

Description

The **MD-HRA371-H10-3W** is a small package, high SNR and Multimode bottom port digital MEMS microphone with 1-bit PDM output, consists of a MEMS sensor, a low noise level amplifier, and a $\Sigma-\Delta$ modulator.

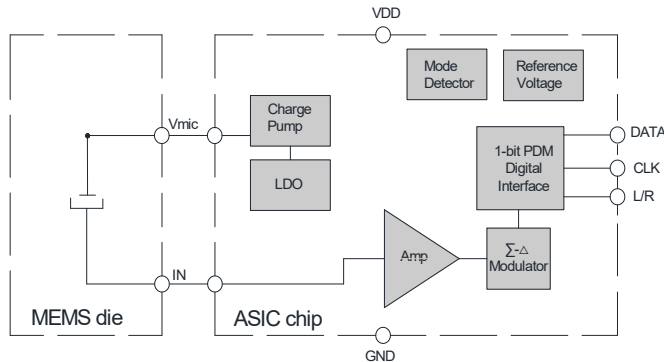
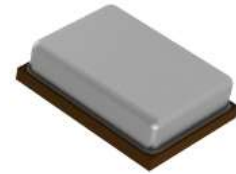
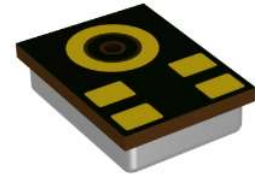


Fig. 1 Microphone block diagram



Top View



Bottom View

Key Features

- ✧ 3.5x2.65x0.98mm Bottom Port
- ✧ 1-bit PDM Output
- ✧ Narrow Sensitivity +/-1dB
- ✧ High SNR of 64dBA
- ✧ IP68 proof Character
- ✧ LFRO <20Hz
- ✧ Flat Frequency Performance
- ✧ Multi Mode(Sleep,Low power,Normal)
- ✧ Compatible with Standard SMD Reflow Technology
- ✧ RoHSCompliance&Halogen Free

Typical Applications

- ✧ Mobilephones
- ✧ NotebookComputers
- ✧ Smart Speakers
- ✧ Wearable Electronics
- ✧ Digital Video Cameras
- ✧ 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

| Parameters | Maximum Ratings | Unit |
|-----------------------------|-----------------|------|
| Supply voltage | 3.6 | V |
| Voltage on any pin | 3.6 | V |
| Operation temperature range | -40~85 | °C |
| Storage temperature range | -40~100 | °C |

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 | 1.2 | 2.4 | 3.3 | MHz |
| I _{DD} | Supply Current ¹ | | 970 | 1100 | uA |
| S | Sensitivity ³ , 94dB SPL@1KHz | -38 | -37 | -36 | dBFS ² |
| ΔS | Sensitivity drop | <0.5 | | | dBFS |
| SNR | 20-20KHz Bandwidth, A-weighted | 62 | 64 | | dB(A) |
| THD | 94dB SPL@1KHz | | 0.15 | 0.5 | % |
| | 124dB SPL@1KHz | | 1 | | % |
| AOP | 10%THD@1KHz | | 130 | | dB SPL |
| PSR | Measured with 217Hz, 100mV _{pp} square wave | | -93 | -80 | 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 | | 280 | 350 | uA |
| S | Sensitivity, 94dB SPL@1KHz | -22 | -21 | -20 | dBFS |
| ΔS | Sensitivity drop | <0.5 | | | dBFS |
| SNR | 20Hz~8KHz Bandwidth, A-weighted | | 64 | | dB(A) |
| THD | 94dB SPL@1KHz | | 0.15 | 0.5 | % |
| | 111dB SPL@1KHz | | 1 | | % |
| AOP | 10%THD@1KHz | | 116 | | dB SPL |
| PSR | Measured with 217Hz, 100mV _{pp} square wave | | -80 | -70 | 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 General 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 | | 1.6 | 1.8 | 3.3 | V |
| F _{CLK} | Clock Frequency | Standby Mode | | | 320 | KHz |
| | | Low Power Mode | 450 | 768 | 850 | KHz |
| | | Normal Mode | 1.2 | 2.4 | 3.3 | MHz |
| Data Format | | | 1/2 Cycle PDM | | | |
| Directivity | | | Omni-directional | | | |
| Polarity | Increasing sound pressure | | Increasing density of 1's | | | |
| I _{SC} | Short circuit current, Grounded DATA | | 1 | | 20 | mA |
| C _{LOAD} | Load capacitance | | | | 200 | pF |
| Reset time | Time to start up in any mode after VDD has been off for more than10ms, while CLOCK remained on | | | | 20 | ms |
| Start-up time | Start-up into normal mode or LP mode | | | | 20 | ms |
| Mode-switch time | Mode-switch Normal mode to LP mode or LP mode to Normal mode | | | 20 | | ms |

Table 5 Digital input—output specifications

| Parameter | Symbol | Min. | Typ. | Max. | Unit | Note |
|----------------------------|------------------|----------------------|------|----------------------|------|------|
| Clock duty cycle | | 45 | | 55 | % | |
| Operation Voltage | V _{DD} | 1.6 | | 3.3 | V | |
| Input Logic Low Level | V _{IL} | -0.3 | | 0.28×V _{DD} | V | |
| Input Logic High Level | V _{IH} | 0.65×V _{DD} | | V _{DD} +0.3 | V | |
| Hysteresis width | V _{hys} | 0.08 | | | V | |
| Output Logic Low Level | V _{OL} | | | 0.3×V _{DD} | V | |
| Output Logic High Level | V _{OH} | 0.7×V _{DD} | | | V | |
| Clock rise time | t _{CR} | | | 13 | ns | |
| Clock fall time | t _{CF} | | | 13 | ns | |
| Delay time for DATA driven | t _{DD} | 28 | | | ns | |
| Delay time for data valid | t _{DV} | | | 100 | ns | |
| Delay time for data high Z | t _{Hz} | 14 | | 26 | 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 |

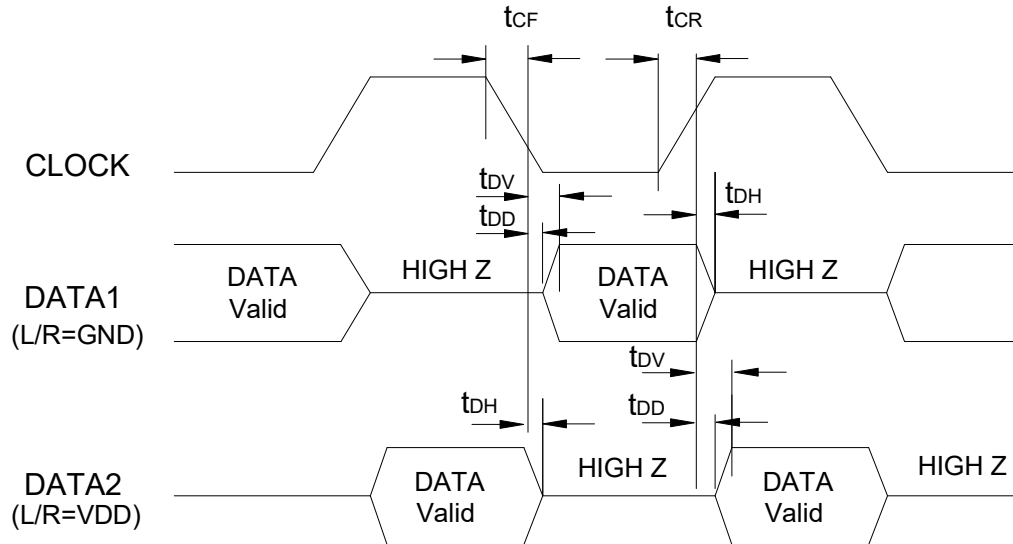


Fig. 2 Recommended timing diagram

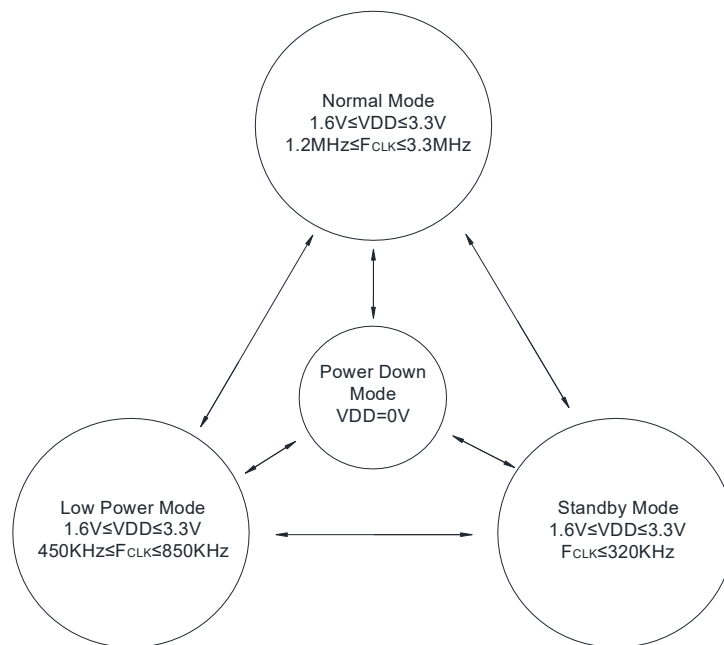


Fig. 3 State diagram

Performance Curves

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

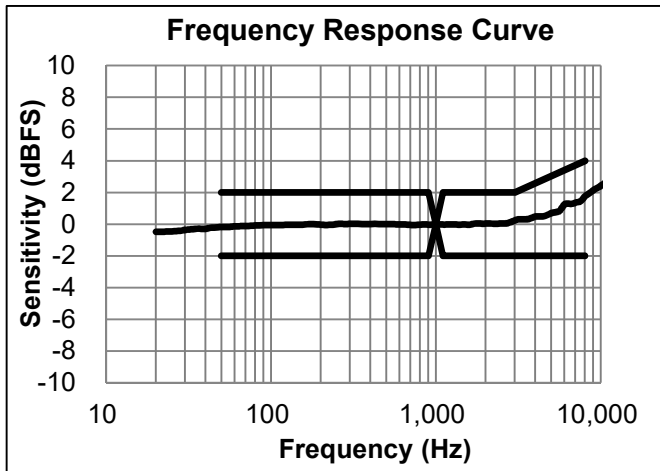


Fig. 4 Normal mode FR normalized to 1KHz

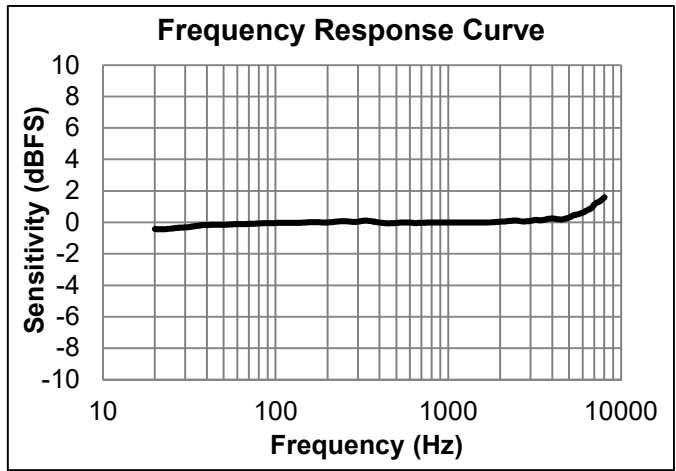


Fig. 5 Low power mode FR normalized to 1KHz

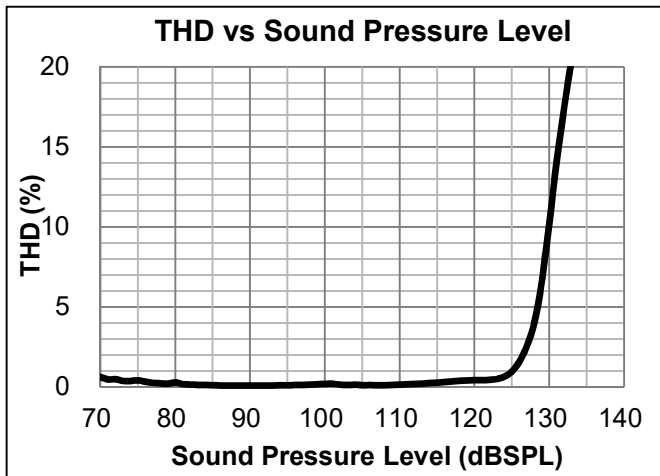


Fig. 6 Typical THD vs Sound Pressure Level

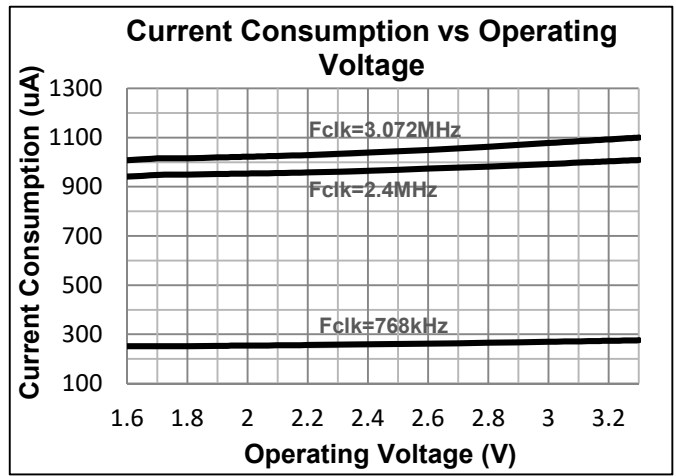


Fig. 7 Typical Current Consumption curve

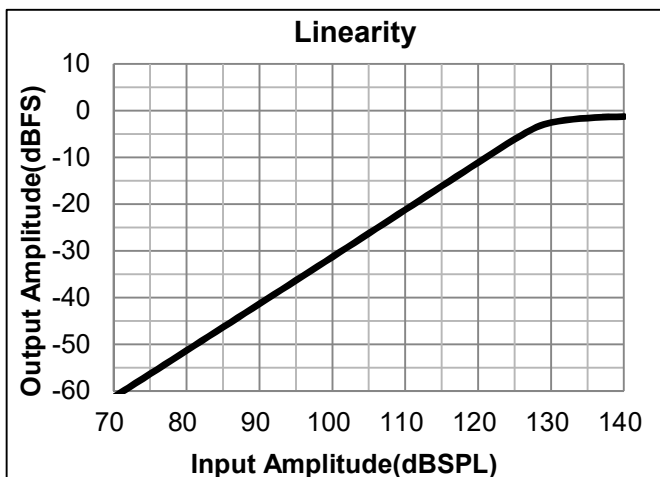


Fig. 8 Linearity

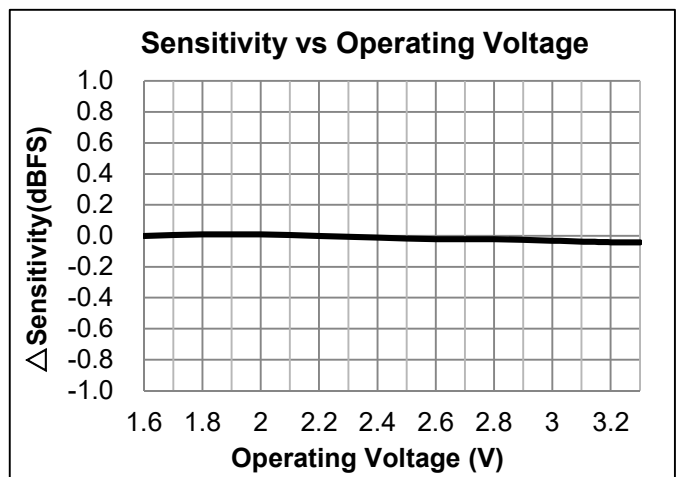


Fig. 9 Sensitivity vs Operating Voltage

Measurement System Setup

Test signal: Sinusoid, Sweep,

Step: 1/12 octave

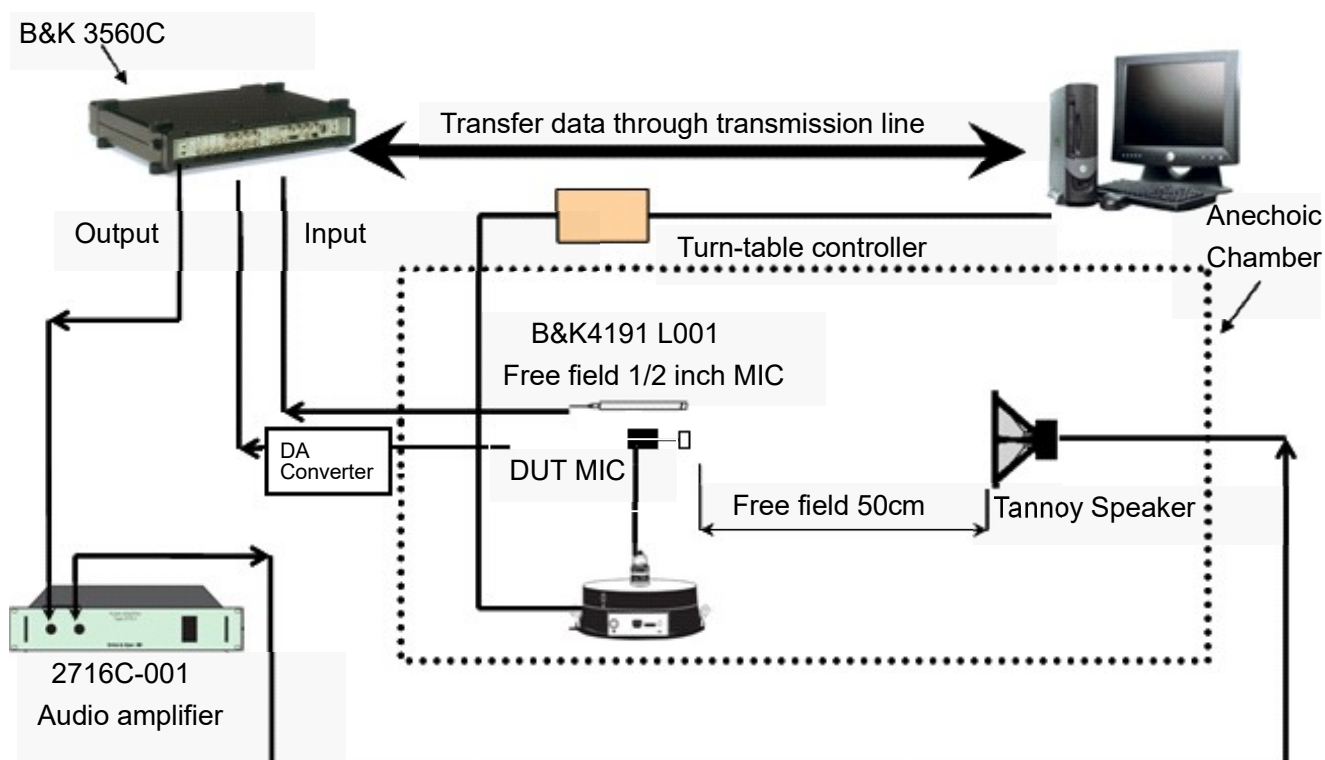


Fig. 10 Measurement System Setup

Typical Application Circuit

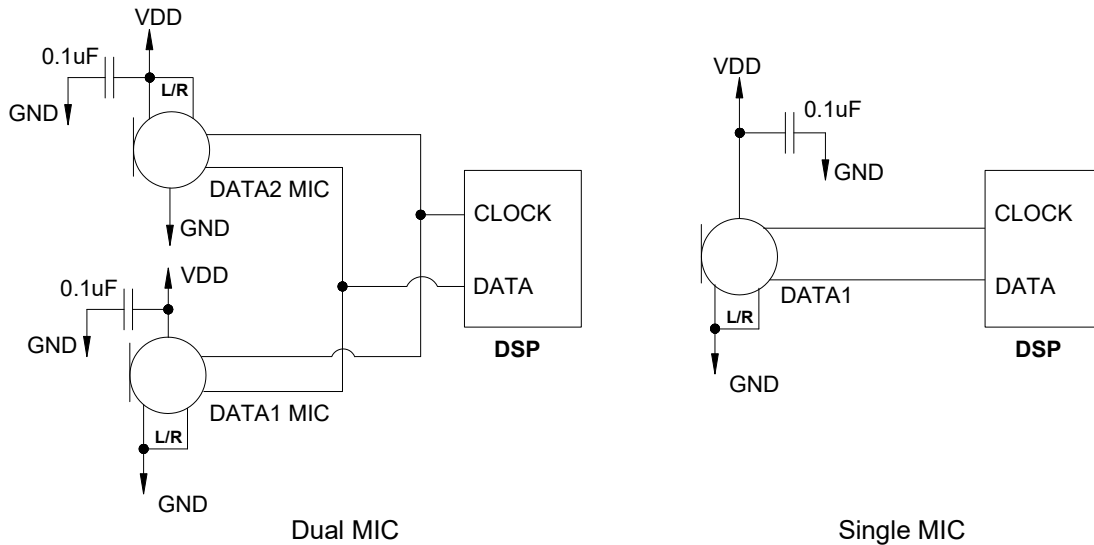


Fig. 11 Typical Application Circuit

Note1:L/R must be connected to VDD or GND even single MIC use.

Note2: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.

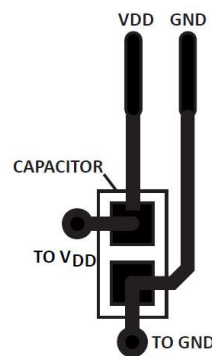
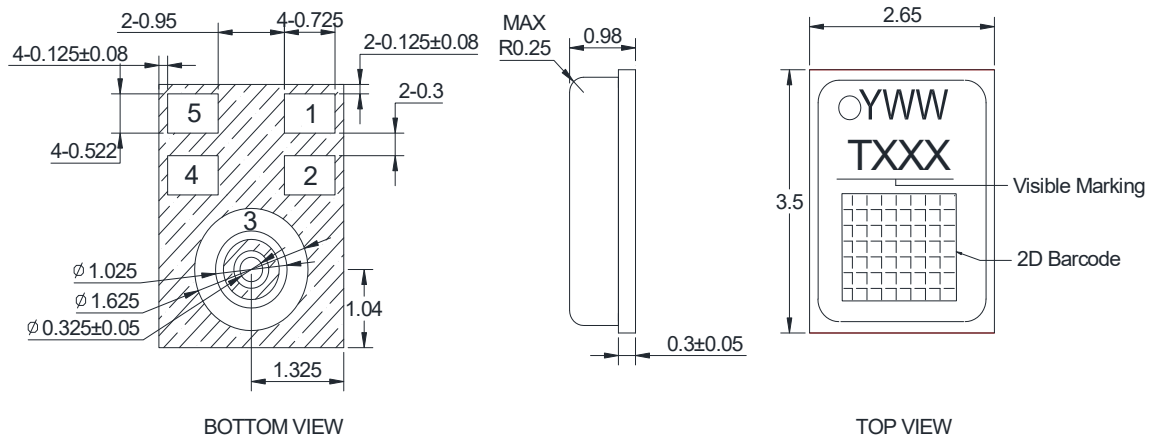


Fig. 12 Recommended Power Supply Decoupling Capacitor Layout

Note3: 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 50~100Ωresistor should be placed near the codec to reduce signal over-shoot or ringing.

Mechanical Specifications



Unit: mm Unmarked Tolerance: ± 0.1

Fig. 13 Dimension

| Item | Dimension | Tolerance |
|---------------|-----------|-----------|
| Length | 3.50 | ± 0.1 |
| Width | 2.65 | ± 0.1 |
| Height | 0.98 | ± 0.1 |
| Acoustic Port | 0.325 | ± 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 |
| 4 | CLK | Clock input |
| 5 | VDD | Power 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 Specifications

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

Table 7 Electrical 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 | $105\pm 3^{\circ}\text{C}$, 1000h, recover for two hours |
| 3 | Hi-Temperature operating Test | $105\pm 3^{\circ}\text{C}$, under upper limit bias, 1000h, recover for two hours |
| 4 | Low-Temperature storage Test | $-40\pm 3^{\circ}\text{C}$, 1000h, recover for two hours |
| 5 | Low-Temperature operating Test | $-40\pm 3^{\circ}\text{C}$, under upper limit bias, 1000h, recover for two hours |
| 6 | High Humidity & High Heat operating Test | $85\pm 3^{\circ}\text{C}$, 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 | $65\pm 3^{\circ}\text{C}$, 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°C for 15mins \rightarrow 125°C 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 $\geq 0.8\text{mm}$) 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 $\geq 0.8\text{mm}$) Duration: 300 times Recommended Time: 10-11 times/Min The sensitivity change should be less than 1dB after testing |

| | | |
|----|----------------------|--|
| 12 | ESD Test 1 | <p>a. HMB Discharge Position: I/O pins Charge Voltage: $\pm 3000V$ Discharge Network: 100pF & 1500Ω</p> <p>b. CDM Discharge Position: I/O pins Charge Voltage: $\pm 250V$</p> |
| 13 | ESD Test 2 | <p>The tests are performed acc. to IEC61000-4-2 level 3:</p> <p>a. Contact Discharge Discharge Position: Output of Microphone Charge Voltage: $\pm 6000VDC$ Discharge Network: 150pF & 330Ω</p> <p>b. Air Discharge Discharge Position: Sound Hole Charge Voltage: $\pm 8000VDC$ Discharge Network: 150pF & 330Ω</p> |
| 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 $^{\circ}C$ according to reflow profile |

Packaging Details

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

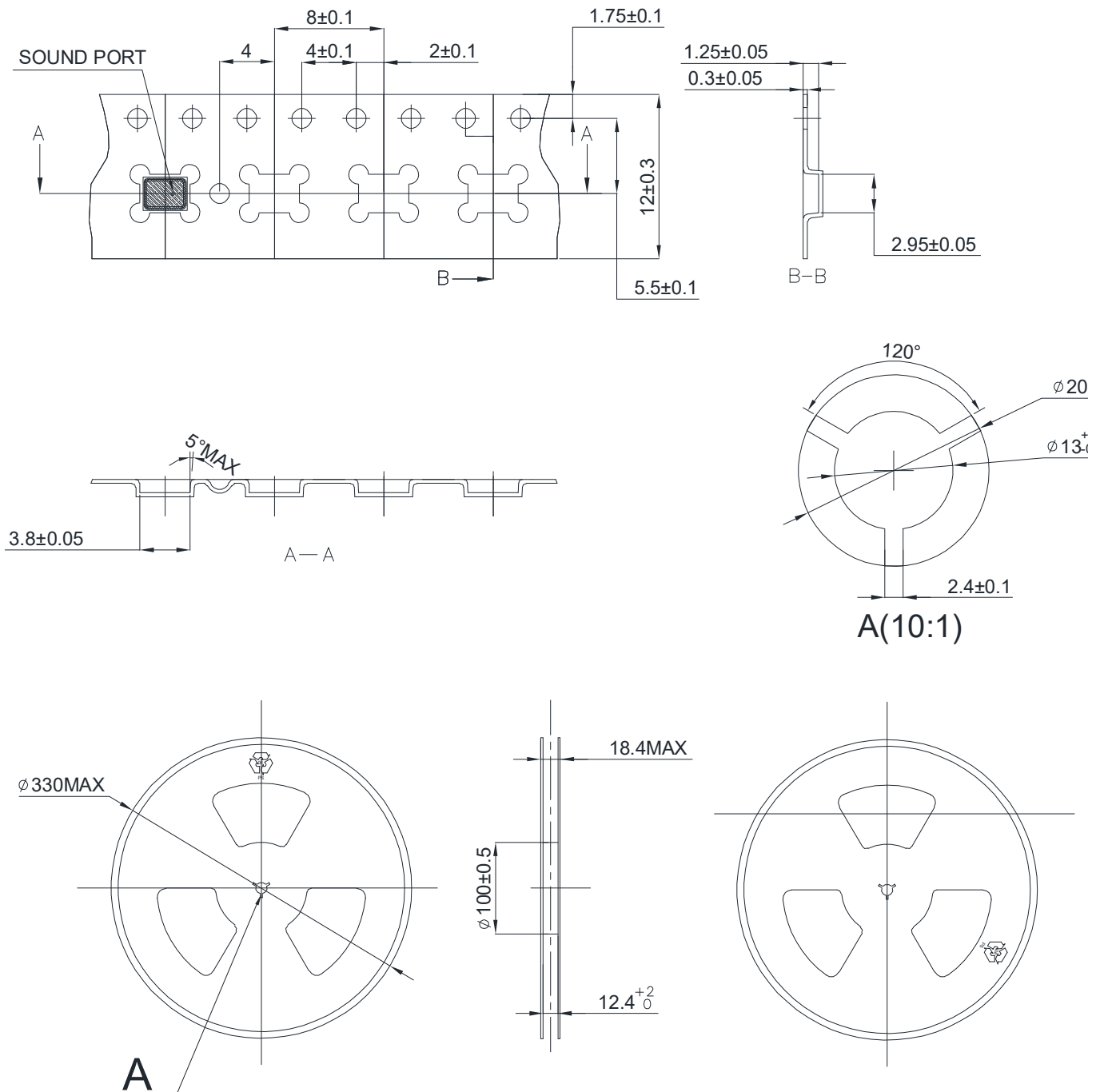
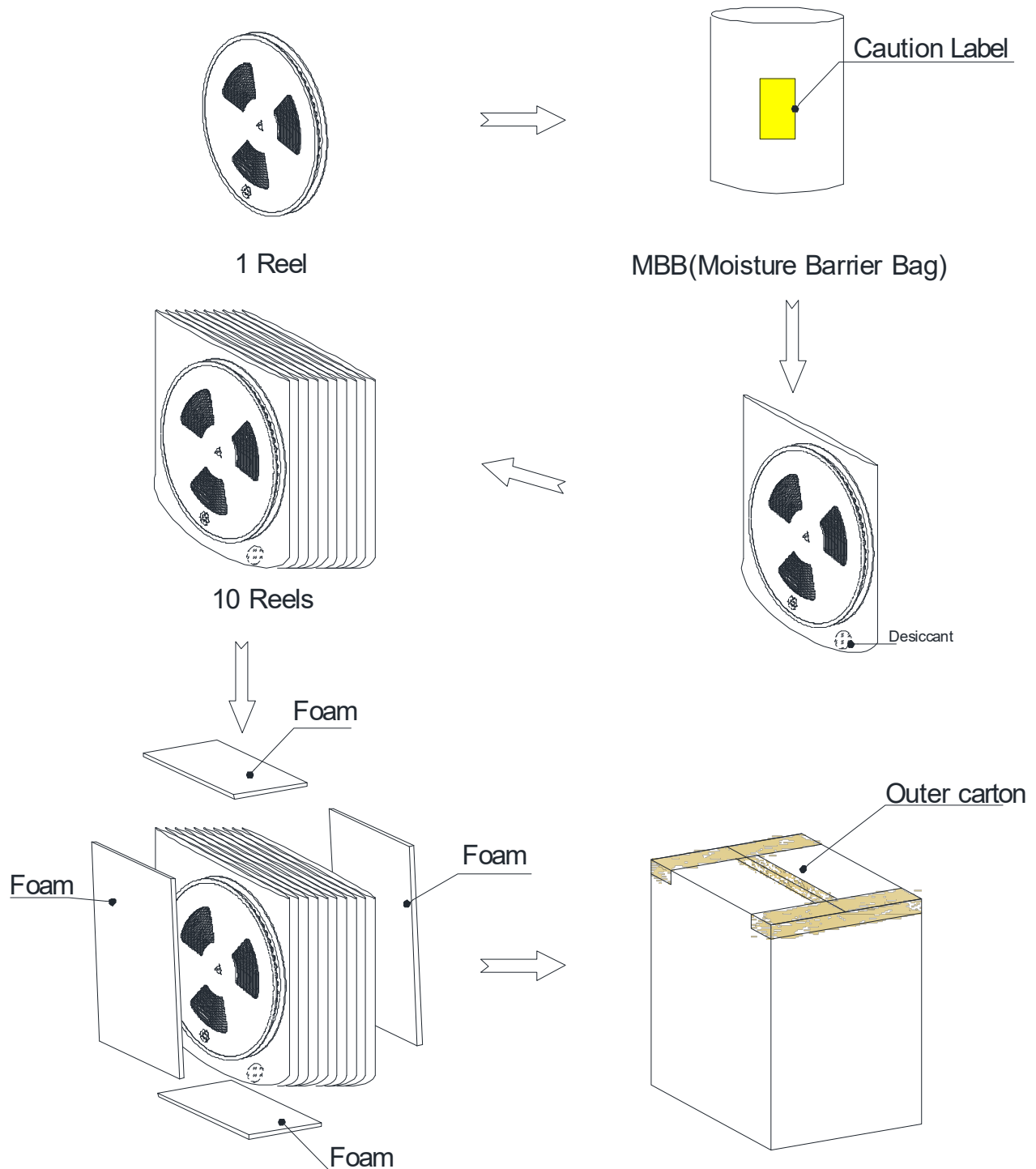


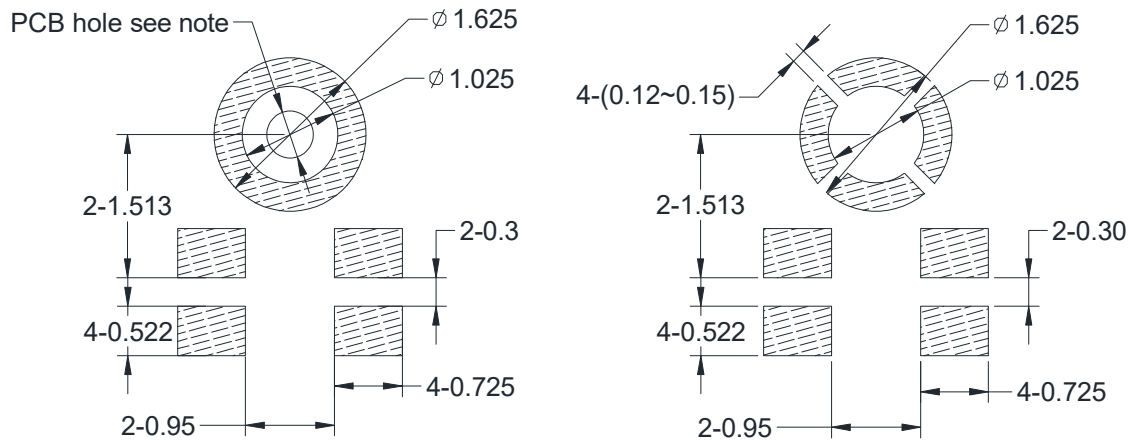
Fig. 14 Packaging



| | | |
|---------------|-------------------|-----------------------|
| 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 $\pm 0.1\text{mm}$ unless otherwise specified.
- The recommended non-plated hole diameter of PCB is 0.4-0.8mm.

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 ($t_{25^\circ\text{C}}$) to Peak Temperature | | | 8 min max |

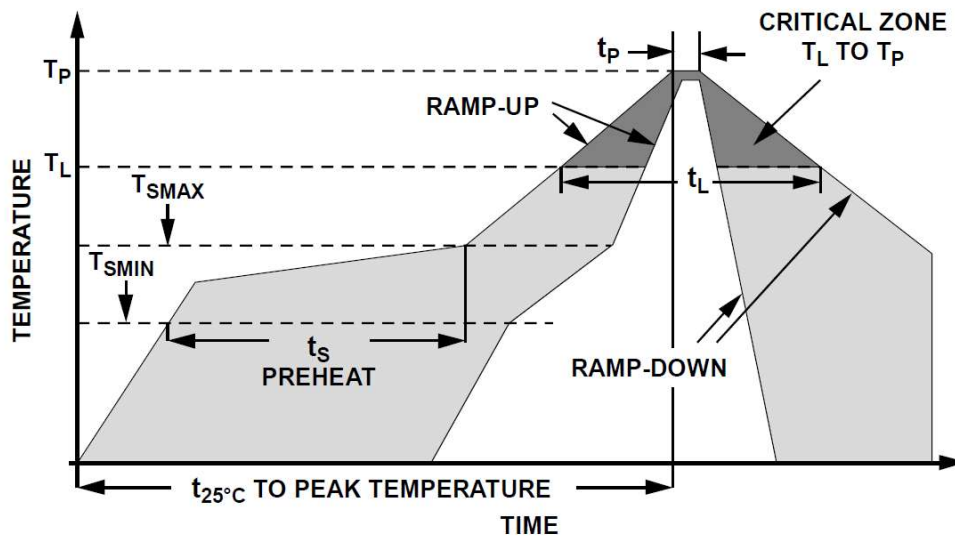


Fig. 15 Reflow Profile

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 $\Phi 1.8\text{mm}$

Inside diameter is $\Phi 1.2\text{mm}$

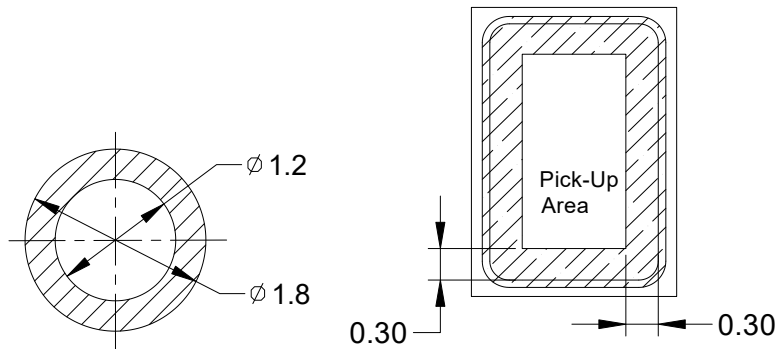


Fig. 16 Recommended nozzle for reflow MIC and Pick-up Area

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 < 5sec.

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

[illegible]