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## waveshare High-Precision AD/DA Board

# Waveshare High-Precision AD/DA Expansion Board for Raspberry Pi User Manual

Model: High-Precision AD/DA Board

## 1. OVERVIEW

The Waveshare High-Precision AD/DA Expansion Board is designed to add advanced analog-to-digital (AD) and digital-to-analog (DA) conversion capabilities to your Raspberry Pi. This board integrates the ADS1256, an 8-channel 24-bit high-precision ADC, and the DAC8552, a 2-channel 16-bit high-precision DAC. It is compatible with Raspberry Pi and provides a robust solution for applications requiring precise analog signal processing.

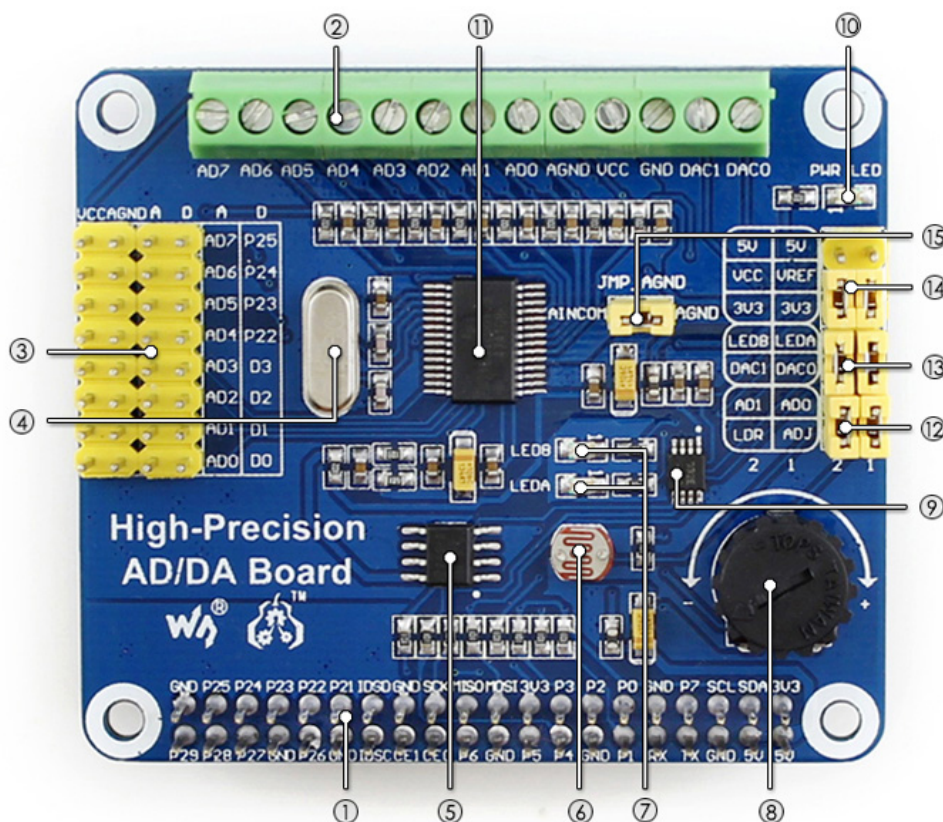


Figure 1: Overview of the Waveshare High-Precision AD/DA Board connected to a Raspberry Pi.

## 2. FEATURES

- Standard Raspberry Pi 40PIN GPIO extension header for direct connection.
- Onboard ADS1256, an 8-channel 24-bit high-precision ADC (4-channel differential input) with a 30ksps sampling rate.
- Onboard DAC8552, a 2-channel 16-bit high-precision DAC.
- Input interface via pinheaders for connecting analog signals.
- Compatible with Waveshare sensor interface standard for easy connection to various analog sensor modules.
- Onboard input/output interface via screw terminals for connecting analog/digital signals.
- Features an AD/DA detect circuit for signal demonstration.

### 3. BOARD LAYOUT AND INTERFACE DEFINITION

This section details the physical layout and pin definitions of the AD/DA Expansion Board.

#### Overview

There's no AD/DA function on the Raspberry Pi GPIO interface, this may trouble you in the Pi development. However, it won't be a problem anymore. The High-Precision AD/DA Board allows you to add high-precision AD/DA functions to the Raspberry Pi.

#### Features

- Standard Raspberry Pi 40PIN GPIO extension header, supports Raspberry Pi series boards, Jetson Nano
- Onboard ADS1256, 8ch 24bit high-precision ADC (4ch differential input), 30ksps sampling rate
- Onboard DAC8552, 2ch 16bit high-precision DAC
- Onboard input interface via pinheaders, for connecting analog signal
  - the pinout is compatible with Waveshare sensor interface standard, easy to connect various analog sensor modules
- Onboard input/output interface via screw terminals, for connecting analog/digital signal
- Features AD/DA detect circuit, easy for signal demonstration

#### Interface Definition

PIN	SYMBOL	DESCRIPTION
1, 17	3.3V	Power supply (3.3V)
2, 4	5V	Power supply (5V)
3, 5, 7, 8, 10, 18, 22, 24, 26, 27, 28, 29, 32, 36, 38, 40	NC	NC
6, 9, 14, 20, 25, 30, 34, 39	GND	Ground
11	DRDY	ADS1256 data ready output, low active
12	RESET	ADS1256 reset input
13	PDWN	ADS1256 sync/power off input, low active
15	CS0	ADS1256 chip select, low active
16	CS1	DAC8552 chip select, low active
19	DIN	SPI data input
21	DOUT	SPI data output
23	SCK	SPI clock
31, 33, 35, 37	GPIO	extend to sensor interface

#### What's on Board

1. Raspberry Pi GPIO interface : for connecting with the Pi
2. AD/DA input/output : screw terminals
3. AD input : pinheaders, the pinout is compatible with Waveshare sensor interface standard, easy to connect various analog sensor modules
4. 7.68M crystal
5. LM285-2.5 : provides reference voltage for the ADC chip
6. Photo resistor
7. LED output indicator
8. 10K potentiometer
9. DAC8552 : 16bit high-precision DAC, 2ch
10. Power indicator
11. ADS1256 : 24bit high-precision ADC, 8ch (4ch differential input)
12. ADC testing jumper
13. DAC testing jumper
14. Power selection jumper
15. ADC reference ground configuration : when AD single inputted, the AINCOM is reference terminal, can be connected to GND or external reference voltage

Figure 2: Labeled components of the Waveshare High-Precision AD/DA Board.

1. Raspberry Pi GPIO interface: For connecting with the Pi.
2. AD/DA input/output: Screw terminals for signal connections.
3. AD input: Pinheaders, compatible with Waveshare sensor interface standard.
4. 7.68M crystal: Provides timing for the board.
5. LM285-2.5: Provides reference voltage for the ADC chip.
6. Photo resistor: An example sensor for demonstration.
7. LED output indicator: Visual feedback for output.

8. 10K potentiometer: An example input for demonstration.
9. DAC8552: 16-bit high-precision DAC, 2 channels.
10. Power indicator: LED to show power status.
11. ADS1256: 24-bit high-precision ADC, 8 channels (4 differential input).
12. ADC testing jumper: For configuring ADC test modes.
13. DAC testing jumper: For configuring DAC test modes.
14. Power selection jumper: To select power source.
15. ADC reference ground configuration: When AD single inputted, the AINCOM is reference terminal, can be connected to GND or external reference voltage.

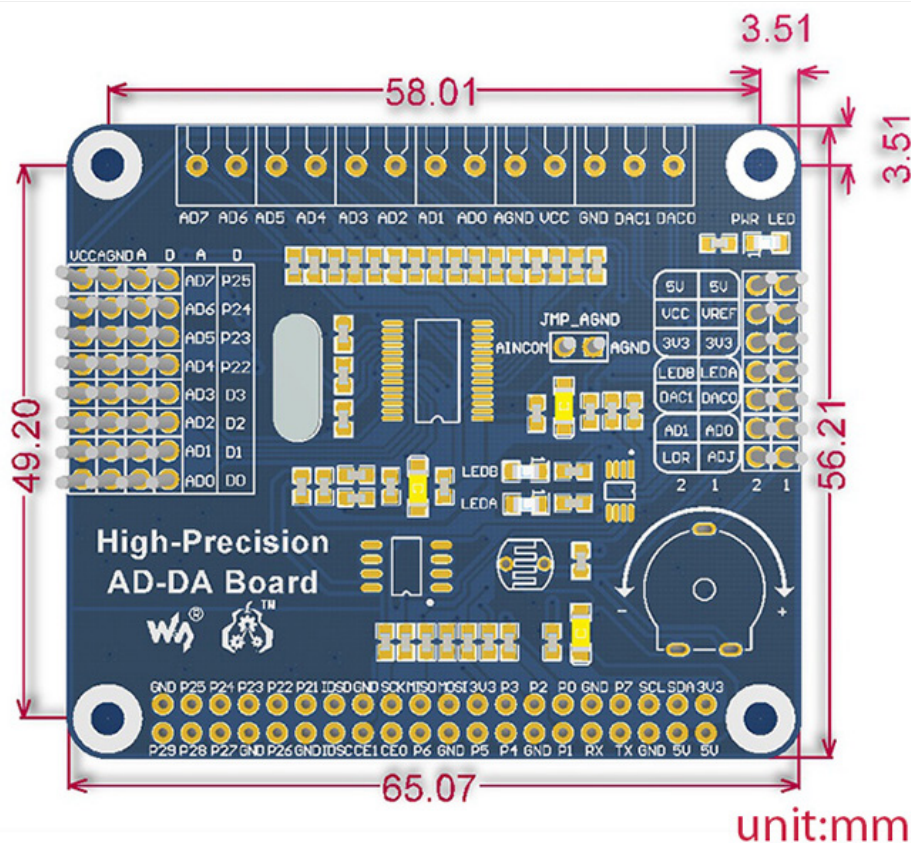


Figure 3: Pin definitions for the Waveshare High-Precision AD/DA Board.

Table 1: Pin Definitions

PIN	SYMBOL	DESCRIPTION
1, 17	3.3V	Power supply (3.3V)
2, 4	5V	Power supply (5V)
3, 5, 7, 8, 10, 18, 22, 24, 26, 27, 28, 29, 32, 36, 38, 40	NC	Not Connected
6, 9, 14, 20, 25, 30, 34, 39	GND	Ground
11	DRDY	ADS1256 data ready output, low active
12	RESET	ADS1256 reset input
13	PDWN	ADS1256 sync/power off input, low active
15	CS0	ADS1256 chip select, low active
16	CS1	DAC8552 chip select, low active



PIN	SYMBOL	DESCRIPTION
19	DIN	SPI data input
21	DOUT	SPI data output
23	SCK	SPI clock
31, 33, 35, 37	GPIO	Extend to sensor interface

## 4. SETUP INSTRUCTIONS

Follow these steps to set up your Waveshare High-Precision AD/DA Expansion Board with a Raspberry Pi:

- Physical Connection:** Carefully align the 40-pin GPIO header of the AD/DA board with the corresponding pins on your Raspberry Pi. Press down gently to ensure a secure connection.
- Power Supply:** Ensure your Raspberry Pi is powered off before connecting the AD/DA board. Once connected, power on the Raspberry Pi. The power indicator LED on the AD/DA board should illuminate.
- Software Installation:**
  - Access the official Waveshare Wiki for the "High-Precision AD/DA Board" to find the latest drivers and example code.
  - Download and install the necessary libraries and example programs for the ADS1256 ADC and DAC8552 DAC. This typically involves cloning a Git repository and compiling C or Python code.
  - Ensure the Broadcom GPIO library is correctly installed and configured for your Raspberry Pi operating system (e.g., Raspbian).
- Initial Testing:** Run the provided example code to verify basic functionality of both the ADC and DAC. This will help confirm correct hardware connection and software setup.

*Note:* Refer to the Waveshare Wiki for detailed, up-to-date software installation guides and specific commands for your Raspberry Pi model and operating system.

## 5. OPERATING INSTRUCTIONS

Operating the High-Precision AD/DA Board involves configuring the ADC and DAC chips via SPI communication from the Raspberry Pi.

### 5.1 Analog-to-Digital Conversion (ADC) with ADS1256

- Input Connection:** Connect analog signals to the AD input pinheaders or screw terminals (AD0-AD7). The ADS1256 supports 8 single-ended channels or 4 differential channels.
- Configuration:** Use the provided software libraries to configure the ADS1256. Key parameters include:
  - Channel Selection:** Select the desired input channel(s).
  - Gain Setting:** Adjust the programmable gain amplifier (PGA) for optimal signal range.
  - Data Rate:** Set the sampling rate (up to 30ksps). Note that higher sample rates may introduce more noise.
  - Reference Voltage:** Configure the internal or external reference voltage.
- Data Acquisition:** Initiate conversions and read the 24-bit digital data from the ADS1256 via SPI. The DRDY pin indicates when new data is available.

### 5.2 Digital-to-Analog Conversion (DAC) with DAC8552

- Output Connection:** Connect your output devices to the DAC0 and DAC1 pins on the screw terminals.
- Data Output:** Send 16-bit digital values to the DAC8552 via SPI. The DAC will convert these values into corresponding

analog voltages.

- **Waveform Generation:** By continuously updating the DAC with a sequence of digital values, you can generate various analog waveforms.

Refer to the example code and the ADS1256/DAC8552 datasheets for detailed programming information and advanced configurations.

## 6. MAINTENANCE

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Proper maintenance ensures the longevity and reliable operation of your AD/DA Expansion Board:

- **Handling:** Always handle the board by its edges to avoid touching components, especially the sensitive ICs. Static electricity can damage electronic components.
- **Cleaning:** If necessary, gently clean the board with a soft, dry brush or compressed air to remove dust. Avoid using liquids or abrasive materials.
- **Storage:** Store the board in an anti-static bag in a dry, cool environment when not in use.
- **Connections:** Periodically check all connections (GPIO, screw terminals) to ensure they are secure and free from corrosion.
- **Firmware/Software Updates:** Regularly check the Waveshare Wiki for any updated drivers, libraries, or firmware that may improve performance or fix issues.

## 7. TROUBLESHOOTING

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If you encounter issues with your AD/DA Expansion Board, consider the following troubleshooting steps:

- **Board Not Detected:**
  - Ensure the board is correctly seated on the Raspberry Pi's GPIO header.
  - Verify that the Raspberry Pi is powered on and the AD/DA board's power LED is lit.
  - Check SPI interface enablement on your Raspberry Pi (e.g., `viaraspi-config`).
- **Incorrect Readings/Outputs:**
  - Double-check your wiring for analog inputs/outputs.
  - Review your software configuration for the ADS1256 (gain, data rate, channel selection) and DAC8552.
  - Ensure the reference voltage settings are correct.
  - Test with known voltage sources for ADC and measure DAC output with a multimeter.
  - Noise at higher sample rates for ADC is expected; consider lower rates for higher precision.
- **Software/Driver Issues:**
  - Confirm that you are using the correct and latest software libraries from the Waveshare Wiki.
  - Verify that all dependencies (e.g., Broadcom GPIO library) are installed and correctly configured.
  - Check for compilation errors if building from source.
  - Consult community forums or the Waveshare support page for known issues and solutions.
- **Board Not Functioning:**
  - Disconnect and reconnect the board.
  - Try a different Raspberry Pi if available to rule out Pi-specific issues.
  - Inspect the board for any visible damage or bent pins.

## 8. SPECIFICATIONS

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Feature	Detail
Product Name	High-Precision AD/DA Board
Brand	Waveshare
ADC Chip	ADS1256 (24-bit, 8-channel, 4-differential input)
ADC Sampling Rate	Up to 30ksps
DAC Chip	DAC8552 (16-bit, 2-channel)
Interface	SPI (Serial Peripheral Interface)
Compatibility	Raspberry Pi (40PIN GPIO)
Operating System	Linux
Connectivity Technology	GPIO
Product Dimensions	7.09 x 3.94 x 3.54 inches (approx. 180 x 100 x 90 mm)
Item Weight	0.353 ounces (approx. 10 grams)
Included Components	High-Precision AD/DA Board, RPi screws pack (2pcs)

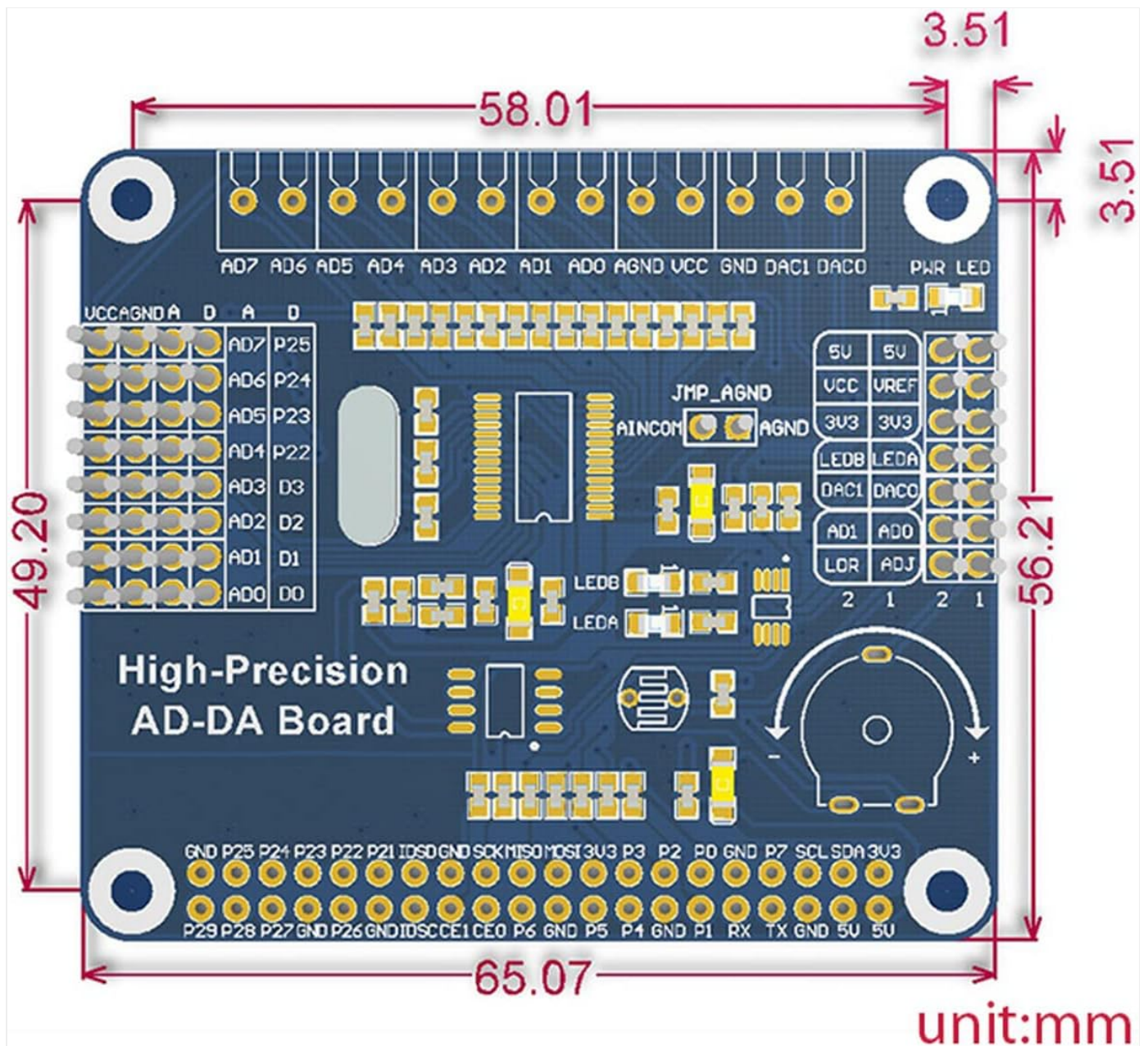


Figure 4: Physical dimensions of the Waveshare High-Precision AD/DA Board in millimeters.

## 9. WARRANTY AND SUPPORT

For warranty information, technical support, and additional resources, please visit the official Waveshare website or their product Wiki page. The Wiki often contains detailed documentation, schematics, and example code that can be invaluable for advanced users and troubleshooting.

**Waveshare Official Website:** [www.waveshare.com](http://www.waveshare.com)

**Product Wiki:** Search for "High-Precision AD/DA Board" on the Waveshare Wiki for specific documentation.