NationalChip

# Microphone Array Design Considerations

**V1.0**

2023-02-01

# Summary

The document details the guidance related to the structural design of the NationalChip microphone array scheme.

History modification record:

| Modification time | Version | author | Correction description |
|---|---|---|---|
| 2022/9/16 | V1.0.0 | Weidong | Initial version |
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| | | | |

# Catalogue

# 1. Microphone system design

## 1.1. MIC model selection

### 1.1.1. Parameter Description

- The ultimate goal of the index is to obtain better acoustic effect for the hardware. There is no absolute limit value, as long as the hardware acoustic test is passed
- The following indicators are for reference
- Both digital MIC and analog MIC can be used

### 1.1.2. Parameter index requirements

- Sensitivity：> -38dBV @94dB 1KHz
- SNR >= 65dB
- Acoustic overload point（AOP）：>= 120dB SPL
- Harmonic distortion of single microphone(THD): <=1%(1kHz)
- Microphone phase consistency requirements：< 3°
- Omnidirectional pickup
- Fluctuation of microphone monomer spectral response < 2dB （100Hz-8KHz）

### 1.1.3. Recommended model

It has passed the index test of Nationalchip, and has been used in mass production. Please consult with Nationalchip Business for contact information.

## 1.2. MIC sound outlet design

### 1.2.1. Microphone cavity design principles

- Make sure that the voice reaches the receiver directly and to each microphone the same.
- To ensure that the voice can reach the receiver directly and be the same as each microphone to avoid vibration, the silicone protective sleeve should be as thick, soft and stable as possible.
- In order to avoid inconsistency caused by cavities, it is required that the reception between microphones should not be affected. The design and installation of each microphone cavity are the same.
- In order to ensure the sealing, silicone, sealing ring or foam shall be used for sealing between the panel and PCB as well as the silicon microphone itself
- In order to prevent the MIC sound hole from being blocked, it is necessary to put a dust screen
- The microphone shall be installed as far away from vibration or interference as possible, and shall be isolated from the solid surface to reduce the vibration and sound transmission of the housing and seal it

### 1.2.2. Microphone structure suggestions

➢ Mems MIC

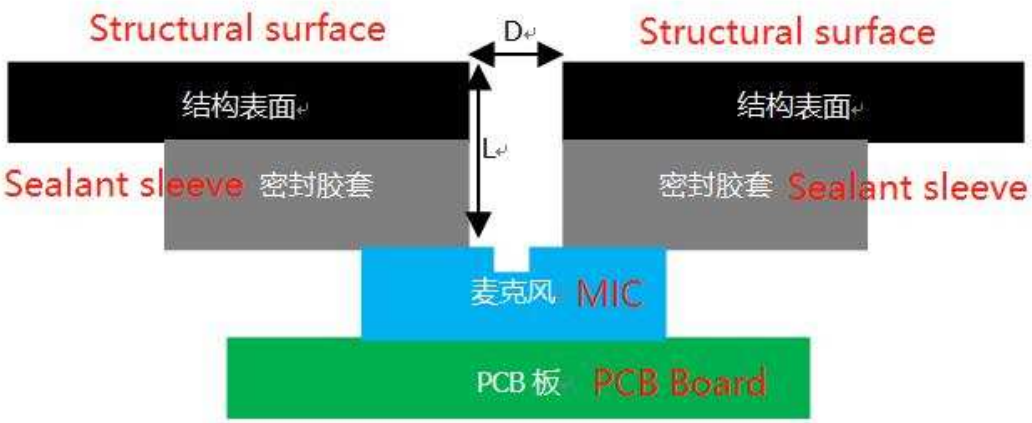


Fig1TopMEMSMic

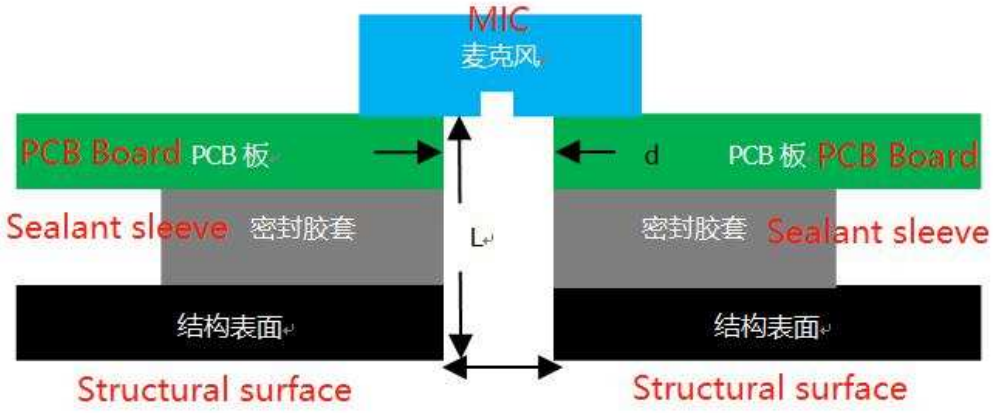


Fig2 Bottom MEMS Mic

1) Figure 1 shows the TOP pickup microphone, and Figure 2 shows the Mic of Bottom pickup, where L represents the depth and D represents the opening diameter. D represents the hole diameter of PCB.

2) During structural design, it is necessary to ensure that the opening is as large as possible (D>1mm) and the hole depth is as small as possible (L<5mm). It is recommended to ensure that L/D<3, that is, the smaller L is, the larger D is, the better.

3) The opening diameter d of PCB needs to select the corresponding mic according to the plate thickness and determine the opening diameter.

At present, there are two kinds of bottom type silicon wafer seal rings with inner diameters of 0.6mm and 1.0mm. Considering the machining accuracy, the PCB opening corresponding to these two types of silicon wafer can be 0.4mm and 0.8mm. When the PCB board thickness is greater than 1mm, try to select a seal ring with an inner diameter of 1mm.

**SMT Parameters:**

**1. Recommend PCB land pattern & stencil pattern**

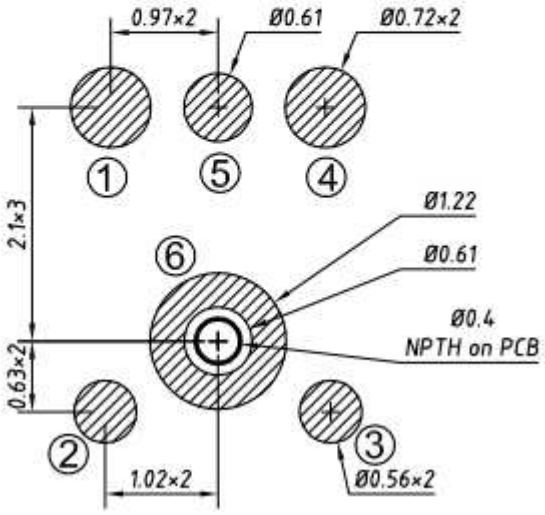


Fig.3 Inner diameter of sealing ring is 0.6mm.

**SMT Parameters：**

**1. Recommend PCB land pattern & stencil pattern layout：**

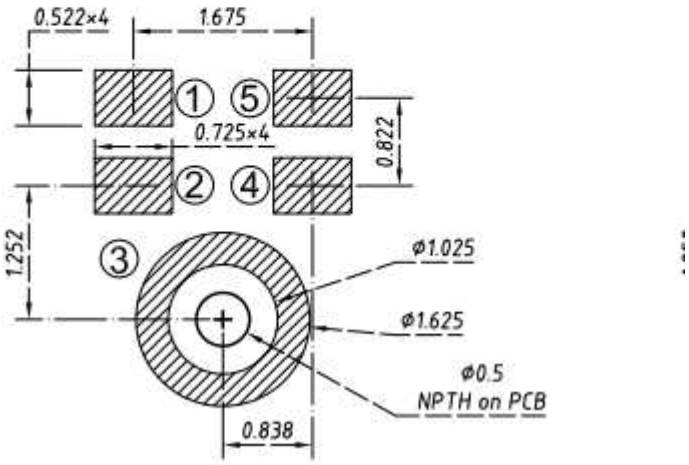


Fig4 Inner diameter of sealing ring 1mm

4) The Helmholtz resonator should be avoided during structural design. As shown in the figure below, this structure will lead to high frequency response spikes.

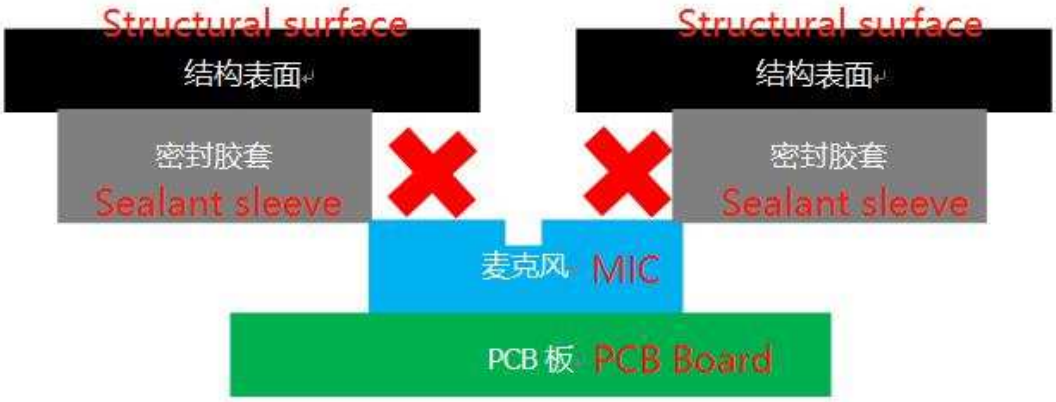


Fig5 TOP Helmholtz resonator

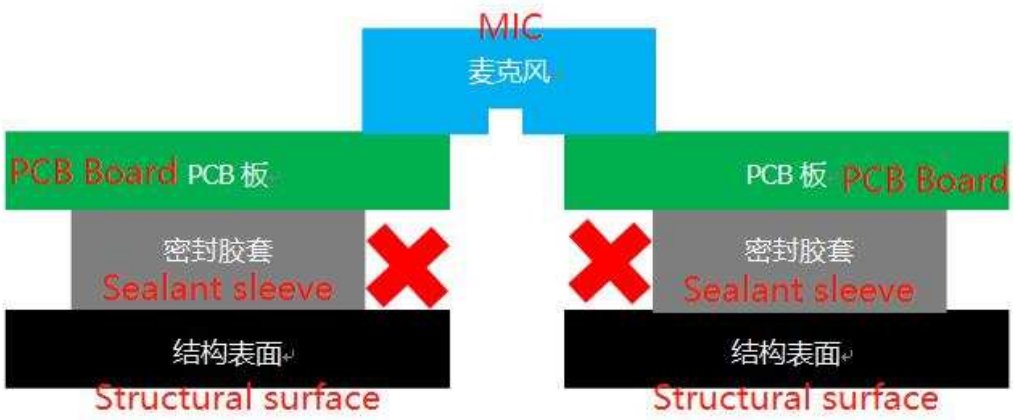


Fig6 BOTTOM Helmholtz resonator

- electret condenser microphone

The stripline electret microphone can adapt to different structures, and the microphone cavity design is simpler without special requirements.

Due to manual assembly, it is easy to form a resonant cavity on the structure when the product is not installed
properly.

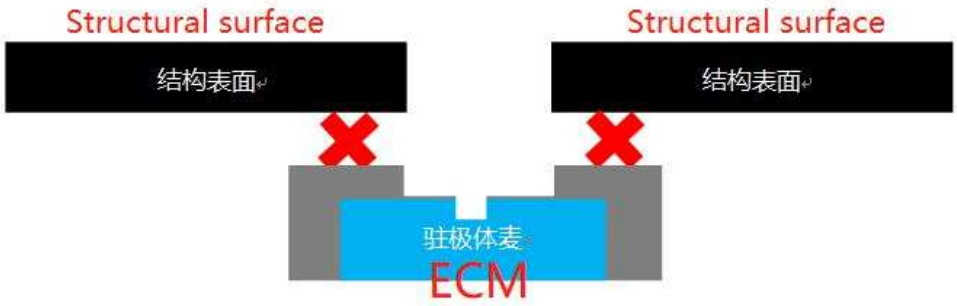


Fig7 Inadequate assembly

## 1.2.3. Sound insulation and shock absorption design

1) For the sound box scene with the product's own speaker, internal sound insulation treatment is required between MIC and SPK to

prevent the sound from SPK from being directly transmitted to MIC through the product interior

2) The distance from MIC pickup to SPK sounding hole is more than 100mm.

3) The microphone needs to be isolated from the surface of the firmware by a silicone sleeve to prevent direct hard contact between the silicon microphone and the structure, so as to reduce the vibration and sound transmission of the housing and play a sealing role.

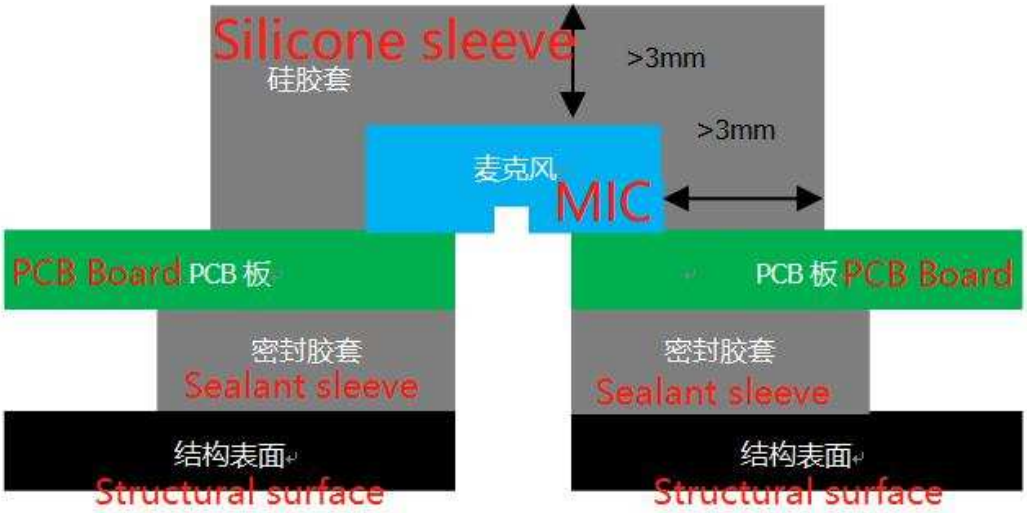


Fig8 BOTTOM MEMS MIC

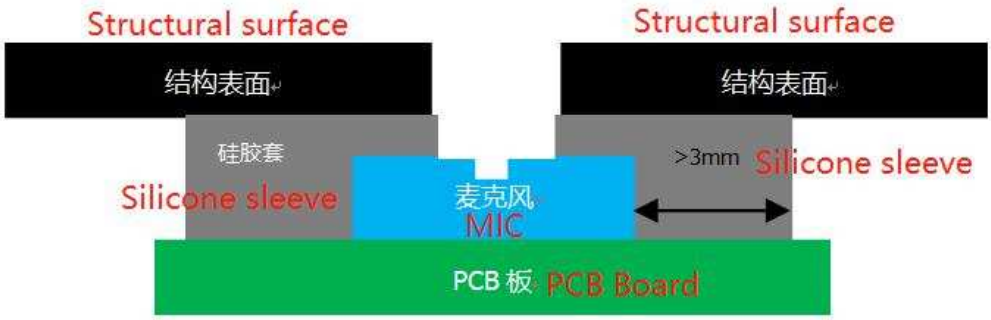

Fig9 TOP MEMS MIC

4) The MEMS mic itself is surrounded by silica gel, and the thickness of silica gel needs to be greater than 3mm

### 1.2.4. Dust screen

For products with MIC pickup hole facing up, it is better to add a dust-proof screen to prevent dust accumulation after long use, which will affect MIC performance. The dust-proof screen shall be of a model with flat frequency response and low sound transmission loss

## 1.3. MIC array layout

### 1.3.1. Linear array

Linear array requires that all microphones face the same direction, and all microphone inlets are in the same line

2MIC~4MIC linear array, recommended spacing [30mm, 60mm]

5MIC~6MIC linear array, recommended spacing [21.3mm, 50mm]

[30mm, 40mm] is a better choice

### 1.3.2. Circular array

Recommended array radius [30mm, 40mm]

# 2. Speaker system design

## 2.1. Suggestions on structural design

1) Ensure that the distance between the speaker and microphone is as far as possible, so that the sound pressure from the speaker to the

microphone does not exceed 90db (measured at MIC), and the intensity signal-to-noise ratio of the human volume and speaker volume at MIC is not less than - 25db. The effect of interrupting wake-up has no absolute relationship with the power of the horn, but only with the signal-to-noise ratio at the MIC.

2) MIC pickup hole and SPK generation hole should be oriented at 90 degrees, not in the same direction

3) When designing the loudspeaker, the cavity shall be kept 2mm away from other parts to prevent abnormal sound caused by collision

4) The loudspeaker shall be designed with shock absorption to avoid internal sound transmission caused by structural vibration

## 2.2. Speaker Selection

1) Distortion of single loudspeaker in each frequency band:<1Hhz, THD<5%;> 1Khz，THD < 3%

# 3. Technical cooperation

In the structural design stage, it is recommended that the customer provide the microphone datasheet, power amplifier datasheet, loudspeaker datasheet and structural drawings selected to CIMC for further confirmation.

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