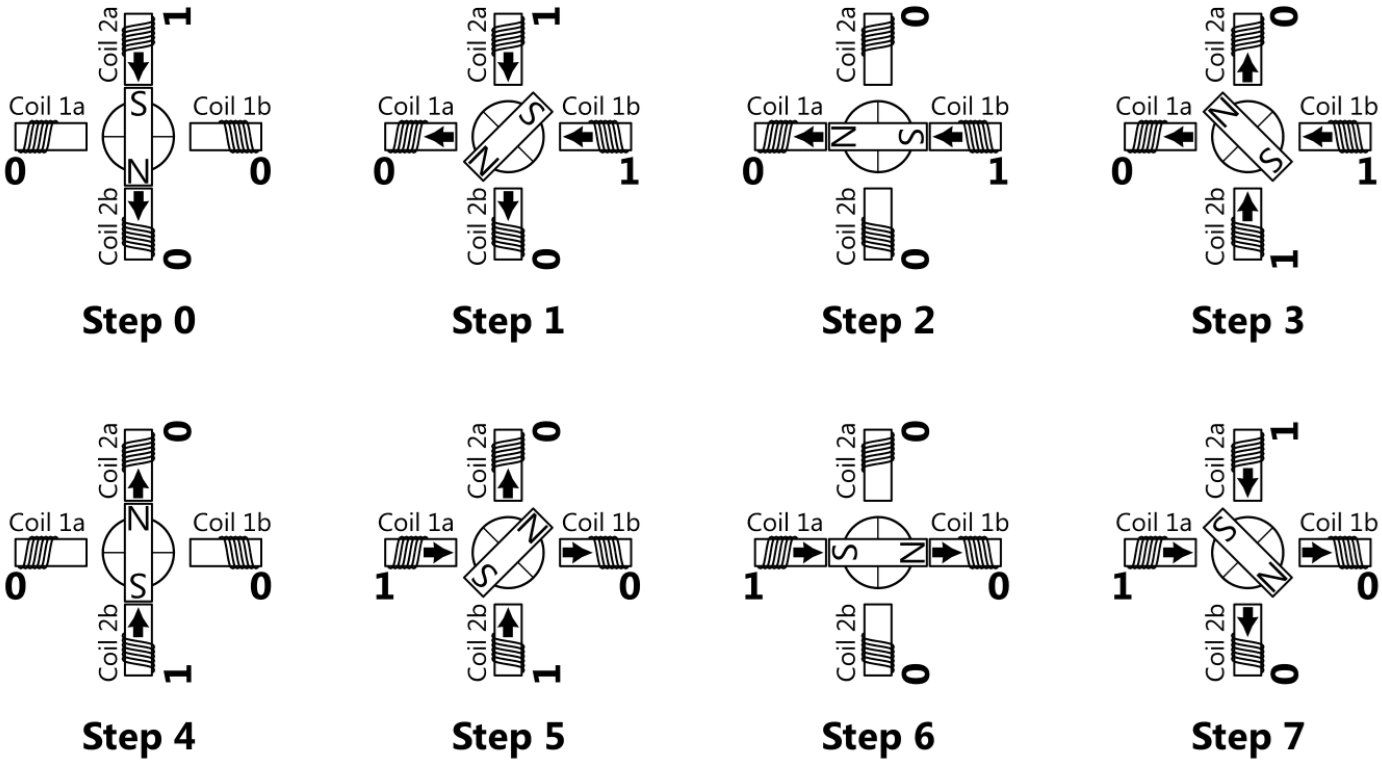
The Stepper Motor

Application:
Stepper Motors are great for accurate 360 degree positioning and precise incremental movement in CNC machinery.

Control:
Stepper Motors require motor driver circuitry to handle high current and voltage. Most stepper motors have a total of four control lines, with two for each of the magnetic coils.

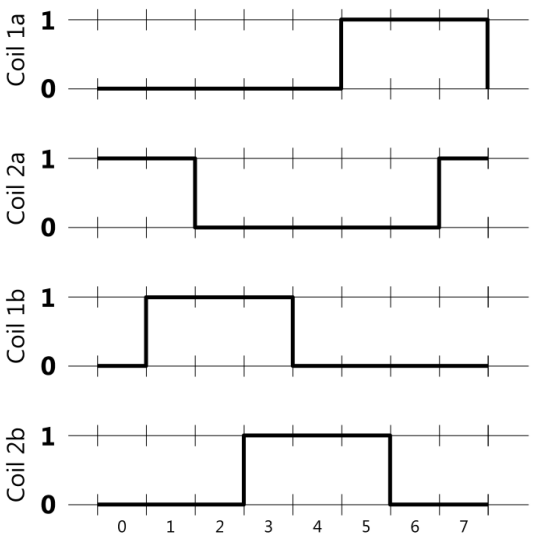
How it Works:
The easiest way to use a Stepper Motor is to apply a 'Stepping Sequence' to control the push and pull of the two magnetic coils. A full revolution of the rotor can take eight steps. And some stepper motors have internal gearing so that it takes hundreds of steps to turn the shaft one full revolution.



Stepper Motor—Eight Step Sequence

Explanation:
In the example above, completing steps 0 to 7 will turn the rotor clockwise one full revolution by energizing the two coils in the particular sequence. The Arrows represent the Magnetic polarity and the *Binary* numbers (1 & 0) represent the digital equivalent. Using a microcontroller, it is easy to create the eight step sequence with the binary numbers, but make sure you have enough time in between each step to energize the coils.

Waveform:
Below is the table/graph for the above stepping sequence showing each of the four control lines.



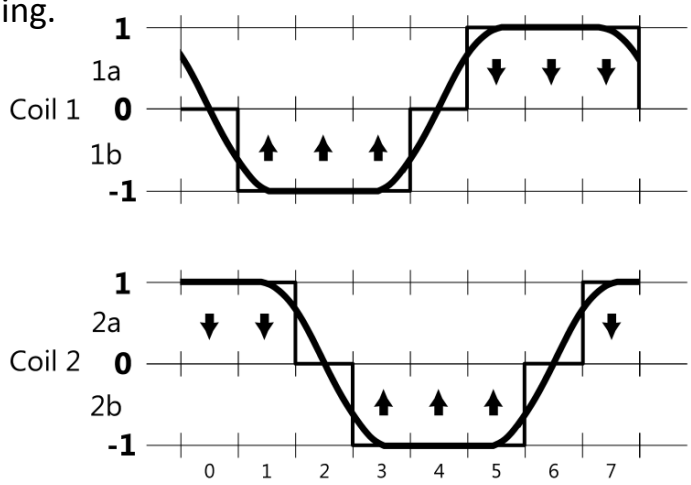
	Coil 1a	Coil 2a	Coil 1b	Coil 2b
Step 0	0	1	0	0
Step 1	0	1	1	0
Step 2	0	0	1	0
Step 3	0	0	1	1
Step 4	0	0	0	1
Step 5	1	0	0	1
Step 6	1	0	0	0
Step 7	1	1	0	0

Stepper Motor 8 Step Sequence - Graph and Binary Table

Further Technology:
Using this eight step sequence is the easiest way to start out with stepper motors. However, it is sometimes beneficial to use a technique called micro-stepping.

Micro-stepping makes the steps smoother by adding extra steps in between the major steps. To do this, high frequency PWM is used to derive an analogue voltage so as to smooth out the curve. The downside of this technique is that it somewhat weakens the high torque of the stepper motor available with the Eight Step Sequence.

But there is a compromise between high torque and smooth steps and this technique is called *High Torque Micro-stepping*. The graph below shows the voltage at each of the two coils, where each pair of control lines is combined (1a with 1b, and 2a with 2b). Note the square edges caused by the Eight Step Sequence, and the smooth transition of High-Torque Micro-Stepping.



Stepper Motor Comparison—Eight Step Sequence vs. High-Torque Micro-Stepping

Compared with High-Torque Micro-stepping, the Eight Step Sequence is quite clunky, causes voltage spikes, vibrations, and extra noise at every step. And yet, for most applications, the Eight Step Sequence is quite sufficient and easy to implement.

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