SNS COLLEGE OF ENGINEERING

Kurumbapalayam (Po), Coimbatore – 641 107

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DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

COURSE NAME : 19EC309 ELECTRICAL MACHINES AND POWER SYSTEMS

II YEAR / 03 SEMESTER MECH & MCT

Unit 4 – SPECIAL MACHINES

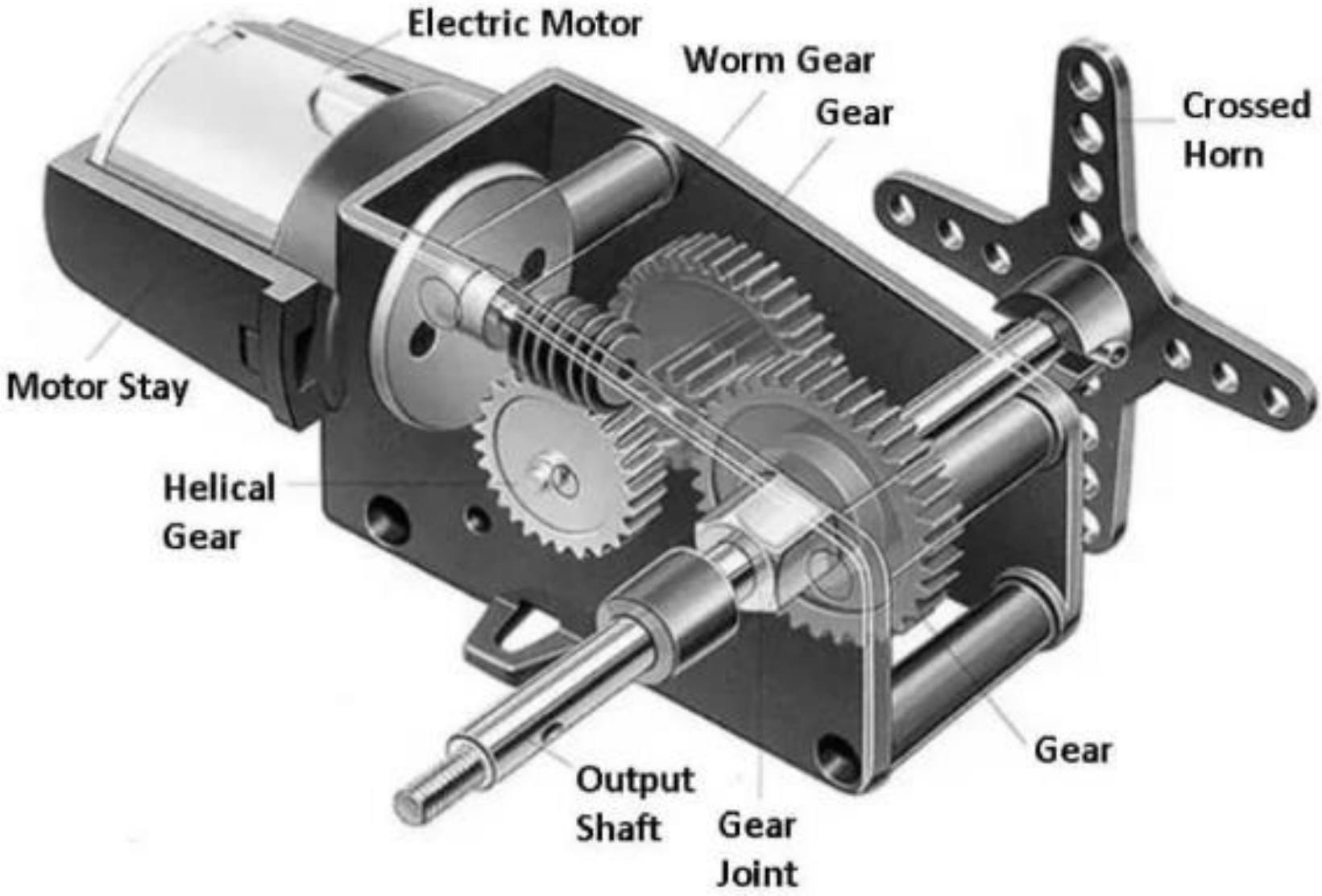
Servo Motors

Servo Motor

- It is defined as a linear or rotary type of actuator that provides fast precision position control for closed-loop position control applications.
- As compared to large industrial electric motors, servo motors are not useful for continuous energy conversion.
- These motors have a high-speed response due to how inertia and are designed with small diameters and long rotor lengths.
- Servo motors have a mechanism that uses position feedback to control the speed and final position of the motor.
- Internally, a servo motor combines a motor, feedback circuit, controller, and another electronic circuit.

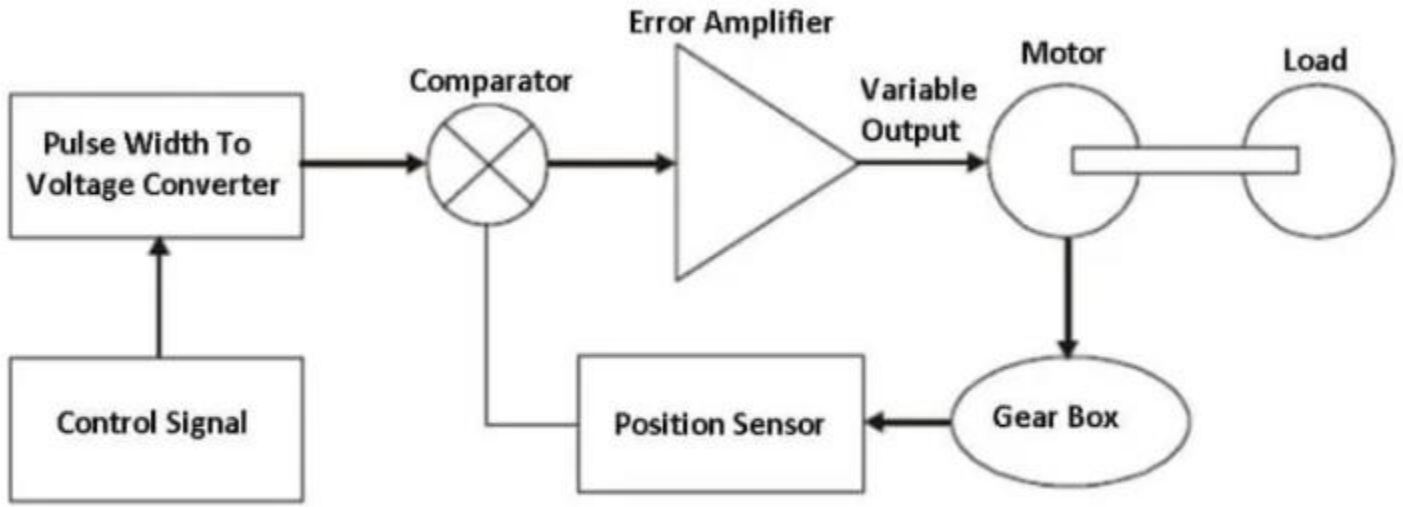
Construction of Servo Motor

- It uses an encoder or speed sensor to provide speed feedback and position.
- This feedback signal is compared with the input command position (desired position of the motor corresponding to a load) and produces the error signal (if there exists a difference between them).
- The error signal available at the output of the error detector is not enough to drive the motor.
- So the error detector followed by a servo amplifier raises the voltage and power level of the error signal and then turns the shaft of the motor to the desired position.
- Essentially, servo motors are divided into AC and DC servo motors based on the supply used for their operation.
- Brushed permanent magnet servo motors are used for simple applications due to their low cost, efficiency, and simplicity of working.


Electric Motor
Worm Gear
Gear
Crossed
Horn
Motor Stay
Helical
Gear
Gear
Output
Shaft
Gear
Joint

Servo Motor Working Principle

- **The servo motor works on the principle of the pulse width modulation method**.
- In this, the angle of rotation is controlled by the duration of the applied pulse to its control pin.
- Essentially, the servo motor is a type of DC motor controlled by a variable resistor (potentiometer) and some gears.



DC Servo Motor Working

- It consists of a DC motor, a position sensing device, a gear assembly, and a control circuit.
- The DC servo motor has a small DC motor is employed for driving the loads at a precise speed and position.
- Now, a DC reference voltage is set to the corresponding desired output.
- This voltage is applied using a potentiometer by controlling the pulse width to the voltage converter or via a timer depending on the control circuitry.
- The dial on the potentiometer generates a related voltage which is then applied to the error amplifier.
- In some circuits, a pulse control method is used to create a DC reference voltage corresponding to the desired position or speed of the motor.
- It is then applied to the voltage converter by the pulse width.

- Through this converter, the capacitor begins to charge at a constant rate when the pulse is high.
- Then the charge on the capacitor is fed to the buffer amplifier when the pulse is low and this charge is further applied to the error amplifier.
- So the length of the pulse decides the voltage applied at the error amplifier as the desired voltage to produce the desired speed or position.
- The feedback signal corresponding to the present position of the load is obtained by using a position sensor.
- This sensor is normally a potentiometer that produces the voltage corresponding to the absolute angle of the motor shaft through the gear mechanism.

Types of Servo Motor

- DC servo motor
- AC servo motor
- Positive rotation
- Continuous rotation
- Linear servo motor

DC Servo Motor

- This type uses separate DC sources in the field of winding & armature winding.
- A DC servo motor consists of some components which are a small DC motor, feedback potentiometer, gearbox, motor drive circuit, and feedback control loop.
- It is quite similar to the normal DC motor.
- Motor control by controlling armature current or field current.
- These provide a very precise and fast response to the start or stop command signal due to low armature inductive reactance.
- These motors are used in computerized numerically controlled machines.

AC Servo Motor

- AC motors include encoders that are used with controllers to provide feedback and closed-loop control.
- This motor can feature high accuracy and has a high design of tolerances.
- Some designs also use higher voltages to obtain more torque.
- They are used in automation, robotics, CNC machinery, and other applications for the high degree of accuracy and versatility required.

Advantages of Servo Motor

- They have the ability to produce high output power relative to motor size and weight.
- It has high efficiency and can reach 90% at light loads.
- The motor provides high torque to inertia ratio and can accelerate loads rapidly.
- It can provide quiet operation, run smoothly, and provide high accuracy.
- The position of servo motors can be controlled more precisely as compared to other DC motors.

Disadvantages of Servo Motor

- The drawback of the servo motor is that it demands tuning to stabilize the feedback loop.
- If something breaks, the motor will be unreliable. Therefore, a protection circuit is required.
- The overall system cost and installation cost are higher than that of a stepper motor due to the need for feedback components.
- It would require a complex controller to provide the encoder and electronic support.

Applications of Servo Motor

- It is used in robotics to activate movements, giving the arm its precise angle.
- These are used to start, move, and stop-conveyor belts carrying the product along with many stages. For instance, product labeling, bottling, and packaging.
- The servo motor is built into the camera to correct the lens of the camera to improve out-of-focus images.
- This motor is used in a robotic vehicle to control the robot wheels, Producing plenty of torque to move, start and stop the vehicle and control its speed.
- These are also used in the solar tracking system to correct the angle of the panel so that each solar panel stays to face the sun. In addition, These are also used in metal forming and cutting machines to deliver specific motion control for milling machines.
- Servo motor is used in Textiles to control spinning and weaving machines, knitting machines, and looms.
- The servo motor is used in automatic door openers to control the door in public places like supermarkets, hospitals, and theatres.
- In Automobiles, servomechanism is used in power steering, braking system, and cruise (speed) control.