knowles

KNOWLES AEC-Q100/Q103 QUALIFIED MEMS MICROPHONES FOR AUTOMOTIVE APPLICATIONS SELECTION GUIDE

MARCH 2023

INTRODUCTION

Knowles is the world leader in MEMS microphones and has shipped 20 billion units to date. 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 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-Q100/103 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.

Scale + Supply
5-Yr Supply Warranty

Support
Field Quality for Auto

Technology
Turnkey Provider

Quality
AEC-Q100/103

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	Waterproof exterior mic module	Environmental robustness, high AOP
	Retrofit ECM with MEMS	Replace with MEMS module	Small package size

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

MICROPHONE TECHNOLOGIES

SOLUTIONS	IMPACT OF MIC SPECS	MEMS	ECM
Beamforming	LFRO Variation / Phase Matching	✓	
	Environmental Stability - Temp/Humidity	✓	
	Multiple Mics → Smaller Footprint	✓	
	Insensitive to Vibration/Shock	✓	
Active Noise Cancellation	Low Latency / LFRO	✓	✓
	LFRO Variation / Phase Matching	✓	
Barge-In/E-Call	High AOP	✓	
System Flexibility	Digital Interface → Lower Noise, Ease of Layout, Multi-Mics	✓	
Manufacturing Ease	Auto pick and place, surface mountable	✓	

- ECM sensitive to temperature and humidity over time
- Voice mic in head unit →Small size important MEMS footprint smaller than ECM
- Vibration in ECM affects acoustic output
- MEMS offers more consistent acoustics
- Phase response tighter for MEMS

MEMS mics are robust, reliable and offer several features ideally suited to solve acoustic automotive challenges

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.

SENSITIVITY OF PDM MICROPHONES

Sensitivity of microphones is the reference output for 94dB SPL sound. Higher sensitivity implies more signal for a given sound. In PDM microphones, higher sensitivity does not imply higher performance because gain can simply be applied in the digital domain by multiplying the output code. Dynamic range is a better indicator of microphone performance.

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.

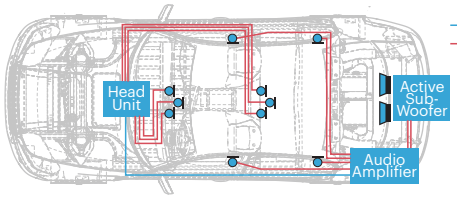
ULTRASONIC APPLICATIONS

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.

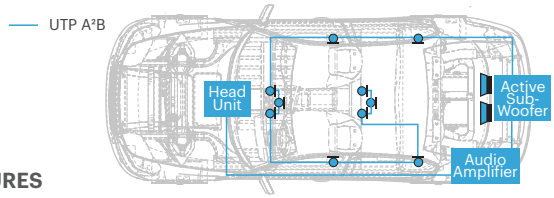
EMERGING DIGITAL ARCHITECTURES IN AUTO

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