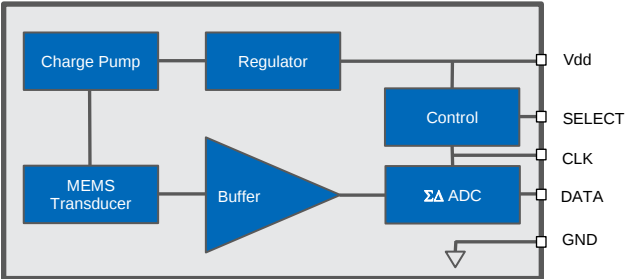


V2S200DZA  
AEC-Q103-003 QUALIFIED MULTIMODE DIGITAL VIBRATION SENSOR

The V2S200DZA is a miniature, high-performance, low power, digital Voice Vibration Sensor (V2S) with a single bit PDM output. Derived from Syntiant’s proven high performance SiSonic™ MEMS technology, the V2S200DZA consists of a transducer, a low-noise input buffer, and a sigma-delta modulator. The sensor meets the AEC-Q103-003 quality standard, making it ideal for automotive applications. These devices provide high vibration sensitivity suitable for picking up audio via bone conduction in devices such as earphones, wearables, and other applications where flat response to vibration and excellent acoustic isolation are required. In addition, the V2S200DZA offers multiple clock modes for wide compatibility with audio codecs.

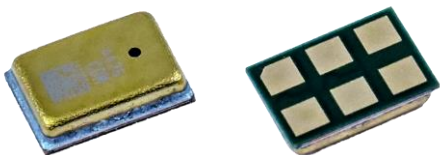


ABSOLUTE MAXIMUM RATINGS

Table 1: Absolute Maximum Ratings

| Parameter                     | Absolute Maximum Rating     | Units |
|-------------------------------|-----------------------------|-------|
| Vdd to Ground                 | -0.5, +5.0                  | V     |
| DATA, CLOCK, SELECT to Ground | -0.3, +5.0                  | V     |
| Input Current                 | ±5                          | mA    |
| Short Circuit to/from DATA    | Indefinite to Ground or Vdd | sec   |
| Storage Temperature           | -40 to +125                 | °C    |
| Operating Temperature         | -40 to +125                 | °C    |

Stresses exceeding these “Absolute Maximum Ratings” may cause permanent damage to the device. These are stress ratings only. Functional operation at these or any other conditions beyond those indicated under “Performance & Electrical Specifications” is not implied. Exposure beyond those indicated under “Performance & Electrical Specifications” for extended periods may affect device reliability.



PRODUCT FEATURES

- Low Current Consumption in Low-Power Mode
- Wide Sensor Bandwidth (10 kHz)
- High Drive Capability
- Supports Dual Multiplexed Channels
- Multiple Performance Modes (Sleep, Low-Power, Normal)
- Ultra-Stable Performance
- IPX7 Rating
- Standard SMD Reflow
- LGA Package

TYPICAL APPLICATIONS

- Automotive Voice Commands
- Emergency Vehicle Detection
- Wind Noise Reduction
- Wearables, Smart Watches
- Waterproof Devices
- Medical Applications, Sethoscopes
- Predictive Maintenance

## PERFORMANCE & ELECTRICAL SPECIFICATIONS<sup>1</sup>

Table 2: General Sensor Specifications

Test Conditions: 23 ± 2° C, 55 ± 20% R.H., Vdd = 1.8 V, Tedge ≤ 3 ns, unless otherwise indicated

| Parameter                           | Symbol | Conditions                                                                                                                                                                                                       | Min                       | Typ      | Max  | Units |
|-------------------------------------|--------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------|----------|------|-------|
| Supply Voltage                      | Vdd    |                                                                                                                                                                                                                  | 1.65                      | 1.8      | 3.3  | V     |
| Bandwidth                           | BW     |                                                                                                                                                                                                                  | -                         | 10       | -    | kHz   |
| High Frequency Flatness             |        | +3dB relative to 1 kHz                                                                                                                                                                                           | -                         | 4        | -    | kHz   |
| Resonant Frequency Peak             | Fres   | Acceleration response                                                                                                                                                                                            | -                         | 7        | -    | kHz   |
| Sound Isolation <sup>2</sup>        |        | Output ratio, 1g peak input vs 94dB input @ 100 Hz                                                                                                                                                               | -                         | >70      | -    | dB    |
|                                     |        | Output ratio, 1g peak input vs 94dB input @ 1 kHz                                                                                                                                                                | -                         | >70      | -    |       |
| DC Offset                           |        | Fullscale = ±100 (SEL = Low / SEL = High)                                                                                                                                                                        | -                         | 0.0/0.78 | -    | %     |
| Polarity                            |        | + Z axis (Refer to Mechanical Specs for axis definition)                                                                                                                                                         | Increasing density of 1's |          |      |       |
| Data Format                         |        |                                                                                                                                                                                                                  | ½ Cycle PDM               |          |      |       |
| Sensitivity Drop                    |        | Vdd(min) ≤ Vdd ≤ Vdd(max)                                                                                                                                                                                        | -                         | -        | .5dB | dB    |
| Clock Input Capacitance             | Cin    |                                                                                                                                                                                                                  | -                         | 5        | -    | pF    |
| Data Output Load                    | Cload  |                                                                                                                                                                                                                  | -                         | -        | 160  | pF    |
| SELECT (high)                       |        |                                                                                                                                                                                                                  | Vdd-0.2                   | -        | 3.3  | V     |
| SELECT (low)                        |        |                                                                                                                                                                                                                  | -0.3                      | -        | 0.2  | V     |
| Short Circuit Current               | Isc    | Grounded DATA pin                                                                                                                                                                                                | 1                         | -        | 20   | mA    |
| Startup Time <sup>3</sup>           |        | Powered Down → Active, S within 1 dB of final value                                                                                                                                                              | -                         | -        | 20   | ms    |
| Time to First Data Bit <sup>4</sup> |        | Time from valid Vdd and CLK until the first logical bit is driven on the DATA line. The output is tristate until First Data Bit. Initial output bits represent muted audio. Audio data will follow Startup Time. | -                         | 4        | -    | ms    |
| Mode-Change Time <sup>3,4</sup>     |        | Low Power Mode ⇌ Normal Mode, S within 1 dB of final value                                                                                                                                                       | -                         | -        | 20   | ms    |

Table 3: Normal Mode

Test Conditions: 23 ± 2° C, 55 ± 20% R.H., Vdd = 1.8 V, Fclock = 2.4 MHz (D.C. = 50%), Tedge ≤ 3 ns, SELECT grounded, no load, unless otherwise indicated

| Parameter                    | Symbol  | Conditions                                                              | Min | Typ  | Max | Units   |
|------------------------------|---------|-------------------------------------------------------------------------|-----|------|-----|---------|
| Supply Current <sup>5</sup>  | Idd     | Fclock = 1.2 MHz                                                        | -   | 480  | -   | μA      |
|                              |         | Fclock = 1.536 MHz                                                      | -   | 550  | -   |         |
|                              |         | Fclock = 2.4 MHz                                                        | -   | 700  | -   |         |
|                              |         | Fclock = 3.072 MHz                                                      | -   | 850  | -   |         |
| Sensitivity                  | S       | 1g peak @ 1 kHz (Z-Axis)                                                | -26 | -25  | -24 | dBFS    |
| G range                      |         | 10% THD                                                                 | -   | ±25  | -   | g peak  |
| Signal to Noise Ratio        | SNR     | Sensitivity @ 1kHz, A-weighted (BW = 100 – 4 kHz)<br>Fclock = 1.2 MHz   | -   | 63.5 | -   | dB(A)   |
|                              |         | Sensitivity @ 1kHz, A-weighted (BW = 100 – 4 kHz)<br>Fclock = 1.536 MHz | -   | 63.5 | -   |         |
|                              |         | Sensitivity @ 1kHz, A-weighted (BW = 100 – 4 kHz)<br>Fclock = 2.4 MHz   | -   | 64.5 | -   |         |
|                              |         | Sensitivity @ 1kHz, A-weighted (BW = 100 – 4 kHz)<br>Fclock = 3.072 MHz | -   | 64.5 | -   |         |
|                              |         |                                                                         |     |      |     |         |
| Noise Density                |         | @ 1 kHz                                                                 | -   | 9    | -   | μg/√Hz  |
| Total Harmonic Distortion    | THD     | 1 g peak @ 1 kHz                                                        | -   | .25  | -   | %       |
|                              |         | 1% THD @ 1 kHz, S = typ                                                 | -   | >10  | -   | g peak  |
| Power Supply Rejection Ratio | PSRR    | 200 mVpp sinewave @ 1 kHz                                               | -   | 75   | -   | dB V/FS |
| Power Supply Rejection       | PSR + N | 200 mVpp 7/8 duty cycle rectangular waveform<br>@ 217 Hz, A-weighted    | -   | -80  | -   | dBFS(A) |

Table 4: Low-Power Mode

Test Conditions: 23 ± 2° C, 55 ± 20% R.H., Vdd = 1.8 V, Fclock = 768 kHz (D.C. = 50%), Tedge ≤ 3 ns, SELECT grounded, no load, unless otherwise indicated

| Parameter                    | Symbol  | Conditions                                                           | Min   | Typ   | Max   | Units   |
|------------------------------|---------|----------------------------------------------------------------------|-------|-------|-------|---------|
| Supply current <sup>5</sup>  | Idd     |                                                                      | -     | 290   | -     | μA      |
| Sensitivity                  | S       | 1g peak @ 1 kHz (Z-Axis)                                             | -26.5 | -25.5 | -24.5 | dBFS    |
| G range                      |         | 10% THD                                                              | -     | ±26   | -     | g peak  |
| Signal to Noise Ratio        | SNR     | Sensitivity @ 1 kHz, A-weighted (BW = 100 – 4 kHz)                   | -     | 63    | -     | dB(A)   |
| Noise Density                |         | @ 1 kHz                                                              | -     | 11    | -     | μg/√Hz  |
| Total Harmonic Distortion    | THD     | 1g peak @ 1 kHz                                                      | -     | .25   | -     | %       |
|                              |         | 1% THD @ 1 kHz, S = typ                                              | -     | >10   | -     | g peak  |
| Power Supply Rejection Ratio | PSRR    | 200 mVpp sinewave @ 1 kHz                                            | -     | 72    | -     | dB V/FS |
| Power Supply Rejection       | PSR + N | 200 mVpp 7/8 duty cycle rectangular waveform<br>@ 217 Hz, A-weighted | -     | -80   | -     | dBFS(A) |

Table 5: «Mode3»

Test Conditions: 23 ±2° C, 55 ±20% R.H., Vdd = 1.8 V, Fclock grounded, SELECT grounded, no load, unless otherwise indicated

| Parameter     | Symbol | Conditions                        | Min | Typ | Max | Units |
|---------------|--------|-----------------------------------|-----|-----|-----|-------|
| Sleep Current | Isleep | CLOCK = Pulled Low, DATA = High-Z | -   | .5  | 10  | µA    |

<sup>1</sup> Sensitivity and Supply Current are 100% tested.<sup>2</sup> Isolation measurements are setup limited at 70db. Sensor isolation is beyond what the setup can measure.<sup>3</sup> Valid sensor states are: Powered Down Mode (mic off), Sleep Mode (low current, DATA = high-Z, fast startup), Low-Power Mode (low clock speed) and Normal Mode.<sup>4</sup> Output is temporarily muted during the transition between any sensor state.<sup>5</sup> Power consumption varies with Cload according to:  $\Delta P = 1/3 * DVdd * DVdd * \Delta Cload * Fclock$ .

Table 6: Digital Interface

Test Conditions: 23 ±2° C, 55 ±20% R.H., Vdd = 1.8 V, Tedge ≤ 3ns, unless otherwise indicated

| Parameter                                   | Symbol | Conditions                                                         | Min      | Typ | Max      | Units |
|---------------------------------------------|--------|--------------------------------------------------------------------|----------|-----|----------|-------|
| Logic Input High <sup>7</sup>               | Vih    |                                                                    | 0.7xVdd  | -   | 3.3      | V     |
| Logic Input Low <sup>7</sup>                | Vil    |                                                                    | -0.3     | -   | .3xVdd   | V     |
| Logic Output High <sup>7</sup>              | Voh    | I <sub>OUT</sub> = 2 mA                                            | Vdd-0.45 | -   | Vdd      | V     |
| Logic Output Low <sup>7</sup>               | Vol    | I <sub>OUT</sub> = 2 mA                                            | 0        | -   | 0.45     | V     |
| Low→High Threshold <sup>8</sup>             | VL-h   |                                                                    | -        | -   | 0.7xVdd  | V     |
| High→Low Threshold <sup>8</sup>             | Vh-l   |                                                                    | 0.3xVdd  | -   | -        | V     |
| Hysteresis Width <sup>8</sup>               | Vhyst  |                                                                    | 0.10xVdd | -   | 0.29xVdd | V     |
| Clock Frequency <sup>7</sup>                | Fclock | Sleep Mode                                                         | -        | -   | 0        | kHz   |
|                                             |        | Low-Power Mode                                                     | 600      | -   | 950      |       |
|                                             |        | Normal Mode                                                        | 1.2      | -   | 3.3      | MHz   |
| Clock Duty Cycle                            | D.C.   |                                                                    | 40       | 50  | 60       | %     |
| Delay Time to Data Line Driven <sup>7</sup> | Tdd    |                                                                    | 18       | -   | 40       | ns    |
| Delay Time to Valid Data <sup>7</sup>       | Tdv    | Max Cload                                                          | -        | -   | 100      | ns    |
| Delay Time to High Z <sup>7</sup>           | Tdz    |                                                                    | 5        | -   | 16       | ns    |
| Hold Time <sup>7</sup>                      | Thold  | Thold, as observed by the input device, will be dependent on Cload | 5        | -   | -        | ns    |

<sup>7</sup> See Figure 1: Timing Diagram.<sup>8</sup> See Figure 2: Hysteresis Diagram.

# V2S200DZA

## AEC-Q103-003 QUALIFIED MULTIMODE DIGITAL VIBRAITON SENSOR

# SYNTIANT®

Figure 1: Timing Diagram

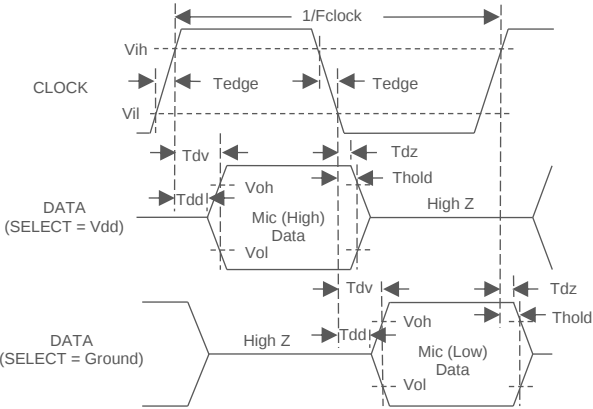


Figure 2: Hysteresis Diagram

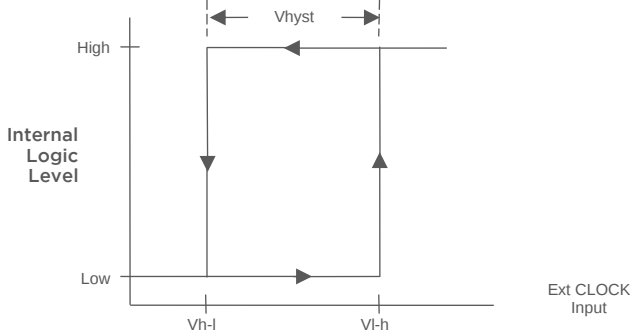


Figure 3: State Diagram

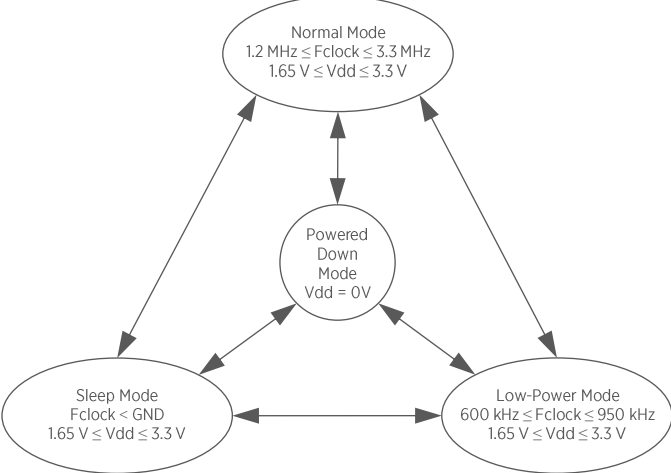


Figure 4: Typical Stereo Application Circuit

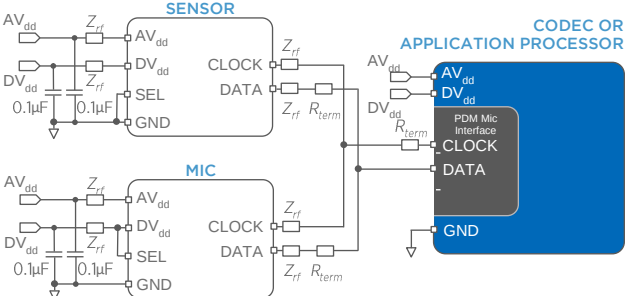
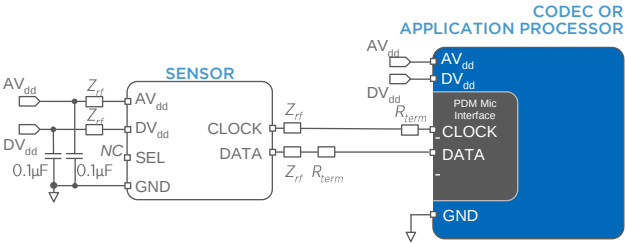


Figure 5: Typical Single-Sensor Application Circuit



### NOTES:

- All Ground pins must be connected to ground.
- If necessary to improve RF performance, optional series components (resistors, ferrites, etc.) should be placed closest to the sensor pads.
- Bypass capacitors should be placed near each Vdd pin for best performance.
- Capacitors near the sensor should not contain Class 2 dielectrics due to their piezoelectric effect.

Table 7: SELECT Functionality

| Sensor     | SELECT | Asserts DATA on  | Latch DATA on    |
|------------|--------|------------------|------------------|
| V2S (High) | Vdd    | CLK rising edge  | CLK falling edge |
| V2S (Low)  | Ground | CLK falling edge | CLK rising edge  |

PERFORMANCE CURVES

Test Conditions: 23 ±2° C, 55 ±20% R.H., Vdd = 1.8 V, Fclock = 2.4 MHz (LPM Fclock = 768 kHz), SELECT grounded, no load, unless otherwise indicated

Figure 6: Typical Acceleration Magnitude

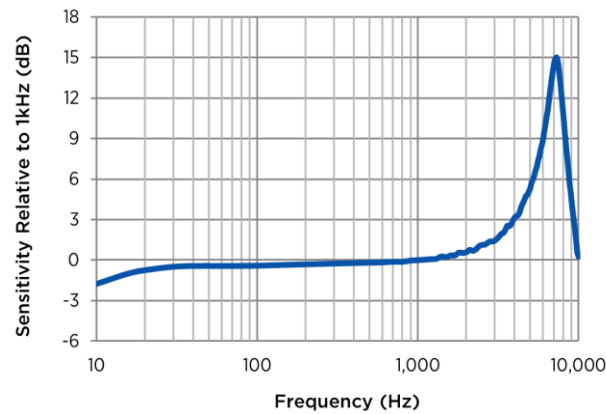


Figure 8: Typical Phase and Group Delay

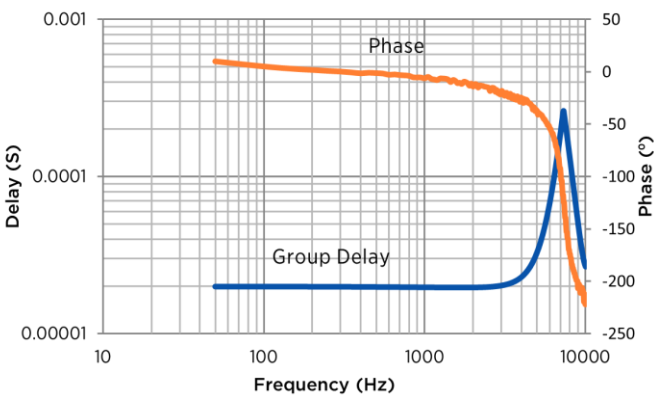


Figure 7: Typical THD vs Acceleration

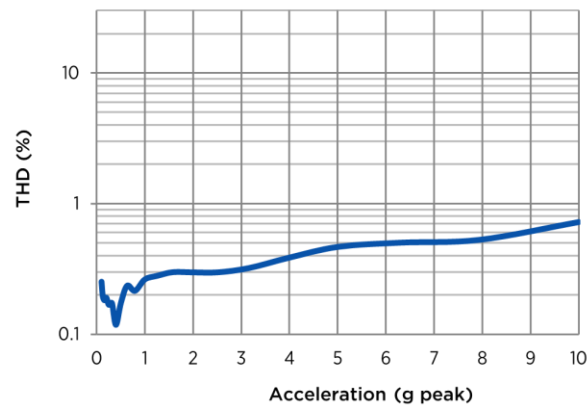


Figure 9: Typical THD vs Frequency (1g peak input)

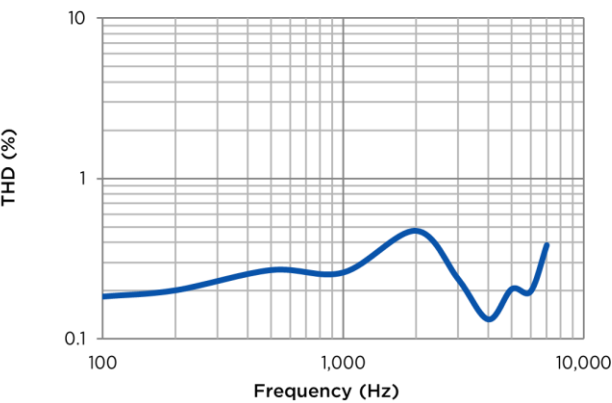


Figure 10: Typical Idd vs Vdd

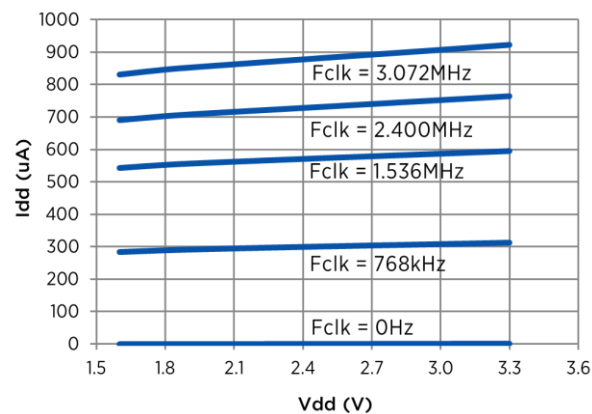


Figure 11: Noise Floor Amplitude Spectral Density

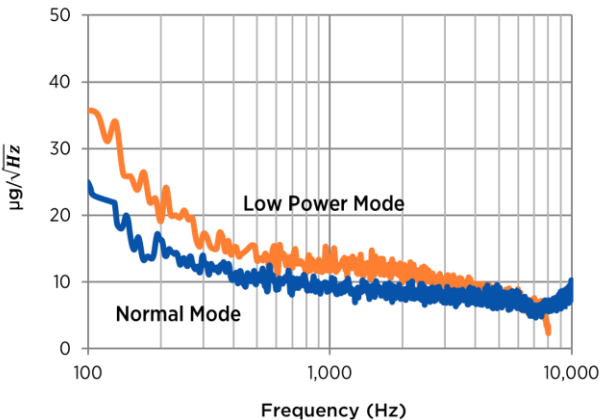
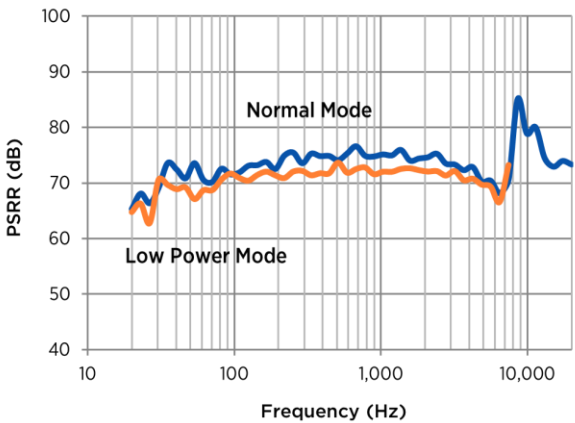
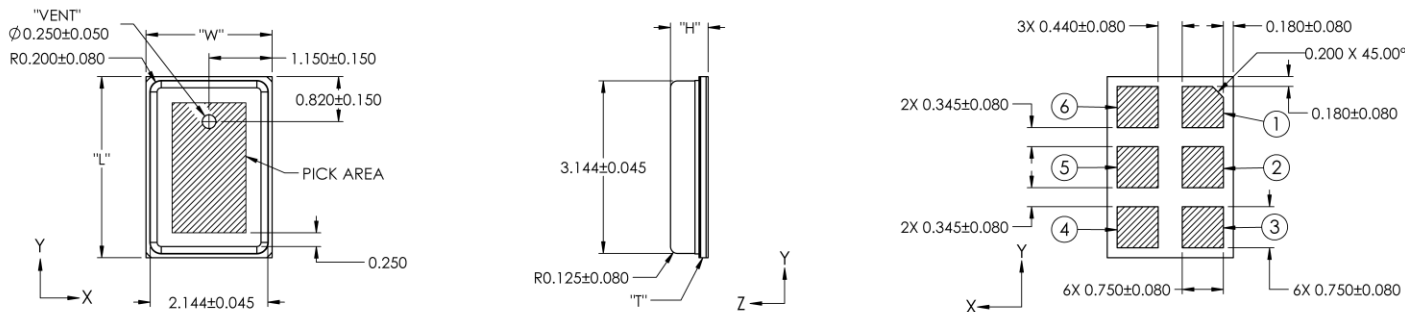


Figure 12: Typical PSRR



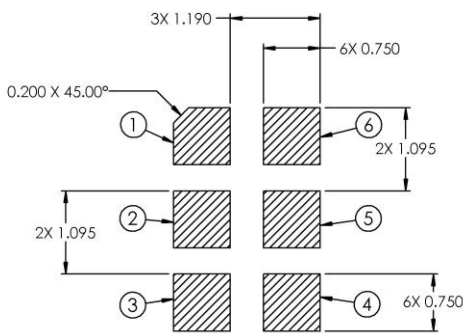
# MECHANICAL SPECIFICATIONS



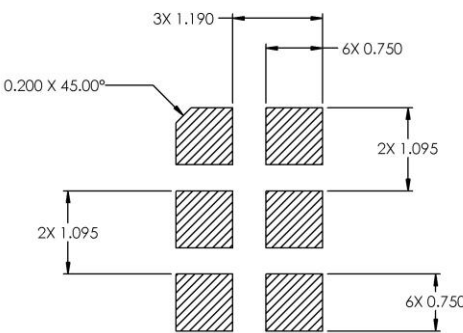
| Item              | Dimension | Tolerance |
|-------------------|-----------|-----------|
| Length (L)        | 3.30      | ±0.10     |
| Width (W)         | 2.30      | ±0.10     |
| Height (H)        | 0.70      | ±0.10     |
| PCB Thickness (T) | 0.165     | ±0.05     |

| Pin # | Pin Name | Type      | Description        |
|-------|----------|-----------|--------------------|
| 1     | Vdd      | Power     | Power Supply       |
| 2     | CLOCK    | Digital I | Clock Input        |
| 3, 4  | GROUND   | Power     | Ground             |
| 5     | SELECT   | Digital I | Lo/Hi (L/R) Select |
| 6     | DATA     | DIGITAL O | PDM Output         |

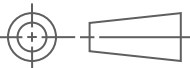
## Example Land Pattern



## Example Solder Stencil Pattern

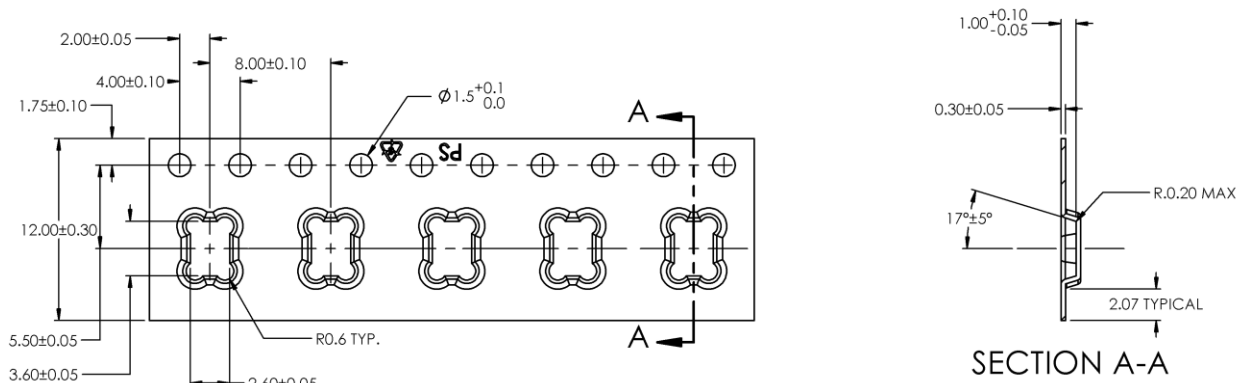


### NOTES:



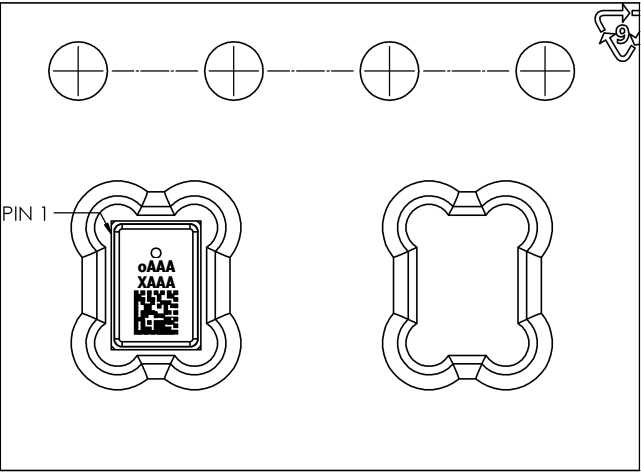
Pick Area only extends to 0.25 mm of any edge or hole unless otherwise specified. Dimensions are in millimeters unless otherwise specified. Tolerance is ±0.15mm unless otherwise specified. In the acoustic path, «MechanicalsPCBThickness», «MechanicalsGasketDiameter» and «MechanicalsCaseDiameter». Further optimizations based on application should be performed.

# PACKAGING & MARKING DETAIL



| Model Number | Suffix | Reel Diameter | Quantity Per Reel |
|--------------|--------|---------------|-------------------|
| V2S200D-1    | -8     | 13"           | 5900              |

| Component    | Surface Resistance (ohms) |
|--------------|---------------------------|
| Reel         | $10^5 - 10^9$             |
| Carrier Tape | $10^5 - 10^9$             |
| Cover Tape   | $10^4 - 10^{10}$          |

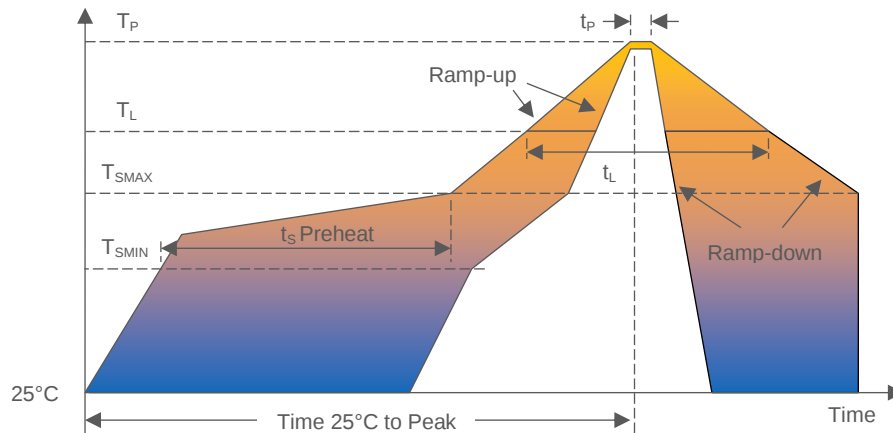


Letter: "o", orientation mark (pin 1)  
 AAA = Internal Code  
 X = Optional Character  
 AAA = Internal Code  
 2D barcode "ABCDEFHJKLMNPQRSTUVWXYZ0123456789":  
 Unique Job Identification Number for product traceability

## NOTES:

Dimensions are in millimeters unless otherwise specified.  
 Vacuum pickup only in the pick area indicated in Mechanical Specifications.  
 Tape & reel per EIA-481.  
 Labels applied directly to reel and external package.  
 Shelf life: Twelve (12) months when devices are stored in the factory-supplied, unopened ESD moisture sensitive bag under the maximum environmental conditions of 30°C, 70% R.H.

## RECOMMENDED REFLOW PROFILE



| Profile Feature                                                                                                                                                                                               | Pb-Free                          |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------|
| Average Ramp-up rate (T <sub>S</sub> MAX to T <sub>P</sub> )                                                                                                                                                  | 3°C/second max.                  |
| Preheat <ul style="list-style-type: none"> <li>Temperature Min (T<sub>S</sub>MIN)</li> <li>Temperature Max (T<sub>S</sub>MAX)</li> <li>Time (T<sub>S</sub>MIN to T<sub>S</sub>MAX) (t<sub>S</sub>)</li> </ul> | 150°C<br>200°C<br>60-180 seconds |
| Time maintained above: <ul style="list-style-type: none"> <li>Temperature (T<sub>L</sub>)</li> <li>Time (t<sub>L</sub>)</li> </ul>                                                                            | 217°C<br>60-150 seconds          |
| Peak Temperature (T <sub>P</sub> )                                                                                                                                                                            | 260°C                            |
| Time within 5°C of actual Peak Temperature (t <sub>P</sub> )                                                                                                                                                  | 20-40 seconds                    |
| Ramp-down rate (T <sub>P</sub> to T <sub>S</sub> MAX)                                                                                                                                                         | 6°C/second max                   |
| Time 25°C to Peak Temperature                                                                                                                                                                                 | 8 minutes max                    |

## NOTES:

Based on IPC/JDEC J-STD-020 Revision C.

All temperatures refer to topside of the package, measured on the package body surface.

The actual reflow profile used should be optimized based on the reflow requirements of all components, board design, solder paste formulation and reflow equipment used. Details of recommended handling and manufacturing processes can be found in AN25 SMT Manufacturing Guidelines for SiSonic™ Microphones.

## ADDITIONAL NOTES

- (A) Barometric relief hole (vent)
- Hole must be open during reflow.
  - No other special treatment is needed on the barometric relief hole during assembly
  - If the sensor is exposed to harsh environment, seal the hole with non-porous, low viscosity material (e.g. UV cure, hard plastic overmold)
- (B) MSL (moisture sensitivity level) Class 1.
- (C) Maximum of 3 reflow cycles is recommended.
- (D) In order to minimize device damage:
- Only board wash with deionized water and allow dry time.
  - Do not brush board with or without solvents after the reflow process.
  - Do not directly expose to vapor phase soldering.
  - Do not subject the sensor to strong mechanical agitation.

MATERIALS STATEMENT

Meets the requirements of the European RoHS directive 2011/65/EC as amended.

Meets the requirements of the industry standard IEC 61249-2-21:2003 for halogenated substances and Syntiant Green Materials Standards Policy section on Halogen-Free.

Product is Beryllium Free according to limits specified on the Syntiant Hazardous Material List (HSL for Products).

Ozone depleting substances are not used in the product or the processes used to make the product, including compounds listed in Annex A, B, and C of the “Montreal Protocol on Substances That Deplete the Ozone Layer.

RELIABILITY SPECIFICATIONS

| Test             | Description                                                                                  |
|------------------|----------------------------------------------------------------------------------------------|
| Thermal Shock    | 100 cycles of air-to-air thermal shock from -40C to +125C with 15 minute Soaks (IEC 68-2-14) |
| High Temperature | +105°C environment for 1,000 hours (JESD22-A103)                                             |
| Low Temperature  | -40°C environment for 1,000 hours (JESD22-A119)                                              |
| ESD-HBM          | 3 discharges at ±2kV direct contact to I/O pins (ANSI/ESDA/JEDEC JS-001-2014)                |
| ESD-HMM          | 10 discharges at ±8kV direct contact to lid when unit is grounded (AMSI/ESD SP5.6-2009)      |
| ESD-CDM          | 3 discharges at ±500V (ANSI/ESDA/JEDEC JS-002-2014)                                          |
| Reflow           | 5 reflow cycles with peak temperature of +260°C (JEDEC 22-A113F)                             |
| Mechanical Shock | 3 pulses of 20,000g in each of the X, Y, Z directions (IEC 68-2-27 Test Ea)                  |
| Waterproof       | 1 meter water submersion for 30 minutes (IPX7)                                               |

NOTES:

Sensors meet all performance and electrical specifications before and after reliability testing, except sensitivity which can deviate up to 3dB.

After 3 reflow cycles, the sensitivity of the sensors shall not deviate more than 1 dB from its initial value.

SPECIFICATION REVISIONS

| Revision | Specification Changes                                                     | Date      |
|----------|---------------------------------------------------------------------------|-----------|
| 1        | Initial Release                                                           | 7/22/2024 |
| 2        | Edited Absolute Maximums for operating temp and storage temp              | 7/29/2024 |
| 3        | Corrected Bandwith Spec                                                   | 7/31/2024 |
| 4        | Updated Maximum Operating Temperature                                     | 8/22/2024 |
| 5        | Corrected qualification number in title and added IPX7 rating to features | 9/26/2024 |
| 6        | Clarified stimulus conditions for Sensitivity, SNR, and THD measurements  | 10/1/2024 |
| 7        | Format Update                                                             | 12/2/2024 |
| 8        | Updated transfer error in LPM supply current                              | 12/5/2024 |
|          |                                                                           |           |
|          |                                                                           |           |
|          |                                                                           |           |

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