soundskrit
Hear the impossible.

Introduction

On the Qualcomm QCC5181 platform, implementing both acoustic echo cancellation (AEC) and beamforming (BF) in the same transmit chain is non-trivial.

Qualcomm's AEC, part of their cVc™ technology, is intended to suppress loudspeaker echo on a single microphone signal, producing a single output. Meanwhile, Soundskrit BF relies on a combination of omnidirectional and/or directional microphones to achieve directivity, and requires simultaneous access to all microphone signals. The QCC5181 audio framework does not expose modules that can simultaneously satisfy both requirements.

This application note documents two supported signal-chain patterns that resolve this conflict:

- **Solution 1 – Two-mic heterogeneous array**
  Each microphone path includes its own AEC instance; the echo-reduced signals are then combined using a non-linear beamformer. This approach is appropriate for headsets and other compact two-mic products.
- **Solution 2 – Four-mic homogeneous array**
  Microphone pairs are first combined linearly to preserve phase, then passed through per-pair AEC instances, and finally merged using a non-linear beamformer. This approach targets larger devices (e.g., conference or far-field designs) that require higher directivity.

Beamforming

Soundskrit develops high-quality MEMS microphones that offer high directionality and a very low noise floor. These microphones can easily be beamformed and steered to exhibit different polar patterns[1], as seen in Figure 1, providing great control over the direction from which voice is picked up. This makes them ideal for use in noise, focusing their reception on the person talking and attenuating their environment.

[1] See Soundskrit AN220 for more information about polar patterns.

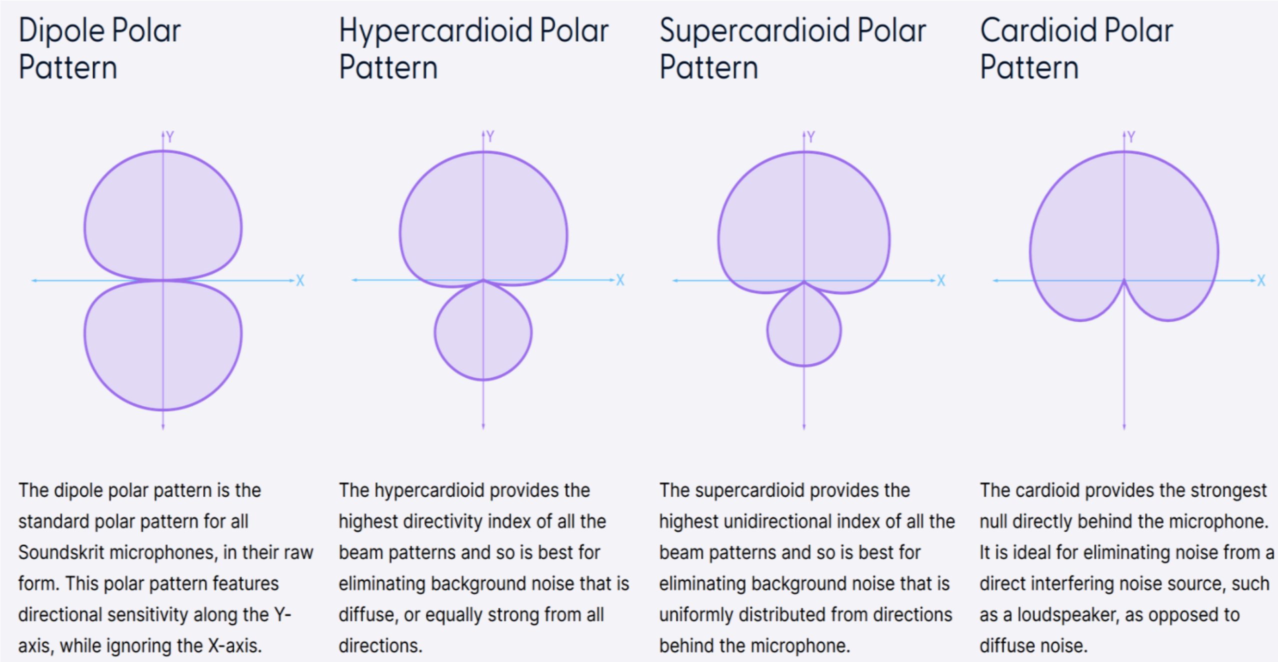


Figure 1: Different polar patterns achievable with Soundskrit microphones.

Soundskrit microphones are naturally directional (dipole pattern), but their directionality can be adjusted, either via their mechanical integration or via digital signal processing algorithms[2]. The latter approach results in superior acoustic performance by leveraging additional microphones. For instance, they can be paired with a secondary omnidirectional microphone, or used in a homogeneous array, depending on the use case.

Figure 2: Boom microphone prototype featuring a pair of microphones (dipole + omnidirectional).

Figure 3: Hypothetical product using a homogeneous array of dipole microphones.

Software beamforming has many advantages over mechanical beamforming, such as a polar pattern that is consistent across frequencies, as illustrated in Figure 4.

[2] See Soundskrit AN240 for more information about software beamforming.

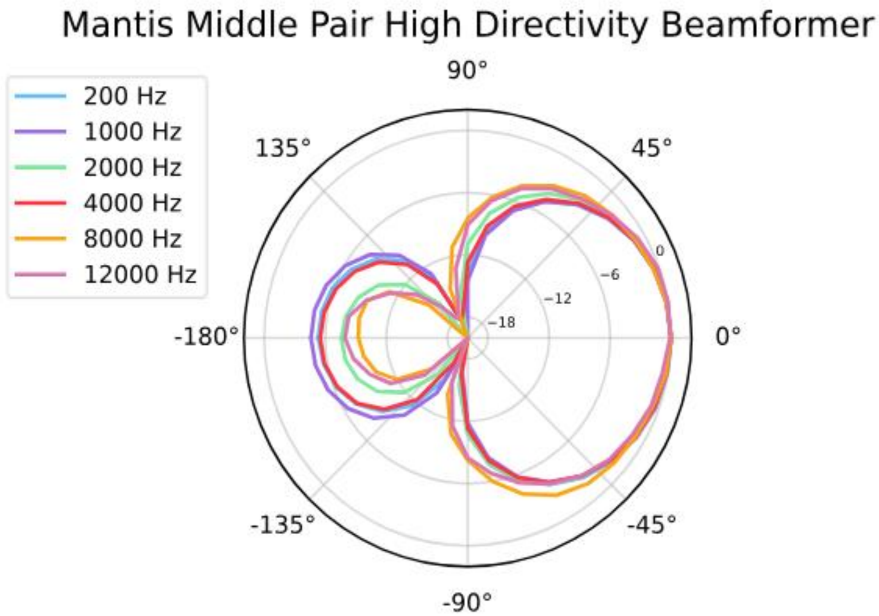


Figure 4: Polar pattern of a dipole-omnidirectional pair using Sounskrit linear beamforming.

Digital signal processing can also leverage non-linear algorithms to further improve noise rejection. For example, by only activating when voice is detected from a specific direction, as can be seen in Figure 5.

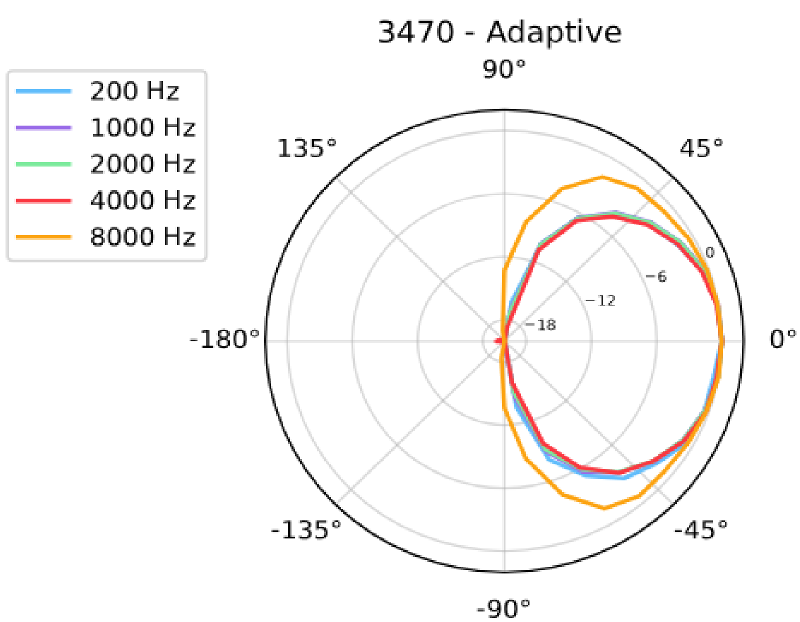


Figure 5: Activation pattern of a dipole-omnidirectional pair using Soundskrit non-linear beamforming.

Custom Audio Chain Solutions

In this section, we describe two custom audio chains devised to integrate Qualcomm's cVc™ technology with Soundskrit's beamforming algorithm, allowing both software beamforming and AEC to operate concurrently.

Solution 1. Custom AEC Chain with Two Heterogeneous Microphones

The first such chain is applicable to use cases relying on a Soundskrit microphone and an omnidirectional microphone. This topology is ideal for devices requiring a compact microphone footprint, such as headsets with boom microphones.

This chain instantiates a separate AEC module for each microphone. A splitter capability is used to duplicate the reference signal needed by the CVC-SEND capability for AEC. Both echo-cancelled signals are then passed to a Soundskrit capability which performs non-linear beamforming.

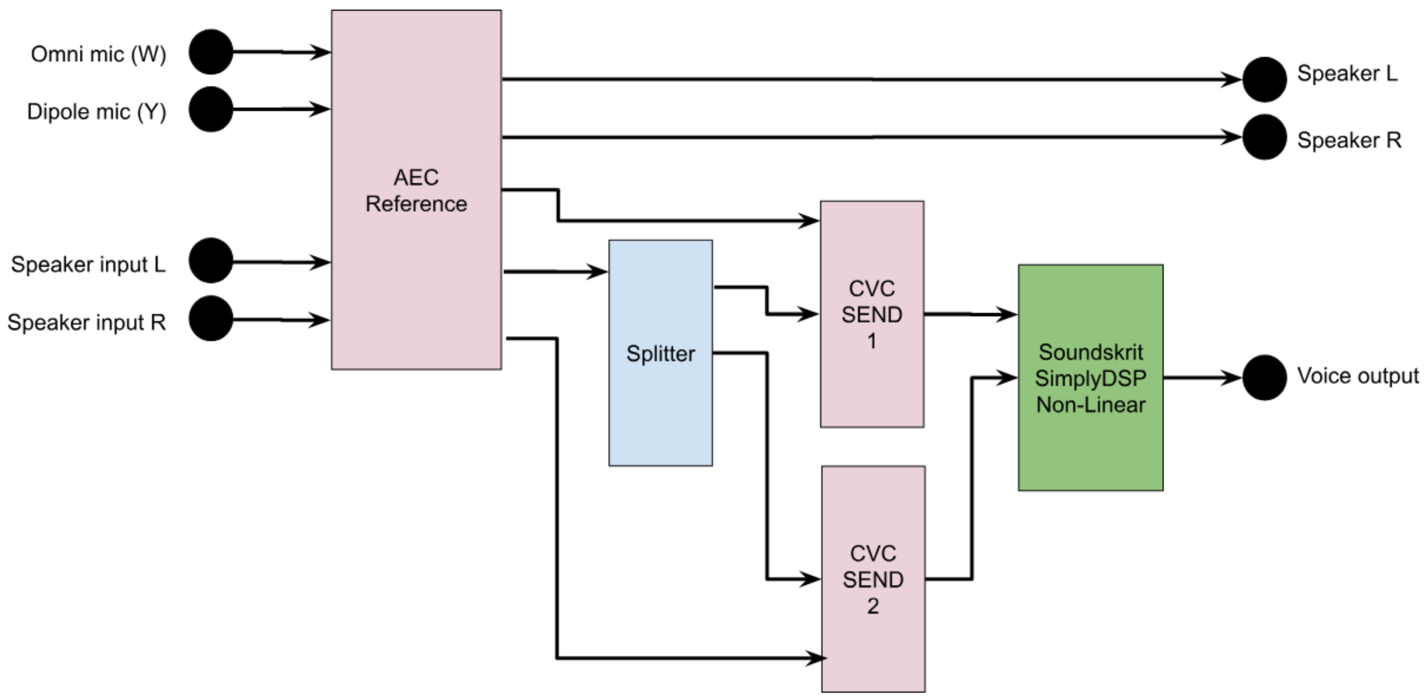


Figure 6: Custom QCC5181 audio chain for two-microphone AEC.

Solution 2. Custom AEC Chain with Four Homogeneous Microphones

The second custom chain is applicable to use cases requiring more than two identical Soundskrit microphones, such as videoconferencing equipment capturing voice signals coming from different directions.

Unlike the previous audio chain, this one makes use of two Soundskrit capabilities. The first one (Linear) performs a first stage of linear beamforming, and operates before AEC. This capability outputs two beamformed signals (Y1&Y2, Y3&Y4) and two reference signals. These first-stage beamformed signals are then echo-cancelled, before being further beamformed to yield a single voice signal (Y1&Y2&Y3&Y4).

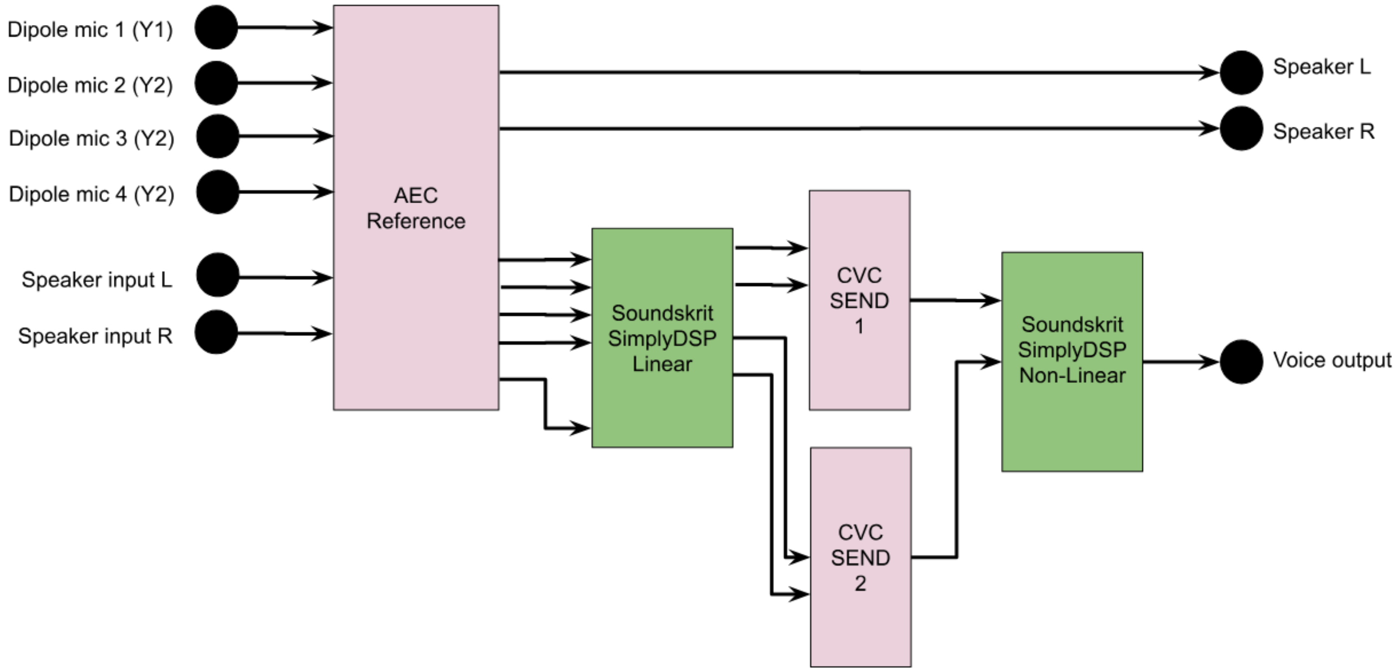


Figure 7: Custom QCC5181 audio chain for four-microphone AEC.

CPU Performance

This section provides an estimate of the CPU requirements of the Qualcomm cVc™ AEC and the Soundskrit beamforming algorithms, running on the QCC5181 at maximum clock frequency on a single audio core. This corresponds to the "Solution 1" use case.

Block Name	CPU Usage (%)	Million Cycles per Second (MCPS)
CVC-SEND 1	6.2%	14.9
CVC-SEND 2	6.2%	14.9
SimplyDSP Non-Linear (WY)	5.6%	13.4
AEC Reference	4.1%	9.8
Splitter	0.3%	0.7

Table 1: CPU usage of the custom audio chain at f = 240 MHz.

Conclusion

Beamforming and acoustic echo cancellation are useful techniques for reducing unwanted noise pick-up in voice communication systems, coming from either the environment or from acoustically-coupled loudspeakers.

This application note has demonstrated two effective custom audio chains for integrating Soundskrit's advanced beamforming with Qualcomm's cVc AEC on the QCC5181 platform. By providing solutions for both heterogeneous and homogeneous microphone configurations, developers can achieve superior noise reduction and echo cancellation without sacrificing performance. The provided CPU usage data confirms that these solutions are efficient and practical for real-world applications.

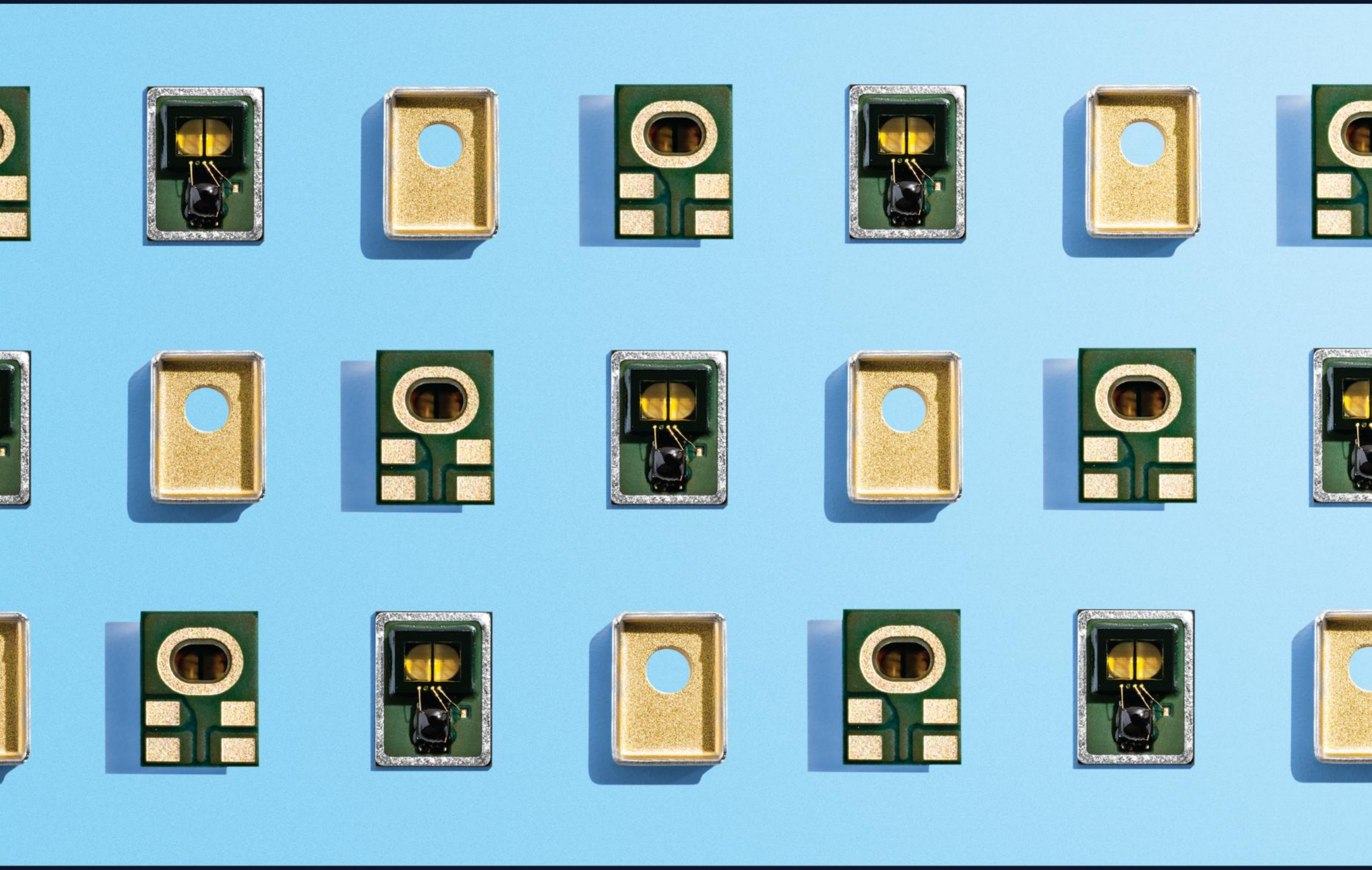
Additional Support

For further information on Soundskrit's products, visit our website at https://www.soundskrit.ca where you can find more application notes, datasheets, and purchasing information. If you have any questions or need technical support, please reach out to applications@soundskrit.ca.

Revision Label	Revision Date	Sections Revised
-	September 2025	Initial Release

Soundskrit developed the first high-performance directional MEMS microphone on the market, leveraging years of research in bio-inspired MEMS based on how spiders and other insects in nature hear. In combination with Soundskrit's in-house audio processing algorithms, directional microphones can be used to capture and isolate any sound in an environment with a fraction of the size, power, and computation of traditional omnidirectional-based microphone arrays.

Soundskrit was founded in 2019 and is headquartered in Montreal, Quebec with an R&D facility in Ann Arbor, Michigan.



soundskrit

Hear the impossible.