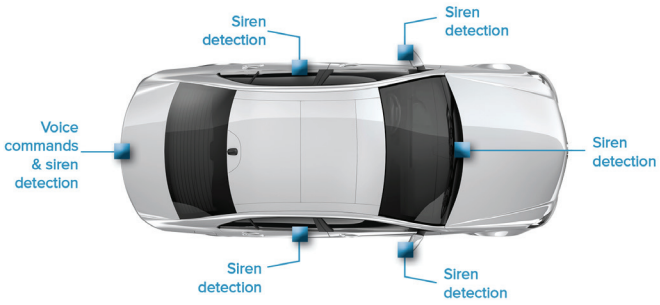
KNOWLES MICROPHONES AND VIBRATION SENSORS FOR AUTOMOTIVE APPLICATIONS SELECTION GUIDE

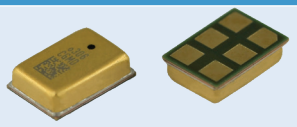
Introducing Vibration Sensing for Automotive Audio Applications

The **V2S200D** is a high bandwidth, low-power specialized vibration sensor which enables sound pickup, including in harsh environments. It can be mounted on a car (windscreen, side mirror, or body panel) to

1. pick up external sounds including **emergency vehicle sirens**
2. process **voice UI commands** (eg. 'open car trunk')

Unlike a traditional microphone which requires extensive environmental protection when mounted at the exterior of a car, a vibration sensor does not have a port hole and is therefore **inherently robust to wind, dust, dirt, snow, and water**. The PDM interface facilitates seamless integration on a PDM bus. Listen to the V2S200D difference on www.knowles.com/V2S/automotive



	SENSOR	DESCRIPTION	SIZE	SNR*	1% THD	CURRENT	
V2S	**V2S200D** On flex: KAS-700-0177 *NEW*	Voice Vibration Sensor with PDM output	3.30 × 2.30 × 0.93mm	64.5 dB (A) (BW=100Hz-4kHz)	> 10g	290µA @ 768kHz 700µA @ 2.4MHz	

** SNR specs apply to normal mode. For low power mode specs, refer to the datasheet.*

AEC-Q103-003 MEMS Microphones

Knowles' automotive microphones are engineered to a higher standard of quality and supply assurance to support the increasing demands of the automotive market for hands-free calling, advanced voice assistance, parking assist with ultrasonic sensors, and in-cabin noise cancellation for passenger comfort. The launch of the latest microphones marks Knowles' further commitment to the automotive market, building on its industry-leading high quality and innovation standards. The microphones follow the AEC-Q103-003 qualification requirements set by the Automotive Electronics Council, the standardization body for establishing standards for reliable, high-quality electronic components for use in the harsh automotive environment. *Let us help you choose the right microphone for your project.*

AUTOMOTIVE CHALLENGES AND SOLUTIONS NEEDED

	CUSTOMER CHALLENGES	SOLUTION	IMPACT ON MIC SPECS
COMMUNICATION	Hands Free Communication, Phone calls	Beamforming (x2-x8 mics)	High SNR, maximum linearity (<1%) even in loud environment for effective algorithm operation
	Emergency Call	Temp/humidity robustness	MEMS Reliability /Robustness to variations
	Voice-Enabled User Interface / Conversational AI	Voice Wake / Barge-In	High SNR, Close to speaker --> High AOP
PASSENGER COMFORT	Cancel Engine/Road Noise	Active Noise Cancellation (ANC)	ANC --> Low Latency and low LFRO
	In-cabin Intercom (SUV/MiniVan)	Beamforming (x2-x8 mics)	High SNR, maximum linearity (<1%) even in loud environment for effective algorithm operation
	In-cabin presence detection	Ultrasonic Response	Wideband / Ultrasonic response
ADVANCED FEATURES	Parking Assist	Ultrasonic Response	Wideband / Ultrasonic response
	Smart tires	Temp / humidity robustness	Stability at high temp / high humidity, high pressure robustness
	Listening to car surrounding / Siren detection	Vibration sensor	Environmental robustness
	Retrofit ECM with MEMS	Replace with MEMS module	Small package size

Scale + Supply
5-Yr Supply Warranty

Support
Field Quality
for Auto

Technology
Turnkey Provider

Quality
AEC-Q103-003

Emerging use cases like Voice UI, E-Call, ANC are driving new solutions and new mic requirements

CHOOSING THE RIGHT MICROPHONE

SIGNAL TO NOISE RATIO

For far field applications, high SNR microphones result in superior audio pickup. ANC and transparency mode features in TWS need high SNR microphones for better user experience. When comparing analog to PDM microphones, reduce the analog SNR by ~1.5dB to account for the external ADC's noise contribution.

ACOUSTIC OVERLOAD POINT (AOP) AND 1% THD

The AOP is the sound pressure level at 1kHz at which the total harmonic distortion is 10%. At this point, audio is heavily clipped and sounds very distorted. Microphones require a high AOP spec if they are subject to high sound levels (eg. close to loudspeakers or outdoor applications exposed to wind noise). Maximum linearity (<1% THD), even in loud environments benefits effective operation of algorithms including beam forming.

MEMS VS. ELECTRET CONDENSER (ECM) MICROPHONES

MEMS microphones are reflow capable SMT devices with stable performance under extreme conditions. They are resistant to power supply noise, humidity, and mechanical shock and vibration. Compared to ECMs, MEMS microphones have wide operating temperature and supply voltage ranges where sensitivity does not drift.

LOW FREQUENCY ROLL-OFF (LFRO)

The LFRO is the -3dB point of the frequency response with respect to the sensitivity at 1kHz. A low LFRO is advantageous for bass frequency pickup and ANC, but it is more sensitive to wind noise and low frequency overload in a feedback ANC system.

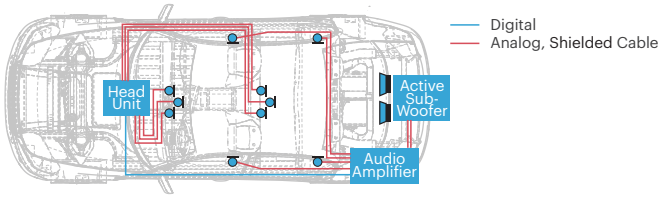
ULTRASONIC APPLICATIONS

MEMS microphones inherently have a very usable ultrasonic response from 20kHz to 80kHz or more. The output of the u/s signal must be processed by an amp, CODEC, or ADC that can extract the needed frequencies, usually by using a higher sample rate and/or lower decimation rate. Operating MEMS microphones at a high CLK rate allows increased ultrasonic bandwidth without noise penalty.

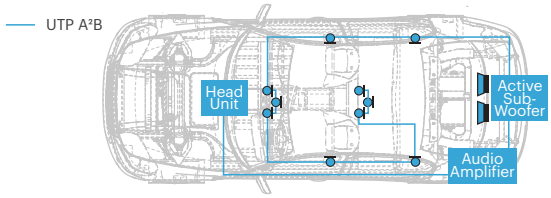
EMERGING DIGITAL ARCHITECTURES IN AUTO

Digital (PDM) microphones have an integrated ADC and return oversampled PDM data at the supplied clock frequency. Digital architectures enable transmission of digital PDM mic output data over an automotive bus such as ADI's A2B audio bus with system benefits on lower weight cables, noise immunity, and scalability.

ANALOG ARCHITECTURE



DIGITAL ARCHITECTURE



BENEFITS OF DIGITAL ARCHITECTURES

Signal susceptible to noise & EMI	**Noise Immunity**	Improved RF/EMI robustness
Complex design with multiple iterations	**Faster Design**	Easier system design with fewer iterations
Dedicated shielded cables needed w/more mics →Higher system cost, more weight	**Scalability**	Newer architecture like A2B scalable→ Cheaper cables, fewer wires, less weight

	MICROPHONE	DESCRIPTION	SIZE	SNR | 1% THD | 10% THD*	LFRO	OPER. TEMP. | STORAGE TEMP.	CURRENT	
DIGITAL	**SPH6855LM4H-1** Samples on flex: KAS-700-0147	Automotive AEC-Q103-003 -35dBFS sensitivity	3.50 x 2.65 x 0.98mm	68 dB(A) | 117 dB SPL | 130 dB SPL	30Hz	-40 to + 100°C | -40 to + 125°C	260µA @ 768kHz 1000µA @ 2.4MHz	
	SPH6655LM4H-1 Samples on flex: KAS-700-0174	Automotive AEC-Q103-003 -26dBFS sensitivity	3.50 x 2.65 x 0.98mm	68 dB(A) | 117 dB SPL | 121 dB SPL	30Hz	-40 to + 100°C | -40 to + 125°C	260µA @ 768kHz 1000µA @ 2.4MHz	
	SPH9855LM4H-1 Samples on flex: KAS-700-0160	Automotive AEC-Q103-003 -37dBFS sensitivity ± 1dB sensitivity matching	3.50 x 2.65 x 0.98mm	66 dB(A) | 130.5 dB SPL | 132.5 dB SPL	25Hz	-40 to + 100°C | -40 to + 125°C	260µA @ 768kHz 1000µA @ 2.4MHz	
	SPH9855LM4H-C Samples on flex: KAS-700-0161	Automotive AEC-Q103-003 -37dBFS sensitivity ± 0.5dB sensitivity matching						
	SPH8855LM4H-1 Samples on flex: KAS-700-0162	Automotive AEC-Q103-003 -26dBFS sensitivity	3.50 x 2.65 x 0.98mm	66 dB(A) | 118 dB SPL | 121 dB SPL	25Hz	-40 to + 100°C | -40 to + 125°C	270µA @ 768kHz 800µA @ 2.4MHz	
ANALOG	**SPH1878LR5H-1** Samples on flex: KAS-700-0167	Automotive AEC-Q103-003 ± 1dB sensitivity matching	3.50 x 2.65 x 1.26mm	67 dB(A) | 124 dB SPL | 134 dB SPL	7Hz	-40 to + 85°C | -40 to + 125°C	100µA @ 1.8V 250µA @ 2.75V	
	SPH1878LR5H-C Samples on flex: KAS-700-0168	Automotive AEC-Q103-003 ± 0.5dB sensitivity matching						
	SPH2878LR5H-1	Automotive AEC-Q103-003 ± 1dB sensitivity matching	3.50 x 2.65 x 1.26mm	67 dB(A) | 124 dB SPL | 134 dB SPL	7Hz	-40 to +105°C | -40 to +125°C	100µA @ 1.8V 250µA @ 2.75V	
	SPH2878LR5H-C	Automotive AEC-Q103-003 ± 0.5dB sensitivity matching						

** SNR AND THD SPECS APPLY TO NORMAL MODE. FOR LOW POWER MODE SPECS, REFER TO THE DATASHEET*

ADDITIONAL RESOURCES

Datasheets: www.Knowles.com/SiSonic
SiSonic Design Guide: www.Knowles.com/SiSonic/Design-Guide
Evaluation kits: www.Knowles.com/SiSonic/Evaluation-Kits
Application notes: www. Knowles.com/SiSonic/Application-Notes
Automotive: www. Knowles.com/SiSonic/Automotive
Voice Vibration Sensor: www.knowles.com/V2S/automotive