1. Overview

Figure 1: Soundskrit Module Demo Kit (Scarab-1600)

The Module Demo Kit (Scarab) is designed to easily evaluate Soundskrit's various microphone modules and associated beamforming algorithms. The kit works with three module variations: the SKM1600, SKM1610 and the SKR0710+Omni coupon board. All modules come with an integrated dipole and an omnidirectional MEMS microphone. The version will be decided when you order a Scarab from Soundskrit.

Soundskrit provides a variety of audio processing algorithms for the Scarab kit. These algorithms include linear, adaptive, and nonlinear beamformers, as well as AI-based denoising models, all of which can be configured and evaluated using the Soundskrit Demo Kit Interface software, either with or without a connected Scarab demo kit. Developed specifically for demo kit evaluation, Soundskrit Demo Kit Interface platform enables customers to quickly test and compare different algorithms on the demo kit within seconds.

What's In the Box	
Scarab Board	Small module with a dipole and an omnidirectional microphone
Soundskrit PARDI audio interface	Multichannel audio interface to connect microphones over USB
SKM Adapter Board[1]	An adapter to connect the SKM16X0 to the PARDI Board
Molex cable	Preconnected cable which links the microphone module adapter board/SKR710+Omni board to the PARDI audio interface
USB-A to USB-C Cable	A cable to connect the board to your PC.

1. *Applies only to Scarab units configured with the SKM16X0 version.*

Table of Contents

2. Hardware Introduction

2.1 SKM16X0 Module

The SKM16x0 is a small module with both omnidirectional and dipole microphones (SKR06X0) to demonstrate adjustable polar pattern beamforming. It is product ready and makes microphone integration easy—we have done all the work in designing the acoustic path, ensuring sealing, proper performance, etc. The module provides 2 options: SKM1600 and SKM1610, which have an analog and PDM output respectively. The side opposite the flex connector is the front or 0° on the polar pattern.

You can check the detailed introduction for SKM16X0 module on our website SKM1600 series.

To facilitate integrating the module into a product, the module has a strong double-sided adhesive tape on the top. To expose the adhesive, peel off the blue cover tape on the top. This exposes the adhesive, allowing the module to be securely attached inside a prototype.

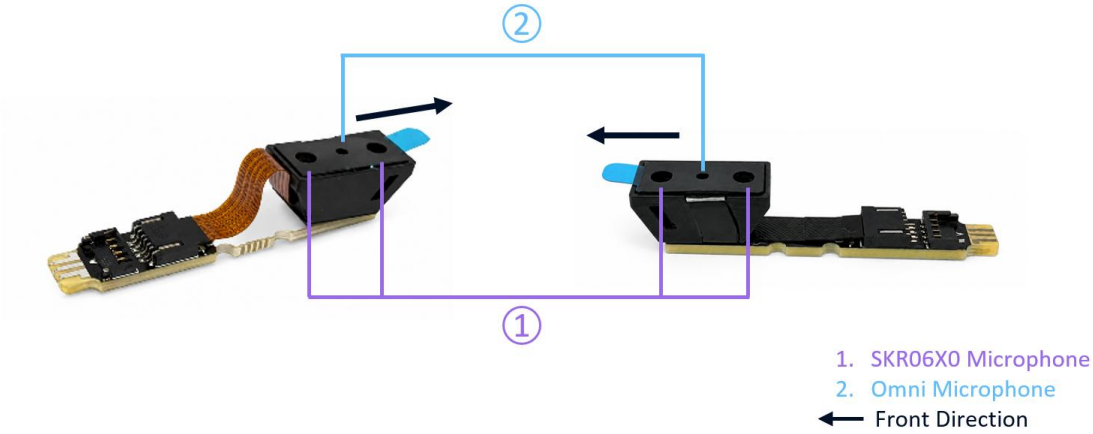


Figure 2: SKM16X0 Module and Front on the Polar Pattern

2.2 SKR0710+Omni Module

The SKR0710 + Omni module board is another configuration that uses a SKR0710 microphone and omnidirectional microphone integrated together. With the inherent in-plane design of the SKR0710 sound ports, this module has more compact form factors than the SKM16X0 modules, which makes it easier for integration into end products.

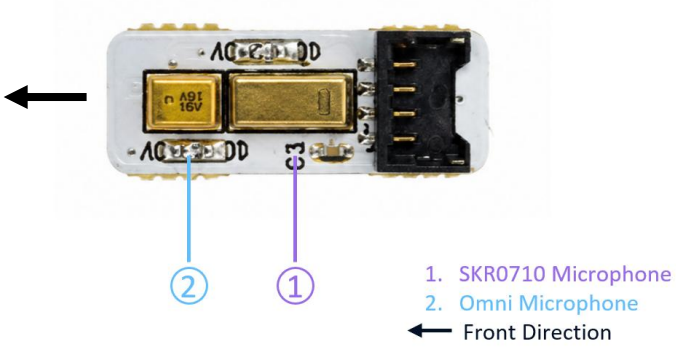


Figure 3: SKR0710+Omni Module and Front on the Polar Pattern

2.3 PARDI Board Interface

The PARDI audio interface has a USB-C connector to connect it to a PC and a Molex connector to connect the Scarab board. The cable comes pre-connected and only needs to be reattached if it becomes disconnected.

Figure 4: Scarab PARDI Board Interface

3. Software Introduction

The Soundskrit Demo Kit Interface is a platform used for evaluating performance of the Scarab demo kit. It enables users to quickly test the different algorithms provided by Soundskrit.

Figure 5: Soundskrit Demo Kit Interface

The software allows users to capture a recording via Live Recording mode and process the raw signals through various algorithms. This mode lets users compare algorithm performance side by side through playback. To facilitate quick evaluations, sample audio files are also provided in the software, allowing users to test the algorithms even without connecting to the Scarab demo kit.

The Demo Kit Interface also provides relevant computational metrics across all algorithms, including CPU usage and RAM usage for various processor cores to help customers understand the algorithm requirements in embedded implementation.

For more detailed introduction of Soundskrit Demo Kit Interface, please refer to Downloads → **Soundskrit Demo Kit Interface User Manual**.

4. Scarab Algorithm Introduction

To help customers understand the performance differences between algorithms and identify the most suitable solution for processing audio signals in their projects, Soundskrit provides various algorithm families across all versions of the Scarab. These algorithms are optimized for isolating voice pickup and suppressing background noise. Below is a detailed overview of these algorithms.

4.1. Beamformers

The table below shows the beamformers that can be evaluated with the Scarab.

Beamformer Descriptions*	
Omni	Outputs the equalized omnidirectional microphone signal, used as a reference for performance comparison.
Dipole	Outputs the equalized dipole microphone signal, showcasing the pure hardware directionality.
Linear Cardioid	A fixed, distortionless beamformer with cardioid polar pattern pointing forwards.
Adaptive	A beamformer that dynamically switches polar patterns to minimize background noise while maintaining minimal distortion.
Nonlinear	An enhanced beamformer providing stronger background noise suppression, while introducing some distortion and artifacts.
Nonlinear AI	Combines a nonlinear beamformer with an AI denoiser running in parallel to achieve stronger noise suppression while maintaining low CPU usage.

** Please refer to the computational requirement shown in the GUI.*

4.1.1. Equalized Omnidirectional Microphone

The omnidirectional microphone of the Scarab is equalized to match the dipole, regardless of the module kit. It is necessary that the two microphones are equalized to match one another for further beamforming and processing.

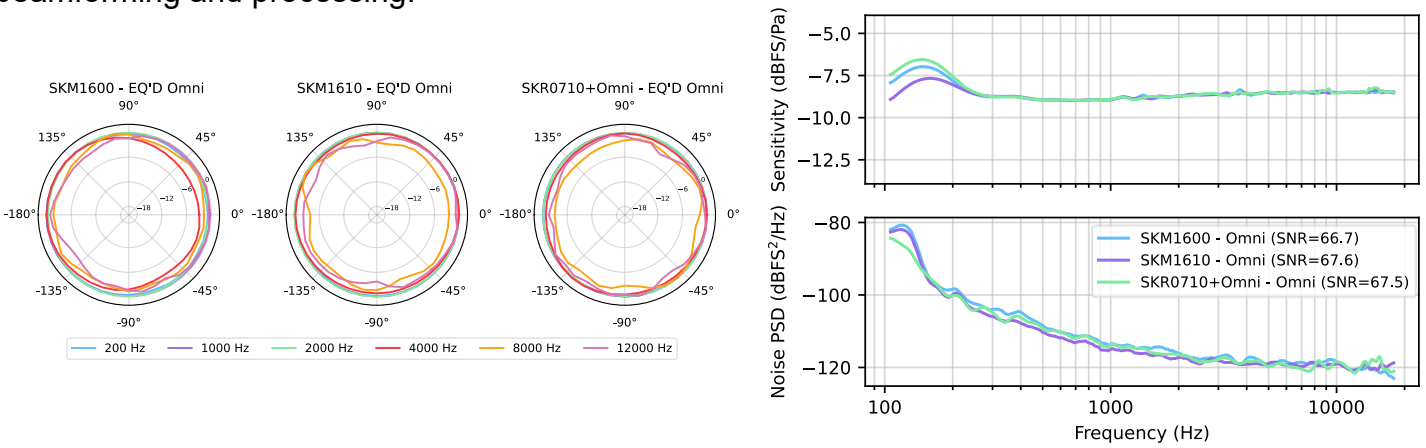


Figure 6: Polar Pattern for Omnidirectional and Sensitivity

4.1.2. Equalized Dipole Microphone

The dipole microphone of the Scarab with an EQ applied to flatten the response.

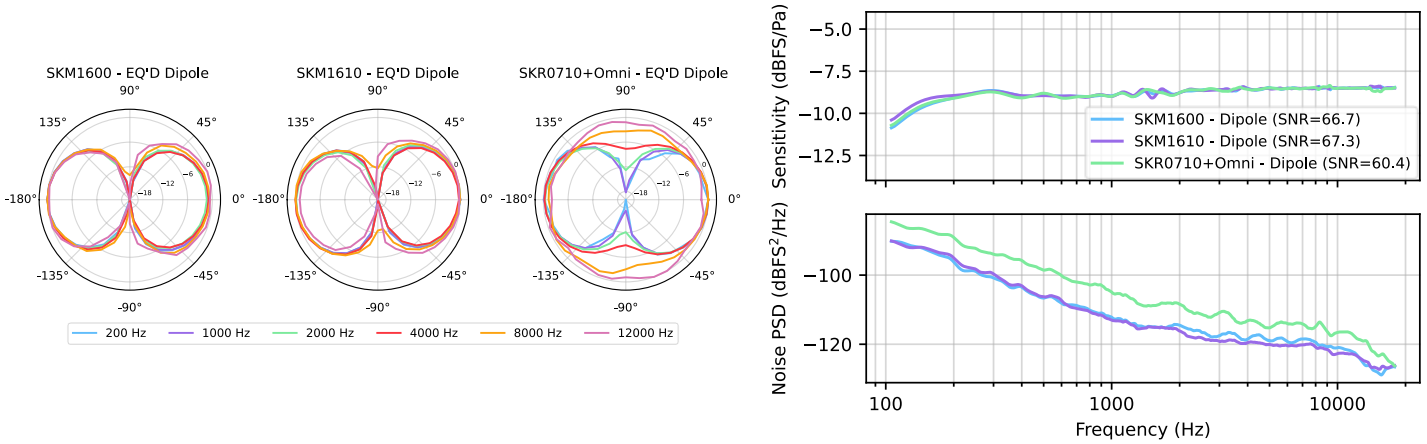


Figure 7: Polar Pattern for Dipole and Sensitivity

4.1.3. Linear Cardioid Beamformer

A beamformer which creates a cardioid polar pattern using both directional and omnidirectional microphones. This pattern is useful to create a strong null in the rear. This does not use any noise reduction processing and just creates the cardioid pattern for distortion-free high-quality recordings.

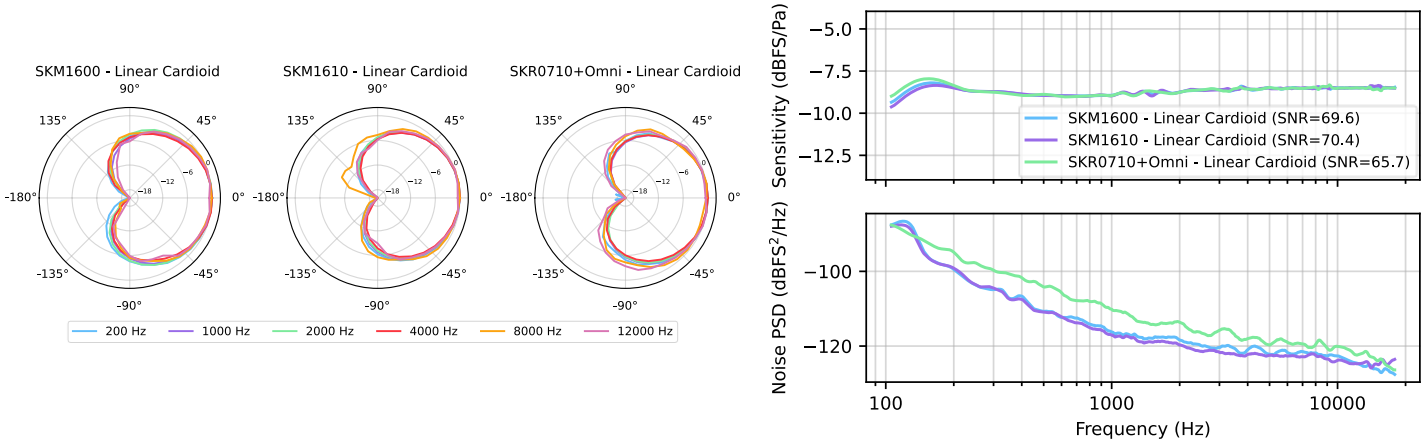


Figure 8: Polar Pattern for Linear Cardioid and Sensitivity

4.1.4. Adaptive Beamformer

The Adaptive Beamformer varies the polar pattern over time and frequency between omni and dipole to maximize noise rejection. This is a non-linear beamformer which rejects a large amount of noise and sounds more natural than typical non-linear processing techniques.

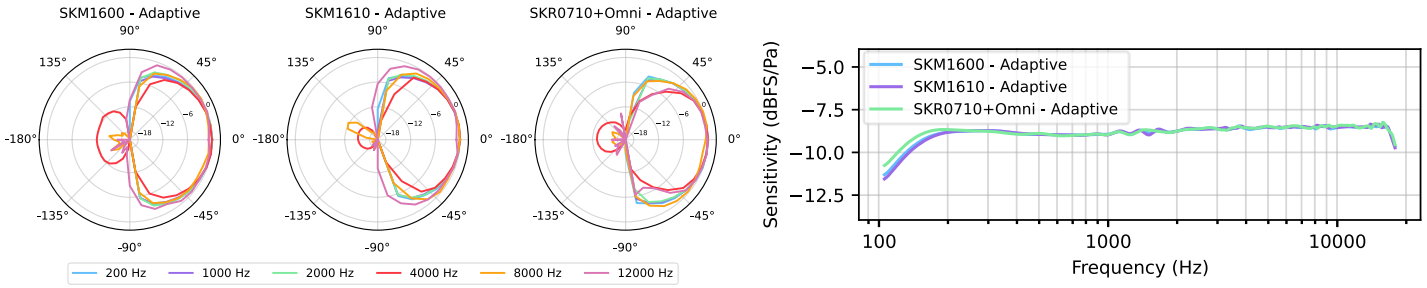


Figure 9: Polar Pattern for Adaptive and Sensitivity

Note: The polar plot shown above shows the rejection of direct noise, the polar pattern in real scenarios varies over time.

4.1.5. Nonlinear Beamformer

Nonlinear Beamformer uses phase information provided by the omnidirectional-dipole pair to mute the microphone unless speech is coming from ±60°. When the microphone is unmuted for the frequency bands containing speech, Cardioid Beamformers in those bands are used together with the phase information to further reduce non-speech noise.

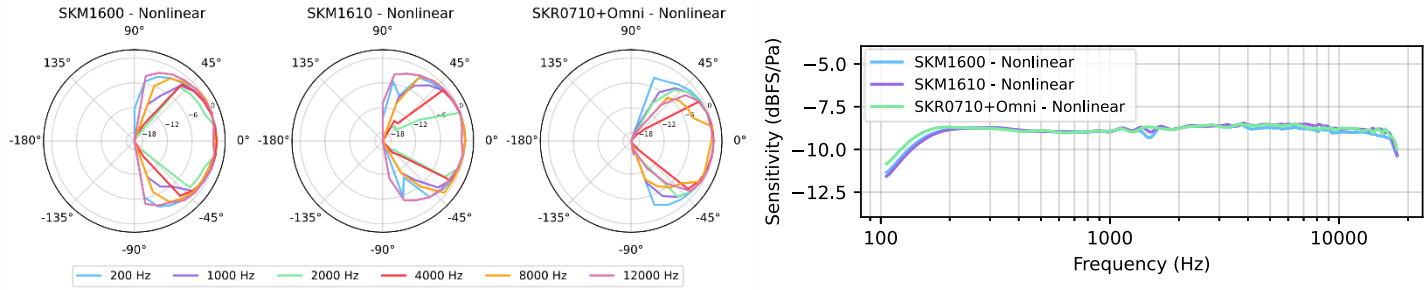


Figure 10: Polar Pattern for Nonlinear and Sensitivity

4.1.6. Nonlinear AI Beamformer

The Nonlinear AI Beamformer combines an AI denoiser with a nonlinear beamformer operating in parallel to further suppress background noise and provide more stable noise reduction. Compared with a cascaded AI denoiser, the Nonlinear AI Beamformer achieves similar denoising performance while requiring significantly lower computational cost.

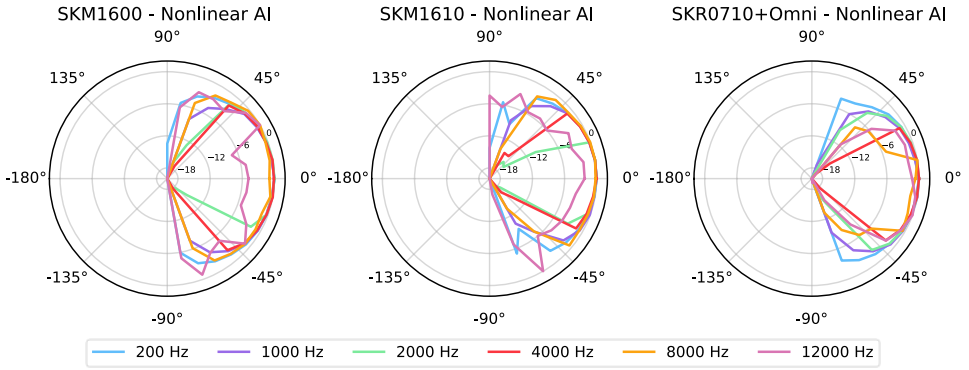


Figure 11: Polar Pattern for Nonlinear AI

4.2. AI Denoising

The GUI comes equipped with AI denoising models that are divided into three categories: Small, Medium, and X-Large. These models can be cascaded on top of a chosen beamformer. The table below shows the detailed description for each AI model.

AI Denoiser Description*	
Small	Small AI model for noticeable background noise suppression, with some distortion and artifacts.
Medium	Medium AI model for enhanced background noise suppression, with less distortion and artifacts.
X-Large	Extra-large AI model for premium background noise suppression, with minimal distortion and artifacts.

** Please refer to the computational requirements shown in the GUI.*

4.3. Algorithm Performance

The table below summarizes the measured performance of each algorithm across the three module options. Scores were obtained using the 3QUEST methodology, which separately rates speech quality and background-noise suppression under realistic noise conditions. For every metric, a higher value is better.

Performance is measured using three metrics, all scored so that higher values are better:

- S-MOS (Speech Mean Opinion Score) rates how natural and undistorted the voice sounds on a scale of 1 to 5
- N-MOS (Noise Mean Opinion Score) rates how well background noise is suppressed on a scale of 1 to 5, with higher scores meaning the residual noise is less audible
- SNR (Signal-to-Noise Ratio), expressed in decibels, captures how much louder the desired speech signal is compared to the level of unwanted background noise.

Algorithm	SKM1600			SKM1610			SKR0710+Omni		
	S-MOS	N-MOS	SNR	S-MOS	N-MOS	SNR	S-MOS	N-MOS	SNR
Omni	3.35	2.06	2.98	3.34	2.08	2.93	3.20	2.09	3.35
Linear Cardioid	3.55	2.12	5.51	3.55	2.11	5.28	3.54	2.11	5.52
Adaptive	3.58	2.13	5.94	3.59	2.11	5.78	3.54	2.10	5.55
Nonlinear	3.67	2.27	8.09	3.62	2.17	7.25	3.59	2.16	6.62
Nonlinear AI	3.82	3.43	22.27	3.74	3.47	21.88	3.82	3.45	21.16

5. Setup Guide

5.1 Installation

Download and launch the installer file from Downloads then follow the installation steps.

Connect the Scarab to your PC using the included USB-C to USB-A cable.

To start the software, search from the Windows start menu for ‘Soundskrit Demo Kit Interface’ or use the desktop shortcut generated by the installer.

Make sure the Scarab is correctly connected to the PC and that the PARDI board is in **raw mode**. If the PARDI board is not in raw mode (this may apply to units shipped before June 2026), a window will appear, prompting you to change the PARDI board to raw mode.

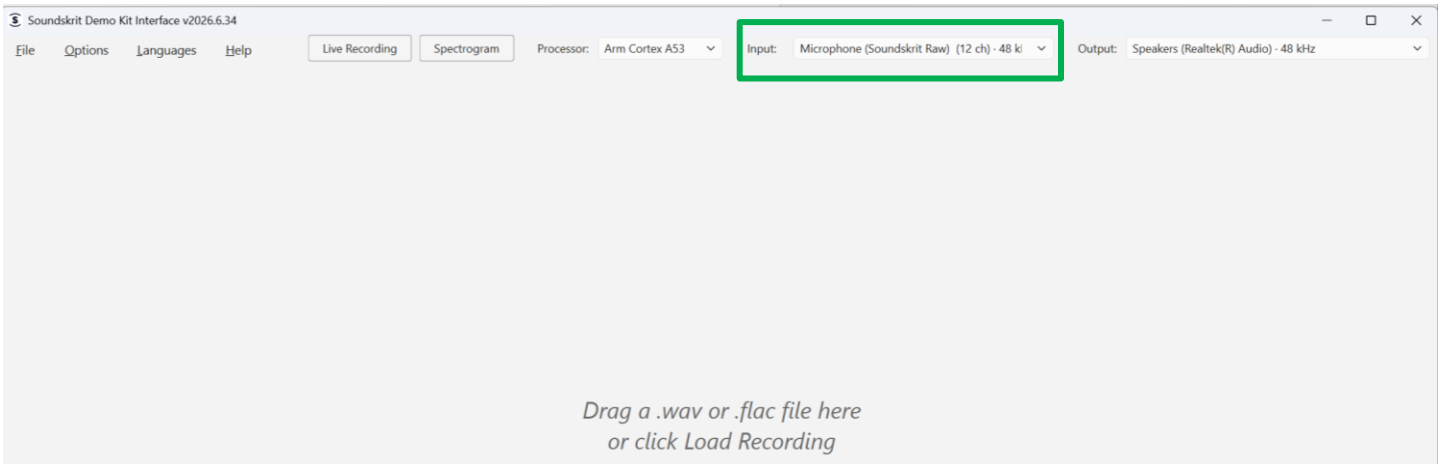


Figure 12: Raw Mode Detected

5.2 Audio Performance Evaluation

There are **three ways** to get audio for audio performance evaluation.

5.2.1 Option 1: Load built-in audio samples

Users can find pre-recorded audio samples and load them in the Soundskrit Demo Kit Interface for quick performance comparison without the Scarab kit connected. To find the audio samples, click 'File' in the top-left corner, and choose ‘Samples’.

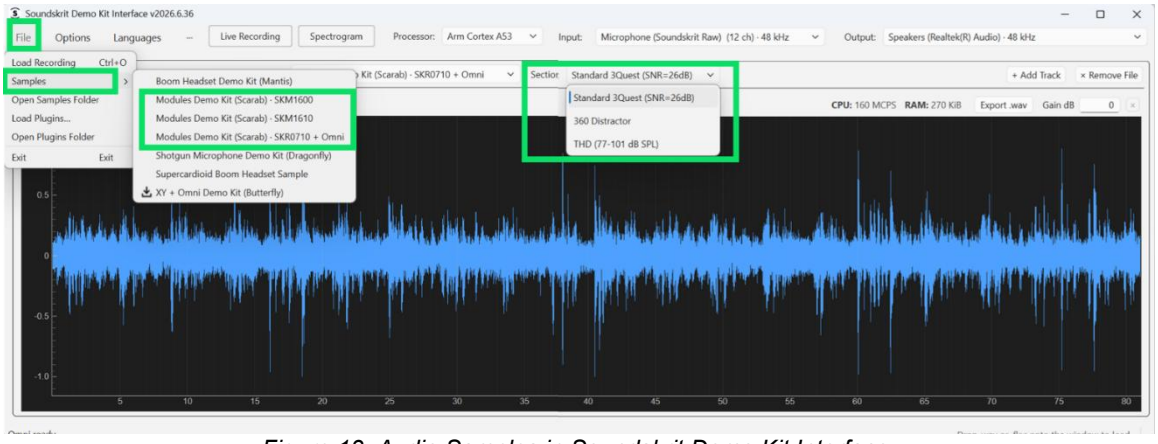


Figure 13: Audio Samples in Soundskrit Demo Kit Interface

3QUEST samples assess speech quality and noise suppression in typical noise. In a 3QUEST test, a talker speaks a set of standard sentences while realistic background noise is played around the device. The signal-to-noise ratios for speech level to background noise is 26dB (standard 3QUEST setup). The SNR is computed at the HATS mouth reference point (25mm in front of the mouth).

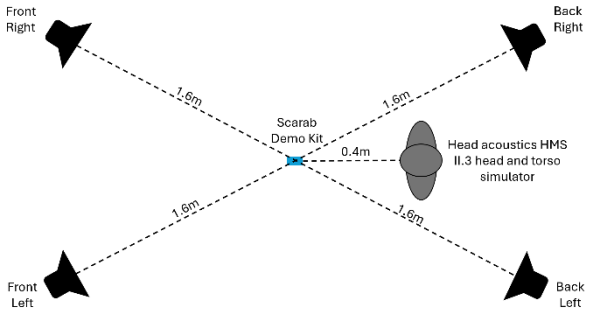


Figure 14: 3QUEST Testing Setup

THD samples test for distortion at high speech levels. In this test, a talker's voice is played at progressively increasing levels, from 77 to 101 dB SPL, to simulate a person speaking louder and louder. The recording contains speech rising in level with no added background noise, letting you check whether the algorithms introduce any distortion as the voice gets louder.

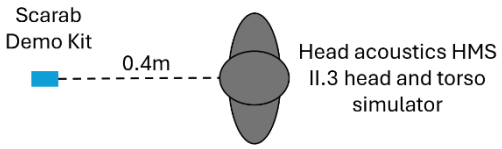


Figure 15: THD Samples Testing Setup

The **360 Distractor** sample evaluates how well competing talkers in the environment are removed. Throughout the test, a constant background noise at 26dB SNR is present while an interfering speaker (the distractor) is played through loudspeakers placed at five positions around the listener. The distractor speech is played in the following order: front center, front left, front right, back left, and back right. For each position, the sample contains three segments back-to-back: the target speaker alone, the distractor alone, and then the two together.

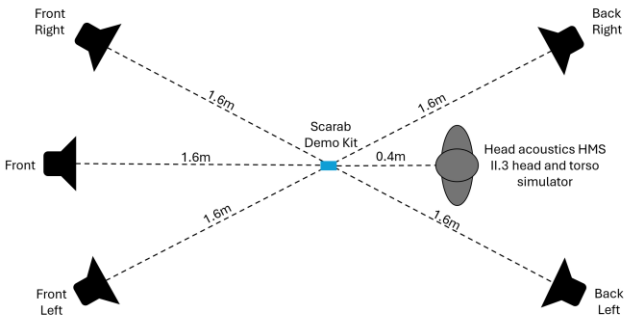


Figure 16: 360 Distractor Samples Testing Setup

5.2.2 Option 2: Load an External .wav File

Users can upload external .wav file for audio processing. The .wav file must be a raw signal recording captured from the Scarab demo kit.

Please note, if the external audio file is not recorded by Scarab demo kit, the audio file will only be marked as ‘External’, and no demo kit can be chosen for it. Under this circumstance, external audio file could be set as benchmark reference to compare the audio performance between Soundskrit Scarab Kit and other audio solutions.

5.2.3 Option 3: Record Live with the Scarab

Use Live Recording (see image below) to capture audio with the Scarab and process it in real-time.

1. Click **Live Recording** to open the recording window. By default, six tracks are configured to compare performance across the algorithms in parallel (see Tracks Map below).
2. Click **Record** to start and **Stop** to end. The audio is distributed across the tracks with preset algorithms applied. All audio tracks are normalized to facilitate easy comparisons. Recording again replaces the previous take.
3. To compare the performance with AI algorithm combined, set the AI options for corresponding track.
4. Click **Save Raw Audio** to keep all six raw channels (re-loadable later for processing), or **Export .wav** to save a single processed track.

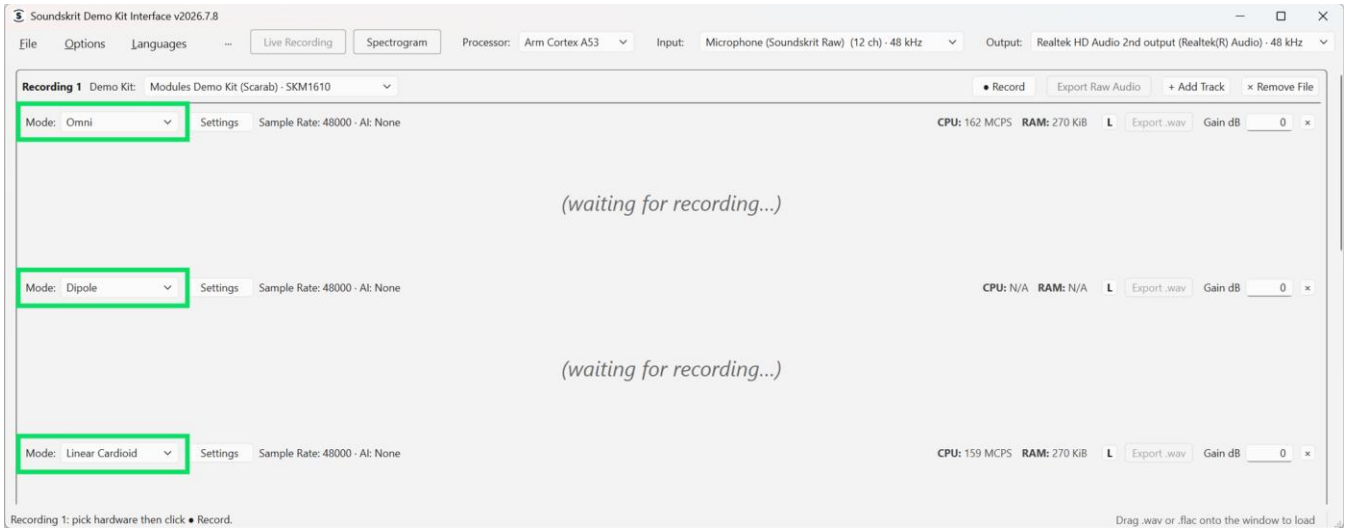


Figure 17: Automatic Tracks Setup in Live Recording

Tracks Map	
Track 1	Omni (reference audio)
Track 2	Dipole
Track 3	Linear Cardioid
Track 4	Adaptive
Track 5	Nonlinear
Track 6	Nonlinear AI

6. Troubleshooting

This section provides solutions to common issues encountered during installation and operation of the demo kit.

Problem	Possible Cause	Solution
Soundskrit Demo Kit Interface doesn't show " Microphone (Soundskrit Raw) (12ch) ·48 kHz"	Scarab is not correctly connected to PC.	Verify the connection between PARDI board and Scarab, as well as between PARDI board and PC. A green LED indicator on PARDI board should be flashing if the connection is correct.
Cannot configure the tracks after loading external audio file recorded by Scarab	'Demo Kit' is not chosen as Module Demo Kit.	Set Module Demo Kit as the demo kit.

7. Additional Support

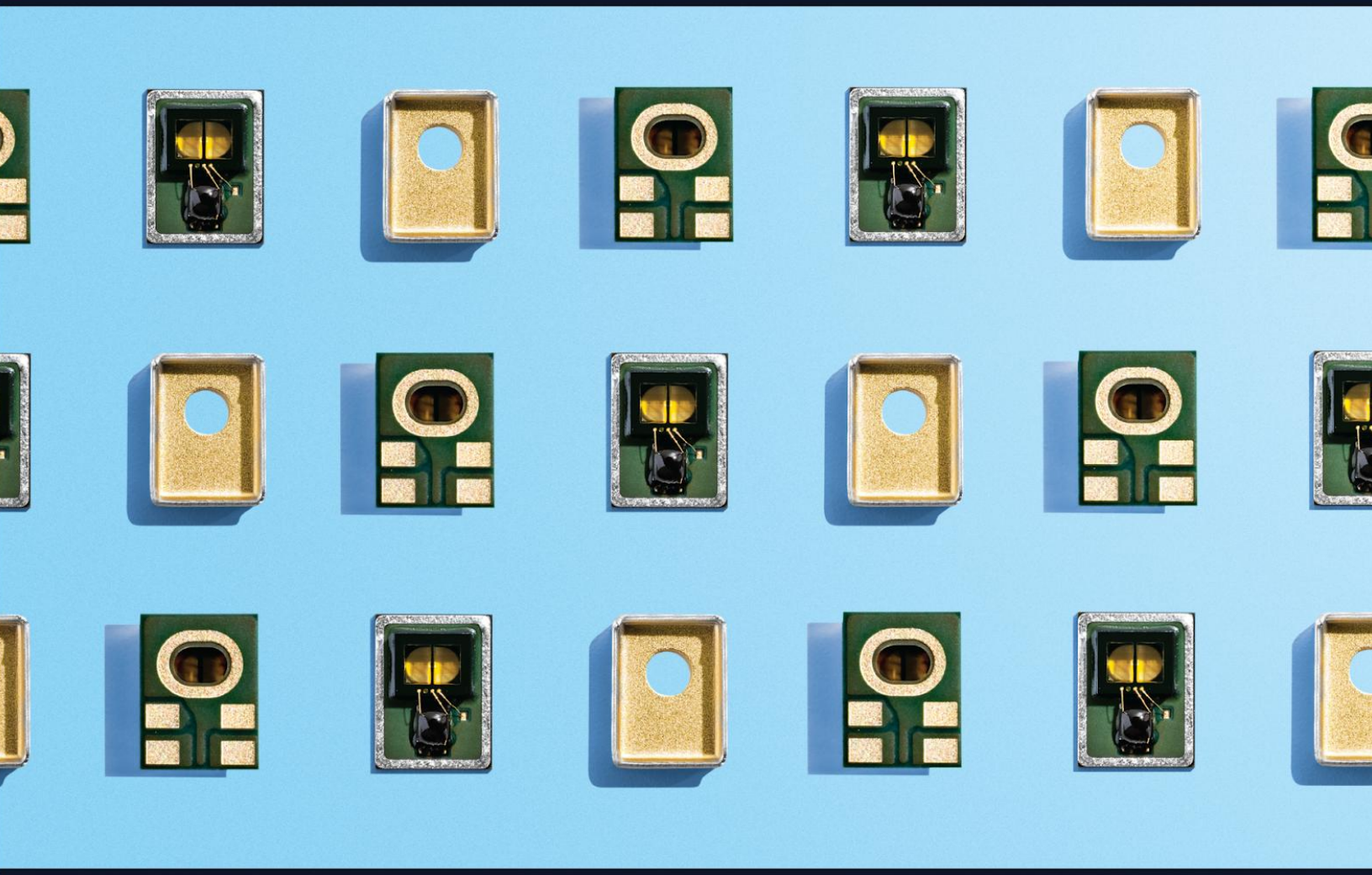
For further information on Soundskrit's products, visit our website at http://www.soundskrit.ca where you can find more application notes, datasheets, and purchasing information. If you have any questions or need technical support, please reach out to applications@soundskrit.ca.

8. Revision History

Revision Label	Revision Date	Sections Revised
-	Jul 2026	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.



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