

Analog-to-Digital Converter (ADC) Pins

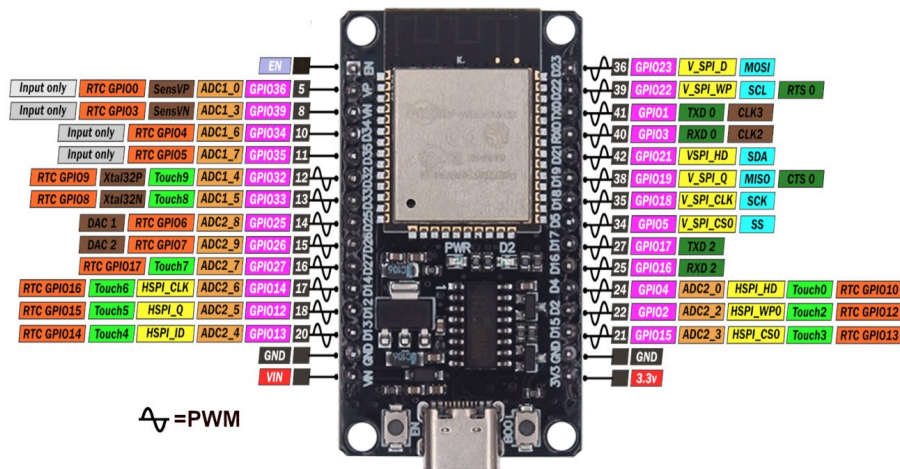


Figure 1: **ESP32-WROOM Development Board Pinout Diagram**

The ESP32-WROOM has a total of **15 ADC (Analog-to-Digital Converter) pins**, which allow it to measure real-world analog signals such as voltages from sensors.

What is an ADC?

- An **ADC** converts a continuous analog signal (e.g., voltage from a sensor) into a digital value that the ESP32 can process.
- Example: If a temperature sensor outputs 1.65V (out of 0–3.3V), the ADC may return **2048** on a 12-bit scale (0–4095).
- This lets the ESP32 understand physical quantities like **light intensity, temperature, sound, or pressure**.

ESP32 ADC Characteristics

- The ESP32 has **two ADC units: ADC1 and ADC2**.
 - **ADC1:** Dedicated for user applications, stable, not affected by Wi-Fi.
 - **ADC2:** Shared with the Wi-Fi module; some pins cannot be used for ADC when Wi-Fi is active.
- Resolution: Up to **12-bit** (0–4095 values). Configurable to 9, 10, or 11 bits.
- Voltage range: Typically **0V to 3.3V**.

Example Usage

For instance, connecting a potentiometer to GPIO34 (ADC1_CH6) allows the ESP32 to read varying voltages between 0V and 3.3V and convert them into values between 0 and 4095. This makes it possible to use sensors and analog devices directly with the microcontroller.

Digital-to-Analog Converter (DAC) Pins

The ESP32 includes **2 DAC (Digital-to-Analog Converter) channels**, which allow it to generate real analog output voltages from digital values.

What is a DAC?

- A **DAC** converts a digital value (binary number) into a continuous analog voltage signal.
- Example: Writing the digital value **128** (out of 0–255) to a DAC pin produces a voltage of approximately **1.65V** (on a 0–3.3V scale).
- This enables the ESP32 to output analog signals for devices such as speakers, actuators, or analog circuits.

ESP32 DAC Characteristics

- The ESP32 has **two DAC pins**:
 - **GPIO25 (DAC1)**
 - **GPIO26 (DAC2)**
- Resolution: **8-bit** (0–255 levels).
- Output Voltage Range: **0V to 3.3V** (depending on supply).

Example Usage

For example, connecting a small speaker to **GPIO25 (DAC1)** allows the ESP32 to generate simple audio tones. Similarly, writing different values to the DAC can produce varying voltages to control analog circuits, such as LED brightness without PWM or voltage-controlled devices.