

## **3SM222KMB1HA-P MEMS Microphone IC**

### **Product Description**

The **3SM222KMB1HA-P** microphone IC are integrated with specialized pre-amplification & analog-to-digital converter ASIC to provide high SNR output from a capacitive audio sensor. It's packaged for surface mounting and high temperature reflow assembly. **3SM222KMB1HA-P** is ideal in many compact portable consumer electronic devices such as TV, smart speaker.

### **Features**

- Bottom port
- High stability - no risk of membrane aging
- Suitable for automatic pick-and-place handler and SMT process
- Pulse density modulator (PDM) output interface supports two microphones on a single data line
- Miniature dimension 3.50mm x 2.65mm x 0.98mm
- RoHS/Green compliant
- Sensitivity deviation within  $\pm 1\text{dB}$
- Package type : LGA 5-pin
- Omnidirectional

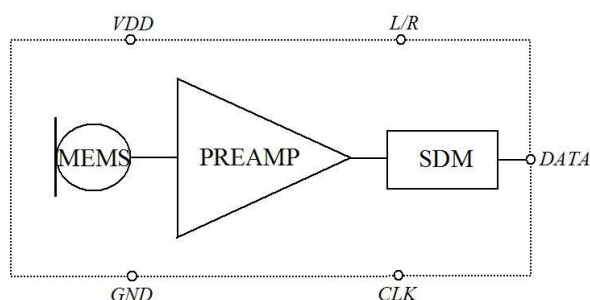
### **Applications**

- TVs
- Smart Speakers
- IoT Devices

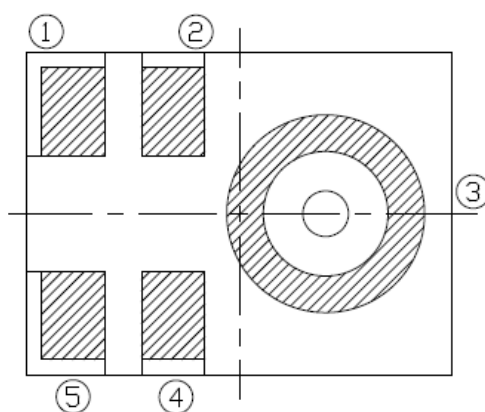
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## Functional Block Diagram



## Pin Definition and Function



Bottom View

Table 1.

| Pin # | Symbol | Type          | Function                           |
|-------|--------|---------------|------------------------------------|
| 1     | DATA   | Digital O     | Digital Output Signal              |
| 2     | L/R    | Non-Digital I | Left(Low) / Right(High) Select Pin |
| 3     | GND    | Power         | Ground                             |
| 4     | CLK    | Digital I     | Clock Input to Microphone          |
| 5     | VDD    | Power         | Power Supply                       |

## Temperature Range

Table 2.

|                             |                  |               |
|-----------------------------|------------------|---------------|
| Storage Temperature         | T <sub>STG</sub> | -40°C ~ 125°C |
| Operating Temperature Range | T <sub>A</sub>   | -40°C ~ 105°C |

## Acoustical and Electrical Characteristics

*Table 3. General Microphone Specifications*

*Typical test conditions are TA = 23 °C, VDD = 1.8V and R.H. = 50 % measured in a pressure chamber test setup. All voltages refer to GND node*

| Parameters                  | Symbol                    | Min. | Typ. | Max. | Unit | Test Conditions           |
|-----------------------------|---------------------------|------|------|------|------|---------------------------|
| Low Frequency Roll-off      | LFRO                      |      | 35   |      | Hz   | -3dB relative to 1KHz     |
| Supply Voltage              | Vdd                       | 1.6  |      | 3.6  | V    |                           |
| Output Load                 | C <sub>Load</sub>         |      |      | 100  | pF   |                           |
| Wake-up Time <sup>(1)</sup> |                           |      | 100  |      | ms   | Fclk ≥ 1MHz               |
| Startup Time                |                           |      | 100  |      | ms   |                           |
| Sleep Time                  |                           |      | 1    |      | ms   | Fclk ≤ 1KHz               |
| Data Format                 | 1/2 Cycle PDM             |      |      |      |      |                           |
| Directivity                 | Omnidirectional           |      |      |      |      |                           |
| Polarity                    | Increasing density of 1's |      |      |      |      | Increasing sound pressure |

*Table 4. Performance Mode Microphone Specifications*

*Typical test conditions are TA = 23 °C, VDD = 1.8V, Clock=2.4MHz and R.H. = 50 % measured in a pressure chamber test setup. All voltages refer to GND node*

| Parameters                   | Symbol | Min. | Typ. | Max. | Unit     | Test Conditions                                                              |
|------------------------------|--------|------|------|------|----------|------------------------------------------------------------------------------|
| <b>Acoustic</b>              |        |      |      |      |          |                                                                              |
| Sensitivity                  | S      | -27  | -26  | -25  | dBFS     | 1KHz, 94dBSPL                                                                |
| Signal to Noise Ratio        | S/N    |      | 64   |      | dBA      | A-weighted                                                                   |
| Equivalent Noise Level       | ENL    |      | 30   |      | dBA      | A-weighted                                                                   |
| Total Harmonic Distortion    | THD    |      | <0.2 |      | %        | 94dBSPL                                                                      |
|                              |        |      | 1    |      | %        | 110dBSPL                                                                     |
| Acoustic Overload Point      | AOP    |      | 120  |      | dBSPL    | 10% THD@1KHz,<br>S = Typ.                                                    |
| <b>Electrical</b>            |        |      |      |      |          |                                                                              |
| Clock Frequency              | Fclk   | 1.0  |      | 4.8  | MHz      |                                                                              |
| Current Consumption          | Isb    |      | 550  |      | μA       | Vdd=1.8V                                                                     |
|                              |        |      | 850  |      | μA       | Vdd=3.6V                                                                     |
| Power Supply Rejection Ratio | PSRR   |      | 60   |      | dBV/FS   | 1KHz, 200mV peak to peak sinewave on Vcc 2.1V                                |
| Power Supply Rejection       | PSR+N  |      | -80  |      | dBFS (A) | 217Hz, 100mV 1/8 duty cycle peak to peak square wave on Vcc 2.1V, A-weighted |

**Table 5. Low-Power Mode Microphone Specifications**

Typical test conditions are  $T_A = 23\text{ }^{\circ}\text{C}$ ,  $V_{DD} = 1.8\text{V}$ ,  $\text{Clock} = 768\text{KHz}$  and  $R.H. = 50\%$  measured in a pressure chamber test setup. All voltages refer to GND node

| Parameters                   | Symbol | Min. | Typ. | Max. | Unit          | Test Conditions                                                              |
|------------------------------|--------|------|------|------|---------------|------------------------------------------------------------------------------|
| <b>Acoustic</b>              |        |      |      |      |               |                                                                              |
| Sensitivity                  | S      | -27  | -26  | -25  | dBFS          | 1KHz, 94dBSPL                                                                |
| Signal to Noise Ratio        | S/N    |      | 64   |      | dBA           | A-weighted                                                                   |
| Equivalent Noise Level       | ENL    |      | 30   |      | dBA           | A-weighted                                                                   |
| Total Harmonic Distortion    | THD    |      | <0.2 |      | %             | 94dBSPL                                                                      |
|                              |        |      | 1    |      | %             | 110dBSPL                                                                     |
| Acoustic Overload Point      | AOP    |      | 120  |      | dBSPL         | 10% THD@1KHz, S = Typ.                                                       |
| <b>Electrical</b>            |        |      |      |      |               |                                                                              |
| Clock Frequency              | Fclk   | 350  |      | 800  | KHz           |                                                                              |
| Current Consumption          | Isb    |      | 300  |      | $\mu\text{A}$ | Vdd=1.8V                                                                     |
|                              |        |      | 400  |      | $\mu\text{A}$ | Vdd=3.6V                                                                     |
| Power Supply Rejection Ratio | PSRR   |      | 60   |      | dBV/FS        | 1KHz, 200mV peak to peak sinewave on Vcc 2.1V                                |
| Power Supply Rejection       | PSR+N  |      | -80  |      | dBFS (A)      | 217Hz, 100mV 1/8 duty cycle peak to peak square wave on Vcc 2.1V, A-weighted |

**Table 6. Sleep Mode Microphone Specifications**

Typical test conditions are  $T_A = 23\text{ }^{\circ}\text{C}$ ,  $V_{DD} = 1.8\text{V}$ ,  $\text{Clock} = 0\text{Hz}$  and  $R.H. = 50\%$  measured in a pressure chamber test setup. All voltages refer to GND node

| Parameters                     | Symbol | Min. | Typ. | Max. | Unit          | Test Conditions    |
|--------------------------------|--------|------|------|------|---------------|--------------------|
| Clock Frequency                | Fclk   | 0    |      | 250  | KHz           |                    |
| Current Consumption Sleep Mode | Isleep |      | 10   |      | $\mu\text{A}$ | Clock = VDD or GND |

(1). Time from the first clock edge to valid output data

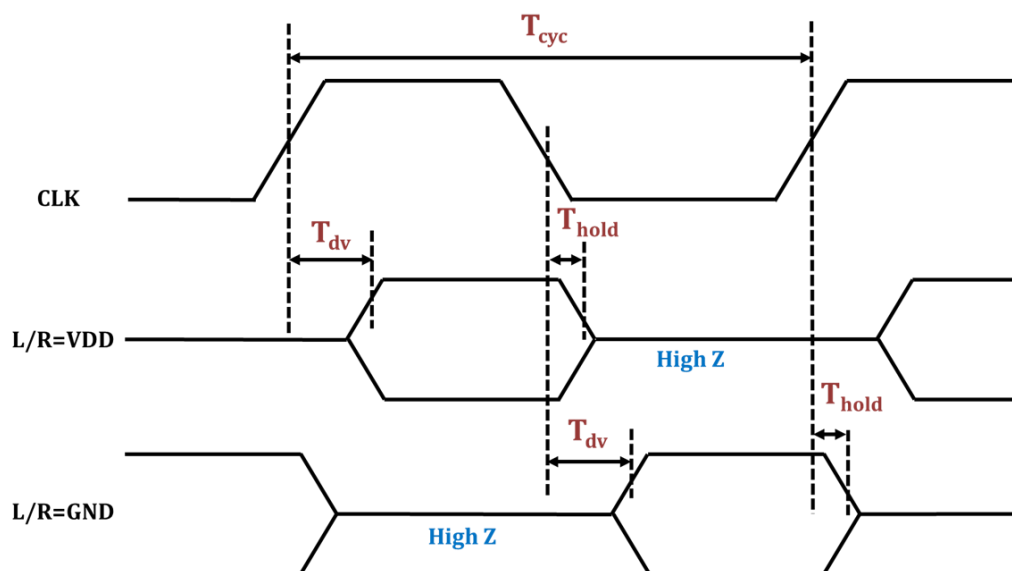
## Timing Characteristics

Table 7. Microphone Interface Specifications

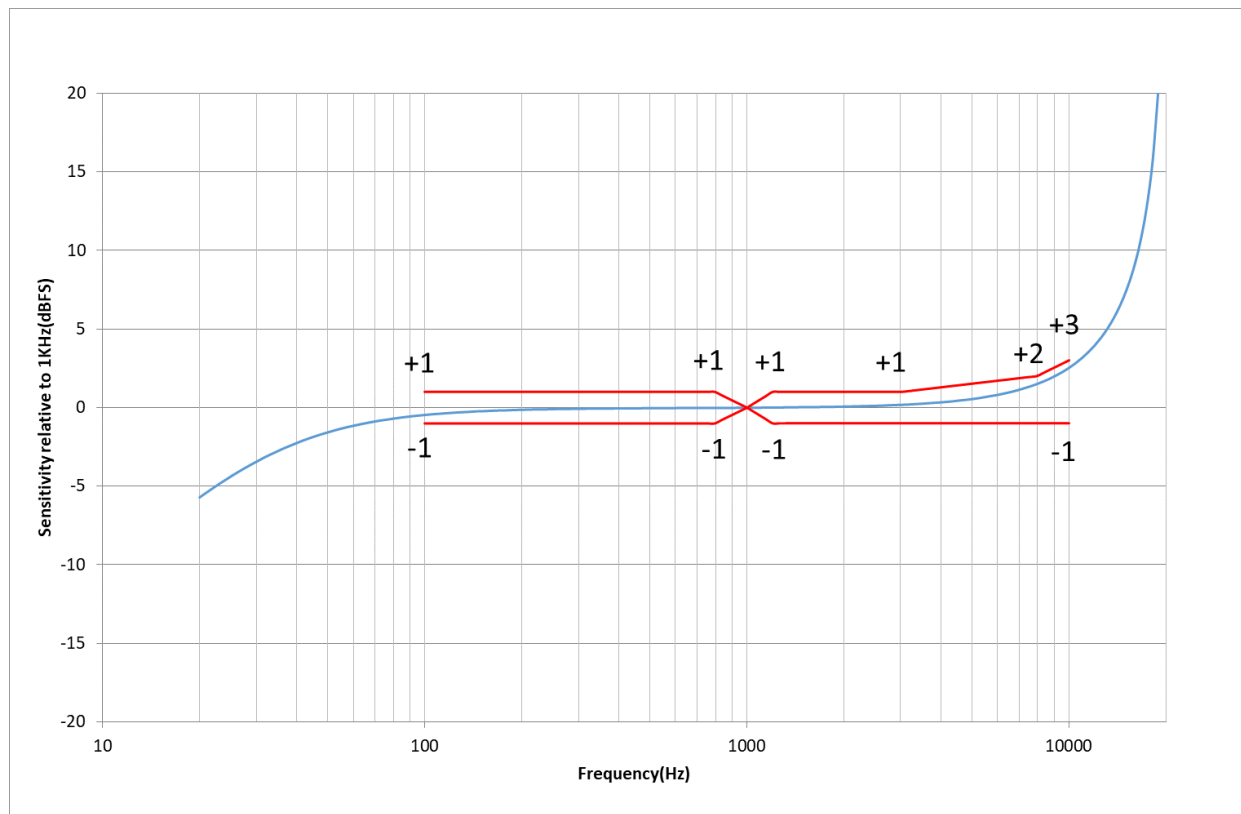
| Parameters                   | Symbol      | Min.             | Typ. | Max.               | Unit | Test Conditions  |
|------------------------------|-------------|------------------|------|--------------------|------|------------------|
| Logic Input High             | $V_{IH}$    | 0.70x<br>VDD     |      | 3.6                | V    |                  |
| Logic Input Low              | $V_{IL}$    | -0.3             |      | 0.30x<br>VDD       | V    |                  |
| Logic Output High            | $V_{OH}$    | VDD<br>-0.45     |      | VDD                | V    | $I_{out} = 1mA$  |
| Logic Output Low             | $V_{OL}$    | 0                |      | 0.45               | V    | $I_{out} = 1mA$  |
| Clock Frequency              | $F_{clock}$ |                  |      | 250                | KHz  | Sleep Mode       |
|                              |             | 350              |      | 800                |      | Low-Power Mode   |
|                              |             | 1.0              |      | 4.8                | MHz  | Performance Mode |
| Clock Duty Cycle             |             | 40               |      | 60                 | %    |                  |
| Clock Period for Normal Mode | $T_{cyc}$   | 208              |      | 1000               | ns   |                  |
| Data Setup Time              | $T_{dv}$    |                  |      | 100 <sup>(1)</sup> | ns   |                  |
| Data Hold Time               | $T_{hold}$  | 3 <sup>(1)</sup> |      |                    | ns   |                  |

(1). Guaranteed by design

## Timing Waveforms



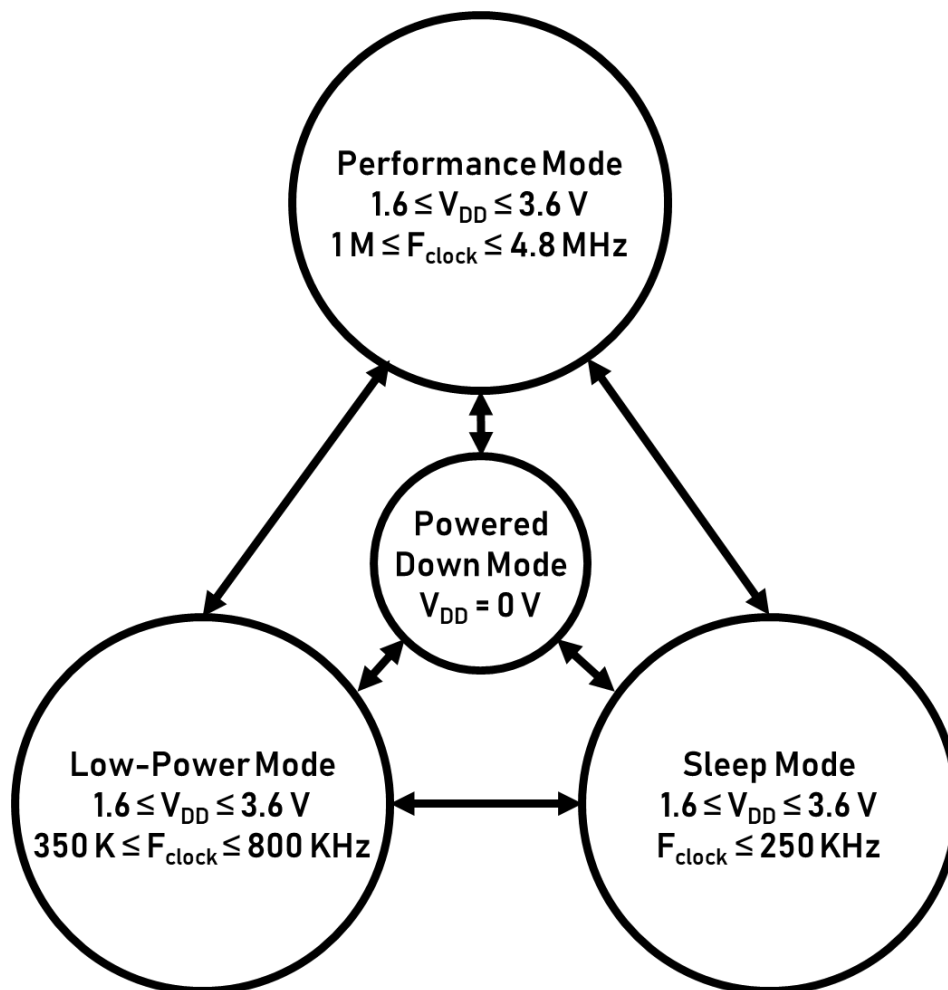
## Frequency Response



\* Measured frequency of 1 KHz

| Upper Limit  |     |     |      |      |      |      |       |
|--------------|-----|-----|------|------|------|------|-------|
| Hz           | 100 | 800 | 1000 | 1200 | 3000 | 8000 | 10000 |
| dB ref. 1KHz | +1  | +1  | 0    | +1   | +1   | +2   | +3    |
| Lower Limit  |     |     |      |      |      |      |       |
| Hz           | 100 | 800 | 1000 | 1200 | 3000 | 8000 | 10000 |
| dB ref. 1KHz | -1  | -1  | 0    | -1   | -1   | -1   | -1    |

## State Diagram





## Reliability Qualifications

Table 8.

| Test Item                       | Description                                                                                                                                                                                              |
|---------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| High Temperature Storage        | Storage at 125°C for 1,000 hours<br>JESD22-A103                                                                                                                                                          |
| Low Temperature Storage         | Storage at -40°C for 1,000 hours<br>JESD22-A119                                                                                                                                                          |
| High Temperature Operation Bias | Under Bias at 105°C for 1,000 hours<br>JESD22-A108                                                                                                                                                       |
| Low Temperature Operation Bias  | Under Bias at -40°C for 1,000 hours<br>JESD22-A108                                                                                                                                                       |
| Temperature Humidity Bias       | Under Bias at 85°C/85%RH for 1,000 hours<br>JESD22-A101                                                                                                                                                  |
| Thermal Cycling Test            | Thermal Cycle from -40°C~125°C, 100 cycles<br>JESD22-A104                                                                                                                                                |
| Reflow                          | 5 reflow cycles with peak 260°C<br>J-STD-020                                                                                                                                                             |
| Vibration                       | 4 cycles lasting 12 minutes from 20 to 2KHz in X, Y and Z with peak acceleration of 20G<br>JESD22-B103                                                                                                   |
| Mechanical Shock                | Total 18 pulses 10,000G in X,Y and Z<br>JESD22-B104                                                                                                                                                      |
| ESD                             | HBM:3KV, MM:300V, CDM:500V<br>Air Discharge:15KV,<br>Contact Discharg:8KV<br>JESD22-A114(HBM)<br>JESD22-A115(MM)<br>JESD22-C101(CDM)<br>IEC 61000-4-2(Air Discharge)<br>IEC 61000-4-2(Contact Discharge) |

Notes: Microphones meet all acoustic and electrical specifications before and after reliability testing, except sensitivity which can deviate up to 3dB from its initial value.

After 5 reflow cycles, the sensitivity of the microphone shall not deviate more than 1 dB from its initial value.

## Reflow Profile

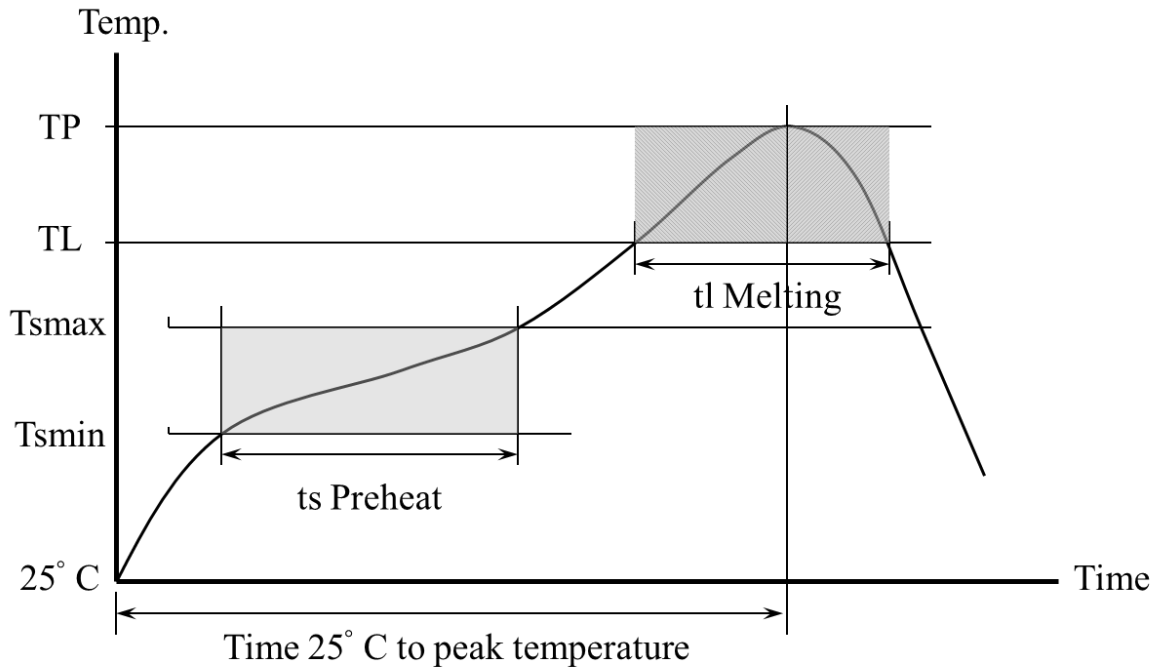


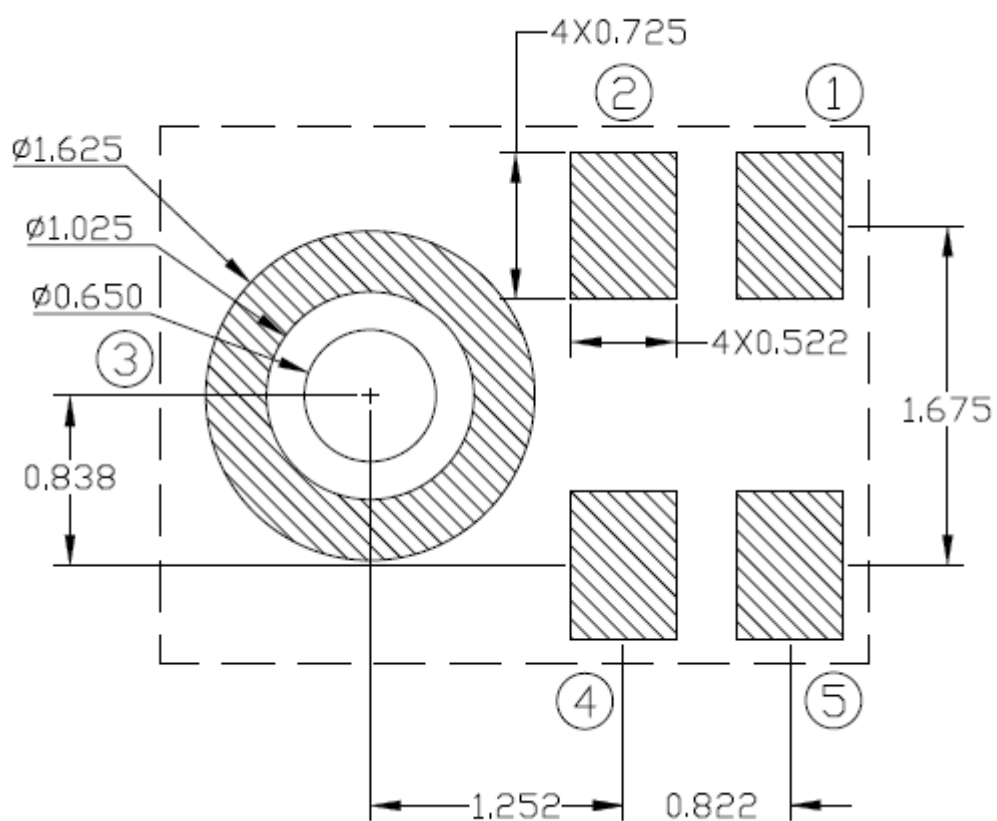
Table 9. Recommended Reflow Profile Limits

| Profile Feature                              | Pb-free          |
|----------------------------------------------|------------------|
| Preheat                                      |                  |
| Minimum temperature ( $T_{smin}$ )           | 150 °C           |
| Maximum temperature ( $T_{smax}$ )           | 200 °C           |
| Time ( $t_s$ )                               | 60~180 sec       |
| Average Ramp up rate ( $T_{smax}$ to $T_p$ ) | 3 °C/sec         |
| Melting area                                 |                  |
| Melting temperature ( $TL$ )                 | 217 °C           |
| Time maintained above melting ( $t_l$ )      | 60~150 sec       |
| Peak Temperature ( $TP$ )                    | 260 °C           |
| Time within 5°C of actual peak temperature   | 20~40 sec        |
| Ramp down rate                               | 6 °C/sec maximum |
| Time $25^{\circ}C$ to peak temperature       | 8 minute maximum |

Notes: Based on IPC/JDEC J-STD-020 Revision F.

All temperatures refer to topside of the package, measured on the package body surface

## PCB Land Pattern Layout



## Application Circuit

The L/R pad lets the user to select the DATA signal pattern as explained in Table 7.  
The L/R pin must be connected to either VDD or GND.

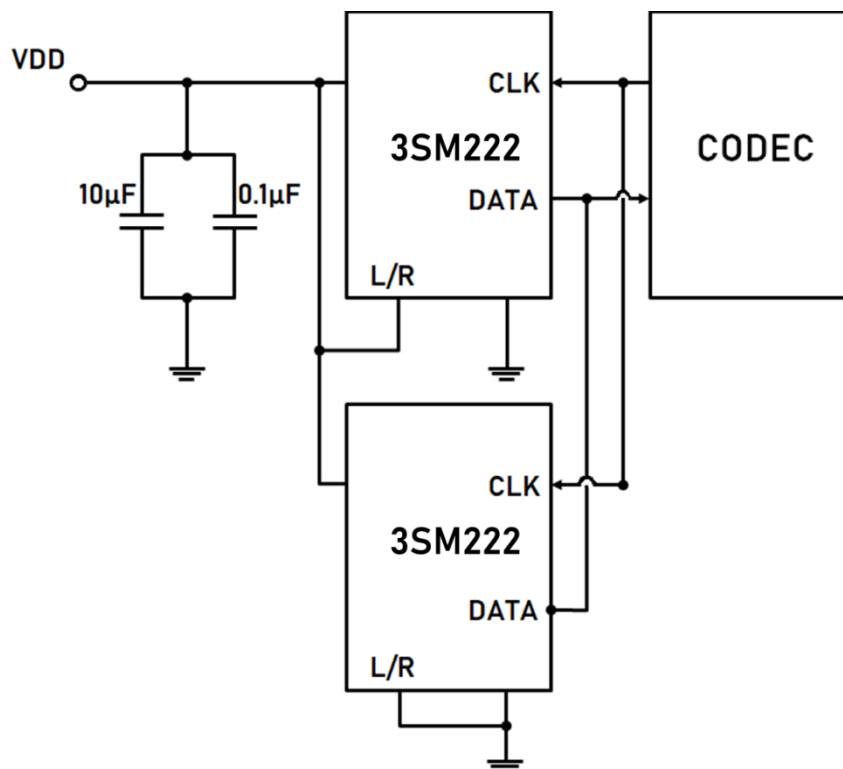
*Table 10. L/R channel selection*

| L/R | CLK low        | CLK high       |
|-----|----------------|----------------|
| GND | DATA valid     | High impedance |
| VDD | High impedance | DATA valid     |

### Single microphone application:

0.1 $\mu$ F ceramic, and 10 $\mu$ F ceramic power supply decoupling capacitors should be placed as near as possible to VDD of the device. **The L/R pin must be connected to VDD or GND.**

### Two microphones application:

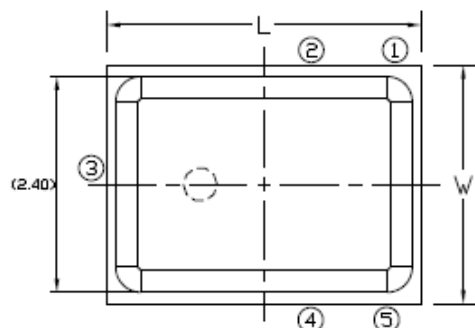


## Handling Instructions

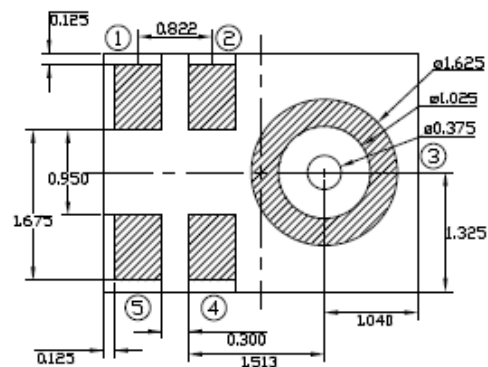
The MEMS microphone IC can be handled using standard pick-and-place and chip shooting equipment. Care should be taken to avoid damage to the MEMS microphone IC structure as follows:

- Do not apply vacuum nozzle over the acoustic port (AP) of the microphone to avoid damage to the device.
- Do not blow air directly into acoustic port.
- Brushing the board with/without solvents may damage the device.
- Do not use excessive force to place the microphone on the PCB.
- In case of manual handling, it should be handled with plastic tweezers to avoid damage the device.

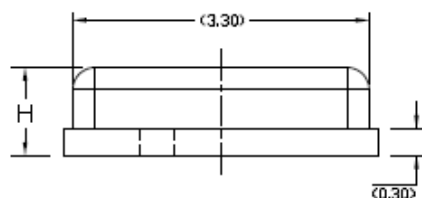
## Dimensions



Top View



Bottom View



Side View

Unit: mm

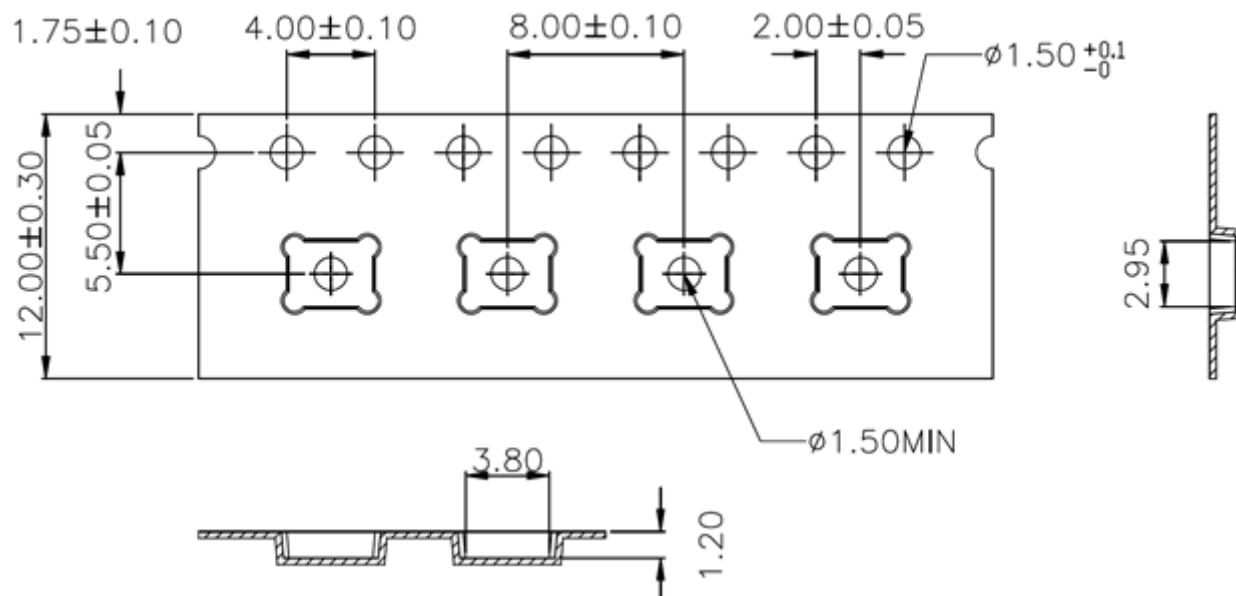
Dimension tolerance is  $\pm 0.15\text{mm}$  unless otherwise specified

Table 11. (Top View)

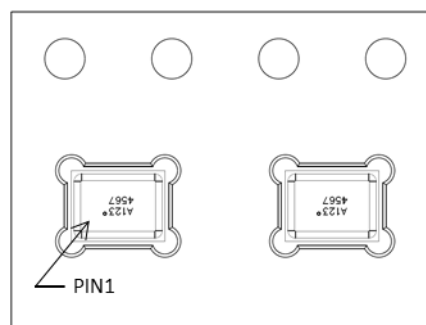
| Item          | Dimension       | Tolerance     |
|---------------|-----------------|---------------|
| Length (L)    | 3.50 mm         | $\pm 0.10$ mm |
| Width (W)     | 2.65 mm         | $\pm 0.10$ mm |
| Height (H)    | 0.98 mm         | $\pm 0.10$ mm |
| Acoustic Port | $\Phi 0.375$ mm | $\pm 0.05$ mm |

## Package Information

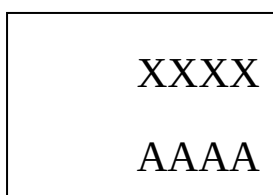
### Carrier Tape:



1. 10 sprocket hole pitch cumulative tolerance  $\pm 0.20$ .
2. Carrier camber is within 1 mm in 250 mm.
3. Material : Black Conductive Polystyrene Alloy.
4. All dimensions meet EIA-481 requirements.
5. Thickness :  $0.30 \pm 0.05$  mm.
6. MSL(Moisture sensitivity level) Class1.

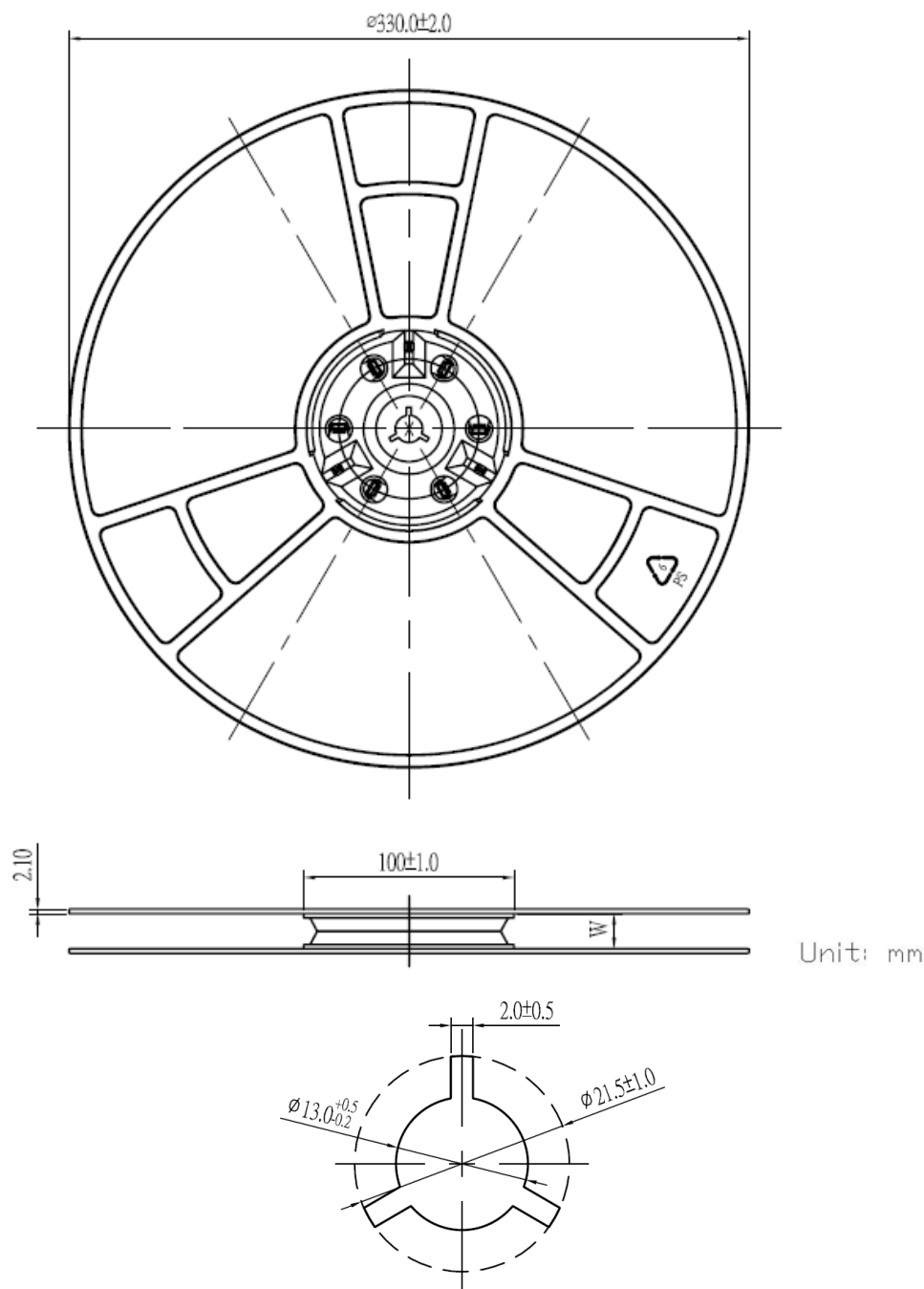


### Laser Marking:



### Laser marking on the top side

|      |                        |
|------|------------------------|
| XXXX | Internal Tracking Code |
| AAAA | Lot Tracking Code      |

**13" Tape Reel :**


| Model Number   | Reel Diameter | Quantity Per Reel |
|----------------|---------------|-------------------|
| 3SM222KMB1HA-P | 13"           | 5,000             |



## Revision History

| Revision | Date       | Description                                                                                                                                              |
|----------|------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1.0      | 2021/04/19 | Formal release                                                                                                                                           |
| 1.1      | 2021/07/14 | Modify “Acoustical and Electrical Characteristics”<br>Modify “Frequency Response”<br>Modify “Reliability Qualifications”<br>Modify “Package Information” |
| 1.2      | 2022/01/19 | Modify “Acoustical and Electrical Characteristics”<br>Modify “Timing Characteristics”<br>Modify “State Diagram”                                          |
| 1.3      | 2022/03/15 | Modify “Timing Characteristics”                                                                                                                          |
| 1.4      | 2022/04/12 | Modify “Timing Characteristics”                                                                                                                          |
| 1.5      | 2023/02/08 | Modify “Timing Characteristics”<br>Modify “Frequency Response”                                                                                           |
| 1.6      | 2023/04/25 | Modify “Reliability Qualifications”<br>Modify “Package Information”                                                                                      |
| 1.7      | 2024/03/14 | Modify “PCB Land Pattern Layout”                                                                                                                         |
| 1.8      | 2024/05/15 | Modify “Acoustical and Electrical Characteristics”<br>Modify “Frequency Response”                                                                        |