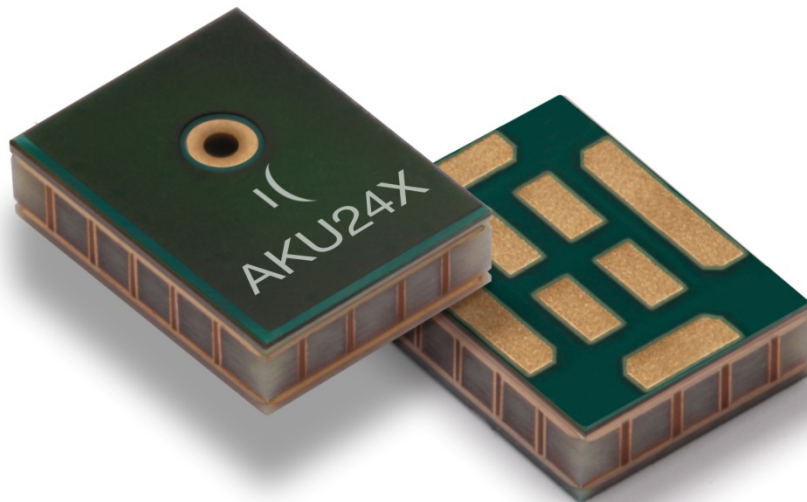


# AKU240 Family

## Top port, Digital Silicon MEMS Microphones



### Data Sheet

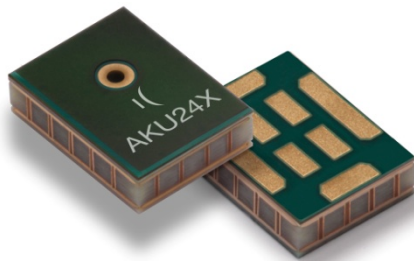
|                     |   |
|---------------------|---|
| Part number(s)      | AKU240, AKU241, AKU242  |
| Package type        | 8-pin LGA top port  |
| Data sheet revision | 1.02  |
| Release date        | 22 June 2015  |
| Document number     | DS45-1.02 AKU240 Family Data Sheet  |
| Notes               | Specifications are subject to change without notice.<br>Product photos and pictures are for illustration purposes only and may differ from the real product's appearance. |

# AKU240 Family

## Digital, HD Voice Silicon MEMS Microphones

### General Description

AKU240 family consists of HD Voice quality, top 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 4.0 x 3.0 x 1.0 mm<sup>3</sup> package. The robust digital output stream from the



AKU240 family is 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 in this family provide a pulse density modulated (PDM), single-bit digital 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.

### Key Features

- Digital PDM output
- Omni-directional audio sensor
- Excellent acoustic performance: 63dB SNR
- Sensitivity: -26dBFS
- Tightly controlled sensitivity tolerances:
  - AKU240:  $\pm 2$ dB
  - AKU241:  $\pm 1$ dB
  - AKU242:  $\pm 1.5$ dB
- Compatible with Microsoft® Windows®, LYNC® & Skype® logo certifications, Intel® Ultrabook™ and Google® Chromebook™ requirements for digital microphones
- Robust digital-output & Faraday-cage constructed 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 std. package: 4.00x3.00x1.00mm<sup>3</sup>


### Typical Applications

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

|   |  |            |
|---|--|------------|
|  | <b>AKU240 Family</b><br>Digital Silicon MEMS Microphones | Data Sheet |
|---|--|------------|

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|---|--|------------|
|  | <b>AKU240 Family</b><br>Digital Silicon MEMS Microphones | Data Sheet |
|---|--|------------|

### 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:  
 $V_{DD} = 1.8V$     $T_a = 25^\circ C$     $RH = 50\%$     $CLK = 2.4MHz$

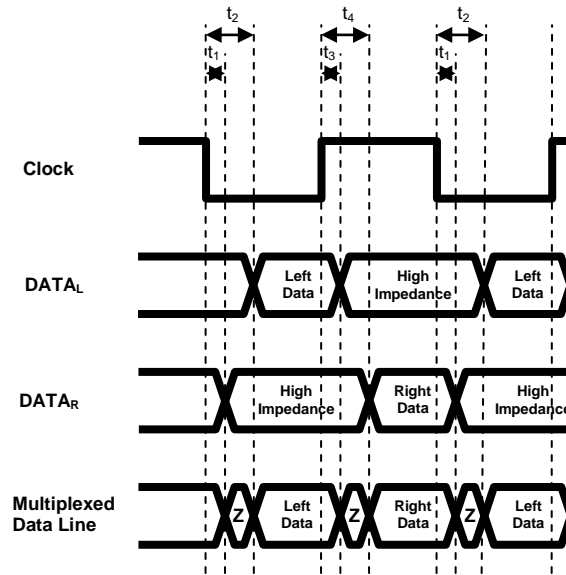
| Parameter                                       |            | Test Conditions   | Min.                   | Typ. | Max.     | Unit    |
|---|------------|---|------------------------|------|----------|---------|
| Directivity                                     |            |   | Omni-directional       |      |          |         |
| Signal to Noise Ratio (SNR)                     |            | $f_{in} = 1kHz$ , A-weighted, 20Hz-10kHz                                  |                        | 63   |          | dB      |
| Low Frequency Corner <sup>1</sup>               |            | -3dB from 1kHz sensitivity value  |                        | 50   | 100      | Hz      |
| High Frequency Corner                           |            | +3dB from 1kHz sensitivity value  |                        | 11   |          | kHz     |
| Sensitivity <sup>1</sup>                        | AKU240     | 1kHz, 94dB SPL, full-scale = 100% 1's density at PDM output of microphone | -28                    | -26  | -24      | dBFS    |
|   | AKU241     |   | -27                    | -26  | -25      |         |
|   | AKU242     |   | -27.5                  | -26  | -24.5    |         |
| Total Harmonic Distortion <sup>1</sup> (THD)    |            | @ 100dB SPL, $f_{in} = 1kHz$  |                        |      | 1        | %       |
|   |            | @ 110dB SPL, $f_{in} = 1kHz$  |                        |      | 5        |         |
| Acoustic Overload Point (AOP)                   |            | < 10% THD, $f_{in} = 1kHz$  |                        | 116  |          | dB SPL  |
| Power Supply Rejection (PSR)                    |            | Signal on $V_{DD} = 217Hz$ , 100mV <sub>pp</sub>                          |                        | -73  |          | dBFS    |
| Part-to-part phase matching from nominal        |            | $f_{in} = 1kHz$   |                        |      | $\pm 10$ | °       |
| Current Consumption <sup>1</sup> (with no load) | AKU240/242 | Clock on (CLK = 2.8MHz)   |                        | 800  | 930      | $\mu A$ |
|   | AKU241     |   |                        | 865  | 1020     | $\mu A$ |
|   |            | Clock off   |                        | 5    | 7        | $\mu A$ |
| Power-up initialization                         |            | Data invalid time from clock on   |                        |      | 28       | ms      |
| Polarity  |            | Increasing sound pressure   | Increasing 1's density |      |          |         |

Note 1: Max. value of 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 |
|-------------------------|--------------|---------------|---------------|-------------------------|
| <b>DATA<sub>L</sub></b> | Left         | Falling clock | Rising clock  | GND                     |
| <b>DATA<sub>R</sub></b> | Right        | Rising clock  | Falling clock | V <sub>DD</sub>         |



| Output                  | Parameter            | Typical Value | Description   |
|-------------------------|----------------------|---------------|---|
| <b>DATA<sub>R</sub></b> | <b>t<sub>1</sub></b> | 6ns           | Time from falling edge of clock until data becomes high impedance |
| <b>DATA<sub>L</sub></b> | <b>t<sub>2</sub></b> | 61ns          | Time from falling edge of clock until data becomes valid          |
| <b>DATA<sub>L</sub></b> | <b>t<sub>3</sub></b> | 6ns           | Time from rising edge of clock until data becomes high impedance  |
| <b>DATA<sub>R</sub></b> | <b>t<sub>4</sub></b> | 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           |                     | $0.4 \cdot V_{DD}$  | V     |
| $V_{IH\ MIN}$ | Minimum level considered a logic 1           | $0.5 \cdot V_{DD}$  |                     | V     |
| $V_{OL\ MAX}$ | Maximum level a driven output logic 0 can be |                     | $0.05 \cdot V_{DD}$ | V     |
| $V_{OH\ MIN}$ | Minimum level a driven output logic 1 can be | $0.95 \cdot V_{DD}$ |                     | V     |

### 3.3 Sleep Mode, and Active Mode

The AKU24X enters Sleep Mode within 5 $\mu$ S of the clock signal becoming inactive (i.e. clock frequency = 0Hz).

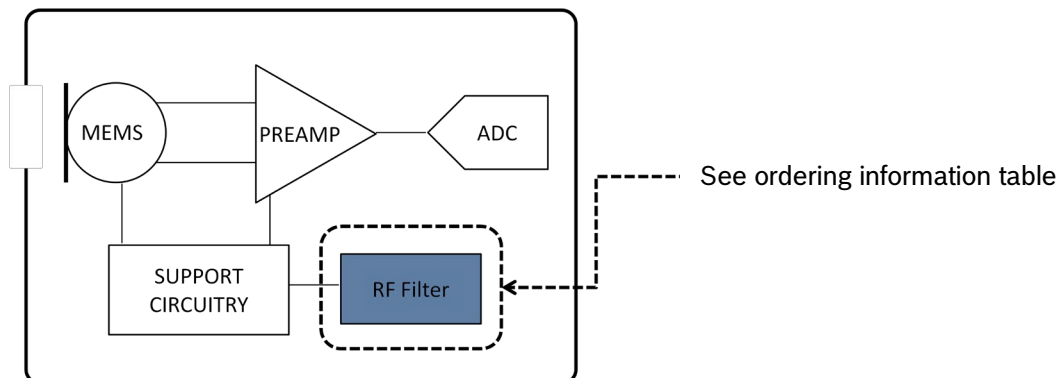
In Sleep Mode the microphone PDM Data output pin is in high impedance state.

The microphone returns from Sleep Mode to Active Mode 65,536 cycles after the clock becomes active (i.e. clock frequency  $\geq$  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 AKU240 family is 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.

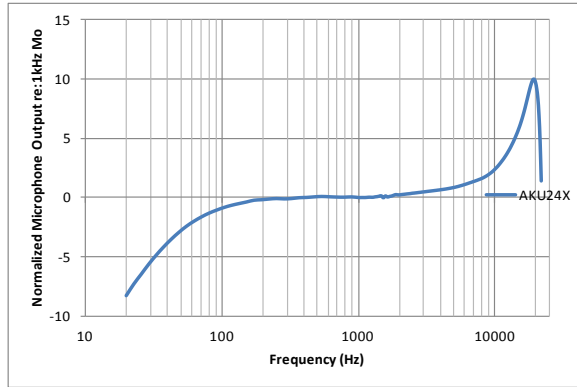
Please refer to the ordering information table in section 11, for available device options.



## 4. DEVICE CHARACTERISTICS

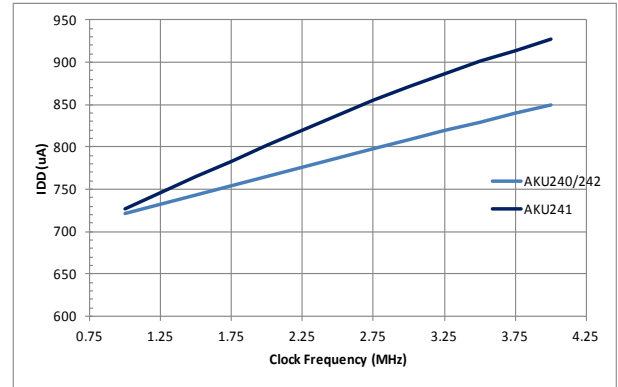
### 4.1 Frequency Response

(Measured frequency response normalized to 1kHz)



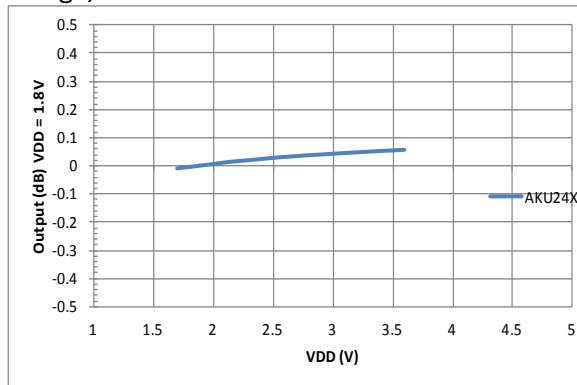
### 4.2 I<sub>DD</sub> vs. V<sub>DD</sub>

(Measured current consumption relative to supply voltage)



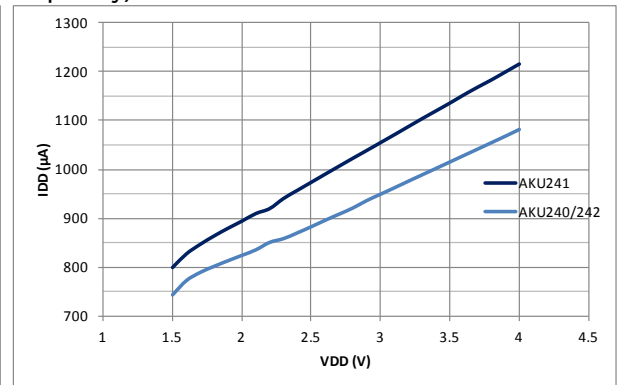
### 4.3 Sensitivity vs. V<sub>DD</sub>

(Measured sensitivity changes relative to supply voltage)



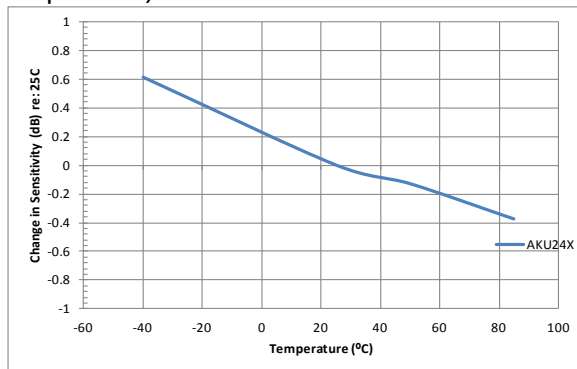
### 4.4 I<sub>DD</sub> vs. Clock Frequency

(Measured current consumption relative to clock frequency)



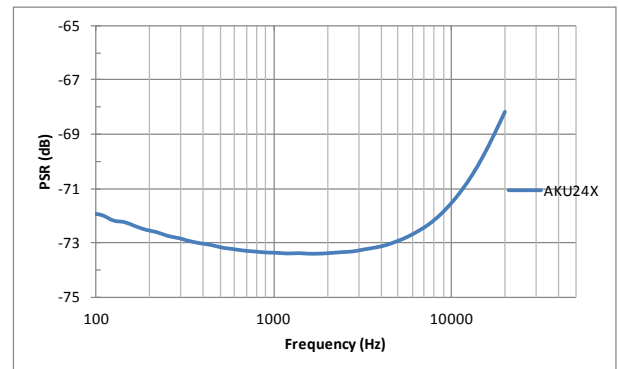
### 4.5 Sensitivity vs. Temperature

(Typical sensitivity changes relative to temperature)

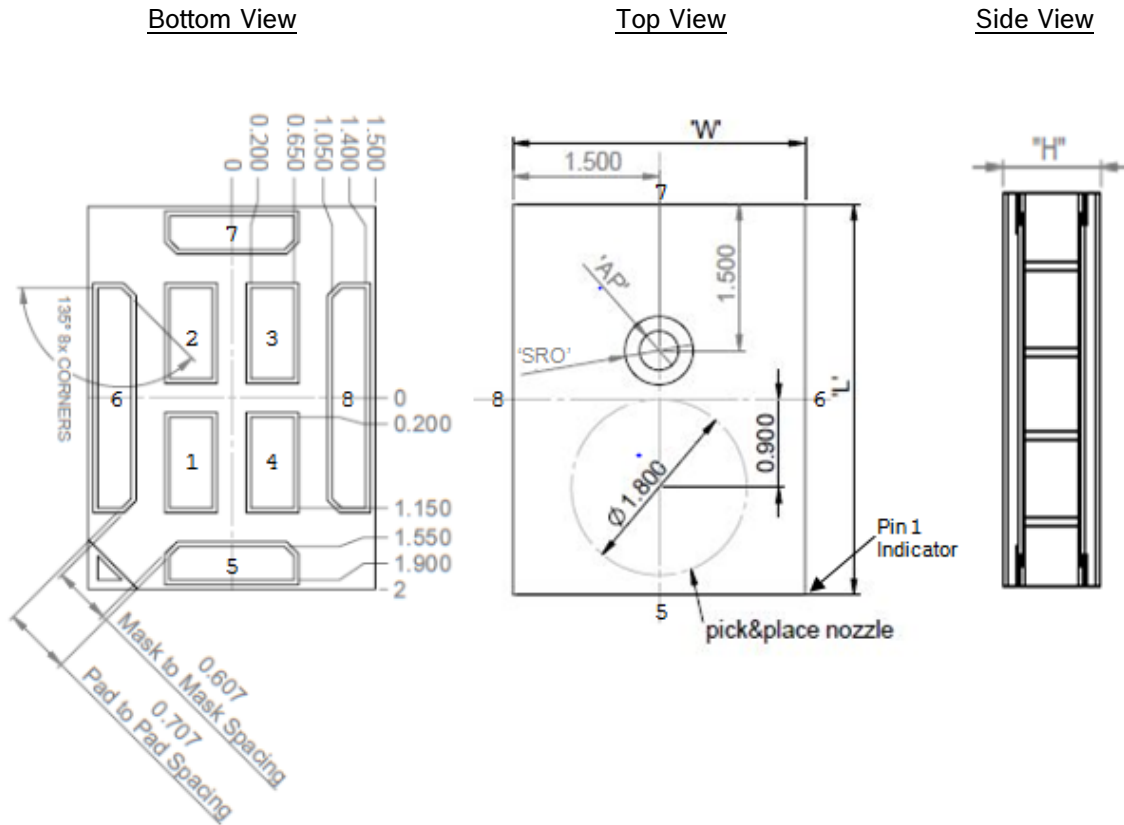


### 4.6 PSR vs. Frequency

(Typical PSR relative to frequency)



**5. MECHANICAL SPECIFICATIONS**



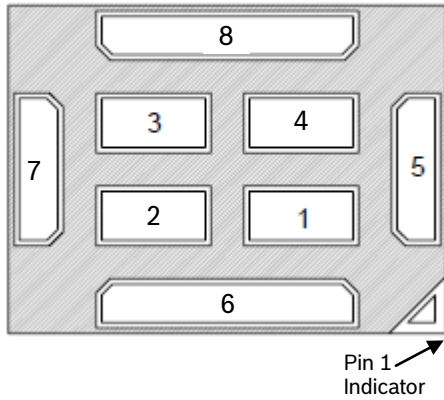
| Item   | Dimension  | Tolerance  | Units |
|--|------------|------------|-------|
| Length (L)   | 4.00       | $\pm 0.10$ | mm    |
| Width (W)  | 3.00       | $\pm 0.10$ | mm    |
| Height (H)   | 1.00       | $\pm 0.10$ | mm    |
| Acoustic Port (AP)   | 0.400      | $\pm 0.10$ | mm    |
| Solder Mask (SRO)  | 0.700      | $\pm 0.05$ | mm    |
| Planarity  | Top/Bottom | $\pm 0.10$ | mm    |
| All dimensions in mm<br>Tolerance $\pm 0.05$ mm unless otherwise specified |            |            |       |



## 6. PIN-OUT AND CONNECTION DIAGRAMS

### 6.1 Pin-Out

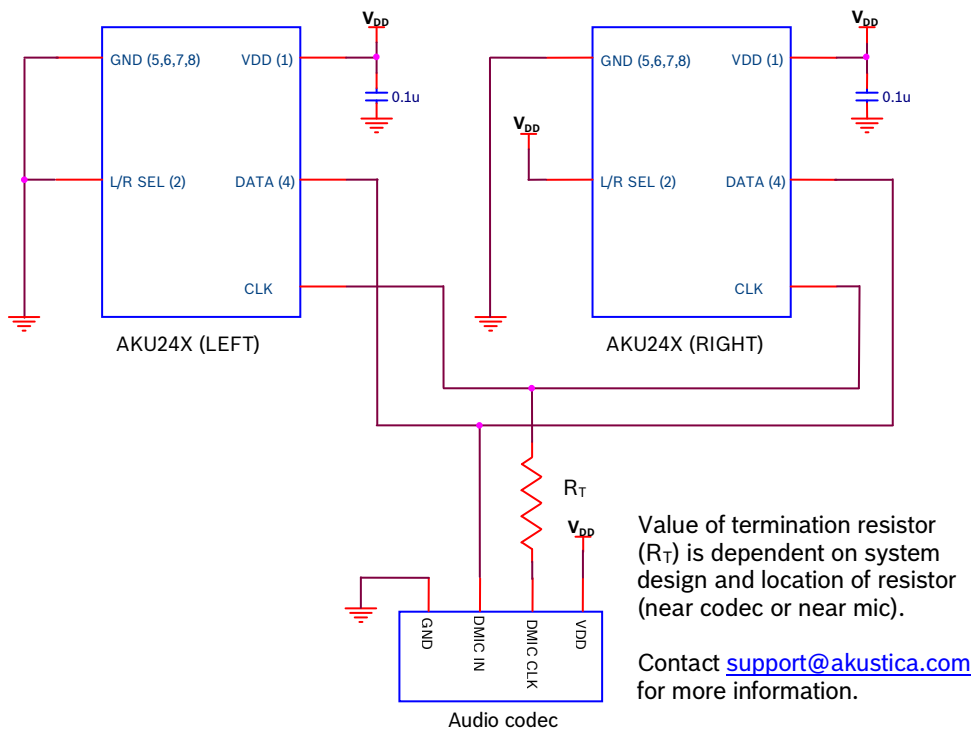
(As viewed from **bottom** of package)



| Pin        | Name            | Function            |
|------------|-----------------|---------------------|
| 1          | V <sub>DD</sub> | Power               |
| 2          | L/R*            | Left / Right Select |
| 3          | CLK             | Clock               |
| 4          | DATA            | PDM Data output     |
| 5, 6, 7, 8 | GND             | Ground              |

\*Must be electrically connected to either ground or V<sub>DD</sub>.

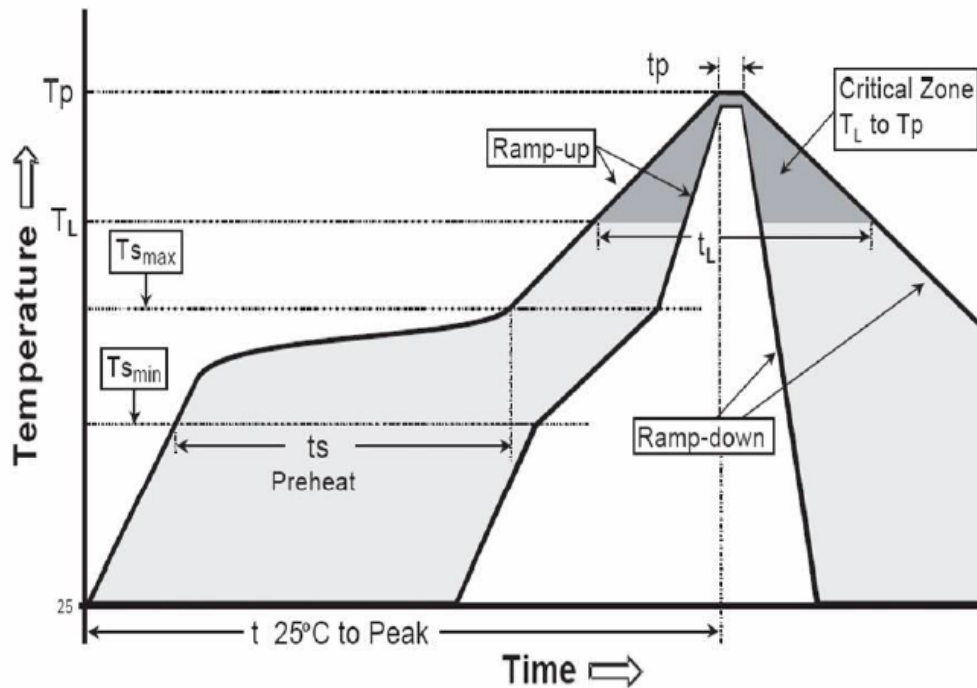
### 6.2 Typical Application Schematic



## 7. MANUFACTURING NOTES

### 7.1 Solder Reflow

Typical solder reflow profile



IPC-0206-5-1

|  |            |
|--|------------|
| Average ramp-up rate   | max. 3°C/s |
| Time $t_s$ between $T_{s_{min}}$ (150°C) and $T_{s_{max}}$ (200°C) | 60s – 120s |
| Time $t_L$ above liquidous temperature $T_L$ (217°C)               | 60s – 90s  |
| Peak temperature $T_P$   | max. 260°C |
| Time $t_p$ at $T_P$  | max. 20s   |
| Average ramp-down rate   | 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 acoustic port of the microphone
  - See section 5.0 for pick & place location
- 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.

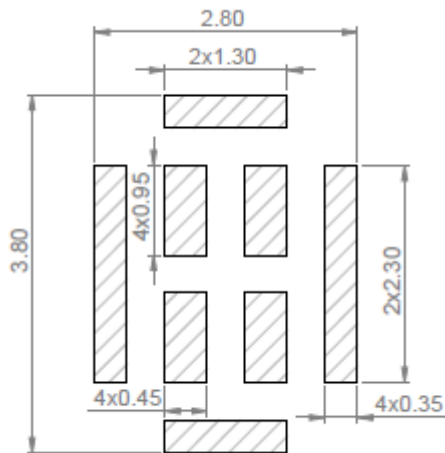
### ESD Handling Procedures



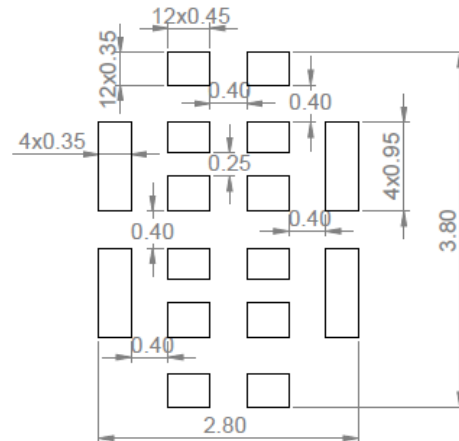
Follow CMOS handling procedures with Akustica MEMS microphones. Handle the microphone with proper workplace grounding to include wrist straps and ionized airflow over open trays and reels of microphones. Do not hot-swap/hot-plug during testing. Device pins have ESD ratings of 2kV/200V for HBM/MM respectively.

### 7.3 PCB Land Pattern & Stencil Pattern

**PCB Land Pattern Layout**




**Suggested Solder Paste Stencil Pattern Layout**



Note: Stencil printer settings will likely require minor optimizations when transferring this stencil pattern to a high volume production printer.

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

|   |  |            |
|---|--|------------|
|  | <b>AKU240 Family</b><br>Digital Silicon MEMS Microphones | Data Sheet |
|---|--|------------|

## 8. RELIABILITY SPECIFICATIONS

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

|    | Test                       | Test Condition   |
|----|----------------------------|--|
| 1  | Cold Temp Operation        | Temperature = -40°C, 1000 hours (with bias)  |
| 2  | Hot Temp Operation         | Temperature = 105°C, 1000 hours (with bias)  |
| 3  | Humidity Operation         | Temperature = 85°C, RH = 85%, 1000 hours (with bias)   |
| 4  | Cold Temp Storage          | Temperature = -40°C, 1000 hours (without bias)   |
| 5  | Hot Temp Storage           | Temperature = 105°C, 1000 hours (without bias)   |
| 6  | Humidity Storage           | Temperature = 85°C, RH = 85%, 1000 hours (without bias)  |
| 7  | Thermal Cycle              | 100 Cycles, -40°C to +125°C, 15min soaks, <30sec ramps   |
| 8  | Vibration                  | Sinusoidal Vibration, 20Hz-2000Hz, 4min sweeps, 16min along each of 3 axis, amplitude 3 limits of 20G and 0.06"          |
| 9  | Mechanical Shock           | 10,000G shocks, 5 impacts along each of 6 axes   |
| 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. |
| 11 | ESD (HBM)                  | +/- 2000V, 1 discharge for each polarity, 11 pin combinations, 22 total discharges per microphone                        |
| 12 | ESD (MM)                   | +/- 200V, 1 discharge for each polarity, 11 pin combinations, 22 total discharges per microphone                         |
| 13 | ESD                        | +/- 8kV, contact discharge to lid with DUT grounded  |
| 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)            |

## 9. PART MARKING INFORMATION

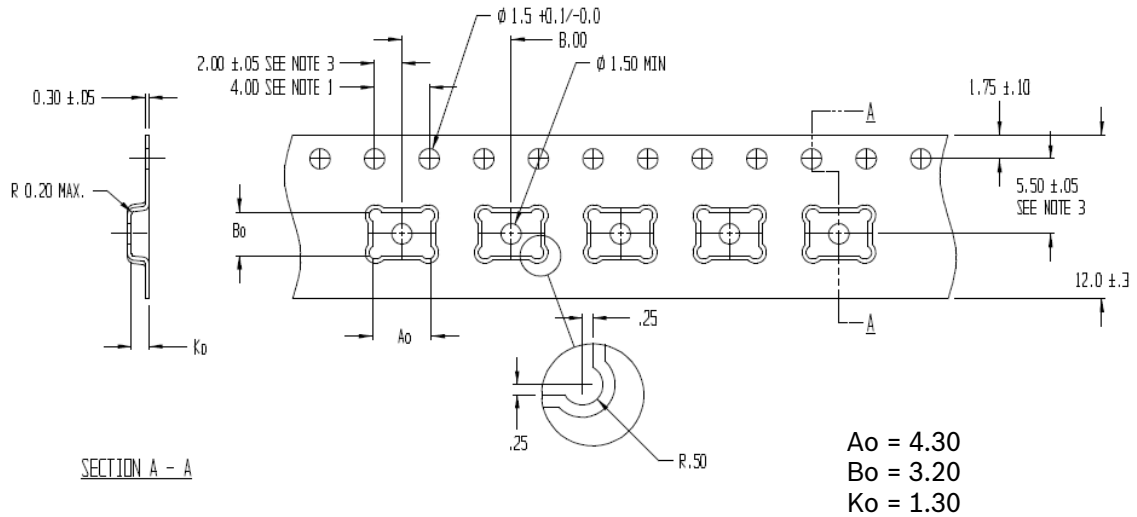


Line 1: A24XF (A = Akustica | 24X = Part Num | X = 0, 1, 2 | F = Assembly Facility)  
 Line 2: WWYLL (WW = Work Week | Y = Year | LL = Lot Number Processed During Work Week)

← Pin 1

## 10. PACKAGING INFORMATION

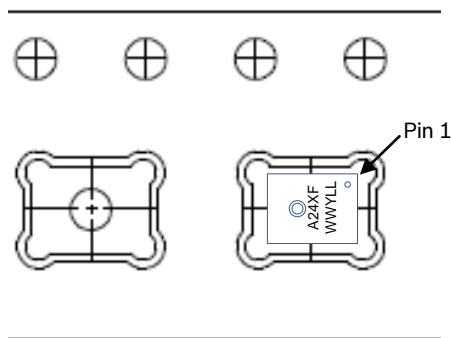
### 10.1 Tape Specification




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

### 10.2 Component Orientation



|   |  |            |
|---|--|------------|
|  | <b>AKU240 Family</b><br>Digital Silicon MEMS Microphones | Data Sheet |
|---|--|------------|

## 11. ORDERING INFORMATION

| Order Number | Sensitivity Tolerance (dB) | RF Filter | Part Marking | Package   | Shipping Method | Standard Quantity |
|--------------|----------------------------|-----------|--------------|-----------|-----------------|-------------------|
| 02730A0007*  | +/- 2                      | No        | A240         | 8-Pad LGA | 13" Reel        | 5,700             |
| 02730A0029   | +/- 1                      | Yes       | A241         |           |                 |                   |
| 02730A0019   | +/- 1.5                    | No        | A242         |           |                 |                   |

\*Not recommended for new designs

## 12. DOCUMENT REVISIONS

| Rev. No | Description of modification/changes | Date      |
|---------|-------------------------------------|-----------|
| 0.75    | Released 0.75.                      | 26-Aug-14 |
| 0.76    | Updated first page description      | 25-Sep-14 |
| 0.77    | Updated sensitivity tolerance       | 06-Oct-14 |
| 0.78    | Updated current consumption         | 20-Oct-14 |
| 1.0     | Released 1.0                        | 06-Nov-14 |
| 1.02    | Updated ordering table content      | 22-Jun-15 |

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