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CVC®

Two Microphone Headset Industrial Design Guideline

Document (Miscellaneous)

Issue 3

Document History

Revision	Date	History
1	14 NOV 13	Original publication of this document
2	01 JAN 12	Updated to latest CSR style
3	19 NOV 13	Updated to latest CSR style, added details to sections 2 and 3.

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Tables, Figures and Equations

1. Introduction

CSR recommends that you follow the guidelines in this document to ensure that the 2 microphone CVC algorithm works effectively, particularly regarding microphone spacing and orientation.

This document provides guidelines for the effective design of a 2 microphone CVC headset.

2. Headset Design Recommendations

2.1. Microphone Placement

This section describes CSR's recommendations for the placement of microphones in a 2 microphone headset using the CVC algorithm.

Note:

Figure 2.1 applies to a *sliding boom* headset and Figure 2.2 applies to a fixed microphone configuration headset.

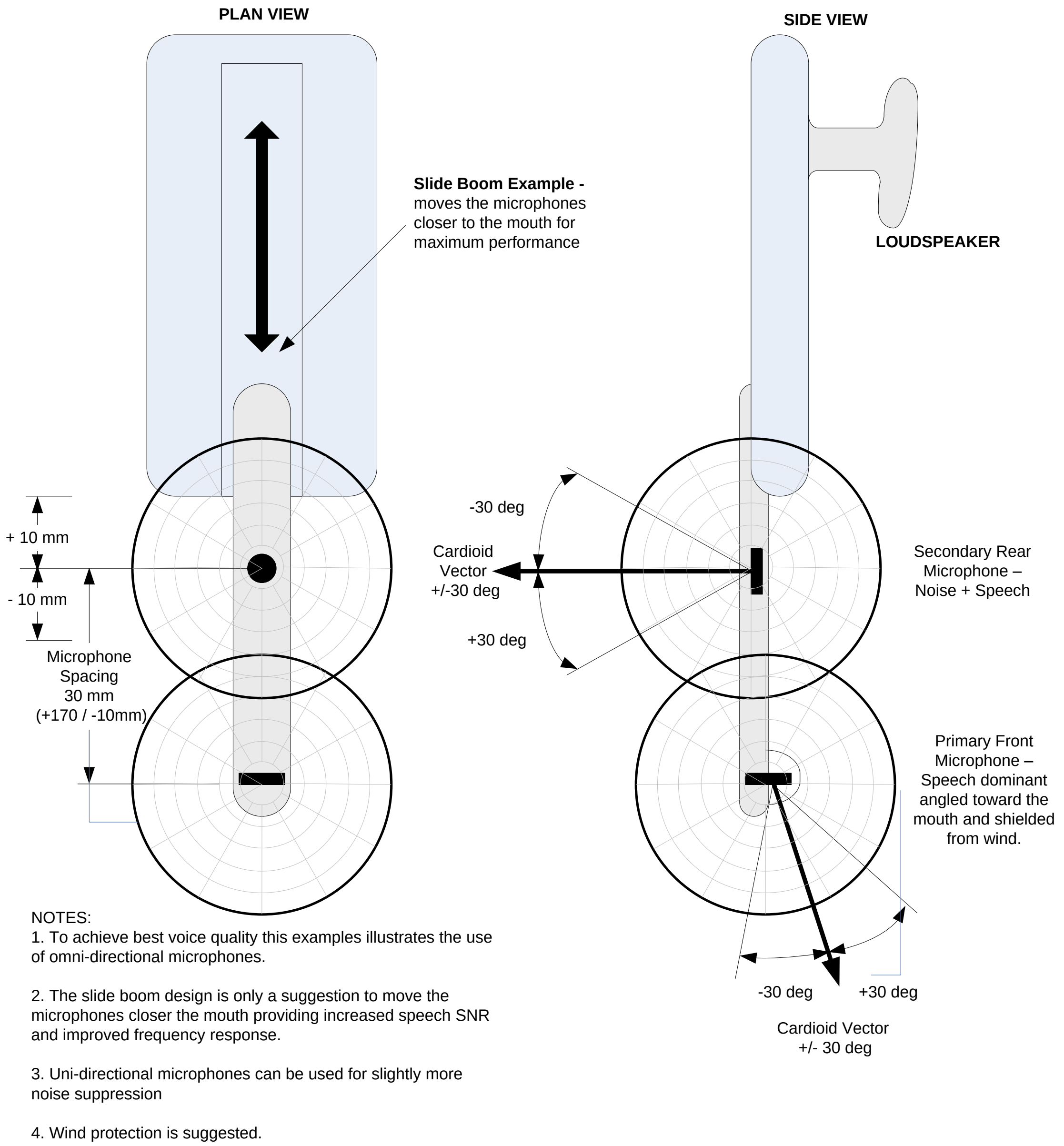

Figure 2.1: Microphone Configuration for Sliding Boom Headsets

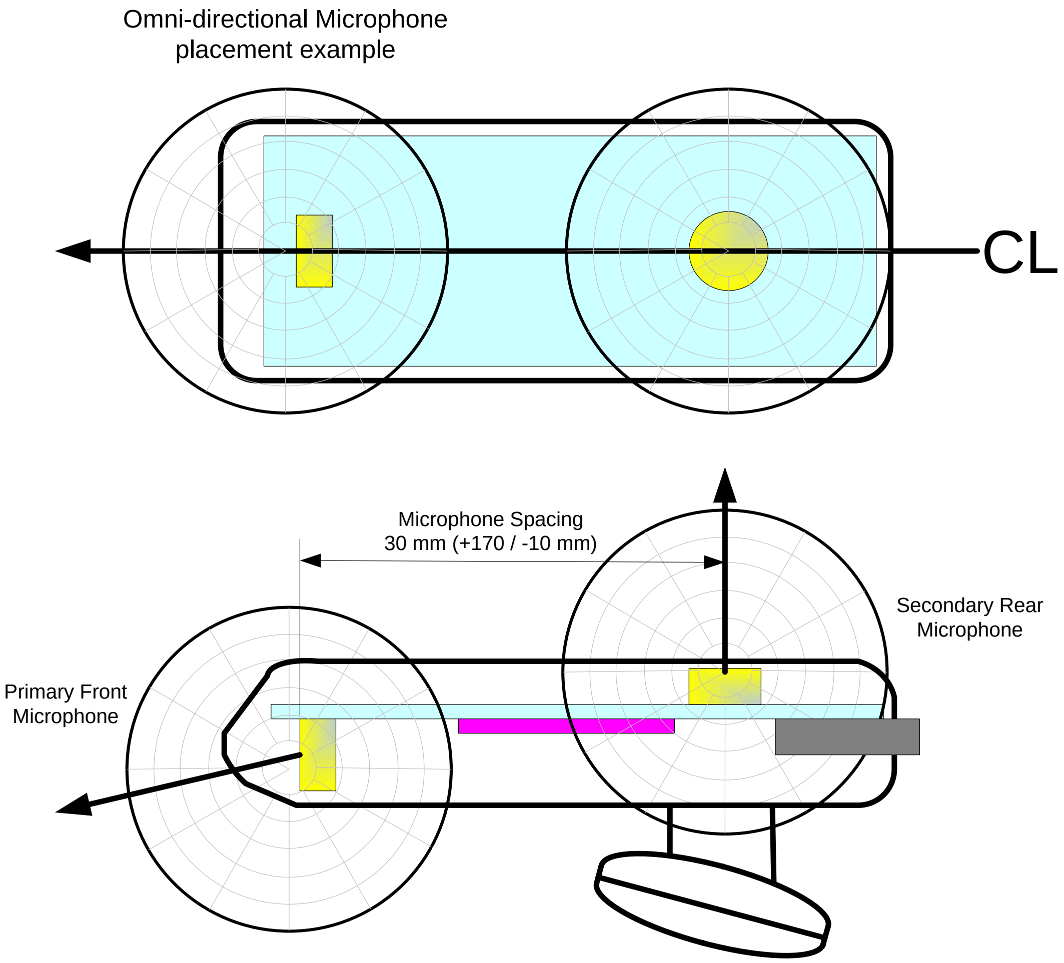

Figure 2.2: Fixed Microphone Configuration

2.2. Design Recommendations

1. Microphone separation distance is 30 mm, with a tolerance of +170 mm and -10 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 while the microphone nearest the mouth is oriented to face towards the direction of the mouth.
3. Use omni-directional microphones for low cost, design ease and good frequency response.
4. Mount microphones on the headset centreline, so sensitivity is similar when worn on the left or right ear.
5. Minimise the front microphone-to-mouth distance as conceptually illustrated in Figure 2.1
   - 5.1. The closer the front microphone is to the mouth, this increases the speech power while not affecting the noise level at the microphone. This helps improve speech SNR, allowing lower microphone gains to be used. Lower gains reduce the surrounding acoustic noise and electrical noise signals.
   - 5.2. Front microphone nearer the mouth enables the CVC software to yield maximum noise suppression at the highest speech quality (lowest distortion).
   - 5.3. It also improves frequency response making the users speech sound more natural, reducing the need for equalisation.

2.3. Additional Design Considerations

As well as the placement recommendations described in section 2.1 CSR recommends you:

1. Attempt mechanical wind protection using microphone placement, porting or the addition of a wind-screen.
    - 1.1. Orienting the front microphone port at a angle towards the mouth, and using the headset housing to shield the direct wind would have very positive results, allowing 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 of similar microphones where possible.
    - 2.1. This helps to achieve a similar frequency response, phase and gains between the microphones. These are underlying assumption to get the maximum performance from the CVC software algorithm.
3. Gasket microphones into position, sealing the microphone face and the case. Benefits include:
    - 3.1. Isolates vibration between microphone, PCB and case.
    - 3.2. Avoids multipath leakage by sealing microphone chambers.
    - 3.3. Baffles the loudspeaker, reducing echo.
4. Minimise the acoustic echo from the loudspeaker to microphone, i.e:
    - 4.1. Provide a sealant material blocking any cavities where sound could travel internal to the device from the loudspeaker to the microphones.
    - 4.2. Provide a mechanical design where the hardware delivers > 25 TCLw.
    - 4.3. Any acoustic echo should be biased or stronger in the rear microphone.
    - 4.4. Orients the microphone diaphragm perpendicular to the loudspeaker.
5. If analogue electrets or MEMS microphones are used, wire them differentially into the CSR ADC inputs to reduce common mode noise.
6. A very clean microphone bias is mandatory to achieve maximum algorithm performance. Ensure an electronic filter is used in the microphone bias circuit, limiting any electrical noise from being inducted into the ADC inputs of the CSR chip.
7. Microphones of various technologies can be supported depending on the CSR silicon chosen. The primary microphone types include analogue electrets, digital and analogue MEMS but always try to always use the same microphone model in the device.
8. Minimise the acoustic, electrical and mechanical crosstalk between microphones to > 40 dB.
9. Good RF design practices should be considered to ensure the radio signals (antenna placement) do not interfere with the microphone inputs.

3. Recommended Microphone and Speaker Specifications

3.1. Electrets Microphone

- **Distortion:** < 2%THD from 100 Hz to 10 kHz at the desired 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
- **Voltage Rating:** Typical < 1.8 volts
- **S/N Ratio**: Typical 55dB 1kHz, 0 dB=1 V/Pa, A weighted or lower
- **Directivity:** Omni-directional

3.2. Analogue MEMS Microphone

Typical specifications for analogue MEMS microphones.

- **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)
- **Voltage Rating:** operational range 1.5 V to 3.3 Volts DC
- **S/N Ratio:** Typical 62 dB 1 kHz, 0 dB=1 V/Pa, A weighted or lower
- **Frequency range:** 70-15000 Hz + 5 dB Ref Sens. @1 KHz
- **Directivity:** Omni-directional

3.3. Loudspeaker

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

Document References

Document	Reference
CSR8620 BGA Datasheet	CS-212920-DS
CSR8620 WLCSP Datasheet	CS-218111-DS
CSR8645 BGA Datasheet	CS-218182-DS
CSR8640 BGA Datasheet	CS-209182-DS

Terms and Definitions

ADC	Analogue to Digital Converter
BlueCore®	Group term for CSR's range of Bluetooth wireless technology chips
Bluetooth®	Set of technologies providing audio and data transfer over short-range radio connections
CSR	Cambridge Silicon Radio
CVC®	Clear Voice Capture
i.e.	*Id est*, that is
MEMS	Micro-electro-mechanical systems
PCB	Printed Circuit Board
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