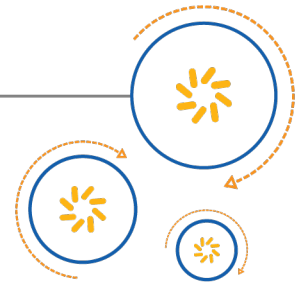




Qualcomm Technologies International, Ltd.



# Qualcomm cVc Two Microphone Handsfree

## Design Guidelines

80-CT411-1 Rev. AE

November 6, 2017

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# Revision history

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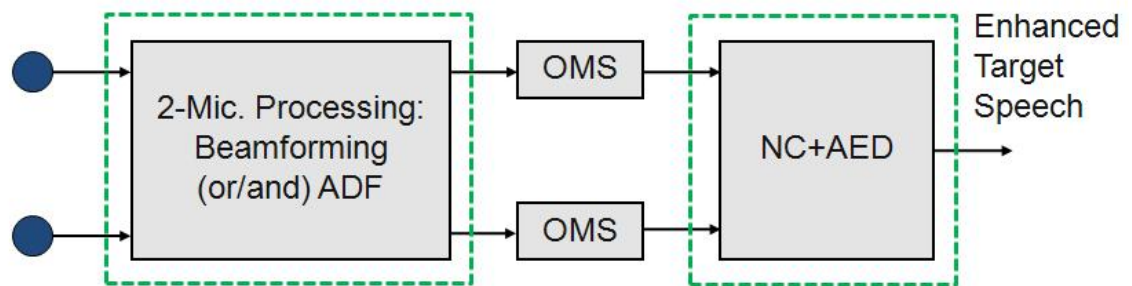
| Revision | Date           | Description   |
|----------|----------------|---|
| 1        | February 2014  | Original publication of this document. Alternate number: CS-00225939-AN |
| 2        | May 2014       | Editorial updates   |
| 3        | May 2014       | Editorial updates   |
| 4        | September 2016 | Updated to reflect QTIL rebranding                                      |
| 5        | November 2017  | Updated to reflect new document and revision numbering scheme           |

# 1 2 cVc 2-mic Handsfree system overview

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The modules in the cVc algorithm that impact the functional quality of the 2-mic Handsfree system are:

- Beamforming
- ADF
- OMS
- AED



**OMS:** One Microphone Solution

**ADF:** Adaptive Decorrelation Filter (Blind Source Separation)

**NC :** (Adaptive) Noise Canceller

**AED:** Acoustic Events Detection and Suppression

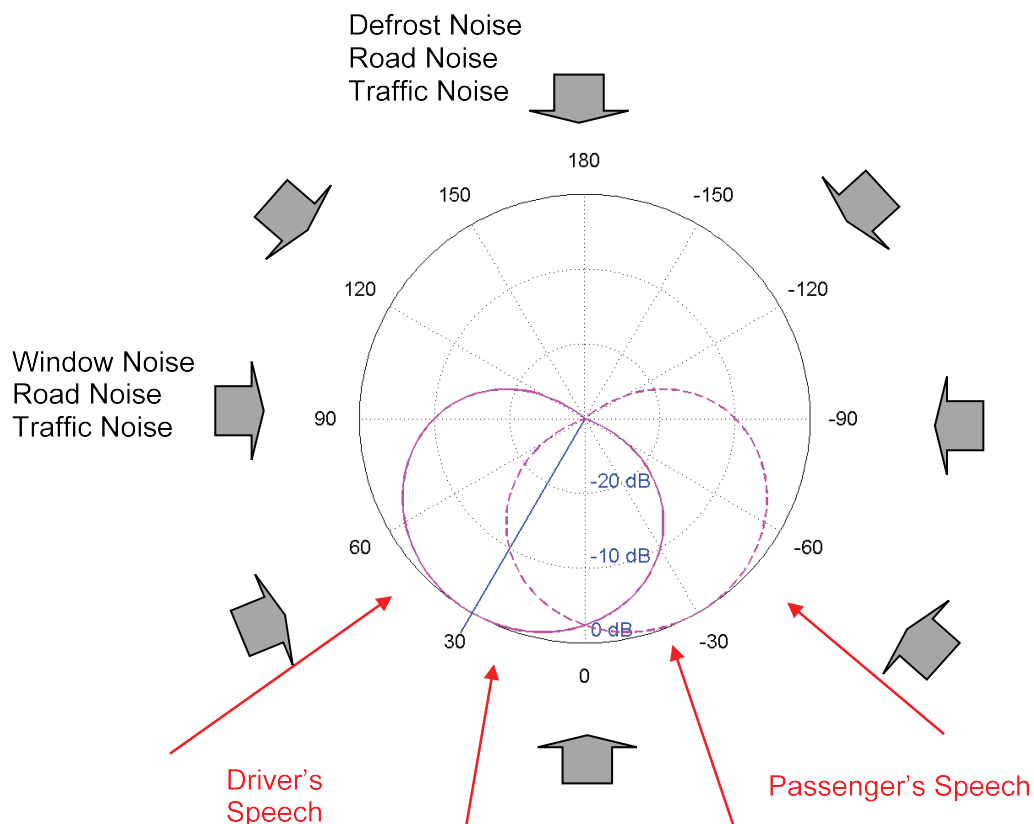
**Figure 1-1 2-mic Handsfree system**

The cVc 2-mic Handsfree system enables you to select either omni-directional or uni-directional microphones.

Microphone types include:

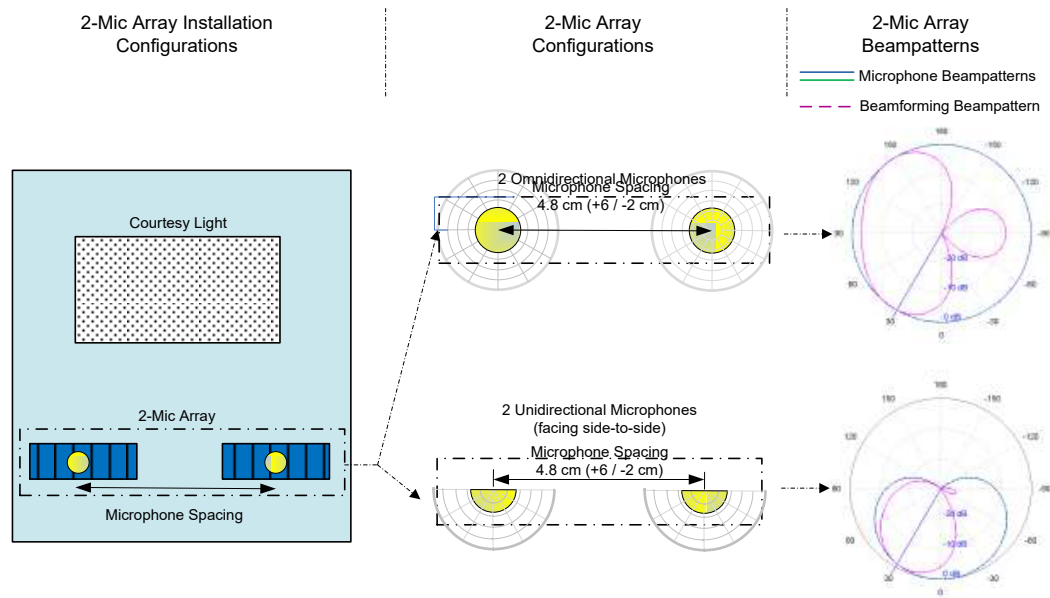
- Analog electrets
- MEMS digital
- MEMS silicon analog

cVc does not support a mix of microphone types. The processing does not support more than two microphones.



**Figure 1-2 Typical In-car noise environment**

Figure 1.3 shows array configurations and spacing for microphones with different directionality, and their corresponding beam patterns. Courtesy Light refers to the lamp assembly inside the car.



**Figure 1-3 2-mic configurations overview**

The cVc Handsfree system recommended microphone placement position is on the interior ceiling at the windshield, centered between the driver and passenger, either in:

- The rear view mirror
- The overhead lamp assembly

The microphones should be forward of the driver with a microphone-to-mouth distance of up to 60 cm. The cVc Handsfree system does not support microphone placement in the Vehicle A-pillars. For any position other than the recommended position, consult with QTIL for guidance.

## 1.1 Uni-directional microphones

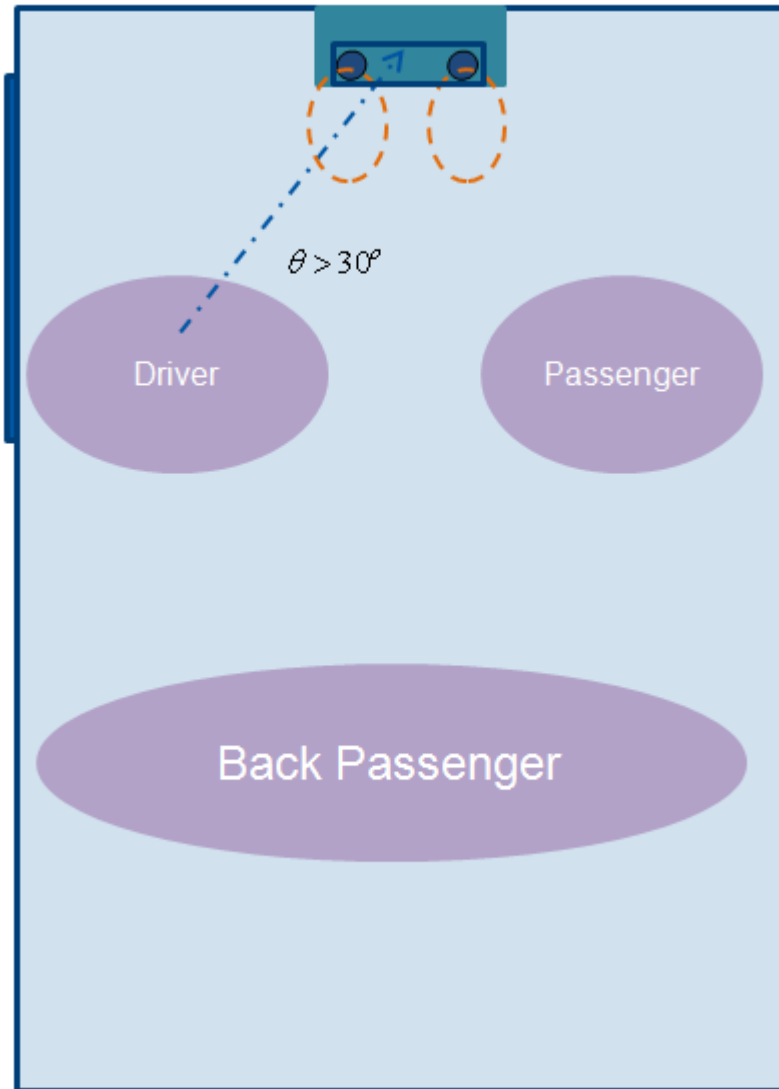
This section describes QTIL's recommendations for uni-directional microphone placement.

## 1.2 Beamforming of directional microphones facing side-to-side

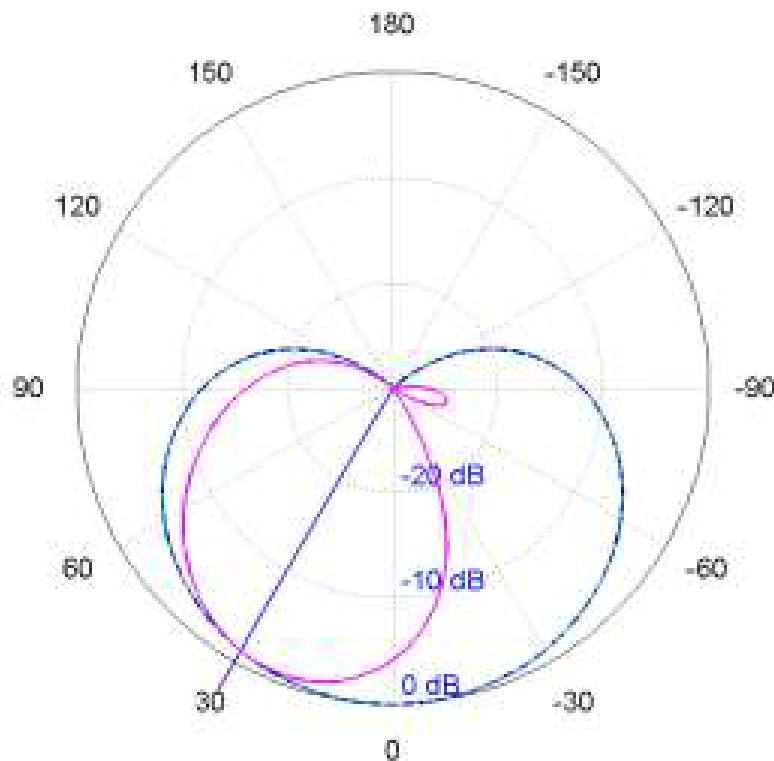
In this configuration, the cVc system contains:

- Beamforming
- AED
- ADF
- OMS





**Figure 1-4 Beamforming of directional microphones facing side-to-side**



**Figure 1-5 Beam pattern of directional microphones facing side-to-side**

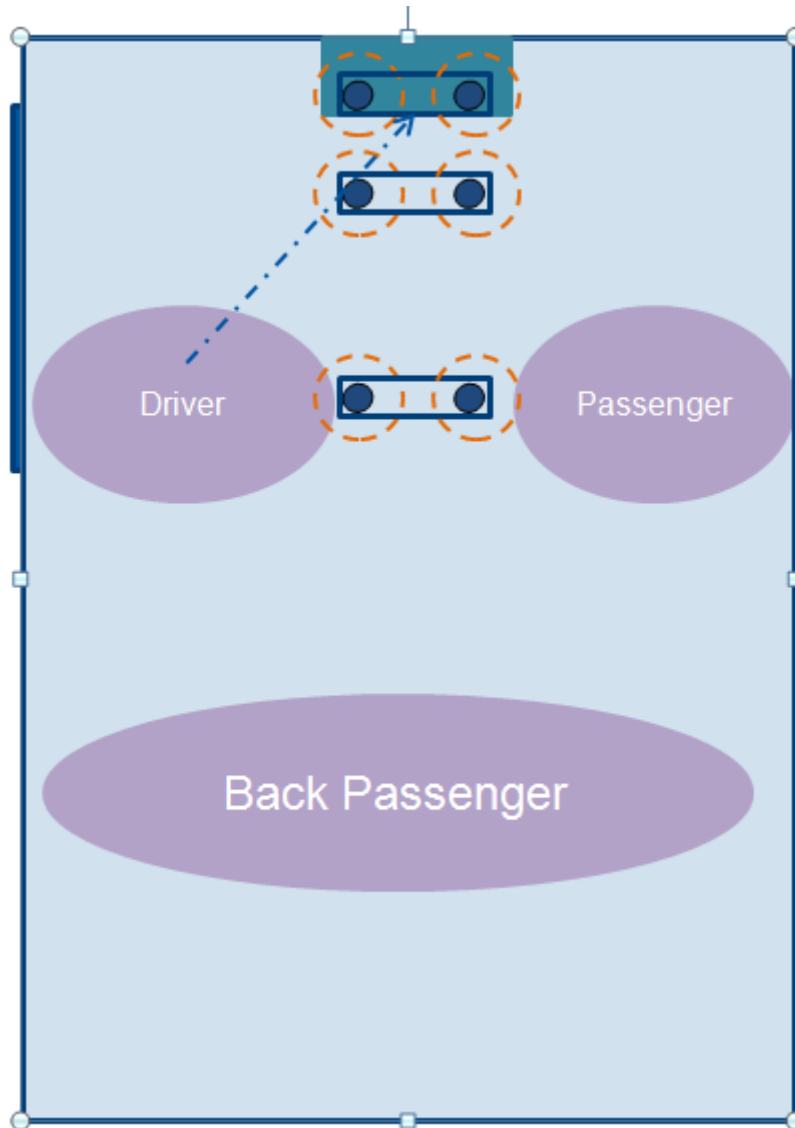
QTIL recommends these guidelines for the omni-direction microphones:

- Direction of arrival:  $\sim 30^\circ$
- Distance between two microphones: 5 cm (range between 5 to 6 cm)
- Well-matched 2-mic frequency response and beam pattern <3 dB of mismatch is allowed
- Must be the same microphone model in each position

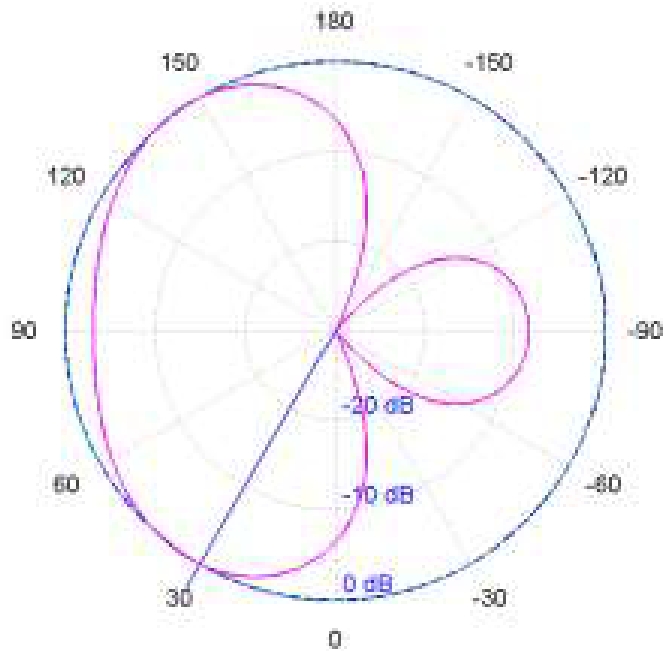
### 1.3 Omni-directional microphones

In this configuration, the cVc system contains

- Beamforming
- ADF
- OMS
- AED



**Figure 1-6 Beamforming of omni-directional microphones**



**Figure 1-7 Beam pattern of omni-directional microphones**

QTIL recommends these guidelines for the omni-direction microphones:

- Direction of arrival:  $\sim 30^\circ$
- Distance between two microphones: 5 cm (range between 5 to 6 cm)
- Well-matched 2-mic frequency response and beam pattern <3 dB of mismatch is allowed
- Must be the same microphone model in each position

## 2 2 cVc 2-mic Handsfree system design example

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This section describes an example design and does not represent a specific QTIL recommendation.

**Table 2-1 Example microphone specification**

|  |                                     |
|--|-------------------------------------|
| <b>Type</b>                              | Analog MEMS                         |
| <b>Grade</b>                             | Automotive                          |
| <b>Directionality</b>                    | Uni-directional or omni-directional |
| <b>Frequency range</b>                   | 70 to 12000 Hz @ -10 dB             |
| <b>Sensitivity</b>                       | -40 ± 0.5 dB part to part variance  |
| <b>Distortion</b>                        | <3% THD @ 115 dB SPL @1 kHz         |
| <b>SNR</b>                               | > 55 dB 1 kHz, A weighted           |
| <b>Operating and storage temperature</b> | -40 to 100° C                       |
| <b>Tolerance</b>                         | ± 3 dB                              |

**Table 2-2 Example microphone positioning**

|                                     |                     |
|-------------------------------------|---------------------|
| <b>Placement</b>                    | Rear-view mirror    |
| <b>Microphone spacing</b>           | 4.8 cm              |
| <b>Microphone orientation</b>       | Facing side-to-side |
| <b>Direction of arrival</b>         | 30°                 |
| <b>Microphone to mouth distance</b> | 40 cm               |

**Table 2-3 cVc details**

|                      |  |
|----------------------|--|
| <b>Version</b>       | BCSW-CVC-HF-5-0-x                                |
| <b>Blocks used</b>   | ■ Beamforming<br>■ ADF<br>■ OMS<br>■ AED         |
| <b>Target speech</b> | Driver of the vehicle                            |
| <b>Hardware</b>      | CSR8670, DaleAuto2 A08 ROM running QTIL Software |

## Document references

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| Document  | Reference                  |
|---|----------------------------|
| <i>BCSW-CVC-HF-5-0-3 2M-HF Parameter Manager User Guide</i> | 80-CT413-1/CS-00309823-UG  |
| <i>BCSW-CVC-HF-5-0-3 2M-HF Tuning Guide</i>                 | 80-CT412-1 /CS-00309822-UG |

# Terms and definitions

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|            |   |
|------------|---|
| ADF        | Adaptive Decorrelation Filter   |
| AED        | Acoustic Events Detection   |
| BCSW       | BlueCore Software   |
| BlueCore®  | Group term for QTIL's range of Bluetooth wireless technology chips.                       |
| Bluetooth® | Set of technologies providing audio and data transfer over short-range radio connections. |
| cVc®       | Clear Voice Capture DSP audio processing software   |
| HF         | Handsfree   |
| HFK        | Headset Mode  |
| HS         | Headset   |
| MEMS       | Micro-electro-mechanical systems  |
| OMS        | One Microphone solution   |
| PRD        | Product Requirements Document   |
| QTIL       | Qualcomm Technologies International, Ltd.   |
| SDK        | Software Development Kit  |
| SNR        | Signal to Noise Ratio   |
| SPL        | Sound Pressure Level  |
| THD        | Total Harmonic Distortion   |