

Knowles

July 2020

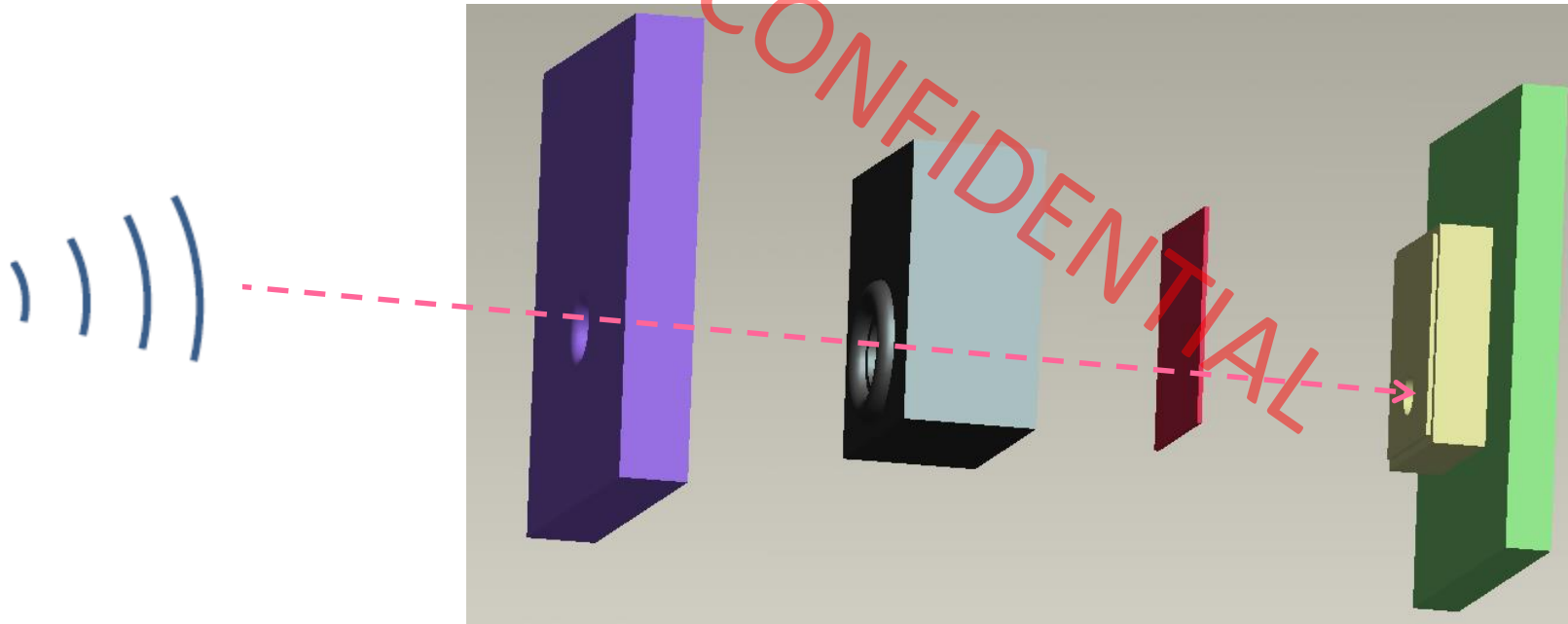
Microphone Mechanical Design Guide

Application

How to approach good acoustic performance by microphone mechanism designs?

▶ Microphone Unit Performance

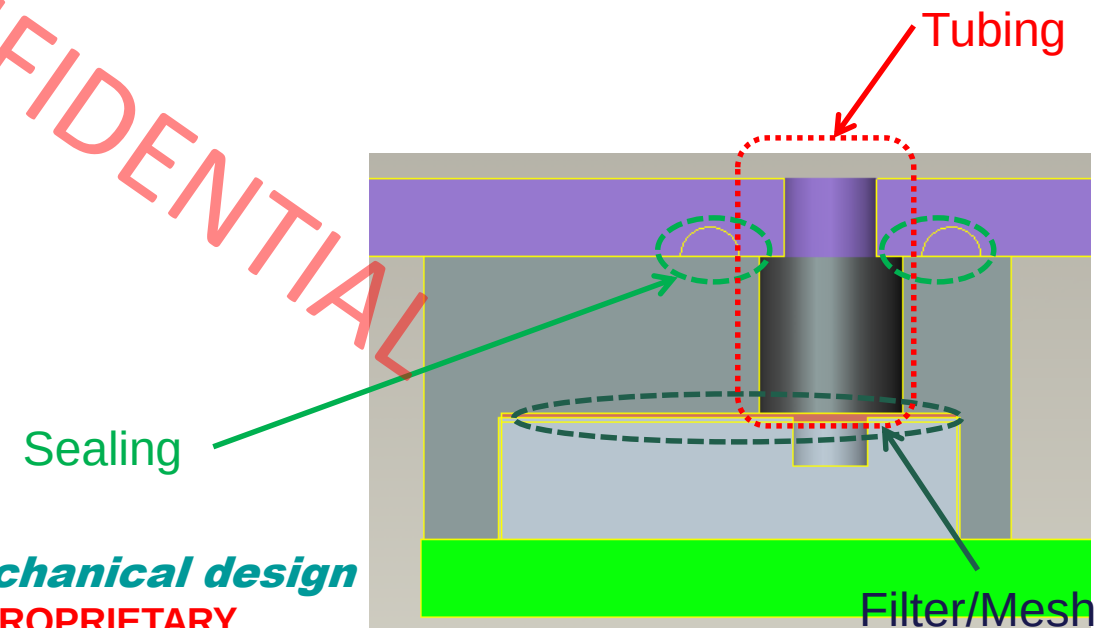
▶ Mechanical Design



Key Insight

Factors that Impact Audio Performance in Mechanical design:

- ▶ Tubing: The volume of air channel from outside of housing till microphone inside.
- ▶ Sealing: Rubber boot and housing; mic and rubber boot; rubber boot and PCB (for bottom port mic).
- ▶ Filter/Mesh: Attenuation damper. The SiSonic frequency response can be extended beyond the voice band.
- ▶ Gasket material selection.



Four elements of good mechanical design

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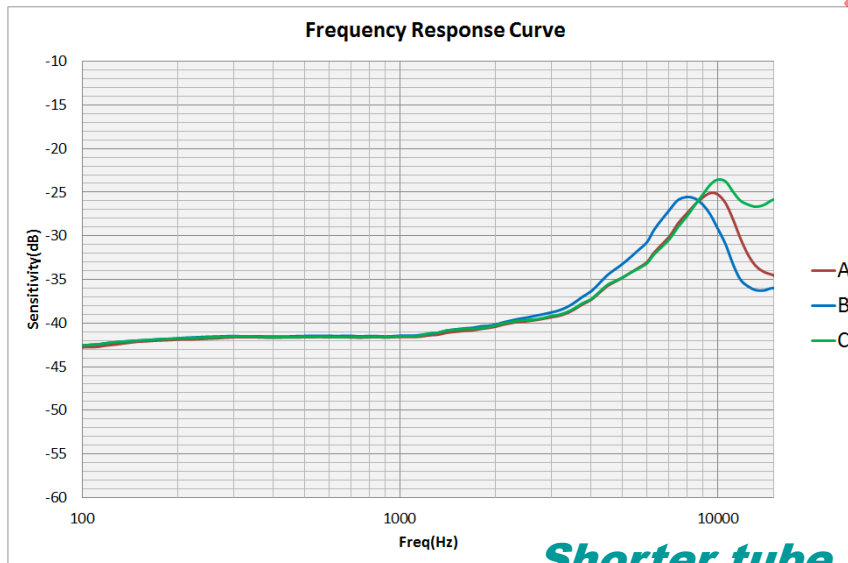
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Solution

Tubing – Type 1

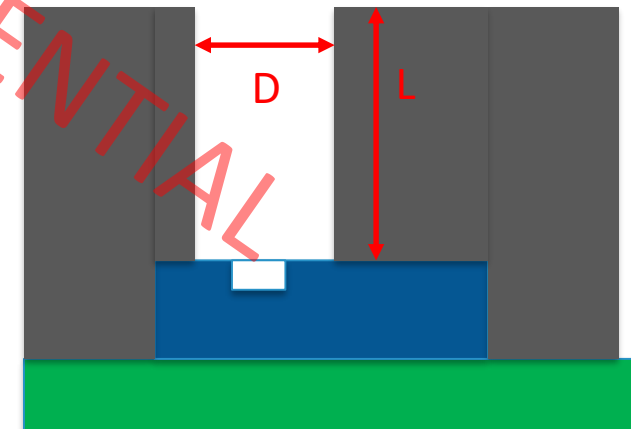
► When acoustic path is one tube only:

1. Shorter length and larger port hole is better for acoustic performance.
2. Port hole size is directly proportional to resonant peak frequency and amplitude.
3. Tube length is inversely proportional to resonant peak frequency and amplitude.



	Length of tube(mm)	Diameter of tube(mm)	Peak Location of Freq(KHz)
Curve A	2	1	9.5
Curve B	4	1	8
Curve C	4	2	10

Note: The test data is based on SPU top port analog mic.



Shorter tube, bigger port is better

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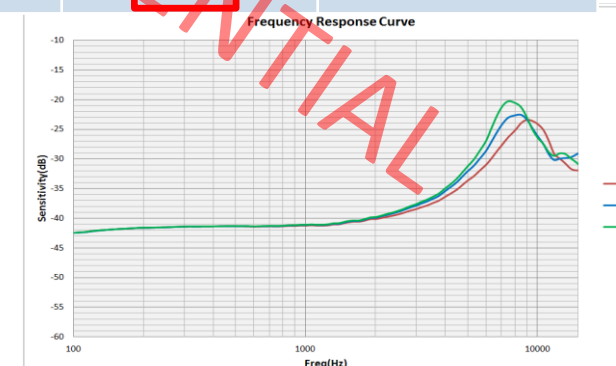
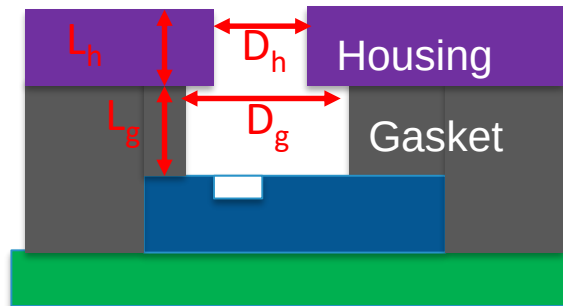
Solution

Tubing – Type 2

► When acoustic path is formed by two sections of tube (housing+gasket):

1. Shorter gasket length is better for acoustic performance.
2. Gasket hole larger than housing hole a little bit, for:
 - (1). Beautify product appearance
 - (2). Sound transmission won't be attenuated.
3. Gasket hole size is as close to the housing hole size as possible.

	Length of housing (mm)	Dia. of housing (mm)	Length of gasket (mm)	Dia. of gasket (mm)	Peak Location of Freq(KHz)
Curve A	1	1	2	1.5	9
Curve B	1	1	4	1.5	8.5
Curve C	1	1	4	2	7.5



Shorter gasket tube, and make gasket hole as close to housing hole as possible

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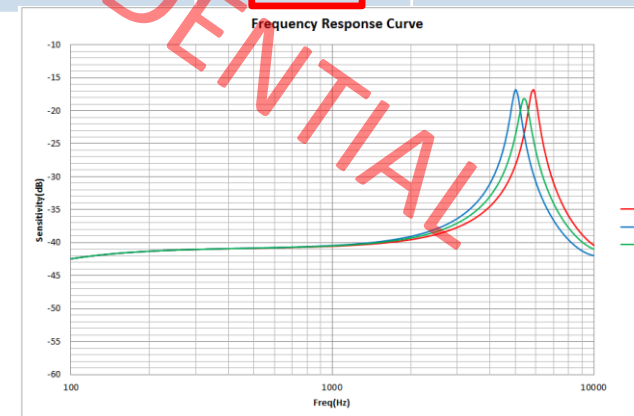
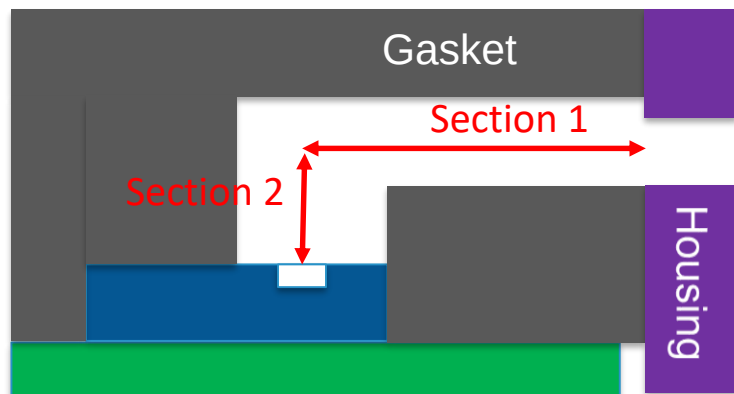
Solution

Tubing – Type 3

► When acoustic path is formed by two sections of tube (housing+gasket), and the gasket tube is with bend(s):

1. The gasket port hole size should keep the same if possible, and the bend of the port in gasket tube should be as short as possible and as small as possible.

	Length of housing (mm)	Dia. Of housing (mm)	Length of gasket - section 1 (mm)	Dia of gasket - section 1 (mm)	Length of gasket – section 2 (mm)	Dia of gasket – section 2 (mm)	Peak Location of Freq (KHz)
Curve A	1	1	3	1.2	3	1.8	5.8
Curve B	1	1	3	1.2	5	1.8	5.0
Curve C	1	1	3	1.2	5	1.0	5.3



The bend of the port in gasket tube should be short and small

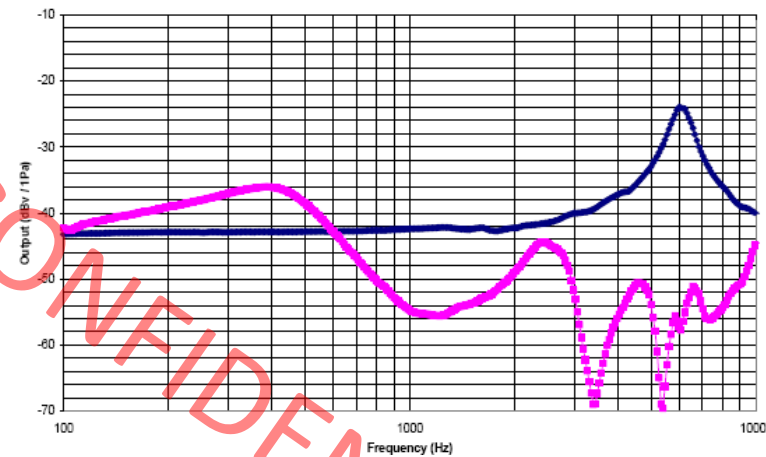
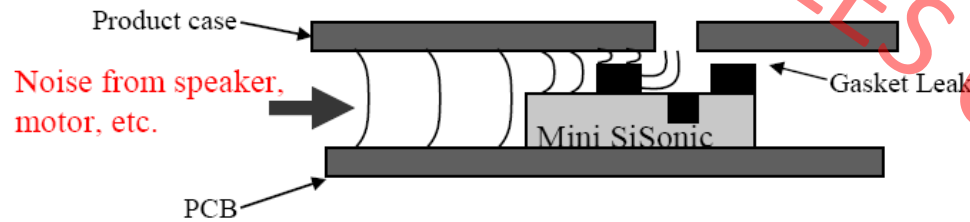
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Solution

Sealing

- ▶ A good seal prevents echo and component noise problems that are typical of gasket leaks.



- ▶ The gasket material must ensure a sealed acoustic path.

- Housing well sealed.
- Tight fit over the microphone.
- Sealing material is another key factor.

Sealing the acoustic path is a key requirement

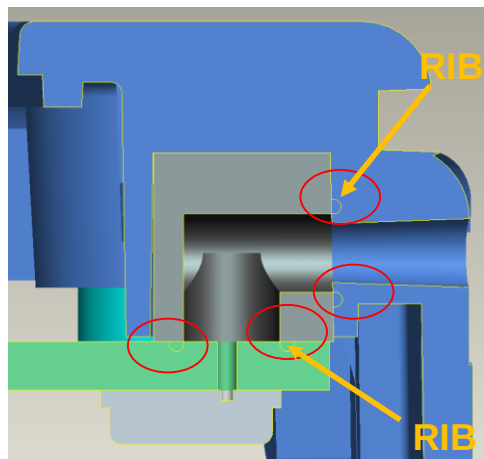
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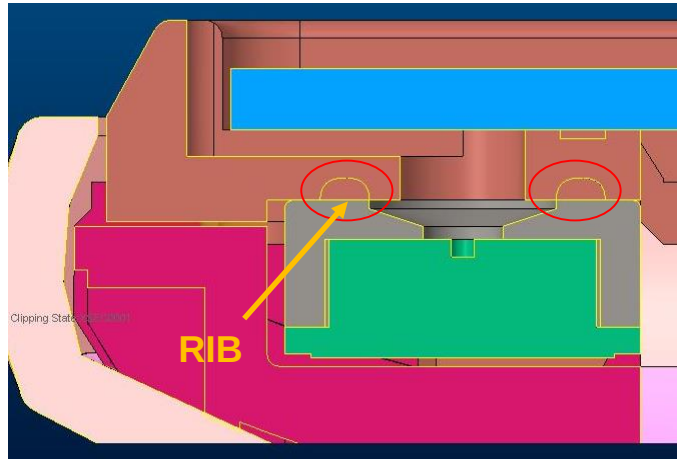
Solution

Sealing

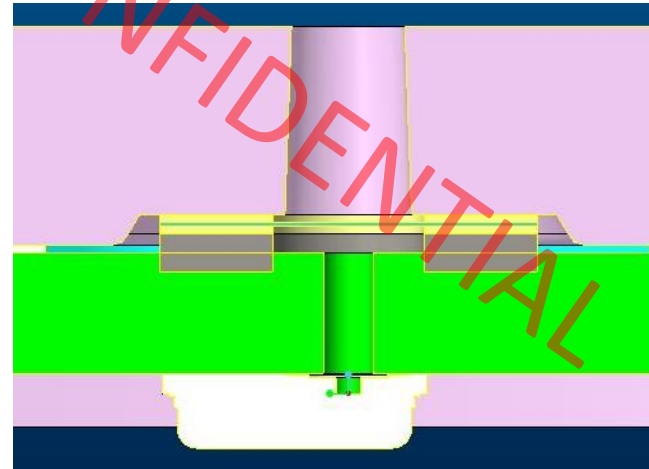
- ▶ To make a good seal, adding proper interference between rubber boot and product case is needed because of assembly and parts dimension tolerance.
- ▶ “**RIB**” is a recommended way to do interference for good sealing, or adding adhesive tape to get acoustic seal is also a solution.



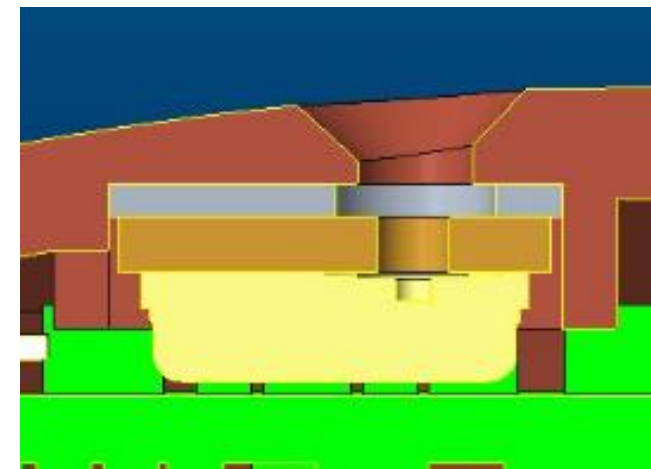
Mobile



NB



IOT



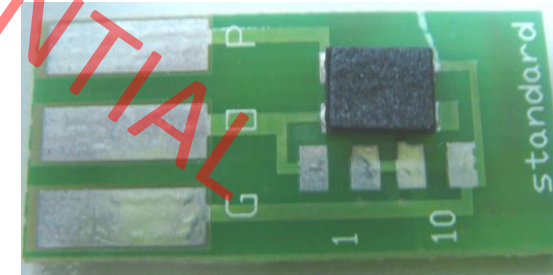
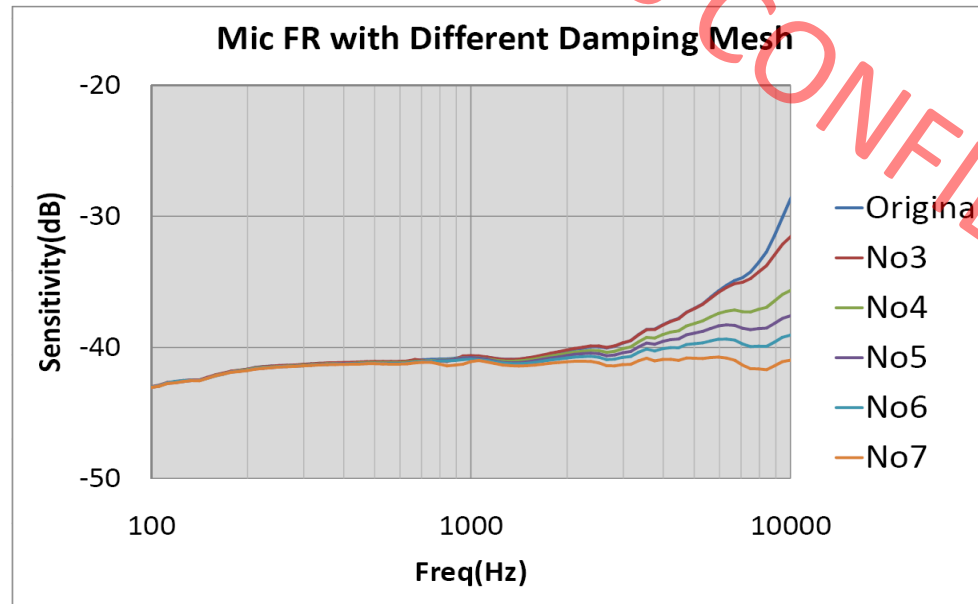
TWS

Initial rib interference design to ensure seal

Solution

Filter/Mesh

- ▶ Acoustical resistive material flattens the resonant peak.
- ▶ This material is a screen or mesh that blocks a significant percentage of the acoustic path area, or a porous sheet of material that resists but allows airflow.
- ▶ The tighter the screen mesh, the higher the acoustic resistance.
- ▶ An acoustic resistance can be inserted almost anywhere in the acoustic path.



Note: The test data is based on SPM top port analog mic.

Flat frequency response can be extended beyond voice band by adding filter

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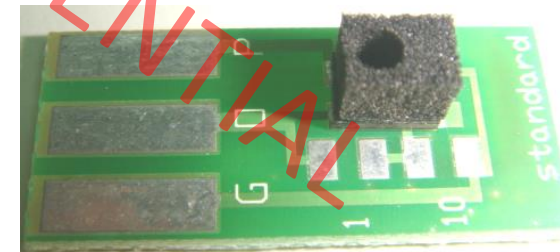
Solution

Material of Gasket Choosing

Sponge to be a gasket? – NO, WE DON'T RECOMMEND.

Foam / Poron (tolerance stuff):

- ▶ Foam has a high compression rate, and has been used by designers to compensate for sloppy tolerance or to reduce stress on a flimsy housing.
- ▶ When tubing length is long, to increase sponge thickness to be gasket isn't a recommendation because of acoustic leakage through larger foam area.



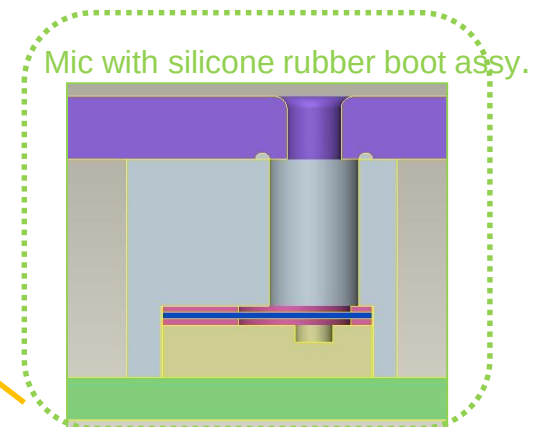
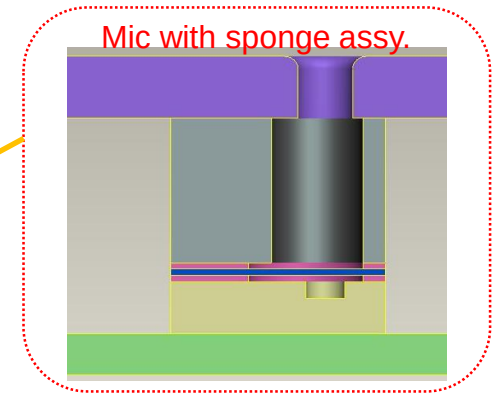
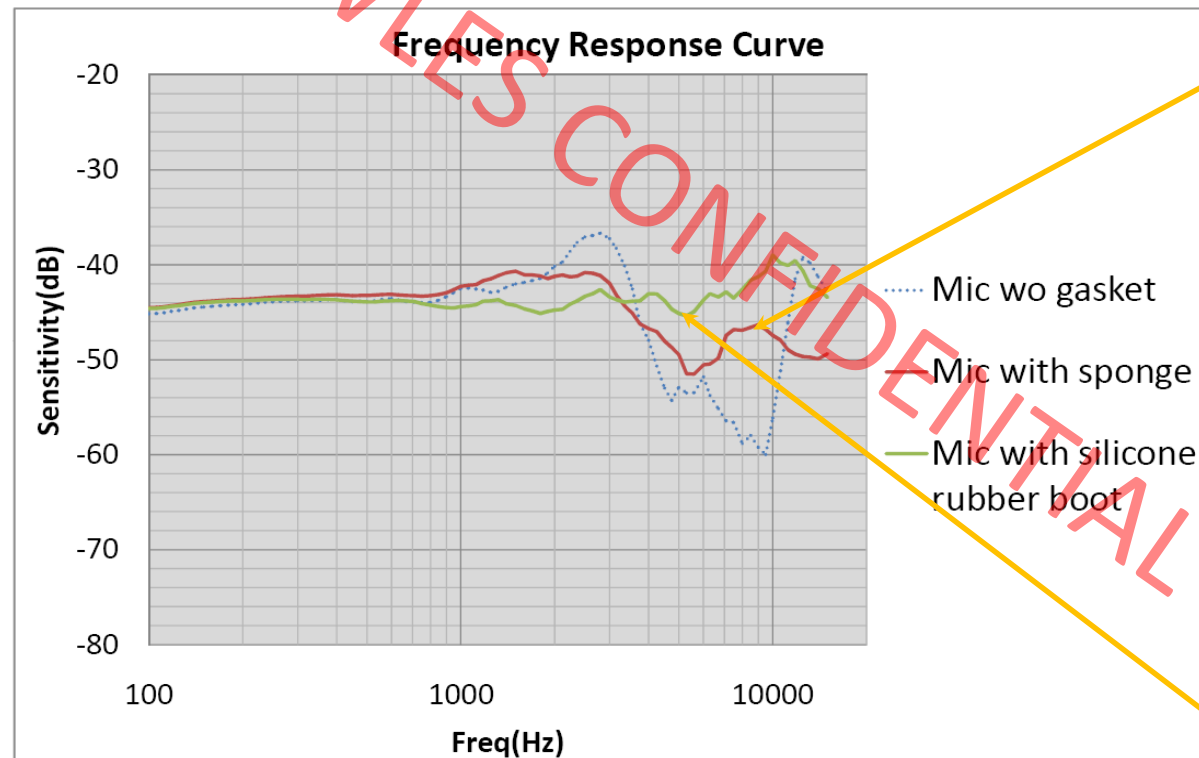
Sponge has high compression rate but acoustic leakage risk

Solution

Material of Gasket Choosing

► Frequency Response Curve Comparison:

In the same mechanical structure, acoustic performance of using silicone rubber boot as gasket is better than sponge.



Sponge does not provide acoustic isolation from outside sounds

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Conclusion

- ▶ Microphone mechanical acoustic design is fundamental, it affects the user's experience directly.
- ▶ Criteria of a good acoustic design(Mic path):
 - Short tube, suitable housing port hole size, good mechanical sealing.
 - Make gasket port hole size closer to the housing port hole size.
 - The diameter of entire acoustic tunnel should be kept as similar as possible.
- ▶ Design for manufacturing(DFM) must be well considered, apply some proper interference on rubber gasket or adhesive tape can get better acoustical sealing performance also the better assembly quality.
- ▶ Silicone rubber is the recommended material for microphone gasket, which is providing very good acoustical isolation.

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Thank you