AYWHP INMP441

INMP441 Omnidirectional I2S Microphone Module

Model: INMP441 | Brand: AYWHP

1. INTRODUCTION

The AYWHP INMP441 Omnidirectional Microphone Module is a high-performance, low-power digital MEMS microphone designed for audio capture in various applications. It utilizes an I2S digital interface to provide high-precision 24-bit audio data, ensuring clear and stable sound acquisition. Its compact design makes it ideal for integration with popular IoT development boards, such as the ESP-32, for projects requiring voice input or environmental sound monitoring.
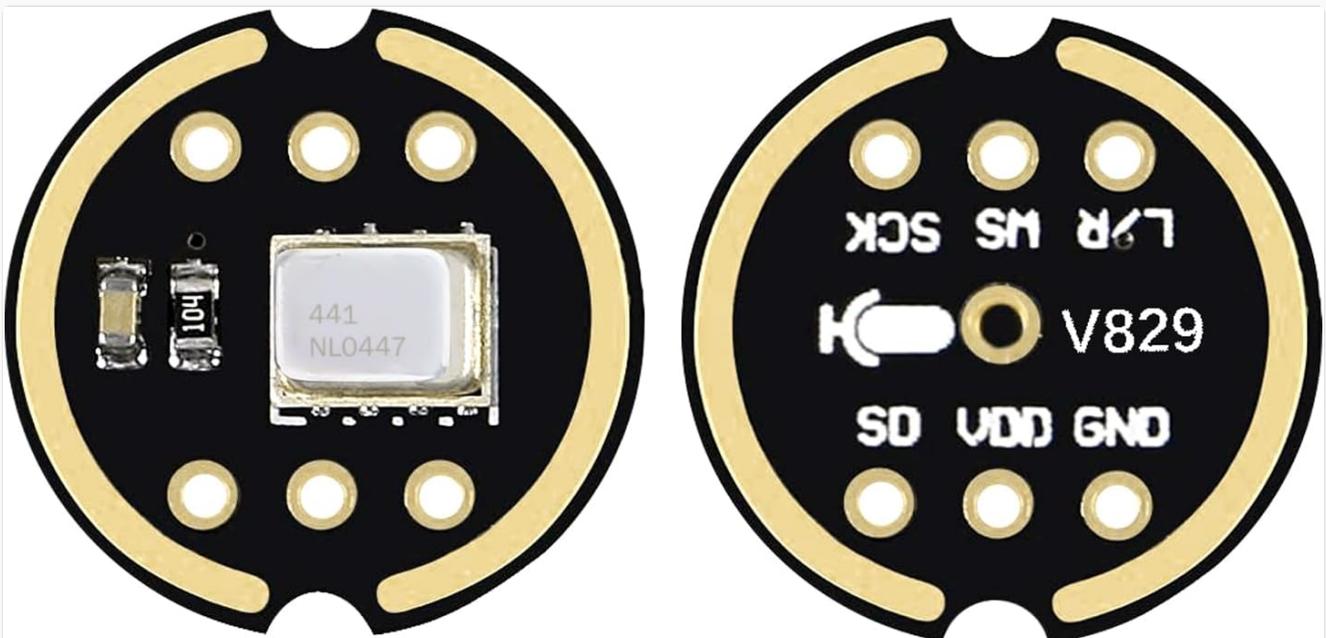

Figure 1: Front and back view of the INMP441 module, illustrating its compact form factor and pin layout.

2. KEY FEATURES

- **High-Performance MEMS Sensor:** Utilizes an advanced MEMS sensor for high sensitivity and low noise, ensuring clear and undistorted audio input.

- **I2S Digital Interface:** Transmits digital audio data via I2S, reducing signal interference and improving audio precision and dynamic range compared to analog microphones. Supports high-quality 24-bit audio sampling.
- **Omnidirectional Sound Capture:** Designed to capture sound from all directions (360°), making it suitable for applications like smart voice devices, voice assistants, and environmental monitoring.
- **Excellent Audio Performance:** Features a high signal-to-noise ratio of 61 dBA and a flat wideband frequency response from 60 Hz to 15 kHz for natural, high-resolution sound. Sensitivity: -26 dBFS.
- **Low Power Consumption:** Operates with a low current consumption of 1.4 mA, making it ideal for battery-powered devices and energy-efficient integrated projects.
- **Compact Design:** Small form factor facilitates easy integration into various embedded systems and IoT devices.

3. PACKAGE CONTENTS

Each package contains:

- 6 x INMP441 Omnidirectional Microphone Modules

4. SETUP AND CONNECTIONS

The INMP441 module features a standard I2S interface for digital audio communication. Proper connection to your development board is crucial for correct operation.

4.1 Pin Descriptions

| Pin	Description
SCK	Serial Data Clock for I2S interface.
WS	Word Select (Left/Right Channel Clock) for I2S interface.
L/R	Left/Right Channel Selection. If low, the microphone outputs the left channel signal. If high, it outputs the right channel signal. *Note: Some modules may have this pin internally tied to GND, limiting stereo configuration.*
SD	Serial Data Output of the I2S interface.
VCC	Input Voltage Supply (1.8V to 3.3V).
GND	Ground connection.

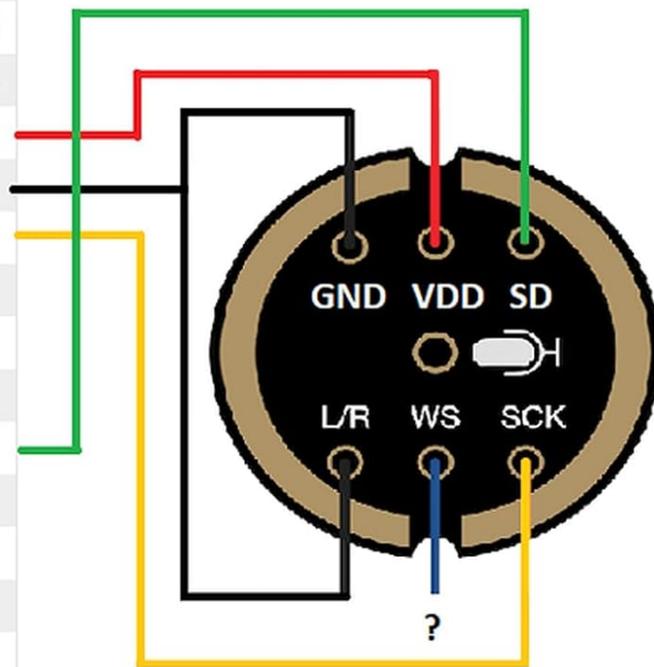# INMP441 Omnidirectional Microphone Module Size
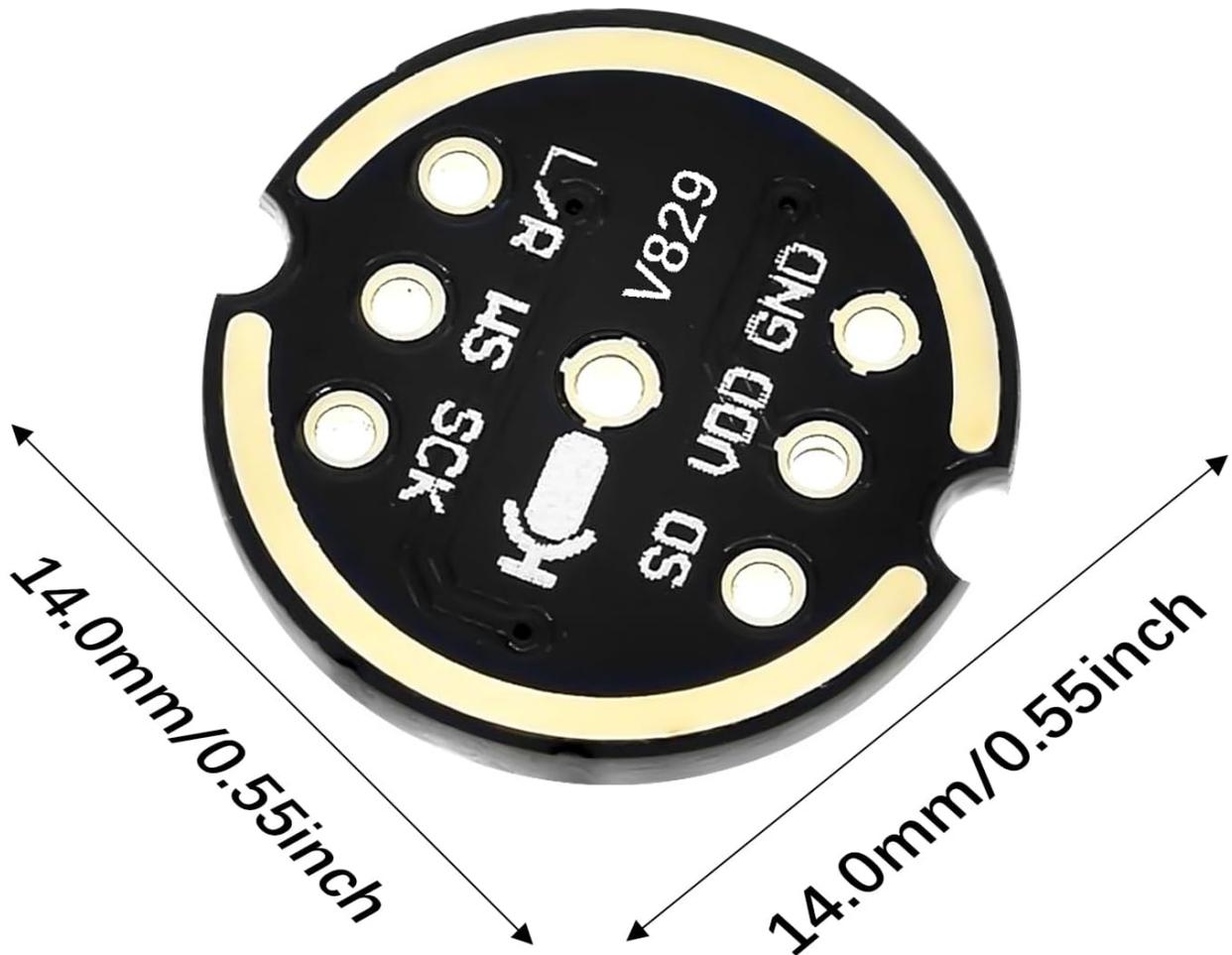
Figure 2: Detailed view of the INMP441 module pins.

4.2 Connection Examples

Below are typical wiring diagrams for connecting the INMP441 module to a development board. Always ensure your board's I2S pins are compatible with the module's requirements.

INMP441 Omnidirectional Microphone Module Interface details

SIGNAL	PIN	PIN	SIGNAL
5V	1	21	GND
5V	2	22	I2C_M3_SCL
USB_DM	3	23	I2C_M3_SDA
USB_DP	4	24	GND
GND	5	25	I2C_AO_SCK
VCC_MCU	6	26	I2C_AO_SDA
MCU_NRST	7	27	3.3V
MCU_SWIM	8	28	GND
GND	9	29	I2SB_SCLK
ADC_CH0	10	30	I2S_MCLK0
1.8V	11	31	I2SB_SDO
ADC_CH3	12	32	I2SB_LRCK
SPDIF_OUT	13	33	I2SB_SDI
GND	14	34	GND
UARTC_RX	15	35	PWM_F
UARTC_TX	16	36	RTC_CLK
GND	17	37	GPIOH_4
Linux_RX	18	38	MCU_PA1
Linux_TX	19	39	GPIODZ_15
3.3V	20	40	GND

VIM3L GPIO

GND VDD SD

L/R WS SCK

?

INMP441 microphone

Figure 3: Example connection diagram for INMP441 with a VIM3 GPIO board.

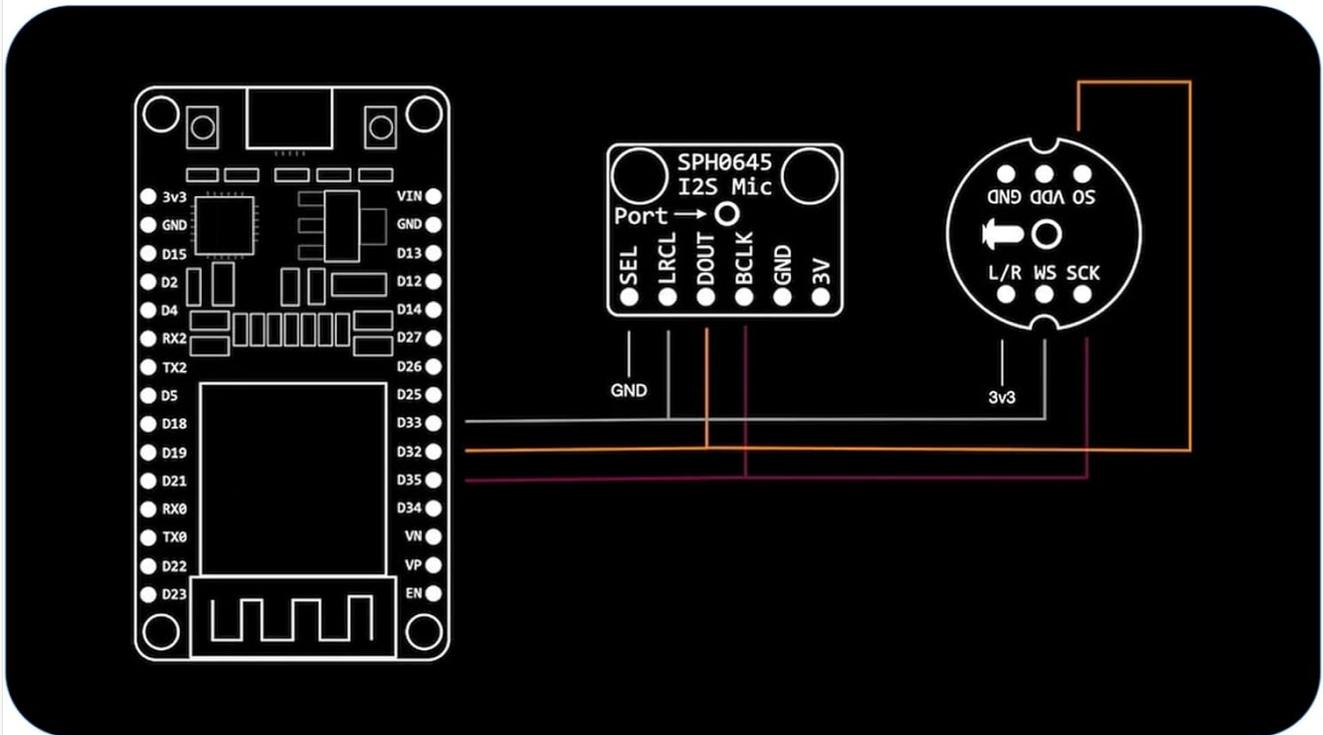# INMP441 Omnidirectional Microphone Module Interface details

Figure 4: Example connection diagram for INMP441 with an ESP32 board.

5. OPERATING INSTRUCTIONS

Once the INMP441 module is correctly wired to your development board (e.g., ESP-32), you will need to configure the I2S peripheral in your microcontroller's firmware. This typically involves:

1. **Initializing the I2S Driver:** Set up the I2S communication protocol, specifying the clock (SCK), word select (WS), and data (SD) pins.

2. **Configuring Audio Parameters:** Define the sample rate (e.g., 44.1 kHz, 48 kHz), bit depth (24-bit), and channel mode (mono or stereo, depending on L/R pin configuration).

3. **Reading Audio Data:** Use the I2S driver functions to read digital audio samples from the SD pin. These samples can then be processed, stored, or transmitted as needed for your application.

4. **Software Libraries:** For platforms like ESP-32, various I2S audio libraries are available (e.g., within the Arduino IDE or ESP-IDF) that simplify the configuration and data acquisition process. Refer to your development board's documentation for specific library usage.

The omnidirectional nature of the microphone means it will pick up sound equally from all directions. Position the module appropriately for your desired sound source and environment.
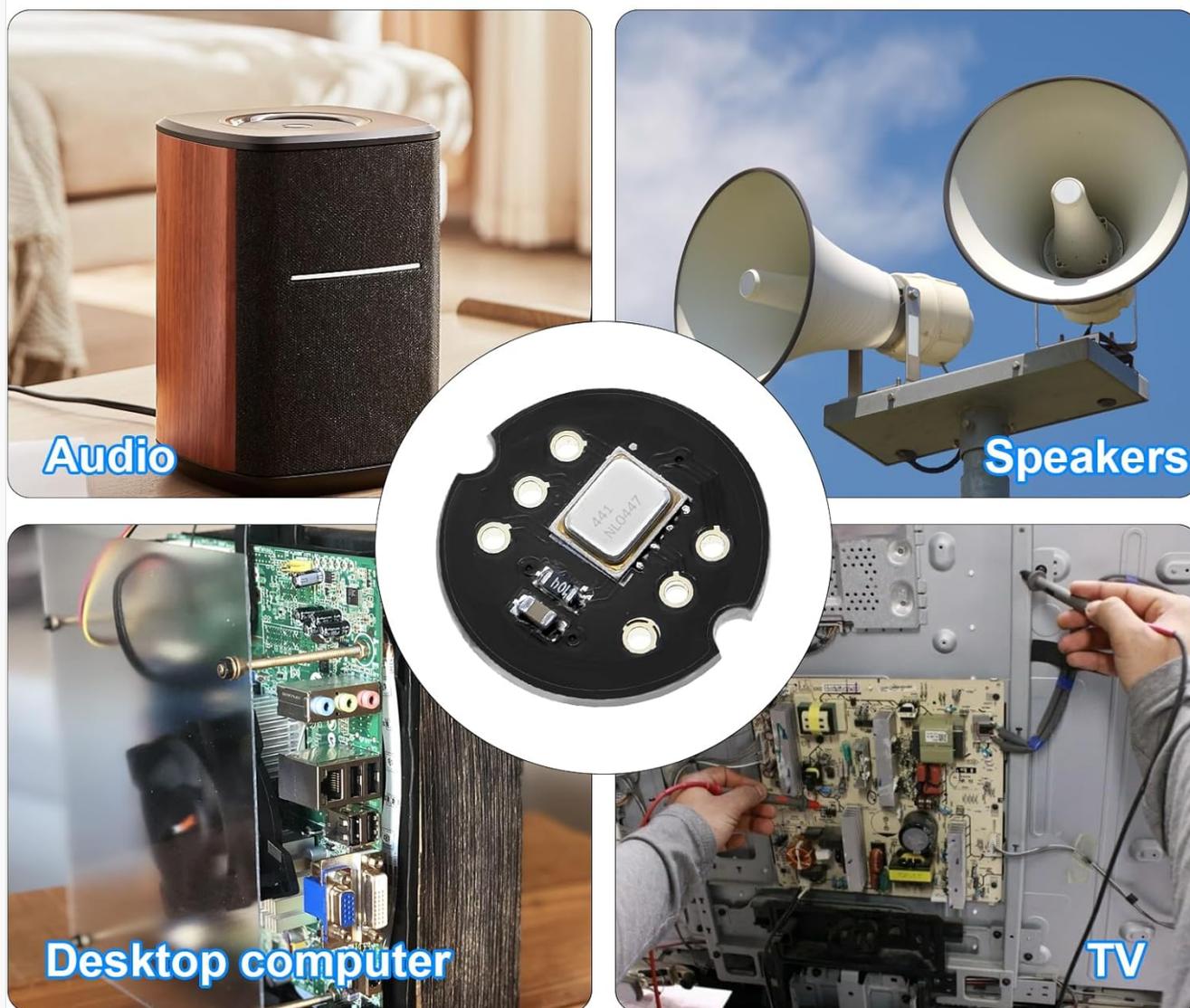
Figure 5: Example applications of the INMP441 module in audio systems and smart devices.

6. Maintenance

The INMP441 microphone module is a robust electronic component, but proper handling and care will ensure its longevity and performance:

- **Keep Dry:** Avoid exposure to moisture or liquids, as this can damage the internal electronics.
- **Handle with Care:** Avoid dropping or subjecting the module to strong impacts.
- **Static Discharge:** When handling, take precautions against electrostatic discharge (ESD) to prevent damage to sensitive components.
- **Cleanliness:** Keep the microphone opening free from dust and debris, which can affect audio quality. Use a soft, dry brush if cleaning is necessary.

7. Troubleshooting

- **No Audio Output:**

- Verify all wiring connections (VCC, GND, SCK, WS, SD) are secure and correct according to the pinout.
- Ensure the power supply (VCC) is within the specified range of 1.8V to 3.3V.
- Check your microcontroller's I2S configuration in the firmware. Confirm pin assignments, sample rate, and bit depth.
- Test with a known working I2S example code if available for your development board.

- **Poor Audio Quality / Noise:**

  - Ensure proper grounding between the module and the development board.
  - Check for electrical interference from nearby components or power lines. Try shielding or relocating the module.
  - Verify that the I2S clock signals are stable and free from jitter.
  - Adjust software gain settings if applicable, to avoid clipping or excessively low signal levels.

- **L/R Channel Issues (for Stereo Applications):**

  - If attempting stereo operation, ensure the L/R pin is correctly configured (pulled high or low) and not inadvertently tied to GND on the module itself, which would force it into a single channel mode.
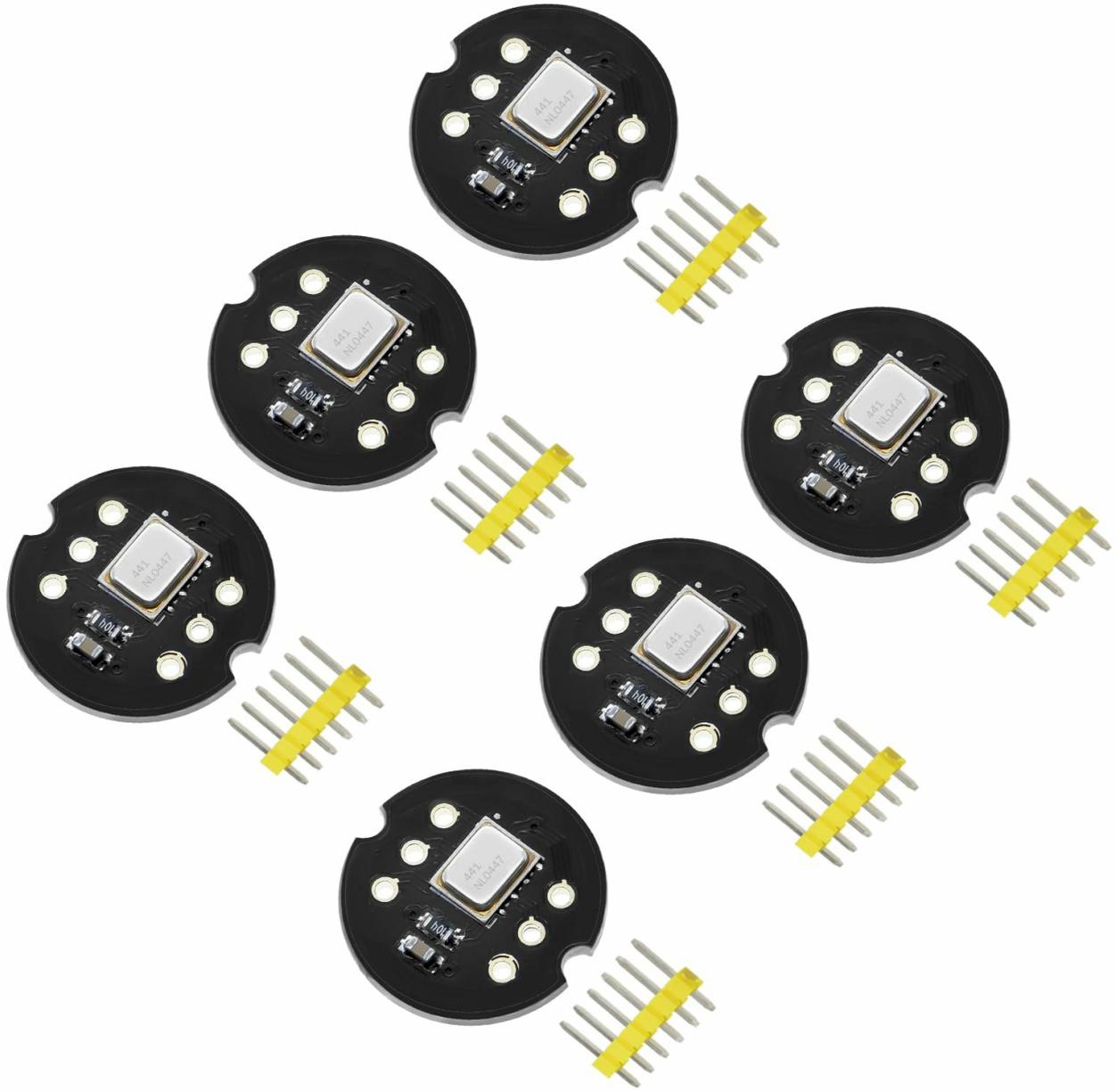
8. SPECIFICATIONS

Figure 6: INMP441 Module dimensions.

Parameter	Value
Digital Interface	I2S, 24-bit data
Signal-to-Noise Ratio (SNR)	61 dBA
Sensitivity	-26 dBFS
Frequency Response	60 Hz to 15 kHz
Current Consumption	1.4 mA (low power)
Power Supply Rejection (PSR)	-75 dBFS
Input Voltage (VCC)	1.8V to 3.3V
Polarity Pattern	Omnidirectional

Parameter	Value
Module Dimensions	Approx. 14.0mm x 14.0mm (0.55 inches)
Manufacturer	AYWHP
Weight (Package)	Approx. 10 g

9. WARRANTY AND SUPPORT

For any questions, technical assistance, or warranty claims regarding your INMP441 Omnidirectional Microphone Module, please contact the seller or manufacturer directly through the platform where the product was purchased. Please provide your order details and a clear description of the issue to facilitate prompt support.