

A **rotary encoder** is an electro-mechanical device that converts the angular position or motion of a shaft or axle into digital signals. These signals are used to determine the direction and amount of rotation, commonly used in applications such as volume controls, robotics, motor control, and user interface dials.

How a Rotary Encoder Works

- **Core Principle:** Rotary encoders generate digital pulses as the shaft rotates. These pulses are analyzed to determine:
 - **Rotation Direction:** Clockwise (CW) or Counter-Clockwise (CCW)
 - **Step Count:** How much the shaft has rotated

Channels A and B (Quadrature Encoding)

- Rotary encoders typically use **two output channels** (Channel A and Channel B), which are slightly offset in their signals (90° phase difference).
- These channels generate **square waves** when the encoder rotates. The sequence of these signals indicates the direction of rotation.

Understanding CW and CCW

1. **Clockwise (CW):**
 - As the shaft rotates clockwise, the signal on **Channel A** leads **Channel B**.

Example Signal Sequence:

A: HIGH -> LOW -> HIGH -> LOW (leads B)

B: LOW -> LOW -> HIGH -> HIGH

- The microcontroller detects this sequence and interprets it as **+1 step** for each pulse.

2. Counter-Clockwise (CCW):

- As the shaft rotates counter-clockwise, the signal on **Channel B** leads **Channel A**.

Example Signal Sequence:

A: HIGH -> LOW -> HIGH -> LOW

B: HIGH -> HIGH -> LOW -> LOW (leads A)

- The microcontroller detects this sequence and interprets it as **-1 step** for each pulse.

Why Two Channels?

- The **phase difference** (90° offset) allows the microcontroller to:
 - **Detect Direction:** Based on whether Channel A leads or lags Channel B.
 - **Handle Noise:** Small glitches in the signal are less likely to cause errors.
 - **Measure Steps Accurately:** Each full pulse cycle corresponds to a measurable increment or decrement in the position.

Example Signal Diagram

Clockwise Rotation (CW)

Step	Channel A	Channel B
1	HIGH	LOW
2	LOW	LOW
3	LOW	HIGH
4	HIGH	HIGH

Counter-Clockwise Rotation (CCW)

Step	Channel A	Channel B
1	HIGH	HIGH
2	LOW	HIGH
3	LOW	LOW
4	HIGH	LOW

Applications

- Volume control (e.g., audio equipment)
- Menu navigation in embedded systems
- Motor position feedback (industrial automation)
- CNC machines and robotics
- Gaming controllers

[What is a rotary encoder?](#)

[What is a Rotary Encoder? How & Where to Use it in?](#)

[How Rotary Encoder Works and How To Use It with Arduino](#)

[This Component solves "All" Motor Problems?! \(Motor Encoder\) EB#58](#)

[What is Encoder?](#)

[What is the Difference between Absolute and Incremental Encoders?](#)