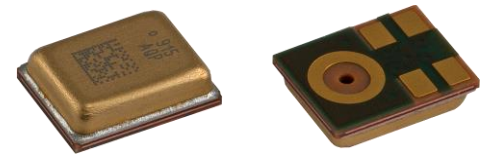
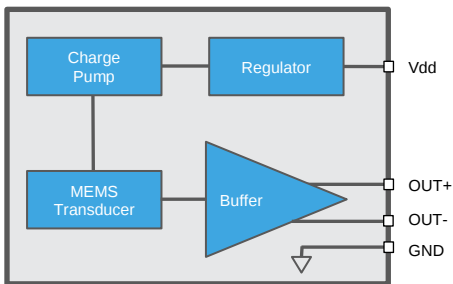


HIGH SNR, HIGH AOP ANALOG BOTTOM PORT SISONIC™ MICROPHONE



The SPH21C3LR5H-1 is a high Signal-to-Noise Ratio (SNR), high Acoustic Overload Point (AOP), bottom port silicon microphone. Using Knowles' proven high performance SiSonic™ MEMS technology, the SPH21C3LR5H-1 consists of an acoustic sensor, a low noise input buffer, and a differential output amplifier. This microphone's high SNR enables enhanced consumer experience with Transparency Mode & Active Noise Cancellation on Ear Products. Its high SNR & AOP provide high dynamic range for Mobile & variety of IoT products in a small form factor. The microphone's low phase distortion lends to superior algorithm performance. Its differential mode configuration improves noise immunity to power supply variations, allowing extension of microphone PCB traces.



PRODUCT FEATURES

- Differential Output
- Low LFRO
- Low Distortion /High AOP
- High SNR
- Flat Frequency Response
- Low Current
- Sensitivity Matching
- Bottom Port
- Ultra-Stable Performance
- Omnidirectional
- Standard SMD Reflow
- LGA Package

TYPICAL APPLICATIONS

- Transparency Mode OTE & TWS
- ANC Mode OTE & TWS
- Far field Voice Speakerphone & Mobile

ABSOLUTE MAXIMUM RATINGS

Table 1: Absolute Maximum Ratings

Parameter	Absolute Maximum Rating	Units
Vdd to Ground	-0.5, +5.0	V
OUT+, OUT- to Ground	-0.3, Vdd+0.3	V
Input Current	±5	mA
Storage Temperature	-40 to +125	°C
Operating Temperature	-40 to +85	°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.



ACOUSTIC & ELECTRICAL SPECIFICATIONS¹

Table 2: Normal Mode Microphone Specifications

Test Conditions: 23 ±2°C, 55±20% R.H., Vdd=2.75V, no load, unless otherwise indicated

Parameter	Symbol	Conditions	Min	Typ	Max	Units
Supply Voltage	Vdd		2.4	2.75	3.2	V
Supply Current	Idd	Vdd = 3.2 V	-	205	-	μA
		Vdd = 2.75 V	-	200	-	
Sensitivity	S	94 dB SPL @ 1 kHz	-39	-38	-37	dBV/Pa
Signal to Noise Ratio	SNR	94 dB SPL @ 1 kHz, A-weighted	67	68.5	-	dBV/Pa
Near-Ultrasonic SNR		94 dB SPL, @ 19 kHz, BW = 18.5 - 20.0 kHz	-	80	-	dB
Total Harmonic Distortion	THD	94 dB SPL @ 1 kHz	-	0.1	-	%
		115 dB SPL @ 1 kHz	-	0.5	-	%
		1% THD @ 1 kHz, S = typ	-	125	-	dB SPL
Acoustic Overload Point	AOP	10% THD @ 1 kHz, S = typ	-	134	-	dB SPL
Low Frequency Rolloff	LFRO	-3dB relative to 1 kHz	-	18	-	Hz
High Frequency Flatness		+3dB relative to 1 kHz	-	20	-	kHz
Resonant Frequency Peak	Fres		-	36	-	kHz
Power Supply Rejection Ratio	PSRR	200 mVpp sinewave @ 1 kHz	-	85	-	dB
Power Supply Rejection	PSR+N	200 mVpp 7/8 duty cycle rectangular waveform @ 217 Hz, A-weighted, BW = 20 kHz	-	-104	-	dBV(A)
DC Output			-	0.75	-	V
DC Offset		OUT+ to OUT-	-	-	±10	mV
Output Impedance	Zout	@ 1 kHz	-	-	120	Ω
Output Load	Cload		-	-	200	pF
	Cdiff		-	-	100	pF
	Cac	AC-coupling input capacitance	1	-	-	μF
	Zin	Codec input impedance	7	-	-	kΩ
Sensitivity Drop		Vdd(min) ≤ Vdd ≤ Vdd(max)	-	-	±0.25	dB
Directivity			Omnidirectional			
Polarity		Increasing sound pressure	Increasing Output Voltage			
Startup Time		S within 1 dB of final value, outputs AC coupled	-	-	30	ms

Table 3: Low-Power Mode Microphone Specifications

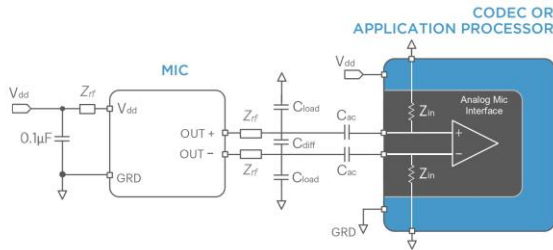
Test Conditions: 23 ±2°C, 55±20% R.H., Vdd=1.8V, no load, unless otherwise indicated

Parameter	Symbol	Conditions	Min	Typ	Max	Units
Supply Voltage	Vdd		1.51	1.8	1.89	V
Supply Current	Idd	Vdd = 1.8 V	-	67	-	µA
		Vdd = 1.51 V	-	60	-	
Sensitivity	S	94 dB SPL @ 1 kHz	-39	-38	-37	dBV/Pa
Signal to Noise Ratio	SNR	94 dB SPL @ 1 kHz, A-weighted	-	67	-	dBV/Pa
Near-Ultrasonic SNR		94 dB SPL, @ 19 kHz, BW = 18.5 - 20.0 kHz	-	78	-	dB
Total Harmonic Distortion	THD	94 dB SPL @ 1 kHz	-	0.05	-	%
		115 dB SPL @ 1 kHz	-	0.5	-	%
		1% THD @ 1 kHz, S = typ	-	124	-	dB SPL
Acoustic Overload Point	AOP	10% THD @ 1 kHz, S = typ	-	130	-	dB SPL
Low Frequency Rolloff	LFRO	-3dB relative to 1 kHz	-	18	-	Hz
High Frequency Flatness		+3dB relative to 1 kHz	-	20	-	kHz
Resonant Frequency Peak	Fres		-	36	-	kHz
Power Supply Rejection Ratio	PSRR	200 mVpp sinewave @ 1 kHz	-	85	-	dB
Power Supply Rejection	PSR+N	200 mVpp 7/8 duty cycle rectangular waveform @ 217 Hz, A-weighted, BW = 20 kHz	-	-102	-	dBV(A)
DC Output		Vdd = 1.8V	-	0.75	-	V
DC Offset		OUT+ to OUT-	-	-	±20	mV
Output Impedance	Zout	@ 1 kHz	-	380	-	Ω
Output Load	Cload		-	-	200	pF
	Cdiff		-	-	100	pF
	Cac	AC-coupling input capacitance	1	-	-	µF
	Zin	Codec input impedance	7	-	-	kΩ
Sensitivity Drop		Vdd(min) ≤ Vdd ≤ Vdd(max)	-	-	±0.25	dB
Directivity			Omnidirectional			
Polarity		Increasing sound pressure	Increasing Output Voltage			
Startup Time		S within 1 dB of final value, outputs AC coupled	-	-	30	ms

¹ Sensitivity and Supply Current are 100% tested.



Figure 1: Typical Differential Application Circuit



NOTES:

All Ground pins must be connected to ground.

If necessary to improve RF performance, optional series components (resistors, ferrites, etc.) should be placed closest to the microphone pads.

Capacitors near the microphone should not contain Class 2 dielectrics due to their piezoelectric effect.

Bypass capacitors should be placed next to each Vdd pin for best performance. Follow the codec manufacturer's recommendations for circuitry and layout.

PERFORMANCE CURVES

Test Conditions: 23 ±2°C, 55±20% R.H., Vdd=2.75V (NM) / 1.8V (LPM), no load, unless otherwise indicated

Figure 2: Typical Free Field Magnitude Response and Masks

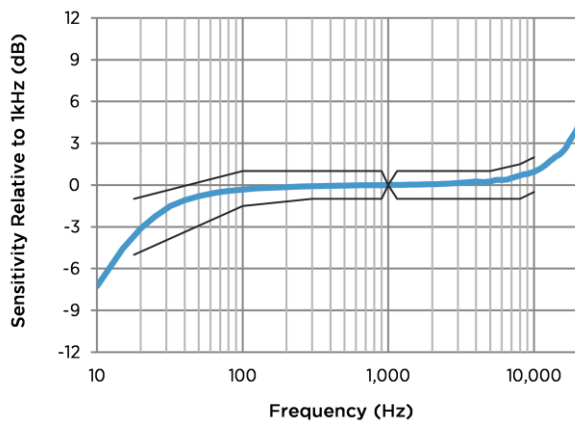


Figure 4: Typical Phase Response and Group Delay

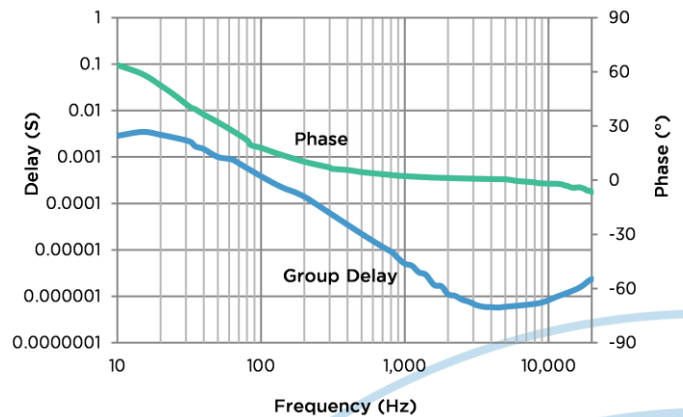


Figure 3: Typical THD vs Input SPL

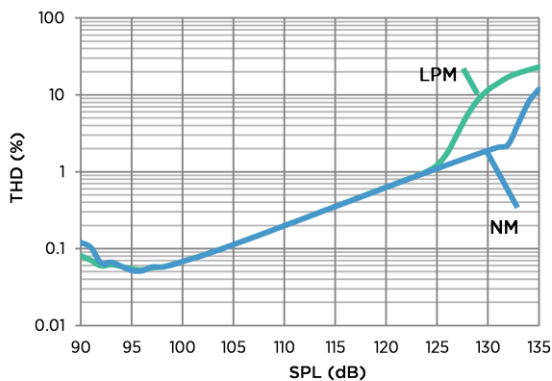


Figure 5: Typical THD vs Input Frequency

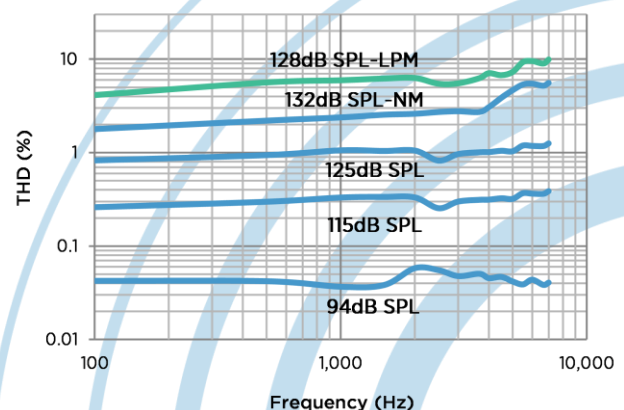


Figure 6: Typical Free Field Ultrasonic Response

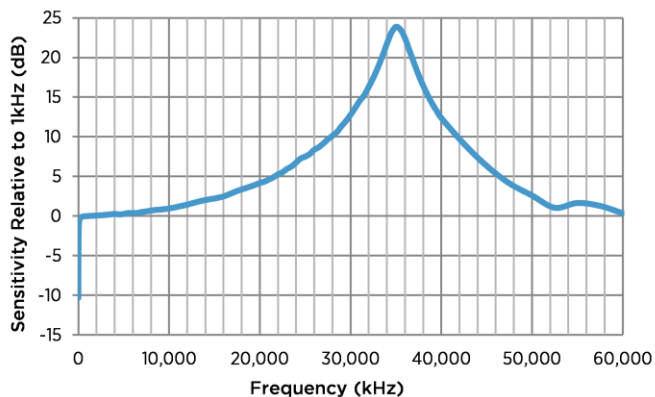


Figure 9: Typical I_{dd} vs V_{dd}

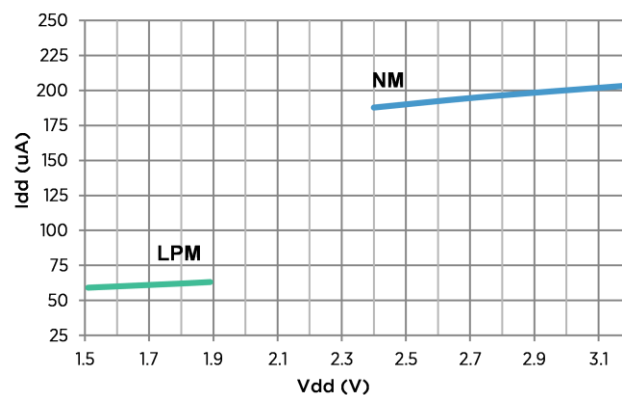


Figure 7: Noise Floor Power Spectral Density (LPM)

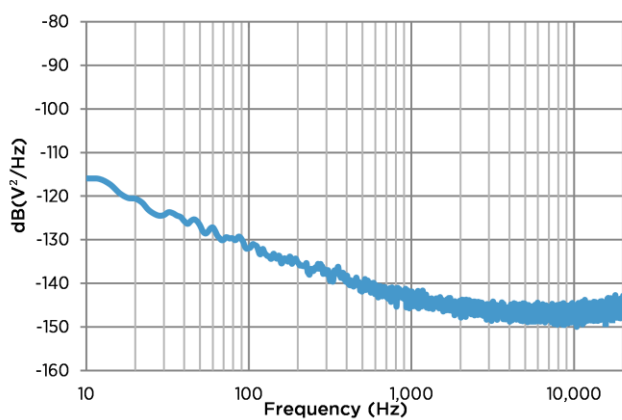


Figure 10: Noise Floor Power Spectral Density (NM)

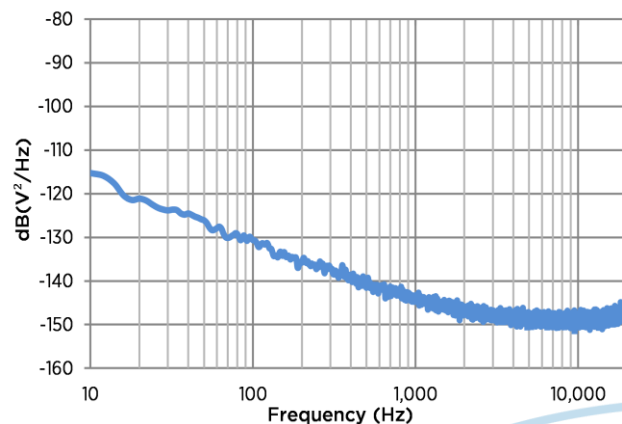


Figure 8: Typical PSRR (LPM)

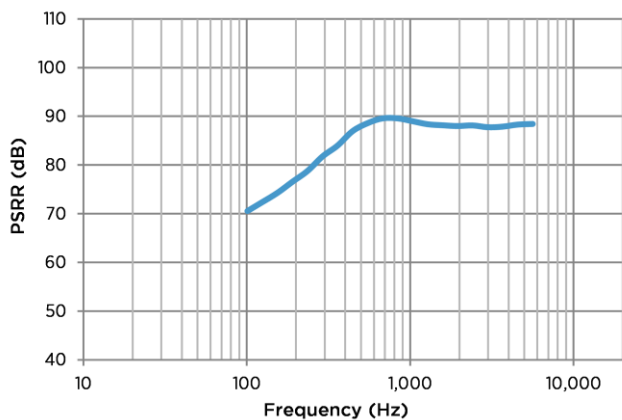
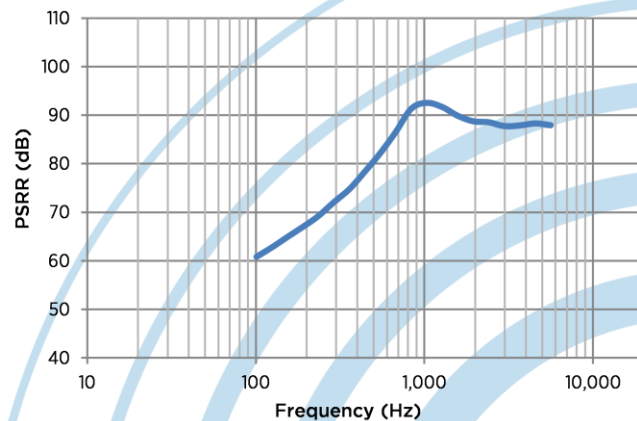
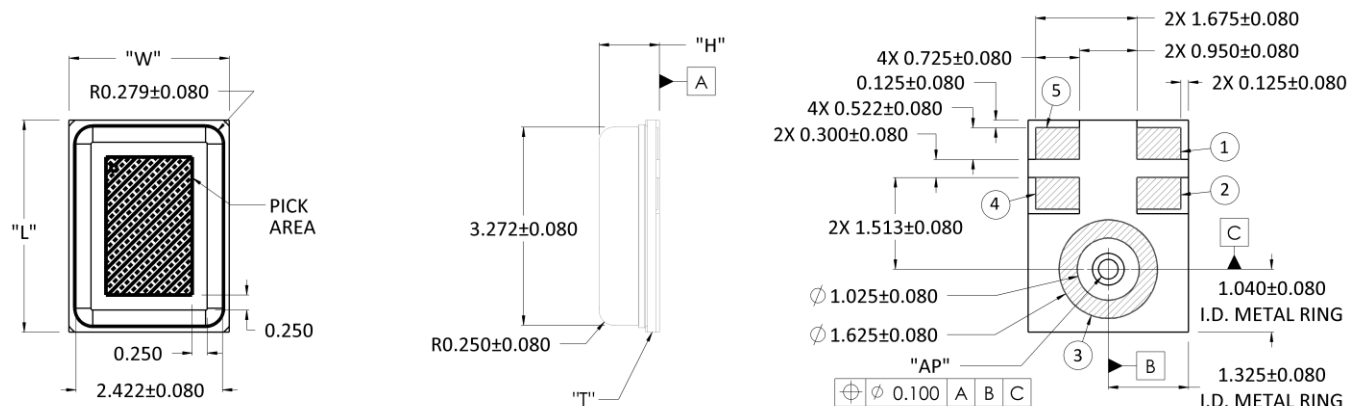


Figure 11: Typical PSRR (NM)



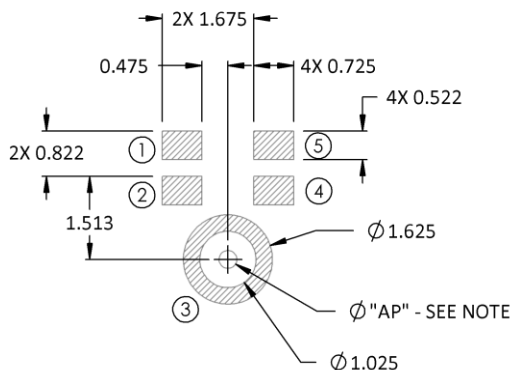
MECHANICAL SPECIFICATIONS



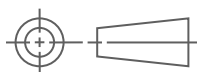
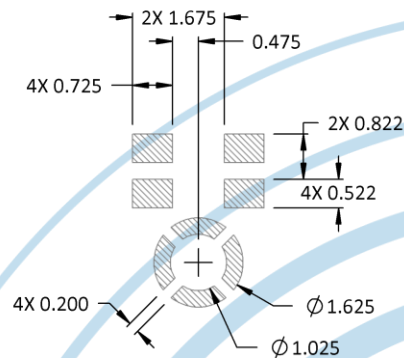
Item	Dimension	Tolerance
Length (L)	3.50	± 0.10
Width (W)	2.65	± 0.10
Height (H)	1.00	± 0.10
Acoustic Port (AP)	$\varnothing 0.325$	± 0.050
PCB Thickness (T)	0.285	-0.035, 0.05

Pin #	Pin Name	Type	Description
1	OUT (+)	Signal	Non-Inverted Output Signal
2	OUT (-)	Signal	Inverted Output Signal
3, 4	GROUND	Power	Ground
5	VDD	Power	Power Supply

Example Land Pattern



Example Solder Stencil Pattern



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 ± 0.15 mm unless otherwise specified.
 In the acoustic path, and . Further optimizations based on application should be performed.



Technical drawing of a rectangular plate with dimensions and a cross-section view.

Top View Dimensions:

- Overall width: 12.0 ± 0.3
- Overall height: 1.75 ± 0.10
- Distance from top edge to center of first row of holes: 5.50 ± 0.05
- Distance between centers of holes in the first row: 2.00 ± 0.05
- Distance from center of first hole to center of second hole: 4.00
- Distance from center of second hole to center of third hole: 8.00 ± 0.10
- Distance from center of third hole to center of fourth hole: 2.90 ± 0.05
- Distance from center of fourth hole to center of fifth hole: 3.75 ± 0.05
- Distance from center of fifth hole to center of sixth hole: 2.00 ± 0.05
- Distance from center of sixth hole to center of seventh hole: 4.00
- Distance from center of seventh hole to center of eighth hole: 8.00 ± 0.10
- Distance from center of eighth hole to center of ninth hole: 2.00 ± 0.05
- Distance from center of ninth hole to center of tenth hole: 4.00
- Distance from center of tenth hole to center of eleventh hole: 8.00 ± 0.10
- Distance from center of eleventh hole to center of twelfth hole: 2.00 ± 0.05
- Distance from center of twelfth hole to center of thirteenth hole: 4.00
- Distance from center of thirteenth hole to center of fourteenth hole: 8.00 ± 0.10
- Distance from center of fourteenth hole to center of fifteenth hole: 2.00 ± 0.05
- Distance from center of fifteenth hole to center of sixteenth hole: 4.00
- Distance from center of sixteenth hole to center of seventeenth hole: 8.00 ± 0.10
- Distance from center of seventeenth hole to center of eighteenth hole: 2.00 ± 0.05
- Distance from center of eighteenth hole to center of nineteenth hole: 4.00
- Distance from center of nineteenth hole to center of twentieth hole: 8.00 ± 0.10
- Distance from center of twentieth hole to center of twenty-first hole: 2.00 ± 0.05
- Distance from center of twenty-first hole to center of twenty-second hole: 4.00
- Distance from center of twenty-second hole to center of twenty-third hole: 8.00 ± 0.10
- Distance from center of twenty-third hole to center of twenty-fourth hole: 2.00 ± 0.05
- Distance from center of twenty-fourth hole to center of twenty-fifth hole: 4.00
- Distance from center of twenty-fifth hole to center of twenty-sixth hole: 8.00 ± 0.10
- Distance from center of twenty-sixth hole to center of twenty-seventh hole: 2.00 ± 0.05
- Distance from center of twenty-seventh hole to center of twenty-eighth hole: 4.00
- Distance from center of twenty-eighth hole to center of twenty-ninth hole: 8.00 ± 0.10
- Distance from center of twenty-ninth hole to center of thirtieth hole: 2.00 ± 0.05
- Distance from center of thirtieth hole to center of thirty-first hole: 4.00
- Distance from center of thirty-first hole to center of thirty-second hole: 8.00 ± 0.10
- Distance from center of thirty-second hole to center of thirty-third hole: 2.00 ± 0.05
- Distance from center of thirty-third hole to center of thirty-fourth hole: 4.00
- Distance from center of thirty-fourth hole to center of thirty-fifth hole: 8.00 ± 0.10
- Distance from center of thirty-fifth hole to center of thirty-sixth hole: 2.00 ± 0.05
- Distance from center of thirty-sixth hole to center of thirty-seventh hole: 4.00
- Distance from center of thirty-seventh hole to center of thirty-eighth hole: 8.00 ± 0.10
- Distance from center of thirty-eighth hole to center of thirty-ninth hole: 2.00 ± 0.05
- Distance from center of thirty-ninth hole to center of fortieth hole: 4.00
- Distance from center of fortieth hole to center of forty-first hole: 8.00 ± 0.10
- Distance from center of forty-first hole to center of forty-second hole: 2.00 ± 0.05
- Distance from center of forty-second hole to center of forty-third hole: 4.00
- Distance from center of forty-third hole to center of forty-fourth hole: 8.00 ± 0.10
- Distance from center of forty-fourth hole to center of forty-fifth hole: 2.00 ± 0.05
- Distance from center of forty-fifth hole to center of forty-sixth hole: 4.00
- Distance from center of forty-sixth hole to center of forty-seventh hole: 8.00 ± 0.10
- Distance from center of forty-seventh hole to center of forty-eighth hole: 2.00 ± 0.05
- Distance from center of forty-eighth hole to center of forty-ninth hole: 4.00
- Distance from center of forty-ninth hole to center of fiftieth hole: 8.00 ± 0.10
- Distance from center of fiftieth hole to center of fifty-first hole: 2.00 ± 0.05
- Distance from center of fifty-first hole to center of fifty-second hole: 4.00
- Distance from center of fifty-second hole to center of fifty-third hole: 8.00 ± 0.10
- Distance from center of fifty-third hole to center of fifty-fourth hole: 2.00 ± 0.05
- Distance from center of fifty-fourth hole to center of fifty-fifth hole: 4.00
- Distance from center of fifty-fifth hole to center of fifty-sixth hole: 8.00 ± 0.10
- Distance from center of fifty-sixth hole to center of fifty-seventh hole: 2.00 ± 0.05
- Distance from center of fifty-seventh hole to center of fifty-eighth hole: 4.00
- Distance from center of fifty-eighth hole to center of fifty-ninth hole: 8.00 ± 0.10
- Distance from center of fifty-ninth hole to center of sixtieth hole: 2.00 ± 0.05
- Distance from center of sixtieth hole to center of sixty-first hole: 4.00
- Distance from center of sixty-first hole to center of sixty-second hole: 8.00 ± 0.10
- Distance from center of sixty-second hole to center of sixty-third hole: 2.00 ± 0.05
- Distance from center of sixty-third hole to center of sixty-fourth hole: 4.00
- Distance from center of sixty-fourth hole to center of sixty-fifth hole: 8.00 ± 0.10
- Distance from center of sixty-fifth hole to center of sixty-sixth hole: 2.00 ± 0.05
- Distance from center of sixty-sixth hole to center of sixty-seventh hole: 4.00
- Distance from center of sixty-seventh hole to center of sixty-eighth hole: 8.00 ± 0.10
- Distance from center of sixty-eighth hole to center of sixty-ninth hole: 2.00 ± 0.05
- Distance from center of sixty-ninth hole to center of seventieth hole: 4.00
- Distance from center of seventieth hole to center of seventy-first hole: 8.00 ± 0.10
- Distance from center of seventy-first hole to center of seventy-second hole: 2.00 ± 0.05
- Distance from center of seventy-second hole to center of seventy-third hole: 4.00
- Distance from center of seventy-third hole to center of seventy-fourth hole: 8.00 ± 0.10
- Distance from center of seventy-fourth hole to center of seventy-fifth hole: 2.00 ± 0.05
- Distance from center of seventy-fifth hole to center of seventy-sixth hole: 4.00
- Distance from center of seventy-sixth hole to center of seventy-seventh hole: 8.00 ± 0.10
- Distance from center of seventy-seventh hole to center of seventy-eighth hole: 2.00 ± 0.05
- Distance from center of seventy-eighth hole to center of seventy-ninth hole: 4.00
- Distance from center of seventy-ninth hole to center of eightieth hole: 8.00 ± 0.10
- Distance from center of eightieth hole to center of eighty-first hole: 2.00 ± 0.05
- Distance from center of eighty-first hole to center of eighty-second hole: 4.00
- Distance from center of eighty-second hole to center of eighty-third hole: 8.00 ± 0.10
- Distance from center of eighty-third hole to center of eighty-fourth hole: 2.00 ± 0.05
- Distance from center of eighty-fourth hole to center of eighty-fifth hole: 4.00
- Distance from center of eighty-fifth hole to center of eighty-sixth hole: 8.00 ± 0.10
- Distance from center of eighty-sixth hole to center of eighty-seventh hole: 2.00 ± 0.05
- Distance from center of eighty-seventh hole to center of eighty-eighth hole: 4.00
- Distance from center of eighty-eighth hole to center of eighty-ninth hole: 8.00 ± 0.10
- Distance from center of eighty-ninth hole to center of ninetieth hole: 2.00 ± 0.05
- Distance from center of ninetieth hole to center of one hundredth hole: 4.00
- Distance from center of one hundredth hole to center of one hundred and first hole: 8.00 ± 0.10
- Distance from center of one hundred and first hole to center of one hundred and second hole: 2.00 ± 0.05
- Distance from center of one hundred and second hole to center of one hundred and third hole: 4.00
- Distance from center of one hundred and third hole to center of one hundred and fourth hole: 8.00 ± 0.10
- Distance from center of one hundred and fourth hole to center of one hundred and fifth hole: 2.00 ± 0.05
- Distance from center of one hundred and fifth hole to center of one hundred and sixth hole: 4.00
- Distance from center of one hundred and sixth hole to center of one hundred and seventh hole: 8.00 ± 0.10
- Distance from center of one hundred and seventh hole to center of one hundred and eighth hole: 2.00 ± 0.05
- Distance from center of one hundred and eighth hole to center of one hundred and ninth hole: 4.00
- Distance from center of one hundred and ninth hole to center of one hundred and tenth hole: 8.00 ± 0.10
- Distance from center of one hundred and tenth hole to center of one hundred and eleventh hole: 2.00 ± 0.05
- Distance from center of one hundred and eleventh hole to center of one hundred and twelfth hole: 4.00
- Distance from center of one hundred and twelfth hole to center of one hundred and thirteenth hole: 8.00 ± 0.10
- Distance from center of one hundred and thirteenth hole to center of one hundred and fourteenth hole: 2.00 ± 0.05
- Distance from center of one hundred and fourteenth hole to center of one hundred and fifteenth hole: 4.00
- Distance from center of one hundred and fifteenth hole to center of one hundred and sixteenth hole: 8.00 ± 0.10
- Distance from center of one hundred and sixteenth hole to center of one hundred and seventeenth hole: 2.00 ± 0.05
- Distance from center of one hundred and seventeenth hole to center of one hundred and eighteenth hole: 4.00
- Distance from center of one hundred and eighteenth hole to center of one hundred and nineteenth hole: 8.00 ± 0.10
- Distance from center of one hundred and nineteenth hole to center of one hundred and twentieth hole: 2.00 ± 0.05
- Distance from center of one hundred and twentieth hole to center of one hundred and twenty-first hole: 4.00
- Distance from center of one hundred and twenty

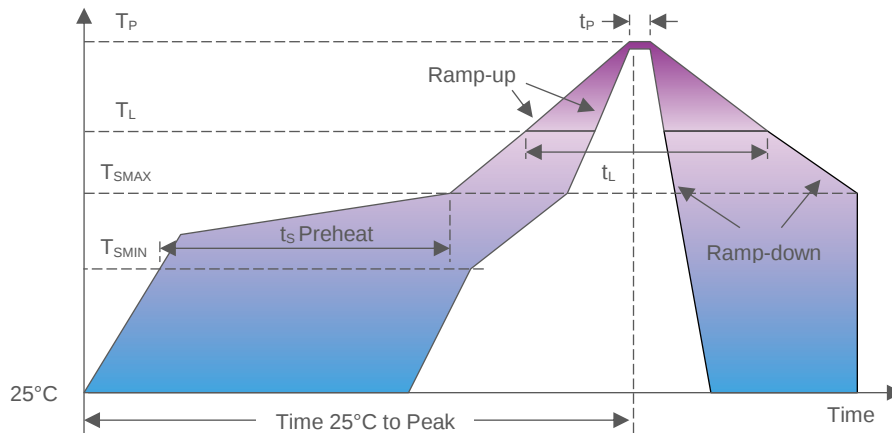
Component	Surface Resistance (ohms)
Reel	$10^5 - 10^9$
Carrier Tape	$10^5 - 10^9$
Cover Tape	$10^4 - 10^{10}$



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 stored in the factory-supplied, unopened ESD moisture sensitive bag under the maximum environmental conditions of 30°C, 70% R.H.



RECOMMENDED REFLOW PROFILE



Profile Feature	Pb-Free
Average Ramp-up rate (T_{SMAX} to T_P)	3°C/second max.
Preheat - Temperature Min (T_{SMIN}) - Temperature Max (T_{SMAX}) - Time (T_{SMIN} to T_{SMAX}) (t_S)	150°C 200°C 60-180 seconds
Time maintained above: - Temperature (T_L) - Time (t_L)	217°C 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_{SMAX})	6°C/second max
Time 25°C to Peak Temperature	8 minutes max

NOTES:

Based on IPC/JEDEC J-STD-020 Revision C.

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

The actual reflow profile used should be optimized based on the reflow requirements of all components, board design, solder paste formulation and reflow equipment used. Details of recommended handling and manufacturing processes can be found in AN25 SMT Manufacturing Guidelines for SiSonic™ Microphones.

ADDITIONAL NOTES

- MSL (moisture sensitivity level) Class 1.
- Maximum of 3 reflow cycles is recommended.
- 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.
 - Do not directly expose to vapor phase soldering.

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.

Product is Beryllium Free according to limits specified on the Knowles Hazardous Material List (HSL for Products).

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."

RELIABILITY SPECIFICATIONS

Test	Description
Thermal Shock	100 cycles of air-air thermal shock from -40°C to +125°C with 15 minute soaks (IEC 68-2-14)
High Temperature Storage	+105°C environment for 1,000 hours (JESD22-A103)
Low Temperature Storage	-40°C environment for 1,000 hours (JESD22-A119)
High Temperature Bias	+105°C environment while under bias for 1,000 hours (JESD22-A108)
Low Temperature Bias	-40°C environment while under bias for 1,000 hours (JESD22-A108)
Temperature/Humidity Bias	+85°C/85% R.H. environment while under bias for 1,000 hours (JESD22-A101A-B)
Vibration	16 minutes in each X, Y, Z axis from 20 to 2,000 Hz with peak acceleration of 20g (MIL STD-883e, Method 2007.2, Condition A)
ESD-HBM	3 discharges at ±2kV direct contact to I/O pins (ANSI/ESDA/JEDEC JS-001-2014)
ESD-HMM	10 discharges at ±8kV direct contact to lid when unit is grounded (ANSI/ESD SP5.6-2009)
ESD-CDM	3 discharges at ±500V (ANSI/ESDA/JEDEC JS-002-2014)
Reflow	5 reflow cycles with peak temperature of +260°C (JEDEC 22-A113F)
Mechanical Shock	3 pulses of 12,000g in each of the X, Y, and Z directions (IEC 68-2-27 Test Ea)

NOTES:

Microphones meet all acoustic and electrical specifications before and after reliability testing, except sensitivity which can deviate up to 3dB.

After 3 reflow cycles, the sensitivity of the microphones shall not deviate more than 1 dB from its initial value.

[illegible]

10

Mouser Electronics

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