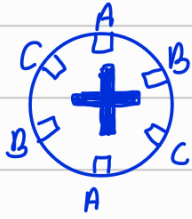


# Stepper motor?

- \* Applies a DC electricity in a controlled sequence to get the movement
- \* One pulse  $\rightarrow$  one movement generally ( $1.8^\circ$  per step)
- \* open loop system



step size =  $30^\circ$

half step energize =  $A \rightarrow AB \rightarrow B \rightarrow BC \rightarrow C \rightarrow CA \rightarrow \dots$

- \* moves in discrete steps.

## Types of Stepper Motors

### 1. Permanent Magnet Stepper Motor

- Uses a permanent magnet rotor.
- Moves in discrete steps when the stator windings are energized.
- Good for low-speed and high-torque applications.

### 2. Variable Reluctance Stepper Motor

- Uses a non-magnetic, toothed rotor.
- Moves based on the principle of minimizing magnetic reluctance.
- Less common but useful for high-speed applications.

### 3. Hybrid Stepper Motor (Most common type)

- Combines features of both permanent magnet and variable reluctance types.
- Offers better torque and precision.
- Typically used in 3D printers, CNC machines, and robotics.

but  $\rightarrow$  High power consumption  
low efficiency  
Possible step loss.

No feedback system to track position

## Closed loop stepper motor

\* Includes feedback system (encoder) to monitor position and adjust its movement in real time.

### How?

1. Controller sends step pulses.
2. The stepper motor rotates according to the given steps.
3. A sensor (optical or magnetic) monitors the actual position of the rotor.
4. Controller compares the actual position with the commanded position.
5. If there is a mismatch controller compensates by adjusting current or reapplying steps.

### **Applications of Closed-Loop Stepper Motors**

- **CNC Machines** – Prevents position loss in machining operations.
- **3D Printers** – Ensures accurate layer positioning without step loss.
- **Robotics** – Provides precise movement with adaptive torque.
- **Medical Equipment** – High accuracy in devices like automated syringes and scanning mechanisms.
- **Automated Manufacturing** – Reduces errors in production lines.

## Advantages of Closed-Loop Stepper Motors

- ✓ No Lost Steps – The system detects and corrects errors in real time.
- ✓ Higher Torque at High Speeds – Unlike open-loop systems, torque does not drop off significantly.
- ✓ Energy Efficient – Only consumes as much power as needed, reducing heat.
- ✓ Smoother Operation – Reduces vibration and noise.
- ✓ Faster Acceleration & Deceleration – Better for dynamic applications.

knows about sync

## Disadvantages

- ✗ More Expensive – Additional components like encoders and advanced drivers increase cost.
- ✗ More Complex – Requires a feedback system and a more advanced controller.

## Difference Between Open-Loop and Closed-Loop Stepper Motors

Feature	Open-Loop Stepper	Closed-Loop Stepper
Feedback	No	Yes (Encoder)
Accuracy	Lower (may lose steps)	Higher (self-correcting)
Efficiency	Always draws max current	Adjusts current based on need
Torque Control	Fixed torque	Adaptive torque
Cost	Lower	Higher
Heat Generation	Higher (constant current)	Lower (optimized current use)

