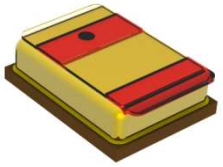
Description

The **MA-HFA381-H13-1AF** is a high SNR and single-ended output top port analog MEMS microphone, consists of a MEMS sensor and a low noise level ASIC.



Top View

Bottom View

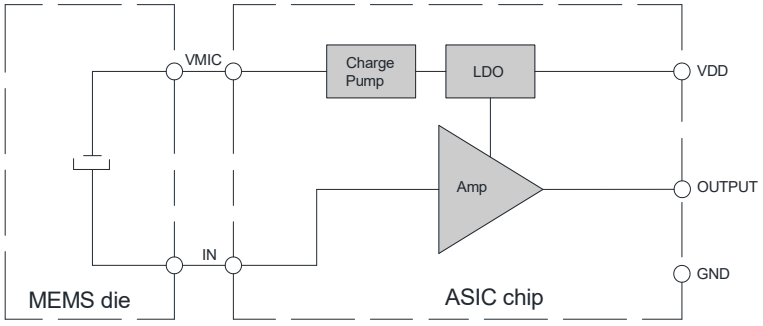


Fig. 1 Microphone block diagram

Key Features

- ✧ 3.5x2.65x0.98mm Top Port
- ✧ Single ended Output
- ✧ Narrow Sensitivity +/-1dB
- ✧ High SNR of 66.5dBA
- ✧ RF Shielded
- ✧ Compatible with Standard SMD Reflow Technology
- ✧ RoHS Compliance & Halogen Free

Typical Applications

- ✧ Mobilephones
- ✧ Wireless Headsets
- ✧ Smart Speakers
- ✧ Wearable Electronics
- ✧ Portable Electronics
- ✧ Smart Home Electronics

Maximum Ratings

Stresses at the maximum ratings shown in Table 1 may cause permanent damage to the device. These are stress ratings only at which the device may not function when an operation at these or any other condition beyond those specified under “Electro-Acoustic Specifications”.

Table 1 Maximum Ratings

Parameter	Maximum Ratings	Unit
Supply voltage	3.6	V
Supply current	1	mA
Output current	1	mA
Operation temperature range	-40~85	℃
Storage temperature range	-40~100	℃

Electro-Acoustic Specifications

Table 2 Electrical Specifications

Test condition:+25±2℃, 60%～70% RH, 86~106Kpa, Vdd=2V, no load, unless otherwise specified.

No.	Parameter	Symbol	Condition	Min.	Nom.	Max.	Unit
1	Sensitivity	S	f=1kHz, Pin=1Pa, 0dB=1V/Pa	-39	-38	-37	dB
2	Operating Voltage	V_{DD}		1.6	2	3.3	V
3	Directivity			Omni-directional			
4	Polarity		Sound pressure increase	Output voltage increase			
5	Sensitivity vs. Voltage	ΔS	Vs= 3.3V to 1.6V	＜0.5			dB
6	Output Impedance	Z_{OUT}	f=1kHz			400	Ω
7	Current Consumption[1]	I	1.6 V to 3.3V		85	200	μA
8	S/N Ratio	S/N	20-20KHz Bandwidth, A-Weighted	64.5	66.5		dBA
9	Total Harmonic Distortion	THD	94dB SPL @1KHz		0.1	0.5	%
			116dB SPL @1KHz		1		
10	Acoustic Overload Point	AOP	THD 10%@1KHz		124		dBSPL
11	Power Supply Rejection	PSR	100mVpp Squarewave @217Hz, A-weighted		-99	-80	dB
12	Power Supply Rejection Ratio	PSRR	200mVpp Sinewave @1KHz	60	67		dB
13	DC output	VDC			0.85		V
14	Output load	C_{load}				150	pF
		R_{load}		10		100	KΩ

Note：Frequency response, sensitivity and current consumption are tested by 100% on product line.

Performance Curves

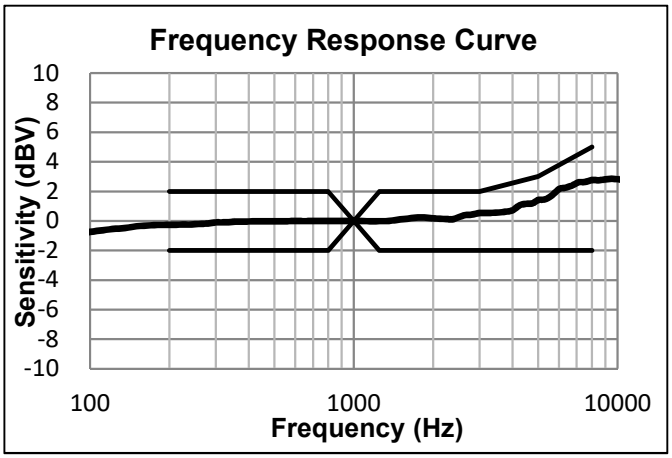


Fig. 2 Frequency response curve normalized to 1kHz

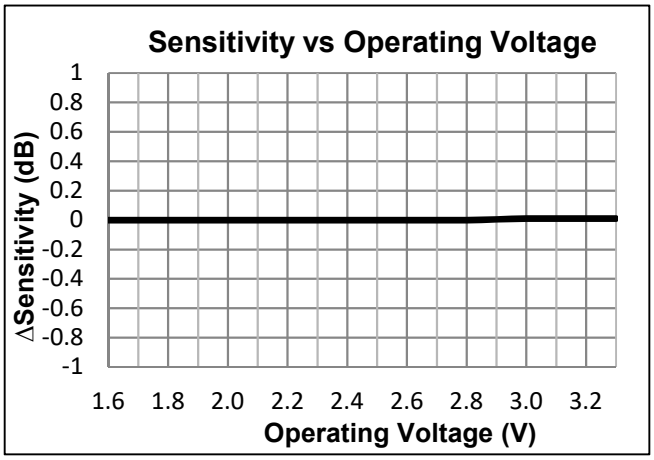


Fig. 3 Sensitivity vs Operating Voltage

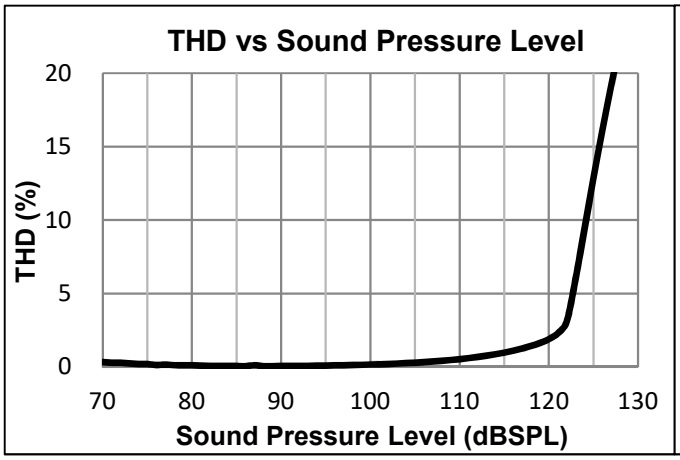


Fig. 4 Typical THD vs Sound Pressure Level

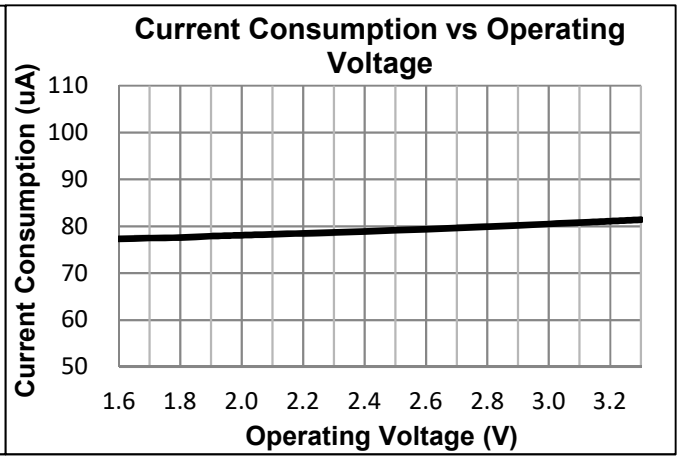


Fig. 5 Typical Current vs Operating Voltage

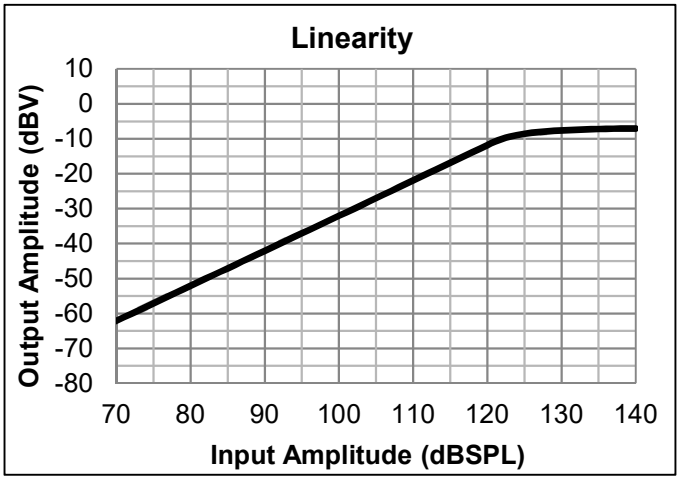


Fig. 6 Linearity

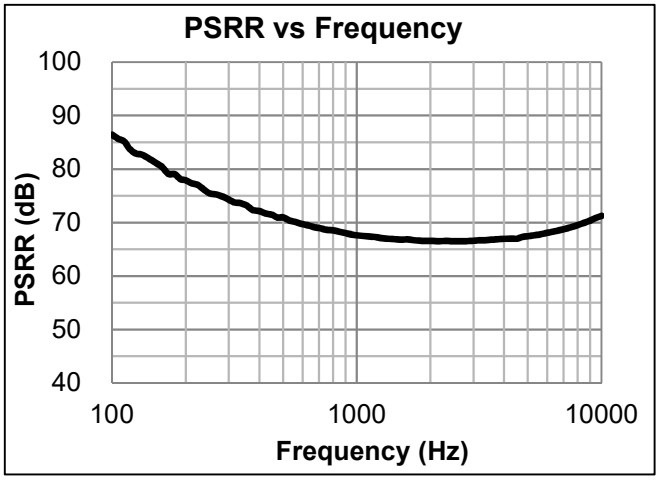


Fig. 7 Typical PSRR curve

Measurement System Setup

Test signal: Sinusoid, Sweep,

Step: 1/12 octave

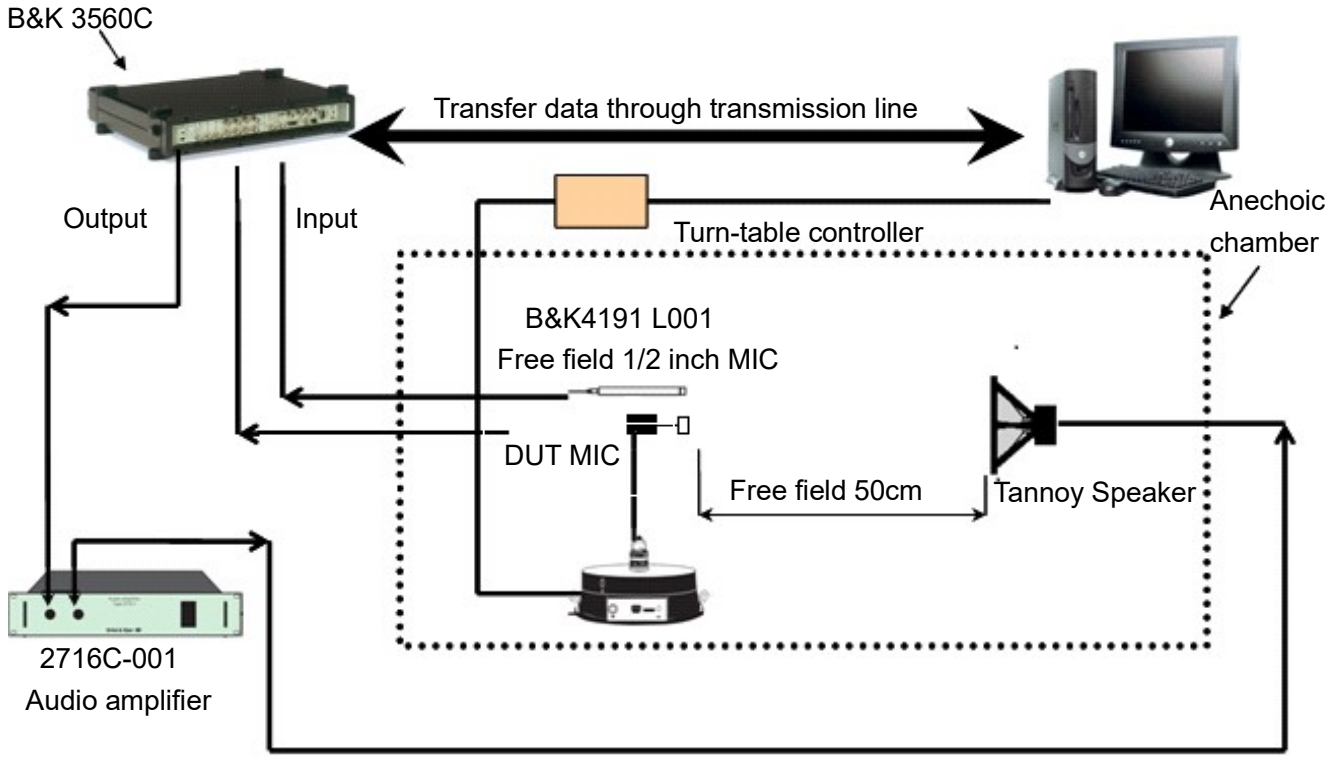


Fig. 8 Measurement System Setup

Typical Application Circuit

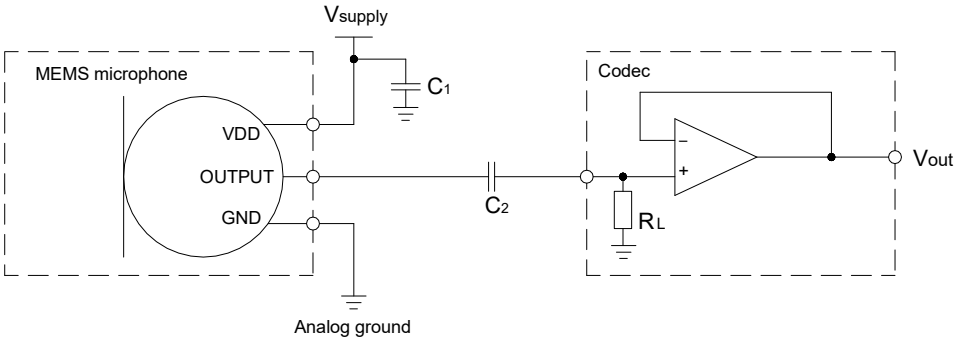


Fig. 9 Typical Application Circuit

Power supply decoupling:

A 0.1uF ceramic type decoupling capacitor C_1 is strongly recommended for every microphone and it should be placed as close to the VDD pad to reduce the noise on power supply;
The trace connected to each pad of capacitor should be as short as possible, and should stay on one layer of PCB without via. For the best performance, recommend to place the capacitor equidistance from power and ground pins of microphone, or slightly closer to the power pin if space not allowed. System ground should connect to far side of the capacitor, as shown in fig.10.

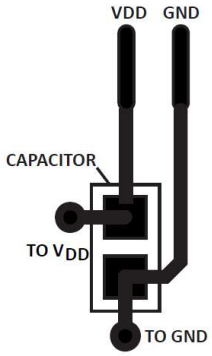


Fig. 10 Recommended Power Supply Decoupling Capacitor Layout

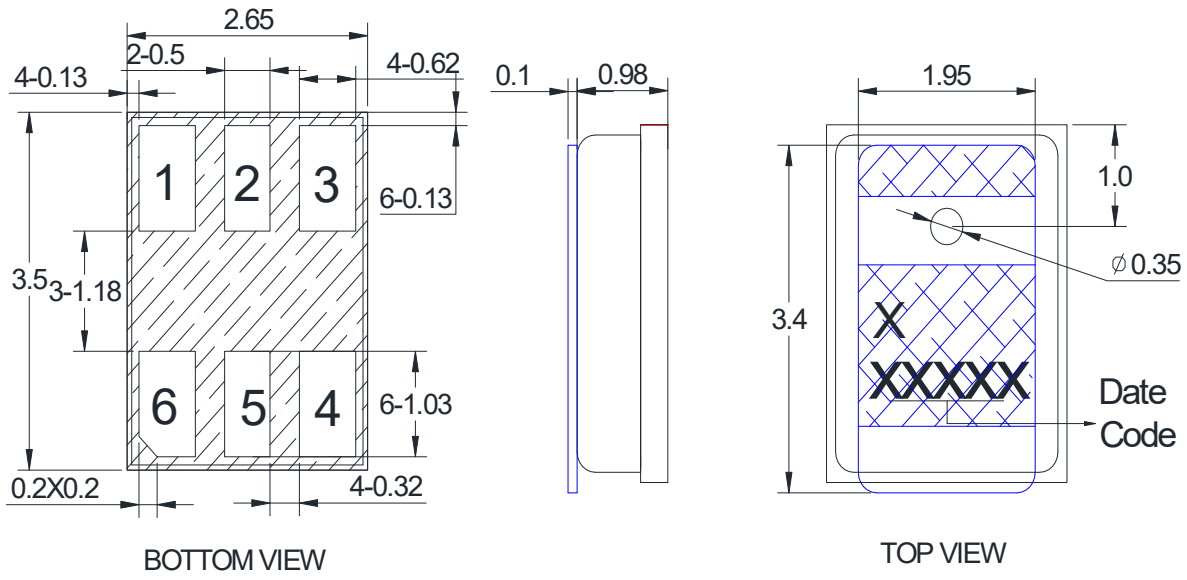
Low frequency roll-off:

DC-blocking capacitor C_2 is required on the output signal line. The 3-dB cut-off frequency can be calculated using follow equation which is related to DC-blocking capacitor C_2 and input resistance of the input amplifier.

$$\text{3dB cut-off frequency} = 1/2\pi R_L C_2$$

In order to get a cut-off frequency below 20 Hz, minimum 1uF value of C_2 and minimum 20KΩ value of input resistance of the input amplifier is recommended.

Mechanical Specifications



Unit：mm　Unmarked Tolerance: ± 0.1 (mm)

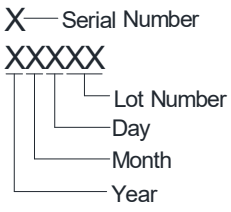
Fig. 11 Dimension

Item	Dimension	Tolerance
Length	3.5	±0.1
Width	2.65	±0.1
Height	0.98	±0.1
Acoustic Port	0.35	±0.05

PIN	Definition	Description
1	GND	Ground
2	GND	Ground
3	GND	Ground
4	Output	Signal Output
5	GND	Ground
6	VDD	Power Supply

Note:

- All Ground Pin must be connected to the ground in end application
- Identification Marking



Reliability Specifications

After conducting any of the following tests, the sensitivity change of DUT shall be less than ±3dB from its initial value unless otherwise noted, and shall keep its initial operation and appearance.

Table 3 Reliability Specifications

No.	Item	Test condition
1	Preconditioning	24 hour bake at 125°C, followed by 168 hours at 85°C, 85%RH, followed by 3 passes solder reflow Only for the following three tests: High Humidity &High Heat operating Test High Humidity &High Heat operating Test Thermal Shocking Test
2	Hi-Temperature Storage Test	105±3℃,1000h,recover for two hours
3	Hi-Temperature operating Test	105±3℃, under upper limit bias,1000h,recover for two hours
4	Low-Temperature storage Test	-40±3℃,1000h, recover for two hours
5	Low-Temperature operating Test	-40±3℃, under upper limit bias,1000h,recover for two hours
6	High Humidity &High Heat operating Test	85±3℃, 85%RH, under upper limit bias, 1000h,recover for two hours, there should be no corrosion and deformation inside of microphone after testing
7	High Humidity &High Heat operating Test	65±3℃, 95%RH, under upper limit bias, 168h,recover for two hours ,there should be no corrosion and deformation inside of microphone after testing
8	Thermal Shocking Test	Double-Case Method, -40℃ for 15mins→125℃ for 15 mins, 100 cycles, recover for two hours
9	Vibration Test	Each 12mins for X, Y and Z axes, Frequency: 20~2000Hz, Peak Acceleration 20g, recover for two hours
10	Drop Test	Height:1.5m Fixture Weight:150g (Sound Hole Diameter in the fixture is >=0.8mm) Reference Surface: slippery marble floor Duration:4 corners*4 times, 6 faces*4 times The sensitivity change should be less than 1dB after testing
11	Tumbling Test	Height:1.0m Fixture Weight:150g (Sound Hole Diameter in the fixture is >=0.8mm) Duration: 300 times Recommended Time: 10-11times/Min The sensitivity change should be less than 1dB after testing

12	ESD Test 1	a. HMB Discharge Position: I/O pins Charge Voltage: ±3000V Discharge Network: 100pF & 1500Ω b. CDM Discharge Position: I/O pins Charge Voltage: ±250V
13	ESD Test 2	The tests are performed acc. to IEC61000-4-2 level 3: a. Contact Discharge Discharge Position: Output of Microphone Charge Voltage:±6000VDC Discharge Network:150pF & 330Ω b. Air Discharge Discharge Position: Sound Hole Charge Voltage:±8000VDC Discharge Network:150pF & 330Ω
14	Structure Shock Test	10000g, Duration: 0.1ms, each 3 shocks for X/Y/Z 3 axes, The sensitivity change should be less than 1dB after testing
15	Reflow	3 reflow cycles with peak temperature of +260℃ according to reflow profile

Packaging Details

* Use ESD reel and tape for microphone packaging.
* Anti-static measures should be applied during packaging operation.

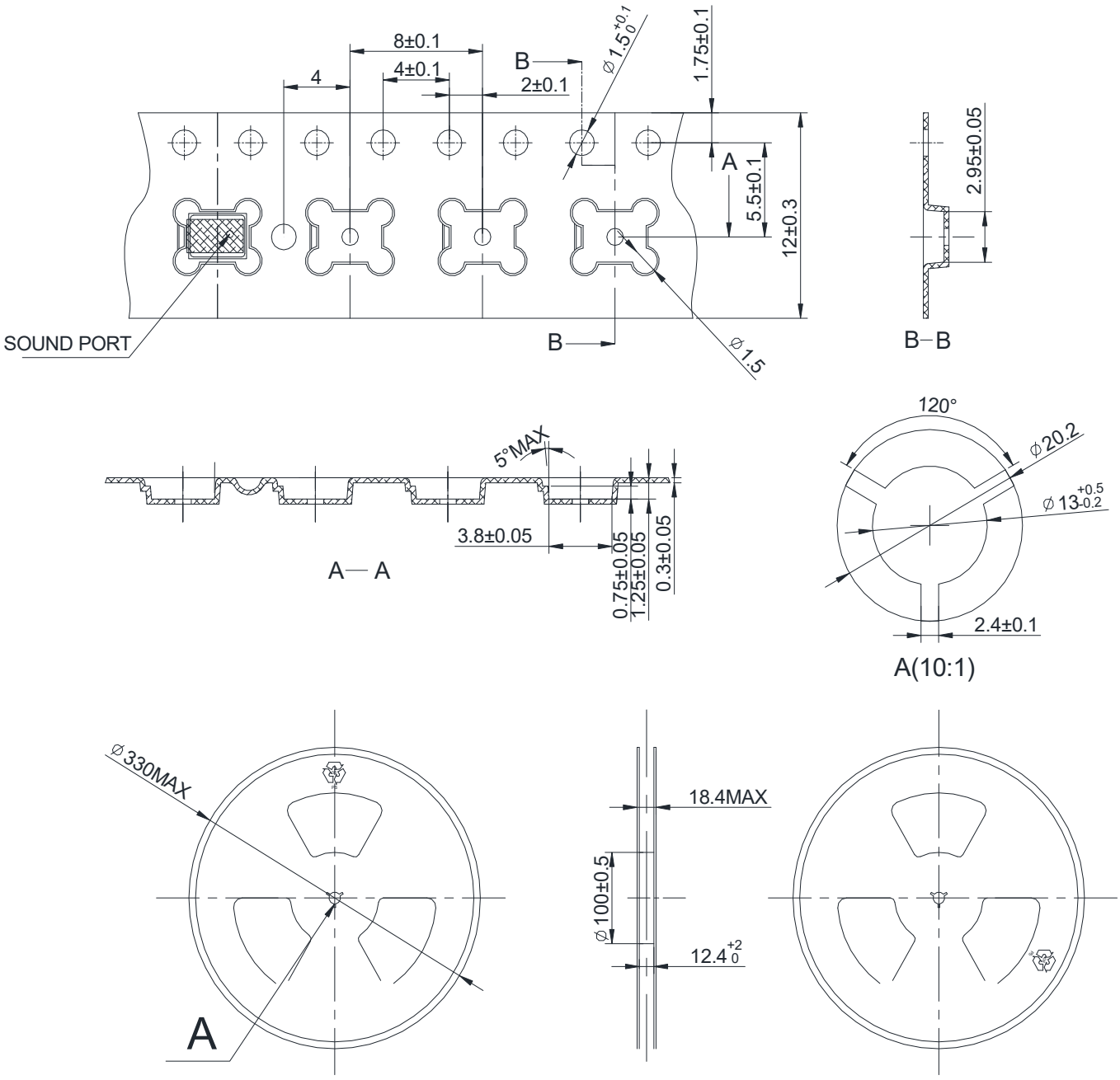
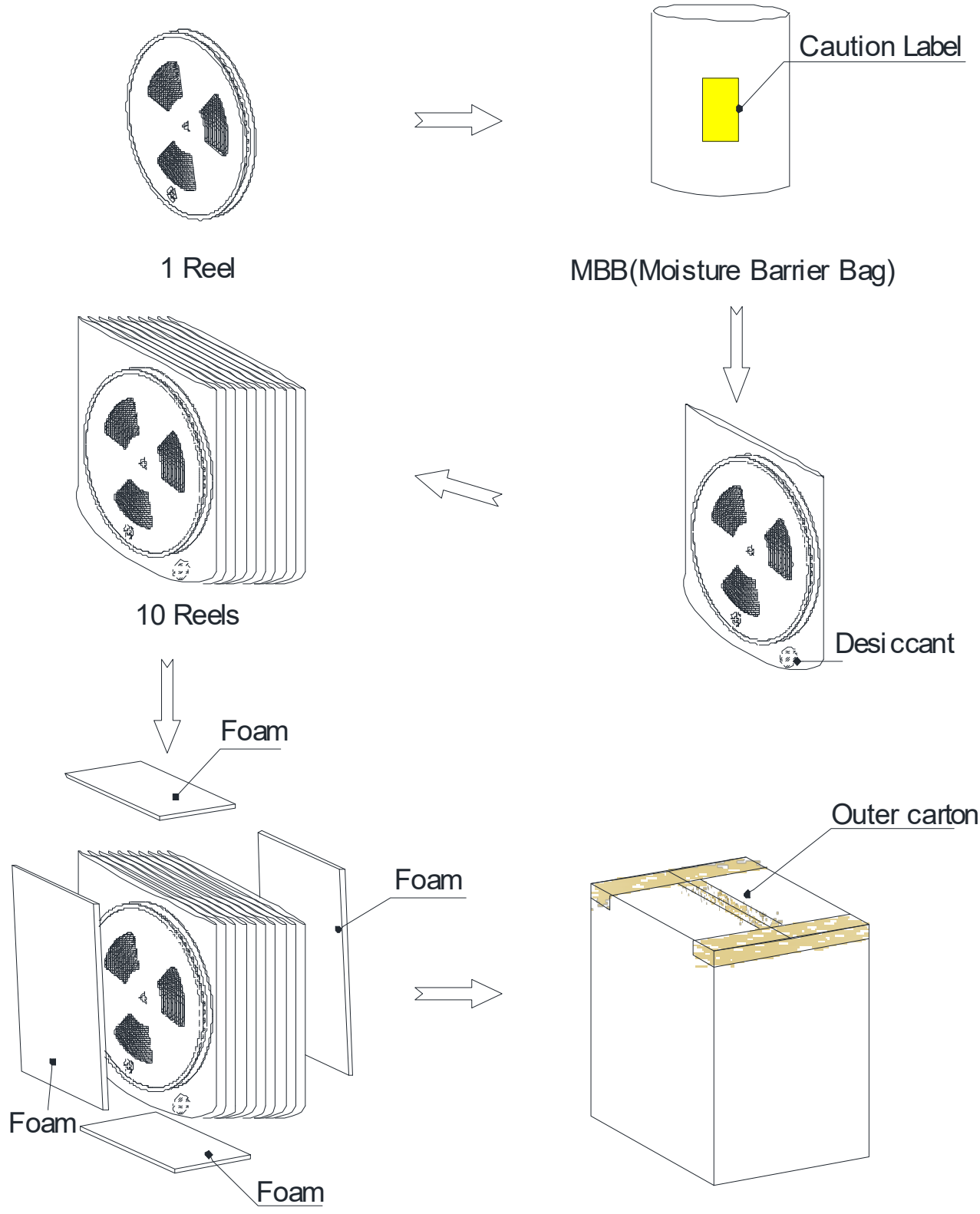


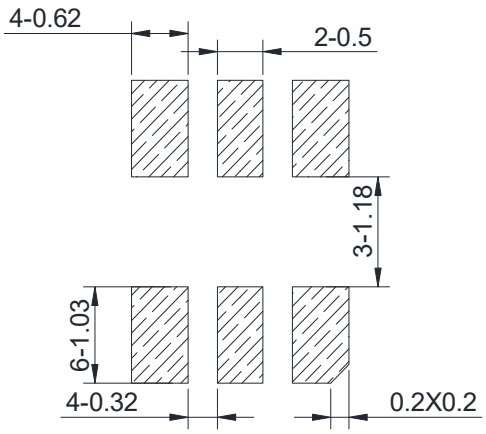
Fig. 12 Packaging



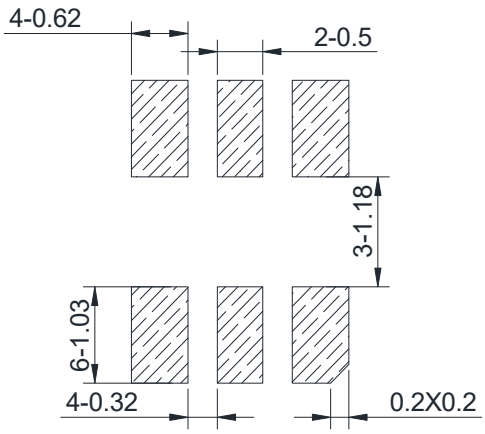
Tape and Reel	φ330mm	5,500PCS×1=5,500PCS
Shipping Box	215mm*370mm*370mm	5,500PCS×10=55,000PCS

Application Design Suggestions

Recommended PCB and Stencil Design Pattern



Example Land Pattern



Example Solder Stencil Pattern

Notes:

- Dimensions are in millimeters unless otherwise specified.
- Tolerance is ±0.1mm unless otherwise specified.

Temperature Profile during Reflow Process

Table 4 Temperature Profile during Reflow Process

Parameter		Reference	Specification
Average Ramp Rate		T_L to T_P	3°C/sec max
Preheat	Minimum Temperature	T_{SMIN}	150°C
	Maximum Temperature	T_{SMAX}	200°C
	Time T_{SMIN} to T_{SMAX}	t_S	60 sec to 180 sec
Ramp-Up Rate		T_{SMAX} to T_L	1.25°C/sec
Time Maintained Above Liquidous		t_L	60 sec to 150 sec
Liquidous Temperature		T_L	217°C
Peak Temperature		T_P	260°C
Time Within +5°C of Actual Peak Temperature		t_P	20 sec to 40 sec
Ramp-Down Rate		T_P to T_{SMAX}	6°C/sec max
Time +25°C (t25°C) to Peak Temperature			8 min max

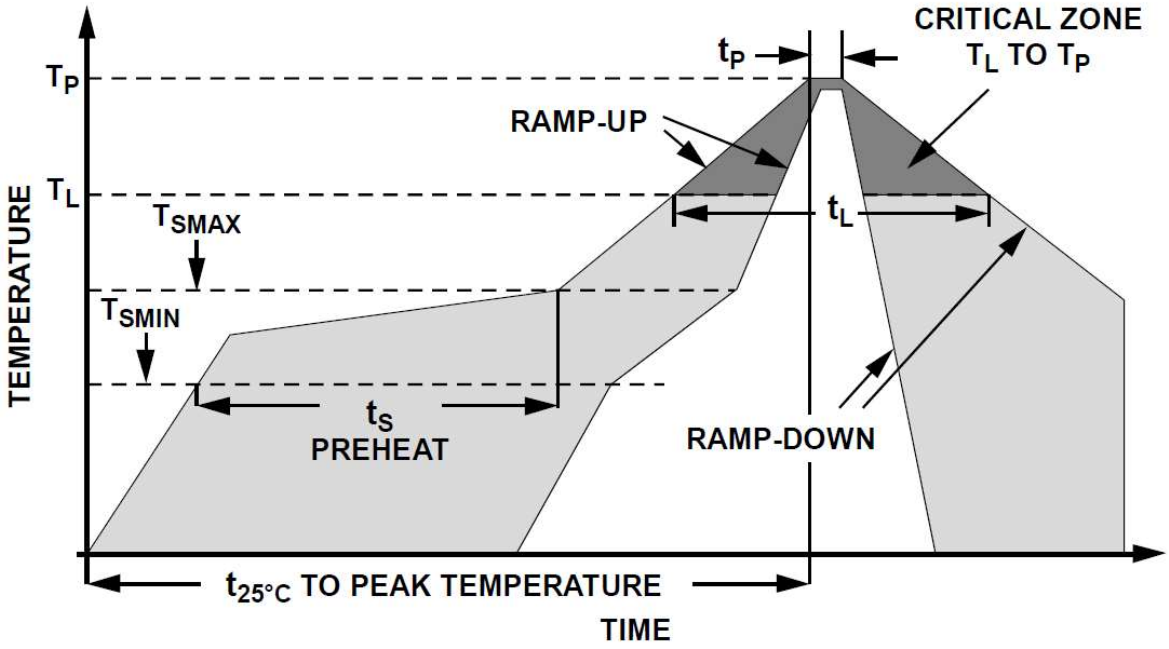


Fig. 13 Reflow Profile

Additional Notes：

- Mic should cool to room temp before next flow cycle if more reflow is needed.
- No more than 3 times reflow is recommended.
- Do not board wash by liquid or ultrasonic after the reflow process.
- Do not pull a vacuum over port hole of the microphone.
- Do not insert any object in port hole of device at any time.
- Suggest SMT the microphone at last time if double side PCBA used.
- Do not seal sound port during reflow .
- If there is any leakage risk, the peak temperature should be set to less than 240°C or more than 255°C.

Recommended nozzle for reflow MIC

External diameter is Φ1.8mm
Inside diameter is Φ1.2mm

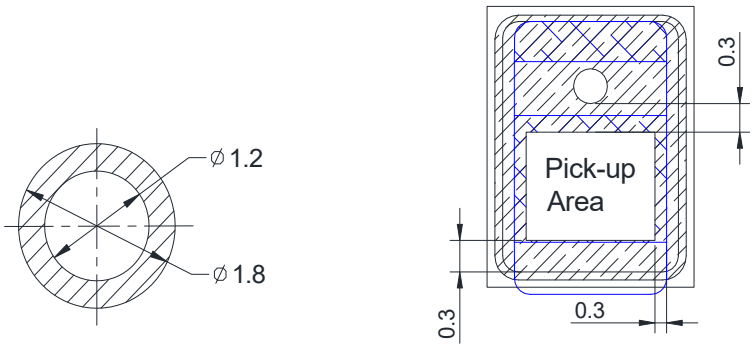


Fig. 14 Recommended nozzle for reflow MIC and Pick-up Area

Special Cautions

Air Rifle Cleaning Restriction

Do not bring air rifle to the port hole directly.
Recommended Condition:
Air pressure < 0.3MPa;
Distance > 5cm;
Time < 5 sec.

Package

Do NOT vacuum seal unused material for storage. Vacuum Sealing can cause mic damage.

Storage

The component needs to meet the requirement of MSL(Moisture Sensitivity Level) class 1. Please keep MICs in warehouse with humidity less than 75% and without sudden temperature change, acid air, and any other harmful air or strong magnetic field.
Please protect products against moist, shock, sunburn and pressure.
Please take proper measures against ESD in the process of assembly and transportation.
Please use the shipping package for long-term storage.

Discard

For microphones to be wasted, customer shall follow the regulation of Waste Electrical and Electronic Equipment (WEEE) Directive (2002/96/EC).

Notes: More application suggestions can be found in the latest "MEMS Microphone Application Notes".

Specification Revisions

Date	Version	Description
11-05-2024	V1.0	Initial release
05-28-2025	V2.0	Updated operation temperature range
07-31-2025	V3.0	Updated Gettop information

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