RF-Hardened, Ultra-Low Noise Microphone with Bottom Port and Analog Output

GENERAL DESCRIPTION

The INMP510* is an RF-hardened, analog output, bottom-ported, omnidirectional MEMS microphone with high performance, ultra-low noise, and low power. The INMP510 consists of a MEMS microphone element, an impedance converter, and an output amplifier. The INMP510 sensitivity specification makes it an excellent choice for both near-field and far-field applications. The INMP510 is pin compatible with the INMP504 microphone. The INMP510 has a very high signal-to-noise ratio (SNR) and extended wideband frequency response, resulting in natural sound with high intelligibility. Low current consumption enables long battery life for portable applications.

The INMP510 is available in a miniature 3.35 × 2.5 × 0.98 mm surface-mount package. It is reflow solder compatible with no sensitivity degradation.

**Protected by U.S. Patents 7,449,356; 7,825,484; 7,885,423; and 7,961,897. Other patents are pending.*

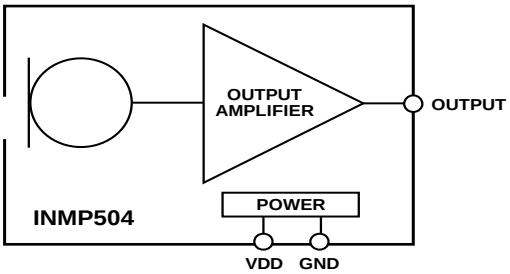
APPLICATIONS

- Smartphones and Feature Phones
- Tablet Computers
- Teleconferencing Systems
- Digital Still and Video Cameras
- Bluetooth Headsets
- Notebook PCs
- Security and Surveillance

FEATURES

- Tiny, 3.35 × 2.5 × 0.98 mm Surface-Mount Package
- High SNR of 65 dBA
- Acoustic Overload Point of 124 dB SPL
- Extended Frequency Response from 60 Hz to 20 kHz
- Omnidirectional Response
- Sensitivity of −38 dBV
- Sensitivity Tolerance of ±2 dB
- Enhanced Radio Frequency (RF) Performance
- Low Current Consumption of 180 µA
- Single-Ended Analog Output
- High PSR of −78 dBV
- Compatible with Sn/Pb and Pb-Free Solder Processes
- RoHS/WEEE Compliant

FUNCTIONAL BLOCK DIAGRAM



ORDERING INFORMATION

PART	TEMP RANGE
INMP510ACEZ-R0*	−40°C to +85°C
INMP510ACEZ-R7†	−40°C to +85°C
EV_INMP510-FX	—

* – 13” Tape and Reel

† – 7” Tape and reel is to be discontinued.

Contact sales@invensense.com for availability.

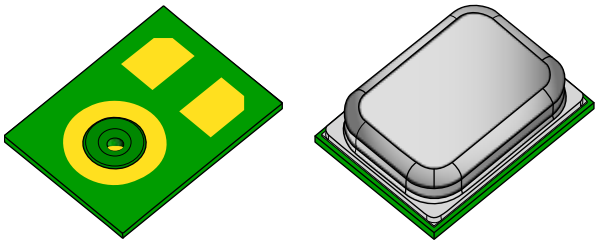


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TABLE OF CONTENTS

Document Number: DS-INMP510-00
Revision: 1.0.

SPECIFICATIONS

TABLE 1. ELECTRICAL CHARACTERISTICS

(T_A = −40 to 85°C, V_{DD} = 1.5 to 3.63 V, unless otherwise noted. All minimum and maximum specifications are guaranteed across temperature and voltage, and are specified in Table 1, unless otherwise noted. Typical specifications are not guaranteed.)

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS	NOTES
PERFORMANCE						
Directionality			Omni			
Sensitivity	1 kHz, 94 dB SPL	−40	−38	−36	dBV	
Signal-to-Noise Ratio (SNR)			65		dBA	
Equivalent Input Noise (EIN)			29		dBA SPL	
Dynamic Range	Derived from EIN and maximum acoustic input		91		dB	
Frequency Response	Low frequency −3 dB point		60		Hz	1
	High frequency −3 dB point		>20		kHz	
Total Harmonic Distortion (THD)	105 dB SPL		0.2	1	%	
Power-Supply Rejection (PSR)	217 Hz, 100 mVp-p square wave superimposed on VDD = 1.8 V (A-weighted)		−78		dBV	
Power-Supply Rejection Ratio (PSRR)	1 kHz, 100 mV p-p sine wave superimposed on V_{DD} = 1.8 V		−55		dB	
Acoustic Overload Point	10% THD		124		dB SPL	
POWER SUPPLY						
Supply Voltage (V_{DD})		1.5		3.63	V	
Supply Current (I_S)						
	V_{DD} = 1.8 V		180	220	µA	
	V_{DD} = 3.3 V		210	250	µA	
OUTPUT CHARACTERISTICS						
Output Impedance (Z_{OUT})			350		Ω	
Output DC Offset			0.7		V	
Maximum Output Voltage	131 dB SPL input		0.398		V rms	
Noise Floor	20 Hz to 20 kHz, A-weighted, rms		−103		dBV	

Note 1: See Figures 3 and 4.

Document Number: DS-INMP510-00
Revision: 1.0.

ABSOLUTE MAXIMUM RATINGS

Stress above those listed as Absolute Maximum Ratings may cause permanent damage to the device. These are stress ratings only and functional operation of the device at these conditions is not implied. Exposure to the absolute maximum ratings conditions for extended periods may affect device reliability.

TABLE 2. ABSOLUTE MAXIMUM RATINGS

PARAMETER	RATING
Supply Voltage (VDD)	−0.3 V to +3.63 V
Sound Pressure Level	160 dB
Mechanical Shock	10,000 *g*
Vibration	Per MIL-STD-883 Method 2007, Test Condition B
Operating Temperature Range	−40°C to +85°C
Storage Temperature Range	−55°C to +150°C

ESD CAUTION

ESD (electrostatic discharge) sensitive device. Charged devices and circuit boards can discharge without detection. Although this product features patented or proprietary protection circuitry, damage may occur on devices subjected to high energy ESD. Therefore proper ESD precautions should be taken to avoid performance degradation or loss of functionality.

Document Number: DS-INMP510-00
Revision: 1.0.

SOLDERING PROFILE

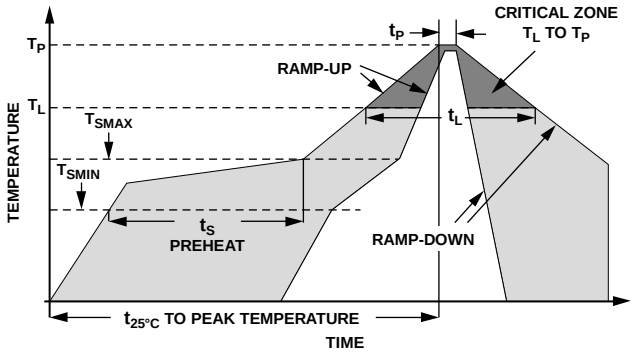


Figure 1. Recommended Soldering Profile Limits

TABLE 3. RECOMMENDED SOLDERING PROFILE*

PROFILE FEATURE		Sn63/Pb37	Pb-Free
Average Ramp Rate (T_L to T_P)		1.25°C/sec max	1.25°C/sec max
Preheat	Minimum Temperature (T_{SMIN})	100°C	100°C
	Minimum Temperature (T_{SMIN})	150°C	200°C
	Time (T_{SMIN} to T_{SMAX}), t_S	60 sec to 75 sec	60 sec to 75 sec
Ramp-Up Rate (T_{SMAX} to T_L)		1.25°C/sec	1.25°C/sec
Time Maintained Above Liquidous (t_L)		45 sec to 75 sec	~50 sec
Liquidous Temperature (T_L)		183°C	217°C
Peak Temperature (T_P)		215°C +3°C/−3°C	260°C +0°C/−5°C
Time Within +5°C of Actual Peak Temperature (t_P)		20 sec to 30 sec	20 sec to 30 sec
Ramp-Down Rate		3°C/sec max	3°C/sec max
Time +25°C ($t_{25°C}$) to Peak Temperature		5 min max	5 min max

**The reflow profile in Table 3 is recommended for board manufacturing with InvenSense MEMS microphones. All microphones are also compatible with the J-STD-020 profile.*

Document Number: DS-INMP510-00
Revision: 1.0.

PIN CONFIGURATIONS AND FUNCTION DESCRIPTIONS

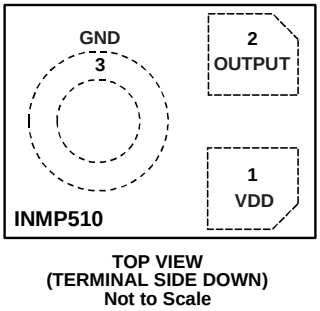


Figure 2. Pin Configuration

TABLE 4. PIN FUNCTION DESCRIPTIONS

PIN	NAME	FUNCTION
1	VDD	Power Supply
2	OUTPUT	Analog Output Signal
3	GND	Ground

Document Number: DS-INMP510-00
Revision: 1.0.

TYPICAL PERFORMANCE CHARACTERISTICS

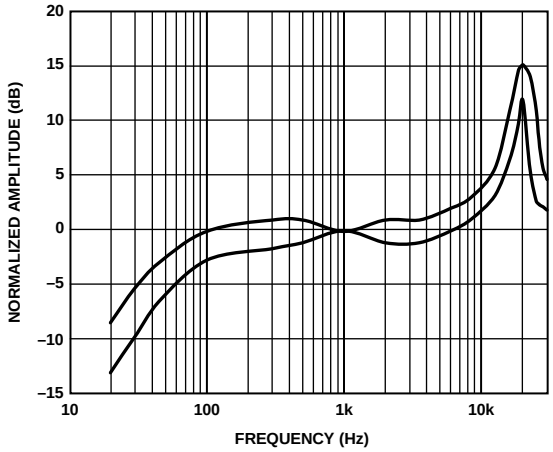


Figure 3. Frequency Response Mask

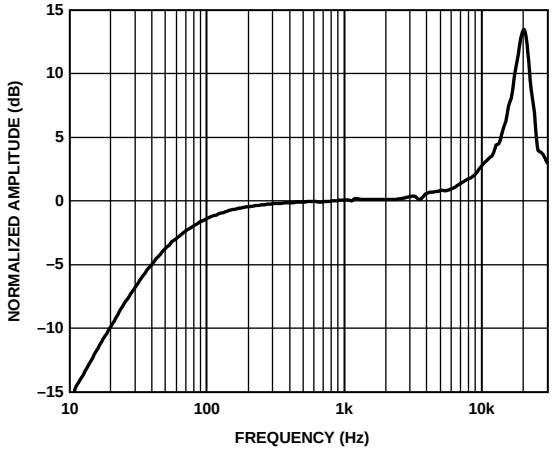


Figure 4. Typical Frequency Response (Measured)

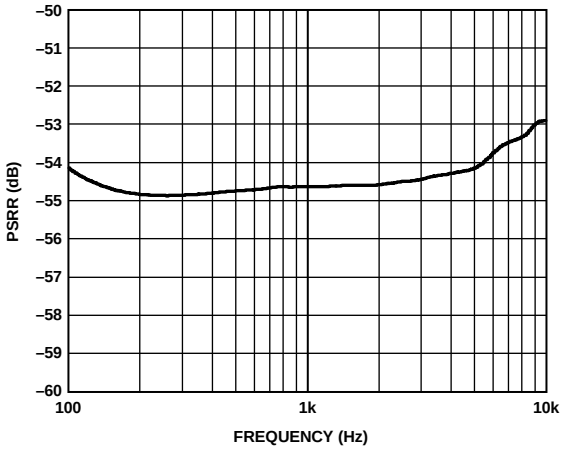


Figure 5. PSR vs. Frequency, 100 mV p-p Swept Sine Wave

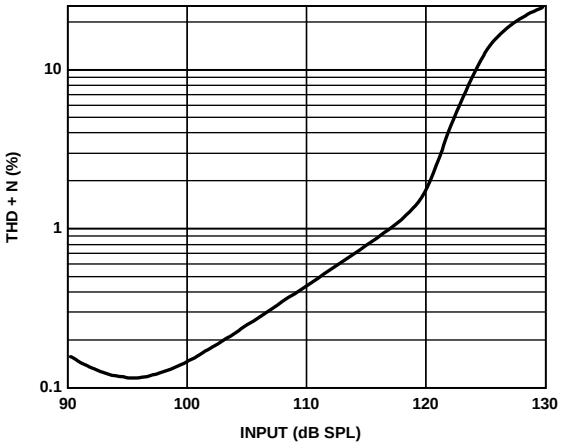


Figure 6. Total Harmonic Distortion + Noise (THD+N) vs. Input SPL

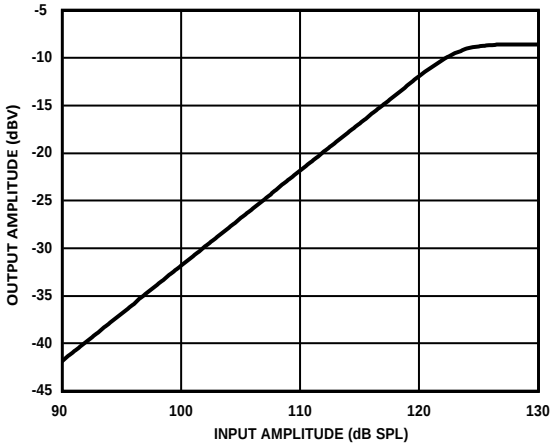


Figure 7. Linearity

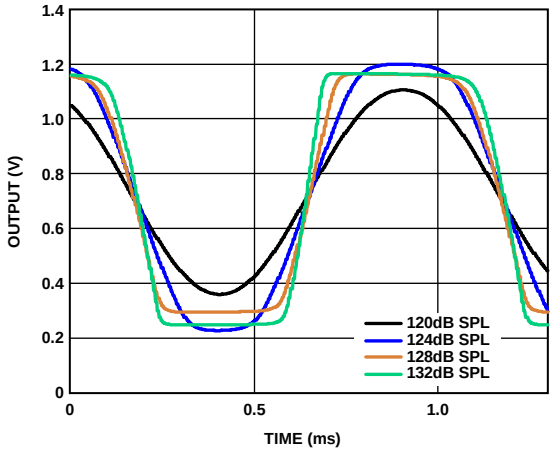


Figure 8. Clipping Characteristics

Document Number: DS-INMP510-00
Revision: 1.0.

APPLICATIONS INFORMATION

CONNECTING TO AUDIO CODECS

The output of the INMP510 can be connected to a dedicated codec microphone input (see Figure 9) or to a high input impedance gain stage (see Figure 10). A 0.1 µF ceramic capacitor placed close to the INMP510 supply pin is used for testing and is recommended to adequately decouple the microphone from noise on the power supply. A DC blocking capacitor is required at the output of the microphone. This capacitor creates a high-pass filter with a corner frequency at

$$f_C = 1/(2\pi \times C \times R)$$

where *R* is the input impedance of the codec.

A minimum value of 2.2 µF is recommended in Figure 9 because the input impedance of codecs can be as low as 2 kΩ at their highest PGA gain setting, which results in a high-pass filter corner frequency at 37 Hz. Figure 10 shows the INMP510 connected to an op amp configured as a noninverting preamplifier.

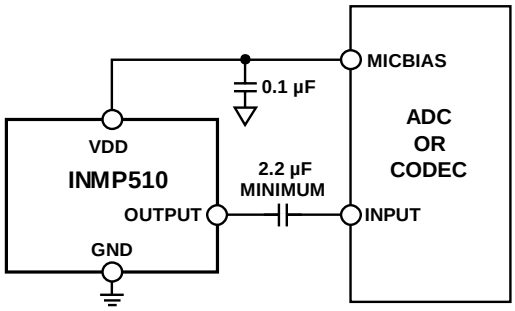


Figure 9. INMP510 Connected to a Codec

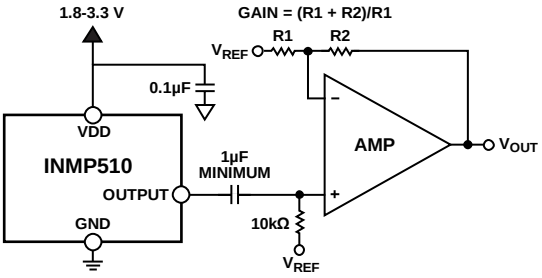


Figure 10. INMP510 Connected to an Op Amp

Document Number: DS-INMP510-00
Revision: 1.0.

SUPPORTING DOCUMENTS

For additional information, see the following documents.

EVALUATION BOARD USER GUIDE

UG-325 Analog Output MEMS Microphone Flex Evaluation Board

APPLICATION NOTES (GENERAL)

AN-1003 Recommendations for Mounting and Connecting the Invensense, Bottom-Ported MEMS Microphones
AN-1068 Reflow Soldering of the MEMS Microphone
AN-1112 Microphone Specifications Explained
AN-1124 Recommendations for Sealing Invensense, Bottom-Port MEMS Microphones from Dust and Liquid Ingress
AN-1140 Microphone Array Beamforming
AN-1165 Op Amps for MEMS Microphone Preamp Circuits
AN-1181 Using a MEMS Microphone in a 2-Wire Microphone Circuit

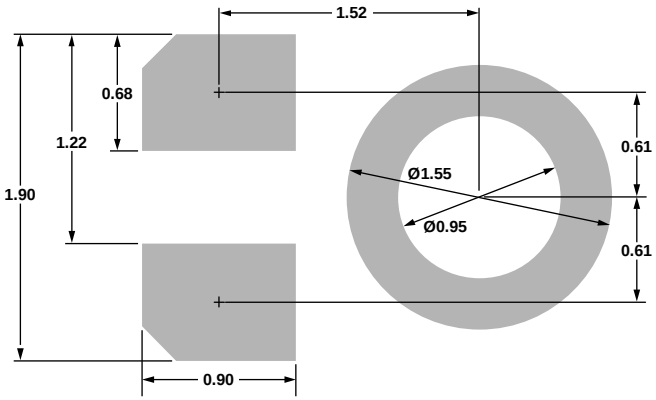
APPLICATION NOTES (PRODUCT SPECIFIC)

AN-0207 High-Performance Analog MEMS Microphone Simple Interface-to-SigmaDSP Audio Codec
AN-0262 Low-Noise Analog MEMS Microphone and Preamp with Compression and Noise Gating

Document Number: DS-INMP510-00
Revision: 1.0.

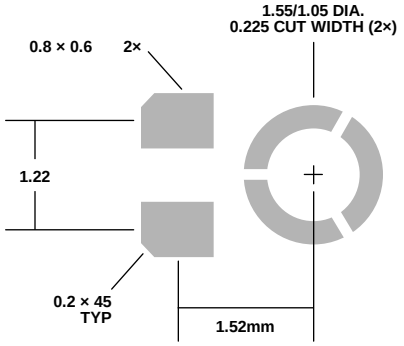
PCB DESIGN AND LAND PATTERN LAYOUT

The recommended PCB land pattern for the INMP504 should be laid out to a 1:1 ratio to the solder pads on the microphone package, as shown in Figure 8. Take care to avoid applying solder paste to the sound hole in the PCB. A suggested solder paste stencil pattern layout is shown in Figure 9. The diameter of the sound hole in the PCB should be larger than the diameter of the sound port of the microphone. A minimum diameter of 0.5 mm is recommended.



Dimensions shown in millimeters

Figure 11. PCB Land Pattern Layout



Dimensions shown in millimeters

Figure 12. Suggested Solder Paste Stencil Pattern Layout

Document Number: DS-INMP510-00
Revision: 1.0.

HANDLING INSTRUCTIONS

PICK AND PLACE EQUIPMENT

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

- Use a standard pickup tool to handle the microphone. Because the microphone hole is on the bottom of the package, the pickup tool can make contact with any part of the lid surface.
- Do not pick up the microphone with a vacuum tool that makes contact with the bottom side of the microphone. Do not pull air out of or blow air into the microphone port.
- Do not use excessive force to place the microphone on the PCB.

REFLOW SOLDER

For best results, the soldering profile must be in accordance with the recommendations of the manufacturer of the solder paste used to attach the MEMS microphone to the PCB. It is recommended that the solder reflow profile not exceed the limit conditions specified in Figure 1 and Table 3.

BOARD WASH

When washing the PCB, ensure that water does not make contact with the microphone port. Do not use blow-off procedures or ultrasonic cleaning.

Document Number: DS-INMP510-00
Revision: 1.0.