ICS-40216

Analog MEMS Microphone with Single Ended Output

GENERAL DESCRIPTION

The ICS-40216 is an analog MEMS microphone with very high dynamic range and high SNR. The ICS-40216 includes a MEMS microphone element, an impedance converter, an output amplifier and an enhanced RF package. The ICS-40216's 65.5 dB SNR and ±1 dB sensitivity tolerance make it an excellent choice for microphone arrays and far field voice control applications.

The ICS-40216 has a linear response up to 130 dB SPL with an output sensitivity specification of −40 dBV.

The ICS-40216 is available in a small 3.5 mm × 2.65 mm × 0.98 mm surface-mount package.

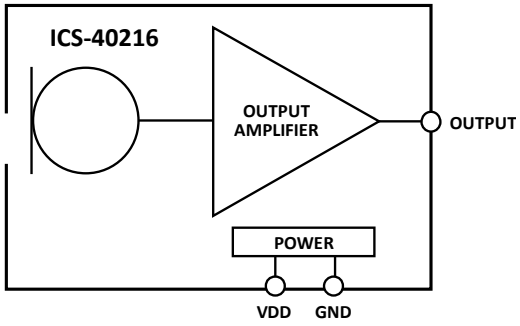
APPLICATIONS

- Tablet Computers
- Teleconferencing Systems
- Digital Still and Video Cameras
- Communication or ANC Headsets
- Security and Surveillance
- Microphone Arrays
- Voice Control and Activation

FEATURES

- −40 dBV Sensitivity
- 130 dB SPL Acoustic Overload Point
- ±1 dB Sensitivity Tolerance
- Small 3.5 × 2.65 × 0.98 mm Surface-Mount Package
- Inverted Signal Output
- Extended Frequency Response from 35 Hz to 20 kHz
- 165 µA Current Consumption
- 65.5 dBA SNR
- −86 dBV PSR
- Compatible with Sn/Pb and Pb-Free Solder Processes
- RoHS/WEEE Compliant

FUNCTIONAL BLOCK DIAGRAM



ORDERING INFORMATION

PART	TEMP RANGE	PACKAGING
ICS-40216	−40°C to +85°C	13" Tape and Reel
EV_ICS-40216-FX	—	—

TDK, a TDK Group Company Inc.
1745 Technology Drive, San Jose, CA 95110 U.S.A
+1(408) 988–7339
www.TDK.com

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SPECIFICATIONS

TABLE 1. ELECTRICAL CHARACTERISTICS

T_A = 25°C, V_{DD} = 1.65 to 3.63 V, unless otherwise noted. Typical specifications are not guaranteed.

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS	NOTES
PERFORMANCE						
Directionality			Omni			
Output Polarity			Inverted			
Sensitivity	1 kHz, 94 dB SPL	−41	−40	−39	dBV	
Signal-to-Noise Ratio (SNR)	20 Hz to 20 kHz, A-weighted		65.5		dBA	
Equivalent Input Noise (EIN)	20 Hz to 20 kHz, A-weighted		28.5		dBA SPL	
Dynamic Range	Derived from EIN and maximum acoustic input		101.5		dB	
Frequency Response	Low frequency −3 dB point		35		Hz	1
	High frequency −3 dB point		>20		kHz	
Total Harmonic Distortion (THD)	105 dB SPL		0.15	1	%	
Power-Supply Rejection (PSR)	217 Hz, 100 mVp-p square wave superimposed on V_{DD} = 2.75V, A-weighted		−86		dBV	
Power Supply Rejection Ratio (PSRR)	1 kHz, 100 mV p-p sine wave superimposed on V_{DD} = 2.75V		−80		dB	
Acoustic Overload Point	10% THD		130		dB SPL	
POWER SUPPLY						
Supply Voltage (V_{DD})		1.65		3.63	V	
Supply Current (I_S)						
	V_{DD} = 1.8 V		165	190	µA	
	V_{DD} = 2.75 V		165	190	µA	
OUTPUT CHARACTERISTICS						
Output Impedance			190		Ω	
Maximum Output Voltage	130 dB SPL input		0.631		V rms	
Noise Floor	20 Hz to 20 kHz, A-weighted, rms		-105.5		dBV	

Note 1: See Figure 3.

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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
Mechanical Shock	10,000 *g*
Vibration	Per MIL-STD-883 Method 2007, Test Condition B
Temperature Range	
Operating	−40°C to +85°C
Storage	−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.

SOLDERING PROFILE

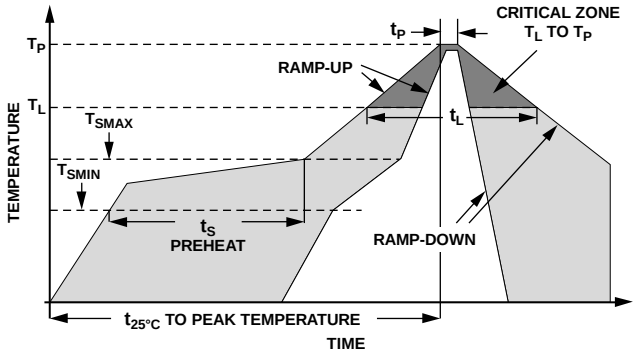

Figure 1. Recommended Soldering Profile Limits

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
	Maximum Temperature (T_{SMAX})	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 TDK MEMS microphones. All microphones are also compatible with the J-STD-020 profile*

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PIN CONFIGURATIONS AND FUNCTION DESCRIPTIONS

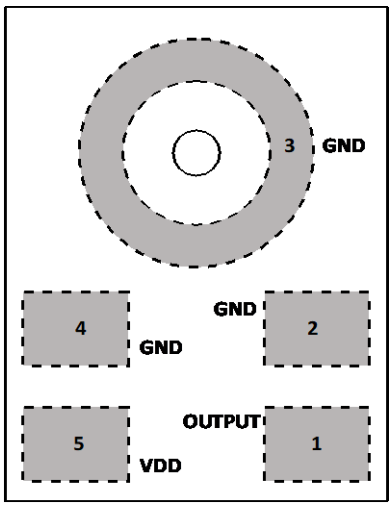

Figure 2. Pin Configuration (Top View, Terminal Side Down)

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

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TYPICAL PERFORMANCE CHARACTERISTICS

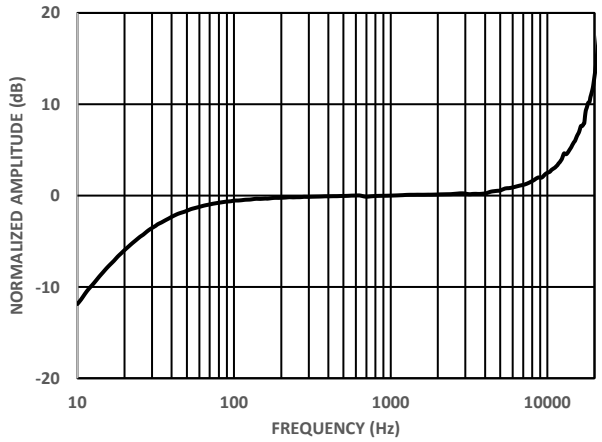

Figure 3. Typical Frequency Response

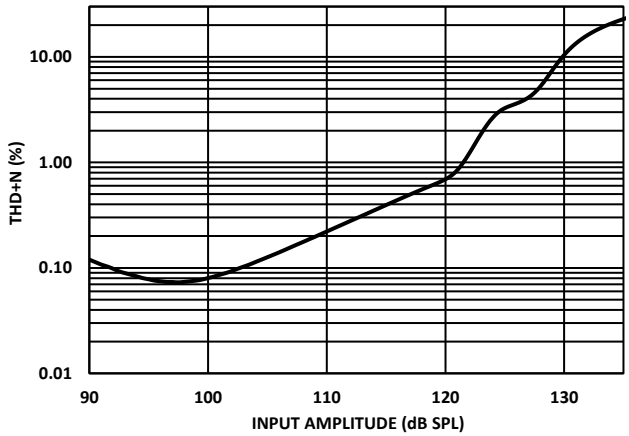

Figure 4. THD + N vs. Input Level

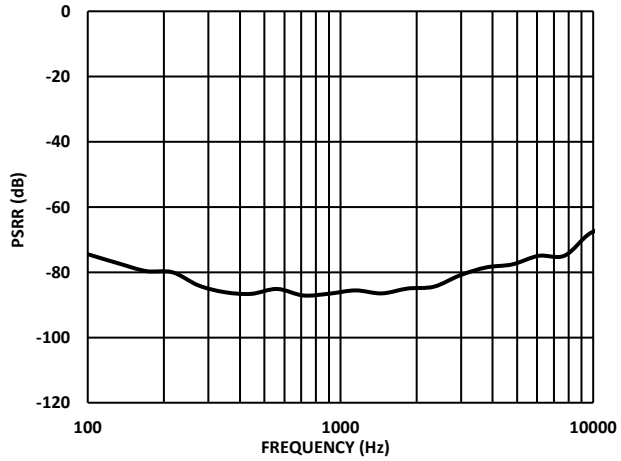

Figure 5. Power-Supply Rejection Ratio (PSRR) vs. Frequency

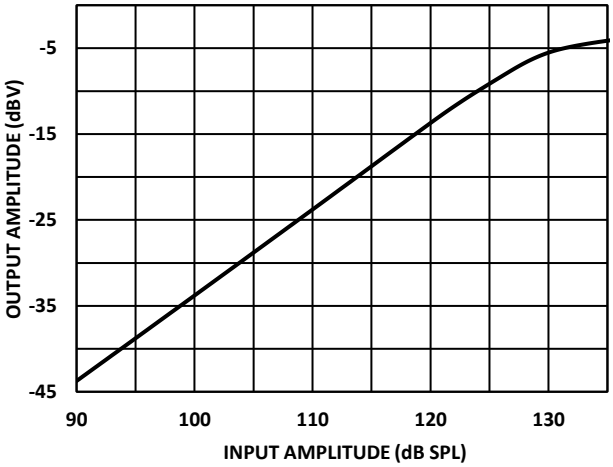

Figure 6. Linearity

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APPLICATIONS INFORMATION

CODEC CONNECTION

The ICS-40216 output can be connected to a dedicated codec microphone input (see Figure 7) or to a high input impedance gain stage. A 0.1 µF ceramic capacitor placed close to the ICS-40216 supply pin is used for testing and is recommended to adequately decouple the microphone from noise on the power supply. DC blocking capacitors are required at the outputs of the microphone. These capacitors create 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 7because the input impedance of some codecs can be as low as 2 kΩ at their highest PGA gain setting.

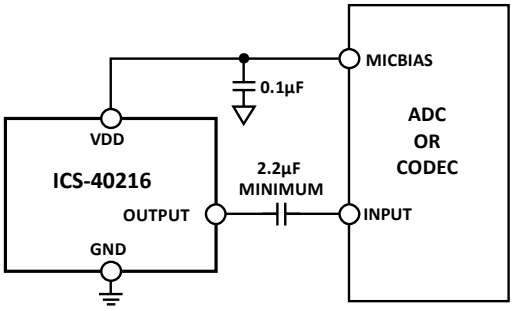

Figure 7. ICS-40216 Connected to a Codec

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SUPPORTING DOCUMENTS

For additional information, see the following documents.

EVALUATION BOARD USER GUIDE

AN-000013, Analog Output MEMS Microphone Flex Evaluation Board User Guide

APPLICATION NOTES

AN-100, *MEMS Microphone Handling and Assembly Guide*
AN-1003, *Recommendations for Mounting and Connecting the TDK Bottom-Ported MEMS Microphones*
AN-1112, *Microphone Specifications Explained*
AN-1124, *Recommendations for Sealing TDK 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*

PCB DESIGN AND LAND PATTERN LAYOUT

Lay out the PCB land pattern for the ICS-40216 at a 1:1 ratio to the solder pads on the microphone package (see Figure 8.) Take care to avoid applying solder paste to the sound hole in the PCB. Figure 9 shows a suggested solder paste stencil pattern layout.

The response of the ICS-40216 is not affected by the PCB hole size, as long as the hole is not smaller than the sound port of the microphone (0.325 mm, in diameter). A 0.5 to 1 mm diameter for the hole is recommended.

Align the hole in the microphone package with the hole in the PCB. The exact degree of the alignment does not affect the performance of the microphone as long as the holes are not partially or completely blocked.

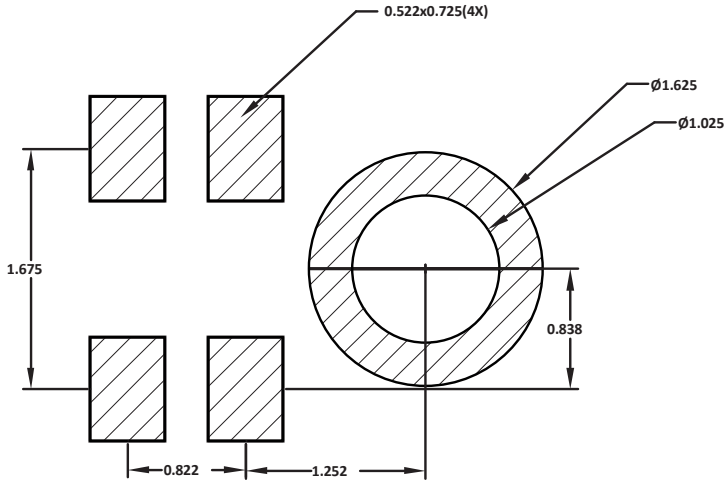

Figure 8. Suggested PCB Land Pattern Layout

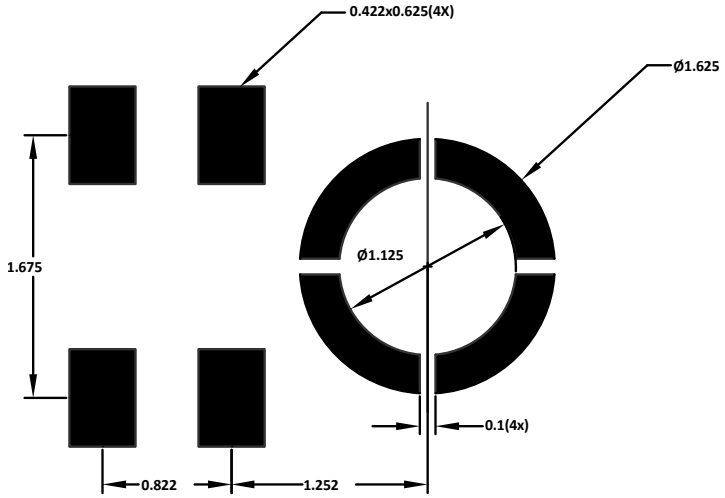

Figure 9. Suggested Solder Paste Stencil Pattern Layout

PCB MATERIAL AND THICKNESS

The performance of the ICS-40216 is not affected by PCB thickness. The ICS-40216 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.

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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 top of the package, the pickup tool should not be placed over the microphone port.
- 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.

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OUTLINE DIMENSIONS

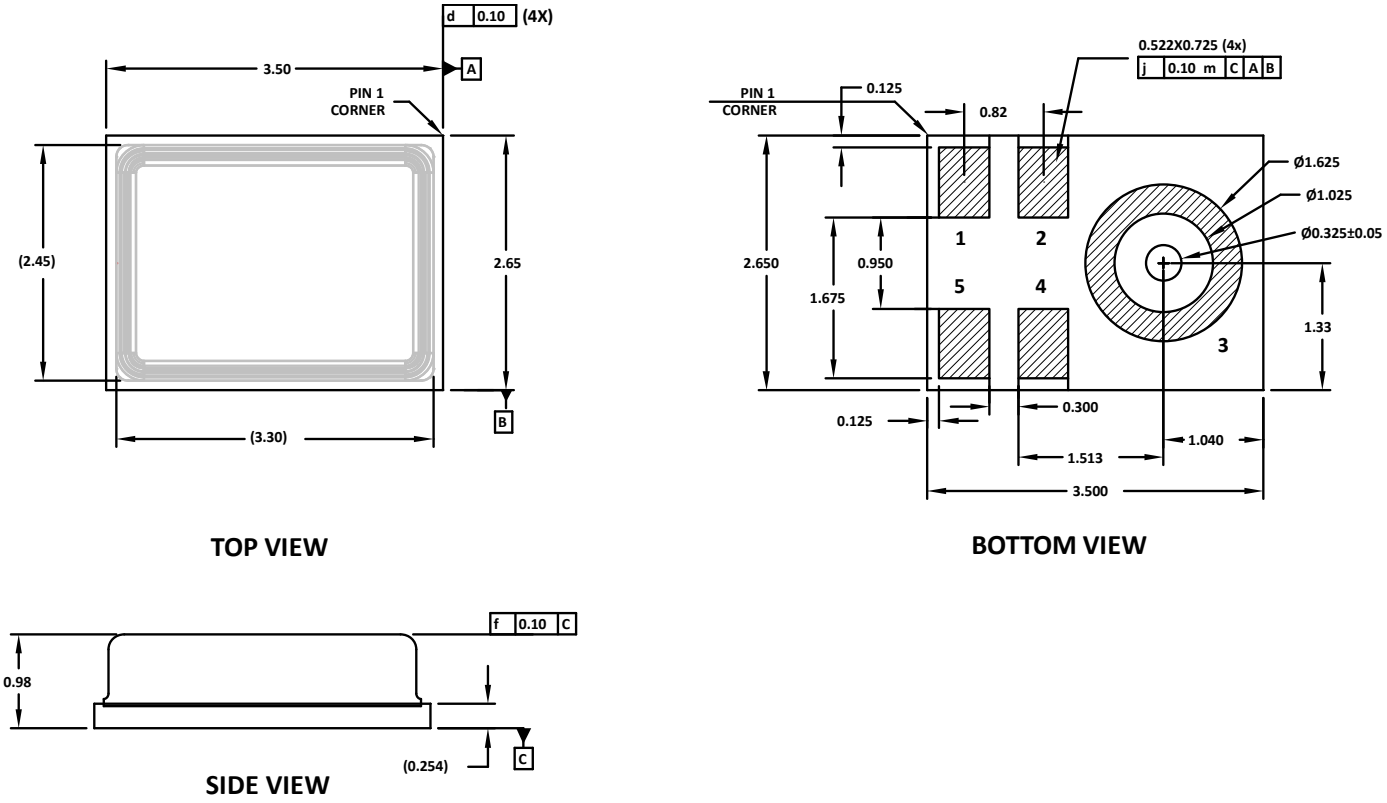

Figure 10. 4-Terminal Chip Array Small Outline No Lead Cavity
3.5 mm × 2.65 mm × 0.98 mm
Dimensions shown in millimeters

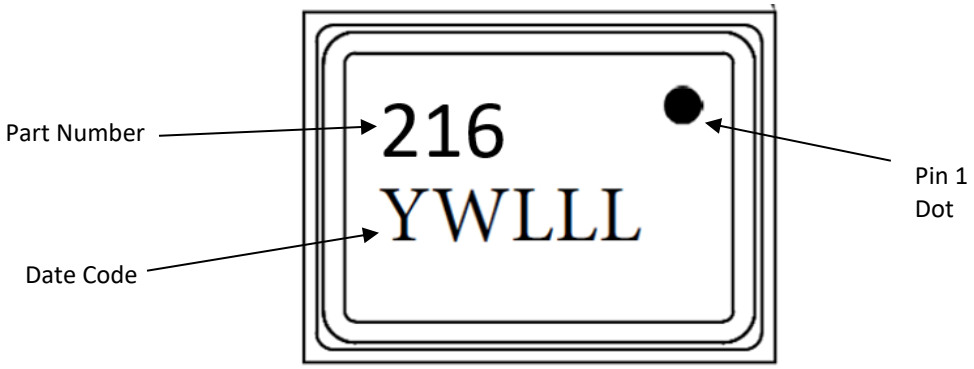

Figure 11. Package Marking Specification (Top View)

ORDERING GUIDE

PART	TEMP RANGE	PACKAGE	QUANTITY	PACKAGING
ICS-40216	−40°C to +85°C	5-Terminal LGA_CAV	10,000	13” Tape and Reel
EV_ICS-40216-FX		Flex Evaluation Board		

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REVISION HISTORY

REVISION DATE	REVISION	DESCRIPTION
3/21/2022	1.0	Initial Version

COMPLIANCE DECLARATION DISCLAIMER

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