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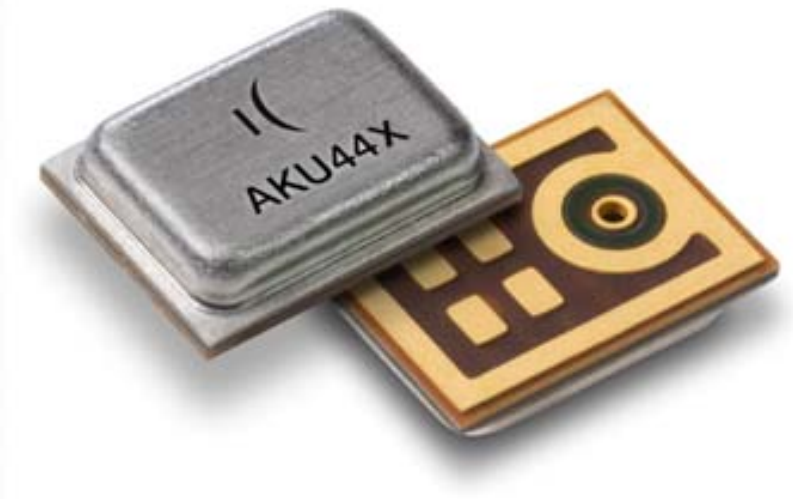
Akustica, Inc.

Data sheet AKU440 / AKU441 / AKU443 Digital Silicon MEMS Microphones



AKU440 / AKU441 / AKU443 Data Sheet

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Data sheet revision	1.15a
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Notes	Specifications are subject to change without notice. Product photos and pictures are for illustration purposes only and may differ from the real product's appearance.

AKU440 / AKU441 / AKU443
Digital, HD Voice Silicon MEMS Microphones

Key Features

- Digital PDM output
- Bottom-port package
- Omni-directional silicon acoustic sensors
- Excellent acoustic performance: 63dB SNR
- Sensitivity: -26dBFS
- Tightly controlled sensitivity tolerances:
  - AKU440: ± 2dB
  - AKU443: ± 1.5dB
  - AKU443P/441: ± 1dB
- Compatible with Microsoft® Windows®, LYNC® & Skype® logo certifications, Intel® Ultrabook™ and Google® Chromebook™ requirements for digital microphones
- Robust digital-output & metal lid package immune to RF/EM interference
- Matched microphones in frequency and phase response for array applications
- Output supports dual-microphone, single-wire multiplexing
- Industry standard microphone interface compatible with multiple codecs
- Low current power-down mode
- Lead-free surface-mountable and RoHS2 compliant
- Halogen-free compliance, IEC61249-2-21
- Thin profile, SMT packaging
- Industry-standard package: 4.0 x 3.0 x 1.0 mm^3

Typical Applications

- Ultrabooks
- Mobile phones
- Media tablets and eReaders
- Microphone arrays
- Webcams and camera modules

General Description

AKU440 / AKU441 / AKU443 consists of HD Voice quality, bottom port, digital output silicon MEMS IC microphones. They are microphones consisting of a MEMS acoustic sensor and an integrated circuit (IC) with a pre-amplifier, analog-to-digital converter, charge pump, and supporting circuitry in a small 4.0mm x 3.0mm x 1.0mm package.

The robust digital output stream from the AKU440 / AKU441 / AKU443 are virtually immune to all forms of Radio Frequency Interference (RFI) and Electromagnetic Interference (EMI) allowing designers the flexibility to integrate the component anywhere on the platform and obtain consistent SNR regardless of proximity to displays, Wi-Fi antennae, or other sources of interference that would degrade the signal of conventional analog microphones.

The devices provide a pulse density modulated (PDM), single-bit digital output stream designed to enable the multiplexing of stereo microphone data onto a single wire. With a user selectable L/R channel option, it is ideal for use in multiple microphone applications.

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1. Absolute maximum ratings

Supply Voltage, V_{DD} to GND	5.5V
ESD Tolerance	
Human Body Model	2000V
Machine Model	200V
Storage Temperature Range	-40°C to 105°C

2. Standard operating conditions

Operating Temperature Range	-40°C to 85°C
Supply Voltage (V_{DD})	1.62V to 3.6V
Clock Frequency	1.00MHz to 3.25MHz

3. Electrical and electro-acoustic specifications

Unless otherwise noted, test conditions are:
V_{DD} = 1.8V Ta = 25°C RH = 50% CLK = 2.4MHz

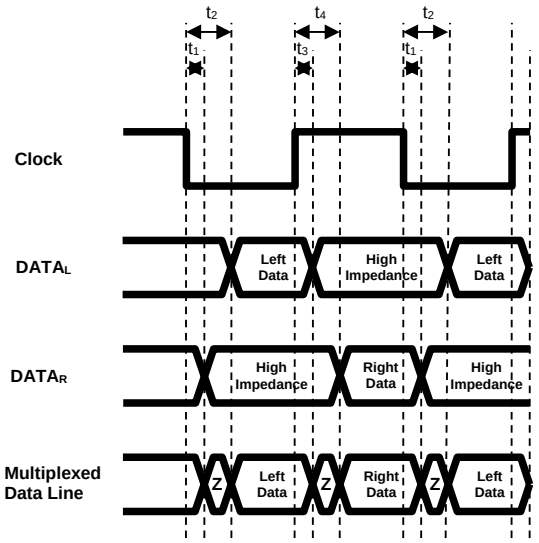
Parameter		Test Conditions	Min.	Typ.	Max.	Unit
Directivity			Omni-directional			
Signal to Noise Ratio (SNR)		f_{in} = 1kHz, A-weighted, 20Hz-10kHz		63		dB
Low Frequency Corner[1]		-3dB from 1kHz sensitivity value		50	100	Hz
High Frequency Corner		+3dB from 1kHz sensitivity value		10		kHz
Sensitivity[1]	AKU440	1kHz, 94dB SPL, full-scale = 100% 1's density at PDM output of microphone	-28	-26	-24	dBFS
	AKU443		-27.5	-26	-24.5	
	AKU443P		-27	-26	-25	
	AKU441		-27	-26	-25	
Total Harmonic Distortion[1] (THD)		@ 100dB SPL, f_{in} = 1kHz			1	%
		@ 110dB SPL, f_{in} = 1kHz			5	
Acoustic Overload Point (AOP)		< 10% THD, f_{in} = 1kHz		116		dBSPL
Power Supply Rejection (PSR)		Signal on V_{DD} = 217Hz, 100mV_{pp}		-72		dBFS
Part-to-part phase matching from nominal		f_{in} = 1kHz			± 10	°
Current Consumption[1] (with no load)		Clock on (CLK = 2.8MHz)		800	930	µA
		Clock off		5	7	µA
Power-up initialization		Data invalid time from clock on			32	ms
Polarity		Increasing sound pressure	Increasing 1's density			

Note 1: Parameter 100% tested

3.1 Timing Characteristics

(Typical performance with load capacitance <20pF and a clock frequency of 2.4MHz)

	Typical Mode	Data Valid	Data Sampled	L/R SELECT Connected to
$DATA_L$	Left	Falling clock	Rising clock	GND
$DATA_R$	Right	Rising clock	Falling clock	V_{DD}



Output	Parameter	Typical Value	Description
$DATA_R$	**t_1**	6ns	Time from falling edge of clock until data becomes high impedance
$DATA_L$	**t_2**	61ns	Time from falling edge of clock until data becomes valid
$DATA_L$	**t_3**	6ns	Time from rising edge of clock until data becomes high impedance
$DATA_R$	**t_4**	53ns	Time from rising edge of clock until data becomes valid

3.2 Digital Logic Characteristics

(Typical performance with load capacitance <20pF and a clock frequency of 2.4MHz)

Symbol	Parameter	Min	Max	Units
$V_{IL\ MAX}$	Maximum level considered a logic 0		$0.4*V_{DD}$	V
$V_{IH\ MIN}$	Minimum level considered a logic 1	$0.5*V_{DD}$		V
$V_{OL\ MAX}$	Maximum level a driven output logic 0 can be		$0.05*V_{DD}$	V
$V_{OH\ MIN}$	Minimum level a driven output logic 1 can be	$0.95*V_{DD}$		V

3.3 Sleep Mode and Active Mode

The AKU44X enters Sleep Mode within 5µS of the clock signal becoming inactive (i.e. clock frequency = 0Hz).

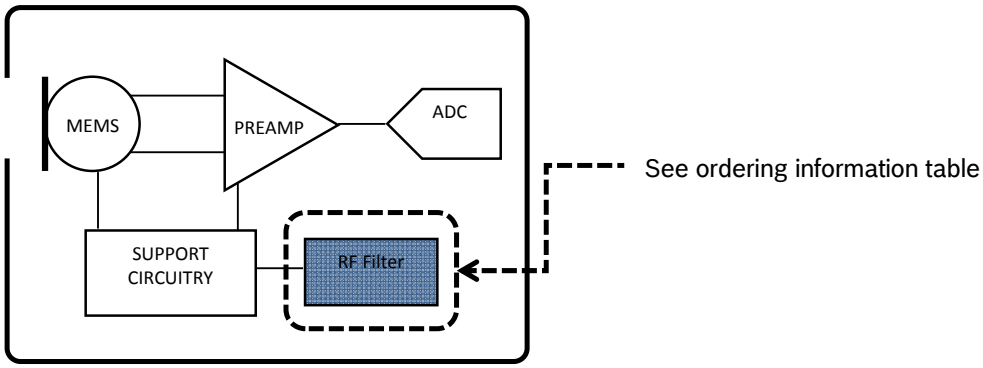
In Sleep Mode the microphone PDM Data output pin is in high impedance state.

The microphone returns from Sleep Mode to Active Mode 65,536 cycles after the clock becomes active (i.e. clock frequency ≥ 1.0MHz). With a 3.072MHz clock, the microphone start-up time is 21.4ms; for a 2.4MHz clock the microphone start-up time is 27.4ms.

3.4 Radio Frequency Interference (RFI) Immunity

The AKU44X products are virtually immune to all forms of Radio Frequency Interference (RFI) and Electromagnetic Interference (EMI). Select devices in the family have additional built-in RF filter(s), as shown in the microphone block diagram below.

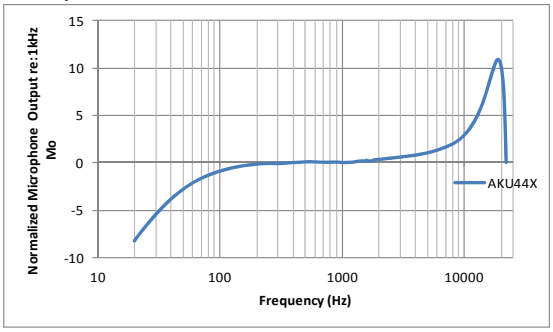
Please refer to the ordering information table in section 11, for available device options.



4. Typical device characteristics

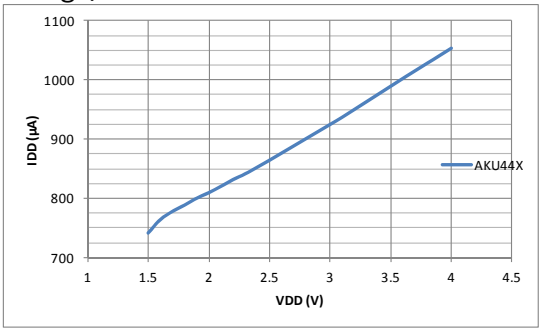
4.1 Frequency Response

(Measured frequency response normalized to 1kHz)



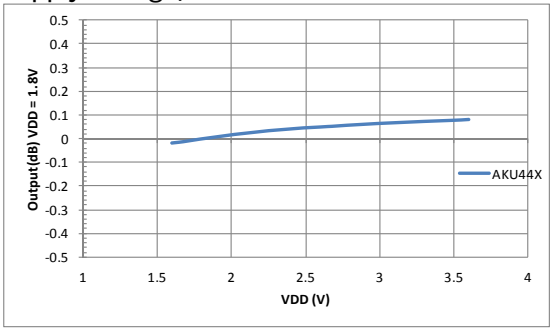
4.2 I_{DD} vs. V_{DD}

(Measured current consumption relative to supply voltage)



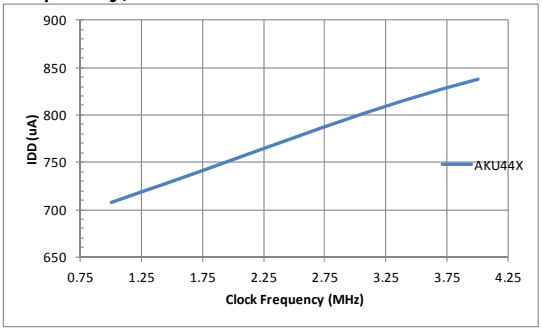
4.3 Sensitivity vs. VDD

(Measured sensitivity changes relative to supply voltage)



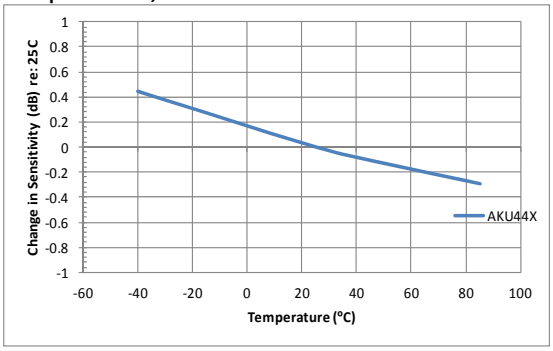
4.4 I_{DD} vs. Clock Frequency

(Measured current consumption relative to clock frequency)



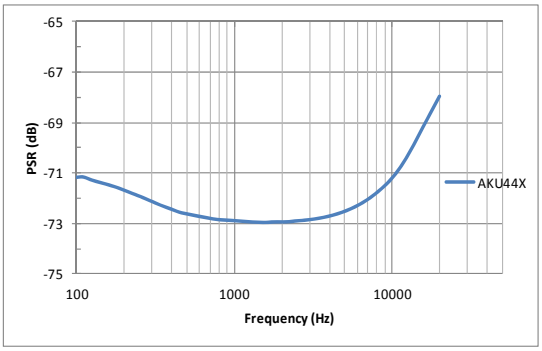
4.5 Sensitivity vs. Temperature

(Typical sensitivity changes relative to temperature)



4.6 PSR vs. Frequency

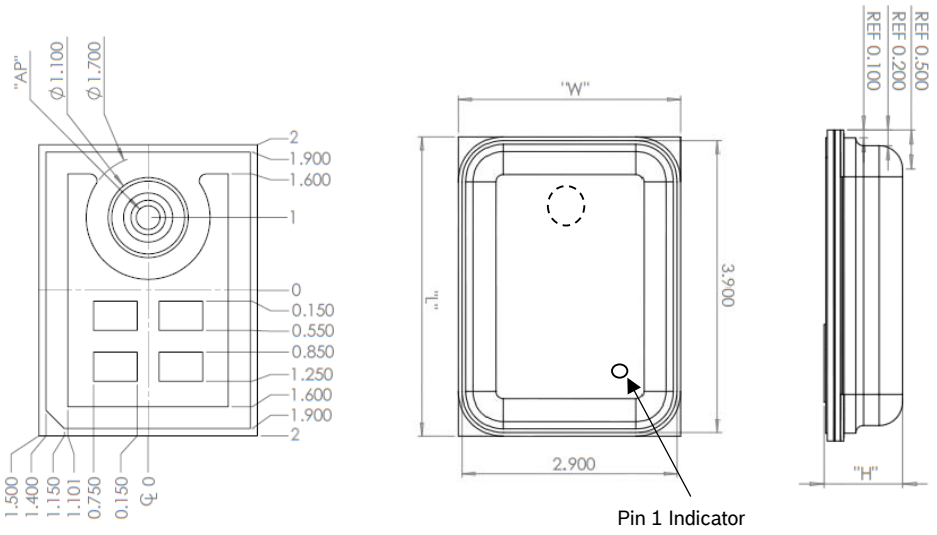
(Typical PSR relative to frequency)



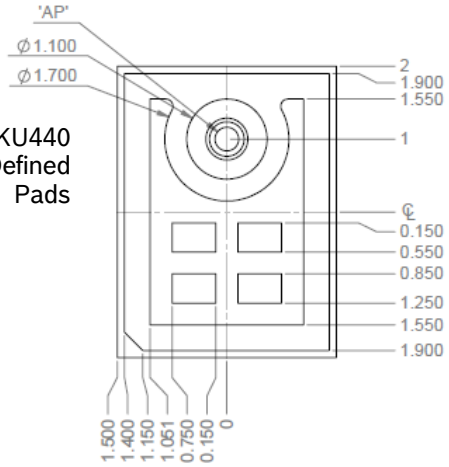
5. Mechanical specifications

Bottom View **Top View** **Side View**

AKU441/443/P
Mask Defined
Pads



AKU440
Metal Defined
Pads

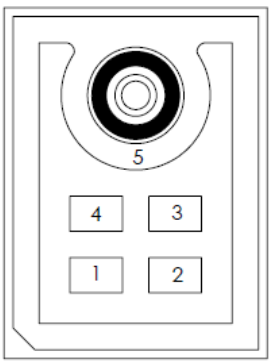


Item	Dimension	Tolerance	Units
Length (L)	4.00	± 0.10	mm
Width (W)	3.00	± 0.10	mm
Height (H)	1.00	± 0.10	mm
Acoustic Port (AP)	0.325	± 0.03	mm
Planarity	Top/Bottom	± 0.05	mm
All dimensions in mm Tolerance ± 0.05mm unless otherwise specified			

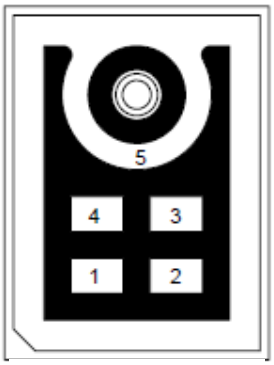
6. Pin-Out and connection diagrams

6.1 Pin-Out

(As viewed from **bottom** of package)



AKU441/443/443P
Metal Defined Pads

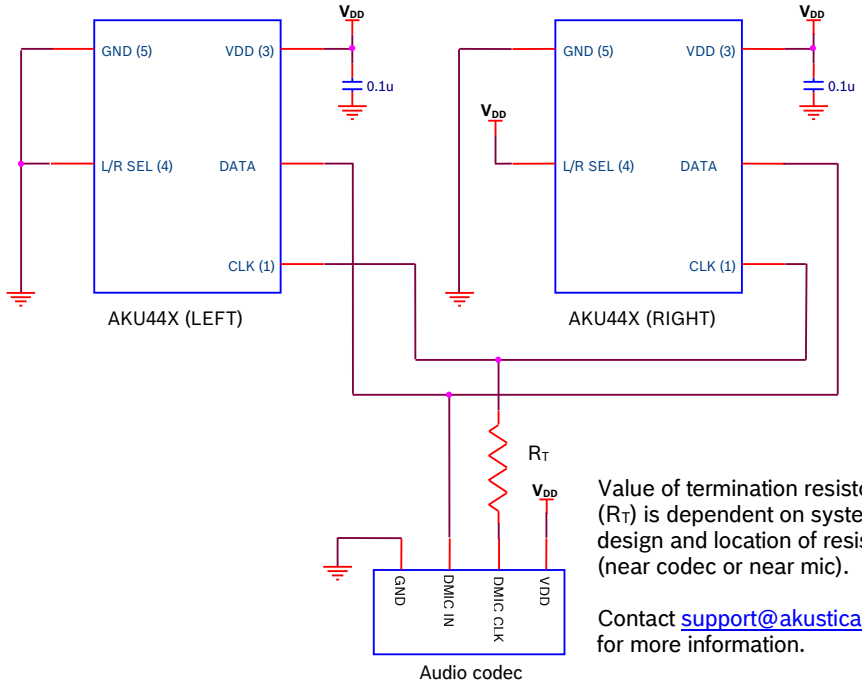


AKU440
Mask Defined Pads

Pin	Name	Function
1	CLK	Clock
2	DATA	PDM Data output
3	V_{DD}	Power
4	L/R*	Left / Right Select
5	GND	Ground

*Must be electrically connected directly to either ground or V_{DD}.

6.2 Typical Application Schematic



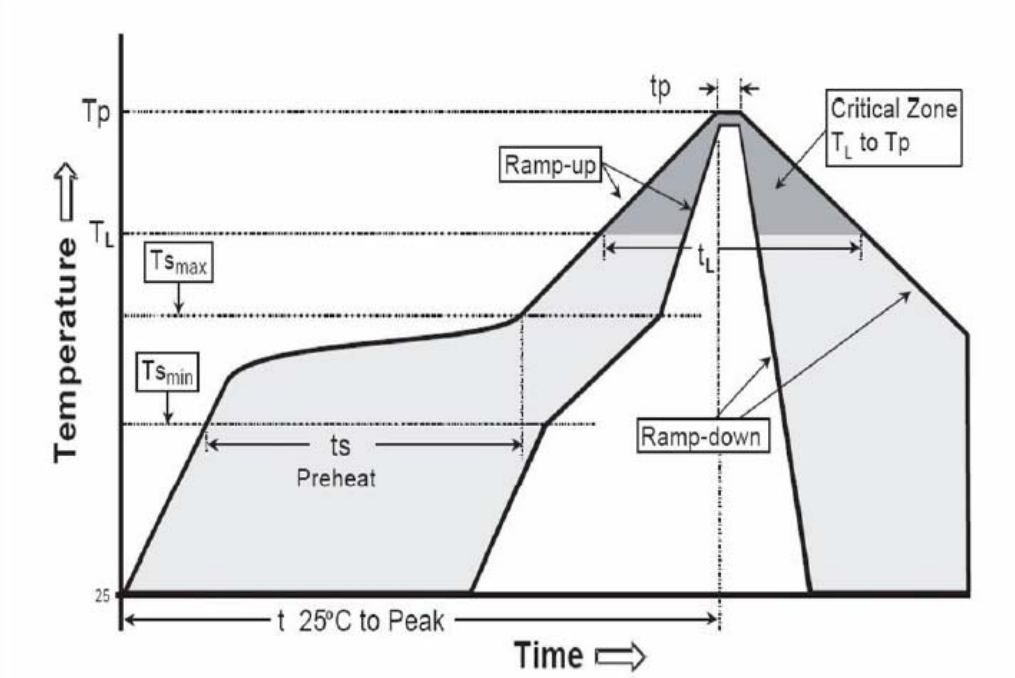
Value of termination resistor (R_T) is dependent on system design and location of resistor (near codec or near mic).

Contact support@akustica.com for more information.

7. Manufacturing notes

7.1 Solder Reflow

Typical solder reflow profile



Description	Parameter	Pb free
Average ramp-up rate	T_L to T_P	max. 3°C/s
Time between Ts_{min} (150°C) and Ts_{max} (200°C)	t_S	60s – 120s
Time above liquidous temperature T_L (217°C)	t_L	60s – 90s
Peak temperature	T_P	max. 260°C
Time at T_P	t_P	max. 20s
Average ramp-down rate	T_P to 25°C	max. 6°C/s

Note: It is recommended to fine-tune the reflow process to optimize for variations in materials, environment, handling, PCB board size and thickness, etc.

Please refer to AN60-Handling, Soldering, and Mounting Instructions for more detailed information and precautions.

7.2. Microphone Handling

Although the microphone may not appear damaged immediately due to inappropriate handling, there can be long term effects that affect the lifetime of the component.

Rule of thumb: The microphone is an artificial ear so treat it like your own ear.

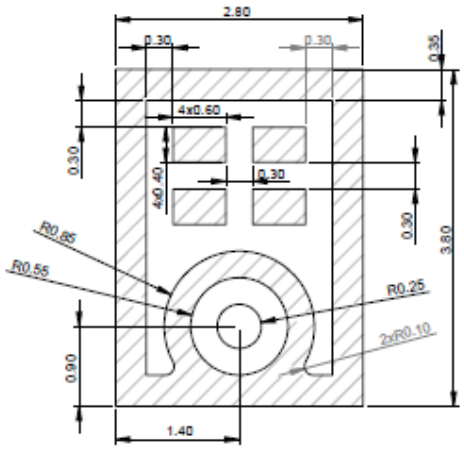
- Do not blow air into the acoustic port of the microphone for any reason. Do not subject it to pressurized air
  - e.g. when cleaning the board or other components on the same board
- Do not apply vacuum to the acoustic port of the microphone
- Do not insert liquids
  - If populated circuit boards are washed, the microphone must be protected
- Do not insert dust
  - The production facilities must be clean
  - e.g. if PCB routing/sawing is done close to the microphone after SMT assembly and reflow
- Do not insert any objects
  - If assembly or rework is done manually, care must be taken that the tools cannot enter the microphone sound port
  - It is best to choose tool size so that it does not fit through the sound port of the microphone
- Do not cover the acoustic port with tape when heating during assembly or reflow
- Do not apply extreme mechanical stresses on the microphone, including mechanical shocks above 10kG or compression of the microphone package.
- After a bottom port microphone has been assembled on a circuit board, protect the sound port (now on the other side of the board) from dust, liquids, and other foreign materials as well as any tools and pressurized air.

ESD Handling Procedures

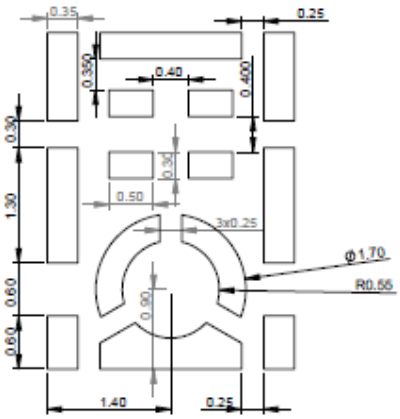
Follow CMOS handling procedures with MEMS microphones. Handle the microphone with proper workplace grounding to include wrist straps and ionized airflow over open trays and reels of microphones. Do not hot-swap/hot-plug during testing. Device pins have ESD ratings of 2kV/200V for HBM/MM respectively.

7.3 PCB Land Pattern and Stencil Pattern

Land Pattern



Stencil Pattern



Note: the aperture of the stencil pattern may require adjustment / optimization based on the thickness of the stencil.

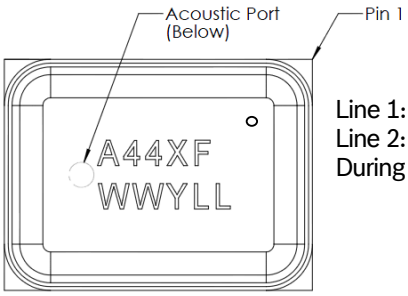
Please refer to AN60-Handling, Soldering, and Mounting Instructions for more detailed information and precautions.

8. Reliability specifications

The microphone sensitivity after stress must deviate by no more than 3dB from the initial value.

	Test	Test Condition	Standard
1	Cold Temp Operation	Temperature = -40°C, 1000 hours (with bias)	IEC 60068-2-1
2	Hot Temp Operation	Temperature = 105°C, 1000 hours (with bias)	IEC 60068-2-2
3	Humidity Operation	Temperature = 85°C, RH = 85%, 1000 hours (with bias)	JESD22-A101-B
4	Cold Temp Storage	Temperature = -40°C, 1000 hours (without bias)	IEC 60068-2-1
5	Hot Temp Storage	Temperature = 105°C, 1000 hours (without bias)	IEC 60068-2-2
6	Humidity Storage	Temperature = 85°C, RH = 85%, 1000 hours (without bias)	JESD22-A101-B
7	Thermal Cycle	100 Cycles, -40°C to +125°C, 15min soaks, <30sec ramps	IEC 60068-2-4
8	Vibration	Sinusoidal Vibration, 20Hz-2000Hz, 4min sweeps, 16min along each of 3 axis, amplitude 3 limits of 20G and 0.06”	Mil-Std-883E, Test A
9	Mechanical Shock	10,000G shocks, 5 impacts along each of 6 axes	MIL-STD-883E
10	Drop Test	Using 150gm aluminum fixture, 3 drops along each of 6 axes (total 18 drops) from 1.5m height onto concrete drop surface.	IEC 60068-2-32
11	ESD (HBM)	+/- 2000V, 1 discharge for each polarity, 11 pin combinations, 22 total discharges per microphone	JESD22-A114-B
12	ESD (MM)	+/- 150V, 1 discharge for each polarity, 11 pin combinations, 22 total discharges per microphone	JESD22-A115-A
13	ESD	+/- 8kV, contact discharge to lid with DUT grounded	IEC 61000-4-2
14	Moisture Sensitivity Level	24 hour bake at 125°C, followed by 168 hours at 85°C, 85%RH, followed by 3 passes solder reflow (MSL Level 1)	JSTD020D-01
15	Reflow Solder	3 pass reflow, peak temperature = 260°C, time duration - see reflow profile in section 7	JSTD020D-01

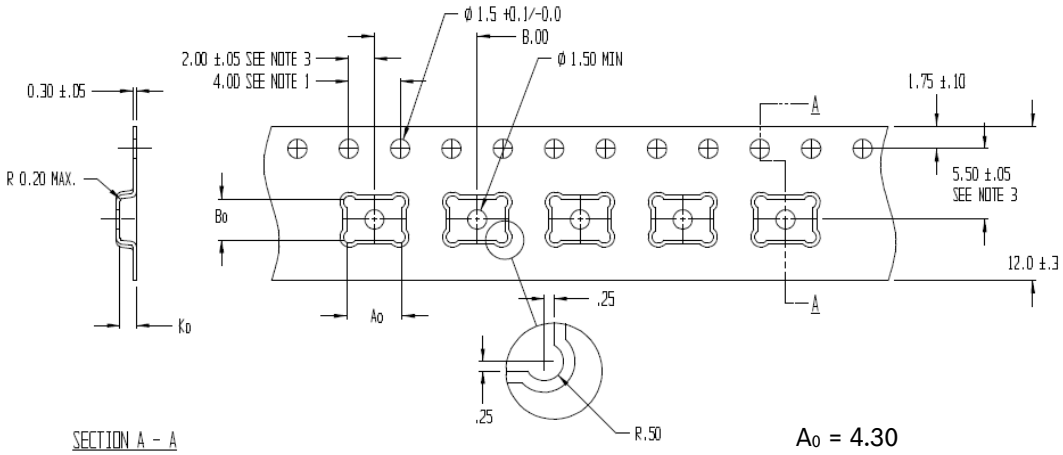
9. Part marking information



Line 1: A44XF (A = Akustica | 44X = Part Code | X = 0, 1, 3 | F = Assy Facility / ID)
Line 2: WWYLL (WW = Work Week | Y = Year | LL = Lot Number Processed During Work Week)

10. Packaging information

10.1 Tape Specification

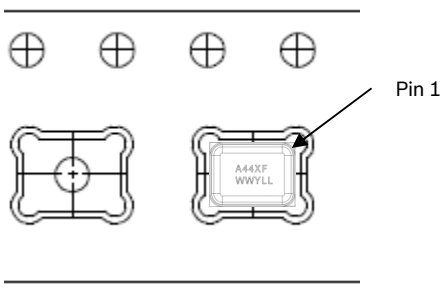


A_0 = 4.30
B_0 = 3.20
K_0 = 1.30

Notes:

1. 10 sprocket hole pitch cumulative tolerance +/- 0.2
2. Camber in compliance with EIA-481
3. Pocket position relative to sprocket hole measured as true position of pocket, not pocket hole
4. A_0 and B_0 are calculated on a plane at a distance of “R” above the bottom of the pocket.

10.2 Component Orientation



11. Ordering information

Order Number	Sensitivity Tolerance (dB)	RF Filter	Part Code	Package	Shipping Method	Standard Quantity
0 273 0A0 021*	+/- 2	No	A440	5-Pad LGA	13” Reel	5,700
0 273 0A0 050	+/- 1.5	No	A443			
0 273 0A0 052	+/- 1	No	A443			
0 273 0A0 030	+/- 1	Yes	A441			

*Not recommended for new designs.

12. Legal Disclaimer

12.1 Engineering samples

Engineering Samples are marked with an asterisk (*) or (e). Samples may vary from the valid technical specifications of the product series contained in this data sheet. They are therefore not intended or fit for resale to third parties or for use in end products. Their sole purpose is internal client testing. The testing of an engineering sample may in no way replace the testing of a product series. Akustica assumes no liability for the use of engineering samples. The Purchaser shall indemnify Akustica from all claims arising from the use of engineering samples.

12.2 Product use

Akustica products are developed for the consumer goods industry. They may only be used within the parameters of this product data sheet. They are not fit for use in life-sustaining or security sensitive systems. Security sensitive systems are those for which a malfunction is expected to lead to bodily harm or significant property damage. In addition, they are not fit for use in products which interact with motor vehicle systems.

The resale and/or use of products are at the purchaser's own risk and his own responsibility. The examination of fitness for the intended use is the sole responsibility of the Purchaser.

The purchaser shall indemnify Akustica from all third party claims arising from any product use not covered by the parameters of this product data sheet or not approved by Akustica and reimburse Akustica for all costs in connection with such claims.

The purchaser must monitor the market for the purchased products, particularly with regard to product safety, and inform Akustica without delay of all security relevant incidents.

12.3 Application examples and hints

With respect to any examples or hints given herein, any typical values stated herein and/or any information regarding the application of the device, Akustica hereby disclaims any and all warranties and liabilities of any kind, including without limitation warranties of non-infringement of intellectual property rights or copyrights of any third party. The information given in this document shall in no event be regarded as a guarantee of conditions or characteristics. They are provided for illustrative purposes only and no evaluation regarding infringement of intellectual property rights or copyrights or regarding functionality, performance or error has been made.

13. Document history and modification

Revision Number	Chapter	Description of modification/changes	Date
0.77	4	Updated sensitivity tolerance	06-Oct-14
0.78	3	Updated current consumption	20-Oct-14
1.01	Cover	Updated cover picture. Deleted “preliminary” footnote.	27-Mar-15
1.02	11	Updated ordering information table	22-Jun-15
1.12	All	Removed AKU442.	06-Jun-16
1.13	All	Added AKU443 products.	21-Jun-16
1.14	All	Applied new datasheet template	05-Jul-16
1.15	11	Updated OPN	02-Sept-16

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