



March 2023
v1.0

Voice Vibration Sensor Overview

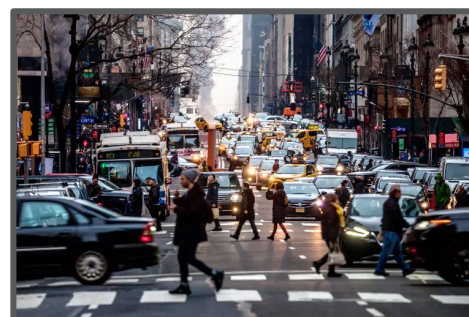
For the latest information, visit:
<https://www.knowles.com/V2S>

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Voice Vibration Sensor (V2S) Solution

The Challenge – Background Noise



Traffic



Loud Bar



Busy Office

- Background noise overwhelms microphones during calls
- Multi-mic beamforming and algos help but are not sufficient
- A targeted solution is needed to selectively pick-up the speaker's voice

The Solution – V2S



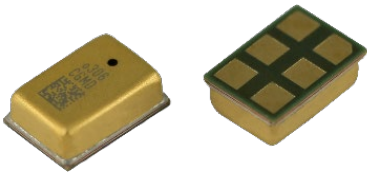
- ① Throat/vocal cord – vibration created on speech
- ② Vibration travels from throat to ear. Body acts as a low pass filter and attenuator. V2S in TWS senses vibrations
- ③ Clear voice signal sent on the Voice Call

Resources to Experience and Evaluate V2S

Resources Available

- Products below
- Product demonstration
- App Notes
- Audio Recordings

V2S Device



Part Numbers: V2S200D

V2S on Flex



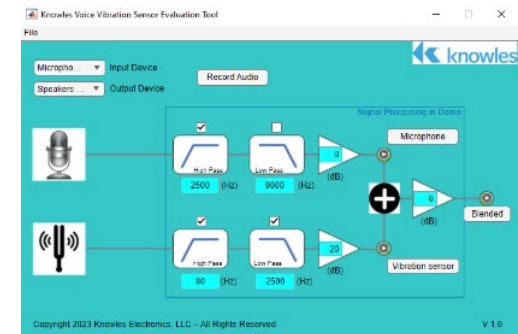
KAS-700-0176

V2S200D Eval Kit



KAS-33100-0006

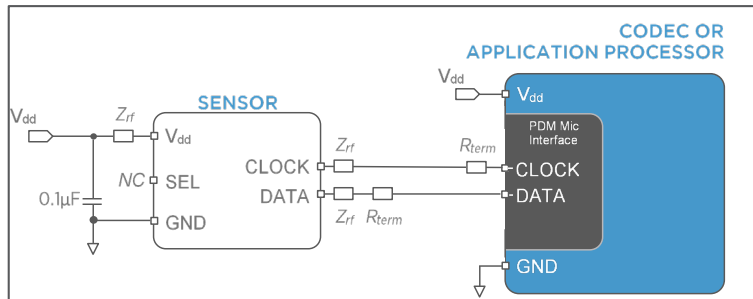
V2S Demo Software



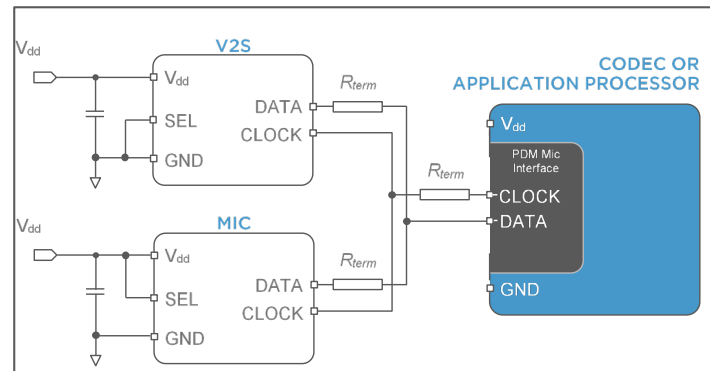
Integrating V2S200D - Electrical

- V2S200D output format is Pulse Density Modulation (PDM), like digital microphones
- It can be electrically integrated into the system like a PDM microphone (*sample integration shown below*)
- Key specs are listed for quick reference

Single Sensor Mode



Stereo Mode with a PDM Mic

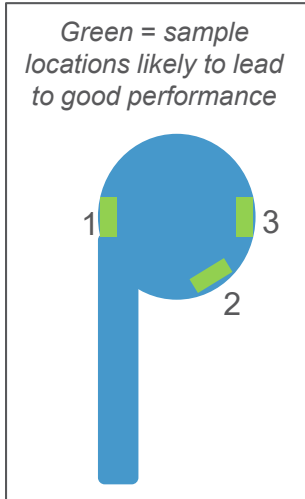


Key Product Specifications

KEY PARAMETERS	SPECIFICATIONS
Signal-to-noise ratio (SNR)	64.5 dB (A)
Bandwidth (± 3 dB)	4 kHz
Current consumption (Low Pwr Mode/ Normal Mode)	290uA / 700 uA
Sensitivity and Tolerance	-25 \pm 1.5 dB FS
Supply voltage	1.65 to 3.3V
Interface	PDM Digital
Clock Rates Supported (Low Pwr Mode/ Normal Mode)	600KHz – 950KHz / 1.2MHz - 3.3 MHz
Package dimensions	3.30 x 2.30 x 0.93 mm

Integrating V2S200D - Mechanical

- **V2S200D is a low noise, large bandwidth, highly sensitive sensor** designed to pick-up speech via vibrations.
 - Understanding the nature of the speech vibration signals and their transmission properties up to the sensor will help engineers get the best results.
- **Speech vibration signals and sound pick-up by V2S200D**
 - Signals attenuated as they travel through the body into the TWS earphone and to the sensor by the body, the ear-tip, etc
 - Expect to add ~20dB gain to the V2S200D output to normalize to signal output of a -26dBFS PDM microphone
 - Higher frequencies get attenuated more than lower frequencies during travel to the sensor
- **Optimal placement may require experimentation.** A placement that maximizes vibration transfer from the body to the sensor is dependent on design factors like shape, weight, fit of the TWS device and sensor orientation. (see image to right)
 - **V2S200D on Flex (KAS-700-0176) is available for placement experimentation**
- **To optimize performance**, use TWS materials that cause less damping of vibrations as they travel to the sensor
- Additional notes
 - V2S200D is a vibration sensor and could pick-up sounds from the vibrations caused by the speaker in TWS device. It is suggested to isolate the two devices so that vibrations from the speaker to the sensor can be minimized.
 - It is not required to seal the barometric relief hole in the metal lid for performance reasons. However, if desired, then it should be done after V2S200D device has gone through its last reflow in the integration process.



V2S200D – Signal Processing Introduction

Low Band (up to 1KHz)

Usually easier to pick-up signal in this range due to higher signal energy. (Speech sounds muffled without higher frequencies)

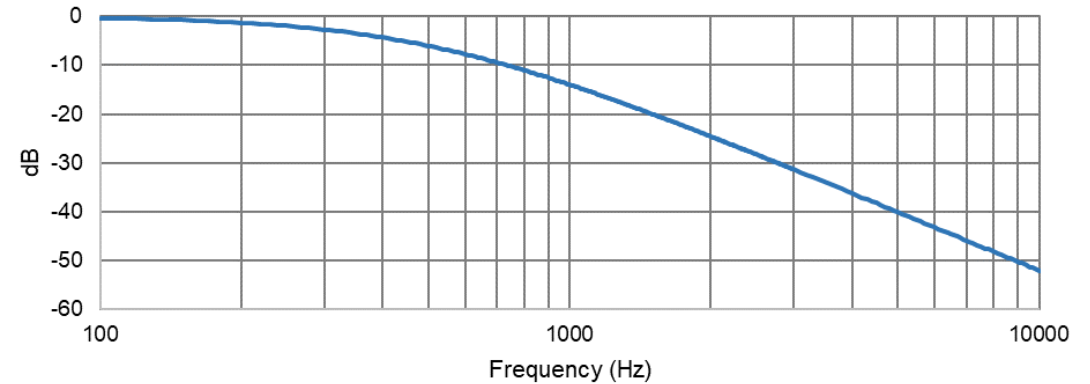
Mid Band (1KHz to 2.5KHz)

May require placement experimentation to get good pick-up in this range. (Speech will be more intelligible & richer sounding)

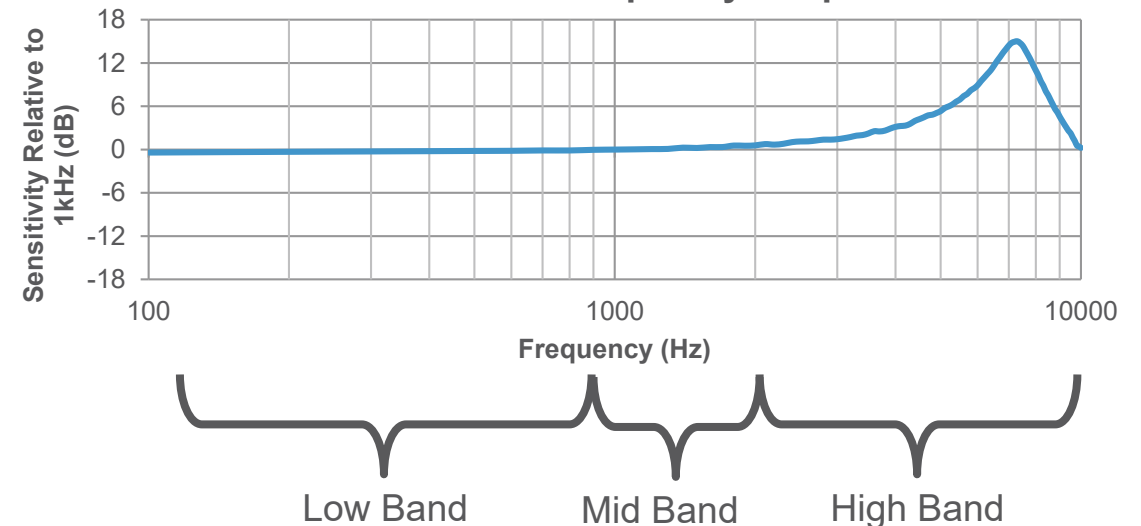
High Band (2.5+KHz):

Will likely require both placement optimization and equalization in software. Trade-off could be gaining higher signal fidelity at the cost of higher noise due to the gain in higher frequency. If signals closer to sensor resonance (e.g. ~5+KHz) are included then more vibration may couple into the signal chain as well as external sounds.

Voice vibration coupling in TWS: body transfer function (concept)

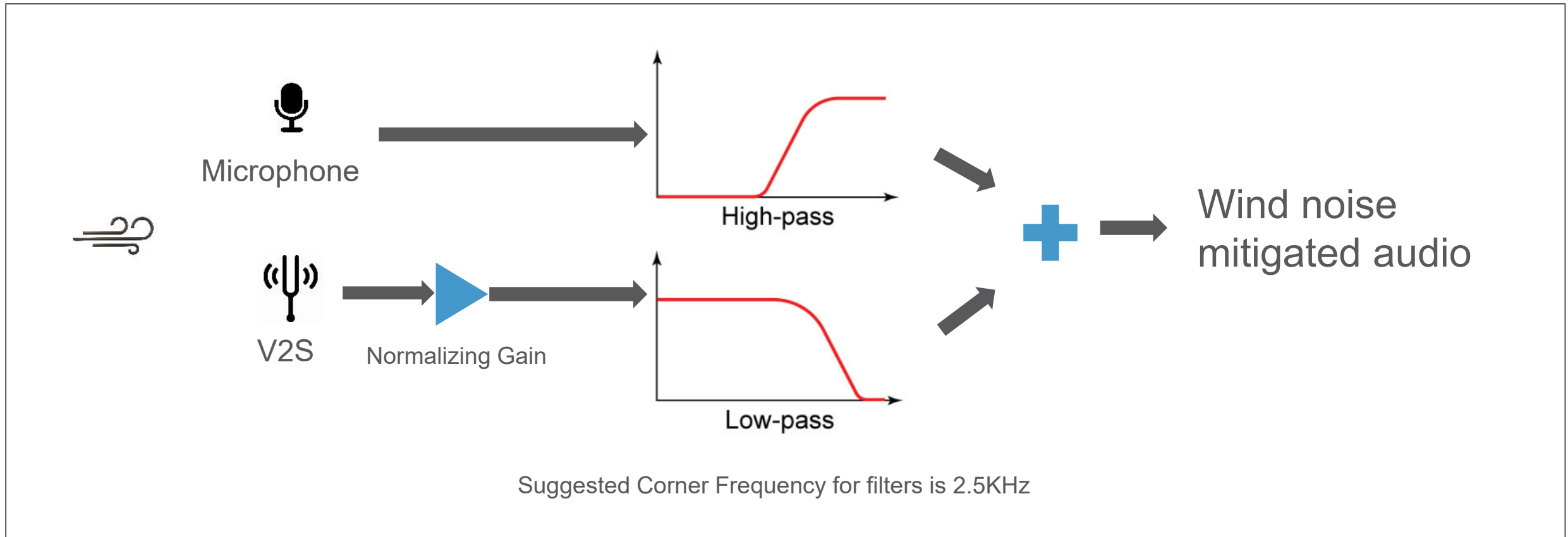


V2S200D Frequency Response



V2S200D – Software Integration Example (*Wind Noise Suppression*)

Wind noise energy is concentrated at low frequencies. Below is a simple but effective mitigation configuration:





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