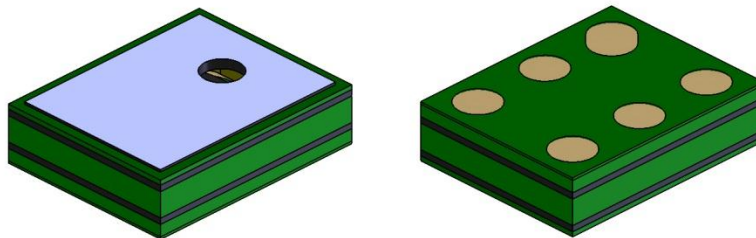


## Digital SiSonic™ Microphone



The SPM0423HD4H-WB is a miniature, high-performance, low power, top port silicon digital microphone with a single bit PDM output. Using Knowles' proven high performance SiSonic™ MEMS technology, the SPM0423HD4H-WB consists of an acoustic sensor, a low noise input buffer, and a sigma-delta modulator. These devices are suitable for applications such as cellphones, smart phones, laptop computers, sensors, digital still cameras, portable music recorders, and other portable electronic devices where excellent wideband audio performance and RF immunity are required.

### Features:

- PDM Output
- Supports Dual Multiplexed Channels
- Ultra-Stable Performance
- Standard SMD Reflow
- Omnidirectional

# SPM0423HD4H-WB

## 1. ABSOLUTE MAXIMUM RATINGS

| Parameter                          | Absolute Maximum Rating                 | Units |
|------------------------------------|---|-------|
| V <sub>DD</sub> , DATA to Ground   | -0.3, +5.0                              | V     |
| CLOCK to Ground                    | -0.3, +5.0                              | V     |
| SELECT to Ground                   | -0.3, +5.0                              | V     |
| Input Current                      | ±5                                      | mA    |
| Short Circuit Current to/from DATA | Indefinite to Ground or V <sub>DD</sub> | sec   |
| Temperature Range                  | -40 to +100                             | °C    |

Stresses exceeding these “Absolute Maximum Ratings” may cause permanent damage to the device. These are stress ratings only. Functional operation at these or any other conditions beyond those indicated under “Acoustic & Electrical Specifications” is not implied. Exposure beyond those indicated under “Acoustic & Electrical Specifications” for extended periods may affect device reliability.

## 2. ACOUSTIC & ELECTRICAL SPECIFICATIONS

TEST CONDITIONS: 23 ±2°C, 55±20% R.H., V<sub>DD</sub>=1.8 V, F<sub>CLOCK</sub>=2.4 MHz, SELECT pin grounded, no load, unless otherwise indicated

| Parameter                       | Symbol             | Conditions                    | Min                       | Typ | Max                  | Units  |
|---------------------------------|--------------------|-------------------------------|---------------------------|-----|----------------------|--------|
| Supply Voltage <sup>1</sup>     | V <sub>DD</sub>    |                               | 1.6                       | -   | 3.6                  | V      |
| Supply Current <sup>1,2,3</sup> | I <sub>DD</sub>    |                               | -                         | 500 | 600                  | μA     |
| Sleep Current <sup>3</sup>      | I <sub>SLEEP</sub> | F <sub>CLOCK</sub> < 1 kHz    | -                         | 25  | 50                   | μA     |
| Sensitivity <sup>1</sup>        | S                  | 94 dB SPL @ 1 kHz             | -29                       | -26 | -23                  | dBFS   |
| Signal to Noise Ratio           | SNR                | 94 dB SPL @ 1 kHz, A-weighted | -                         | 56  | -                    | dB(A)  |
| Total Harmonic Distortion       | THD                | 94 dB SPL @ 1 kHz, S = Typ    | -                         | -   | 1                    | %      |
| Acoustic Overload Point         | AOP                | 10% THD @ 1 kHz, S = Typ      | 115                       | -   | -                    | dB SPL |
| DC Output                       |                    | Fullscale = ±100              | -                         | 4   | -                    | % FS   |
| Directivity                     |                    |                               | Omnidirectional           |     |                      |        |
| Polarity                        |                    | Increasing sound pressure     | Decreasing density of 1's |     |                      |        |
| Data Format                     |                    |                               | ½ Cycle PDM               |     |                      |        |
| Logic Input High                | V <sub>IH</sub>    |                               | 0.65xV <sub>DD</sub>      | -   | 3.6                  | V      |
| Logic Input Low                 | V <sub>IL</sub>    |                               | -0.3                      | -   | 0.35xV <sub>DD</sub> | V      |
| Logic Output High               | V <sub>OH</sub>    | I <sub>OUT</sub> = 1 mA       | 0.65xV <sub>DD</sub>      | -   | V <sub>DD</sub>      | V      |
| Logic Output Low                | V <sub>OL</sub>    | I <sub>OUT</sub> = 1 mA       | 0                         | -   | 0.35xV <sub>DD</sub> | V      |



# SPM0423HD4H-WB

| Parameter                       | Symbol      | Conditions                      | Min            | Typ | Max  | Units |
|---------------------------------|-------------|---------------------------------|----------------|-----|------|-------|
| SELECT (high)                   |             |                                 | $V_{DD} - 0.2$ | -   | 3.6  | V     |
| SELECT (low)                    |             |                                 | -0.3           | -   | 0.2  | V     |
| Short Circuit Current           | $I_{SC}$    | Grounded DATA pin               | -              | 1   | 10   | mA    |
| Output Load                     | $C_{LOAD}$  |                                 | -              | -   | 100  | pF    |
| Clock Frequency                 | $F_{CLOCK}$ |                                 | 1.0            | -   | 3.25 | MHz   |
| Clock Duty Cycle                |             |                                 | 40             | -   | 60   | %     |
| Clock Rise/Fall Time            | $t_{EDGE}$  |                                 | -              | -   | 10   | ns    |
| Fall-asleep Time <sup>4,5</sup> |             | $F_{CLOCK} < 1 \text{ kHz}$     | -              | -   | 10   | ms    |
| Wake-up Time <sup>4,6</sup>     |             | $F_{CLOCK} \geq 1 \text{ MHz}$  | -              | -   | 10   | ms    |
| Delay Time for Valid Data       | $t_{DV}$    | No load for min $t_{DV}$        | 18             | -   | 60   | ns    |
|                                 |             | Max $C_{LOAD}$ for max $t_{DV}$ |                |     |      |       |
| Delay Time for High Z           | $t_{DZ}$    |                                 | 0              | -   | 16   | ns    |

<sup>1</sup> 100% tested.

<sup>2</sup>  $I_{DD}$  varies with  $C_{LOAD}$  according to:  $\Delta I_{DD} = 0.5 * V_{DD} * \Delta C_{LOAD} * F_{CLOCK}$ .

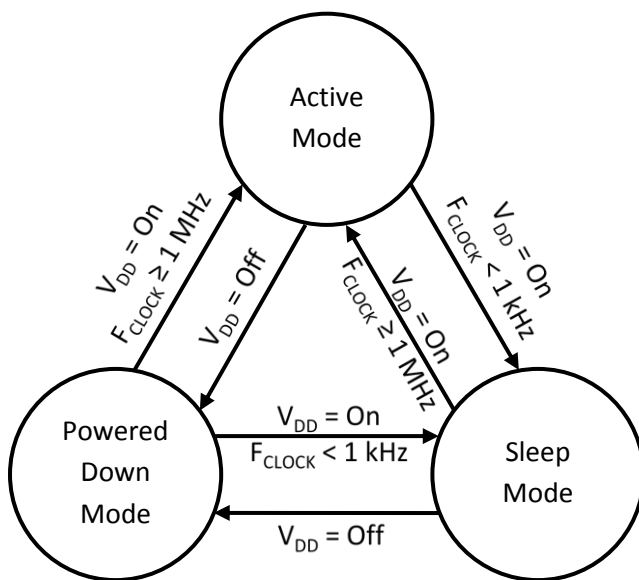
<sup>3</sup> Maximum specifications are measured at maximum  $V_{DD}$ . Typical specifications are measured at standard test conditions.

<sup>4</sup> Valid microphones states are: Powered Down Mode (mic off), Sleep Mode (low current, DATA = high-Z, fast startup), and Active Mode (normal operation).

<sup>5</sup> Time from  $F_{CLOCK} < 1 \text{ kHz}$  to  $I_{SLEEP}$  specification is met when transitioning from Active Mode to Sleep Mode.

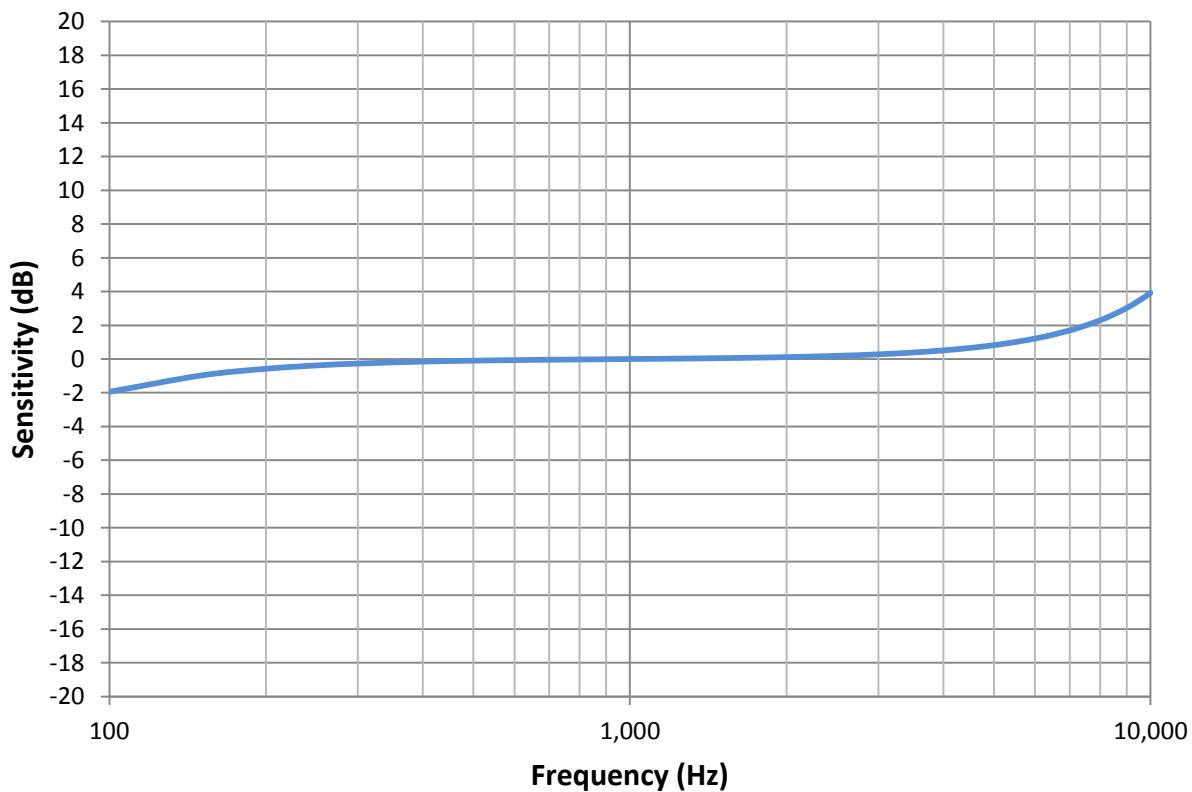
<sup>6</sup> Time from  $F_{CLOCK} \geq 1 \text{ MHz}$  to all applicable specifications are met when transitioning from Sleep Mode to Active Mode.

### 3. MICROPHONE STATE DIAGRAM

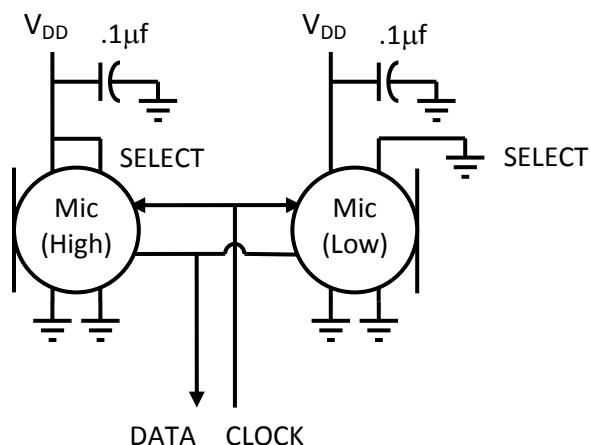


## 4. FREQUENCY RESPONSE CURVE

Typical Free Field Response  
Normalized to 1 kHz



## 5. INTERFACE CIRCUIT



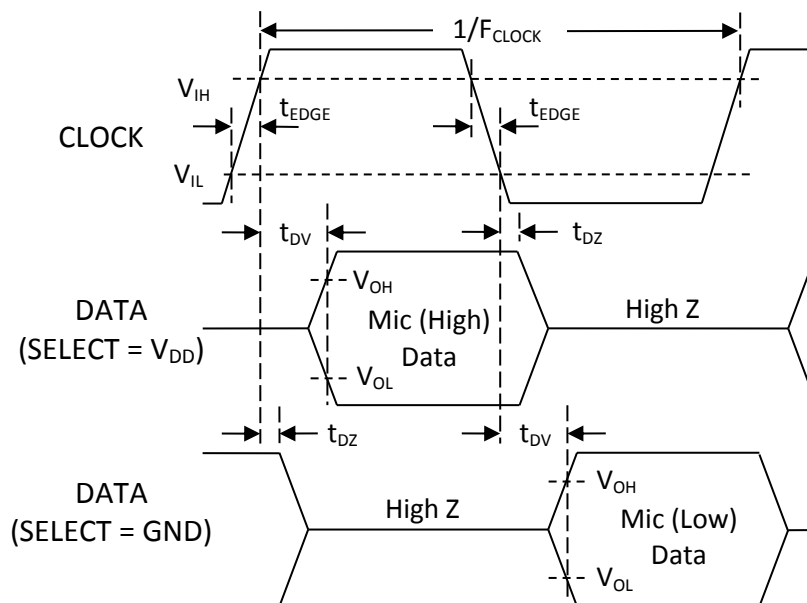
| Microphone | SELECT   | Asserts DATA On    | Latch DATA On      |
|------------|----------|--------------------|--------------------|
| Mic (High) | $V_{DD}$ | Rising Clock Edge  | Falling Clock Edge |
| Mic (Low)  | GND      | Falling Clock Edge | Rising Clock Edge  |

Note: All Ground pins must be connected to ground.

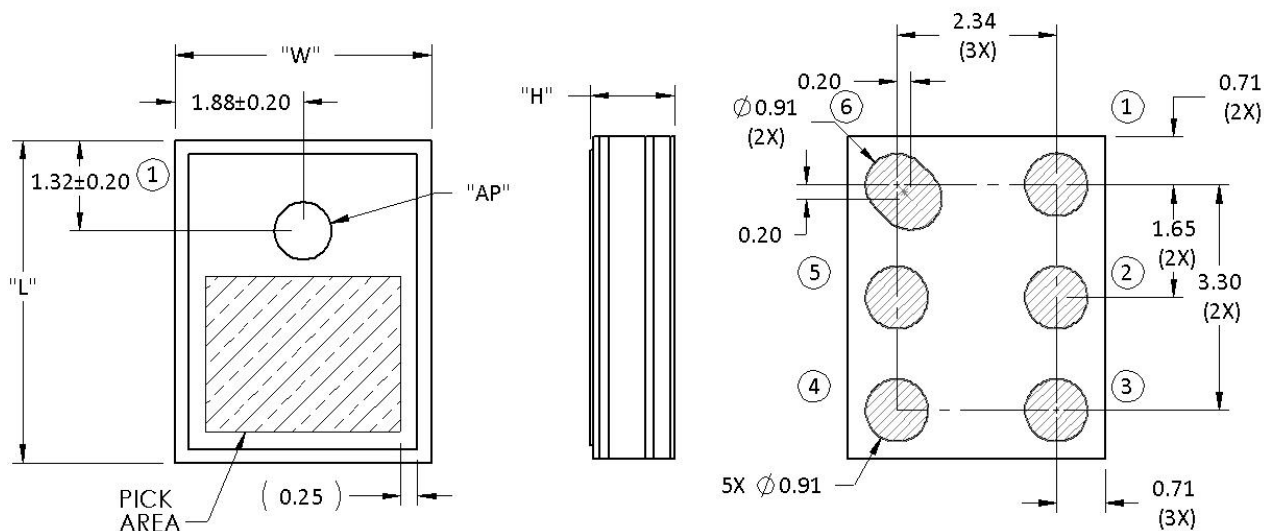
Capacitors near the microphone should not contain Class 2 dielectrics.

Detailed information on acoustic, mechanical, and system integration can be found in the latest *SiSonic™ Design Guide* application note.

## 6. TIMING DIAGRAM



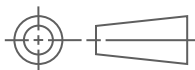
## 7. MECHANICAL SPECIFICATIONS



| Item               | Dimension | Tolerance | Units |
|--------------------|-----------|-----------|-------|
| Length (L)         | 4.72      | ±0.10     | mm    |
| Width (W)          | 3.76      | ±0.10     | mm    |
| Height (H)         | 1.25      | ±0.10     | mm    |
| Acoustic Port (AP) | ∅0.84     | ±0.08     | mm    |

| Pin # | Pin Name        | Type              | Description  |
|-------|-----------------|-------------------|--|
| 1     | GROUND          | Power             | Ground   |
| 2     | SELECT          | Non-Digital Input | Lo/Hi (L/R) Select<br>This pin is internally pulled low. |
| 3     | GROUND          | Power             | Ground   |
| 4     | CLOCK           | Digital I         | Clock Input  |
| 5     | DATA            | Digital O         | PDM Output   |
| 6     | V <sub>DD</sub> | Power             | Power Supply   |

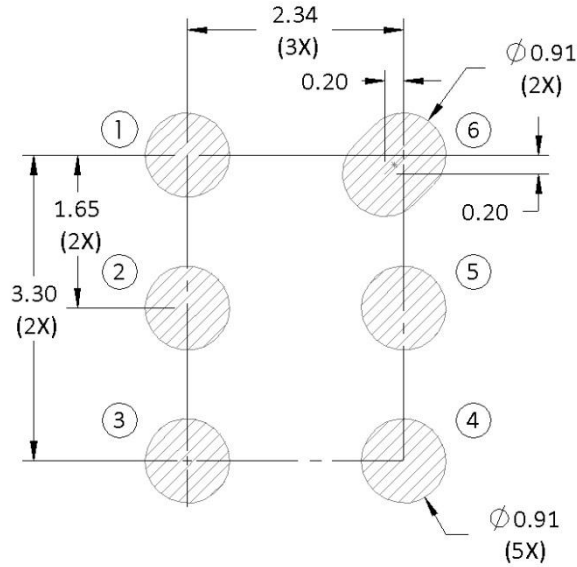
Notes: Pick Area only extends to 0.25 mm of any edge or hole unless otherwise specified.



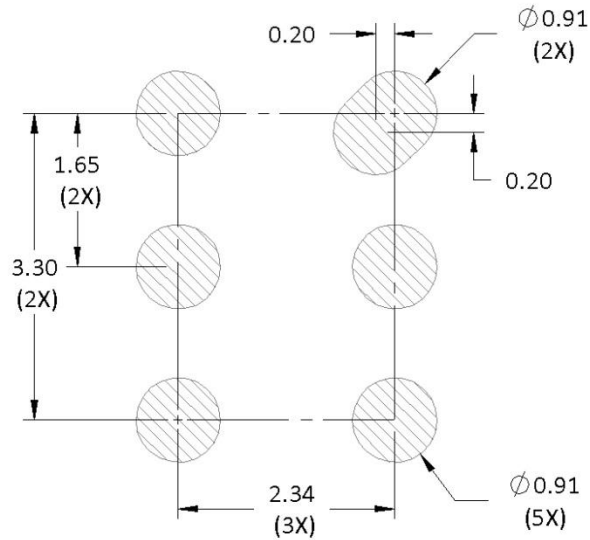
Dimensions are in millimeters unless otherwise specified.

Tolerance is ±0.15mm unless otherwise specified

## 8. EXAMPLE LAND PATTERN



## 9. EXAMPLE SOLDER STENCIL PATTERN



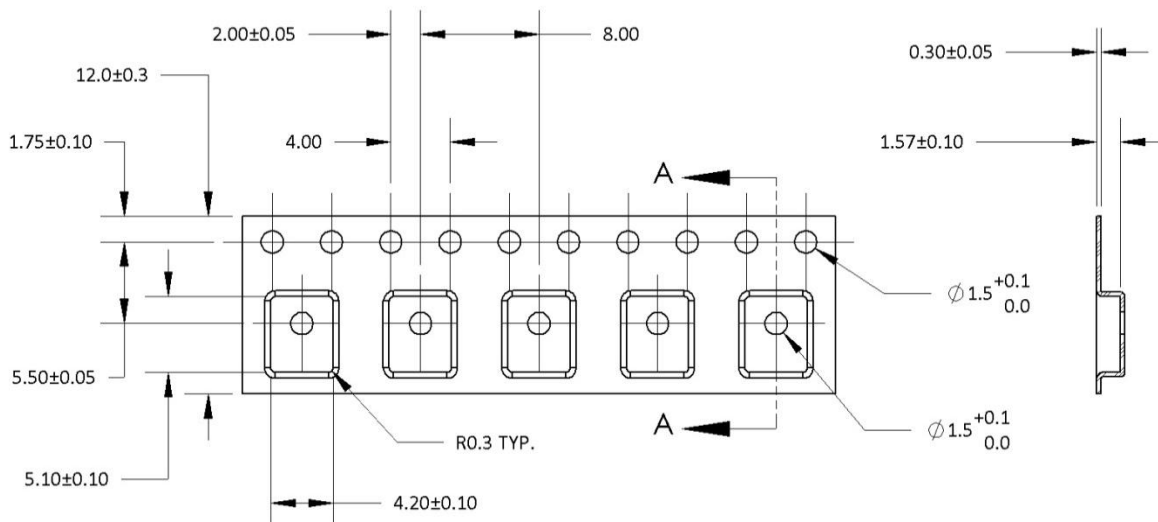
Notes: Dimensions are in millimeters unless otherwise specified.

Further optimizations based on application should be performed.



# SPM0423HD4H-WB

## 10. PACKAGING & MARKETING DETAIL



| Model Number   | Suffix | Reel Diameter | Quantity Per Reel |
|----------------|--------|---------------|-------------------|
| SPM0423HD4H-WB | -6     | 13"           | 4,800             |

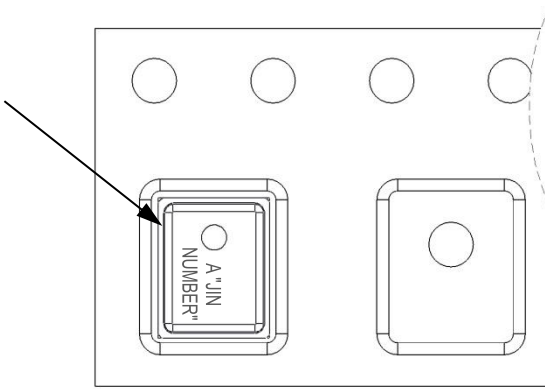
Alpha Character A:

- "S": Knowles SiSonic™ Production
- "E": Knowles Engineering Samples
- "P": Knowles Prototype Samples

"JIN NUMBER":

Unique Job Identification Number for product traceability

Pin 1



Notes: Dimensions are in millimeters unless otherwise specified.

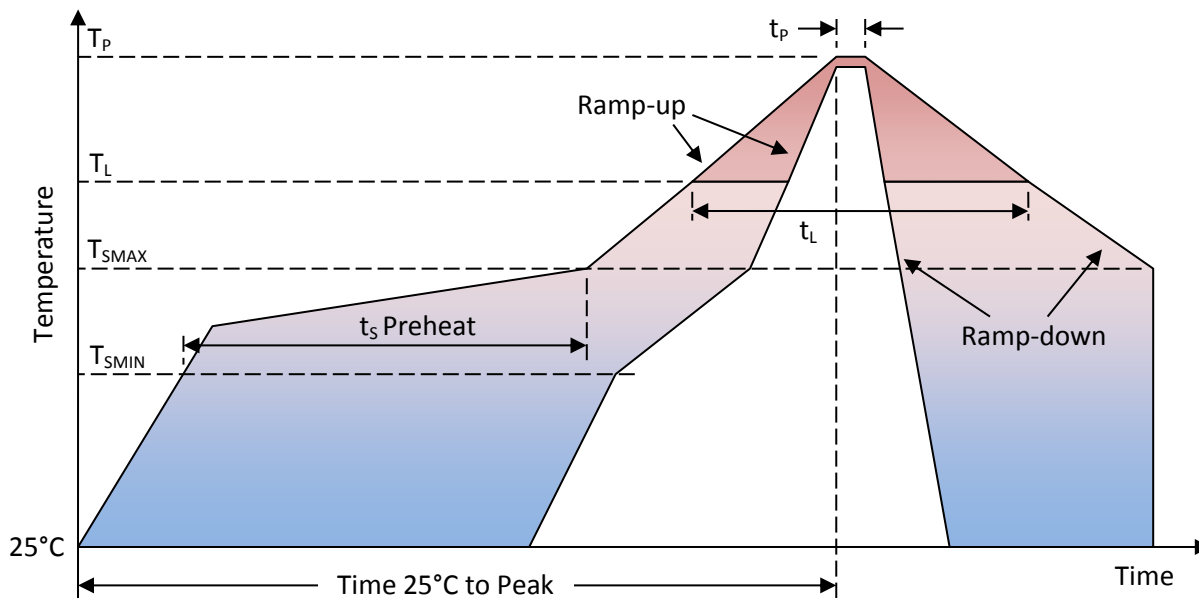
Vacuum pickup only in the pick area indicated in Mechanical Specifications.

Tape & reel per EIA-481.

Labels applied directly to reel and external package.

Shelf life: Twelve (12) months when devices are to be stored in factory supplied, unopened ESD moisture sensitive bag under maximum environmental conditions of 30°C, 70% R.H.

## 11. RECOMMENDED REFLOW PROFILE



| Profile Feature  | Pb-Free                          |
|--|----------------------------------|
| Average Ramp-up rate ( $T_{S_{MAX}}$ to $T_P$ )  | 3°C/second max.                  |
| Preheat <ul style="list-style-type: none"> <li>• Temperature Min (<math>T_{S_{MIN}}</math>)</li> <li>• Temperature Max (<math>T_{S_{MAX}}</math>)</li> <li>• Time (<math>T_{S_{MIN}}</math> to <math>T_{S_{MAX}}</math>) (<math>t_s</math>)</li> </ul> | 150°C<br>200°C<br>60-180 seconds |
| Time maintained above: <ul style="list-style-type: none"> <li>• Temperature (<math>T_L</math>)</li> <li>• Time (<math>t_L</math>)</li> </ul>   | 217°C<br>60-150 seconds          |
| Peak Temperature ( $T_P$ )   | 260°C                            |
| Time within 5°C of actual Peak Temperature ( $t_p$ )   | 20-40 seconds                    |
| Ramp-down rate ( $T_P$ to $T_{S_{MAX}}$ )  | 6°C/second max                   |
| Time 25°C to Peak Temperature  | 8 minutes max                    |

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

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



## 12. ADDITIONAL NOTES

(A) MSL (moisture sensitivity level) Class 1.

(B) Maximum of 3 reflow cycles is recommended.

(C) In order to minimize device damage:

- Do not board wash or clean after the reflow process.
- Do not brush board with or without solvents after the reflow process.
- Do not directly expose to ultrasonic processing, welding, or cleaning.
- Do not insert any object in port hole of device at any time.
- Do not apply over 30 psi of air pressure into the port hole.
- Do not pull a vacuum over port hole of the microphone.
- Do not apply a vacuum when repacking into sealed bags at a rate faster than 0.5 atm/sec.

## 13. MATERIALS STATEMENT

Meets the requirements of the European RoHS directive, 2011/65/EC as amended.

Meets the requirements of the industry-standard IEC 61249-2-21:2003 for halogenated substances and Knowles Green Materials Standards Policy section on Halogen-Free.

Ozone depleting substances are not used in the product or the processes used to make the product including compounds listed in annex A, B, and C of the “Montreal Protocol on Substances that deplete the ozone Layer.”

## 14. RELIABILITY SPECIFICATIONS

| Test                        | Description   |
|-----------------------------|---|
| Thermal Shock               | 100 cycles air-to-air thermal shock from -40°C to +125°C with 15 minute soaks. (IEC 68-2-4)   |
| High Temperature Storage    | 1,000 hours at +105°C environment (IEC 68-2-2 Test Ba)  |
| Low Temperature Storage     | 1,000 hours at -40°C environment (IEC 68-2-2 Test Aa)   |
| High Temperature Bias       | 1,000 hours at +105°C under bias (IEC 68-2-2 Test Ba)   |
| Low Temperature Bias        | 1,000 hours at -40°C under bias (IEC 68-2-2 Test Aa)  |
| Temperature / Humidity Bias | 1,000 hours at +85°C/85% R.H. under bias. (JESD22-A101A-B)  |
| Vibration                   | 4 cycles of 20 to 2,000 Hz sinusoidal sweep with 20 G peak acceleration lasting 12 minutes in X, Y, and Z directions. (Mil-Std-883E, method 2007.2 A) |
| ESD-HBM                     | 3 discharges of ±2 kV direct contact to I/O pins. (ESD STM5.2)  |
| ESD-LID/GND                 | 3 discharges of ±8 kV direct contact to lid while unit is grounded. (IEC 61000-4-2)   |
| ESD-MM                      | 3 discharges of ±2 kV direct contact to I/O pins. (MIL 883E, Method 3015.7)   |
| Reflow                      | 5 reflow cycles with peak temperature of +260°C   |
| Mechanical Shock            | 3 pulses of 10,000 G in the X, Y, and Z direction (IEC 68-2-27, Test Ea)  |

Note: After reliability tests are performed, the sensitivity of the microphones shall not deviate more than 3 dB from its initial value.



# SPM0423HD4H-WB

## 15. SPECIFICATIONS REVISIONS

| Revision | Specification Changes  | Date     |
|----------|--|----------|
| A        | Initial Release (C10111410)  | 6/30/10  |
| B        | Typographical error and format changes.  | 10/20/10 |
| C        | New RoHS statement (C10114438); updated humidity conditions and ESD descriptions (C10114466); released in new format (C10114628) | 2/28/13  |
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