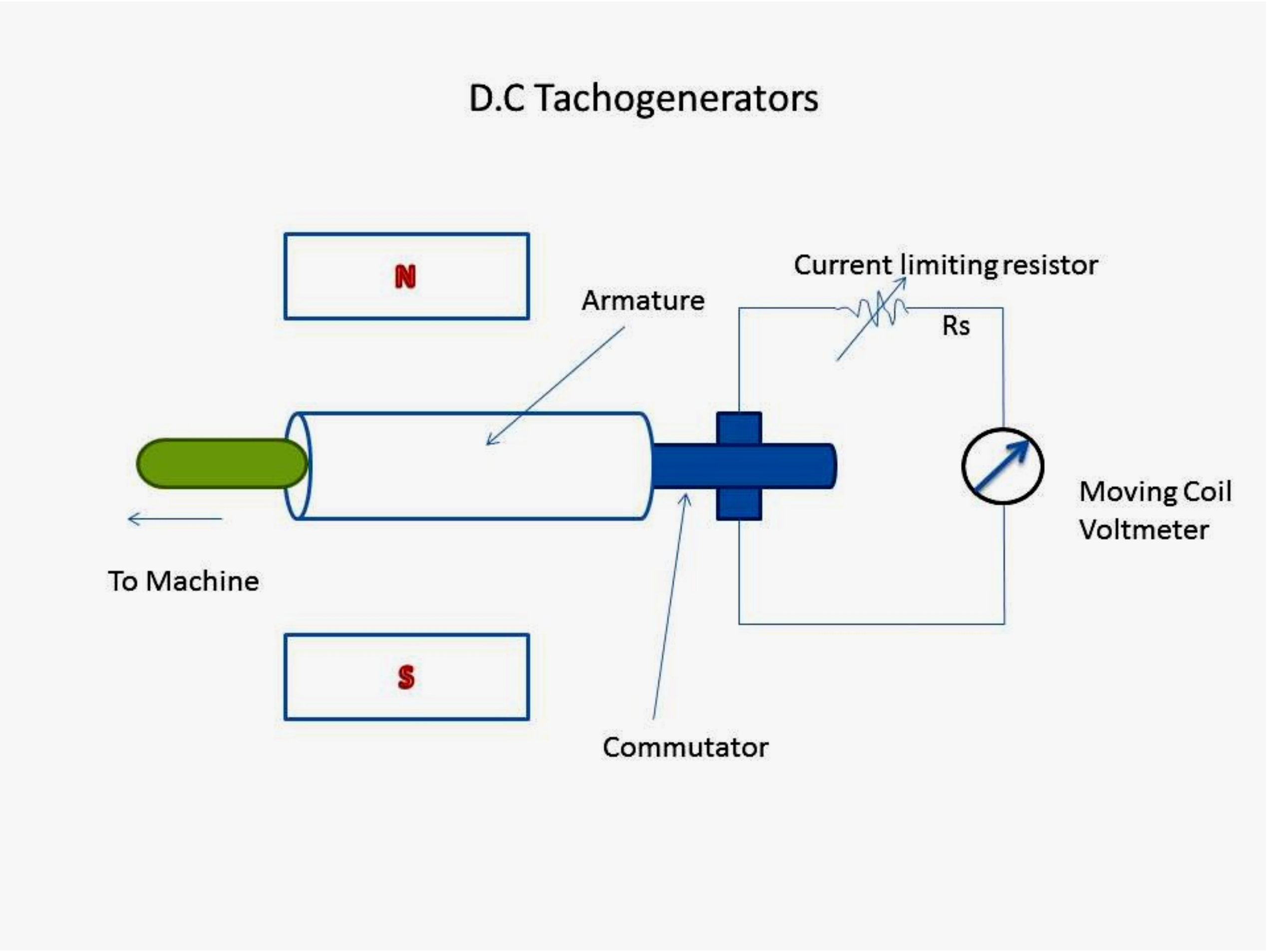
Tachogenerators

- Tachometers are mainly of two types:
  - DC Tachometer
  - AC Tachometer

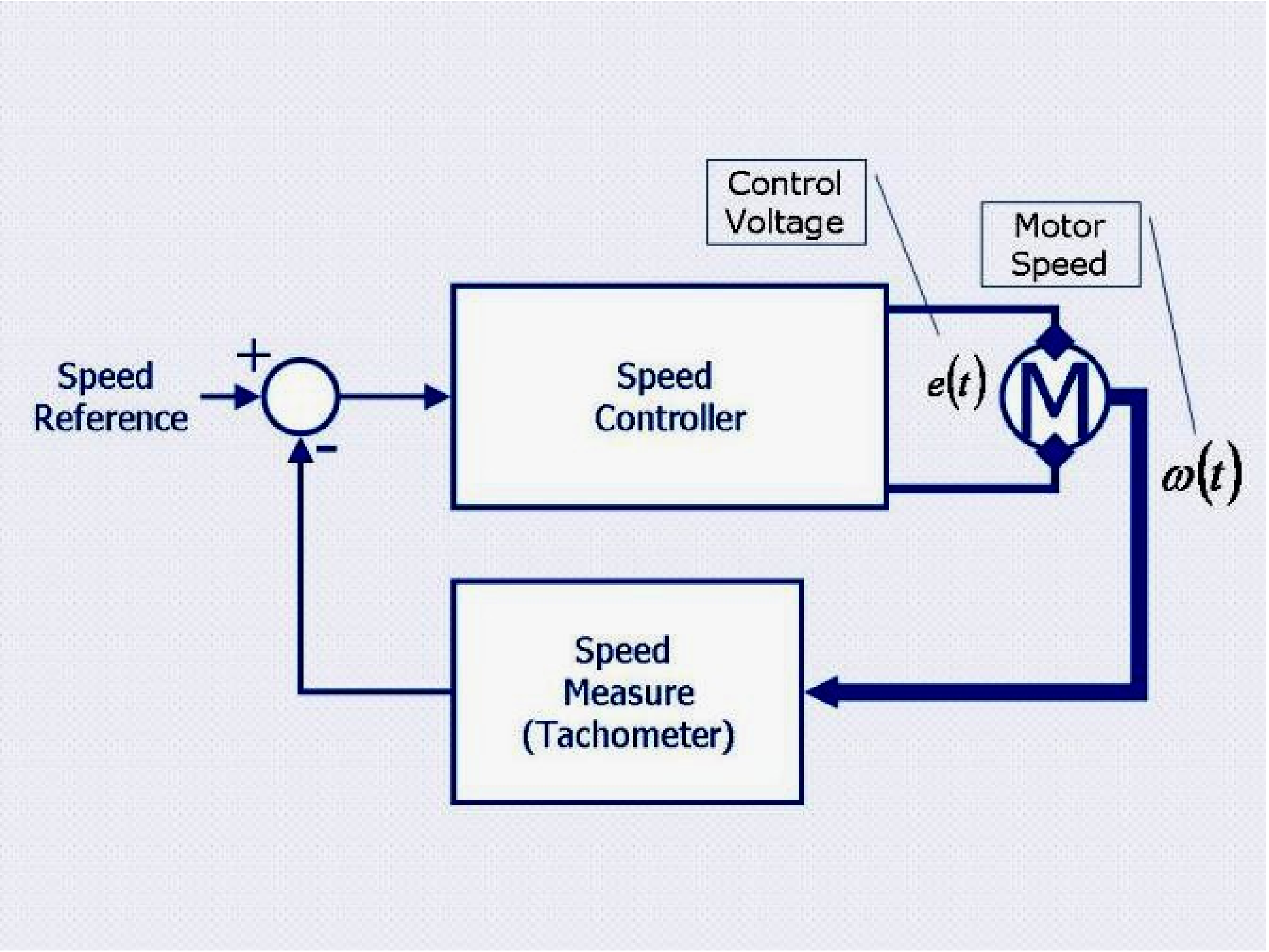
DC Tachometer

- This is a small dc generator. It contains a permanent magnet and an iron core rotor. No external supply voltage is required. The winding on rotor are connected to commutator segments and the output voltage is taken across pair of brushes that ride on the commutator segments. DC tachometers provide visual speed readout of a rotating shaft. Such tachometers are directly coupled to a voltmeter which is calibrated in r.p.m.

DC Tachometer



DC Tachometer as Error Detector



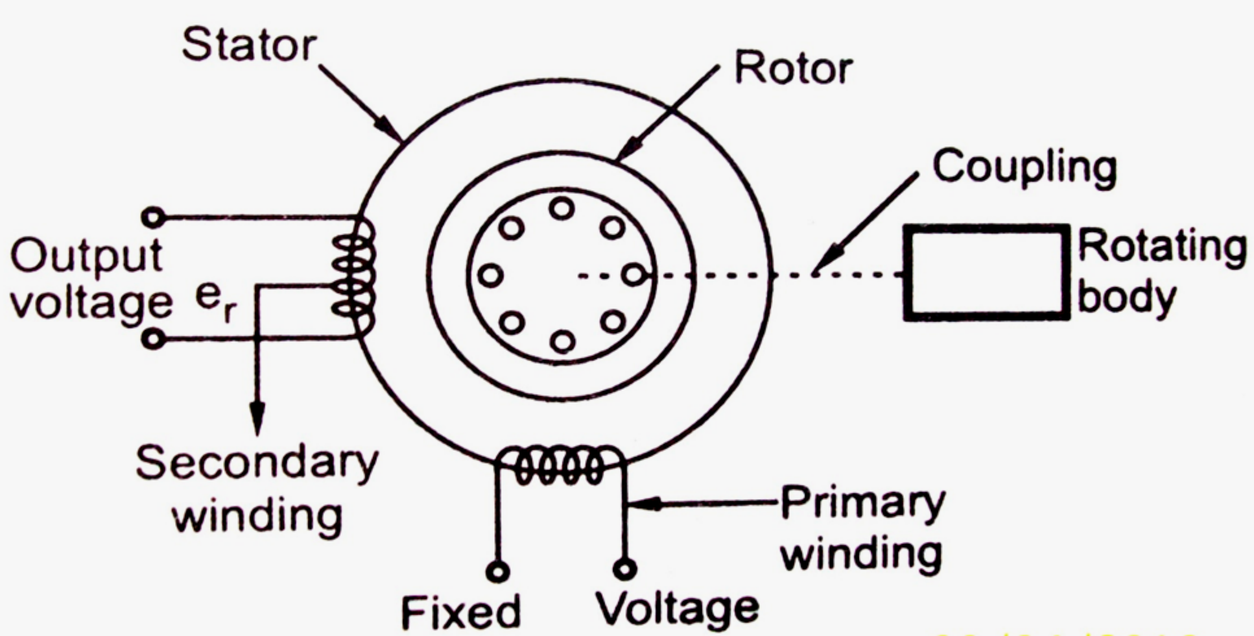
AC Tachometer

- The AC tachometer is a device, which is similar to a two phase induction motor, in which two stator windings are placed in quadrature with each other and rotor is short circuited. In AC Tachometer, a sinusoidal voltage of rated value is applied to the primary winding, which is known as reference winding, the secondary winding is placed 90 degrees apart from primary winding. The magnitude of sinusoidal output voltage is directly proportional to the speed of rotor.

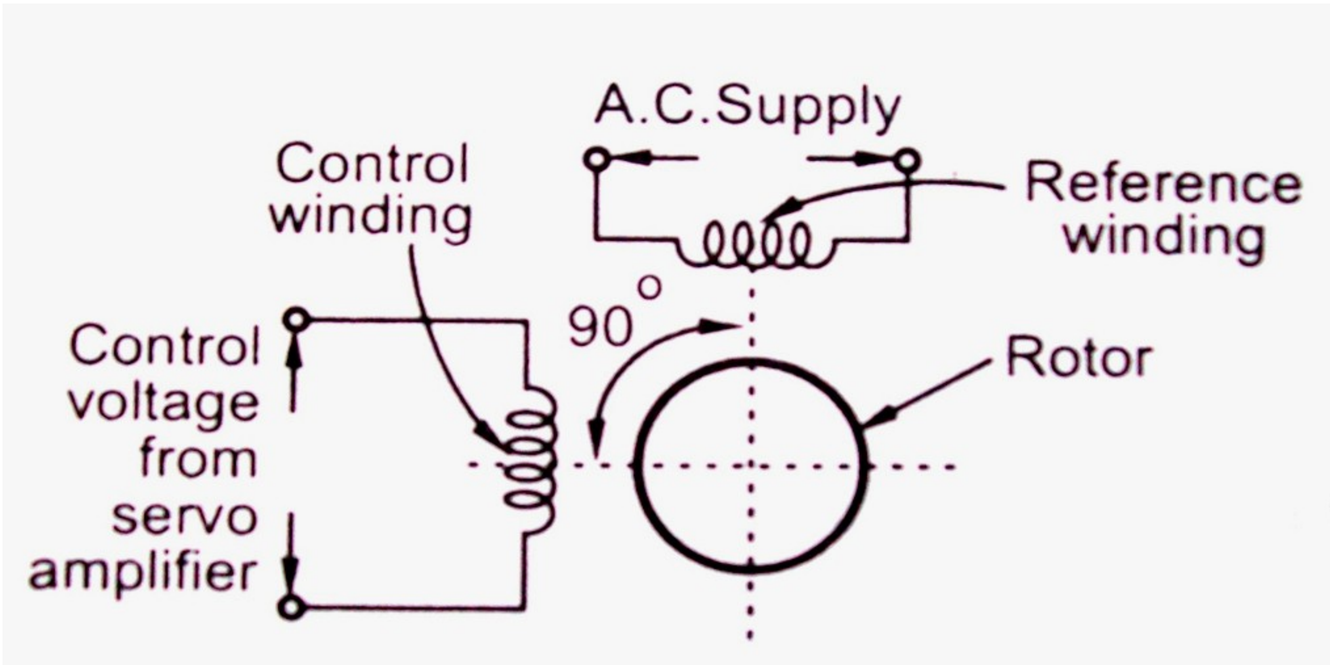
AC Tachometer

AC Tachometer

14.3.4 A.C. Tachometers



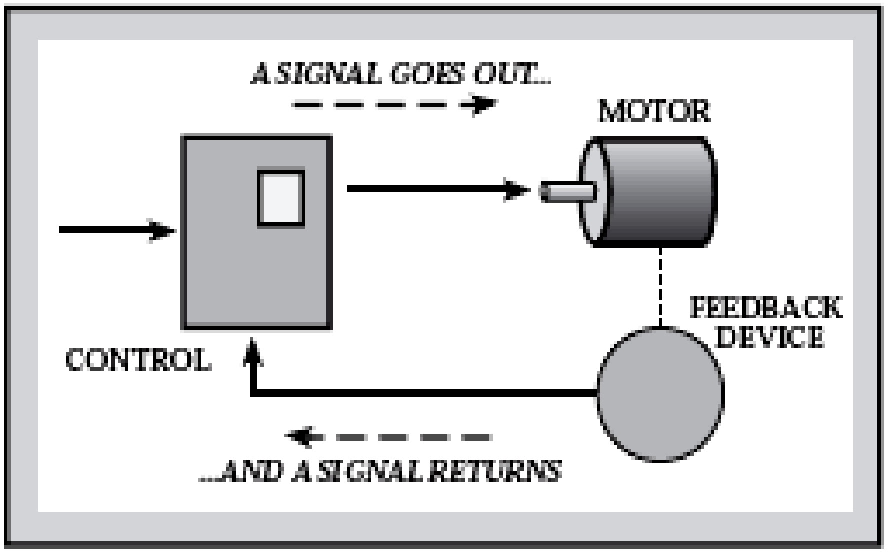
AC Tachometer



Servo System

- A closed-loop motion system using a current amplifier, servo controller, servomotor and a position feedback device such as an encoder to precisely control speed and position of a load.
- The MOTOR can be electric, hydraulic, pneumatic or even internal combustion.
- The FEEDBACK sensor can be mechanical or electronic, analog or digital and it can be rotary or linear

A Basic Servo System



The Feedback device can be Relative or Absolute.

- A servo controller with external input
- Motor connected to a feedback device
- Is a closed loop system
- How might this system work?

Servomotors

- The servo system is the one, in which the output is some mechanical variable such as position, velocity or acceleration. The motors used in the servo systems are called servomotors. These motors are usually coupled to the output shaft for power matching. There are two types of servo motors
  - AC Servomotors
  - DC Servomotors

DC Servo Motors

- DC servo motors are controlled by DC command signals applied directly to coils
- The magnetic fields that are formed interact with permanent magnets and cause the rotating member to turn
- One type of PM uses a wound armature and brushes like a conventional DC motor, but uses magnets as pole pieces
- Another type uses wound field coils and a permanent magnet rotor

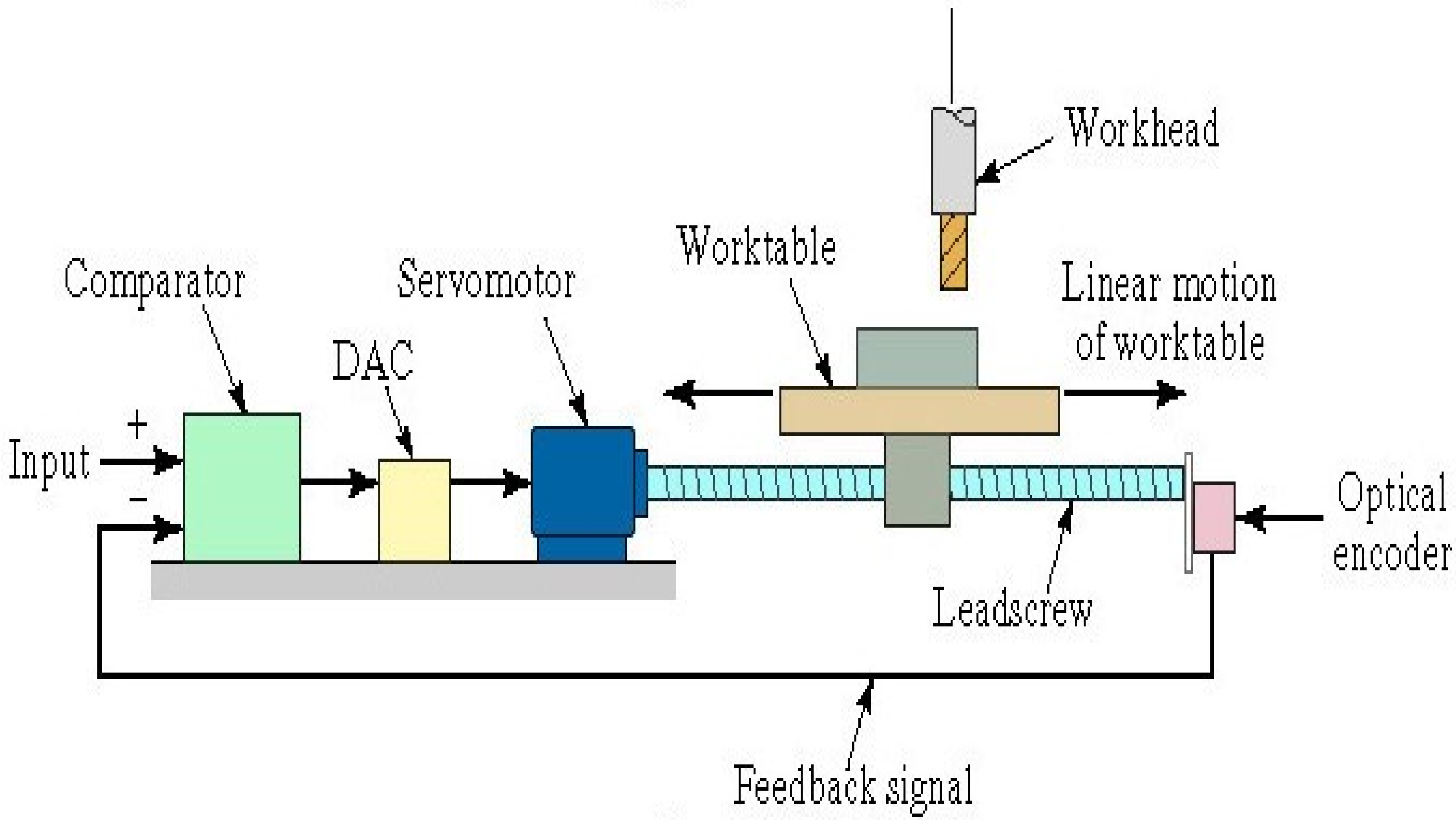
Wound Armature PM Motor

- Armature contains wound coils
- Current is supplied by brushes
- Pole pieces are made of permanent magnets
- Typically 2 or 4-pole structure
- Similar characteristics to a DC shunt motor

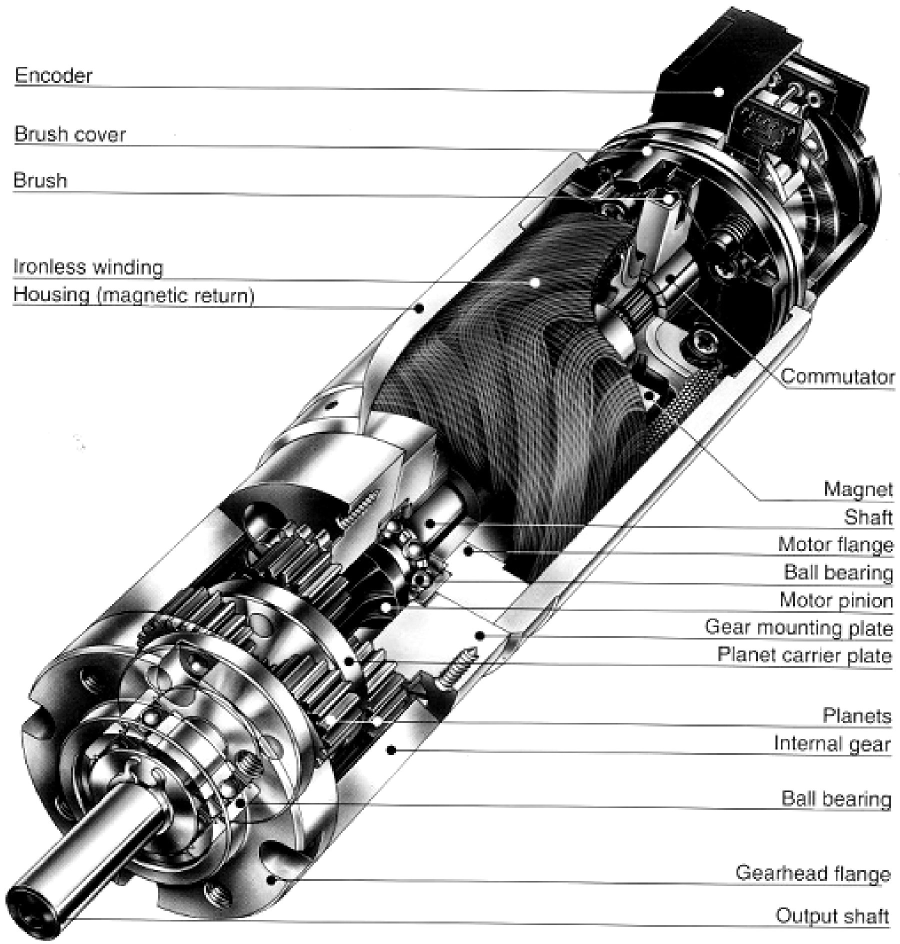
Moving Coil Motor

- The stator field is provided with 8 pairs of permanent magnets
- Arranged to provide alternating magnetic fields
- The armature is made of thin disc of fiberglass laminated with copper conductors

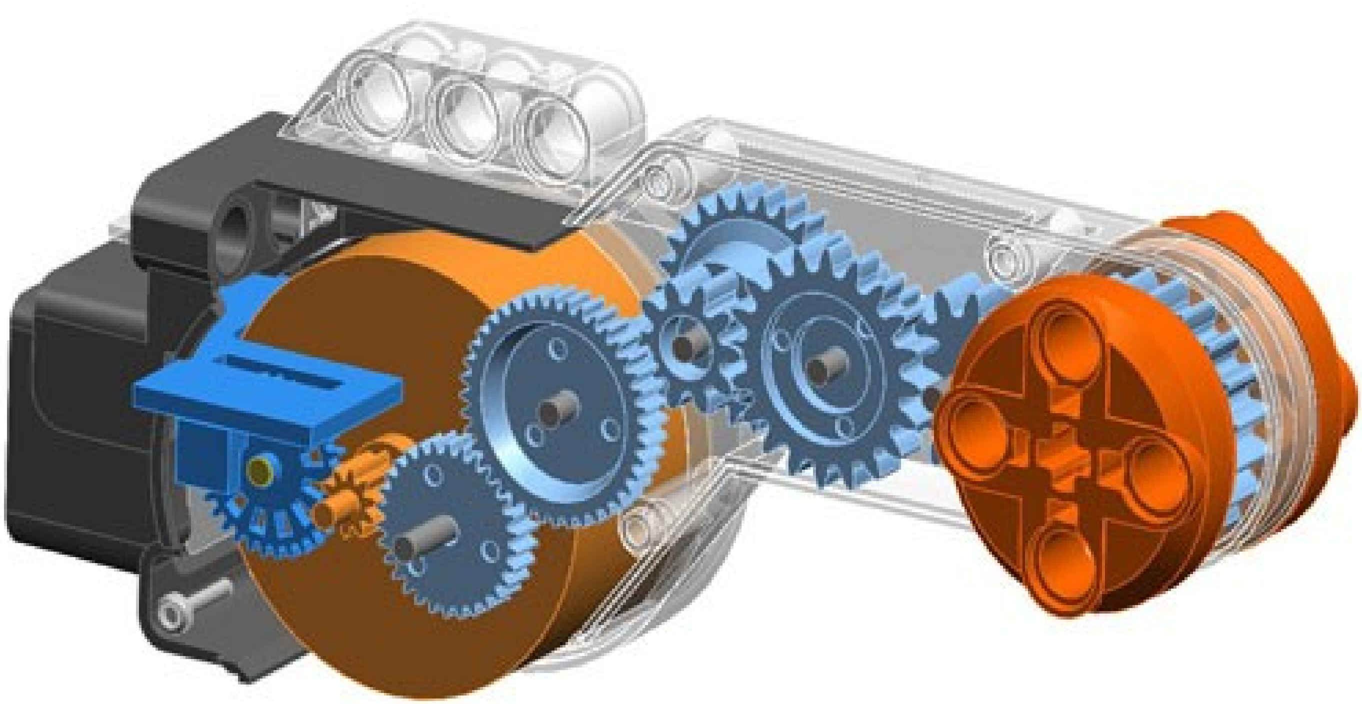
DC Servo Motors



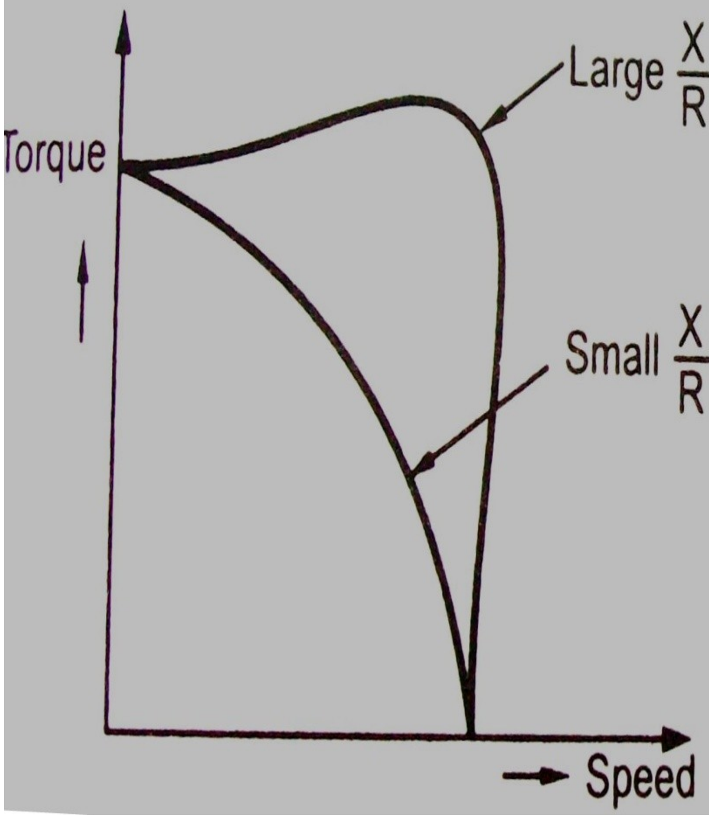
DC Servo Motors

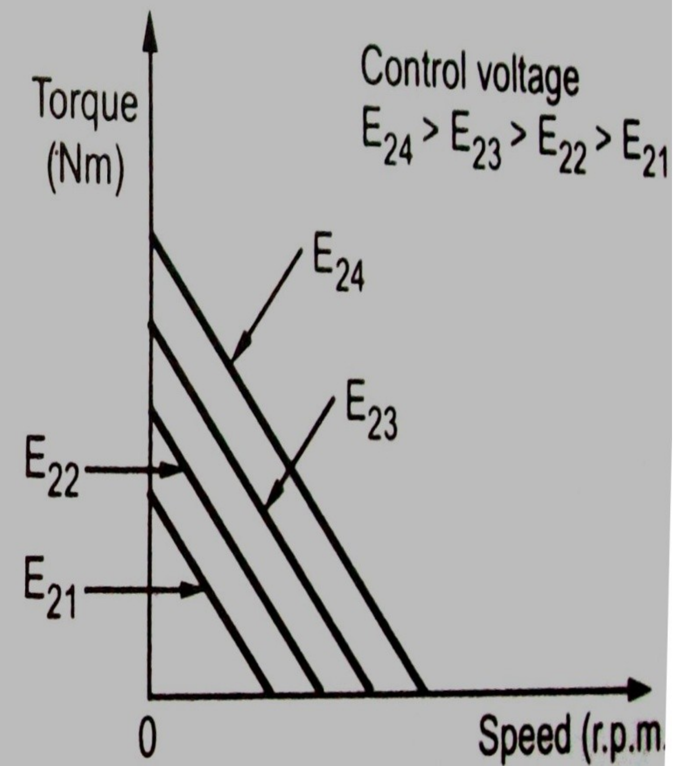


DC Servo Motors



Torque-Speed Curve of a DC Servomotor





AC Servo Motors

- Controlled by AC command signals applied to the coils
- AC Brushless Servo Motor
  - Operates on the same principle as single-phase induction motor

AC Brushless Servo Motor

Two windings

- Main winding
- Auxiliary winding

- Electronic drive provides the necessary phase shift for motor operation

Stepper Motors

- Conventional servo motors are classified as continuous rotation motors
- Stepper motors rotate through a specific number of degrees, or steps, then stop
- Each incoming pulse results in the shaft turning a specific angular distance
- Stepper motors can control velocity, distance, and direction of mechanical load

Permanent Magnet Stepper Motor

- PM stepper motors have rotor *teeth* made of permanent magnets
- Reaction of the rotor teeth to stator fields provides torque for the motor
- Signals are applied to the stator to determine direction and step rate of the rotor

Variable Reluctance Stepper Motor

- The variable reluctance stepper motor uses electromagnetic stator poles
- The soft iron core is un-magnetized
- The rotor is toothed, alternating N-S
  - The more teeth, the greater the resolution

Stepper Motor Terminology

- Stepping Rate - maximum number of steps the motor can make in one second
- Step Angle - number of degrees per arc the motor moves per step
  - Step angle is determined by the number of rotor teeth and stator poles used

Stepper Motor Speed

- Stepper motor speed depends upon the step angle and stepping rate

$$n = \frac{Y \text{ x } S}{6}$$

n = Speed in RPM

Y = Step angles in degrees

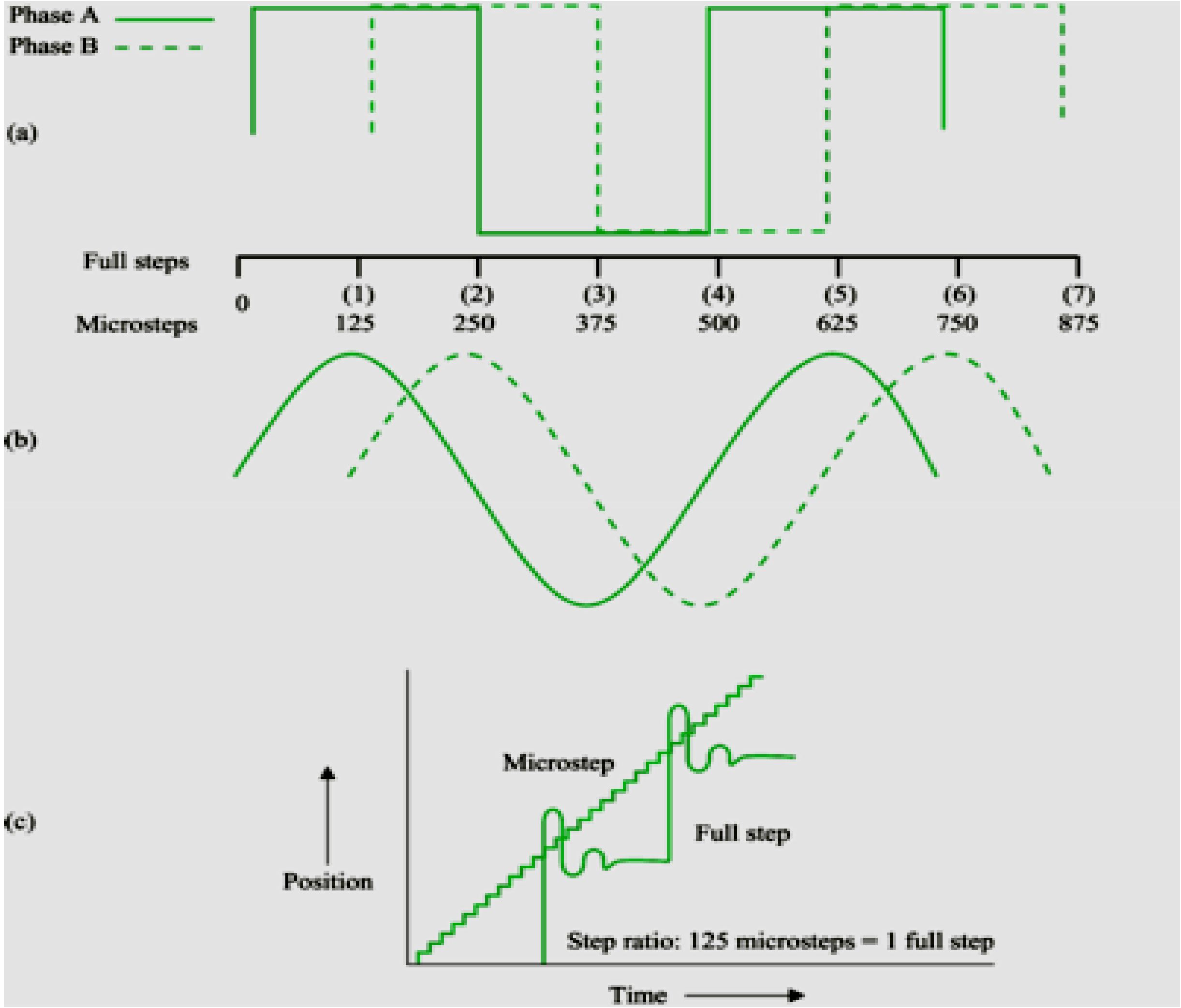
S = Steps per second

6 = Formula constant

Microstepping

- Stepper motors tend to jerk at low speeds
- Stepper motors have limited resolution
- Microstepping overcomes these problems
  - Uses simulated sine waves that increment or decrement in small steps called *microsteps*

Microstepper Operation



THANKS