DEPARTMENT OF

ELECTRICAL ENGINEERING

MEHRAN UNIVERSITY OF ENGINEERING & TECHNOLOGY, JAMSHORO

Advanced Machines & Drives Manual

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MEHRAN UNIVERSITY OF ENGINEERING & TECHNOLOGY, JAMSHORO

Name: _____. Roll No: _____

Score: _____ Signature of Lab Tutor: _____ Date: _____

Lab Experiment # 01

OBJECT: INTRODUCTION TO SCAN DRIVE SYSTEM

PERFORMANCE OBJECTIVE:

To understand the operation of Scan Drive System

Upon successful completion of this experiment, the student will be able to:

- To operate AC Motor from DC generator.
- To operate DC Motor from AC generator.
- To measure the efficiency, Torque and speed of motor.

EQUIPMENTS:

Scan Drive System.

220V AC supply.

Connecting leads.

DISCUSSION:

The TERCO Scan Drive System is a learning system including both hardware and courseware, integrated to cover complete education in electrical machines and motor drives, thus opening a new path where teaching could reach the necessary goals to move industry ahead.

The Scan Drive System is designed and adapted for compatibility and flexibility in pedagogical work for technical and vocational education as well as for engineering courses.

It is designed for active participation by the student who can work independently, which creates a high degree of student motivation.

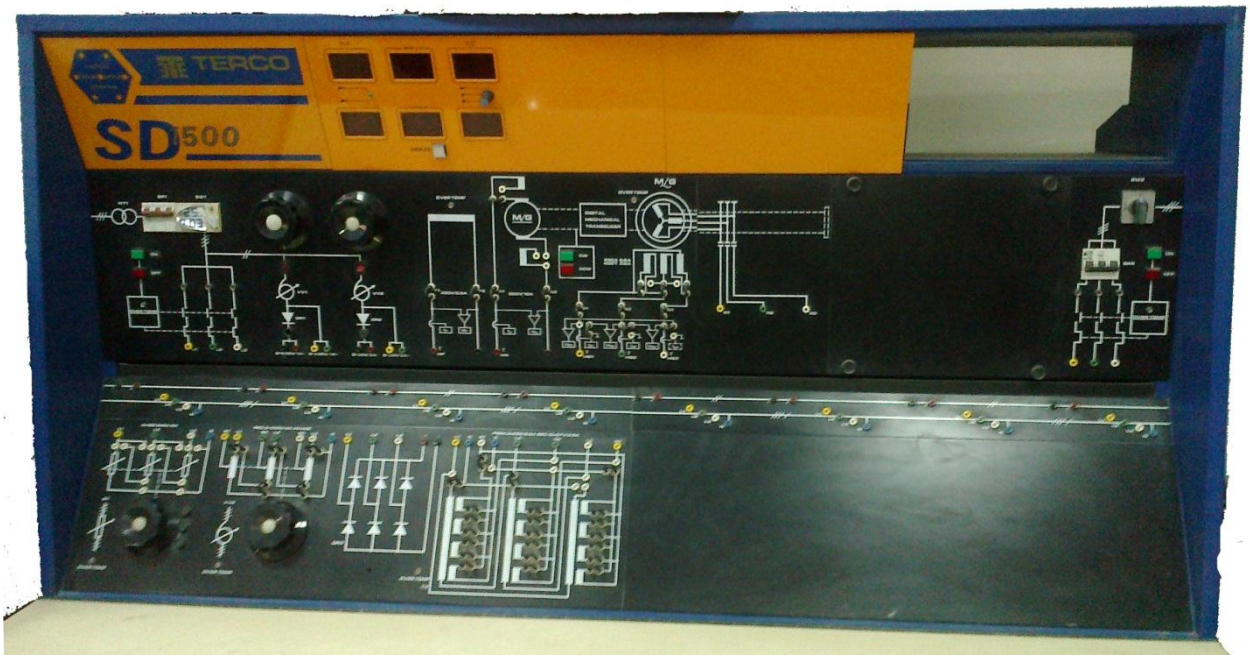

Fig: TURCO SD1500 Scan Drive System

Measuring system:

The SCAN DRIVE measuring system is developed to cover all needs for measurement and studies of electrical machine drives, electric power and power electronics.

Fig: Measuring System

Power Module:

Power module including ON/OFF switch, Circuit breaker, MMC connected through ON and OFF buttons and 3-phase power supply.

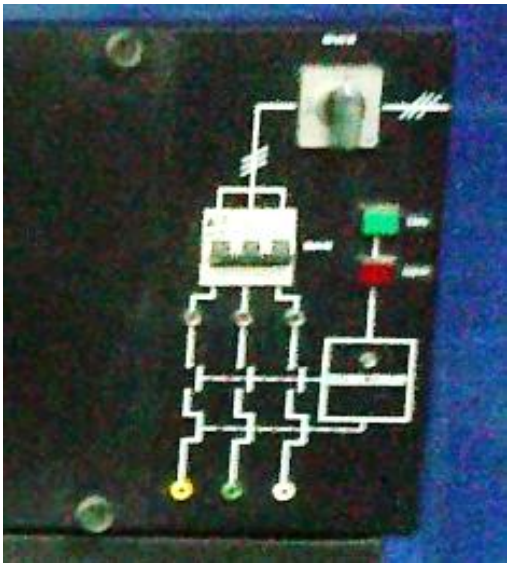

Fig: Power Module

Control Unit

Control unit contains MCB, switch, over temperature sensor, two VARIACs and ON/OFF switches. Each has two outputs, one is AC connected in parallel with rectifier and another is rectified DC output.

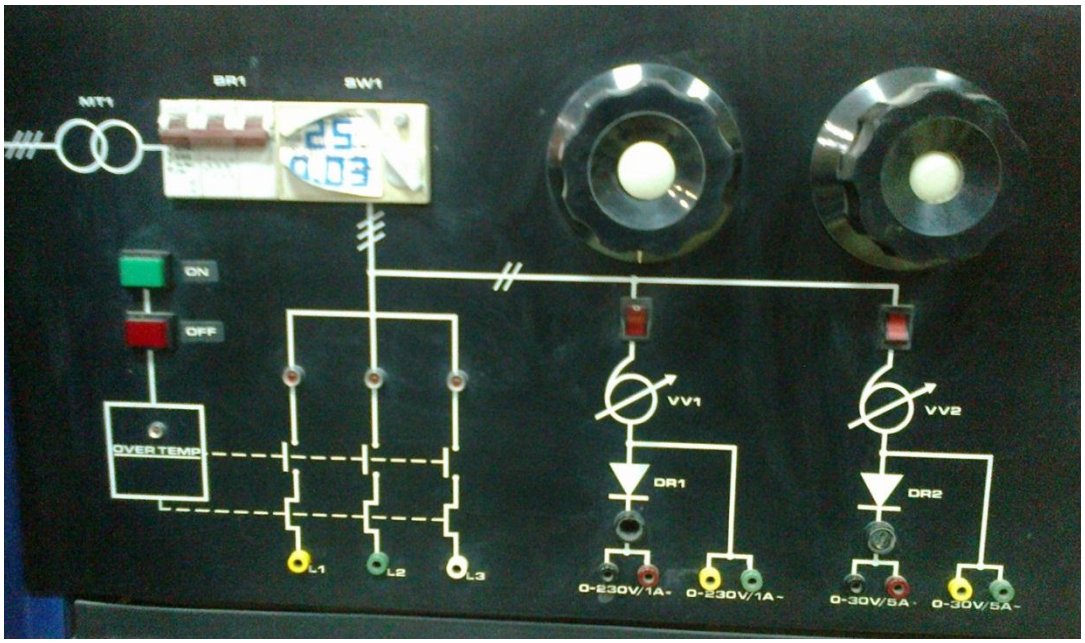

Fig: Control Unit

Motor and Generator Control Unit:

It contains single phase Motor/Generator coupled through Digital Mechanical Transducer with three phase Motor Generator, if it is energized with single phase AC then it give DC output and when it is driven with DC current then we get three phase AC output. The direction of motor can be changed by switches indicated by CW and CCW.

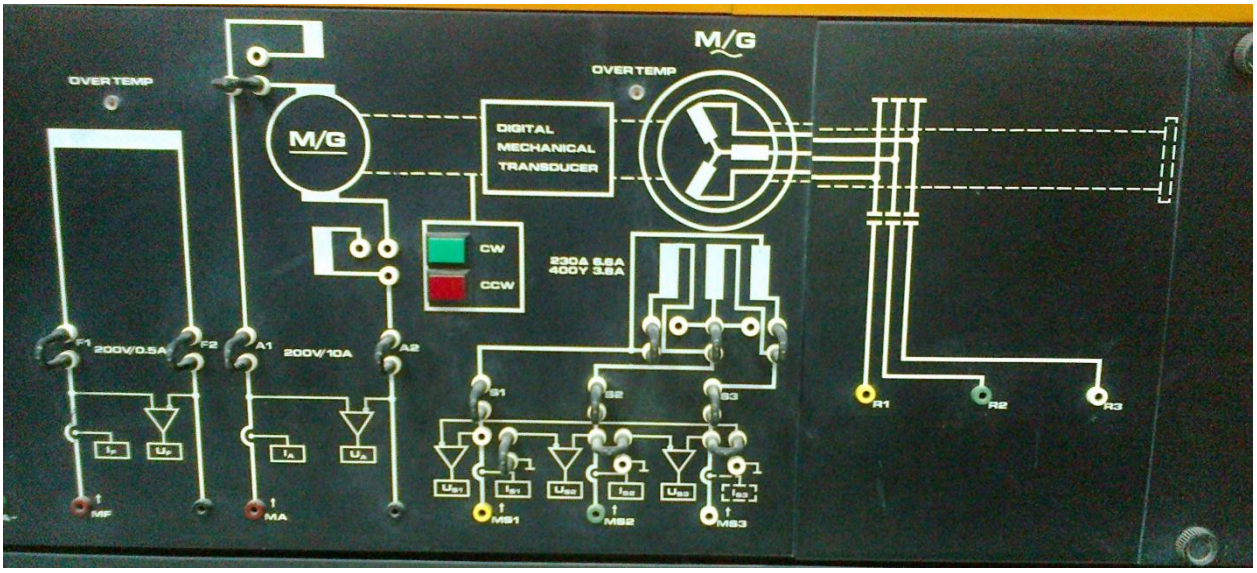

Fig: Motor and Generator Control Unit

Connection Module

Connection module contains Variable Capacitors, VARIAC and rectified DC outputs, each having three outputs.

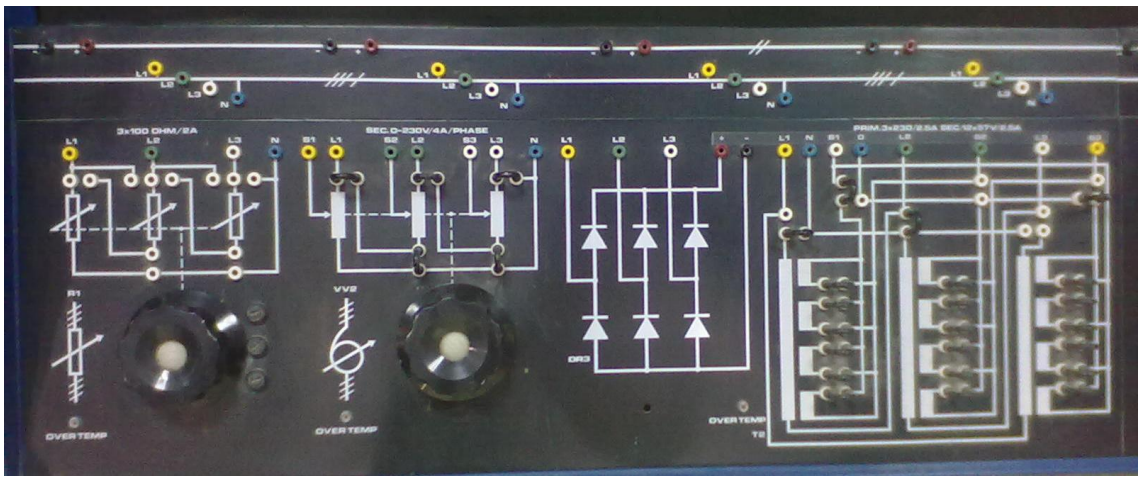
Fig: Connection Module

Motor and Alternator of Scan Drive System:

This portion of Scan drive system contains a Motor which can be driven on DC as well as on AC, and an Alternator which work as prime mover to drive the motor.

Fig: Motor and Alternator of Scan Drive System

Review Question:

1) What kind of experiments we can perform on scan drive system?

Ans:

_____

_____

_____

_____.

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Lab Experiment # 02

OBJECT: NO LOAD TEST OF SINGLE PHASE INDUCTION MOTOR.

PERFORMANCE OBJECTIVES:

Upon successful completion of this experiment, the student will be able to determine:

- Determine no-load current I_0.
- No-load power factor $\cos\emptyset_0$.
- Windage and friction losses, no-load core loss, no-load input and no-load resistance R_0 and reactance X_0.

EQUIPMENT:

- VRIAC (Variable AC or Auto transformer)
- 220V AC Supply
- Single split phase induction motor.
- Wattmeter
- Voltmeter
- Ammeter
- Connecting wires.

DISCUSSION:

The slip of the induction motor at no-load is very low. Thus, the value of the equivalent resistance in the rotor branch of the equivalent circuit is very high. The no-load rotor current is then negligible and the rotor branch of the equivalent circuit can be neglected. The approximate equivalent circuit and phasor diagram for no-load test are shown in fig.1 and fig.1(a) respectively.

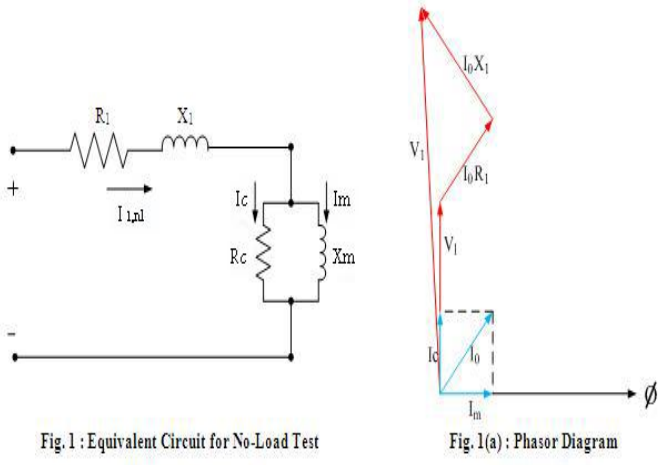

Fig. 1 : Equivalent Circuit for No-Load Test

Fig. 1(a) : Phasor Diagram

Fig: Induction machine equivalent circuit for no-load test

Note that the series resistance in the no-load test equivalent circuit is not simply the stator winding resistance. The no-load rotational losses (windage, friction, and core losses) will also be seen in the no-load measurement. This is why the additional measurement of the DC resistance of the stator windings is required. Given that the rotor current is negligible under no-load conditions, the rotor copper losses are also negligible. Thus, the input power measured in the no-load test is equal to the stator copper losses plus the rotational losses.

PROCEDURE:

Balanced voltages are applied to the stator terminals at the rated frequency with the rotor uncoupled from any mechanical load. Current, voltage and power are measured at the motor input. The losses in the no-load test are those due to core losses, winding losses, windage, and friction losses.

TABLE:

Sr. No.	Voltage (Volts)	Current (Amps)	Power (Watts)
1.			
2.			
3.			
4.			
5.			

PRECAUTIONS:

- Before energizing the circuit, check the connections.
- Confirm the connections of voltmeter (in parallel) and ammeter (in series).
- Wear safety gloves for proper insulation.
- Don't use any equipment without guidance of your Lab Tutor.

REVIEW QUESTIONS :

1) Why open circuit test is also called no load test?

_____

_____

_____

2) Why open circuit test is carried out?

_____

_____

_____

3) Why ammeter is connected in series?

_____

_____

_____

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Lab Experiment # 03

OBJECT: SHORT CIRCUIT OR LOCKED ROTOR TEST OF SINGLE PHASE INDUCTION MOTOR.

PERFORMANCE OBJECTIVES:

Upon successful completion of this experiment, the student will be able to:

- Understand purpose of the experiment
- Understand use of VARIAC
- Connections of different equipment

EQUIPMENT:

Equipments required to perform the Locked Rotor Test are:

1. Single Phase Induction Motor
2. VARIAC
3. Wattmeter
4. Voltmeter
5. Ammeter
6. Connecting Leads

DISCUSSION:

The Short Circuit Test also called the Locked Rotor Test is used to calculate the copper losses of the Single Phase Induction Motor. As name indicates, in this test the rotor of the motor is locked i.e. it's at standstill conditions. At standstill, full load current flows in the motor and full load copper losses (I^2R) can be determined.

PROCEDURE:

1. Set the VARIAC to zero conditions i.e Knob of VARIAC must be set to OV.
2. Take the output from VARIAC through connecting leads and connect it with Ammeter in series.
3. The output from Ammeter is to be connected to motor terminal.
4. Connect Voltmeter in parallel to measure the voltage.
5. Connect wattmeter t measure Copper losses.
6. Increase the voltage gradually and observe the readings of ammeter, voltmeter and wattmeter.

Circuit Diagram:

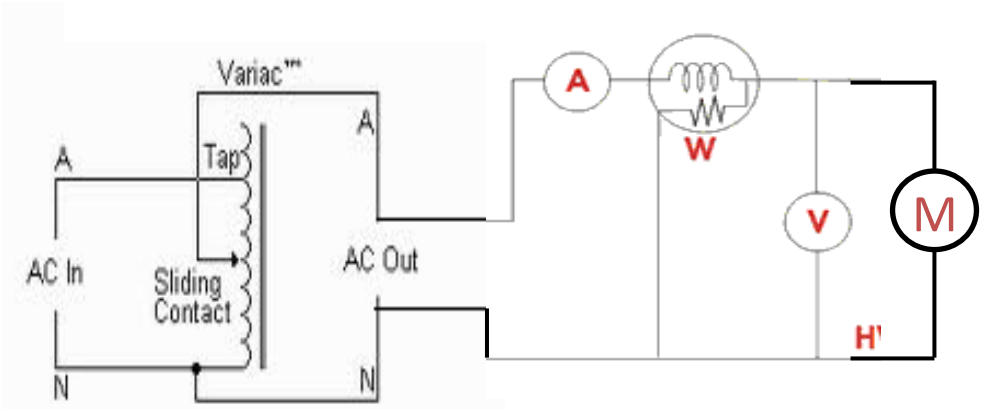

Fig: Equivalent Circuit of Single Phase Induction Motor

TABLE:

S.NO	VOLTAGE (V)	CURRENT	POWER (W)
1			
2			
3			
4			

PRECAUTIONS:

1. Make sure that VARIAC is set at zero Values
2. The supply voltage should not increase the rated value as it can destroy motor insulation because heavy current flows at standstill conditions.
3. Work with Right hand only. Avoid using both hands.
4. After completion of experiment the VARIAC must be first set to zero and then disconnect the connections.

REVIEW QUESTIONS:

1. Why short circuit test is also called locked rotor test?

_____

_____

_____.

2. What short circuit test is carried out?

_____

_____

_____.

3. Why ammeter is connected in series?

_____

_____

_____.

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Lab Experiment #04

OBJECT: REVERSAL OF SPLIT PHASE INDUCTION MOTOR.

PERFORMANCE OBJECTIVE:

To observe the reversal of split phase Induction motor

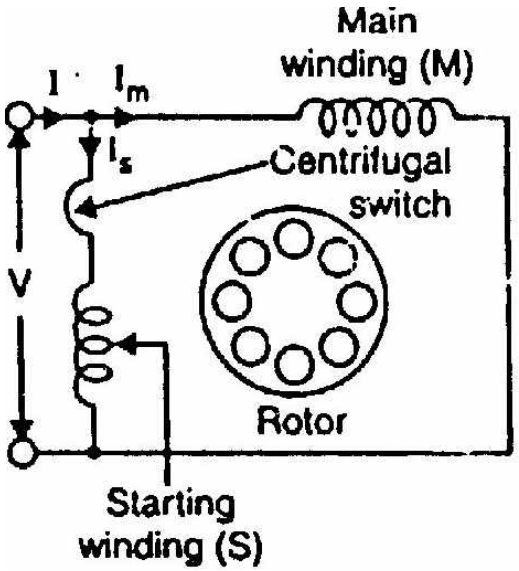
Upon successful completion of this experiment, the student will be able to:

- To identify the main winding & auxiliary winding through terminals
- To recognize the difference between main winding & auxiliary winding
- To reverse the direction of split phase induction motor

EQUIPMENT:

- 220-V single phase ac supply
- Distribution board
- Connecting leads
- VARIAC for 15V AC supply
- Split phase induction motor

DISCUSSION:



In split-phase AC motors, the start winding is used only for starting the motor and has a high resistance and low inductive reactance.

The run winding has low resistance and high reactance. When power is first applied, both windings are energized. Because of their different inductive reactances, the run winding current lags the start winding current, creating a phase difference between the two. Ideally, the phase difference should be 90 degrees; but in practical motors, it is much less. When the motor gets up to operating speed, the rotor is able to follow the alternations of the magnetic field created by the run winding without the field of the start winding. The start winding is then switched out of the circuit by a mechanical device called a centrifugal switch, because it is operated by the centrifugal force created by the rotor revolutions.

The direction of a split-phase rotating field can be reversed by reversing the connections to the start winding. This changes the direction of the initial phase shift, creating a -magnetic field rotating in the opposite direction. The motor speed depends essentially upon the AC power line frequency and the number of poles on the stator.

PROCEDURE:

- Connect the main terminals of main winding & auxiliary winding of split phase induction motor in parallel.
- Connect in parallel the output leads of Variac to the terminals.
- Connect the input leads of Variac to distribution board (220-V ac supply)
- Slowly increase the voltage by means of knob (up to 15-V) & observe the rotation
- Now decrease the voltage to 0-V & disconnect the supply
- Reverse the connection of terminals of auxiliary winding with main winding
- Repeat the above process & observe the reversal of rotation

PRECAUTIONS :

i) Before energizing the circuit checks the connections.
ii) Do not touch the live wires when circuit is energized
iii) Stay away from the motor when in operation
iv) Never attempt to reveres terminals while motor is in operational mode

REVIEW QUESTIONS :

1- What is the difference between main & auxiliary winding?

_____

_____

_____.

2- How the rotation of split phase induction motor is reversed?

_____

_____

_____.

3- What if the terminals of main winding are reversed instead of auxiliary winding?

_____

_____

_____..

4- What if the terminals of both main winding & auxiliary winding are reversed?

_____

_____

_____.

TASKS

Q: 01 What is the resistance of main/stator winding and auxiliary winding?

Ans:

Q: 02 How many terminals of main/stator winding and auxiliary winding?

Ans:

Q: 03 In first go what was the direction of rotation and what was speed in rpm?

Ans:

Q: 04 What will be arrangement of two winding (series or parallel while running the motor)?

Ans:

Q: 05 Will the arrangement be same when motor is made to operate in reverse direction?

Ans:

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Lab Experiment #05

OBJECT: PWM SIGNAL TO ACTIVATE ELECTRONIC SWITCH

PERFORMANCE OBJECTIVES:

To perform the voltage PWM signal on oscilloscope and use this signal to activate electronic switch.

Upon successful completion of this experiment, the student will be able to:

- Understand function generator
- Understand PWM circuit
- Minimize the duty cycle using PWM signal

EQUIPMENT :

- 220-V single phase ac supply
- Function Generator
- Oscilloscope
- Connecting leads
- PWM circuit

DISCUSSION:

PWM, or Pulse Width Modulation, is a method of controlling the amount of power to a load without having to dissipate any power in the load driver.

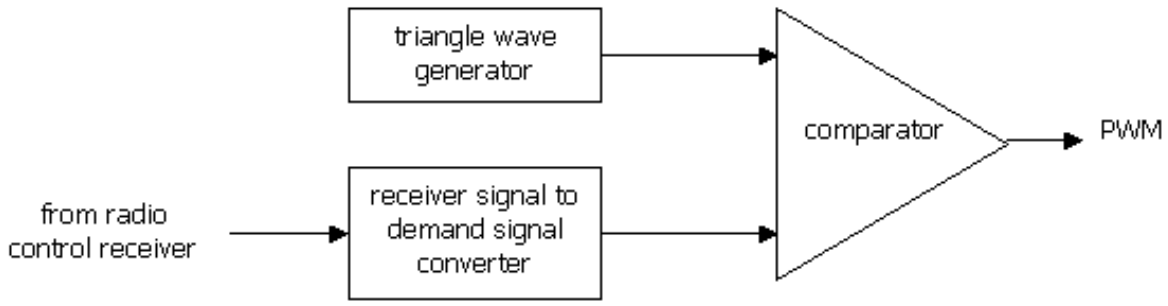

Fig: A block diagram of an analogue PWM generator is shown below:

The comparator

We are starting at the output because this is the easy bit. The diagram below shows how comparing a ramping waveform with a DC level produces the PWM waveform that we require. The higher the DC level is, the wider the PWM pulses are. The DC level is the 'demand signal'.

The DC signal can range between the minimum and maximum voltages of the triangle wave.

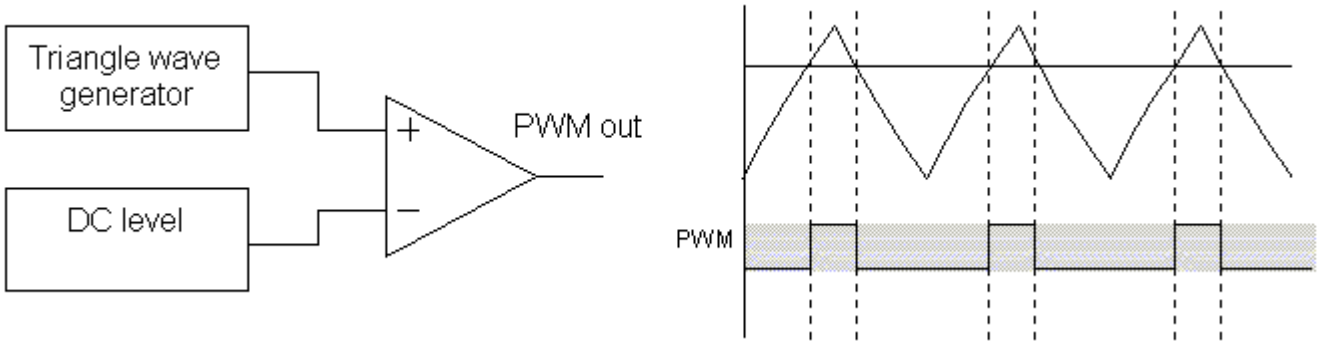

Fig. Comparing a ramping waveform with a DC level

When the triangle waveform voltage is greater than the DC level, the output of the op-amp swings high, and when it is lower, the output swings low.

Detecting the demand signal

We need to convert the signal coming from the radio control receiver into a PWM demand signal. This can be achieved using a servo, or by using a circuit which decodes the signal from the receiver.

Using a servo

In this method, we want a PWM generator that will take a signal from a servo potentiometer (these signals will need to be taken out by wires from the servo body), and deliver a logic-level PWM output to the speed controller. When the servo potentiometer is at minimum, we want the PWM signal to be 100% off 0% on, and when the servo potentiometer is at maximum, we want the PWM signal to be 0% off 100% on. We also want the on percentage to be proportional to the potentiometer position.

The potentiometer generally has its 'top end' connected to a positive power supply, and its 'bottom end' connected to ground. Then as it rotates the voltage at its wiper changes linearly with wiper position.

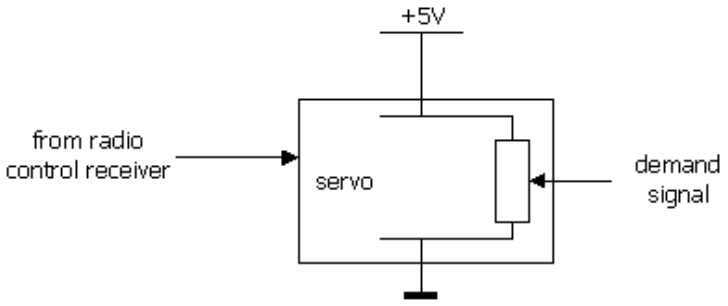

Fig: Analogue PWM Generator using Servo potentiometer

Function Generator

A function generator is usually a piece of electronic test equipment or software used to generate different types of electrical waveforms over a wide range of frequencies. Some of the most common waveforms produced by the function generator are the sine, square, triangular and sawtooth shapes.

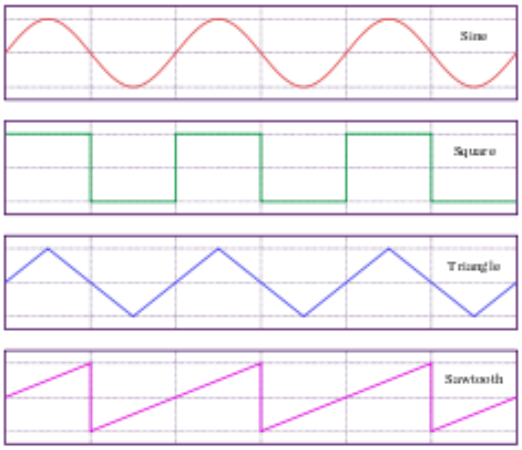

Fig: Sine, square, triangle, and sawtooth waveforms

Fig: Function Generator

PROCEDURE :

- Turn on the oscilloscope
- Turn on the Function Generator
- Connect the leads of oscilloscope with function generator
- Set the axes of oscilloscope at origin

Fig: Analogue PWM Generator using Servo potentiometer

PRECAUTIONS :

v) Before energizing the circuit checks the connections.

vi) Do not touch the live wires when circuit is energized

vii) Confirm the connections of voltmeter (in parallel) and ammeter (in series).

viii) Wear safety gloves for proper insulation.

ix) Don't use any equipment without guidance of your lab. Tutor.

REVIEWQUESTIONS :

1) What is duty cycle of pulse obtained from function generator?

2) Is it possible to minimize the duty cycle? If yes, at what level you can reduce it or if no, why?

3) If the above answer is no what will be the circuit diagram in that case. If answer is yes what change in circuit and components is required?