

## Low Noise Digital Zero-Height SiSonic™ Microphone



The SPA9735LR5H-C is a miniature, high-performance, low power, bottom port silicon digital microphone with a single bit PDM output. Using Knowles' proven high performance SiSonic™ MEMS technology, the SPA9735LR5H-C 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:

- Very Low Noise
- High Drive Capability
- Low Current
- Flat Frequency Response
- RF Shielded
- Zero-Height Mic™
- PDM Output
- Supports Dual Multiplexed Channels
- Ultra-Stable Performance
- Standard SMD Reflow
- Omnidirectional

## 1. ABSOLUTE MAXIMUM RATINGS

Parameter	Absolute Maximum Rating	Units
$V_{DD}$ , 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	$\pm 5$	mA
Short Circuit Current to/from DATA	Indefinite to Ground or $V_{DD}$	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  $\pm$  2°C, 55 $\pm$ 20% R.H.,  $V_{DD}$ =1.8 V,  $F_{CLOCK}$ =2.4 MHz, SELECT pin grounded, no load, unless otherwise indicated

Parameter	Symbol	Conditions	Min	Typ	Max	Units
Supply Voltage	$V_{DD}$		1.6	-	3.6	V
Supply Current	$I_{DD}$		-	800		$\mu$ A
Sleep Current	$I_{SLEEP}$	$F_{CLOCK} < 1$ kHz	-	4	7	$\mu$ A
Sensitivity	S	94 dB SPL @ 1 kHz	-29	-26	-23	dBFS
Signal to Noise Ratio	SNR	94 dB SPL @ 1 kHz, A-weighted		65	-	dB(A)
Phase Match		94 dB SPL @ 1 kHz	-	$\pm 2$	-	°
Total Harmonic Distortion	THD	94 dB SPL @ 1 kHz, S = Typ	-	0.5		%
Acoustic Overload Point	AOP	5% THD @ 1 kHz, S = Typ		115	-	dB SPL
Power Supply Rejection	PSR	100 mVpp square wave @ 217 Hz, A-weighted	-	-	-70	dBFS (A)
DC Output		Fullscale = $\pm 100$	-	3	-	% FS
Directivity			Omnidirectional			
Polarity		Increasing sound pressure	Increasing density of 1's			
Data Format			$\frac{1}{2}$ Cycle PDM			
Logic Input High	$V_{IH}$		$0.65 \times V_{DD}$	-	3.6	V

# SPK9735LM4H-C

Parameter	Symbol	Conditions	Min	Typ	Max	Units
Logic Input Low	$V_{IL}$		-0.3	-	$0.35 \times V_{DD}$	V
Clock Threshold			$0.35 \times V_{DD}$	-	$0.65 \times V_{DD}$	V
Hysteresis Width			No Hysteresis			V
Logic Output High	$V_{OH}$	$I_{OUT} = 2 \text{ mA}$	$0.7 \times V_{DD}$	-	$V_{DD}$	V
Logic Output Low	$V_{OL}$	$I_{OUT} = 2 \text{ mA}$	0	-	$0.3 \times V_{DD}$	V
SELECT (high)			$V_{DD} - 0.2$	-	3.6	V
SELECT (low)			-0.3	-	0.2	V
Short Circuit Current	$I_{SC}$	Grounded DATA pin	2	-	10	mA
Output Load	$C_{LOAD}$		-	-	160	pF
Clock Frequency	$F_{CLOCK}$		1.0	-	3.25	MHz
Clock Duty Cycle			40	-	60	%
Clock Rise/Fall Time	$t_{EDGE}$		-	-	20	ns
Fall-asleep Time <sup>4,5</sup>		$F_{CLOCK} < 1 \text{ kHz}$	-	-	10	ms
Wake-up Time <sup>4,6</sup>		$F_{CLOCK} \geq 1 \text{ MHz}$	-	-	20	ms
Data Time	$t_{SETUP} + t_{EDGE}$	160 pF $C_{LOAD}$	47			ns
Delay Time for Valid Data	$t_{DV}$	No load for min $t_{DV}$	18	-	115	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:  $\Delta I_{DD} = 0.5 \times V_{DD} \times \Delta C_{LOAD} \times F_{CLOCK}$ .

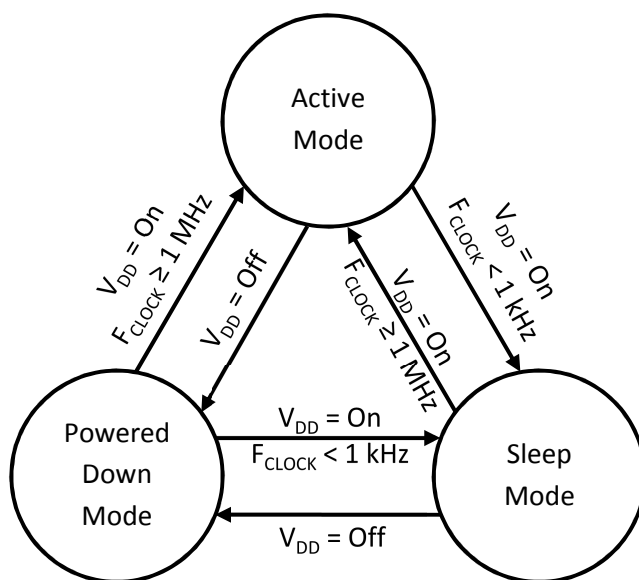
<sup>3</sup> Maximum specifications are measured at maximum  $V_{DD}$ . Typical specifications are measured at standard test conditions.

<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.

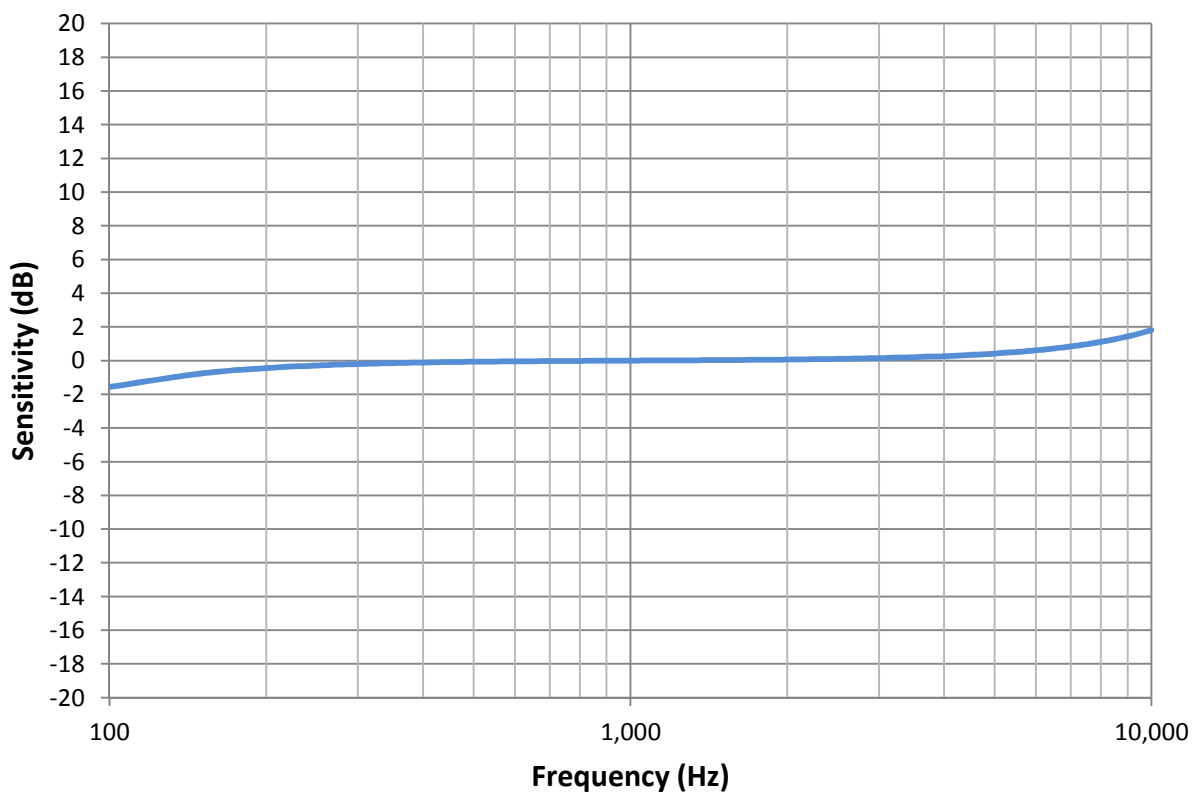
<sup>6</sup> Time from  $F_{CLOCK} \geq 1 \text{ MHz}$  to all applicable specifications are met when transitioning from Sleep Mode to Active Mode.

## 3. MICROPHONE STATE DIAGRAM



## 4. FREQUENCY RESPONSE CURVE

Typical Free Field Response  
Normalized to 1 kHz



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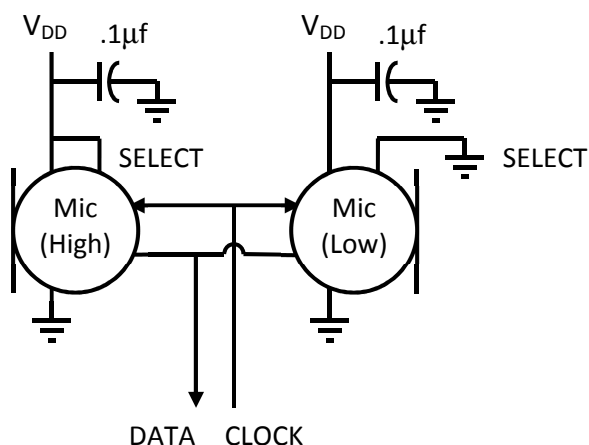
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## 5. INTERFACE CIRCUIT

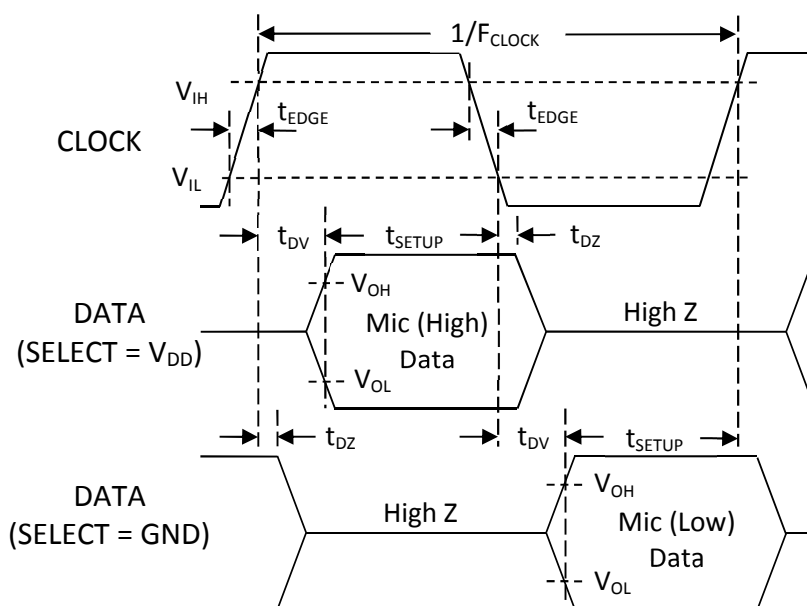


Microphone	SELECT	Asserts DATA On	Latch DATA On
Mic (High)	V <sub>DD</sub>	Rising Clock Edge	Falling Clock Edge
Mic (Low)	GND	Falling Clock Edge	Rising Clock Edge

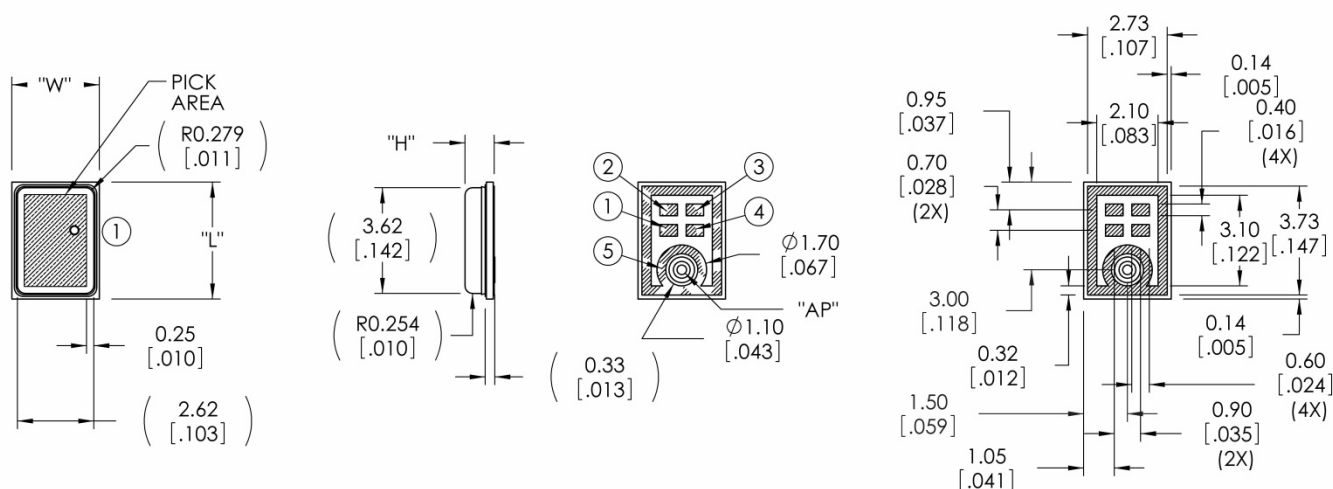
Note: Capacitors near the microphone should not contain Class 2 dielectrics.

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

## 6. TIMING DIAGRAM



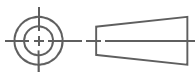
## 7. MECHANICAL SPECIFICATIONS



Item	Dimension	Tolerance
Length (L)	4.00	$\pm 0.10$
Width (W)	3.00	$\pm 0.10$
Height (H)	1.00	$\pm 0.10$
Acoustic Port (AP)	$\phi 0.325$	$\pm 0.05$

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

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

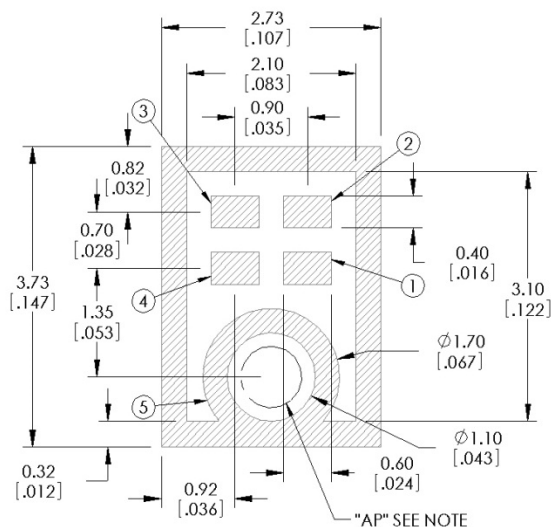


Dimensions are in millimeters unless otherwise specified.

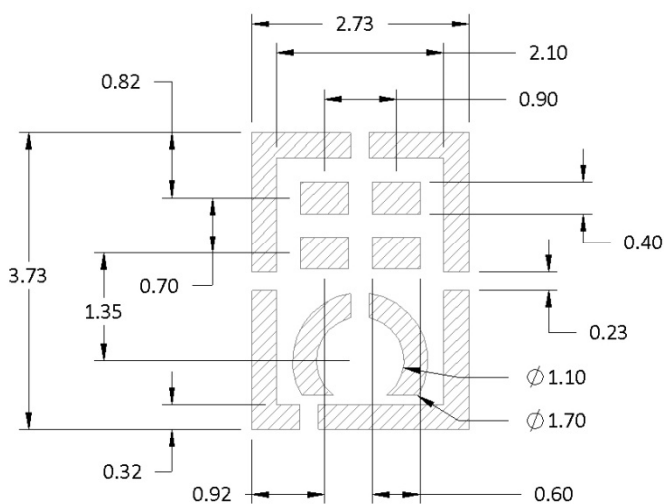
Tolerance is  $\pm 0.15$  mm unless otherwise specified



## 8. EXAMPLE LAND PATTERN



## 9. EXAMPLE SOLDER STENCIL PATTERN



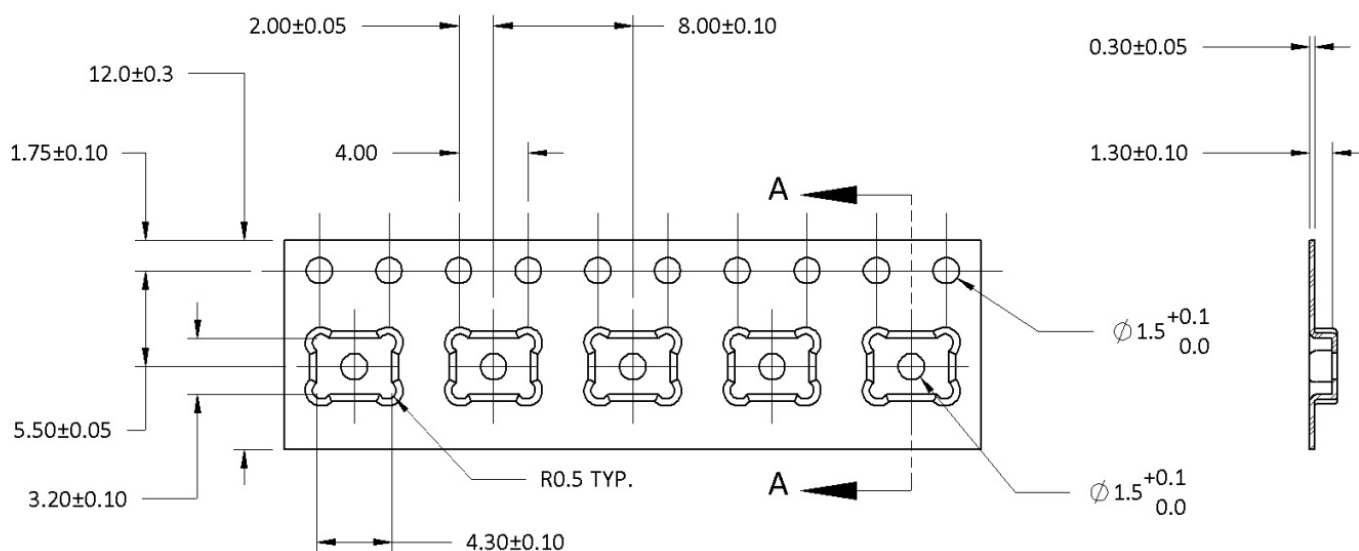
Notes: Dimensions are in millimeters unless otherwise specified.

Detailed information on AP size considerations can be found in the latest *SiSonic™ Design Guide* application note.

Further optimizations based on application should be performed.



## 10. PACKAGING & MARKING DETAIL



Model Number	Suffix	Reel Diameter	Quantity Per Reel
SPK9735LM4H-C	-7	13"	5,700

Alpha Character A:

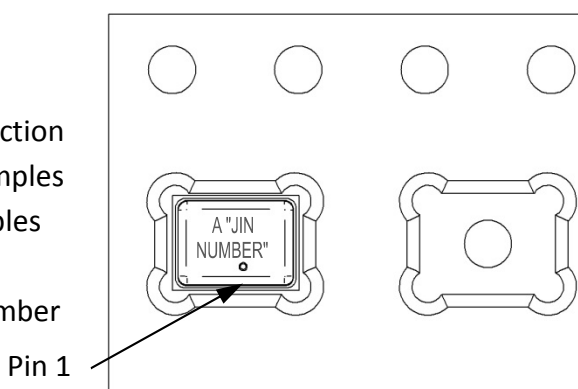
“S”: Knowles SiSonic™ Production

“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.

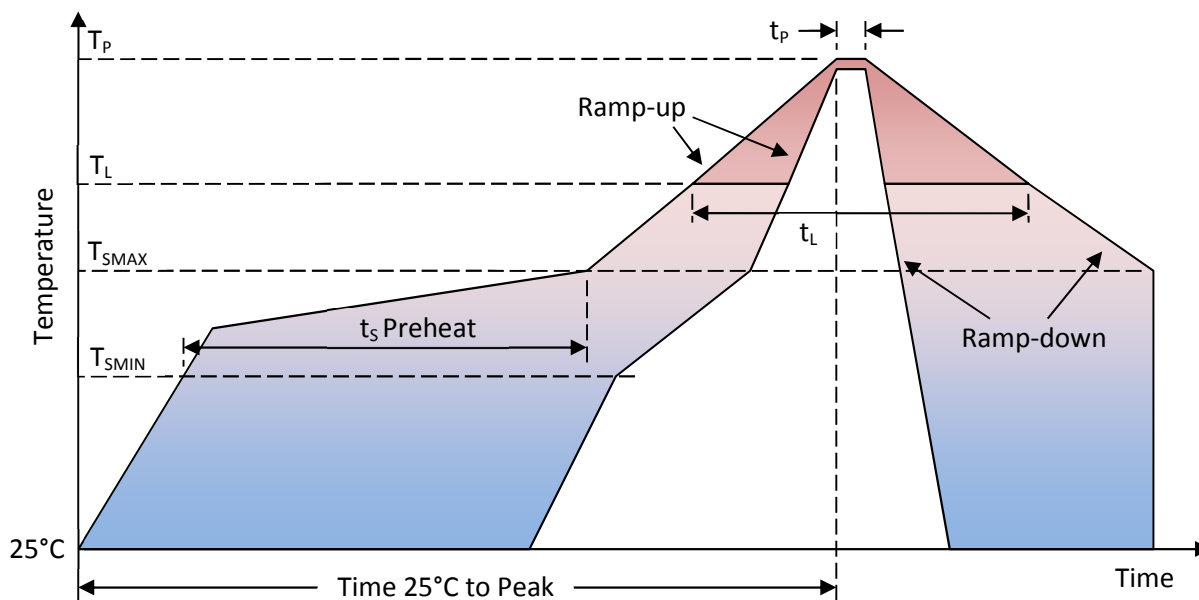
Vacuum pickup only in the pick area indicated in Mechanical Specifications.

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 <sub>SMAX</sub> to T <sub>P</sub> )	3°C/second max.
Preheat <ul style="list-style-type: none"> <li>Temperature Min (T<sub>SMIN</sub>)</li> <li>Temperature Max (T<sub>SMAX</sub>)</li> <li>Time (T<sub>SMIN</sub> to T<sub>SMAX</sub>) (t<sub>s</sub>)</li> </ul>	150°C 200°C 60-180 seconds
Time maintained above: <ul style="list-style-type: none"> <li>Temperature (T<sub>L</sub>)</li> <li>Time (t<sub>L</sub>)</li> </ul>	217°C 60-150 seconds
Peak Temperature (T <sub>P</sub> )	260°C
Time within 5°C of actual Peak Temperature (t <sub>p</sub> )	20-40 seconds
Ramp-down rate (T <sub>P</sub> to T <sub>SMAX</sub> )	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.”

## 1. RELIABILITY SPECIFICATIONS

**Note: Microphones must meet all acoustic and electrical specifications before and after reliability testing**

Test	Description
Thermal Shock	200 cycles of air-air thermal shock from -40°C to +125°C with 30 minute soaks (IEC 68-2-4)
High Temperature Storage	+105°C environment for 1,000 hours (IEC 68-2-2 Test Ba)
Low Temperature Storage	-40°C environment for 1,000 hours (IEC 68-2-2 Test Aa)
High Temperature Bias	+105°C environment while under bias for 1,000 hours (IEC 68-2-2 Test Ba)
Low Temperature Bias	-40°C environment while under bias for 1,000 hours (IEC 68-2-2 Test Aa)
Temperature/Humidity Bias	+85°C/85% R.H. environment while under bias for 1,000 hours (IEC 68-2-78 Test Cab)
Vibration	16 minutes in each axis from 20 to 2,000 Hz in X,Y, and Z directions with peak acceleration of 20g (MIL 883E, Method 2007.2,A)
Electrostatic Discharge	3 discharges at +/-8kV direct contact to lid when unit is grounded (IEC 61000-4-2) and 3 discharges at +/-2kV direct contact to I/O pins (MIL 883E, Method 3015.7) and 3 discharges at +/- 200V pin-to-pin (ESDA STM 5.2, ESD-MM)
Reflow	5 reflow cycles with peak temperature of +260°C
Mechanical Shock	5 pulses of 10,000g in each of the ±X, ±Y, ±Z directions while under bias (IEC 68-2-27 Test Ea)
Accelerated Life Test	96 hours of 130 dB SPL of simulated normal program material under bias (IEC 60268-1)

## 14. SPECIFICATION REVISIONS

Revision	Specification Changes	Date
A	Initial Release ECR 15-422	10/9/15

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