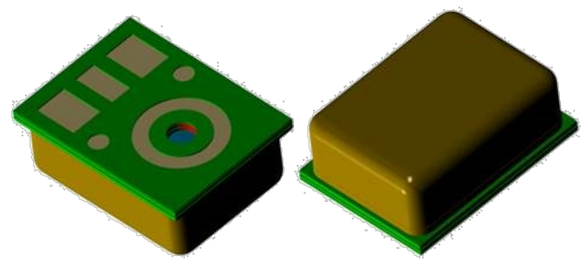
APPLICATION NOTE AN-25

PERFORMANCE OF MM30 TRIMMABLE MEMS MICROPHONE

The MM30 is a MEMS microphone with several parameters that Knowles can modify programmatically, or trim, after manufacturing and before testing. This means that individual and matched microphones can be quickly customized for optimal performance in different applications. This document outlines the parameters that can be trimmed and how changes to these impact other performance parameters.



Trimmable Features Performance Matrix

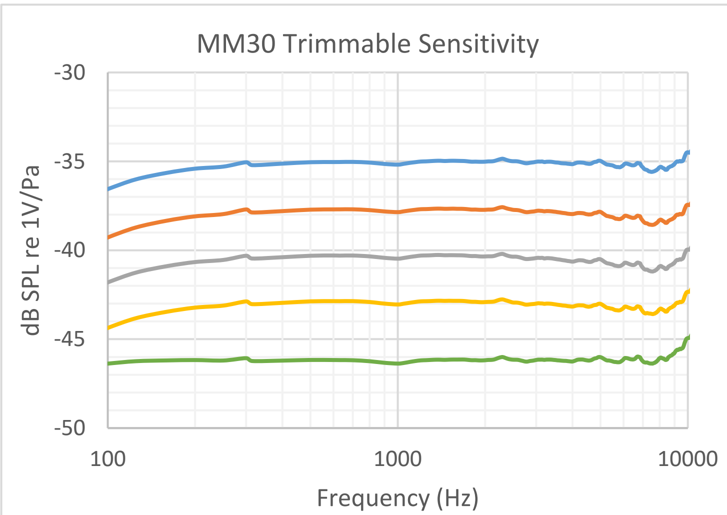
Trimmable Performance Parameter	Recommended trim limits (units)		Trim direction	Resulting Performance Change			
				Equiv. Input Noise	AOP	Audio IMD	Ultrasonic IMD
Sensitivity	-35.5	dB SPL @ 1kHz re 1V/Pa	↑	↓	↓	–	–
	-45.5		↓	↑	↑	–	–
Supply Current	32	µA	↑	↓	–	–	↓
	16		↓	↑	–	–	↑
High Pass Filtering	100	-3.0 dB corner frequency (Hz)	↑	↑	–	–	–
	30		↓	↓	–	–	–
Low Pass Filtering	+2.5	dB SPL @ 10kHz re 1kHz	↑	↓	–	–	↑
	-3.5		↓	↑	–	–	↓

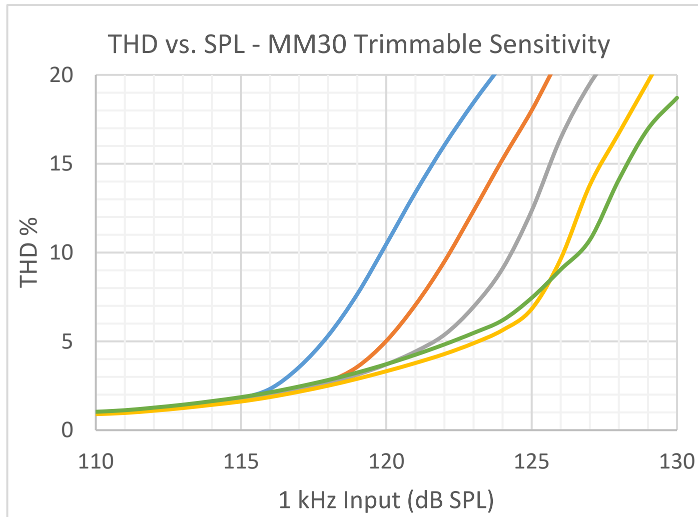
Contact your Knowles sales or applications engineer to discuss trimming options to fit your needs, including but not limited to the contents of this app note.

Sensitivity Trim

Sensitivity trimming is a useful feature for customizing microphone performance to fit certain applications, e.g. need for higher AOP where higher noise may be acceptable, or need for optimized noise with highest sensitivity.

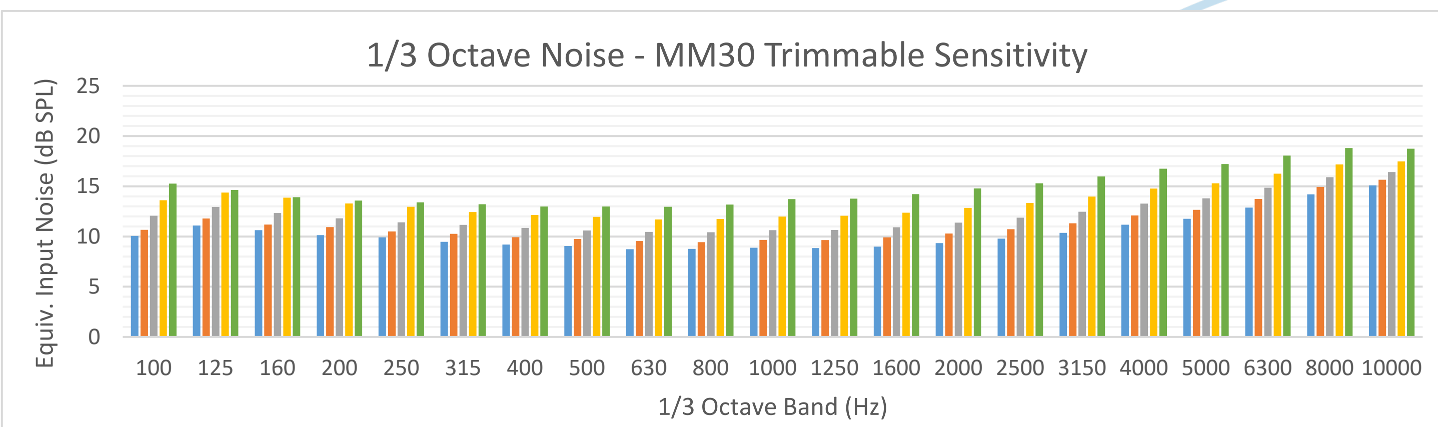
Sensitivity legend: Maximum -37.5 -40 -42.5 Minimum





1kHz sensitivity for this data was trimmed via hard-coded maximum and minimum values, plus three precise values within the recommended range.

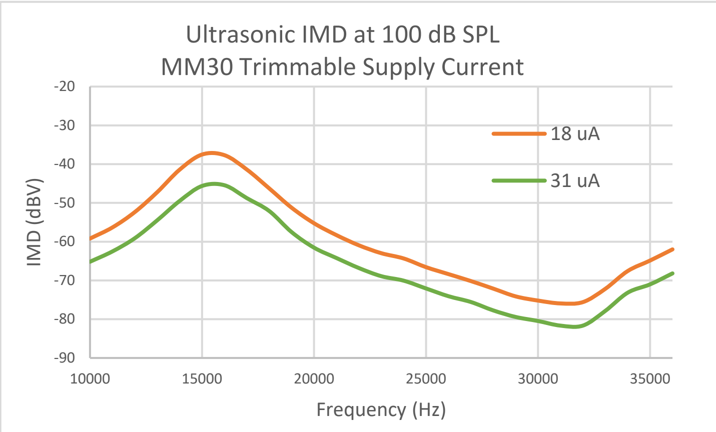
Improved (increased) AOP with decreasing sensitivity is caused by the decrease of the output signal amplitude, and the resulting decrease in the signal clipping that causes distortion.

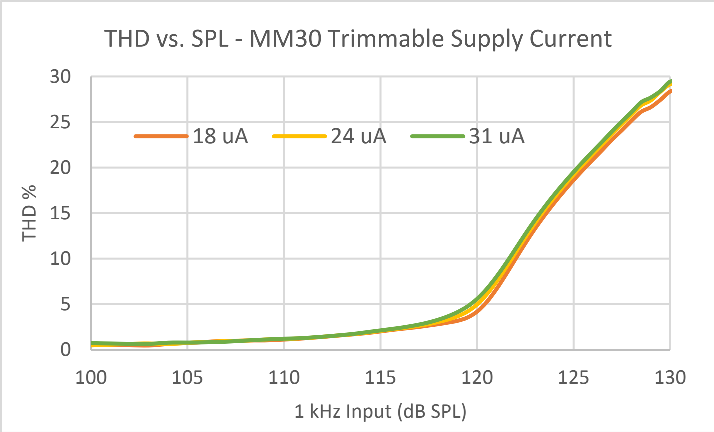


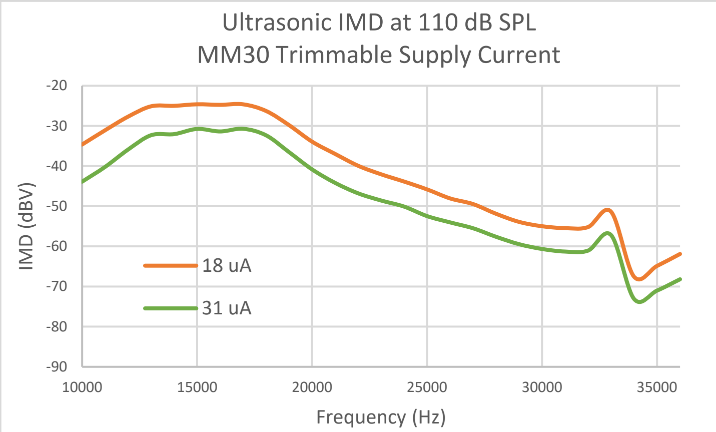
Equivalent input noise increase with decreasing sensitivity is due to the gained-up input-referred electrical noise.

Supply Current Trim

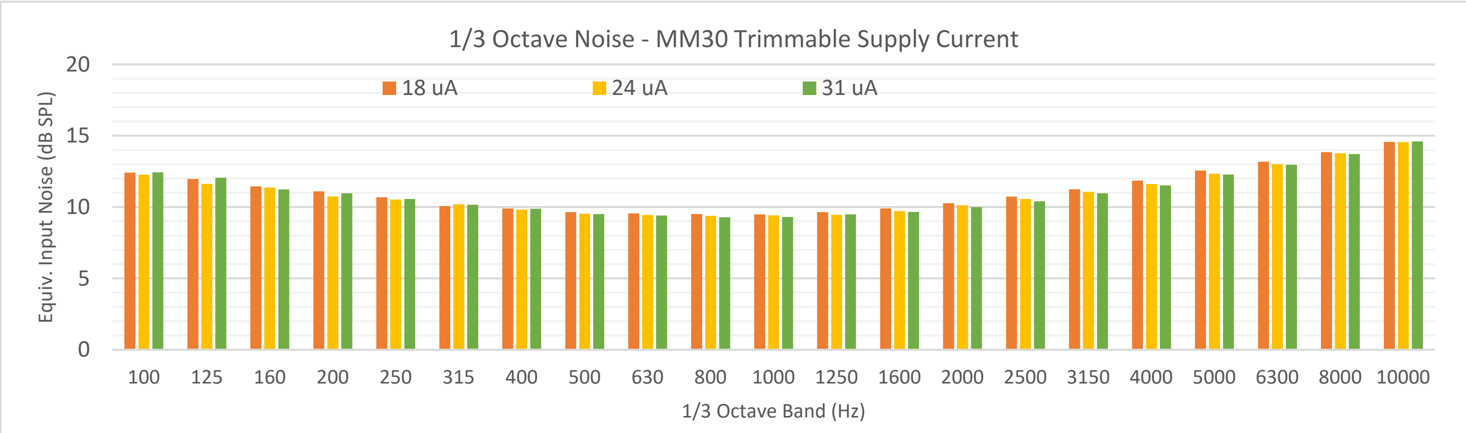
Lower supply current is often desirable and can be trimmed to application-specific values, but higher supply current provides better distortion performance.







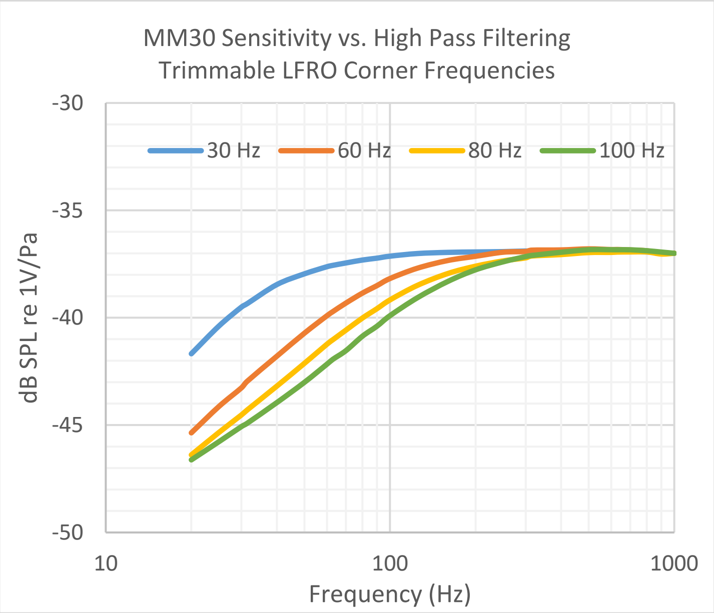
Supply current has the greatest effect on IMD in the ultrasonic range – increasing supply current helps with slew rate limitations that, along with clipping, contribute to higher (worse) IMD. Changing supply current has less than 0.5 dB of effect on AOP, which is considered negligible.



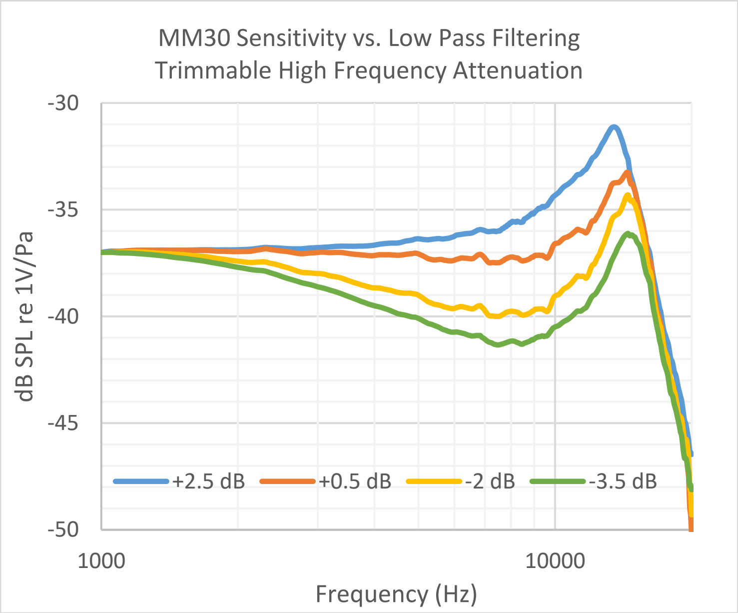
Equivalent input noise is slightly higher with lower supply current; as buffer current is the main factor in the dominant thermal noise in the middle frequency bands. Acoustic noise begins to dominate closer to the acoustic peak frequency.

High and Low Pass Filtering Trim

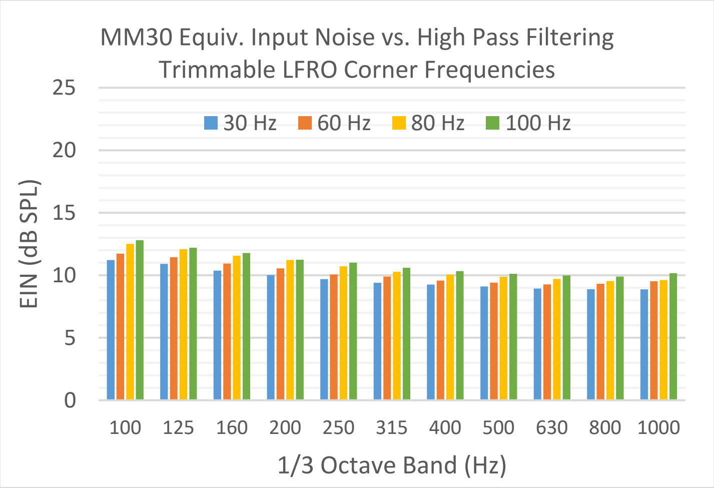
The high and low pass filtering characteristics of the MM30 can be precisely trimmed and customized to fit almost any desired shape of frequency response. At both high and low frequencies, more filtering, i.e. more attenuation, introduces more noise.

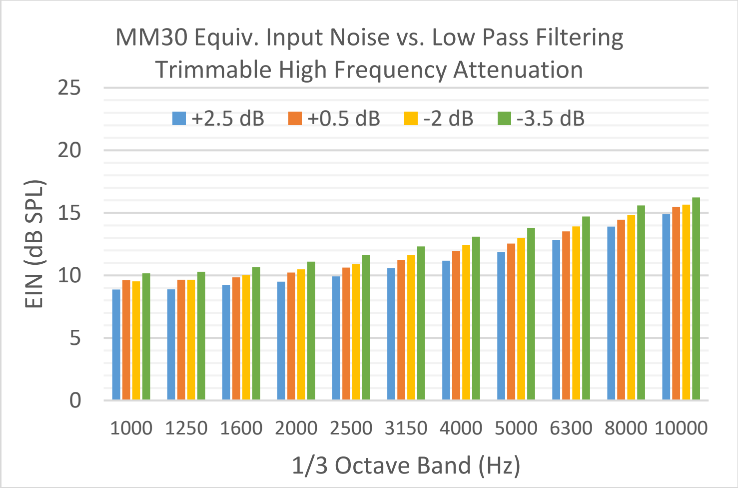


High pass filter trimming targets the frequency point where sensitivity is a certain value relative to 1 kHz sensitivity, commonly known as the corner frequency for low frequency roll-off (LFRO). The trim settings for the data above were for -37.0 dB SPL sensitivity at 1 kHz, and the industry standard -3.0 dB with respect to that for the frequency targets shown in the legend.



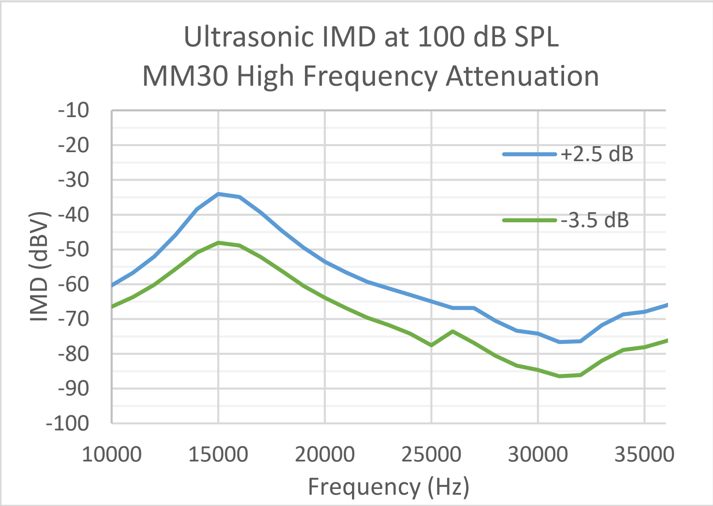
Low pass filter trimming targets the sensitivity at a certain high frequency point, commonly 10 kHz, relative to 1 kHz sensitivity. The trim settings for the data above were for -37.0 dB SPL sensitivity at 1 kHz, and the values shown in the legend for 10 kHz sensitivity with respect to 1 kHz sensitivity.

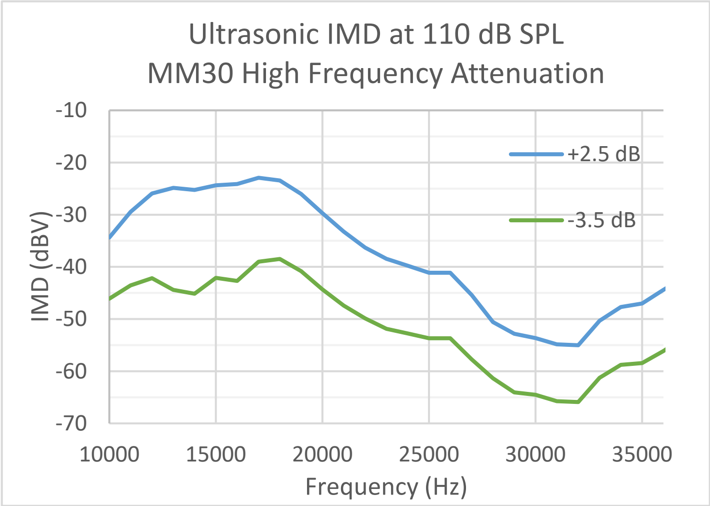




Increasing attenuation via high pass or low pass filtering introduces more thermal noise at the ASIC with the activation of more capacitors and resistors with more aggressive trimming.

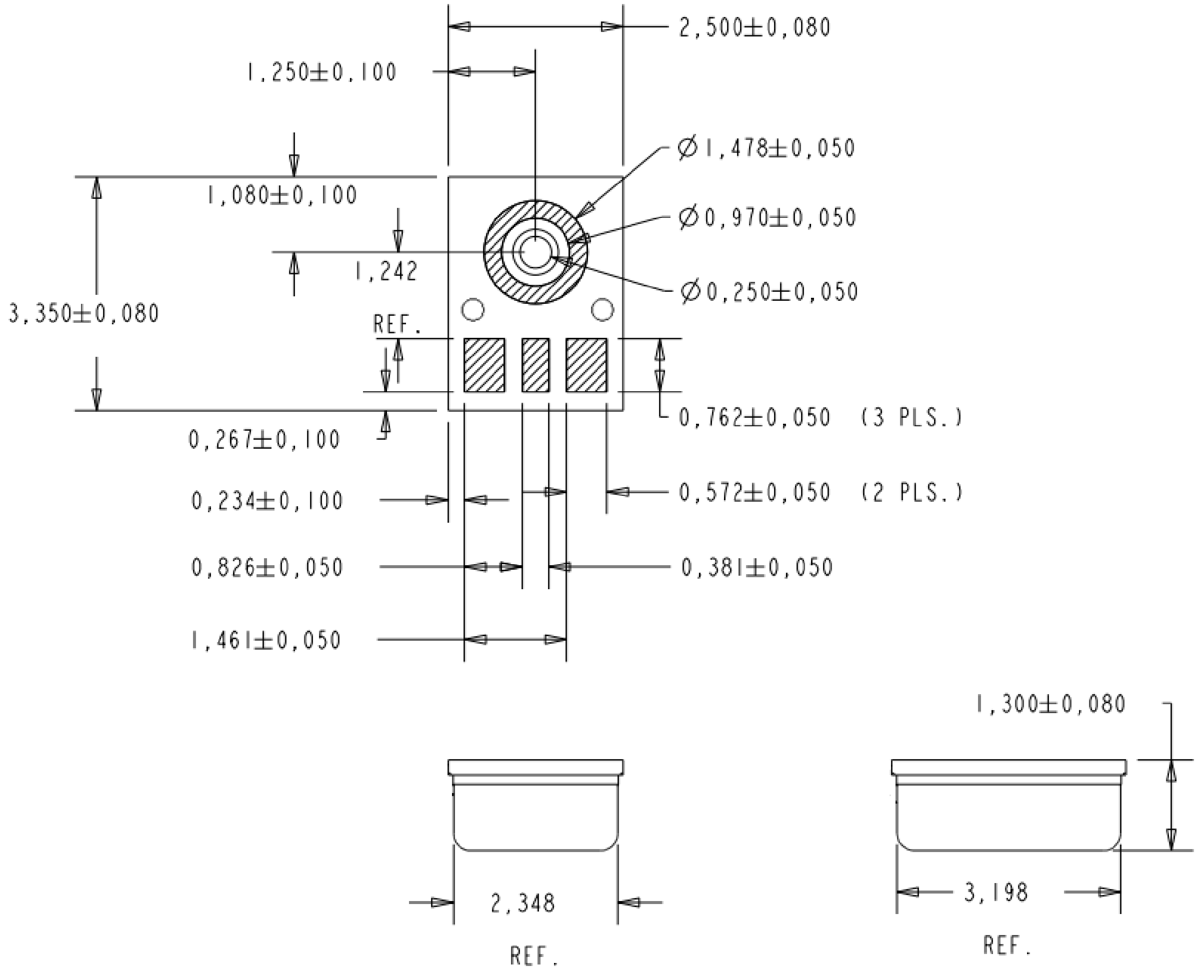
Low Pass Filtering Trim continued





The low pass filter setting can also impact the ultrasonic IMD performance. More attenuation via filtering at high frequency can improve IMD performance.

Mechanical Specifications

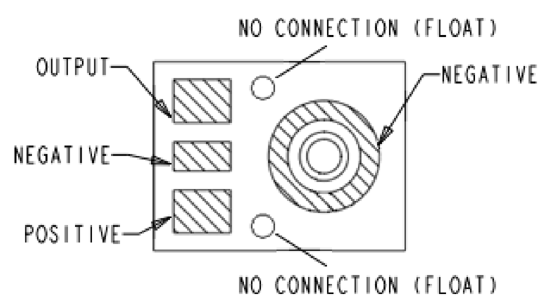


Notes: Metal can may be flush with, but not extend past, edge of microphone base on four sides.

"*" Denotes dimension applies to the center of ground ring.

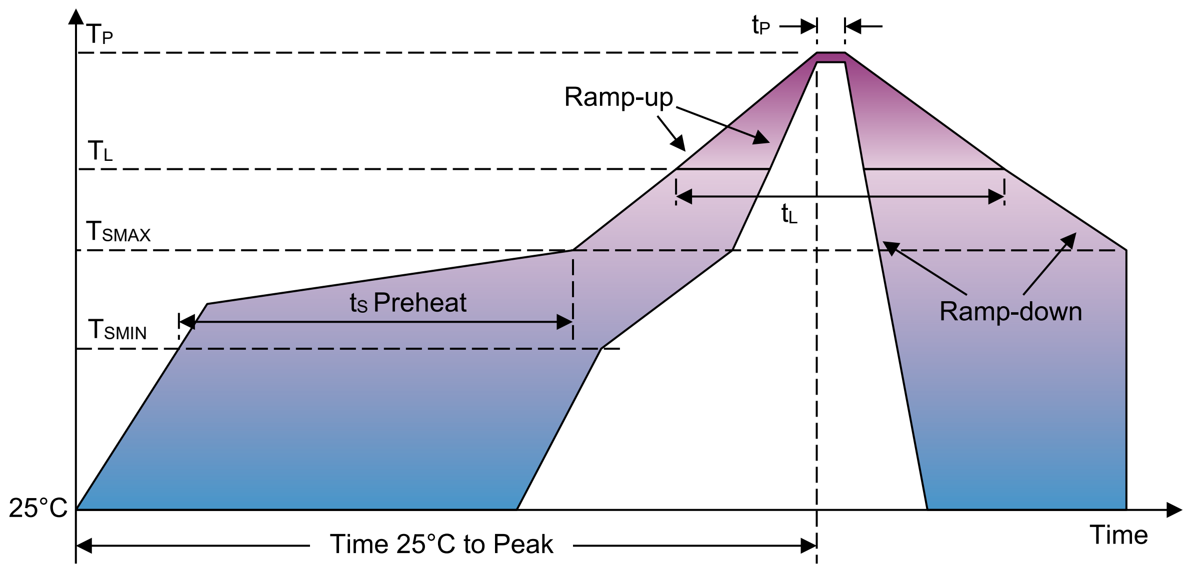
Pick Area only extends to 0.25 mm of any edge or hole unless otherwise specified.

Dimensions in millimeters [inches]



TERMINAL DEFINITION

Recommended Reflow Profile



Profile Feature	Pb-Free
Ramp-up rate (25°C to T_{SMIN})	3°C/second (see note)
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/JDEC J-STD-020 Revision C.
All temperatures refer to topside of the package, measured on the package body surface
Ramp-up rate (25°C to T_{SMIN}) can be optimized based on application.

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.

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Revision	Description	Date
1	Initial Release	December 2021