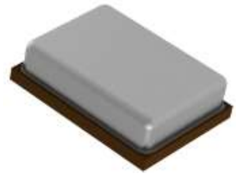
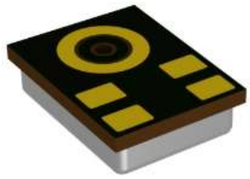
Description

The **MD-HRA461-H10-1** is a high SNR, high AOP and multi mode bottom port digital MEMS microphone with 1-bit PDM output, consists of a dual back-plate MEMS sensor and a low noise level amplifier, and a ∑-△ modulator.



Top View



Bottom View

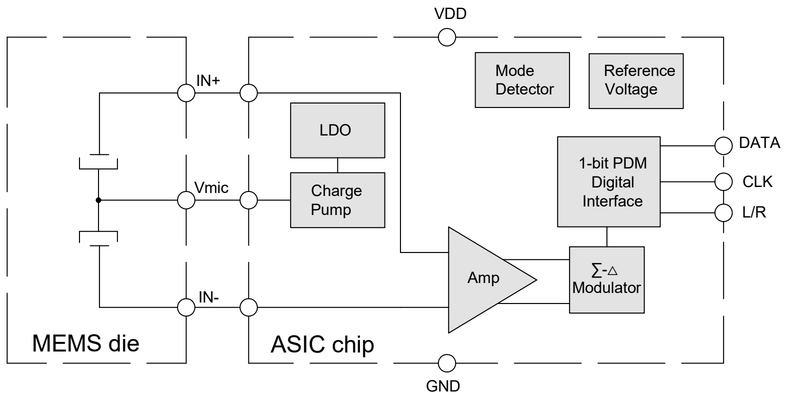


Fig. 1 Microphone block diagram

Key Features

- 3.5x2.65x0.98mm Bottom Port
- PDM Output
- Narrow Sensitivity +/-1dBFS
- High SNR of 65dBA
- High AOP of 135dBSPL
- Flat Frequency Performance
- Multi Mode(Sleep,Low power,Normal)
- 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
Voltage on any pin		3.6	V
Operation temperature range	VDD＜3V	-40~100	℃
	VDD＞3V	-40~70	℃
Storage temperature range		-40~125	℃

Electro-Acoustic Specifications

Table 2 Normal Mode Electrical Specifications

Test condition: +25±2℃, 60%～70% RH, 86~106Kpa, F_{CLK}=2.4MHz,V_{DD}=1.8V, no load, unless otherwise noted.

Symbol	Description	Min	Typ.	Max	Units
F_{CLK}	Clock Frequency	1.38	2.4	3.3	MHz
I_{DD}	Supply Current[1]		850	1100	uA
S	Sensitivity[3], 94dB SPL@1KHz	-47	-46	-45	dBFS[2]
SNR	20-20KHz Bandwidth, A-weighted	63	65		dB(A)
THD	94dB SPL@1KHz		0.05	0.5	%
	129dB SPL@1KHz		1		%
AOP	10%THD@1KHz		135		dBSPL
PSR	Measured with 217Hz,100mVpp square wave		-110	-90	dBFS

Table 3 Low Power Mode Electrical Specifications

Test condition: +25±2℃, 60%～70% RH, 86~106Kpa, F_{CLK}=768KHz, V_{DD}=1.8V, no load, unless otherwise noted.

Symbol	Description	Min.	Typ.	Max.	Units
F_{CLK}	Clock Frequency	450	768	850	KHz
I_{DD}	Supply Current		250	350	uA
S	Sensitivity, 94dBSPL@1KHz	-17	-16	-15	dBFS
SNR	20-8KHz Bandwidth, A-weighted		67		dB(A)
THD	94dB SPL@1KHz		0.1	0.5	%
	110dB SPL@1KHz		1		%
AOP	10%THD@1KHz		112		dBSPL
PSR	Measured with 217Hz,100mVpp square wave		-92	-80	dBFS

Note 1:The current consumption depends on the applied clock frequency and the load on the DATA output

Note 2:dBFS=20*logA/B, where A is the level of signal, and B is the level that corresponds to full-scale level

Note 3:Relative to the rms level of a sine wave with positive amplitude equal to 100% 1s density and Negative amplitude equal to 0% 1s density

Note 4:Frequency response, sensitivity and current consumption are tested by 100% on product line.

Table 4 Electrical Specifications

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

Symbol	Description		Min.	Typ.	Max.	Units
V_{DD}	Supply Voltage		1.62	1.8	3.6	V
F_{CLK}	Clock Frequency (Mode switch clock tolerance +/-5%)	Standby Mode			330	KHz
		Low Power Mode	450	768	850	KHz
		Normal Mode	1.38	2.4	3.3	MHz
Data Format			1/2 Cycle PDM			
Directivity			Omni-directional			
Polarity			Increasing density of 1's			
I_{clock_off}	Clock off mode, Clock pulled low				1	uA
$I_{standby}$	Standby mode, Clock<330KHz				50	uA
I_{SC}	Short circuit current, Grounded DATA pin		1		20	mA
C_{LOAD}	Load capacitance				150	pF
Startup Time	Time to start up in either modes (Low Power- and Normal Mode)				20	ms
Reset Time	Time to start up in either modes (Low Power- and Normal Mode) after VDD has been off for more than10ms, while CLOCK remained on.				20	ms
Mode-Switch Time	Time to switch between modes (Clock Off-, Low Power-, and Normal Mode). VDD remains on during the mode switch.				20	ms

Table 5 Digital input—output specifications

Parameter	Symbol	Min.	Typ.	Max.	Unit	Note
Clock duty cycle		45		55	%	f_{clock}<2.65MHz
		48		52	%	f_{clock}≥2.9MHz
Operation Voltage	V_{DD}	1.62		3.6	V	
Input Logic Low Level	V_{IL}	-0.3		$0.35\times V_{DD}$	V	
Input Logic High Level	V_{IH}	$0.65\times V_{DD}$		$V_{DD}+0.3$	V	
Hysteresis width	V_{hys}	$0.05\times V_{DD}$				
Output Logic Low Level	V_{OL}			$0.3\times V_{DD}$	V	
Output Logic High Level	V_{OH}	$0.7\times V_{DD}$			V	
Clock rise time	t_{CR}			13	ns	
Clock fall time	t_{CF}			13	ns	
Delay time for DATA driven	t_{DD}	40		80	ns	
Delay time for data valid	t_{DV}			100	ns	
Delay time for data high Z	t_{DH}	5		30	ns	

Table 6 L/R Channel Configuration

Channel	L/R pad connection	DATA driven	Data high Z
DATA1	GND	CLK falling edge	CLK rising edge
DATA2	VDD	CLK rising edge	CLK falling edge

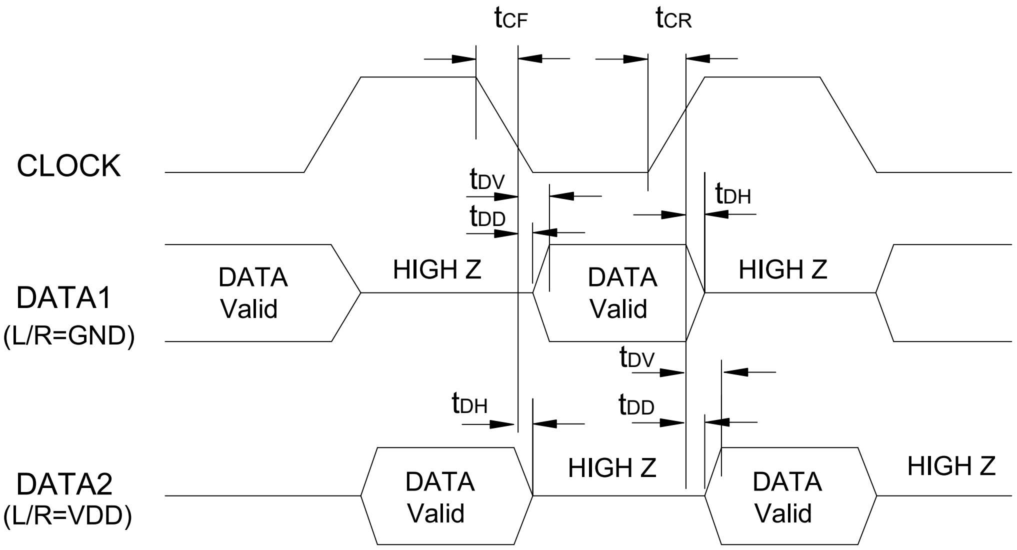


Fig. 2 Recommended timing diagram

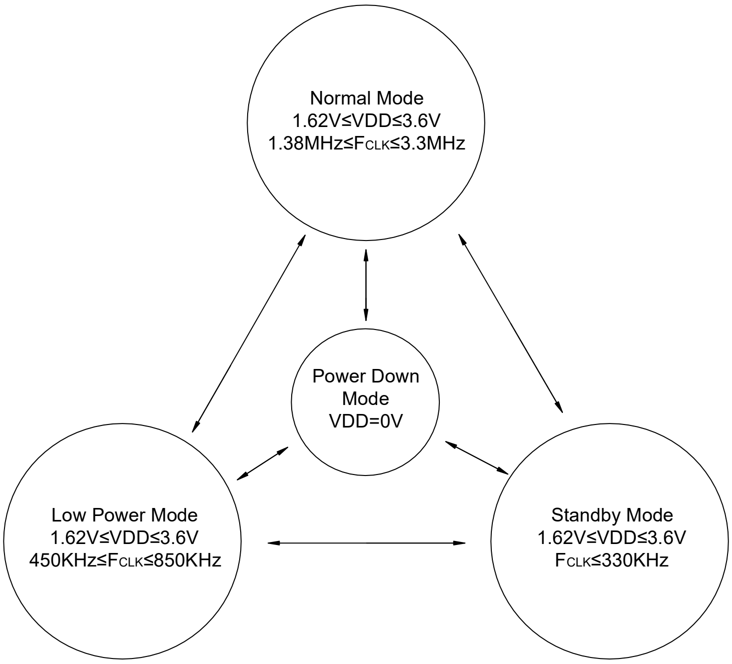


Fig. 3 State diagram

Performance Curves

All curves are tested under 1.8V, 2.4MHz unless otherwise noted.

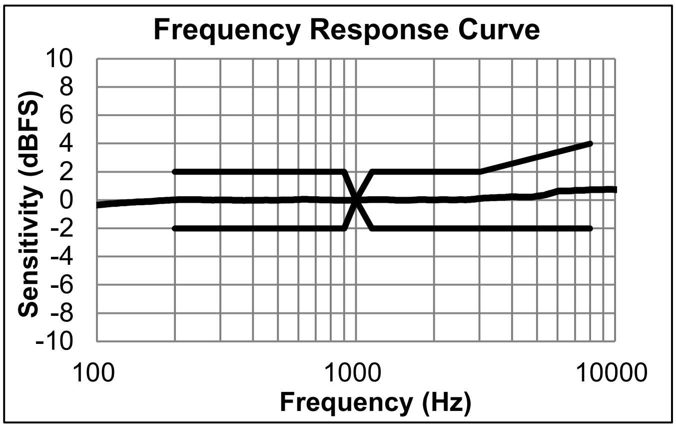


Fig. 4 Normal mode FR normalized to 1kHz

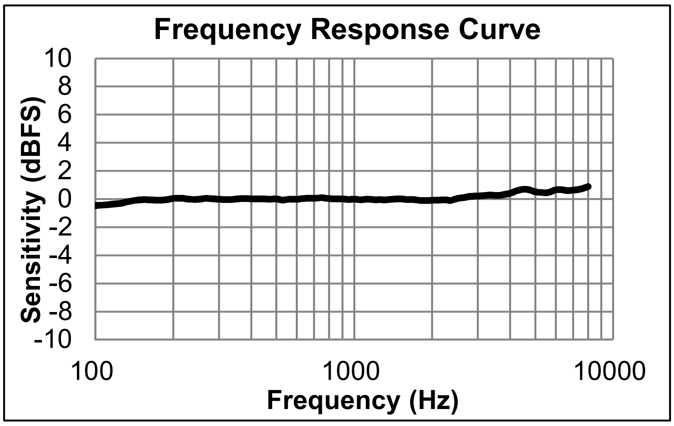


Fig. 5 Low power mode FR normalized to 1kHz

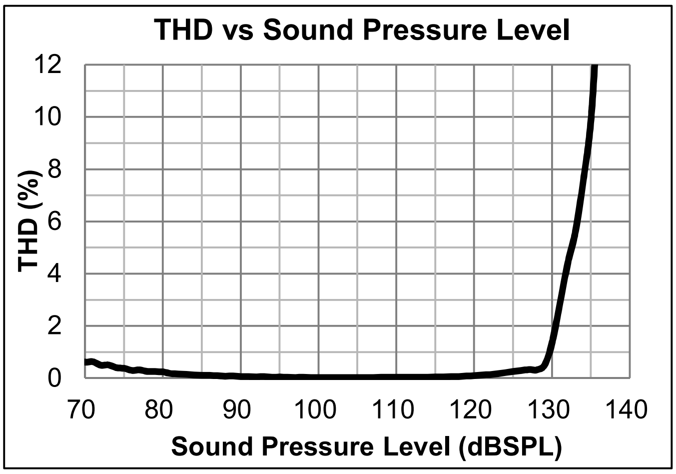


Fig. 6 Typical THD vs Sound Pressure Level

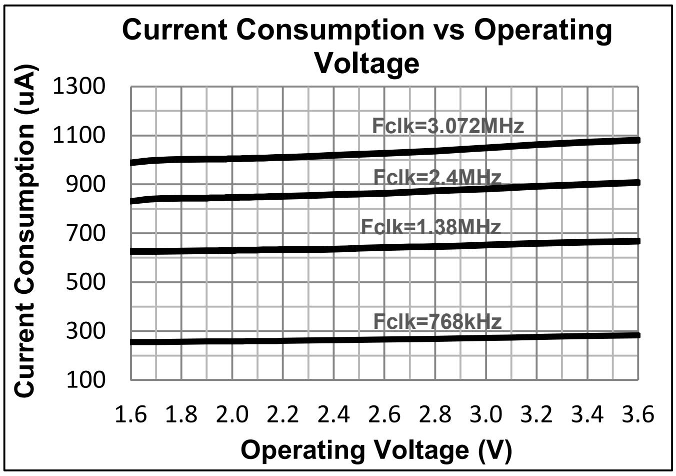


Fig. 7 Typical Current Consumption curve

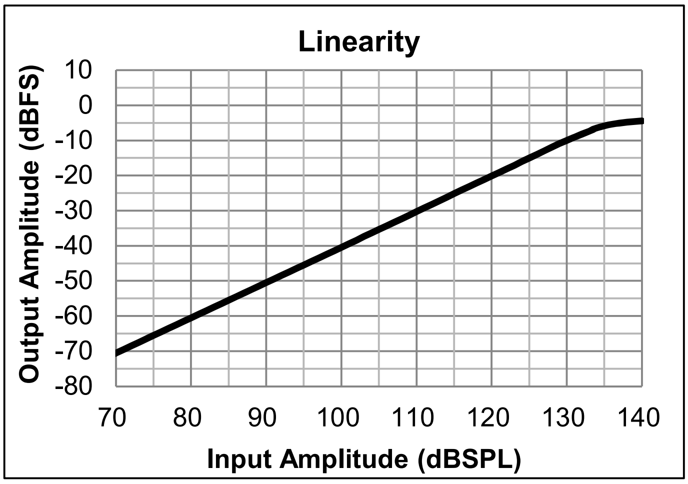


Fig. 8 Linearity

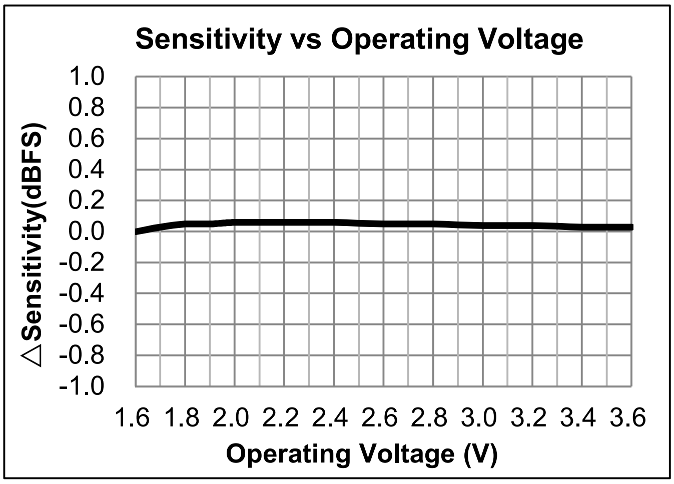


Fig. 9 Sensitivity vs operating voltage

Measurement System Setup

Test signal: Sinusoid, Sweep,
Step: 1/12 octave

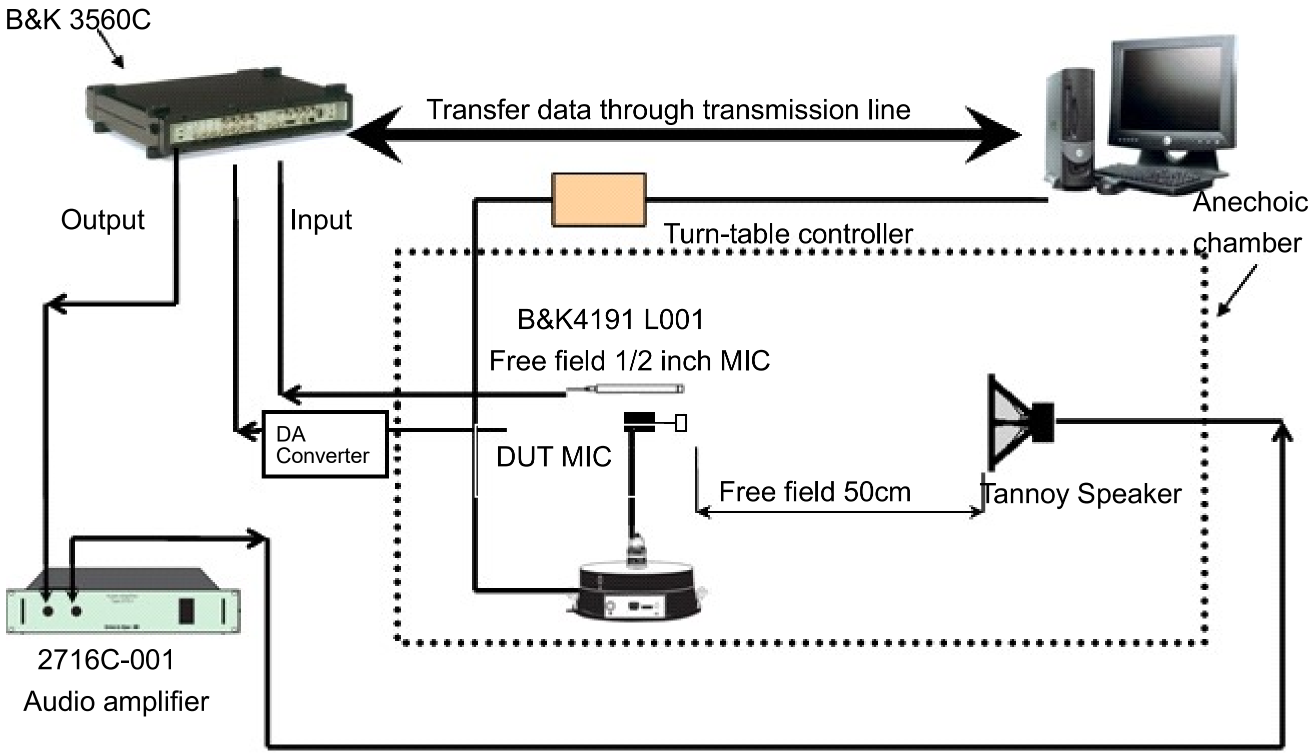


Fig. 10 Measurement System Setup

Typical Application Circuit

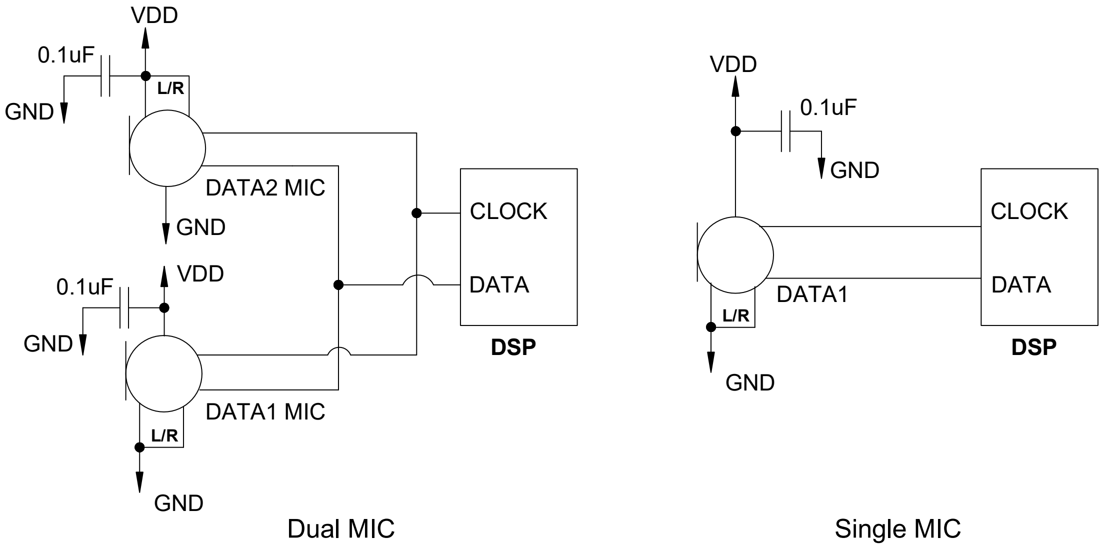


Fig. 11 Recommended interface circuit

Note1: A 0.1uF ceramic type decoupling capacitor 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.12.

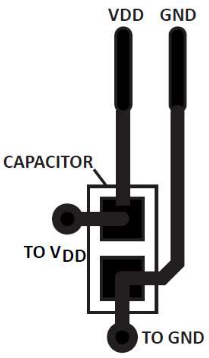
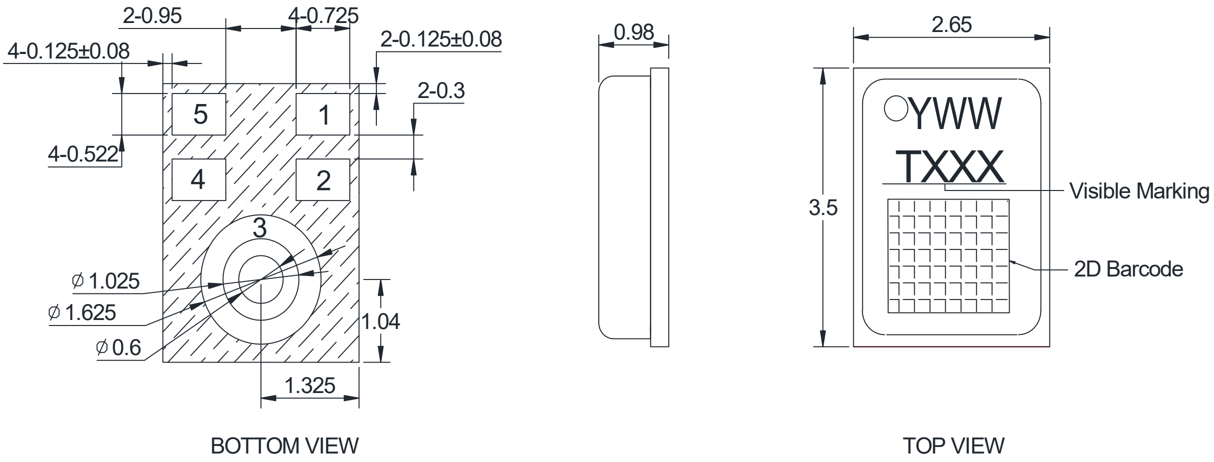


Fig. 12 Recommended Power Supply Decoupling Capacitor Layout

Note2: Do not use a pull-up or pull-down resistor on the PDM data signal line, because it can pull the signal to an incorrect state during the period that the signal line is restarted.
Note3: When long wire is used to connect the CLK of codec and microphone, a 50~100 Ω resistor should be placed near the codec to reduce signal over-shoot or ringing.

Mechanical Specifications



Unit：mm Unmarked Tolerance: ± 0.1 (mm)

Fig. 13 Dimension

Item	Dimension	Tolerance
Length	3.5	±0.1
Width	2.65	±0.1
Height	0.98	±0.1
Acoustic Port	0.6	±0.05

PIN	Definition	Description
1	DATA	PDM Output
2	L/R	L/R select (No internal pull-down. Must be connected to VDD or GND)
3	GND	Ground Power
4	CLK	Clock input
5	VDD	Supply

Note:

- All Ground Pin must be connected to the ground in end application
- The L/R pin is suggested to connect to GND during single mic application.
- Identification Marking

○: Polarity sign Y: Year WW: Week

T: GETTOP XXX: Serial Number

▦ 2D Barcode

Reliability Tests

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

Table 7 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 (Holes diameter on the fixture in the sound hole location≥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 (Holes diameter on the fixture in the sound hole location≥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.

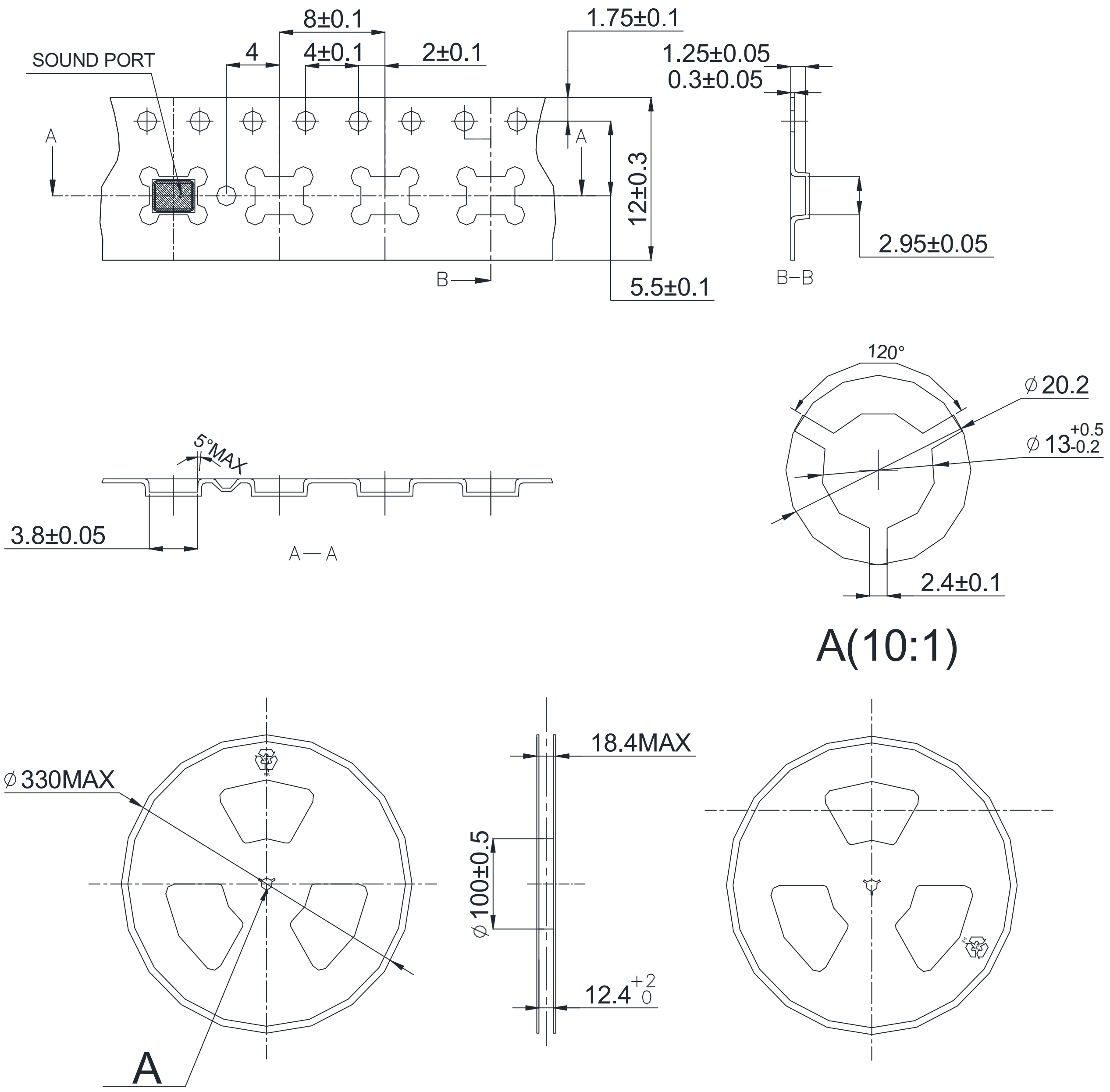
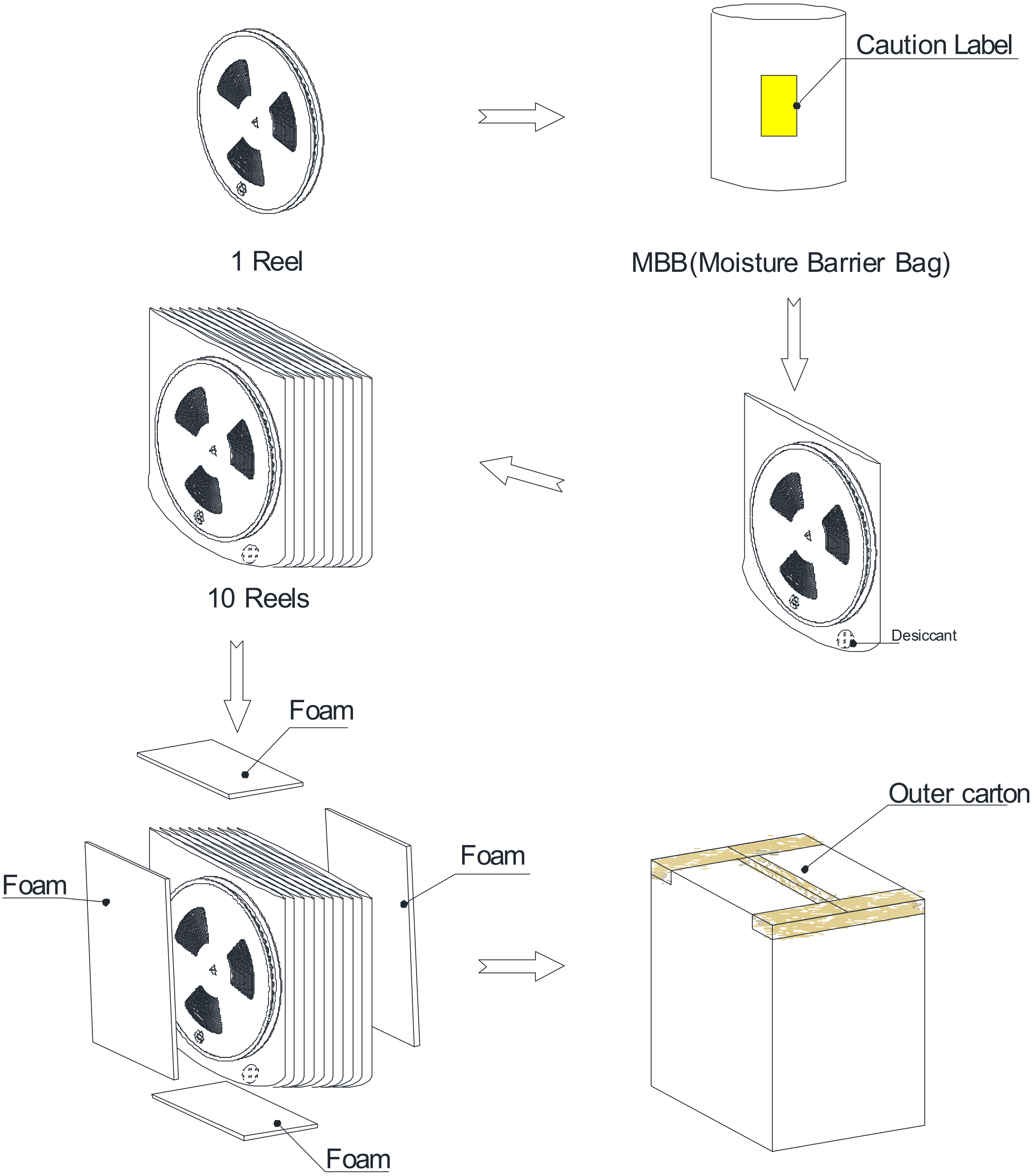


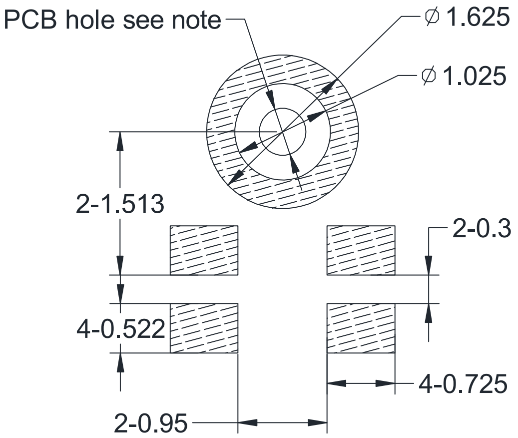
Fig. 14 Packaging



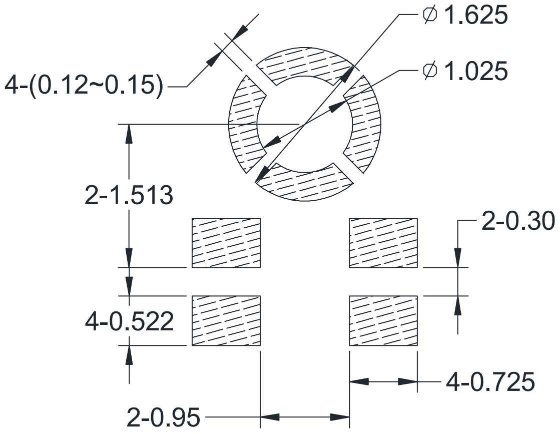
Tape and Reel	φ330mm	5,500PCS×1=5,500PCS
Shipping Box	215mm*370mm*370mm	5,500PCS×10=55,000PCS

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.
- The recommended non-plated hole diameter of PCB is 0.7-0.8mm.

Temperature Profile during Reflow Process

Table 8 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

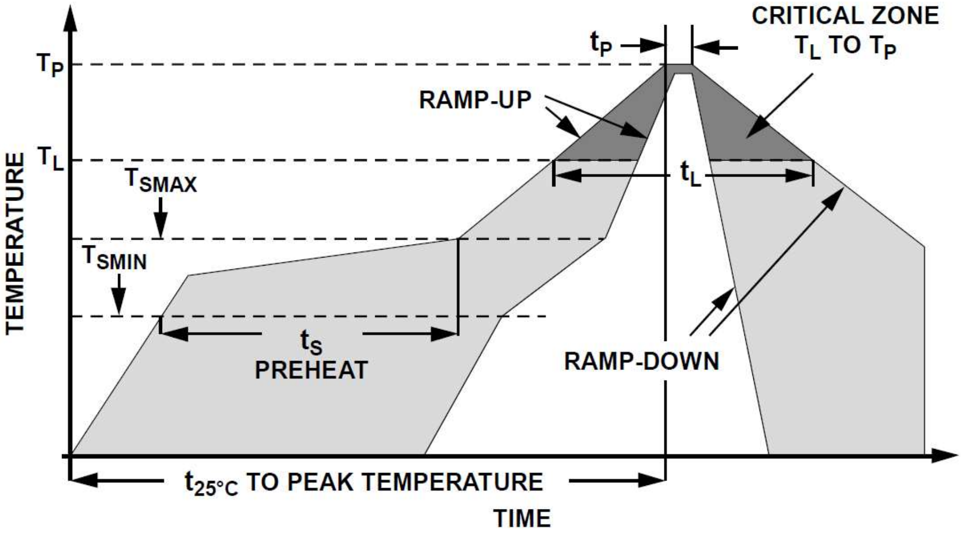


Fig. 15 Reflow Profile

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

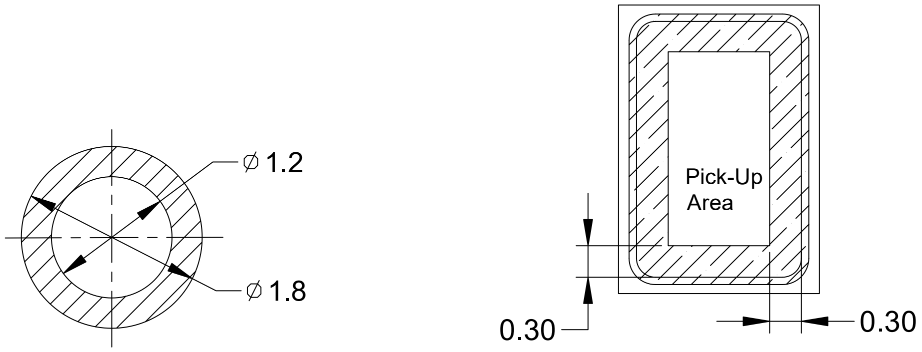


Fig. 16 Recommended nozzle for reflow MIC and Pick-up Area

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
01-21-2025	V1.0	Initial release