

SNS COLLEGE OF TECHNOLOGY

(An Autonomous Institution)



COIMBATORE-35

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Approved by AICTE, New Delhi & Affiliated to Anna University, Chennai**

**DEPARTMENT OF ELECTRICAL AND ELECTRONICS
ENGINEERING**

COURSE NAME: 19EEB210 / Electrical Machines and Drives

II YEAR / IV SEMESTER

Unit II – ELECTRICAL MOTORS

Topic : Servomotor



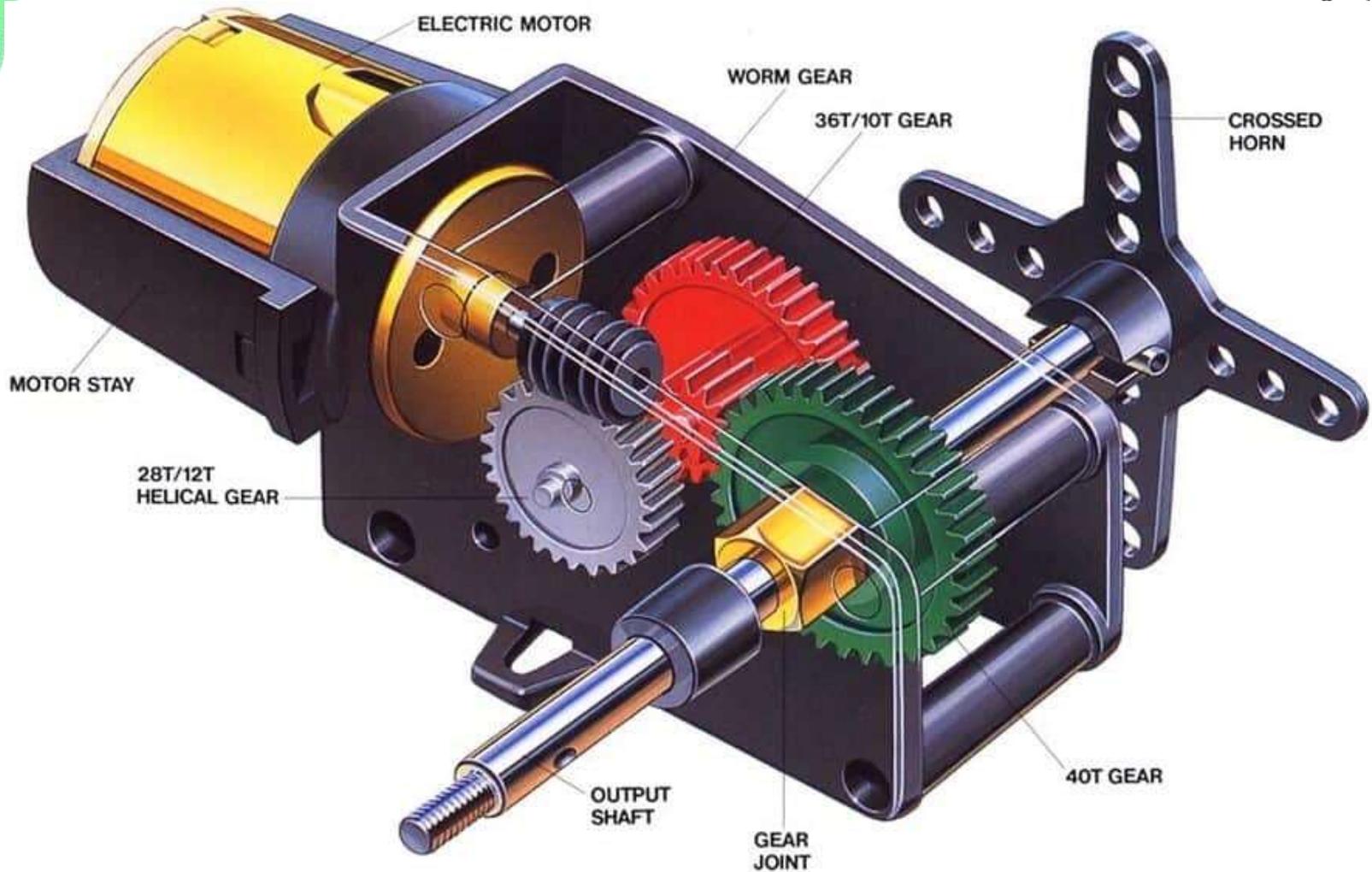
SERVO MOTOR

- A servomotor is a rotary or linear actuator that allows for precise control of angular or linear position, velocity, and acceleration in a mechanical system.
- Mainly consists of:
 - motor,
 - position sensor,
 - Feedback system,
 - gear train, and
 - a control circuit.
- The gear mechanism connected with the motor provides the feedback to the position sensor.
- Servo motors being manufactured by many companies some of them are FUTABA, HITECH, AIRTRONICS, and JR RADIOS.





SERVO MOTOR



Construction of Servo Motor

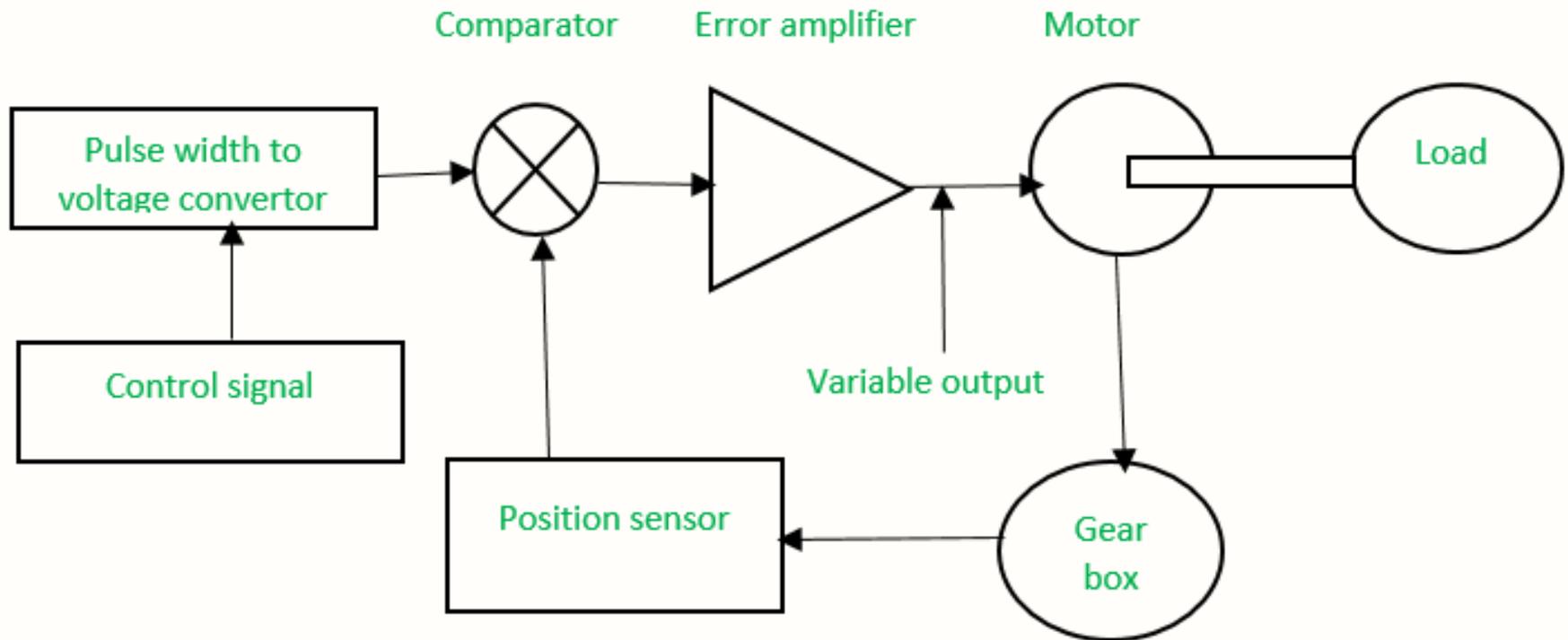


CONSTRUCTION

- **Stator Winding:** This type of winding wound on the stationary part of the motor. It is also known as field winding of the motor.
- **Rotor Winding:** This type of winding wound on the rotating part of the motor. It is also known as an armature winding of the motor.
- **Bearing:** These are of two types, i.e, front bearing and back bearing which are used for the movement of the shaft.
- **Shaft:** The armature winding is coupled on the iron rod is known as the shaft of the motor.
- **Encoder:** It has the approximate sensor which determines the rotational speed of motor and revolution per minute of the motor.



WORKING OF SERVO MOTOR



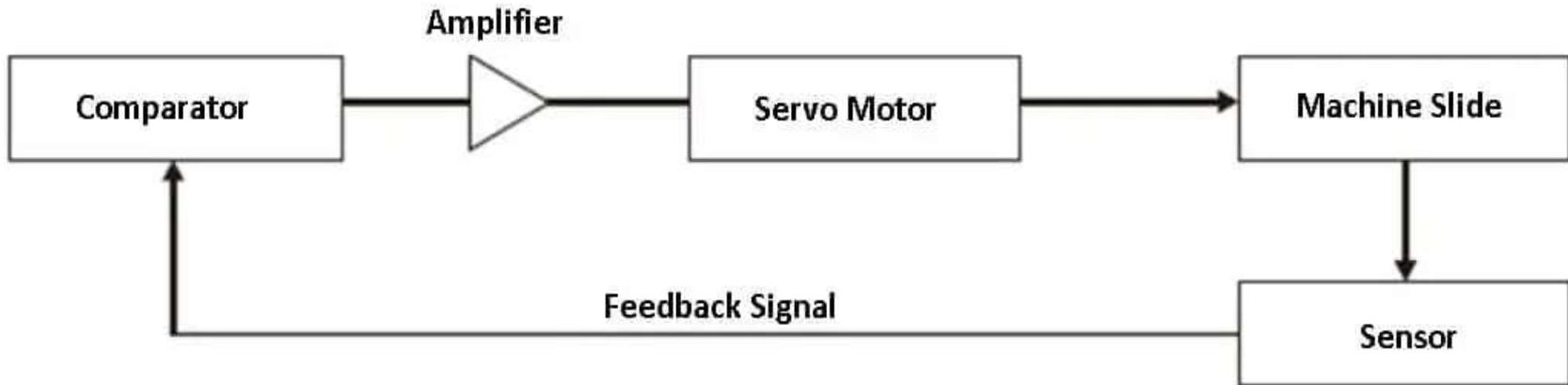


WORKING

- The **position sensor** provide a feedback signal corresponding to the present position of the load.
- This sensor is normally a potentiometer that produces the voltage corresponding to the absolute angle of the motor shaft through gear mechanism.
- Then the **feedback voltage** value applies on the input of error amplifier.
- The **error amplifier** is a negative feedback amplifier and it compares the voltage related to current position of the motor with desired voltage related to desired position of the motor. And it produces the error either a positive or negative voltage.
- This error voltage applied to the armature of the motor. If the error is more then motor armature gets more output.
- The **amplifier** amplifies the error voltage and powers the armature.



SERVO MOTOR MECHANISM



Servo Motor Mechanism

Basic Three Parts are

1. Controlling Device
2. Output Sensor
3. Feedback system



SERVO MOTOR MECHANISM

- The servo motor works on the phenomenon of the automatic closed-loop system.
- The controller is required for this closed-loop system. This controller is composed of a comparator and a feedback path. It has one output and two inputs.
- In this, for producing an output signal, the comparator is used to compare the required reference signal and this output signal is sensed by the sensor.
- The input signal for the motor is termed as a feedback signal. On the basis of the feedback signal, the motor starts working.
- Comparator signal is called a logic signal of the motor. The motor would be ON for the desired time when the logical difference is higher and the motor would be OFF for the desired time when the logical difference is lower.
- Basically, a comparator is used to decide that motor would be ON or OFF. Proper functioning of the motor can be done with the help of a good controller.



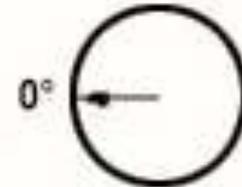
CONTROLLING OF SERVO MOTOR

- The servo motors can be controlled by the method **PWM i.e., Pulse Width Modulation**.
- The width pulse is varied in the range of 1 millisecond to 2 milliseconds and transfer this to the servo motors with repeating 50 times in a second.
- The width of the pulse controls the angular position of the rotating shaft. In this, three terms are used which shows the controlling of the servomotor i.e., a maximum pulse, minimum pulse and repetition rate.
- For example, The servo moves with the pulse of 1 millisecond to turn motor towards 0° whereas a pulse of 2 milliseconds to turn motor towards 180° Between the angular positions, the pulse width interchange by itself. Therefore, the servo turns to the 90° with the pulse of width 1.5 milliseconds.

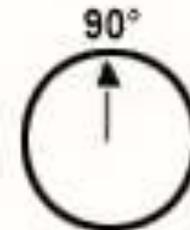
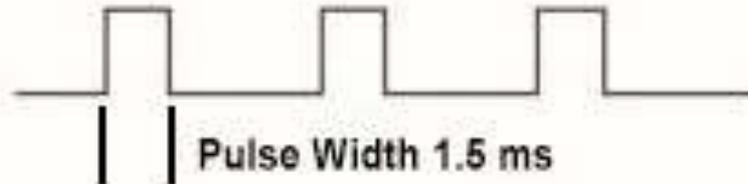


CONTROLLING OF SERVO MOTOR

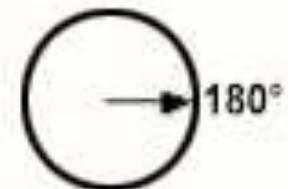
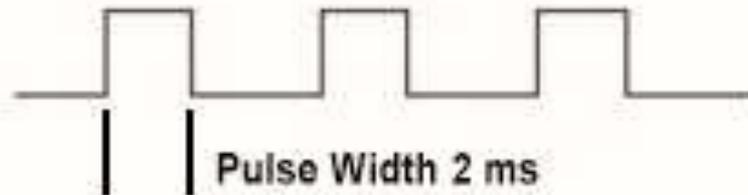
Min Pulse



Neutral



Max Pulse





TYPES OF 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. 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. They are used in automation, robotics, CNC machinery, and other applications for the high degree of accuracy and versatility required.
- **Positive rotation** - In this motor, the output shaft of the motor rotates 180 degrees. The motor mainly consists of physical stops which are in the gear mechanism to prevent the rotation sensor from rotating. These are commonly seen in radio-controlled water, radio-controlled cars, planes, robots, toys, etc.



TYPES OF SERVO MOTOR

- **Continuous rotation** - These are standard servo motors that have been modified to provide open-loop speed control instead of their usual closed-loop position control. The control signal is interpreted as the speed and direction of rotation, rather than determining the position of the servo. Servo to rotate clockwise or counterclockwise in the range of possible command sources at varying speeds. The application is found in a drive motor on a mobile robot.
- **Linear servo motor** - Linear servo motors fall into a class of positional rotation servo motors, but with an additional set of gears to convert the O/P back and forth from circular. These servo motors are rarely found but are sometimes they are used as actuators in higher model airplanes.





CHARACTERISTICS OF SERVO MOTOR

- **High Precision:** Servo motors provide precise control over position, speed, and torque. This precision is achieved through the use of feedback devices such as encoders, which continuously monitor the motor's actual position and provide feedback to the controller.
- **Fast Response Time:** Servo motors have an impressive response time, allowing them to quickly adjust their speed and position based on changing input signals.
- **High Torque:** Another characteristic of servo motors is their ability to deliver high torque even at low speeds. The high torque output of servo motors ensures that they can handle heavy loads and perform tasks with precision.
- **Closed-Loop Control:** Servo motors operate in a closed-loop control system which means that they continuously receive feedback about their actual position and adjust their performance accordingly.
- **Wide Speed Range:** Servo motors offer a wide speed range, allowing them to operate at both high and low speeds without compromising performance.
- **Low Inertia:** Low rotor inertia enables quick acceleration and deceleration, contributing to the motor's dynamic performance.



APPLICATIONS

- They are used to control the positioning and movement of elevators in radio controlled airplanes
- They play an important role in robotics information of robot because of their smooth switching on or off and accurate positioning.
- They are used in hydraulic systems to maintain hydraulic fluid in the aerospace industry.
- In radio controlled toys these are also used.
- They are used to extend or replay the disc trays in electronic devices such as DVDs or Blue-ray Disc players.
- They are used to maintain the speed of vehicles in the automobile industries.



ADVANTAGE & DISADVANTAGE

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.



VIDEOS



Working—<https://www.youtube.com/watch?v=hg3TIFlxWCo>