Stepper Motor theory

Motors convert electrical energy into mechanical energy.

A stepper motor converts electrical pulses into specific rotational movements.

The movement created by each pulse is precise and repeatable,

which is why step- per motors are so effective for positioning applications.

Permanent Magnet stepper motors incorporate a permanent magnet rotor,

coil windings and magnetically conductive stators. Energizing a coil winding

creates an electromagnetic field with a north and south pole .The stator carries

the magnetic field. The magnetic field can be altered by sequentially energizing

or "stepping" the stator coils which generates rotary motion.

Figure 1 illustrates a typical step sequence for a two phase motor.

In Step 1 phase A of a two phase stator is energized.

This magnetically locks the rotor in the position shown, since unlike poles attract, W

hen phase A is turned off and phase B is turned on, the rotor rotates 90° clockwise.

In step 3,phase B is turned on but with the polarty reversed from Step 1,

this causes another 90° rotation.

In Step 4, phase A is turned off and phase B is turned on,

with polarity reversed from Step2.Repeating this sequence causes the rotor to rotate

clockwise in 90° steps.

The stepping sequence illustrated in figure 1 is called "one phase on" stepping.

A more common method of stepping is "two phase on" where both phases of the motor

are always energized.
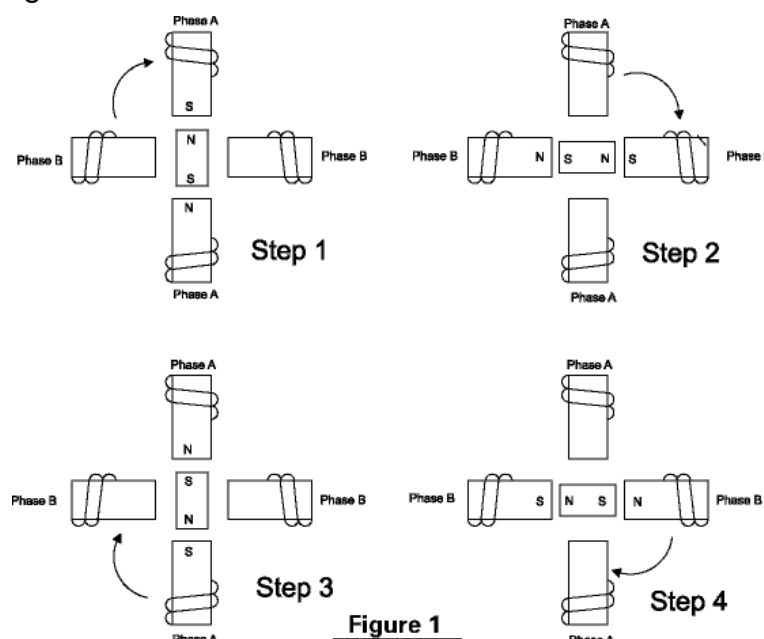
Figure 1

However, only the polarty of phase is switched at a time, as shown in figure 2.
With two phase on stepping the rotor aligns itself between the "average" north
and "average" south magnetic poles. Since both phases are always on,
this method gives 41.4% more torque than "one phase on" stepping.
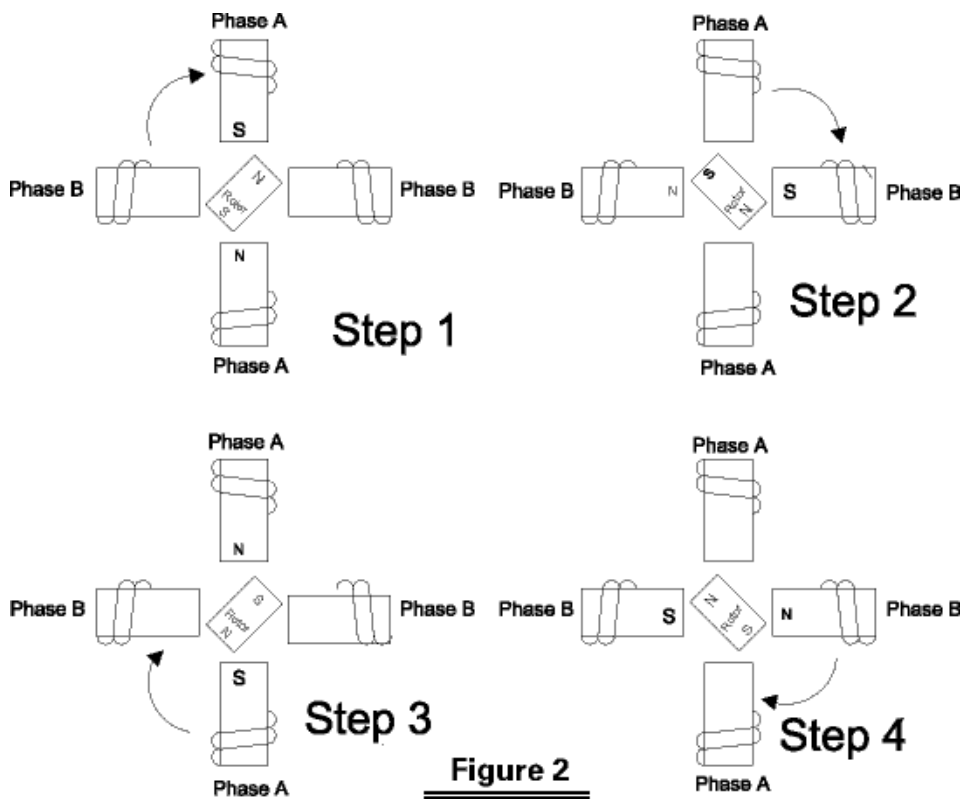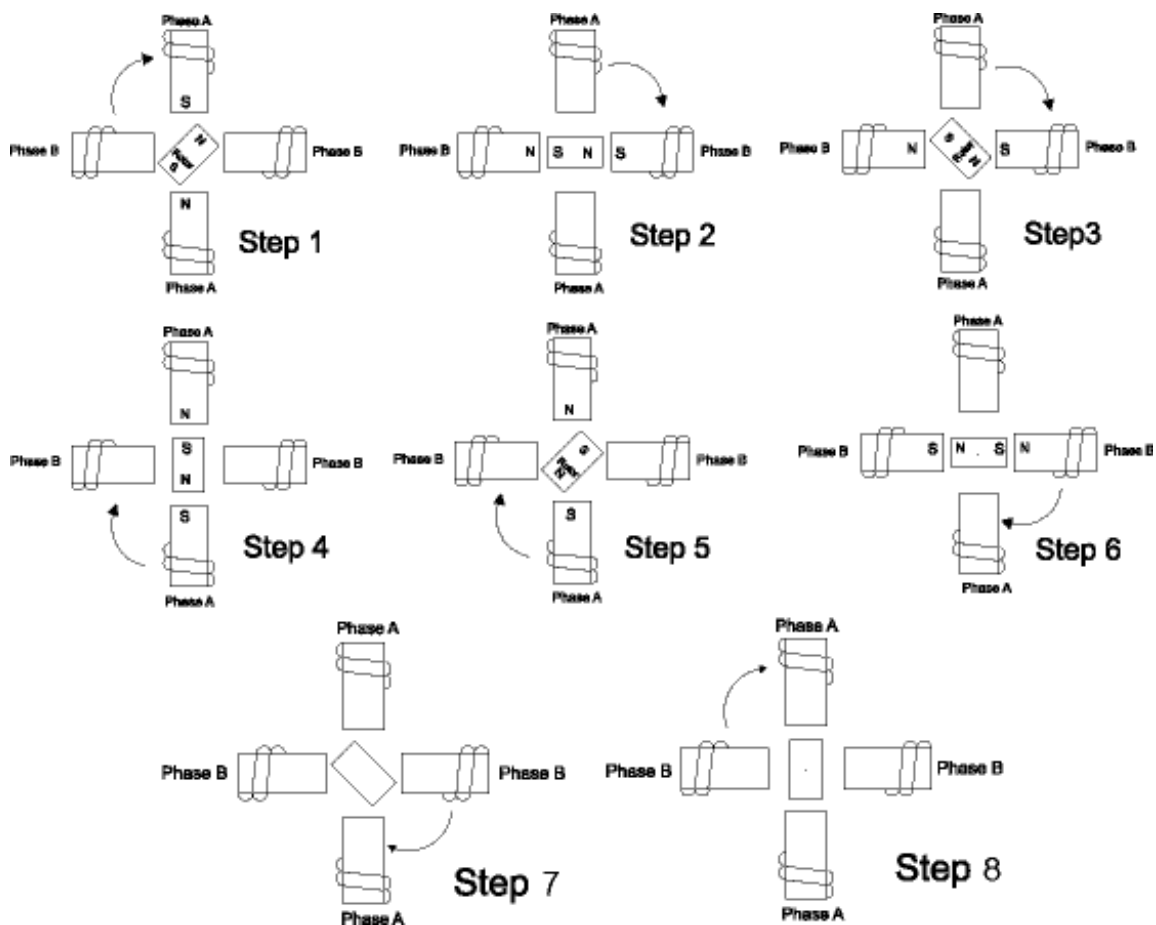

Figure 2

Half Stepping

The motor can also be "half stepped" by inserting an off state between transitioning phases.

This cuts a stepper's full step angle in half.

For example, a 90° stepping motor would move 45 on each half step,figure3

However, half stepping typically results in a 15%-30% loss of torque depending on step rate when compared to the two phase on stepping sequence.

Since one of the windings is not energized during each alternating half step there is less electromagnetic force exerted on the rotor resulting in a net loss of torque