ICS-40300

High SPL Analog Microphone with Extended Low Frequency Response

GENERAL DESCRIPTION

The ICS-40300* is a low-noise, high SPL MEMS microphone with extended low frequency response. The ICS-40300 consists of a MEMS microphone element and an impedance converter amplifier. The ICS-40300 low frequency response makes it an excellent choice for applications requiring precise phase matching. The ICS-40300 is pin compatible with the INMP401 and INMP411 microphones, providing an easy upgrade path.

The ICS-40300 has a linear response up to 130 dB SPL. It offers low frequency extension down to 6 Hz, resulting in excellent phase characteristics in the audio range. Low current consumption enables long battery life for portable applications.

The ICS-40300 is available in a 4.72 mm × 3.76 mm × 3.5 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.*

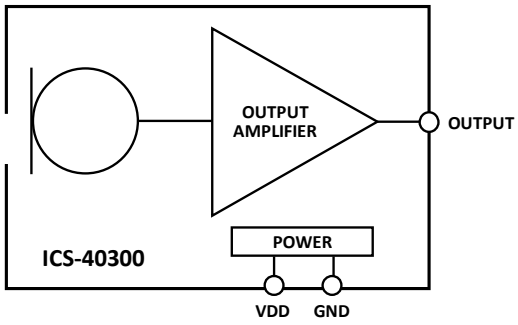
APPLICATIONS

- Active Noise-Cancelling Headsets
- Teleconferencing Systems
- Studio Microphones
- Live Microphones
- Security and Surveillance
- Photoacoustic Gas Sensing

FEATURES

- 4.72 × 3.76 × 3.5 mm Surface-Mount Package
- Extended Frequency Response from 6 Hz to 20 kHz
- 130 dB SPL Acoustic Overload Point
- Sensitivity of −45 dBV
- ±2 dB Sensitivity Tolerance
- Omnidirectional Response
- High SNR of 63 dBA
- Low Current Consumption: <220 µA
- Single-Ended Analog Output
- High PSR of −80 dBV
- Compatible with Sn/Pb and Pb-Free Solder Processes
- RoHS/WEEE Compliant

FUNCTIONAL BLOCK DIAGRAM



ORDERING INFORMATION

PART	TEMP RANGE	PACKAGING
ICS-40300	−40°C to +85°C	13” Tape and Reel
EV_ICS-40300-FX	—	—

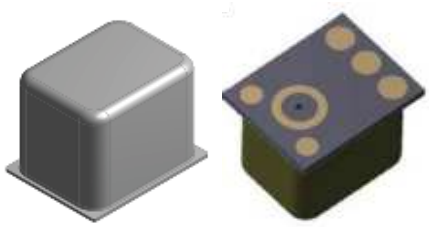


TABLE OF CONTENTS

General Description 1
Applications 1
Features 1
Functional Block Diagram 1
Ordering Information 1
Table of Contents 2
Specifications 3
Table 1. Electrical Characteristics 3
Absolute Maximum Ratings 4
Table 2. Absolute Maximum Ratings 4
ESD CAUTION 4
Soldering Profile 5
Table 3. Recommended Soldering Profile* 5
Pin Configurations And Function Descriptions 6
Table 4. Pin Function Descriptions 6
Typical Performance Characteristics 7
Applications Information 9
Connecting To Audio Codecs 9
Dynamic Range Considerations 9
Supporting Documents 10
Evaluation Board User Guide 10
Application Notes (General) 10
Application Note (Product-Specific) 10
PCB Design And Land Pattern Layout 11
PCB Material And Thickness 11
Handling Instructions 12
Pick And Place Equipment 12
Reflow Solder 12
Board Wash 12
Outline Dimensions 13
Ordering Guide 14
Revision History 14
Compliance Declaration Disclaimer 15

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 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	−47	−45	−43	dBV	
Signal-to-Noise Ratio (SNR)			63		dBA	
Equivalent Input Noise (EIN)			31		dBA SPL	
Dynamic Range	Derived from EIN and maximum acoustic input		99		dB	
Frequency Response	Low frequency −3 dB point		6		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 mV_{P-P} square wave superimposed on V_{DD} = 1.8 V		−80		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		130		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})			200		Ω	
Output DC Offset			0.8		V	
Maximum Output Voltage	130 dB SPL input		0.355		V rms	
Noise Floor	20 Hz to 20 kHz, A-weighted, rms		−108		dBV	

Note 1: See Figure 3 and Figure 4.

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 (V_{DD})	−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
Temperature Range	
Biased*	−40°C to +85°C
Storage	−55°C to +150°C

* ICS-40300 is able to operate at 105C without permanent damage to the device, but device specifications are not guaranteed.

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.

SOLDERING PROFILE

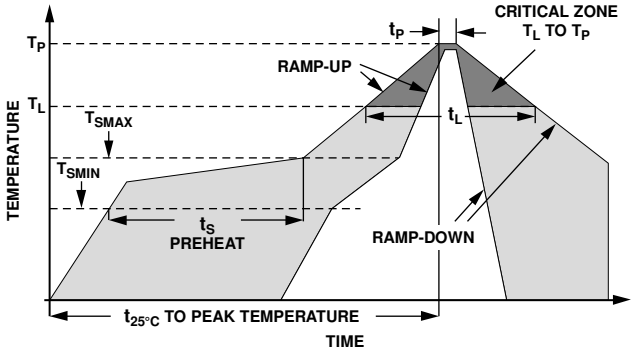


Figure 1. Recommended Soldering Profile Limits

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

***Note:** 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

PIN CONFIGURATIONS AND FUNCTION DESCRIPTIONS

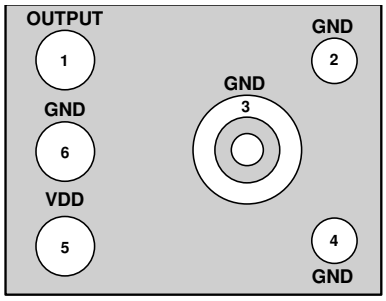


Figure 2. Pin Configuration

TABLE 4. PIN FUNCTION DESCRIPTIONS

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

TYPICAL PERFORMANCE CHARACTERISTICS

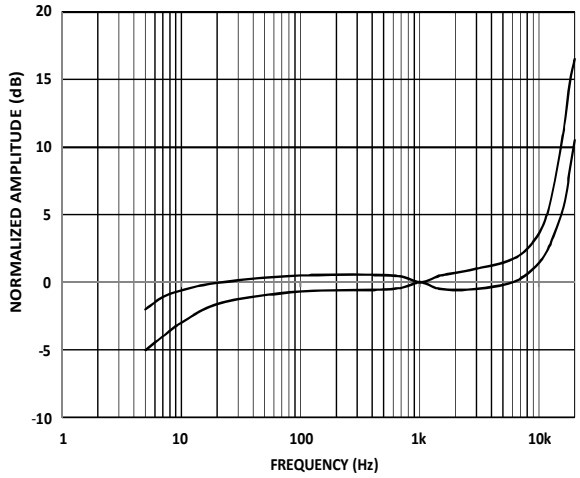


Figure 3. Frequency Response Mask

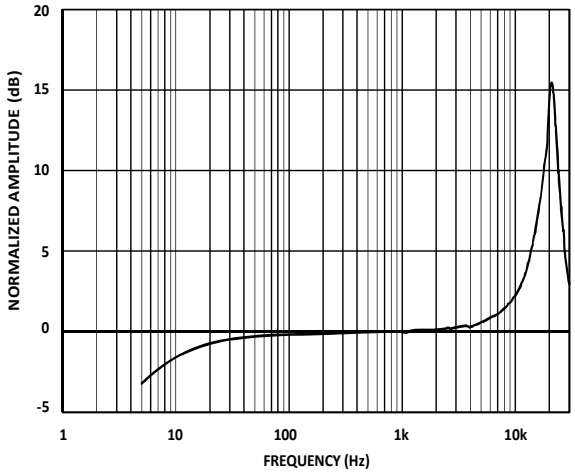


Figure 4. Frequency Response (Measured)

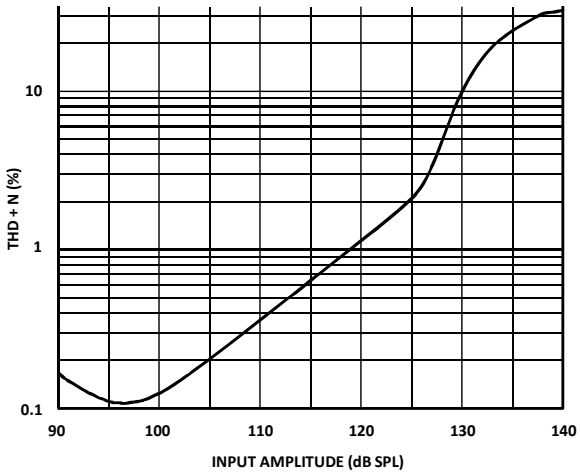


Figure 5. THD + N vs. Input Level

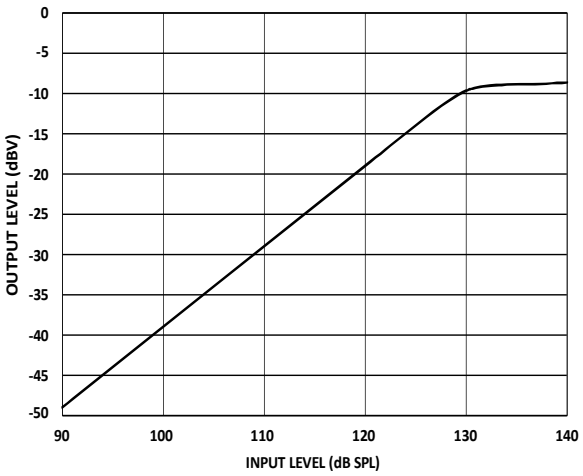


Figure 6. Linearity

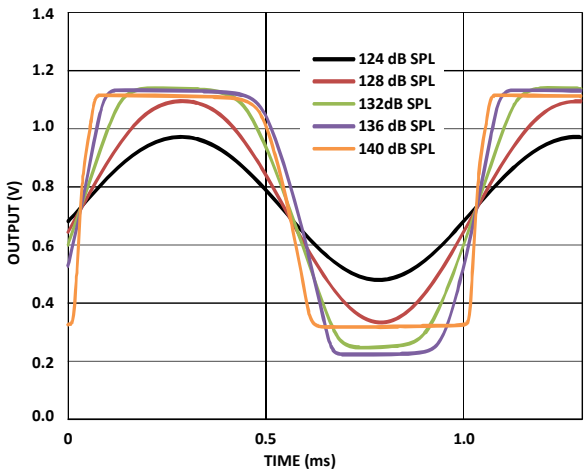


Figure 7. Clipping Characteristics

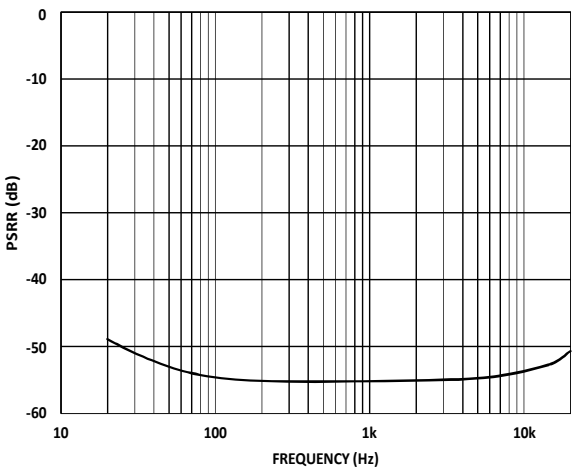


Figure 8. Power Supply Rejection Ratio vs. Frequency

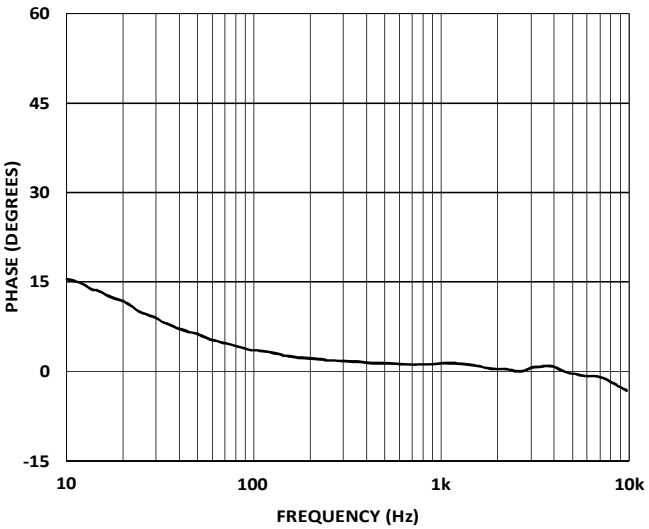


Figure 9. Phase Response (Measured)

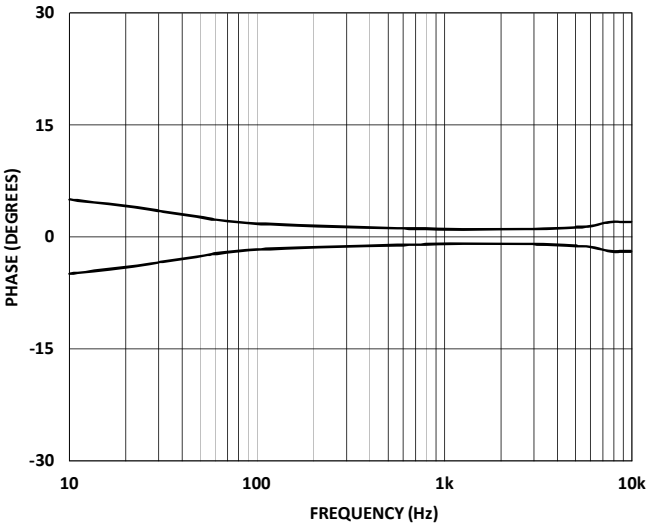


Figure 10. Phase Variation From Typical Response

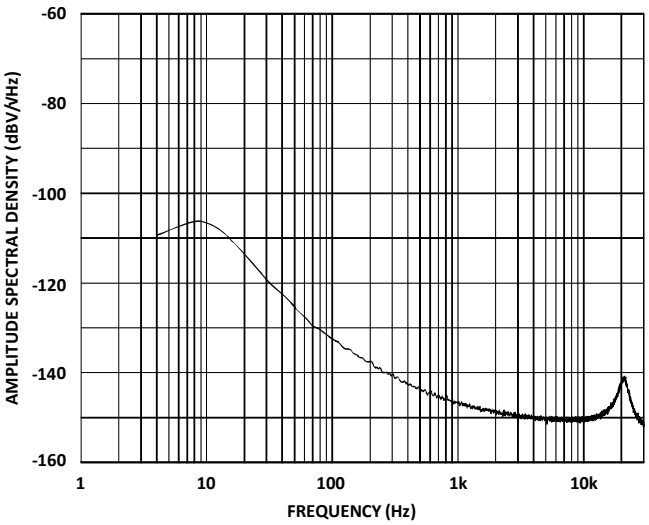


Figure 11. Noise Spectrum Amplitude Spectral Density

APPLICATIONS INFORMATION

CONNECTING TO AUDIO CODECS

The ICS-40300 output can be connected to a dedicated codec microphone input (see Figure 12) or to a high input impedance gain stage (see Figure 13.) A 0.1 µF ceramic capacitor placed close to the ICS-40300 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 22 µF is recommended in Figure 12 because the input impedance of some codecs can be as low as 2 kΩ at their highest PGA gain setting, which results in a high-pass filter corner frequency at 3.6 Hz. At lower gain settings, where the codec input impedance is also lower, a smaller AC-coupling capacitor can be used. Figure 13 shows the ICS-40300 connected to an op amp configured as a non-inverting preamplifier.

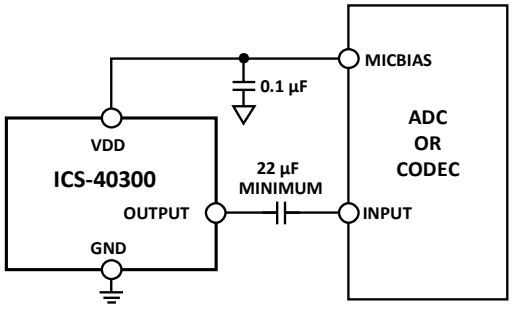


Figure 12. ICS-40300 Connected to a Codec

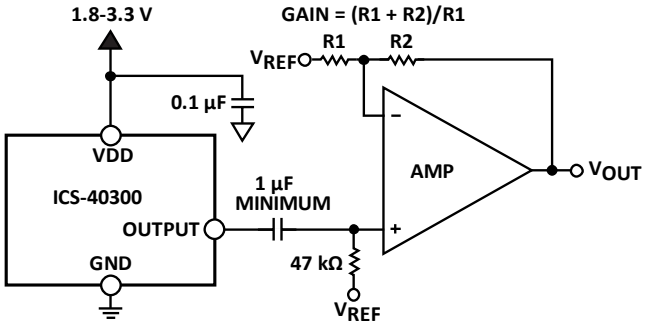


Figure 13. ICS-40300 Connected to an Op Amp

DYNAMIC RANGE CONSIDERATIONS

To fully utilize the 99 dB dynamic range of the ICS-40300 in a design, the preamp, ADC, or codec circuit following it must be chosen carefully. A typical codec may have a 100 dB dynamic range with V_{DD} = 3.3 V. To match the dynamic ranges between the microphone and the ADC input of the codec, some gain must be added to the ICS-40300 output. For example, at the 130 dB SPL maximum acoustic input, the ICS-40300 outputs a −9 dBV rms signal. The full-scale input voltage of a codec may be 0 dBV; therefore, 9 dB of gain must be added to the signal to match the dynamic range of the microphone with the dynamic range of the codec.

SUPPORTING DOCUMENTS

For additional information, see the following documents.

EVALUATION BOARD USER GUIDE

UG-445, *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 Microphone Preamp Circuits*
AN-1181, *Using a MEMS Microphone in a 2-Wire Microphone Circuit*

APPLICATION NOTE (PRODUCT-SPECIFIC)

AN-0284 *Low-Noise Directional Studio Microphone Reference Design*

PCB DESIGN AND LAND PATTERN LAYOUT

The recommended PCB land pattern for the ICS-40300 should be laid out to a 1:1 ratio to the solder pads on the microphone package, as shown in Figure 14. 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 15. 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.

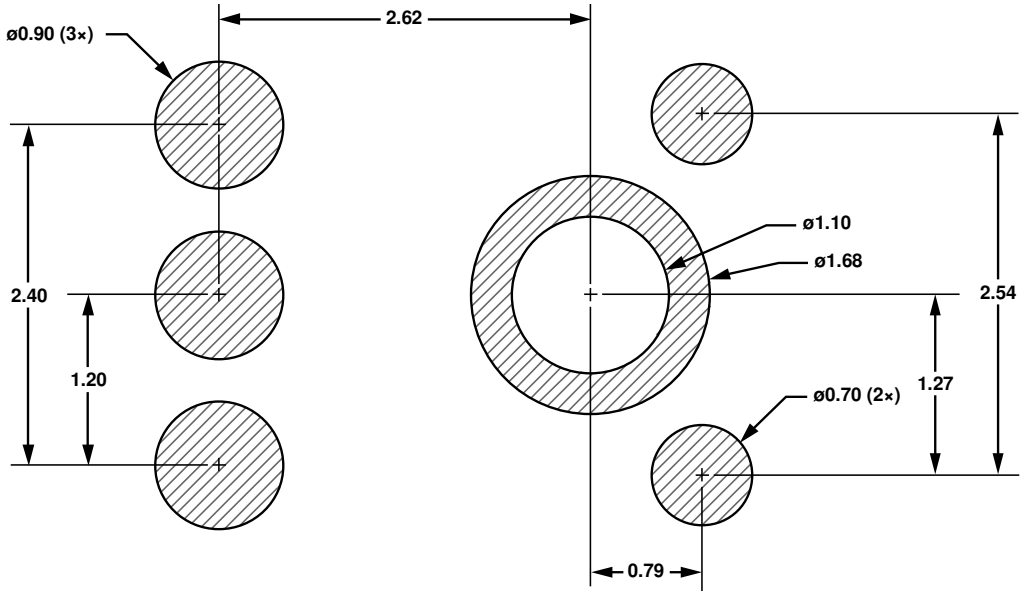


Figure 14. PCB Land Pattern Layout

Dimensions shown in millimeters

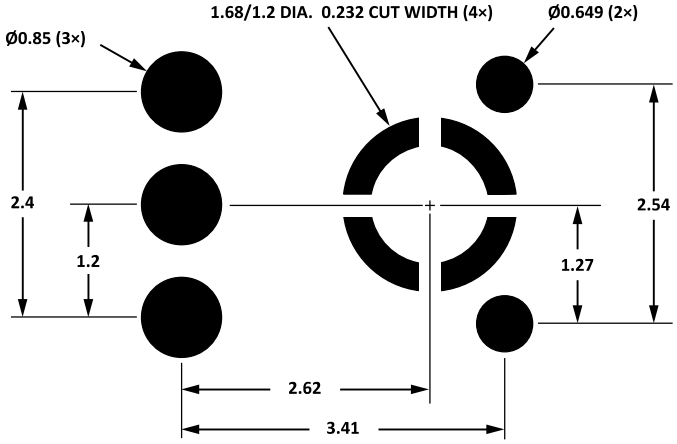


Figure 15. Suggested Solder Paste Stencil Pattern Layout

Dimensions shown in millimeters

PCB MATERIAL AND THICKNESS

The performance of the ICS-40300 is not affected by PCB thickness. The ICS-40300 can be mounted on either a rigid or flexible PCB. A flexible PCB with the microphone can be attached directly to the device housing with an adhesive layer. This mounting method offers a reliable seal around the sound port while providing the shortest acoustic path for good sound quality.

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.

OUTLINE DIMENSIONS

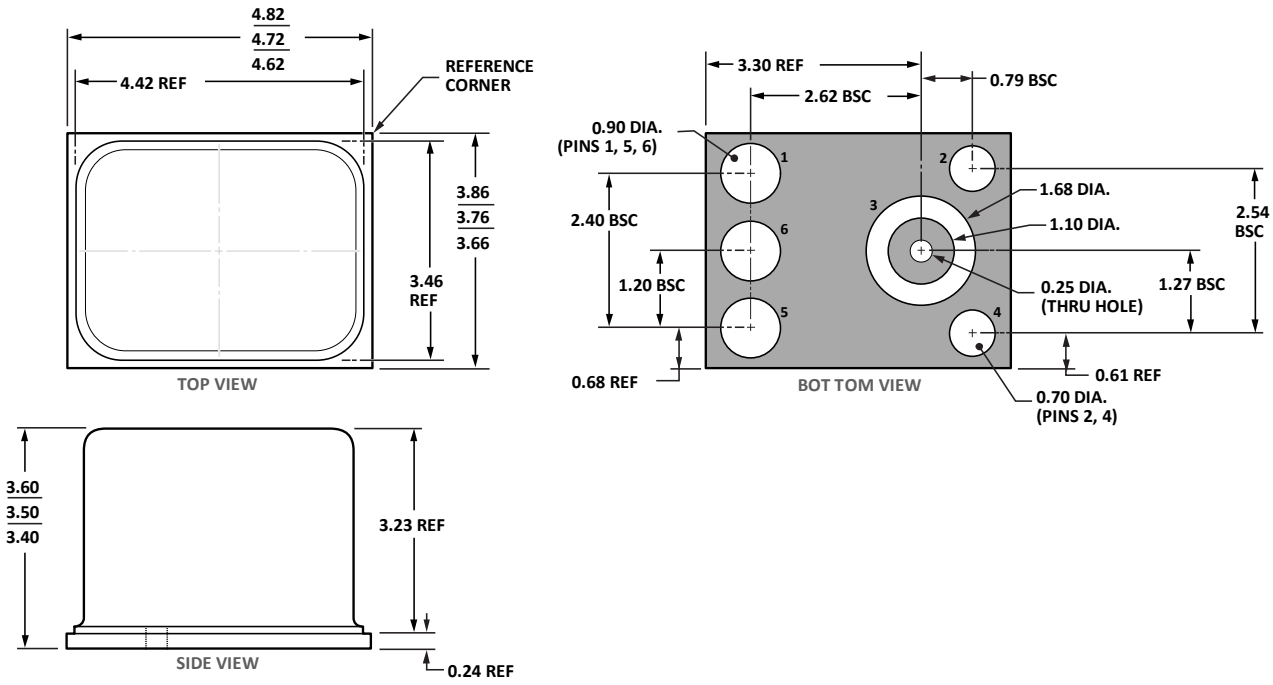


Figure 16. 4-Terminal Chip Array Small Outline No Lead Cavity
4.72 × 3.76 × 3.50 mm Body
Dimensions shown in millimeters

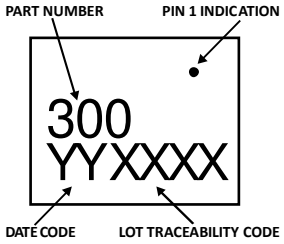


Figure 17. Package Marking Specification (Top View)

ORDERING GUIDE

PART	TEMP RANGE	PACKAGE	QUANTITY	PACKAGING
ICS-40300	−40°C to +85°C	6-Terminal LGA_CAV	2,000	13” Tape and Reel
EV_ICS-40300-FX		Flex Evaluation Board		

REVISION HISTORY

REVISION DATE	REVISION	DESCRIPTION
5/15/2014	1.0	Initial Release
08/18/2015	1.1	Updated reel quantity in *Ordering Guide*
5/9/2018	1.2	Updated Stencil Mask
7/17/2018	1.3	Enviromental Performance

COMPLIANCE DECLARATION DISCLAIMER

InvenSense believes the environmental and other compliance information given in this document to be correct but cannot guarantee accuracy or completeness. Conformity documents substantiating the specifications and component characteristics are on file. InvenSense subcontracts manufacturing, and the information contained herein is based on data received from vendors and suppliers, which has not been validated by InvenSense.

This information furnished by InvenSense, Inc. ("InvenSense") is believed to be accurate and reliable. However, no responsibility is assumed by InvenSense for its use, or for any infringements of patents or other rights of third parties that may result from its use. Specifications are subject to change without notice. InvenSense reserves the right to make changes to this product, including its circuits and software, in order to improve its design and/or performance, without prior notice. InvenSense makes no warranties, neither expressed nor implied, regarding the information and specifications contained in this document. InvenSense assumes no responsibility for any claims or damages arising from information contained in this document, or from the use of products and services detailed therein. This includes, but is not limited to, claims or damages based on the infringement of patents, copyrights, mask work and/or other intellectual property rights.

Certain intellectual property owned by InvenSense and described in this document is patent protected. No license is granted by implication or otherwise under any patent or patent rights of InvenSense. This publication supersedes and replaces all information previously supplied. Trademarks that are registered trademarks are the property of their respective companies. InvenSense sensors should not be used or sold in the development, storage, production or utilization of any conventional or mass-destructive weapons or for any other weapons or life threatening applications, as well as in any other life critical applications such as medical equipment, transportation, aerospace and nuclear instruments, undersea equipment, power plant equipment, disaster prevention and crime prevention equipment.

©2018 InvenSense. All rights reserved. InvenSense, MotionTracking, MotionProcessing, MotionProcessor, MotionFusion, MotionApps, DMP, AAR, and the InvenSense logo are trademarks of InvenSense, Inc.

InvenSense Sensing Everything

©2018 InvenSense. All rights reserved.