

## **3SM227NMB1HA MEMS Microphone IC**

### **Product Description**

The **3SM227NMB1HA** 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. **3SM227NMB1HA** is ideal in many compact portable consumer electronic devices such as automotive and industrial electronics device.

### **Features**

- AEC-Q100/103 qualified
- 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

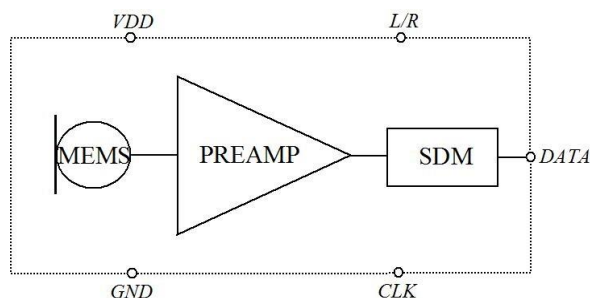
### **Applications**

- Automotive
- Industrial

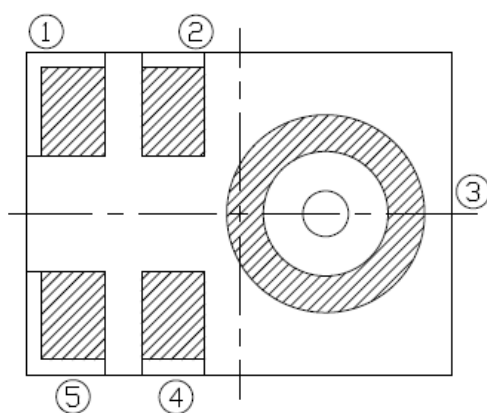
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## Functional Block Diagram



## 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 ~ 150°C |
| Operating Temperature Range | T <sub>A</sub>   | -40°C ~ 125°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           |
|-----------------------------|---------------------------|------|------|------|------|---------------------------|
| Supply Voltage              | Vdd                       | 1.6  |      | 3.6  | V    |                           |
| Low Frequency Roll-off      | LFRO                      |      | 10   |      | Hz   | -3dB relative to 1KHz     |
| High Frequency Flatness     |                           |      | 13   |      | kHz  | +3dB relative to 1KHz     |
| Resonant Frequency Peak     |                           |      | 24   |      | kHz  |                           |
| Output Load                 | C <sub>Load</sub>         |      |      | 100  | pF   |                           |
| Wake-up Time <sup>(1)</sup> |                           |      | 50   |      | ms   | Fclk ≥ 1MHz               |
| Startup Time                |                           |      | 50   |      | ms   |                           |
| Sleep Time                  |                           |      | 1    |      | ms   | Fclk ≤ 1KHz               |
| DC Offset                   |                           | -3.2 |      | 0.3  | %FS  | Fullscale = ±100          |
| 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    |      | 67   |      | dBA      | A-weighted                                           |
| Equivalent Noise Level       | ENL    |      | 27   |      | 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    |      | 1150 |      | μA       | Vdd=1.8V                                             |
|                              |        |      | 1250 |      | μA       | Vdd=3.6V                                             |
| Power Supply Rejection Ratio | PSRR   |      | 65   |      | dBV/FS   | 1KHz, 200mV peak to peak sinewave                    |
| Power Supply Rejection       | PSR+N  |      | -90  |      | dBFS (A) | 217Hz, 100mV 1/8 duty cycle peak to peak square wave |

**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, 94dB SPL                                       |
| Signal to Noise Ratio        | S/N             |      | 67   |      | dBA      | A-weighted                                           |
| Equivalent Noise Level       | ENL             |      | 27   |      | dBA      | A-weighted                                           |
| Total Harmonic Distortion    | THD             |      | <0.2 |      | %        | 94dB SPL                                             |
|                              |                 |      | 1    |      | %        | 110dB SPL                                            |
| Acoustic Overload Point      | AOP             |      | 120  |      | dB SPL   | 10% THD@1KHz,<br>S = Typ.                            |
| <b>Electrical</b>            |                 |      |      |      |          |                                                      |
| Clock Frequency              | Fclk            | 350  |      | 800  | KHz      |                                                      |
| Current Consumption          | I <sub>sb</sub> |      | 400  |      | μA       | V <sub>dd</sub> =1.8V                                |
|                              |                 |      | 450  |      | μA       | V <sub>dd</sub> =3.6V                                |
| Power Supply Rejection Ratio | PSRR            |      | 65   |      | dBV/FS   | 1KHz, 200mV peak to peak sine wave                   |
| Power Supply Rejection       | PSR+N           |      | -90  |      | dBFS (A) | 217Hz, 100mV 1/8 duty cycle peak to peak square wave |

**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 |
|--------------------------------|--------------------|------|------|------|------|-----------------|
| Current Consumption Sleep Mode | I <sub>sleep</sub> |      | 25   |      | μA   | Clock = GND     |

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

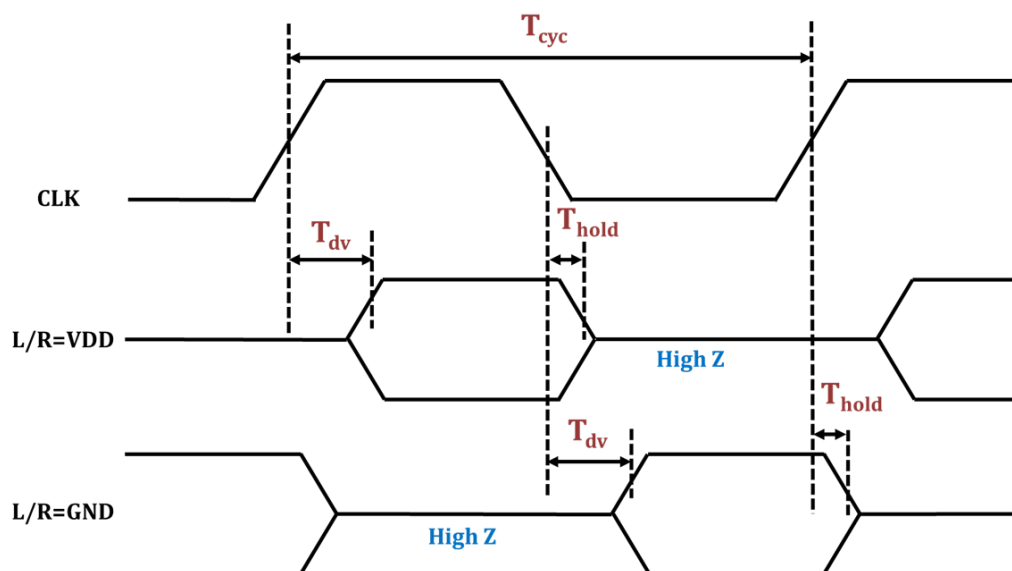
## Timing Characteristics

Table 7. Microphone Interface Specifications

| Parameters                   | Symbol      | Min.             | Typ. | Max.               | Unit | Test Conditions  |
|------------------------------|-------------|------------------|------|--------------------|------|------------------|
| Logic Input High             | $V_{IH}$    | 0.65x VDD        |      | 3.6                | V    |                  |
| Logic Input Low              | $V_{IL}$    | -0.3             |      | 0.35x VDD          | V    |                  |
| Logic Output High            | $V_{OH}$    | VDD -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   |                  |

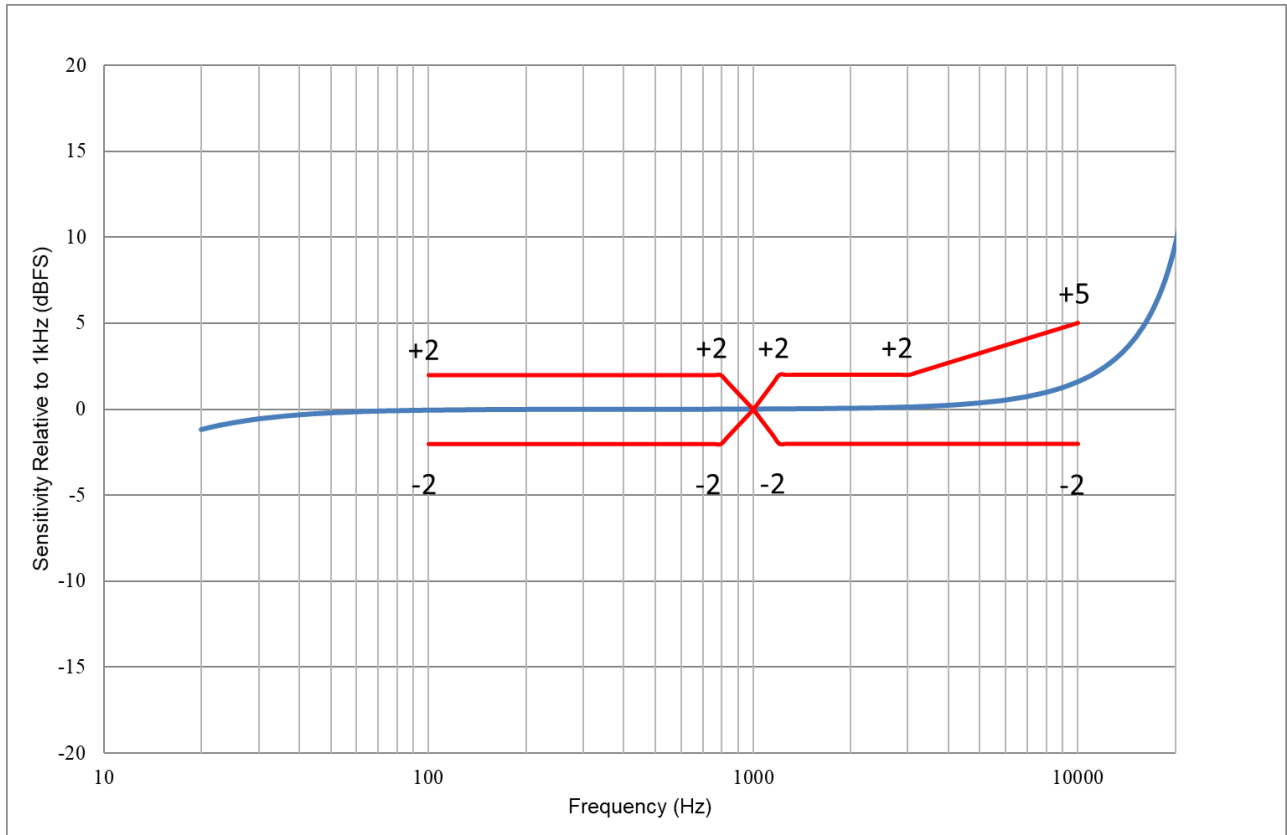
(1). Guaranteed by design

## Timing Waveforms





## Frequency Response



\* Measured frequency of 1 KHz

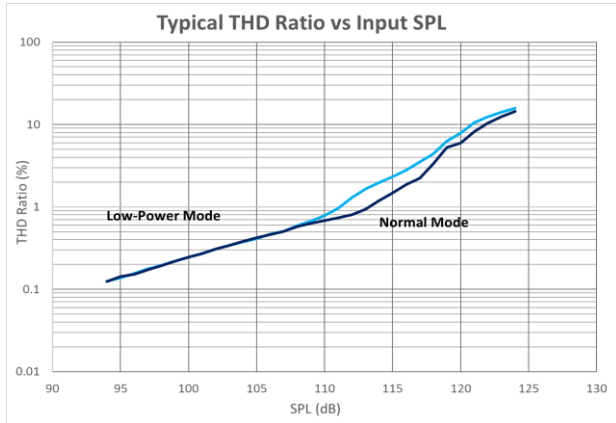
| Upper Limit  |     |     |      |      |      |       |
|--------------|-----|-----|------|------|------|-------|
| Hz           | 100 | 800 | 1000 | 1200 | 3000 | 10000 |
| dB ref. 1KHz | +2  | +2  | 0    | +2   | +2   | +5    |
| Lower Limit  |     |     |      |      |      |       |
| Hz           | 100 | 800 | 1000 | 1200 | 3000 | 10000 |
| dB ref. 1KHz | -2  | -2  | 0    | -2   | -2   | -2    |



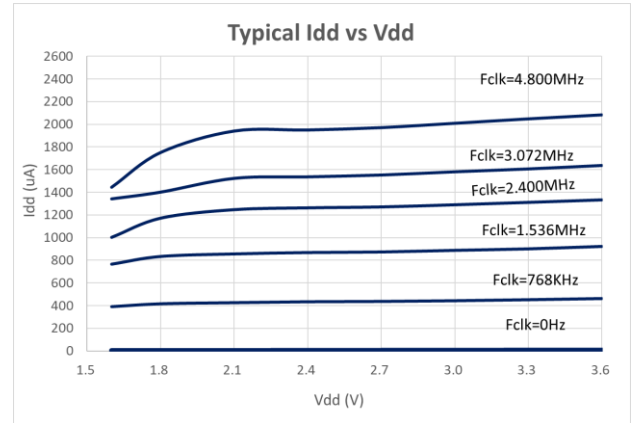
## Performance Curves

Typical test conditions are  $T_A = 23\text{ }^{\circ}\text{C}$ ,  $V_{DD} = 1.8\text{V}$  and  $R.H. = 50\%$ , output unloaded

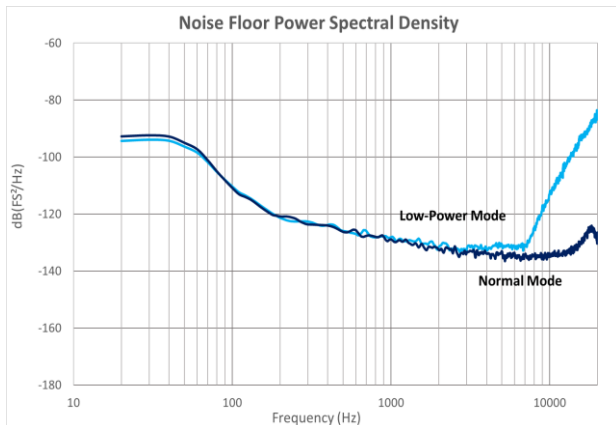
### Typical THD vs Input SPL



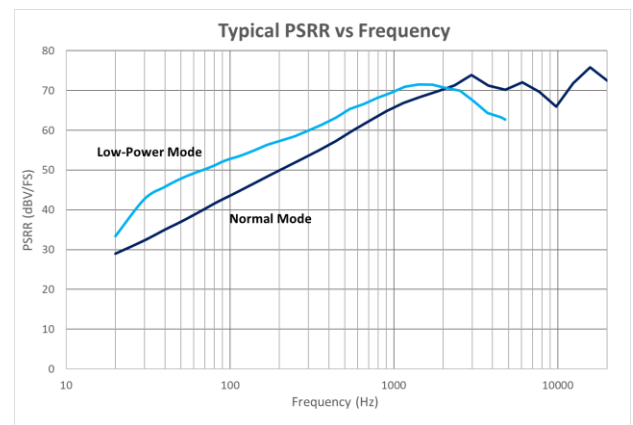
### Typical Idd vs Vdd



### Noise Floor Power Spectral Density

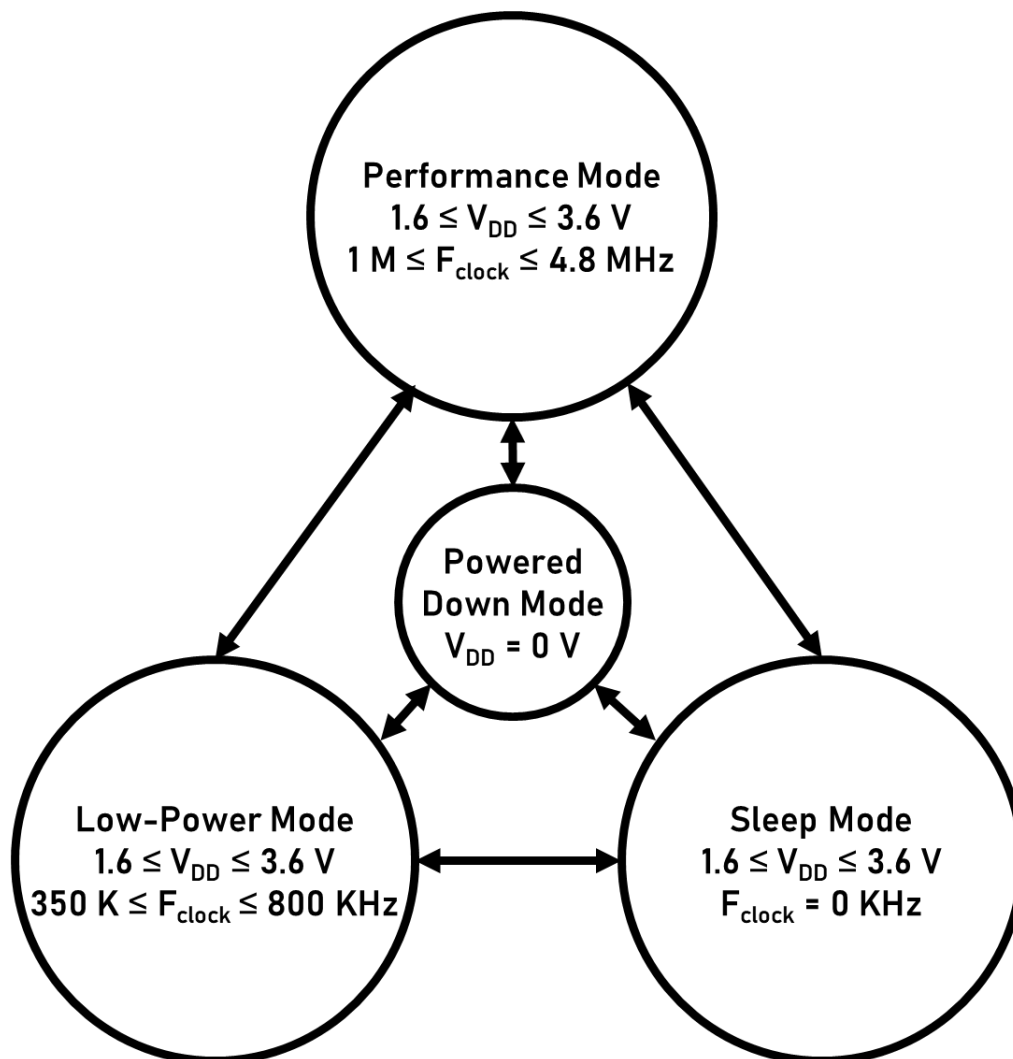


### Typical PSRR vs Frequency





## State Diagram



## Reliability Qualifications

Table 8.

| Test Item                       | Description                                                                             | Standard       | Result |
|---------------------------------|-----------------------------------------------------------------------------------------|----------------|--------|
| High Temperature Operating Life | T <sub>A</sub> =125°C, V <sub>CC</sub> =3.6V, 1000hours                                 | AEC Q100 Rev.H | PASS   |
| Low Temperature Operation Life  | T <sub>A</sub> =-40°C, V <sub>CC</sub> =3.6V, 1000hours                                 | JESD22-A108    | PASS   |
| High Temperature Storage Life   | T <sub>A</sub> =150°C, 1000hours                                                        | AEC Q100 Rev.H | PASS   |
| Low Temperature Storage Life    | T <sub>A</sub> =-40°C, 1000hours                                                        | JESD22-A119    | PASS   |
| Pre-Condition                   | Temperature cycling 5 cycles, Bake 24hrs,<br>Moisture sock 168hrs, Reflow 3 cycles      | JESD22-A113    | PASS   |
| Temperature Humidity Bias       | T <sub>A</sub> =125°C, R.H.=85%, V <sub>CC</sub> =3.6V, 1000hours                       | AEC Q100 Rev.H | PASS   |
| Thermal Cycling                 | T <sub>A</sub> =-55°C to 150 °C, 1000cycles                                             | AEC Q100 Rev.H | PASS   |
| Humidity & Temperature Cycle    | +65°C/90%RH +45°C/95%RH -10°C , 5cycles                                                 | AEC Q103-003   | PASS   |
| Reflow                          | Peak temperature = 260°C, 5cycles                                                       | J-STD-020      | PASS   |
| Variable Frequency Vibration    | Peak acceleration 20G, frequency = 20Hz to<br>2KHz, total 48min duration                | AEC Q103-003   | PASS   |
| Mechanical Shock                | Peak acceleration 10KG, 0.2ms pulse duration, 3<br>pulses/direction, 6 directions       | JESD22-B104    | PASS   |
| Package Drop                    | 10 drops on each of 6 faces (total 60 drops) from<br>a high of 1.2m to concrete surface | AEC Q100 Rev.H | PASS   |
| ESD                             | HBM : All pins, Test Voltage=±3KV                                                       | JESD22-A114    | PASS   |
|                                 | MM : All pins, Test Voltage=±300V                                                       | JESD22-A115    | PASS   |
|                                 | CDM : All pins, Test Voltage=±500V                                                      | JEDEC JS-002   | PASS   |
|                                 | Air Discharge : Test Voltage=±15KV                                                      | IEC 61000-4-2  | PASS   |
|                                 | Contact Discharge : Test Voltage=±8KV                                                   | IEC 61000-4-2  | PASS   |
| Latch-up                        | Class II, T <sub>A</sub> =105°C, I=±150mA                                               | AEC Q100 Rev.H | PASS   |

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

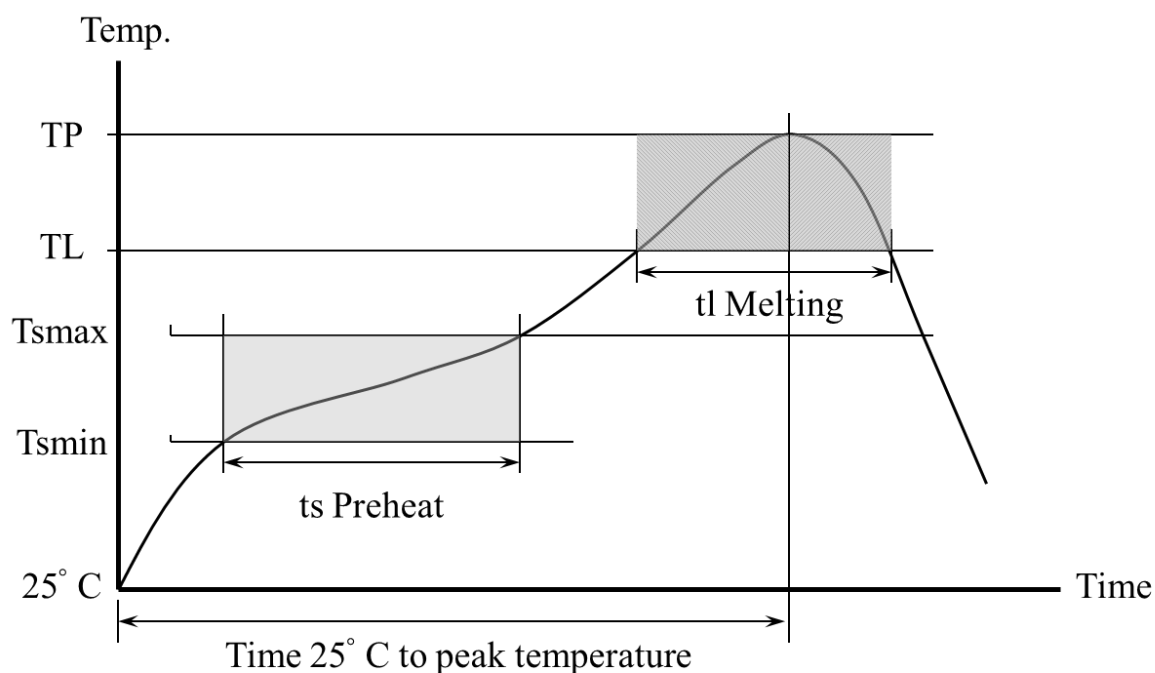


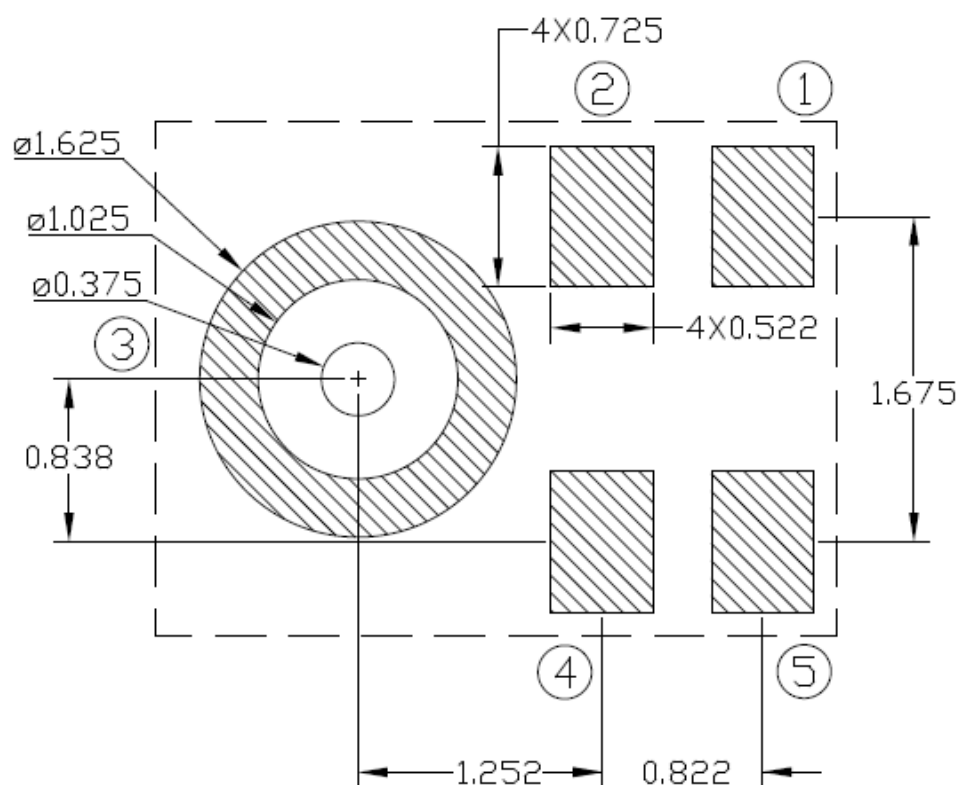
Table 9. Recommended Reflow Profile Limits

| Profile Feature                            | Pb-free          |
|--------------------------------------------|------------------|
| Preheat                                    |                  |
| Minimum temperature (Tsmin)                | 150 °C           |
| Maximum temperature (Tsmax)                | 200 °C           |
| Time (ts)                                  | 60~180 sec       |
| Average Ramp up rate (Tsmax to Tp)         | 3 °C/sec         |
| Melting area                               |                  |
| Melting temperature (TL)                   | 217 °C           |
| Time maintained above melting (tl)         | 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°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.

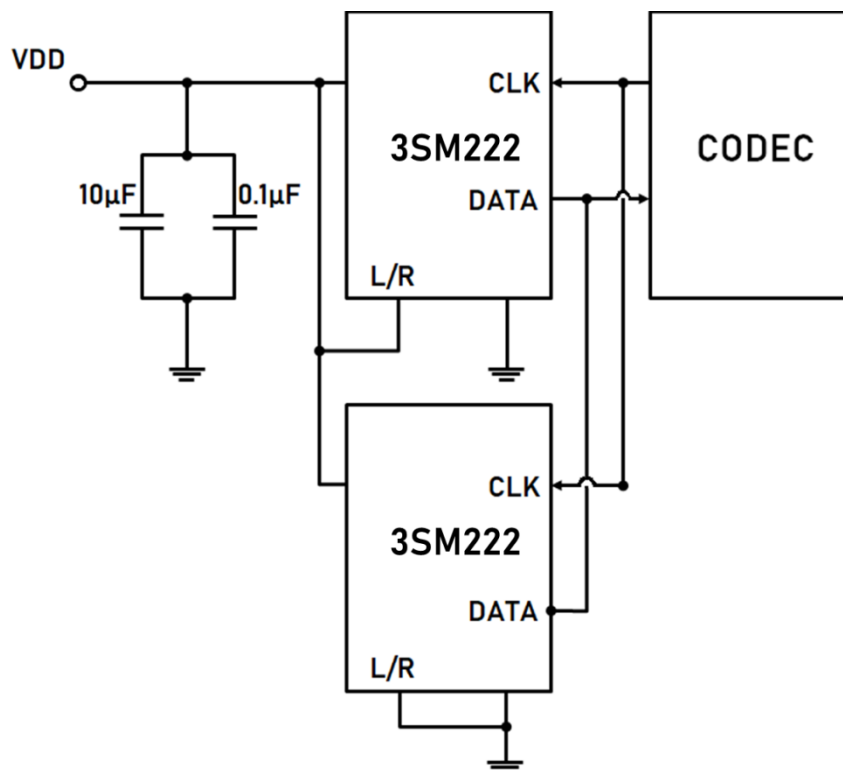
*Table 10. L/R channel selection*

| 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:

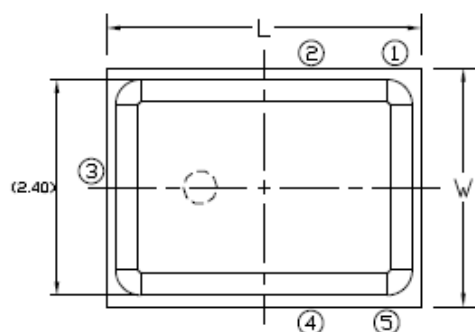


## Handling Instructions

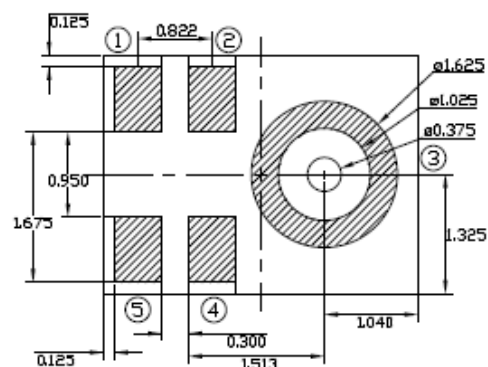
The MEMS microphone IC can be handled using standard pick-and-place and chip shooting equipment. Care should be taken to avoid damage to the MEMS microphone IC structure as follows:

- 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.

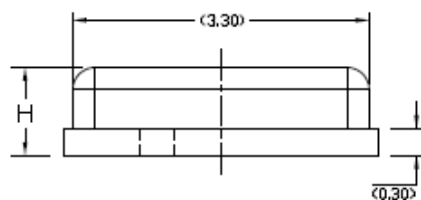
## Dimensions



Top View



Bottom View



Side View

Unit: mm

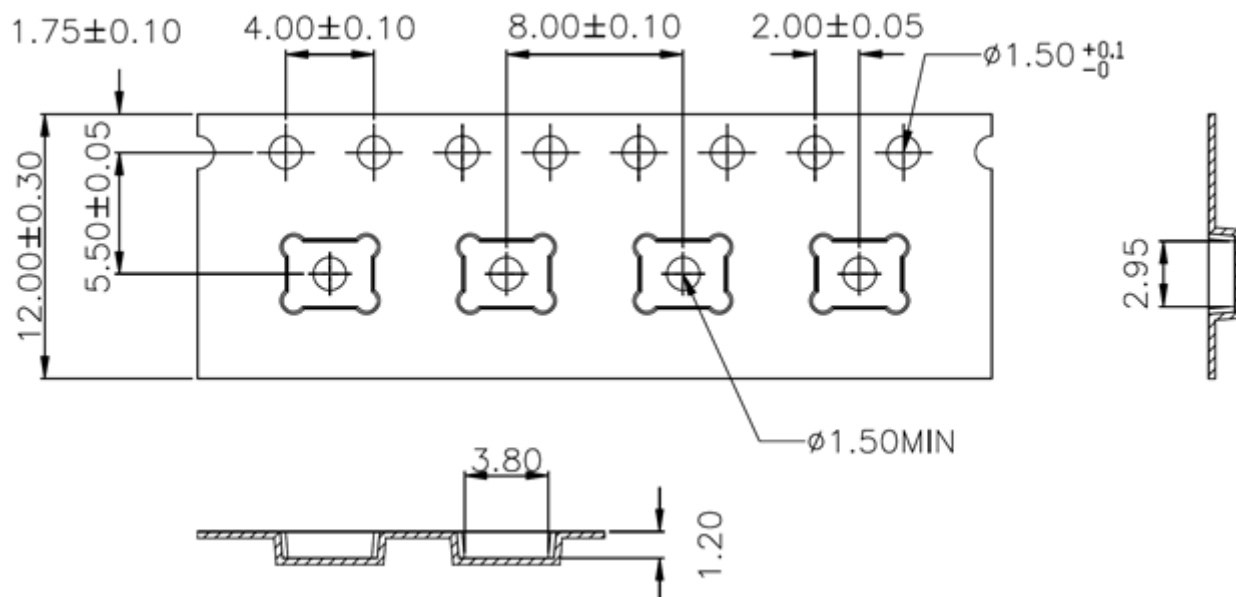
Dimension tolerance is  $\pm 0.15$  mm unless otherwise specified

Table 11. (Top View)

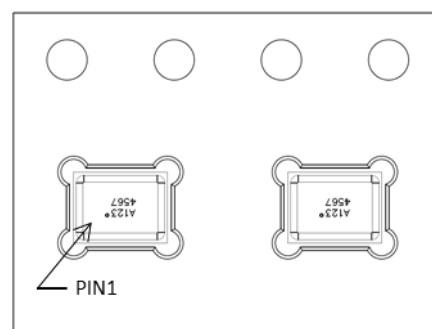
| Item          | Dimension       | Tolerance     |
|---------------|-----------------|---------------|
| Length (L)    | 3.50 mm         | $\pm 0.10$ mm |
| Width (W)     | 2.65 mm         | $\pm 0.10$ mm |
| Height (H)    | 0.98 mm         | $\pm 0.10$ mm |
| Acoustic Port | $\Phi 0.375$ mm | $\pm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

## Package Information

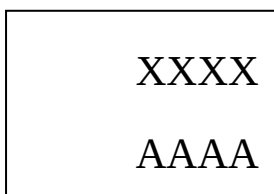
Carrier Tape:



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) 1.
7. Materials comply with ANSI/ESD S20.20 and IEC61340-5-1 standard.



Laser Marking:

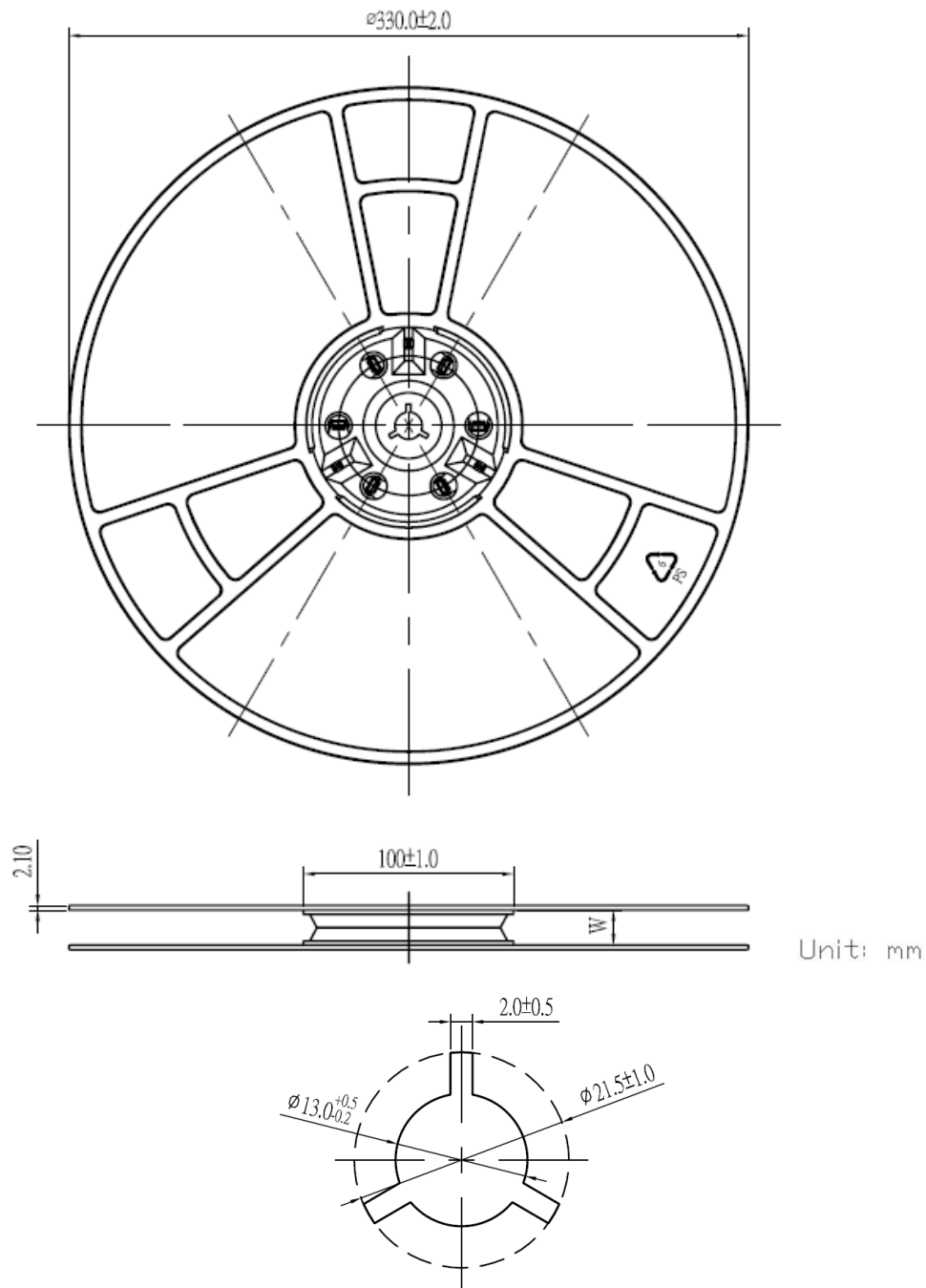


Laser marking on the top side

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



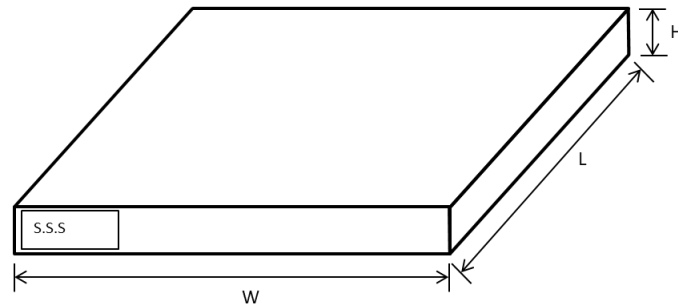
**13" Tape Reel :**



| Model Number | Reel Diameter | Quantity Per Reel |
|--------------|---------------|-------------------|
| 3SM227MMB1HA | 13"           | 5,000             |



**Dimensions for Inner Box :**

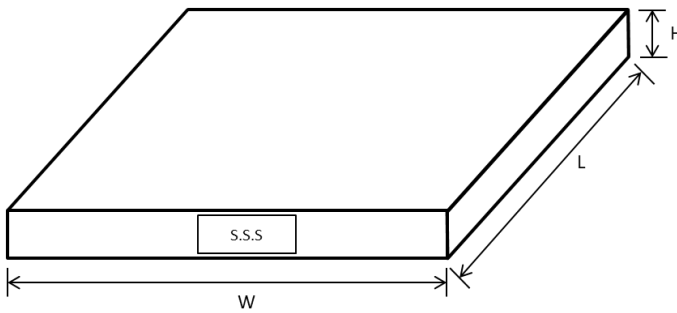


**Unit : mm**

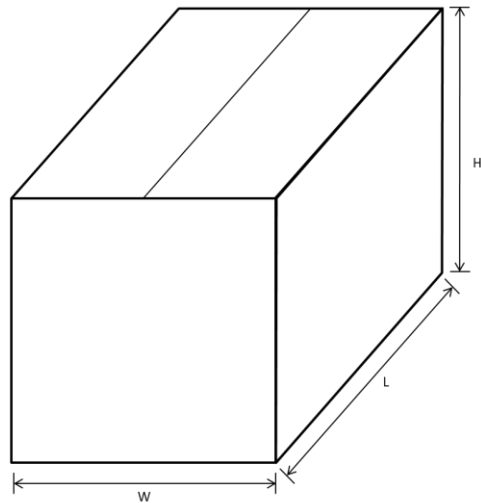
| L   | W   | H  |
|-----|-----|----|
| 355 | 375 | 40 |

**Dimensions for Outer Box:**

**Outer Box for Quantity 5K-10K**



**Outer Box for Quantity 15K-30K, 35K-50K**



**Unit : mm**

| Quantity  | L   | W   | H   |
|-----------|-----|-----|-----|
| 5K – 10K  | 400 | 410 | 100 |
| 15K – 30K | 380 | 280 | 380 |
| 35K – 50K | 420 | 380 | 380 |

**Revision History**

| <b>Revision</b> | <b>Date</b> | <b>Description</b>                                 |
|-----------------|-------------|----------------------------------------------------|
| 1.0             | 2025/07/18  | Formal release                                     |
| 1.1             | 2025/08/29  | Modify “Frequency Response”                        |
| 1.2             | 2025/11/25  | Modify “Acoustical and Electrical Characteristics” |