SKM2600-DP
Analog Dipole Microphone Module

1. Characteristics

- Dipole polar pattern
- 65.5 dBA SNR
- 4.4 dB DI
- Single-ended output
- 115 µA supply current
- Integrated meshes for IP57 with compressible sealing foam
- Pre-tested for >20 dB sealing
- Ports integrated on single surface
- Compressible sealing foam
- 12mm sound port spacing

2. Applications

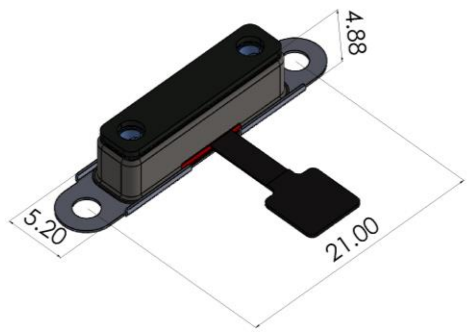
- AR & VR Devices
- Tabletop Microphones
- Conferencing Devices
- Webcams
- Security Cameras
- Headsets
- Voice Badges
- Intercoms
- Smart Home Devices

3. Description

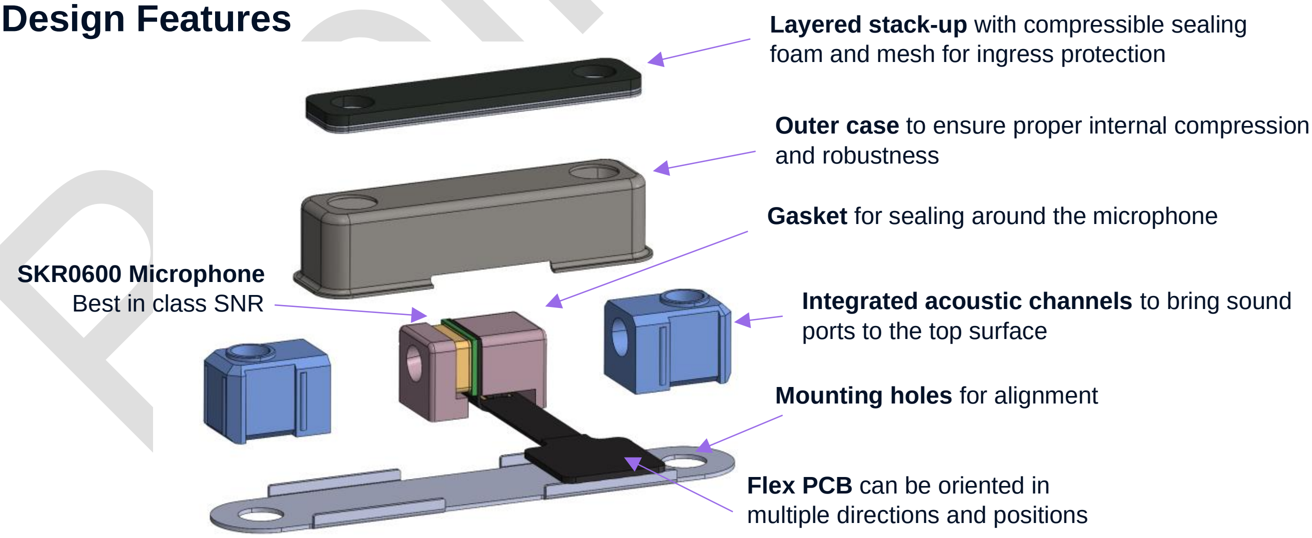
The SKM2600-DP is a plug-and-play analog MEMS-based directional microphone module for consumer electronics. It is based on the SKR0600 analog MEMS directional microphone. This module streamlines acoustic design by rerouting both sound ports on a single surface with a pre-installed acoustic mesh for ingress protection. With its optimized design, the module delivers exceptional directional audio capture with minimal integration effort, enabling fast and reliable product development.

The SKM2600-DP outputs a dipole polar pattern.

4. Dimensions



5. Design Features



6. Table of Contents

7. Typical Application Circuit

The module can be operated with V_{dd} from 1.6 – 2.0 V and 2.2 – 3.6 V. V_{dd} should not be set from 2.0 V – 2.2 V.

A 0.1 µF capacitor between V_{dd} and GND is included on the flex cable of the module to reduce supply noise.

A capacitor C_{out} should be used to block each microphone's output DC from the application processing input. This capacitor creates a high-pass filter according to $C_{out} = 1/\pi \mathrm{f}_c R_{AP}$ (e.g. 80 nF), where f_c (e.g. 20 Hz) is the desired cutoff frequency and R_{AP} (e.g. 100 kOhm) is the application processor resistance.

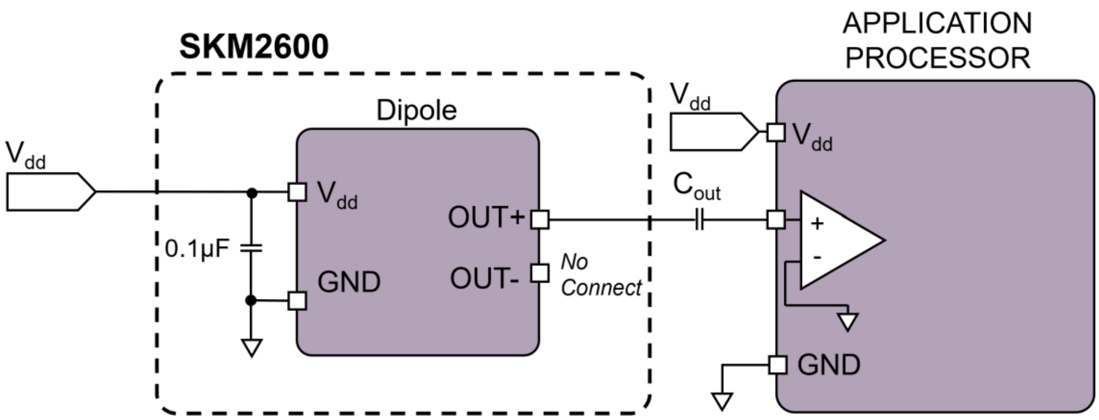


Figure 7.1: Typical application circuit

8. Specifications

The SKM2600-DP incorporates a SKR0600 dipole microphone configured in a single-ended output.

Test conditions throughout full datasheet unless otherwise indicated: 25 ºC, 55 ± 20% R.H., V_{dd} = 1.8 V, 3 m away, no load, dipole PCB port facing toward loudspeaker and defined as 0º.

8.1 Acoustic and Electrical Specifications

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Pickup Pattern				Dipole		
Polarity		Increasing sound pressure at lid port (180°)		Decreasing output voltage		
		Increasing sound pressure at PCB port (0°)		Increasing output voltage		
Average Directivity Index		Integrated from 20 Hz to 20 kHz		4.4		dB
Null Angle				90, 270		º
Supply Voltage	V_{dd}		1.7	1.8	2.0	V
			2.2	2.8	3.6	
Supply Current	I_{dd}	V_{dd} = 1.8 V		115		µA
Sensitivity	S	94 dB SPL, 1 kHz	-32	-31	-30	dBV/Pa
Noise Floor				-92.5		dBV(A)
Signal to Noise Ratio[1]	SNR	20 Hz to 20 kHz, 94 dB SPL		65.5		dB(A)
Total Harmonic Distortion[2]	THD	94dB SPL, 1kHz		<0.1		%
		1% THD, 1 kHz		108		dB SPL
Acoustic Overload Point	AOP	10% THD, 1 kHz		128		
Resonant Frequency	Fres			3.0		kHz
Power Supply Rejection Ratio	PSRR	200 mV_{pp} sine wave on V_{dd} at 1 kHz		67		dB
Power Supply Rejection	PSR+N	200 mV_{pp} 7/8 duty cycle rectangular waveform @ 217 Hz on V_{dd}, A-weighted, BW = 22.4kHz		-85		
DC Voltage Output		V_{dd} = 1.8 V		0.836		V
Output Impedance	Z_{out}				100	Ω
Startup Time		Sensitivity within 1 dB of final value, outputs AC coupled		15		ms

8.2 Specification Calculation Details

Directivity Index and Average Directivity Index Calculation

The directivity index measures the ratio of the microphone output for a sound positioned directly in front of the microphone (θ = 0º) versus sound with the same amount of total acoustic power coming from all directions equally. The directivity index at each frequency is calculated with the equation below.

$$DI = 10log_{10}\left(4\frac{amplitude(\theta=0)^2\left[\frac{V^2}{Pa^2}\right]}{\int_0^{2\pi} amplitude(\theta)^2\left[\frac{V^2}{Pa^2}\right]|sin\,\theta|d\theta}\right)$$

Equation 8.1: Directivity Index

The average directivity index is calculated by logarithmically weighting the directionality index at each frequency and then taking the average of these weighted values from 20 Hz to 20 kHz. For more information, refer to the app note: AN-110: Attributes of Soundskrit Directional Microphones.

[1] A directional microphone has a non-flat frequency response, as such the SNR must be calculated for the entire frequency range. See SNR Calculation for details.

[2] To calculate the THD of a microphone with a non-flat frequency response, the frequency response must first be equalized. See THD Calculation for details.

SNR Calculation

The SNR of a directional microphone with a non-flat frequency response must be calculated differently than the typical method used for omnidirectional microphones that have a flat frequency response. Instead of only using the 1 kHz sensitivity, the electrical noise of the microphone at each frequency (units of V^2/Hz) must be divided by the corresponding sensitivity squared at each frequency (units of V^2/Pa^2) to obtain the input referred acoustic noise at each frequency (units of Pa^2/Hz). Then, the acoustic noise is A-weighted by multiplying it by the A-weighting factor (A_w) and this A-weighted acoustic noise is integrated over the full audio bandwidth and converted to an equivalent sound pressure level (dBA SPL) by dividing by the reference pressure (P_{ref}=20 µPa). Finally, the SNR is calculated by subtracting the integrated input referred noise from 94 dB SPL. The equation for the calculation is shown below. For more information, refer to the app note: AN-110: Attributes of Soundskrit Directional Microphones.

$$SNR = 94 - 20\,log_{10}\left(\frac{1}{P_{ref}^2[Pa^2]}\int_{20Hz}^{20kHz}\frac{noise\left[\frac{V^2}{Hz}\right]}{sensitivity\left[\frac{V^2}{Pa^2}\right]}A_w df[Hz]\right)$$

Equation 8.2: Full-spectrum SNR calculation

THD Calculation

THD is calculated by playing an acoustic sine wave at a specific sound pressure level and frequency and dividing the sum of the powers of the harmonic components of the captured signal by the power of the fundamental frequency. To calculate the THD of a microphone with a non-flat frequency response, the response must first be equalized to equally weigh the fundamental frequency and its respective harmonics. For more information on equalization and THD calculation, refer to the app note: AN-110: Attributes of Soundskrit Directional Microphones.

8.3 Absolute Maximum Ratings

Meeting or exceeding the conditions listed as Absolute Maximum Ratings could permanently damage the devices. Operating the devices at these ratings could impact device reliability.

Parameter	Absolute Maximum Rating	Unit
V_{dd} to GND	5.0	V
Input Current	±5	mA
Storage Temperature	-40 to 85	°C
Operating Temperature	-40 to 85	°C

8.4 Performance Curves

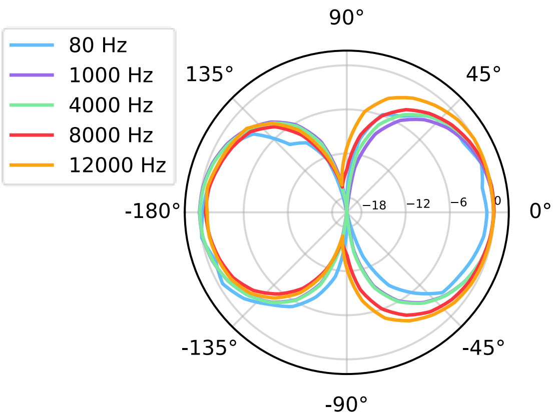


Figure 8.1: Polar pattern

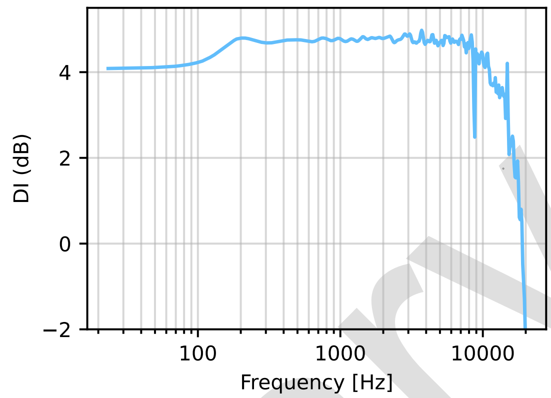


Figure 8.2: Directionality index vs frequency

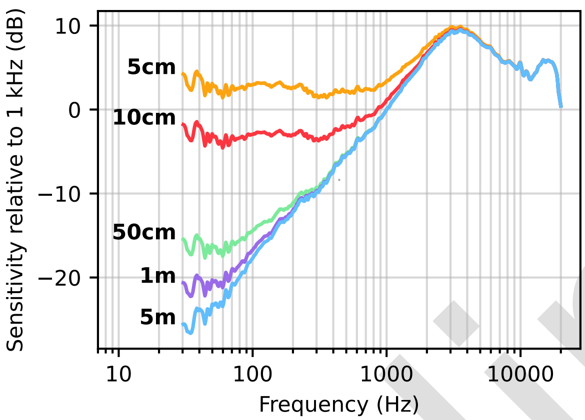


Figure 8.3: Magnitude response[3]

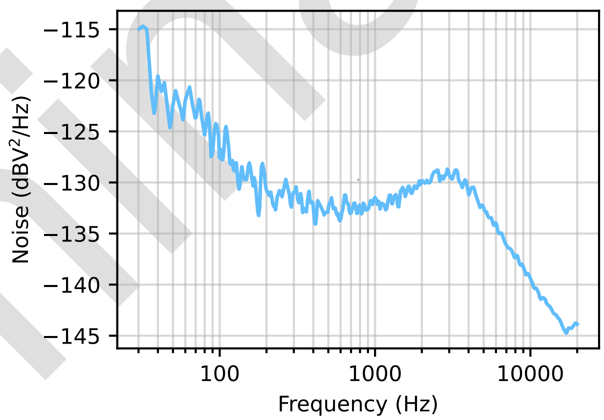


Figure 8.4: Noise floor

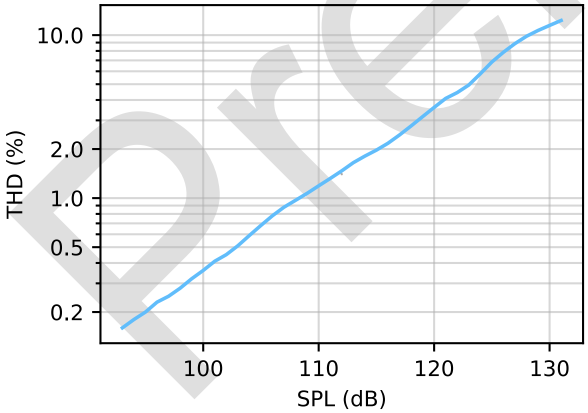


Figure 8.5: 1 kHz THD vs SPL

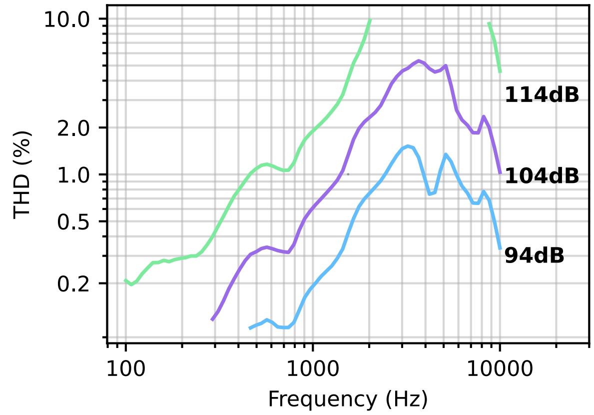


Figure 8.6: THD vs frequency

[3] The increased bass response at close distances is known as the 'Proximity Effect.' See AN-110 for details.

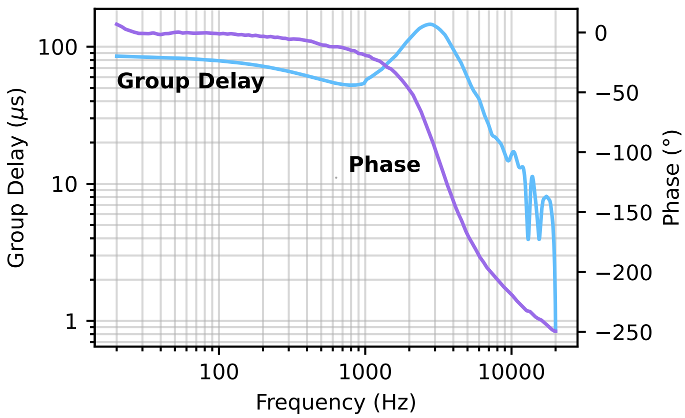


Figure 8.7: Phase and group delay

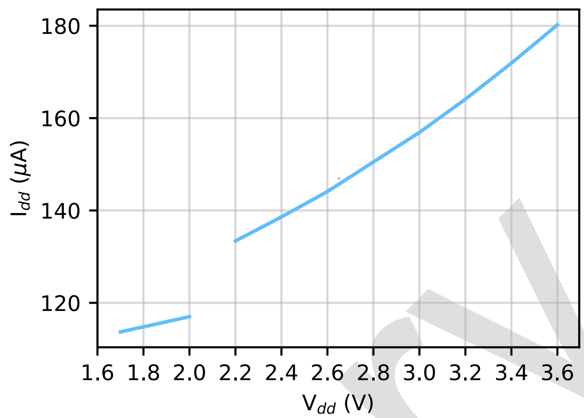


Figure 8.8: Supply current vs input voltage

9. Mechanical Drawings and Integration Design

9.1 Mechanical Drawings and Pinout

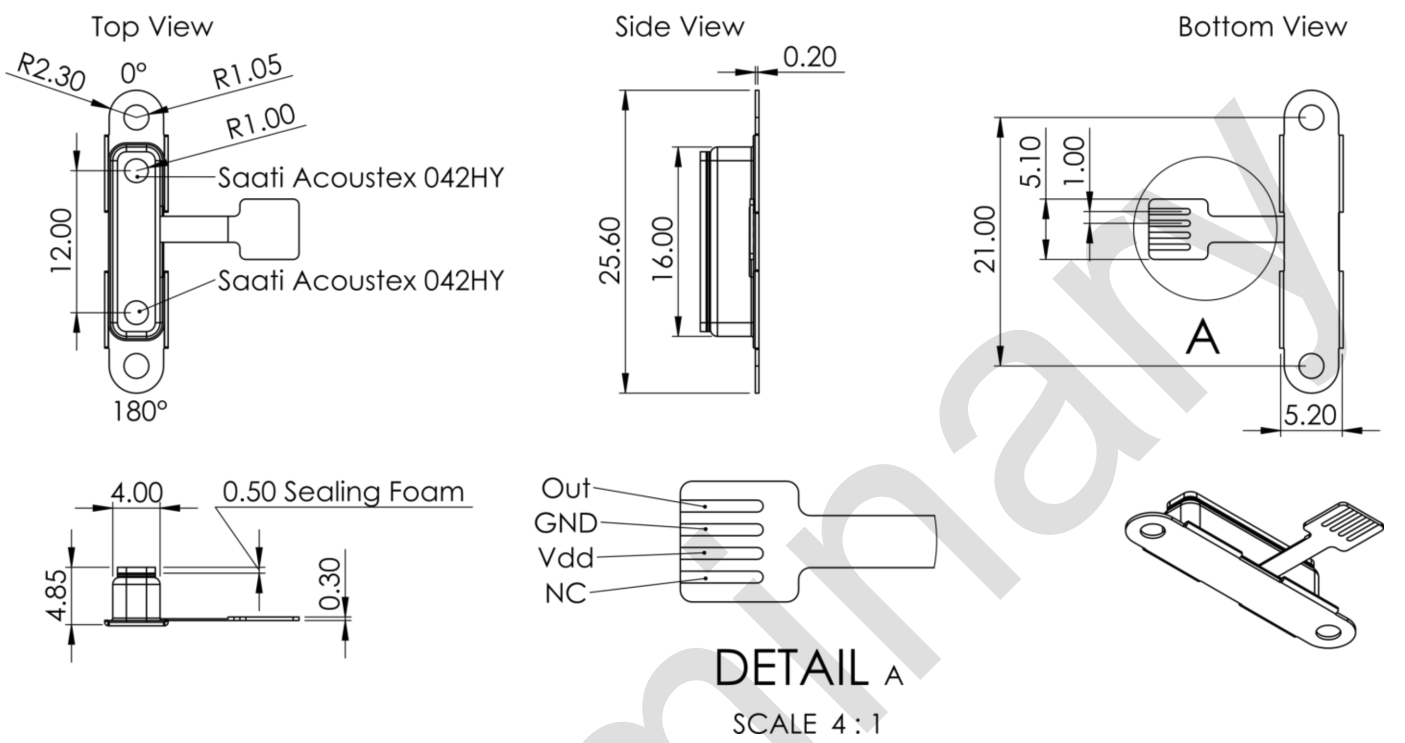


Figure 9.1: Mechanical drawings (mm)

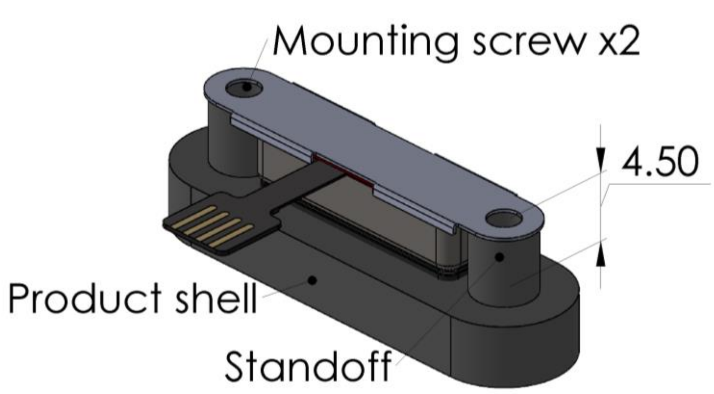
The SKM2600-DP incorporates a SAATI Acoustex 042HY mesh placed above both acoustic ports for IP57 (ingress and water immersion protection) and a dipole output.

9.2 CAD Models

The CAD model for the module is available here: SKM2600 STEP File

9.3 Installation

The SKM2600 module includes a layer of sealing foam which makes for easy installation into a product. To assure proper sealing with this foam, use 4.5-4.7mm standoffs to screw the module into. This ensures proper compression and acoustic sealing.



9.4 Packaging and Ordering Information

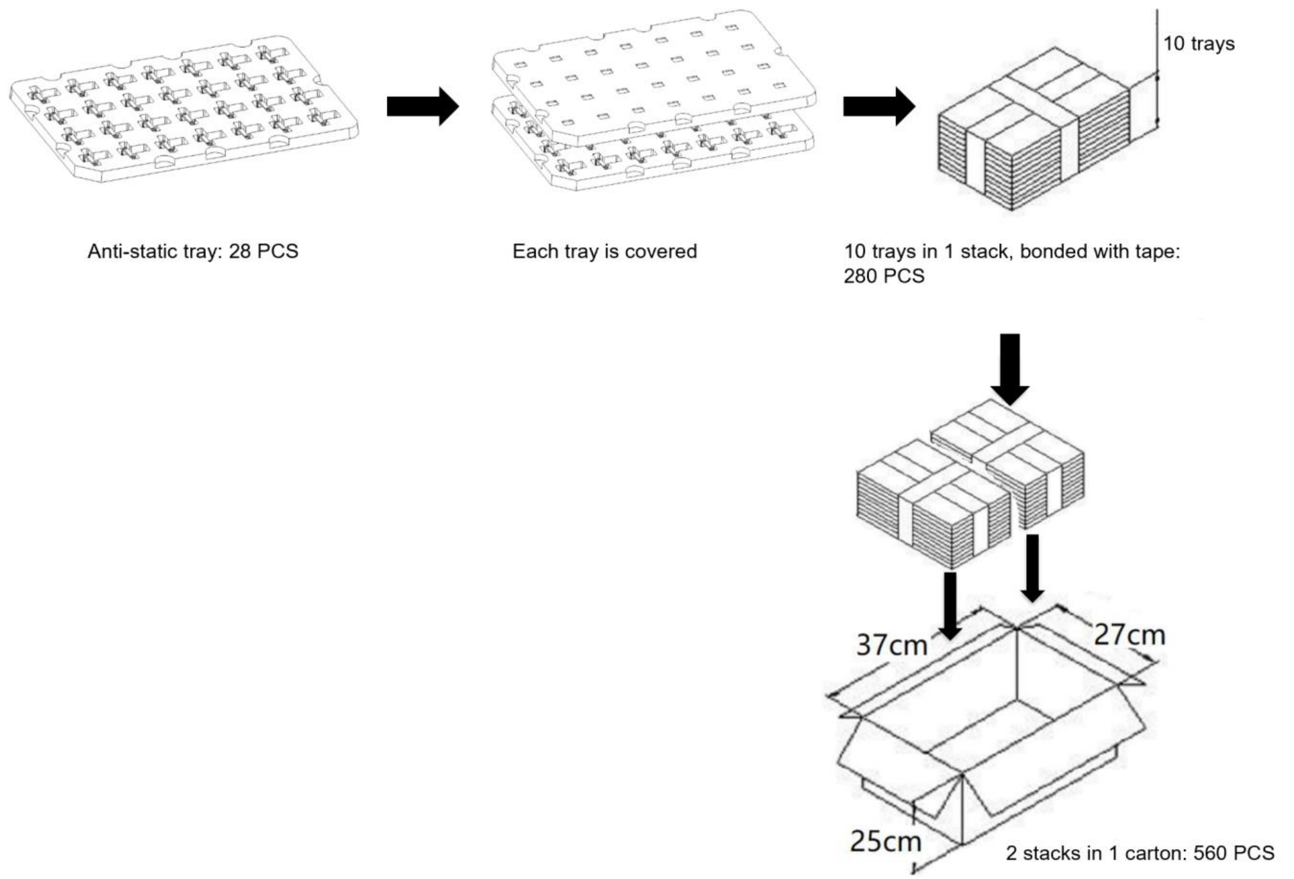


Table 9.1: Ordering Information

Model Number	Quantity per Carton
SKM2600-DP	560

10. Reliability Specifications

The sensitivity of the microphone in the module assembly must deviate by no more than 3 dB after each test. The microphone component itself has passed the standard microphone reliability tests listed in its datasheet (SKR0600).

Test	Test Condition	Standard
Humidity Soak	+85 °C / 93 % R.H., 240 hours	IEC 60068-2-78
Thermal Shock	100 cycles, air-to-air, -40 °C to +85 °C, 30 minutes soak	JESD22.A104-F
High Temperature Storage	+85 °C for 96 hours	JESD22 A-103-B
Low Temperature Storage	-40 °C for 96 hours	JESD22-A119A
Drop (Package)	Modules packaged in standard shipping box, drop from 1 m, 10 drops in total.	ASTM D4169-22
Vibration (Package)	Modules packaged in standard shipping box, apply truck spectrum for 13 minutes and 20 seconds along each axis, then apply air spectrum for 2 hours.	ASTM D4169-22

11. Additional Support

For additional design and applications support, please reach out to applications@soundskrit.ca.

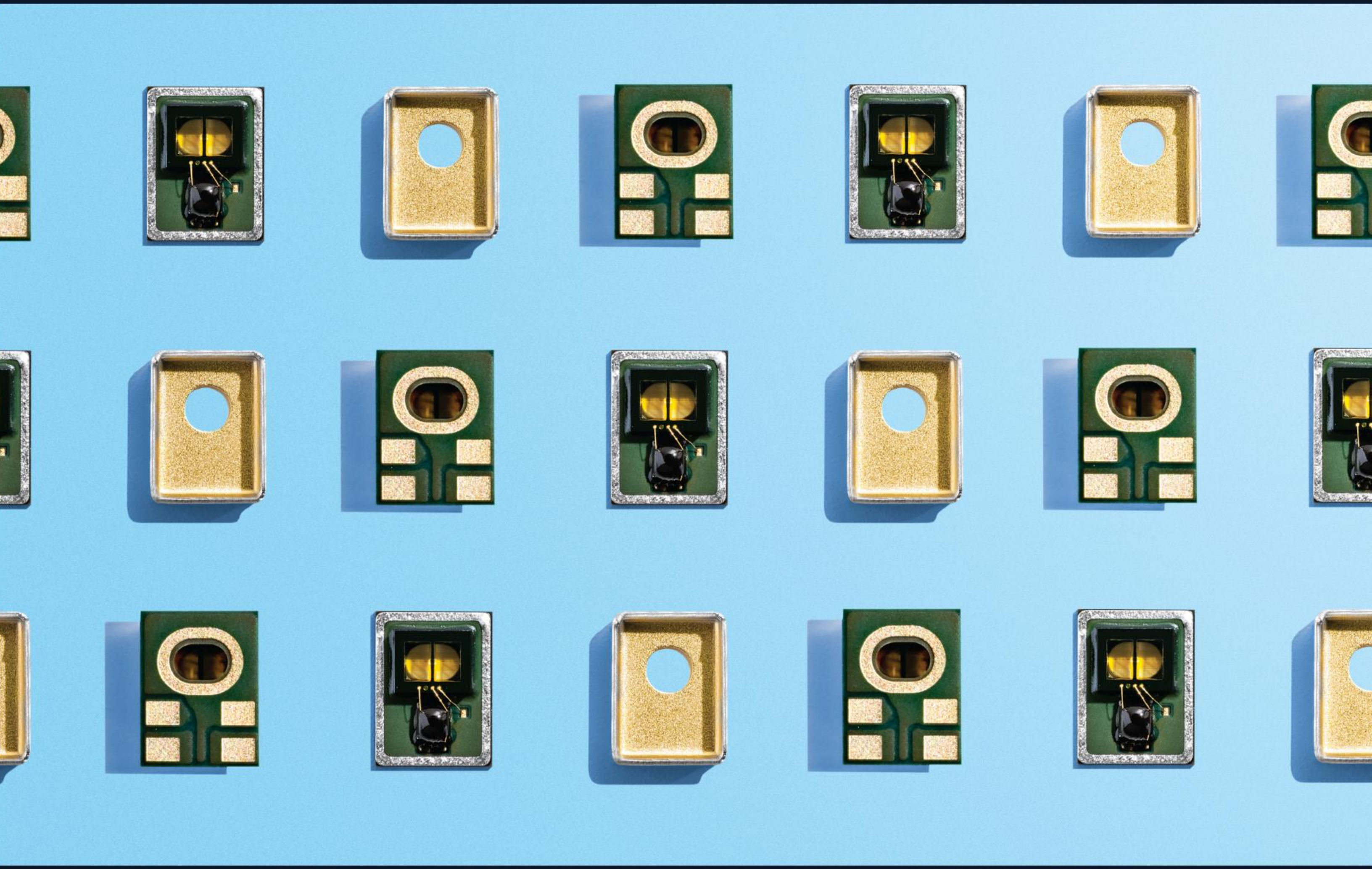
Soundskrit offers a suite of software algorithms to take full advantage of the utility our microphones provide. With a range from lightweight linear DSP tools to multichannel, machine learning based processing, we have a solution to meet any performance requirements. For more information, contact us or head to https://soundskrit.ca/software.

12. Revision History

Revision Label	Revision Date	Sections Revised
-	June 2024	Preliminary release
A	December 2024	Separated datasheet for dipole variant, updated mechanical drawings, added ordering information, and added integration guidelines

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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Hear the impossible.