

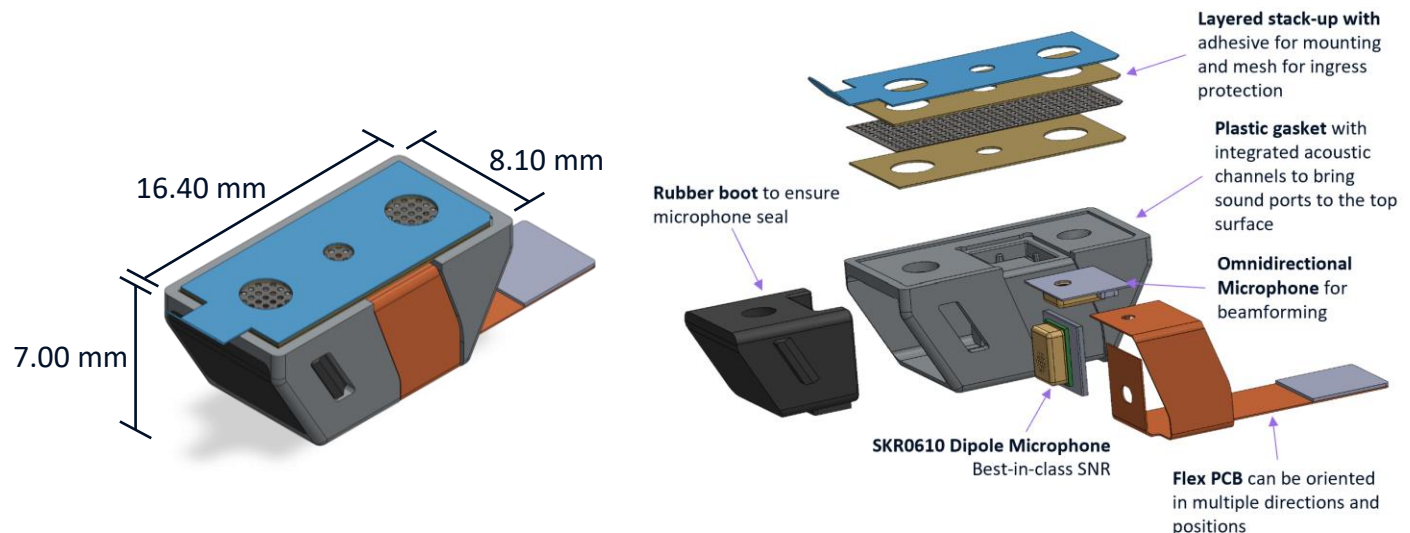
## 1. Characteristics

- Dipole microphone
  - 66 dBA SNR
  - 4.8 dB DI
- Omnidirectional microphone
  - 68 dBA SNR
- Integrated meshes for IP58
- Pre-tested for >20 dB sealing
- Three acoustic ports on same surface
- 1830  $\mu$ A supply current
- 16.40 x 8.10 x 7.00 mm<sup>3</sup>

## 2. Applications

- AR & VR Devices
- Conferencing Devices
- Webcams & Security Cameras
- Headsets
- Intercoms & Video Doorbells
- Voice Badges
- Smart Home Devices

## 4. Design Features



## 3. Description

The SKM1610 is a plug-and-play digital microphone module for consumer electronics with a PDM output. The module incorporates an [SKR0610 dipole microphone](#) with an omnidirectional MEMS microphone. All acoustic ports are conveniently positioned on a single surface and protected by an ingress-resistant acoustic mesh, streamlining integration into devices.

When combined with digital signal processing, the omnidirectional microphone pair allows for robust, switchable polar patterns (omnidirectional, dipole, cardioid, etc.) with a high signal-to-noise ratio. The omnidirectional microphone acoustic port is positioned relative to the two directional microphone acoustic ports to ensure optimal beamforming performance.

The SKM1610 enables customers to achieve high-quality audio pickup quickly and efficiently, making it ideal for applications where premium sound capture and directional flexibility are essential.

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## 6. Typical Application Circuit

The SKM1610 module pairs the SKR0610 with an omnidirectional microphone as shown in the stereo application circuit.

The recommended operating conditions are CLK=3.072 MHz and  $V_{dd}=1.8$  V. Using CLK<3.072 MHz will increase high-frequency noise and decrease SNR due to insufficient oversampling of the PDM signal. CLK>3.072 MHz will increase the current consumption without any improvement in SNR, AOP, or any other specification. Using  $V_{dd}>1.8$  V will increase current consumption without any improvement in SNR, AOP, or any other specification.

The PDM interface (PDM to PCM converter) of the application processor should have a resolution  $\geq 24$  bit to achieve maximum SNR. A 16-bit resolution can also be used but will add high-frequency noise to both microphones and reduce SNR by 1dB.

0.1  $\mu$ F capacitors should be placed between  $V_{dd}$  and GND as close to the microphones as possible to reduce supply noise. According to the PCB trace impedance, damping resistors  $R_{term}$  of 33  $\Omega$  to 100  $\Omega$  may be placed near the microphone DATA pins and near the application processor's CLOCK to reduce overshoots and ringing.

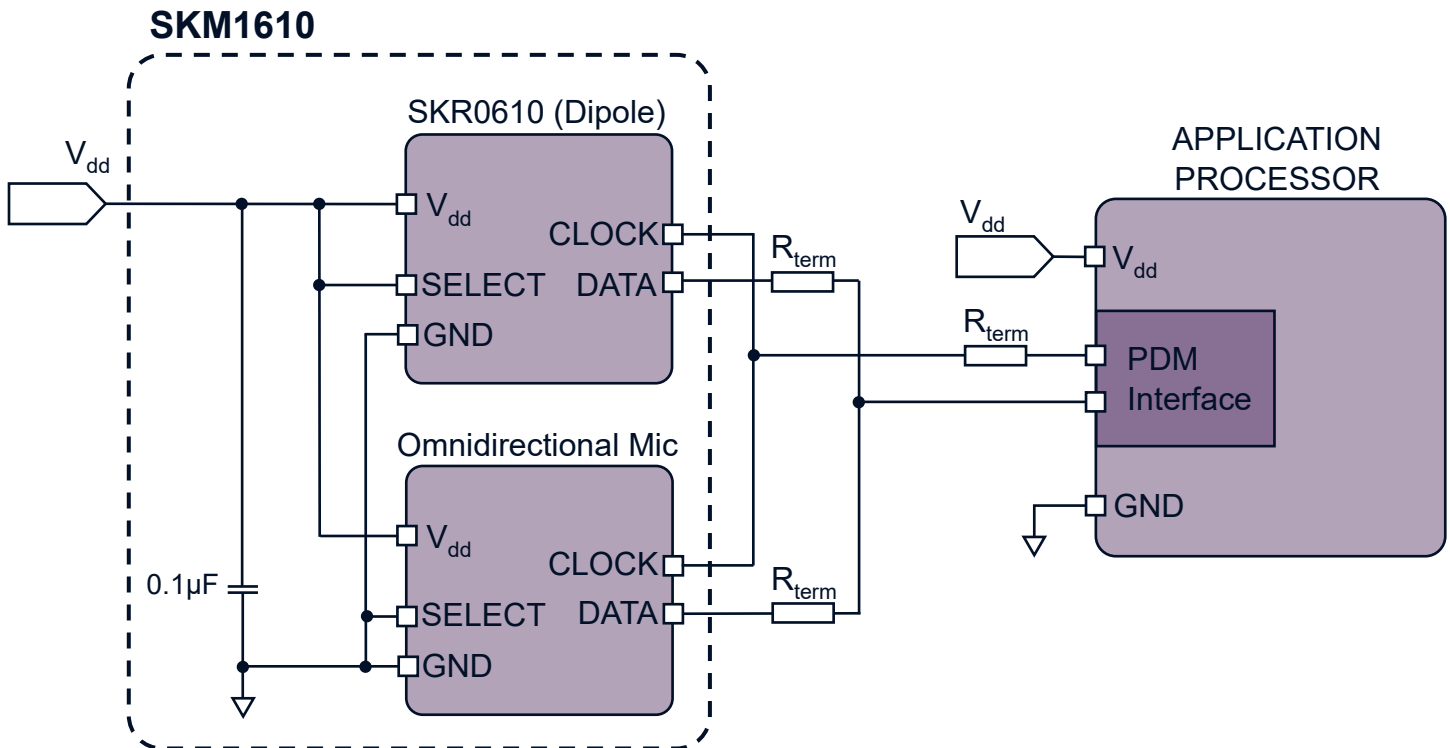


Figure 6.1: Typical stereo application circuit

## 7. Specifications

Test conditions throughout full datasheet unless otherwise indicated: 25 °C, 55 ± 20% R.H.,  $V_{dd} = 1.8\text{ V}$ ,  $f_{clock} = 3.072\text{ MHz}$ ,  $T_{edge} < 3\text{ ns}$ , 1 m away, no load, connector facing toward loudspeaker and defined as 0° (front).

### 7.1 Electrical Specifications

| Parameter                 | Symbol            | Condition  | Min.          | Typ.          | Max.          | Unit          |
|---------------------------|-------------------|--|---------------|---------------|---------------|---------------|
| Supply Voltage            | $V_{dd}$          |  | 1.6           | 1.8           | 3.6           | V             |
| Supply Current            | $I_{dd}$          | $f_{clock} = 3.072\text{ MHz}$   | 1830          |               |               | $\mu\text{A}$ |
|                           | $I_{standby}$     | $f_{clock} < 0.100\text{ MHz}$   | 10            |               |               |               |
| Output Load Capacitance   | $C_{load}$        | On DATA pin  | 200           |               |               | pF            |
| Clock Duty Cycle          |                   | $f_{clock} < 2.7\text{ MHz}$   | 45            | 50            | 55            | %             |
|                           |                   | $f_{clock} \geq 2.7\text{ MHz}$  | 48            | 50            | 52            |               |
| Logic Input/Output Low    | $V_{IL} / V_{OL}$ |  | -0.3          | 0.35 $V_{dd}$ |               | V             |
| Logic Input/Output High   | $V_{IH} / V_{OH}$ |  | 0.65 $V_{dd}$ |               | 0.3+ $V_{dd}$ | V             |
| Delay Time for Valid Data | $t_{DV}$          | Delay time from CLOCK edge (0.5 $V_{DD}$ ) to DATA valid (<0.3 $V_{DD}$ or >0.7 $V_{DD}$ ) | 30            | 180           |               | ns            |
| Delay Time for High Z     | $t_{HZ}$          | Delay time for CLOCK edge (0.5 $V_{DD}$ ) to DATA high impedance state                     | 1             | 26            |               | ns            |
| Startup Time              |                   | Sensitivity within 1 dB of final value, outputs AC coupled                                 | 60            |               |               | ms            |

### 7.2 Dipole Microphone Specifications

The SKM1610 incorporates a SKR0610 dipole microphone. The dipole microphone's SELECT is tied to  $V_{dd}$ .

| Parameter                              | Symbol | Condition  | Min.                      | Typ. | Max. | Unit    |
|--|--------|--|---------------------------|------|------|---------|
| Pickup Pattern                         |        |  | Dipole                    |      |      |         |
| Polarity                               |        | Increasing sound pressure at back (out-of-phase with omnidirectional microphone)             | Decreasing density of 1's |      |      |         |
|  |        | Increasing sound pressure at front (phase-aligned with omnidirectional microphone)           | Increasing density of 1's |      |      |         |
| Average Directivity Index              |        | Integrated from 20 Hz to 20 kHz  | 4.2                       |      |      | dB      |
| Null Angle                             |        |  | 90, 270                   |      |      | °       |
| Sensitivity                            | S      | $f_{clock} \geq 1.536\text{ MHz}$ , 94 dB SPL, 1 kHz   | -30                       | -29  | -28  | dBFS/Pa |
| Noise Floor                            |        |  | -90                       |      |      | dBFS(A) |
| Signal to Noise Ratio <sup>1</sup>     | SNR    | 20 Hz to 20 kHz, 94 dB SPL   | 66                        |      |      | dB(A)   |
| Total Harmonic Distortion <sup>2</sup> | THD    | 94dB SPL, 1kHz   | <0.2                      |      |      | %       |
|  |        | 1% THD, 1 kHz  | 109                       |      |      |         |
| Acoustic Overload Point                | AOP    | 10% THD, 1 kHz   | 127.5                     |      |      | dB SPL  |
| Resonant Frequency                     | Fres   |  | 4                         |      |      | kHz     |
| Power Supply Rejection Ratio           | PSRR   | 200 mV <sub>pp</sub> sine wave on $V_{dd}$ at 1 kHz  | 75                        |      |      | dB      |
| Power Supply Rejection                 | PSR+N  | 200 mV <sub>pp</sub> 7/8 duty cycle rectangular waveform @ 217 Hz, A-weighted, BW = 22.4 kHz | -89                       |      |      | dBFS(A) |

<sup>1</sup> 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.

<sup>2</sup> 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.

### 7.3 Omnidirectional Microphone Specifications

The SKM1610 incorporates Merry Electronics' MMD201-028 omnidirectional microphone. The omnidirectional microphone's SELECT is tied to GND.

| Parameter                    | Symbol | Condition   | Min.                      | Typ. | Max. | Unit    |
|------------------------------|--------|---|---------------------------|------|------|---------|
| Pickup Pattern               |        |   | Omnidirectional           |      |      |         |
| Polarity                     |        | Increasing sound pressure at (PCB) port   | Increasing density of 1's |      |      |         |
| Average Directivity Index    |        | Integrated from 20 Hz to 20 kHz   |                           | 0.4  |      | dB      |
| Sensitivity                  | S      | 94 dB SPL, 1 kHz  | -27                       | -26  | -25  | dBFS/Pa |
| Noise Floor                  |        |   |                           | -94  |      | dBFS(A) |
| Signal to Noise Ratio        | SNR    | 20 Hz to 20 kHz, 94 dB SPL  |                           | 68   |      | dB(A)   |
| Total Harmonic Distortion    | THD    | 94dB SPL, 1kHz  |                           | <0.1 |      | %       |
|                              |        | 1% THD, 1 kHz   |                           | 104  |      | dB SPL  |
| Acoustic Overload Point      | AOP    | 10% THD, 1 kHz  |                           | 127  |      |         |
| Resonant Frequency           | Fres   |   |                           | 30   |      | kHz     |
| Power Supply Rejection Ratio | PSRR   | 200 mV <sub>pp</sub> sine wave on V <sub>dd</sub> at 1 kHz  |                           | 54   |      | dB      |
| Power Supply Rejection       | PSR+N  | 200 mV <sub>pp</sub> 7/8 duty cycle rectangular waveform @ 217 Hz on V <sub>dd</sub> , A-weighted, BW = 22.4kHz |                           | -82  |      | dBFS    |

### 7.4 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 ( $\theta = 0^\circ$ ) 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.

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

Equation 7.1: Directivity Index

The average directivity index is calculated by logarithmically weighing 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](#).

## 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<sup>2</sup>/Hz or FS<sup>2</sup>/Hz) must be divided by the corresponding sensitivity squared at each frequency (units of V<sup>2</sup>/Pa<sup>2</sup> or FS<sup>2</sup>/Hz<sup>2</sup>) to obtain the input referred acoustic noise at each frequency (units of Pa<sup>2</sup>/Hz). Then, the acoustic noise is A-weighted by multiplying it by the A-weighting factor (A<sub>w</sub>) 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<sub>ref</sub>=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](#).

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

Equation 7.2: 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 harmonic frequencies. For more information on equalization and THD calculation, refer to the app note: [AN-110: Attributes of Soundskrit Directional Microphones](#).

## 7.5 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 <sub>dd</sub> to GND | 5.0                     | V    |
| Input Current          | ±5                      | mA   |
| Storage Temperature    | -40 to 85               | °C   |
| Operating Temperature  | -40 to 85               | °C   |

## 7.6 Performance Curves

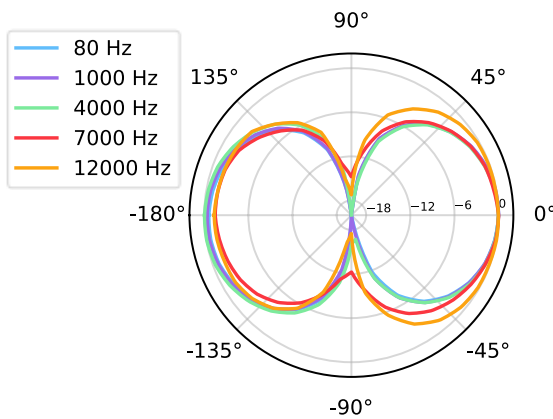


Figure 7.1: Polar pattern (dipole)

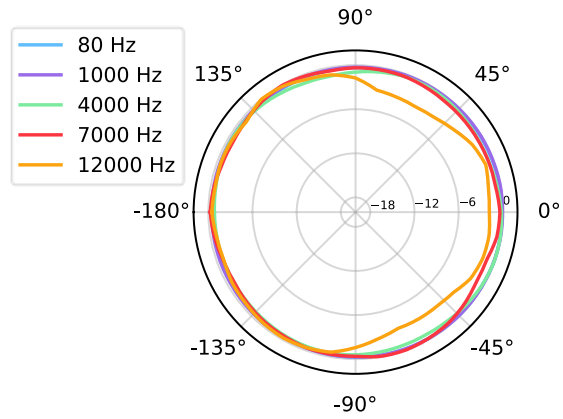


Figure 7.2: Polar pattern (omni)

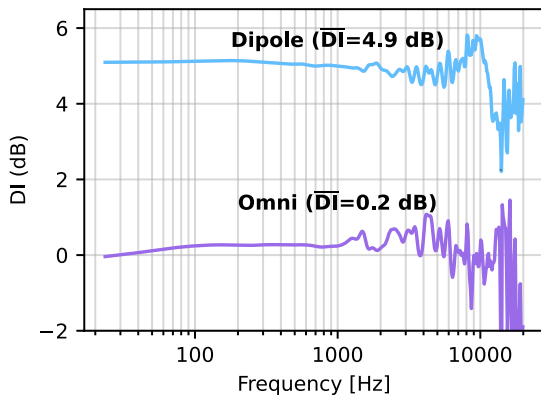


Figure 7.3: Directionality index vs frequency

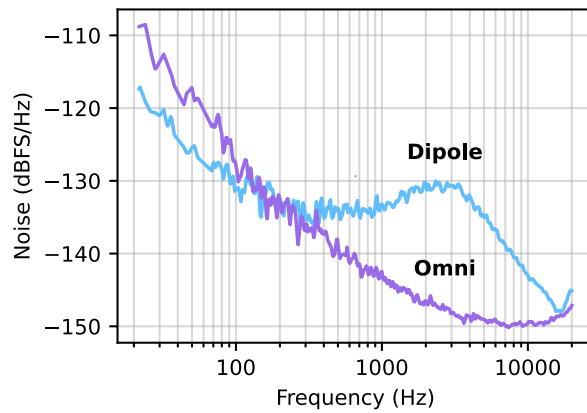


Figure 7.4: Noise floor

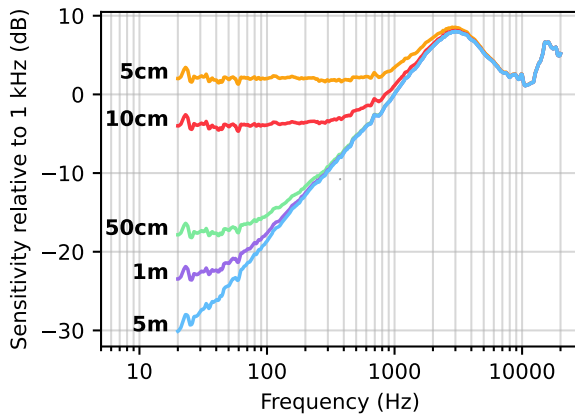


Figure 7.5: Magnitude response<sup>3</sup> (dipole)

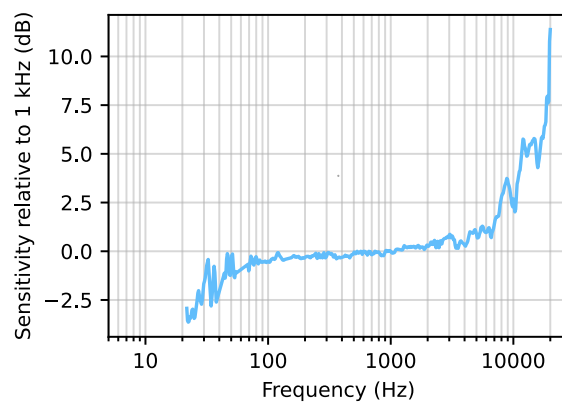


Figure 7.6: Magnitude response (omni)

<sup>3</sup> The increased bass response at close distances is known as the 'Proximity Effect.' See [AN-110](#) for details.

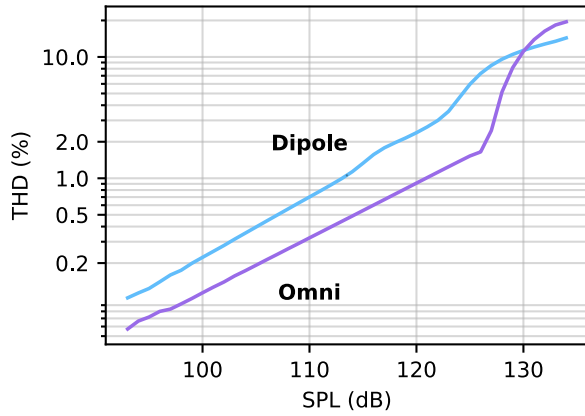


Figure 7.7: 1 kHz THD vs SPL

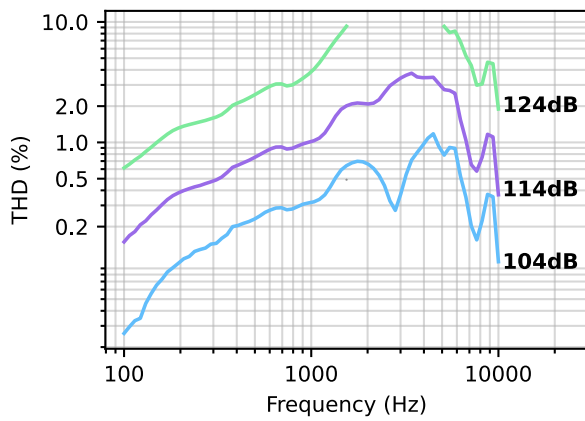


Figure 7.8: THD vs Frequency (dipole)

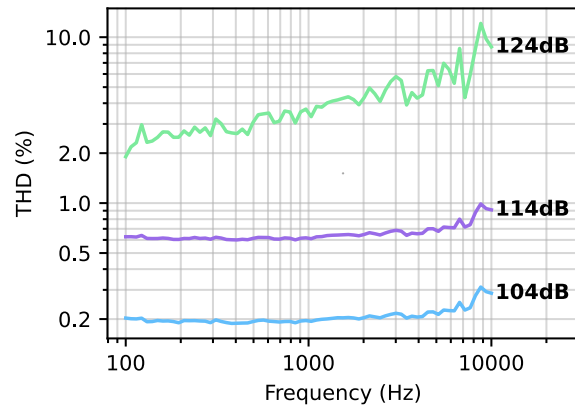


Figure 7.9: THD vs Frequency (omni)

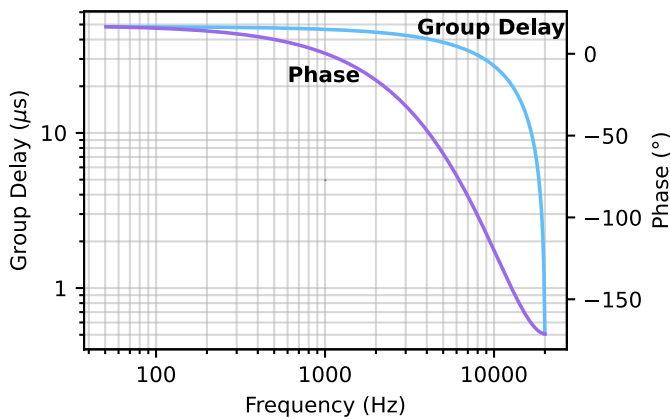


Figure 7.10: Phase and group delay (dipole)

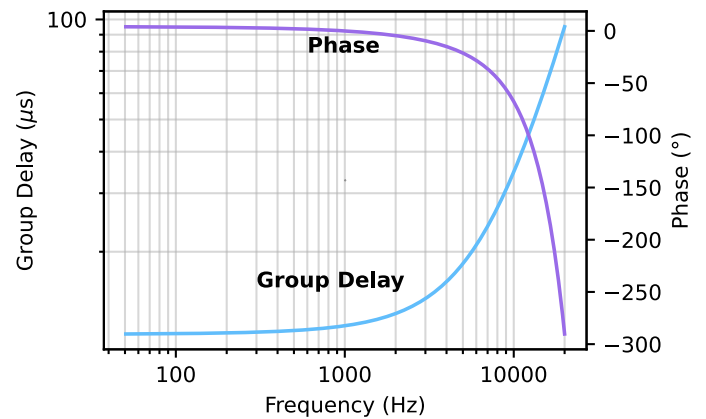


Figure 7.11: Phase and group delay (omni)

## 8. Mechanical Drawings and Integration Design

### 8.1 Mechanical Drawings and Pinout

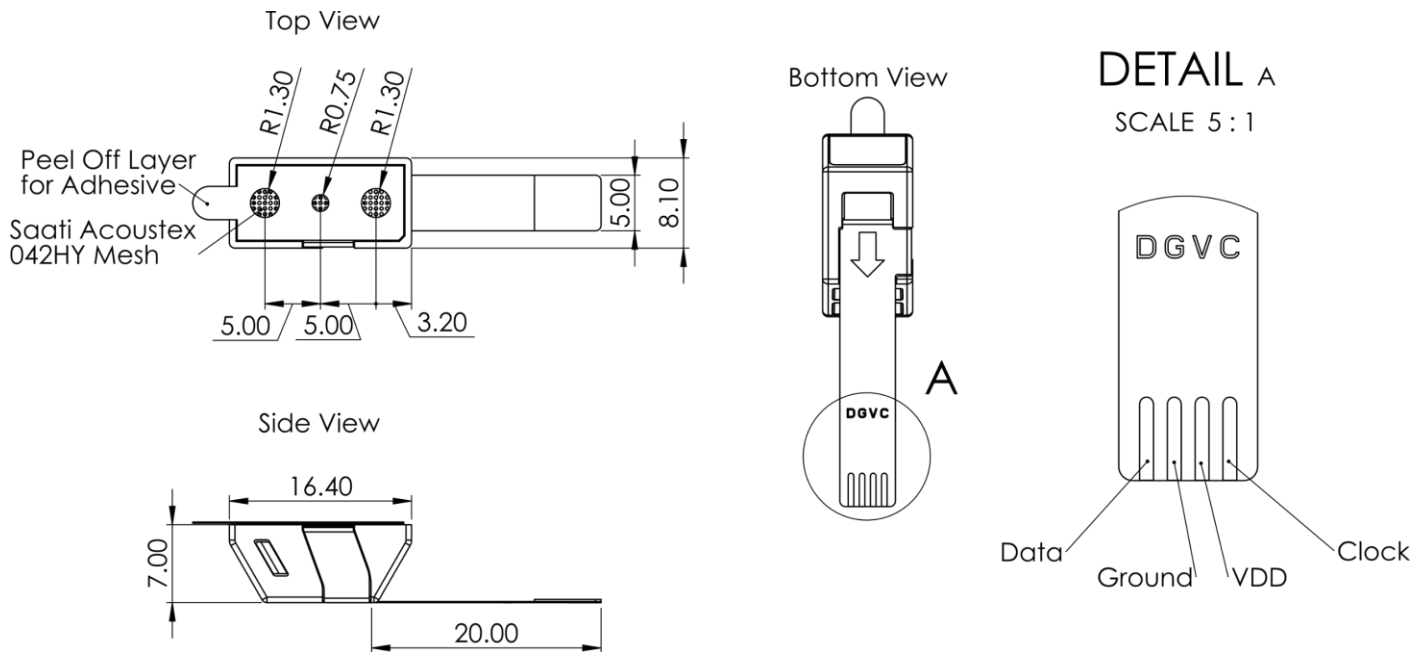


Figure 8.1: Mechanical drawings (mm)

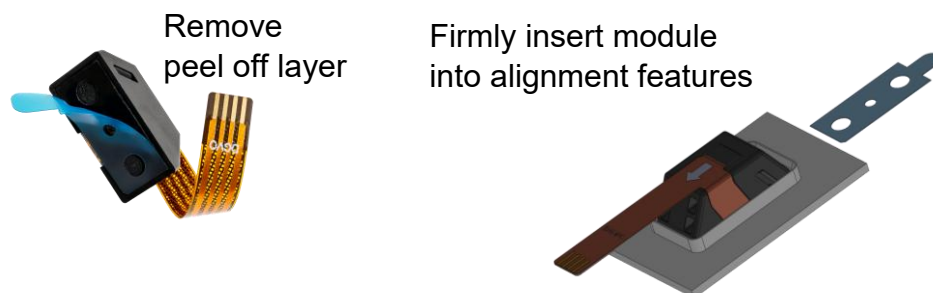
The SKM1610 incorporates a SAATI Acoustex 042HY mesh placed above all acoustic ports for IP58 (ingress and water immersion protection).

### 8.2 CAD Models

The CAD model for the module is available here: [STEP File](#).

### 8.3 Installation

The product shell should include two acoustic ports with a diameter  $\geq 1.8\text{mm}$  for the dipole microphone and a center port with a diameter  $\geq 1\text{mm}$  for the omnidirectional microphone to achieve the specifications listed in this datasheet. The product shell should also include a raised lip that the module fits into to help align the module during installation. To install the SKM1610, remove the peel-off layer to expose the adhesive, then align the module's acoustic ports to the device shell ports and press firmly for a secure acoustic seal. The adhesive will create an acoustic seal between the module ports and the product ports. This is an example of a mating connector: [HFV4R-1STE1H1LF](#)



## 8.4 Packaging and Ordering Information

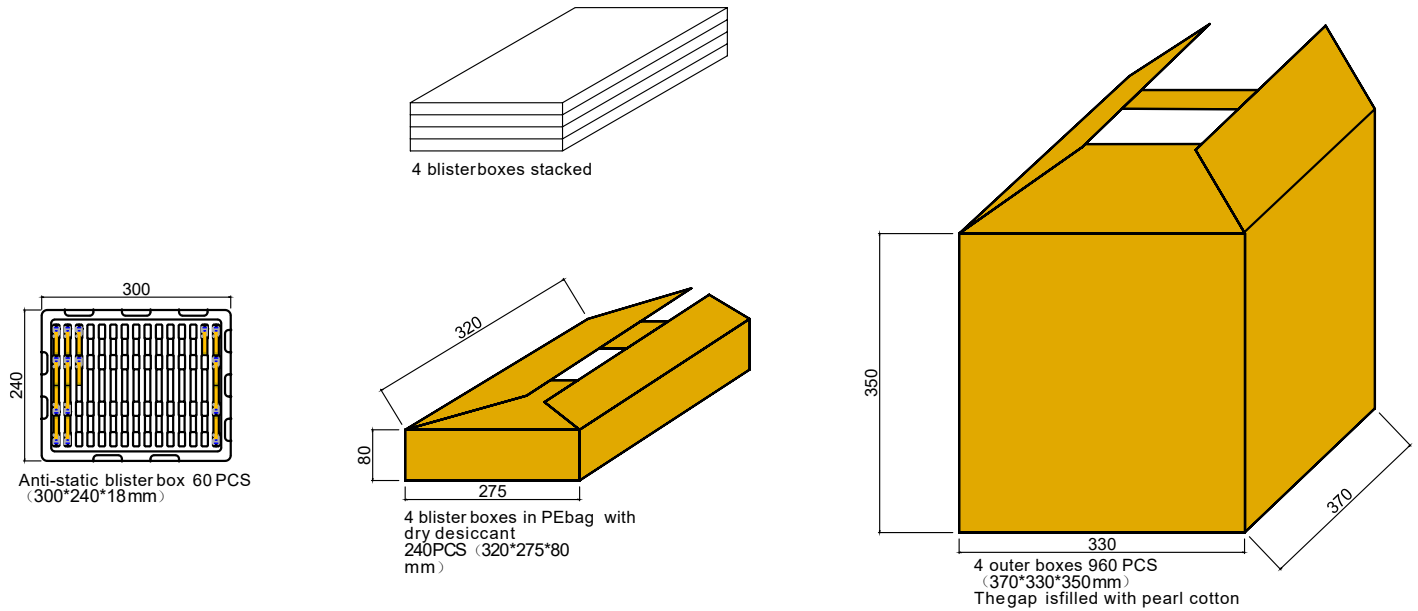


Table 8.4: Ordering Information

| Model Number | Quantity per Box |
|--------------|------------------|
| SKM1610      | 960              |

## 9. Reliability Specifications

The sensitivity of each microphone in the module assembly must deviate by no more than 3 dB after each test. The microphone components themselves have passed the standard microphone reliability tests listed in their respective datasheets ([SKR0610](#) and Merry MMD201-028).

| 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  |

## 10. Additional Support

For additional design and applications support, please reach out to [applications@soundskrit.ca](mailto: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>.

## 11. Revision History

| Revision Label | Revision Date  | Sections Revised        |
|----------------|----------------|-------------------------|
| A              | September 2025 | Release                 |
| B              | March 2026     | Fixed Omni model number |
|                |                |                         |
|                |                |                         |



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.

