default pull-high input<br>Foward button |
| 30 | I/O | P05 | GPIO, default pull-high input<br>REW button |
| 31 | O | HCI_TXD | HCI TX data |
| 32 | I | HXI_RXD | HCI RX data |
| 33 | I/O | P16 | GPIO, default pull-high input<br>Volumn down button |
| 34 | I/O | P01 | GPIO, default pull-high input<br>Volumn up button |
| 35 | I | EAN | Embedded ROM/External Flash enable<br>H: Embedded; L: External Flash |
| 36 | AIO | BT_RF | NC for on board PCB antenna<br>Antenna matching if an external antenna is used |

## Electrical Characteristics

### Absolute Maximum Ratings

| Rating | | Min | Max | Max |
|---|---|---|---|---|
| Operation Temperature | | -40ºC | +85ºC | ºC |
| Core supply voltage | VDD_CORE, VCC_RF, AVDD_SAR, AVDD_PLL | 1.7V | 1.98V | V |
| Codec supply voltage | VDD_AUDIO | | 3 | V |
| I/O voltage | VDD_IO | | 3.3 | V |
| Supply voltage | BK_VDD | | 4.3 | V |
| | 3V1_VIN | | 5 | V |
| | BAT_IN | | 4.3 | V |
| | ADAP_IN | | 7.7 | V |
| | LED[1:0] | | 5 | V |
| | Power switch | | 5 | V |

### Recommended Operate Condition

| Symbol | Parameter | Min | Typical | Max | Unit |
|---|---|---|---|---|---|
| $V_{DD18}$ | Digital core supply voltage<br>SAR ADC supply voltage<br>CODEC supply voltage | 1.8 | 1.85 | 1.95 | V |
| $V_{DDIO}$ | I/O supply voltage | 2.8 | 3 | 3.3 | V |
| $T_{OPERATION}$ | Operating temperature range | -20 | +25 | +70 | ºC |
| $T_{stg}$ | Storage temperature | -40 | | +125 | ºC |
| $V_{LDO}$ | LDO supply voltage | 1.8 | | 3.3 | V |
| $V_{BAT\_IN}$ | Input voltage for SAR ADC | 0.9 | | 3.3 | V |

## Radio Characteristics:

### Transmitter section for BDR

| VCC_RF = 1.85V<br>Temperature = 25ºC | | Min | Typ | Max | Bluetooth specification | Unit |
|---|---|---|---|---|---|---|
| Maximum RF transmit power | | | 3 | 4.0 | -6 to 4 | dBm |
| RF power variation over temperature range with compensation enabled | | | ±2 | | | dB |
| RF power control range | | | 20 | | ≥16 | dB |
| RF power range control resolution | | | 0.5 | | | dB |
| 20dB bandwidth for modulated carrier | | | 900 | | ≤1000 | KHz |
| ACP | F = $F_0$±2MHz | | -28 | | ≤-20 | dBm |
| | F = $F_0$±3MHz | | -46 | | ≤-40 | dBm |
| Note:<br>$F_0$=2441MHz | F = $F_0$±>3MHz | | -54 | | ≤-40 | dBm |
| $\Delta f_{1avg}$ maximum modulation | | 150 | | 165 | 140<$\Delta f_{1avg}$<175 | KHz |
| $\Delta f_{2max}$ maximum modulation | | 140 | | 150 | ≥115 | KHz |
| $\Delta f_{2avg}/\Delta f_{1avg}$ | | 0.95 | 1 | | ≥0.80 | |
| ICFT (abs) | | 0 | 5 | 10 | 75 | KHz |
| Drift rate (abs) | | 2 | | 7 | ≤20 | KHz/50us |
| Drift (single slot packet, abs) | | | 12 | | ≤25 | KHz |
| 2nd harmonic content @ Tx= 4dBm | | | -53 | | ≤-47 | dBm |
| 3rd harmonic content @ Tx= 4dBm | | | -55 | | ≤-47 | dBm |

**Receiver section for BDR**

| Temperature = 25ºC | Frequency (GHz) | Min | Typ | Max | Bluetooth specification | Unit |
|---|---|---|---|---|---|---|
| Sensitivity at 0.1% BER for all basic rate packet types | 2.402 | | -90 | | ≤-70 | dBm |
| | 2.441 | | -90 | | | |
| | 2.480 | | -90 | | | |
| Maximum received signal at 0.1% BER | | | -10 | | ≥-20 | dBm |
| C/I co-channel | | | 5 | | ≤11 | dB |
| Adjacent channel selectivity C/I<br>Note: $F_0$=2441MHz | F = $F_0$+1MHz | | -7 | | ≤0 | dB |
| | F = $F_0$-1MHz | | -7 | | ≤0 | dB |
| | F = $F_0$+2MHz | | -36 | | ≤-30 | dB |
| | F = $F_0$-2MHz | | -22 | | ≤-9 | dB |
| | F = $F_0$-3MHz | | -24 | | ≤-20 | dB |
| | F = $F_0$+5MHz | | -50 | | ≤-40 | dB |
| | F = $F_{image}$ | | -22 | | ≤-9 | dB |
| Maximum level of intermodulation interferers | | | -38 | | ≥-39 | dB |

**Transmitter Section for EDR**

| **Temperature = 25ºC** | | **Min** | **Typ** | **Max** | **Bluetooth specification** | **Unit** |
|---|---|---|---|---|---|---|
| Relative transmit power | | | -1.6 | | -4 to 1 | dB |
| π/4 DQPSK max carrier frequency stability | $\|\omega_o\|$ freq. error | | 5 | | ≤10 for all blocks | KHz |
| | $\|\omega_i\|$ initial freq. error | | 10 | | ≤75 for all blocks | KHz |
| | $\|\omega_o+\omega_i\|$ block freq. error | | 10 | | ≤75 for all blocks | KHz |
| 8DPSK max carrier frequency stability | $\|\omega_o\|$ freq. error | | 5 | | ≤10 for all blocks | KHz |
| | $\|\omega_i\|$ initial freq. error | | 10 | | ≤75 for all blocks | KHz |
| | $\|\omega_o+\omega_i\|$ block freq. error | | 10 | | ≤75 for all blocks | KHz |
| π/4 DQPSK modulation accuracy @ Tx= 2dBm | RMS DEVM | | 7 | | ≤20 | % |
| | 99% DEVM | | Pass | | ≤30 | % |
| | Peak DEVM | | | 25 | ≤35 | % |
| 8DQPSK modulation accuracy @ Tx= 2dBm | RMS DEVM | | 7 | | ≤13 | % |
| | 99% DEVM | | Pass | | ≤20 | % |
| | Peak DEVM | | | 20 | ≤25 | % |

| | | | | | | |
|---|---|---|---|---|---|---|
| In-band spurious emissions<br><br>Note: $F_0$=2441MHz | F > $F_0$+3MHz | | <-54 | | ≤-40 | dBm |
| | F = $F_0$-3MHz | | -46 | | ≤-40 | dBm |
| | F = $F_0$-2MHz | | -28 | | ≤-20 | dBm |
| | F = $F_0$-1MHz | | -30 | | ≤-26 | dBm |
| | F = $F_0$+1MHz | | -30 | | ≤-26 | dBm |
| | F = $F_0$+2MHz | | -28 | | ≤-20 | dBm |
| | F = $F_0$+3MHz | | -46 | | ≤-40 | dBm |
| EDR differential phase encoding | | | 100 | | ≥99 | % |

### Receiver Section for EDR

| Temperature = 25ºC | | Frequency (GHz) | Modulation | Min | Typ | Max | Bluetooth specification | Unit |
|---|---|---|---|---|---|---|---|---|
| Sensitivity at 0.01% BER | | 2.402 | π/4 DQPSK | | -91 | | ≤-70 | dBm |
| | | 2.441 | π/4 DQPSK | | -91 | | | |
| | | 2.480 | π/4 DQPSK | | -91 | | | |
| | | 2.402 | 8DPSK | | -83 | | ≤-70 | dBm |
| | | 2.441 | 8DPSK | | -83 | | | |
| | | 2.480 | 8DPSK | | -83 | | | |
| Maximum received signal at 0.1% BER | | | π/4 DQPSK | | -10 | | ≥-20 | dBm |
| | | | 8DPSK | | -10 | | ≥-20 | |
| C/I co-channel at 0.1% BER | | | π/4 DQPSK | | 4 | | ≤13 | dB |
| | | | 8DPSK | | 5 | | ≤21 | dB |
| Adjacent channel selectivity C/I<br>Note:<br>$F_0$=2441MHz | $F = F_0$+1MHz | | π/4 DQPSK | | -14 | | ≤0 | dB |
| | | | 8DPSK | | -8 | | ≤5 | dB |
| | $F = F_0$-1MHz | | π/4 DQPSK | | -13 | | ≤0 | dB |
| | | | 8DPSK | | -8 | | ≤5 | dB |
| | $F = F_0$+2MHz | | π/4 DQPSK | | -38 | | ≤-30 | dB |
| | | | 8DPSK | | -34 | | ≤-25 | dB |
| | $F = F_0$-2MHz | | π/4 DQPSK | | -21 | | ≤-7 | dB |
| | | | 8DPSK | | -21 | | ≤0 | dB |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | F = $F_0$-3MHz | π/4 DQPSK | | -27 | | ≤-20 | dB |
| | | 8DPSK | | -20 | | ≤-13 | dB |
| | F = $F_0$+5MHz | π/4 DQPSK | | -52 | | ≤-40 | dB |
| | | 8DPSK | | -45 | | ≤-33 | dB |
| | F = $F_{image}$ | π/4 DQPSK | | -21 | | ≤-7 | dB |
| | | 8DPSK | | -21 | | ≤0 | dB |

### Audio Codec: ADC (MIC PATH/Line-in path)

Test Condition:

T= 25°C, $V_{DD}$=2.8V, 1KHz sine wave input, Bandwidth = 20~20KHz

| Parameter | Condition | | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| **Input full-scale** | Full scale (line-in) | | | | 2.2 | Vpp |
| **Resolution** | | | | 16 | | bits |
| **Input Sampling Rate** | | | 8 | | 48 | kHz |
| **SNR** | $f_{in}$=1KHz B/W=20~20KHz A-weighted THD+N < 1% 150mVpp input | 8KHz | | 85 | | dB |
| | | 16KHz | | 85 | | |
| | | 32KHz | | 85 | | |
| | | 44.1KHz | | 85 | | |
| | | 48KHz | | 85 | | |
| **SNR** | A-weighted 1KHz@full scale, Microphone boost enable | | | 75 | | dB |
| **THD+N** (Mic input) @30mVrms input | | | | 0.04 | | % |
| **THD+N** (line input) | | | | 0.01 | | % |
| **Mic Boost Gain** | | | | 20 | | dB |
| **Digital Gain** | | | -54 | | 4.85 | dB |
| **Analog Gain** | | | | | 26 | dB |
| **Digital Gain Step** | | | | 6 | | dB |
| **Analog Gain Step** | | | | 1.7 | | dB |
| **Input impedance** (microphone mode) | Input impedance | | | 6 | 10 | KΩ |
| | Input capacitance | | | | 20 | pF |
| **Analog supply voltage (AVDD)** | | | 1.8 | 2.8 | 3.0 | V |

### Audio Codec: DAC (SPEAKER path)

| Test Condition: T= 25°C, $V_{DD}$=2.8V, 1KHz sine wave input, Bandwidth= 20~20KHz | | | | | | |
|---|---|---|---|---|---|---|
| **Parameter** | **Condition** | | **Min.** | **Typ.** | **Max.** | **Unit** |
| **Output Level** | Full scale | | | 2.1 | | Vpp |
| **Resolution** | | | 16 | | | bits |
| **Output Sampling Rate** | | | 8 | | 48 | KHz |
| **SNR** | $f_{in}$=1KHz B/W=20~20KHz A-weighted THD+N < 0.01% 0dBFS signal Load=100KΩ | 8KHz | | 94 | | dB |
| | | 16KHz | | 94 | | dB |
| | | 32KHz | | 94 | | dB |
| | | 44.1KHz | | 94 | | dB |
| | | 48KHz | | 94 | | dB |
| **Max Output Power** | $R_L$=16Ohm | | | 35 | | mW |
| | $R_L$=32Ohm | | | 17 | | mW |
| **THD+N** | 16Ohm load | | | | 0.05 | % |
| | 100KΩ load | | | | 0.01 | % |
| **Digital Gain** | | | -54 | | 4.85 | dB |
| **Digital Gain Resolution** | | | | 6 | | dB |
| **Analog Gain** | | | -28 | | 3 | dB |
| **Analog Gain step** | | | | 1 | | dB |
| **Output resistance** | $R_L$ | | 8 | 16 | | Ohm |
| **Output capacitance** | Cp | | | | 500 | pF |
| **Crosstalk between channels** | L vs. R, measured at -10dBFS@1KHz input | | | -90 | -80 | dB |
| **Analog supply voltage (AVDD)** | | | 1.8 | 2.8 | 3.0 | V |

### Battery Charger

| **Charging Mode (BAT_IN rising to 4.2V)** | | **Min** | **Typ** | **Max** | **Unit** |
|---|---|---|---|---|---|
| **Operation Temperature** | | -10 | | 55 | ℃ |
| **Input Voltage** (Vin)<br>Note: It needs more time to get battery fully charged when Vin=4.5V | | 4.5 | | 7 | V |
| **Battery trickle charge current**<br>(BAT_IN < trickle charge voltage threshold) | | | 0.1C | | mA |
| **Trickle charge voltage threshold** | | | 3 | | V |
| **Maximum battery charge current** | Headroom > 0.7V | | 350 | | mA |
| | Headroom = 0.3V | | 150 | | mA |
| **Minimum battery charge current** | Headroom > 0.7V | | 1 | | mA |
| | Headroom = 0.3V | | 1 | | mA |
| **Battery charge termination current**,<br>% of fast charge current | | | 10 | | % |
| **Battery recharge hysteresis** (Note1) | | | 100 | | mV |
| **Battery recharge current** (Note2)<br>Note: C → Battery capacity | | | 0.25C | | mA |

Note1：When charging complete and the adapter is still in, the battery voltage will slowly drop down. When the voltage drop is larger than 100mV from the full voltage, the re-charging cycle will start.

Note2：If the battery voltage during plug in is larger than 4V, the charging current will be limited to 0.25C to avoid the battery voltage overshoot.

### Clock

| Parameters | MIN | TYP | MAX | Unit |
|---|---|---|---|---|
| Crystal Frequency | | 16 | | MHz |
| Frequency Tolerance | | ±20 | | ppm |
| Operating Temperature | -20 | | 70 | $^{O}$C |
| Trimming Capacitance | | 6.4 | | pF |
| Trimming Step Size | | 0.2 | | pF |

### Digital GPIO

| Parameters | MIN | TYP | MAX | Unit |
|---|---|---|---|---|
| **Input Voltage** | 2.7 | 3 | 3.6 | V |
| $V_{IH}$ (Input High Voltage) | 2.0 | | Vdd | V |
| $V_{IL}$ (Input Low Voltage) | 0 | | 0.8 | V |
| **Input Reference Resistor** | | | | |
| $R_{PU}$ (Pull-Up Resistor) | | 50K | | Ohm |
| $R_{PD}$ (Pull-Down Resistor) | | 50K | | Ohm |
| **Output Voltage** | | | | |
| $V_{OH}$ (Output High Voltage) | 2.4 | | Vdd | V |
| $V_{OL}$ (Output Low Voltage) | 0 | | 0.4 | V |

### Current Consumption ROM mode

| Test Condition: T= 25°C, BAT_IN=4.0V, with flash code | | | | |
|---|---|---|---|---|
| **Normal Operation** | **Min** | **Typ** | **Max** | **Unit** |
| **Off mode** | 2 | | 10 | uA |
| **Standby mode** | | 0.6 | | mA |
| **Link mode** | | 0.6 | | mA |
| **SCO link** | | 13.7 | | mA |
| **A2DP link** | | 15.3 | | mA |

### Current Consumption Flash mode

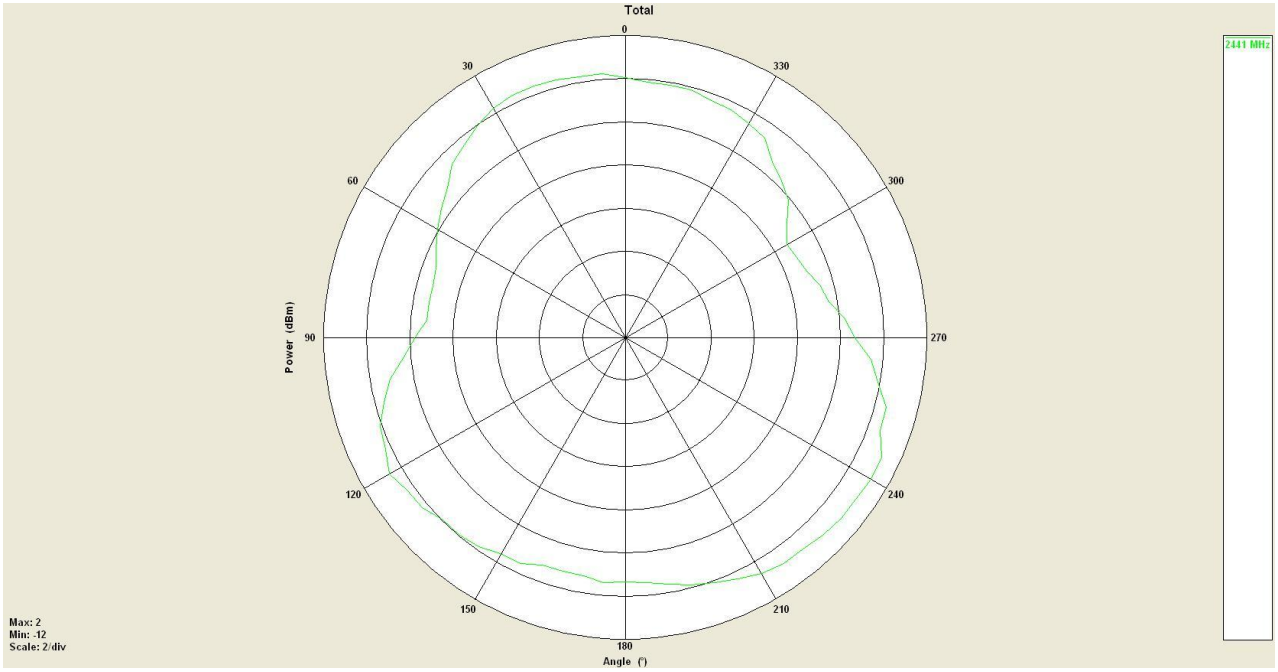
### (special code, the number depends on the FW code)

| Test Condition: T= 25°C, BAT_IN=4.0V, with flash code, codec without loading | | | | |
|---|---|---|---|---|
| **Normal Operation** | **Min** | **Typ** | **Max** | **Unit** |
| **Off mode** | 2 | | 10 | uA |
| **Standby mode** | | 1.4 | | mA |
| **Link mode** | | 1.4 | | mA |
| **SCO link** | | 22.8 | | mA |
| **A2DP link** | | 24.6 | | mA |

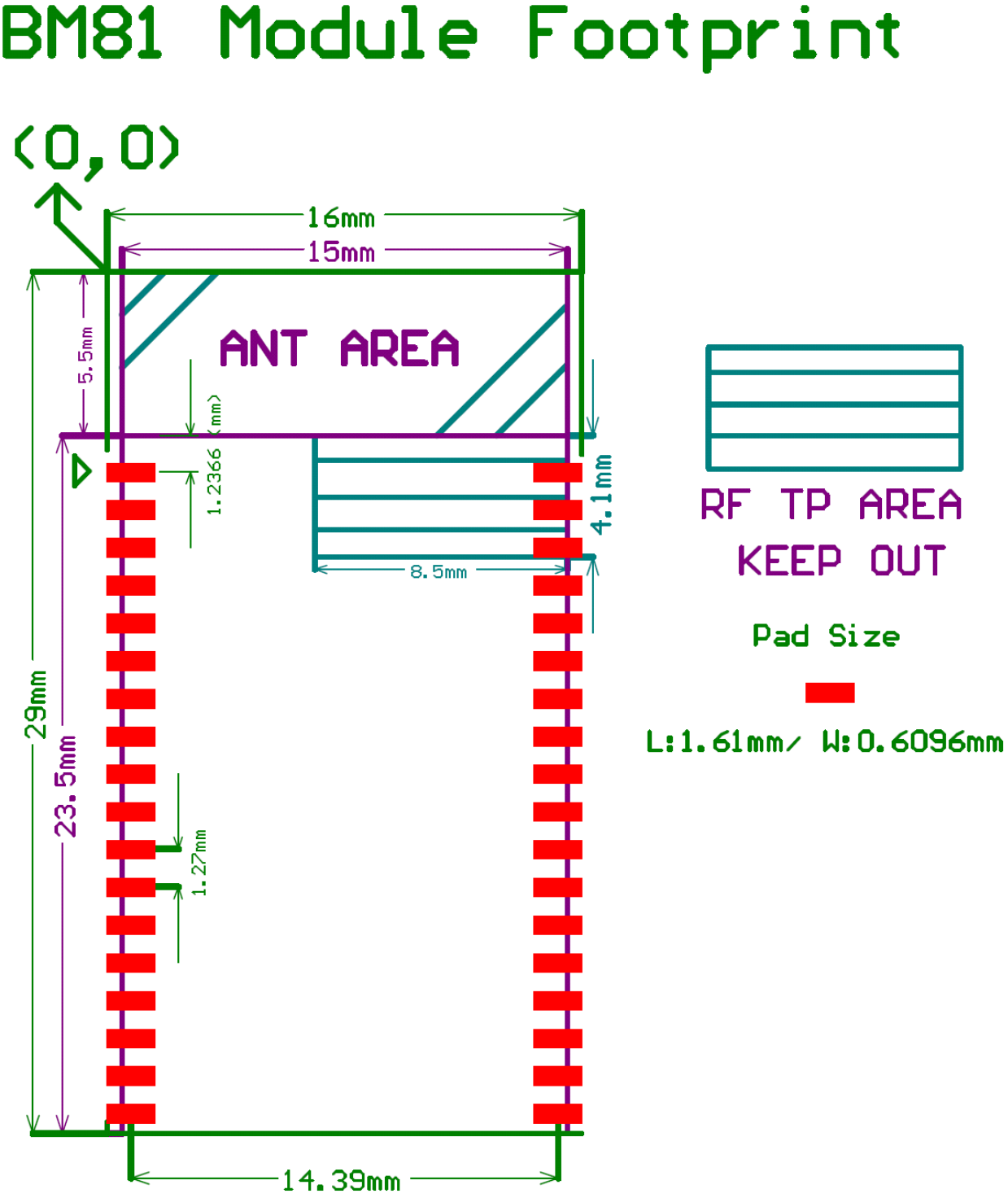
## Antenna performance

| Parameters | MIN | TYP | MAX | Unit |
|---|---|---|---|---|
| Antenna gain | | 1.76 | | dBi |
| Efficiency | 51.5 | | 59.7 | % |

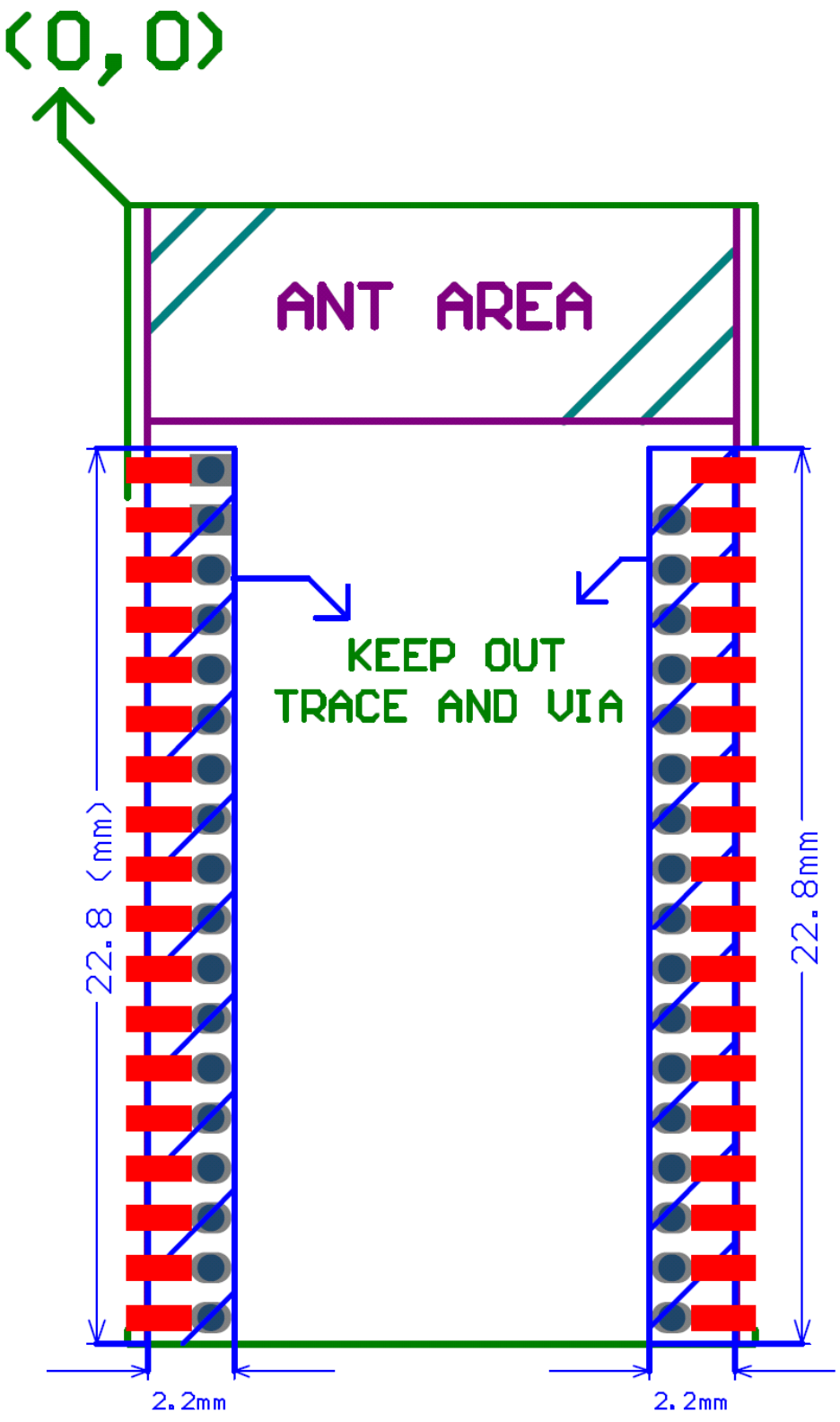
## 2441MHz



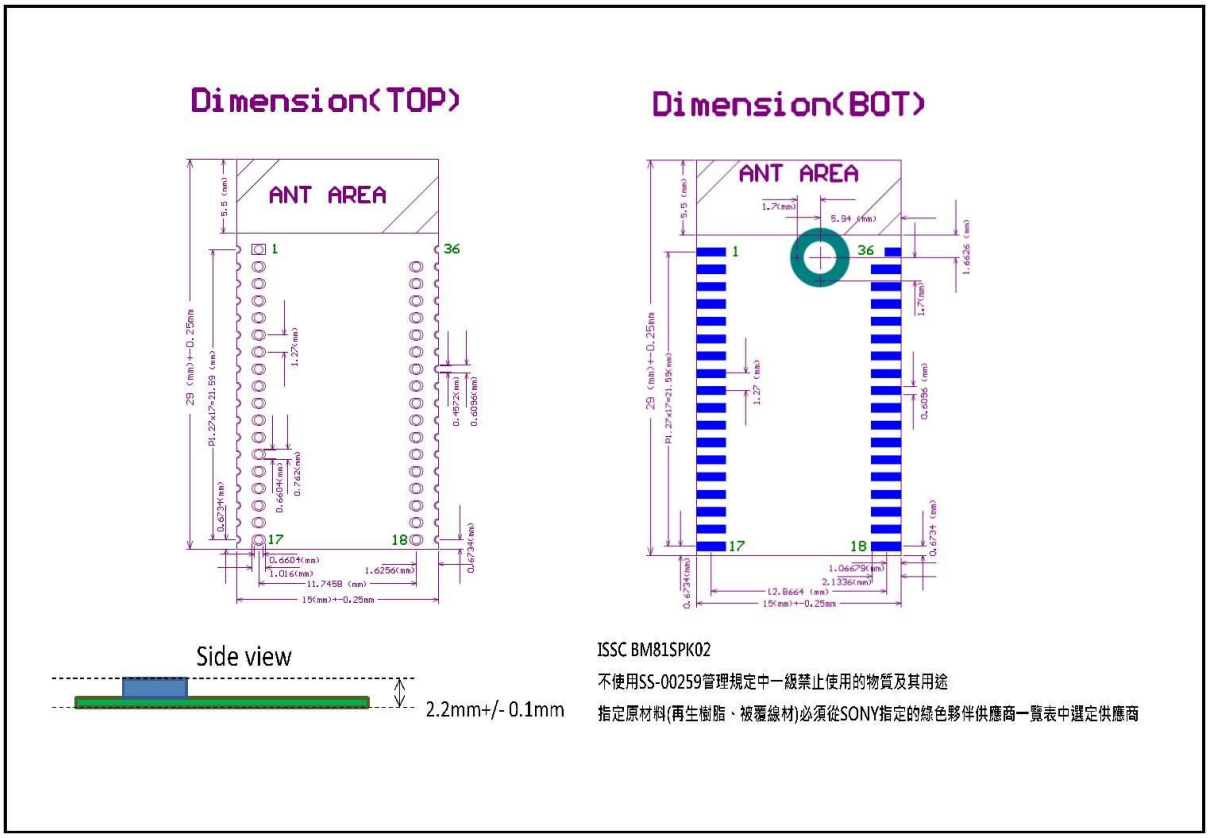
## Outline Dimension (Module Foot print)



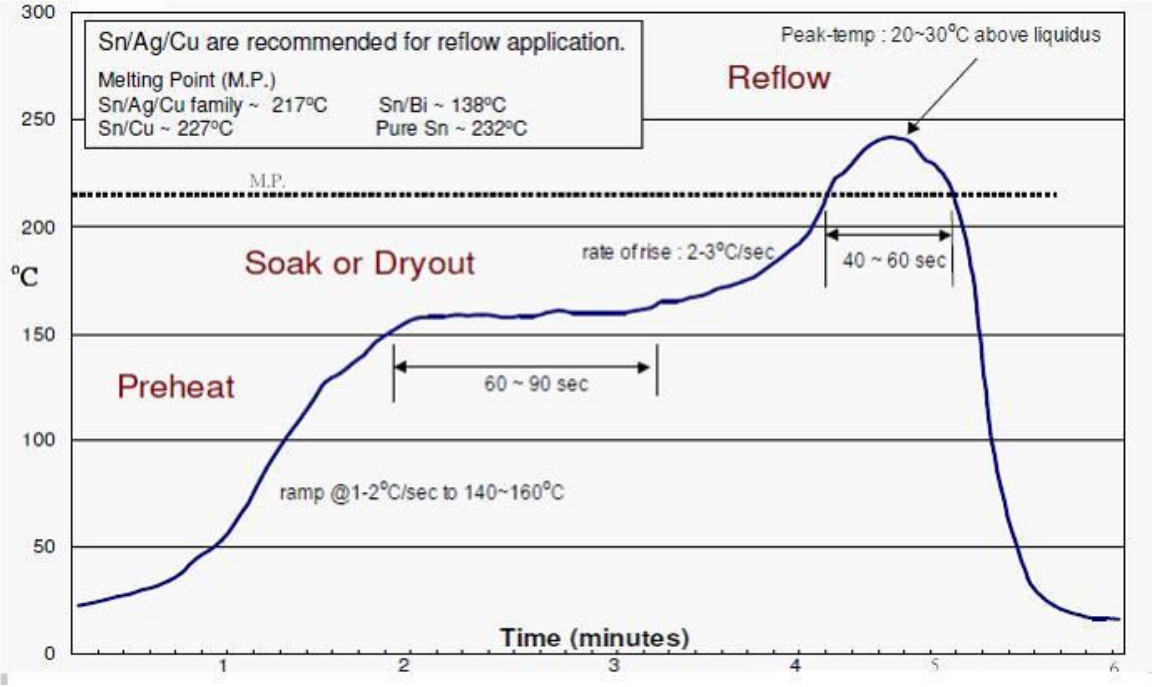
**BM81SPK02 Trace + Via**



## Outline Dimensions



## Reflow profile



## QR code label information

Device Name: BM81SPK02NB6

MAC ID: 8CDE52AABBCC

Customer Code Name: C331AA

Date Code: 1312


Label Size:15±1.5 *6±1.5 mm

## Module Weight

(Test condition: module with QR label)

1.15g ± 10%

Storage standard

**Ordering Information**

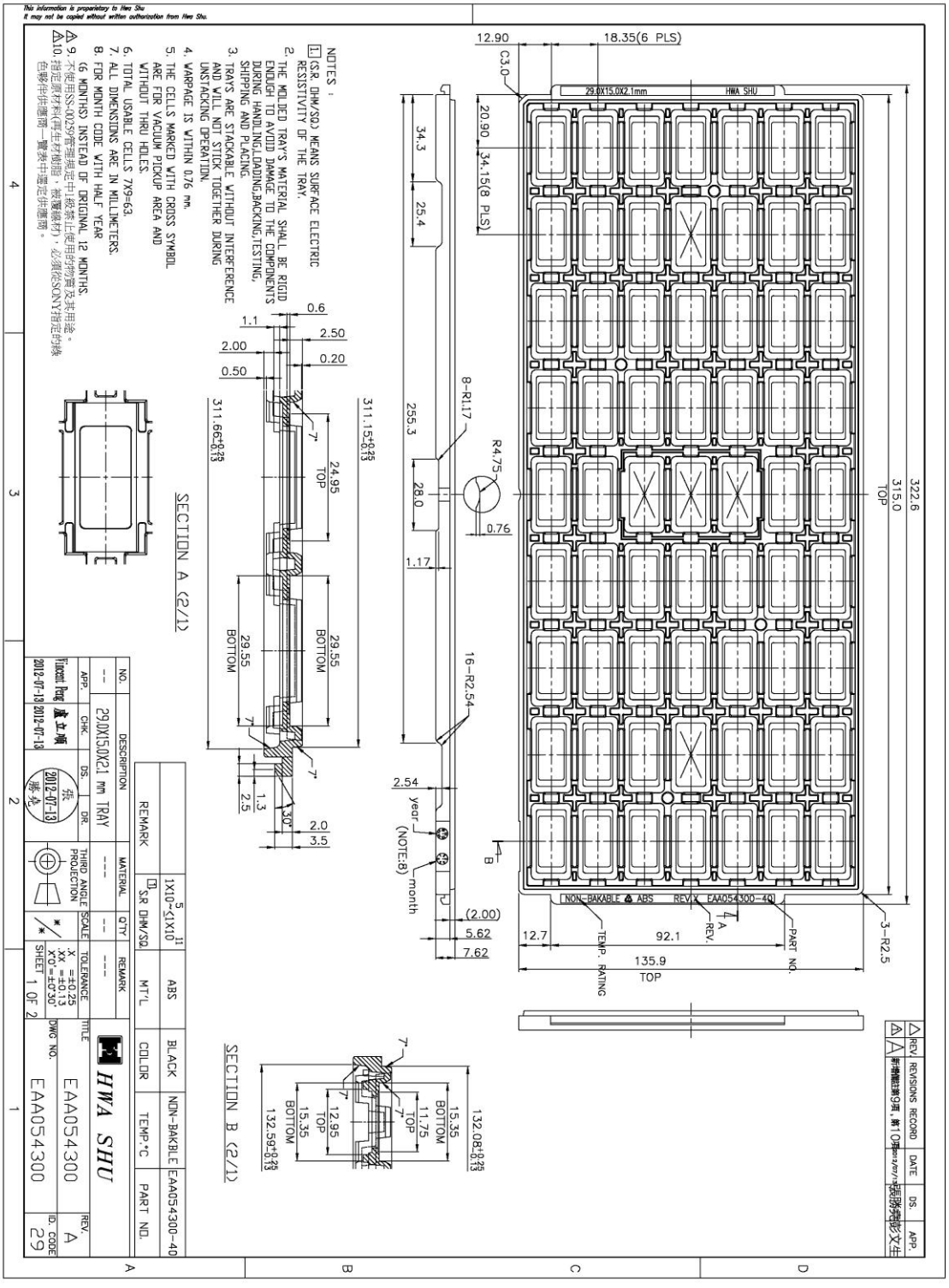
| Device | Module | | Order Number |
|---|---|---|---|
| | Size | Shipment Method | |
| **BM81SPK02NB6**<br>Bluetooth 3.0 EDR<br>Wireless Speaker Module | 29*15 mm | Tray | |

**Note:**

Minimum Order Quantity is 630pcs Tray.

## Packing Information

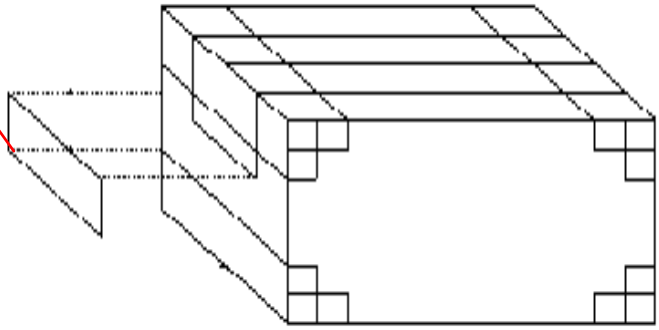
Tray Dimensions



Packing Method

Inner box: Q'ty (630 Pcs)
Dimensions: 36*16*9.5 cm


Bar Code Label
P/N: device name
Lot No: Lot ID
Q'ty: box or Carton Module's Q'ty



Carton: Q'ty (3780 Pcs)
Dimensions: 38*35*30 cm