Qualcomm Technologies International, Ltd.

Qualcomm cVc™ 2-mic Headset Industrial

Design Guidelines

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Revision history

Revision	Date	Description
1	August 2011	Initial release. Alternative document number: CS-00218321-DC
2	May 2012	Editorial updates
3	November 2013	Updated Chapters 2 and 3.
4	September 2016	Editorial updates; no technical content was changed in this document revision.
5	April 2017	Updated microphone spacing information
6	July 2017	Editorial updates.
CA	July 2017	Updated document number.

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1 cVc 2-microphone Headset industrial design guidelines overview

This document provides guidelines for the effective design of a 2-microphone (2-mic) Qualcomm Technologies International, Ltd. (QTIL) cVc headset.

Follow the guidelines in this document to ensure that the 2-mic cVc noise cancellation technology algorithm works effectively, particularly regarding microphone spacing and orientation.

2 Microphone placement

This section describes the QTIL recommendations for the placement of microphones in a 2-mic headset using the cVc algorithm.

Figure 2-1 applies to a sliding boom headset and Figure 2-2 applies to a fixed microphone configuration headset.

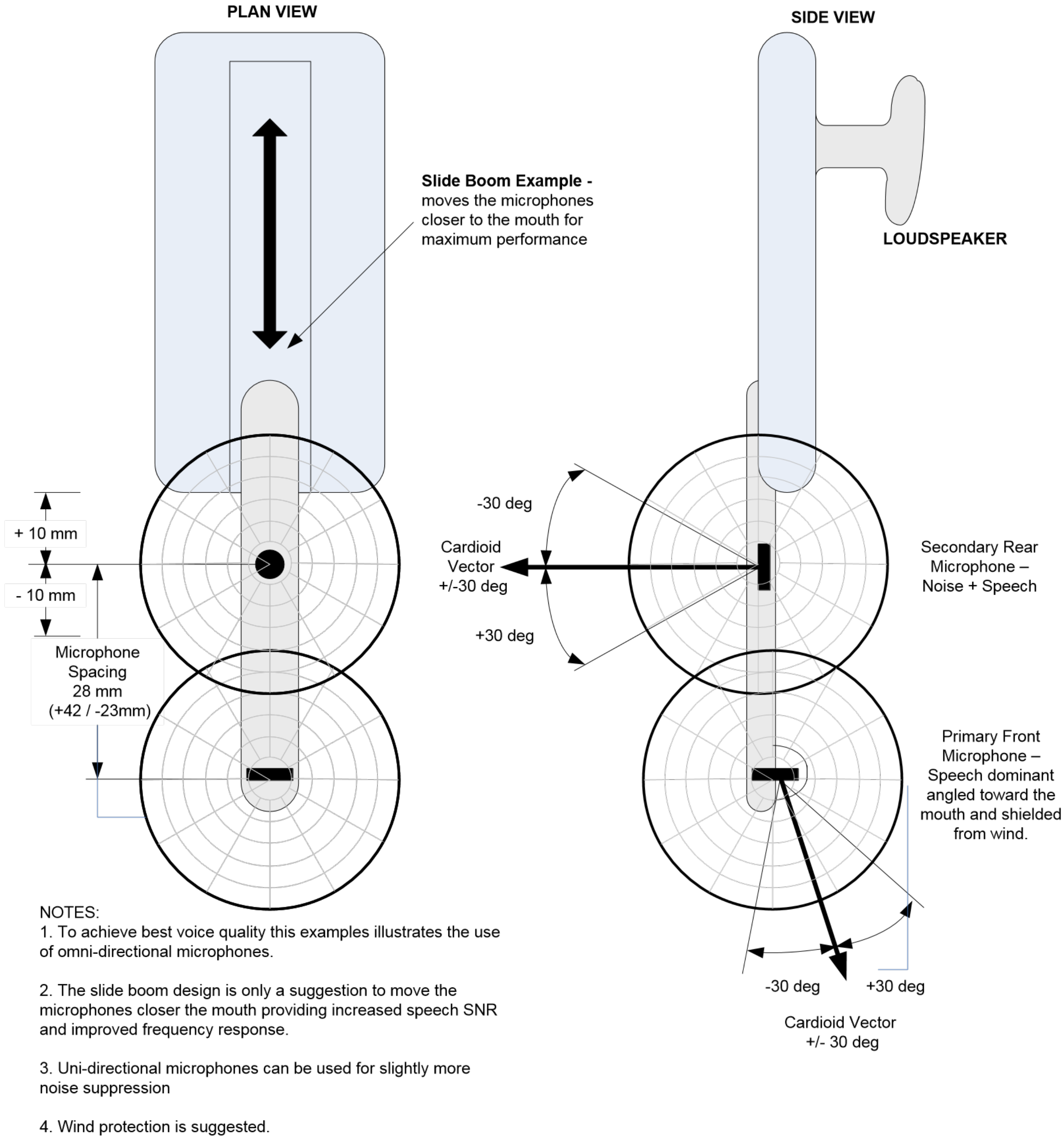

Figure 2-1 Sliding boom headset

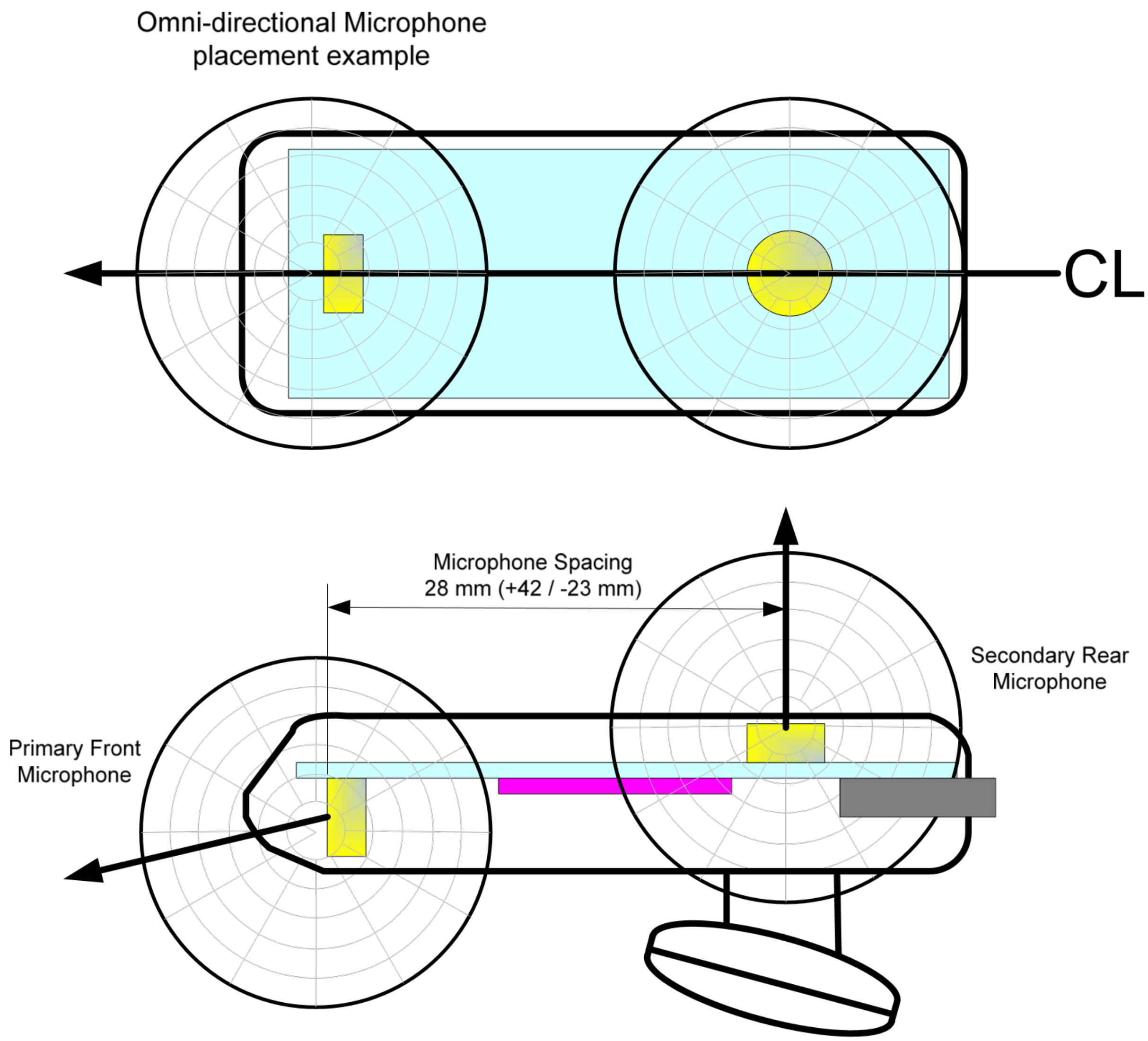

Figure 2-2 Fixed microphone configuration headset

1. The default microphone separation distance is 28 mm, with a tolerance of 42 mm and -23 mm (front to rear arrangement with the mouth). For older algorithm versions (BCSW-CVC-HS-5-4-3 or earlier), 30 mm is recommended, with a tolerance of ±10 mm.
2. Microphones are oriented orthogonal to each other. The microphone furthest from the mouth is oriented to face outwards from the surface of the headset. The microphone nearest the mouth is oriented to face towards the direction of the mouth.
3. Use omnidirectional microphones for low cost, design ease, and good frequency response.
4. Mount microphones on the headset centerline, so that sensitivity is similar when worn on the left or right ear.

5. Minimize the front microphone-to-mouth distance as shown in Figure 2-1 to:
   - Increase the speech power while not affecting the noise level at the microphone. This improves speech SNR, enabling lower microphone gains to be used. Lower gains reduce the surrounding acoustic noise and electrical noise signals.
   - Enable the cVc software to yield maximum noise suppression at the highest speech quality (lowest distortion).
   - Improve frequency response, making the users speech sound more natural and reducing the need for equalization.

3 Additional microphone design recommendations

In addition to placement recommendations, QTIL recommends:

1. Attempt mechanical wind protection using microphone placement, porting, or the addition of a wind-screen. Orienting the front microphone port at an angle towards the mouth, and using the headset housing to shield the direct wind enables the headsets to perform better at higher wind speeds. The more the mechanical wind reduction, the better the microphone audio, and the less the cVc WNR software is required to clean speech.
2. Use similar microphones where possible. This helps to achieve a similar frequency response, phase, and gains between the microphones. These are underlying assumptions to get the maximum performance from the cVc software algorithm.
3. Gasket microphones into position, sealing the microphone face and the case. This:
   □ Isolates vibration between microphone, PCB, and case
   □ Avoids multipath leakage by sealing microphone chambers
   □ Baffles the loudspeaker, reducing echo
4. Minimize the acoustic echo from the loudspeaker to microphone. For example:
   Provide a sealant material blocking any cavities where sound could travel internal to the device from the loudspeaker to the microphones
   Provide a mechanical design where the hardware delivers > 25 TCLw
   Ensure that any acoustic echo should be biased or stronger in the rear microphone
   Orient the microphone diaphragm perpendicular to the loudspeaker
5. If analog electrets or MEMS microphones are used, wire them differentially into the ADC inputs to reduce common mode noise.
6. A clean microphone bias is mandatory to achieve maximum algorithm performance. Ensure that an electronic filter is used in the microphone bias circuit, limiting any electrical noise from being inducted into the ADC inputs of the chip.
7. Microphones of various technologies can be supported depending on the silicon used. The primary microphone types include analog electrets, digital, and analog MEMS but always try to always use the same microphone model in the device.
8. Minimize the acoustic, electrical, and mechanical crosstalk between microphones to > 40 dB.
9. Use good RF design practices to ensure the radio signals (antenna placement) do not interfere with the microphone inputs.

4 Recommended microphone and speaker specifications

Table 4-1 Electrets microphone

Distortion	**< 2%THD from 100 Hz to 10 kHz at the intended maximum SPL**
Sensitivity	-42 dB and < ±3 dB part to part variance at (1 kHz 0 dB = 1 V/Pa)
Impedance	2.2 KΩ, < 5 KΩ to reduce channel crosstalk
S/N ratio	Typical 55 dB 1kHz, 0 dB = 1 V/Pa, A weighted or lower
Voltage rating	Typical < 1.8 volts
Directivity	Omnidirectional

Table 4-2 Analog MEMS microphone

Distortion	**< 1%THD @ 100 dB SPL @ 1 kHz** **Typical < 3%, Max <10% @ 115 dB SPL @ 1 kHz**
Sensitivity	-40 dB and < ±3 dB part to part variance at (1 kHz 0 dB = 1 V/Pa)
S/N ratio	Typical 62 dB 1 kHz, 0 dB = 1 V/Pa, A weighted or lower
Voltage rating	Operational range 1.5 V to 3.3 Volts DC
Frequency range	70 to15000 Hz + 5 dB Ref Sens. @1 KHz
Directivity	Omnidirectional

Table 4-3 Loudspeaker

Distortion	**< 5%THD from 100 Hz to 10 kHz at the required maximum SPL**
Impedance	Typical 16 Ω to 32 Ω, if driven directly from the QTIL Bluetooth IC. See the related datasheets for limitations.

Document references

Document	Reference
CSR8620 BGA Datasheet	CS-00212920-DS
CSR8620 WLCSP Datasheet	CS-00218111-DS
CSR8645 BGA Datasheet	CS-00218182-DS
CSR8640 BGA Datasheet	CS-00209182-DS

Terms and definitions

Term	Definition
ADC	Analog-to-digital Converter
Qualcomm® BlueCore™	Group term for the QTIL range of Bluetooth wireless technology chips
Bluetooth	Set of technologies providing audio and data transfer over short-range radio connections
cVc	Clear Voice Capture
MEMS	Micro-electro-mechanical systems
PCB	Printed Circuit Board
QTIL	Qualcomm Technologies International, Ltd.
RF	Radio Frequency
SNR	Signal to Noise Ratio
SPL	Sound Pressure Level
TCLw	Terminal Coupling Loss - weighted
THD	Total Harmonic Distortion
WNR	Wind Noise Reduction