EXPERIMENT MD2: DC MOTOR

Related course: KIE2009 (Machines and Drives)

OBJECTIVES:
To study the characteristics of DC motor

EQUIPMENT:

Item	Description	Qty	Model
1	AC/DC Variable Power Supply	1	EM-30-09-04-01
2	DC Voltmeter (0~600V)	1	EM-30-13-01
3	DC Ammeter (0 ~ 10A)	1	EM-30-13-02
4	DC Shunt Wound Machine	1	EM-30-01-01
5	Shunt Field Rheostat (2.2KΩ, 300W)	1	EM-30-08-02
6	Tachometer	1	DT-2234C
7	4mm Safety Stackable Leads Set	1	EM-30-15-01

INSTRUCTIONS:

1. Record all your results and observations in a log book / paper.
2. Do not change the circuit connection without permission from the lab demonstrator or technician.
3. Always let the lab demonstrator check your circuit before turning on the power.

REFERENCE(S):
Refer to the main references of KIE2009

TESTS:
Test 1: To reverse the direction of rotation of DC Shunt Wound Motor
Test 2: To study the variation of speed of a dc shunt motor as a function of armature terminal voltage (armature-voltage control)
Test 3: To study the variation of speed of a dc shunt motor as a function of field current (Field control)

CAUTION!
HIGH VOLTAGE!!

HANDLE THE EQUIPMENT WITH EXTREME CARE AS HIGH VOLTAGES ARE PRESENT AT SOME SOCKETS AND EXPOSED TERMINAL.

RECOMMENDATION FOR SAFE AND EFFICIENT OPERATION:

Owing to the versatility and characteristics of this electrical machine training aid, the following measures must be adhered to:

1) The supply to the machines must be protected by earth leakage.

2) All connections must be terminated correctly at both ends before power is connected.

3) No exposed conductive parts of connection must be visible after the connection.

4) No connections must be disconnected whilst power is still connected.

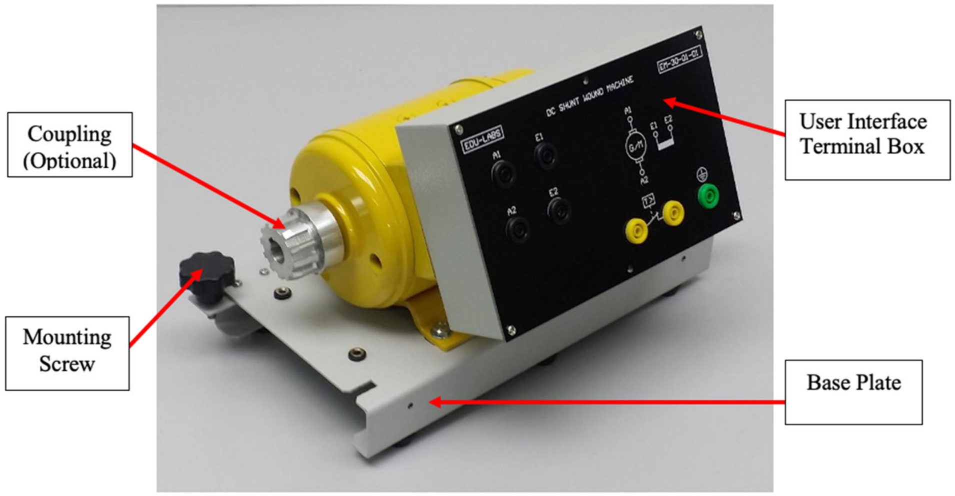
5) Coupling must be done before power is connected if experiments with Brake Unit or Load Unit.

6) Instructions specified in individual assignments must be adhered to.

7) Further experiments or variation must be done only after the teacher consent.

8) Motor should be firmly tightened with solid base before starting to be vibration free.

INTRODUCTION:



The DC compound motor is a combination of the series motor and the shunt motor. It has a series field winding that is connected in series with the armature and a shunt field that is in parallel with the armature. The combination of series and shunt winding allows the motor to have the torque characteristics of the series motor and the regulated speed characteristics of the shunt motor.

The cumulative compound motor is one of the most common DC motors because it provides high starting torque and good speed regulation at high speeds. Since the shunt field is wired with similar polarity in parallel with the magnetic field aiding the series field and armature field, it is called cumulative. When the motor is connected this way, it can start even with a large load and then operate smoothly when the load varies slightly.

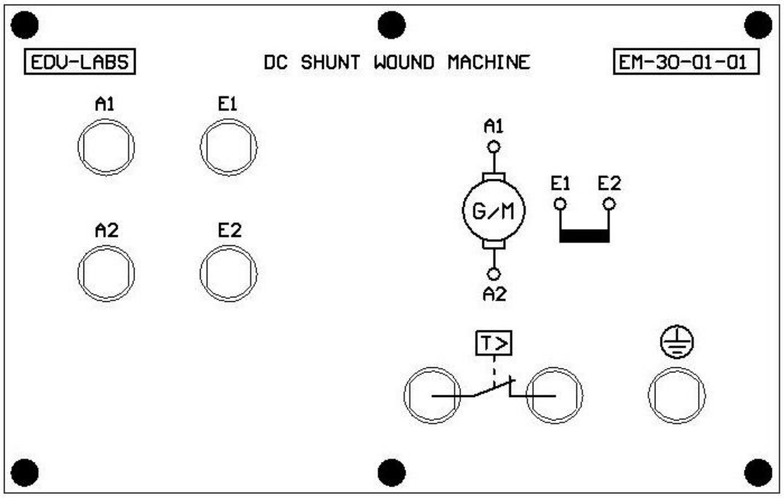
General Specifications:

The shunt motor can provide smooth operation at full speed, but it cannot start with a large load attached, and the series motor can start with a heavy load, but its speed cannot be controlled. The cumulative compound motor takes the best characteristics of both the series motor and shunt motor, which makes it acceptable for most applications like: punch presses, shears, crushers, and reciprocating compressors.

Electrical Features:

DC SHUNT WOUND MACHINE			
MODEL : EM-30-01-01			
Power:	370W	**Current:**	2.5A
Armature Voltage:	0-220 VDC	**Excitation Voltage:**	25 VDC
Starting Torque:	125% Rated Torque	**Duty:**	DFC Continuous
Torque:	10.5 Kg-cm	**Speed Range:**	1500 RPM
Cooling Method:	Self-Cooling		

Terminal Box Display for DC Shunt Wound Machine



Basic Structure of Electric Machines

Stator: This part of the machine does not move and normally is the outer frame of the machine.

Rotor: This part of the machine is free to move and normally is the inner part of the machine.

Both stator and rotor are made of ferromagnetic materials. Slots are cut on the inner periphery of the stator and outer periphery of the rotor.

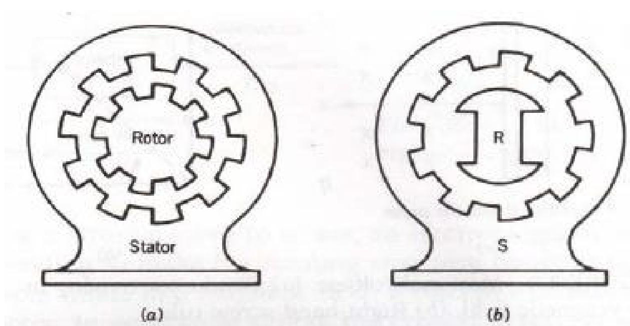


Fig 4: Structure of electric machines

The iron core is laminated to reduce eddy current losses.

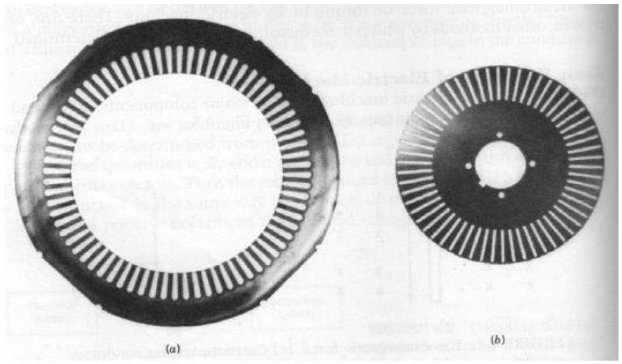


Fig 5: Laminations: (a) Stator. (b) Rotor.

Conductors placed in the slots of the stator or rotor, are interconnected to form windings. The winding in which voltage is induced is called the *armature winding*. The winding through which a current is passed to produce the primary source of flux in the machine is called the *field winding*.

DC MACHINES

DC machine is the earliest machines to be used for power generation, until year 1890. DC machine can be used as either a motor or a generator. However, applications requiring operation of the DC machine as a generator are limited, while applications requiring the DC machine as a motor are commonplace.

DC motors are the obvious choice in applications where DC sources are all that is available (e.g., automotive systems). For special applications, where only AC sources are available, such as in steel mills, mines, and electric trains, it is sometimes advantageous to transform the AC into DC in order to use DC motors. One capability that DC machines possess that induction and synchronous machines do not is precise speed and/or torque control. The torque-speed characteristics of DC motors can be varied over a wide range while retaining high efficiency.

DC Machines Construction

The Stator

- This part of the machine does not move and normally is the outer frame of the machine.
- The stator has poles, which are excited by dc current to produce magnetic fields.

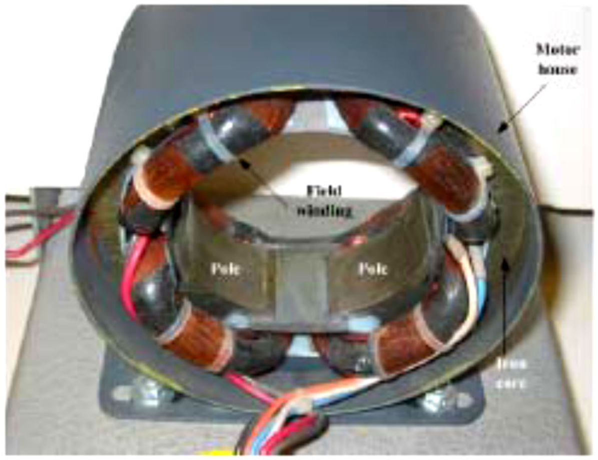


Fig 6: The stator.

The Rotor

- This part of the machine is free to move and normally is the inner part of the machine.
- The Rotor in DC machines is called Armature.
- Armature has slots and the conductors mounted into the slots.

The Commutator

- The commutator consists of insulated copper segments mounted on an insulated tube

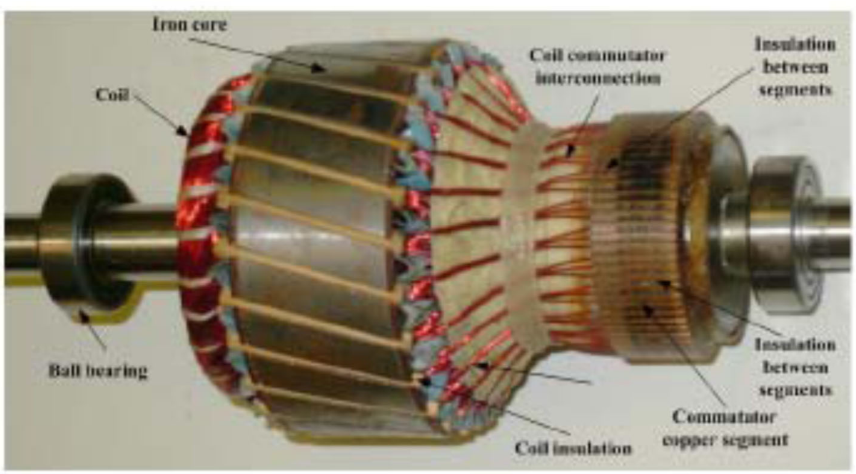
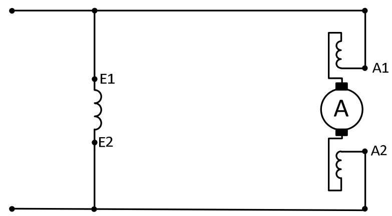


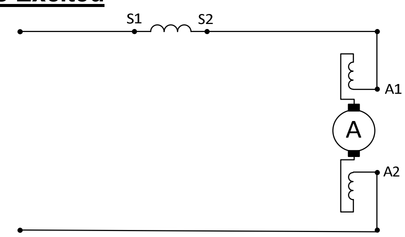
Fig 7: The rotor.

DC Motor Types

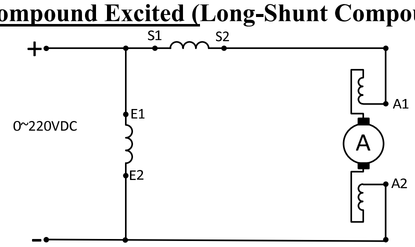
Shunt Excited



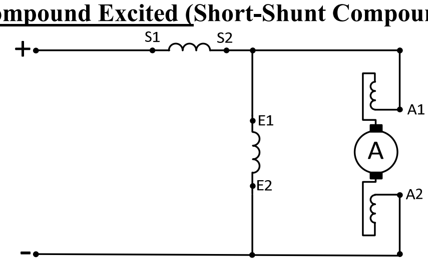
Series Excited



Compound Excited (Long-Shunt Compound)



Compound Excited (Short-Shunt Compound)



TEST 1: To reverse the direction of rotation of DC Shunt Wound Motor

1. Connect as per the circuit diagram shown in Fig 1-1.

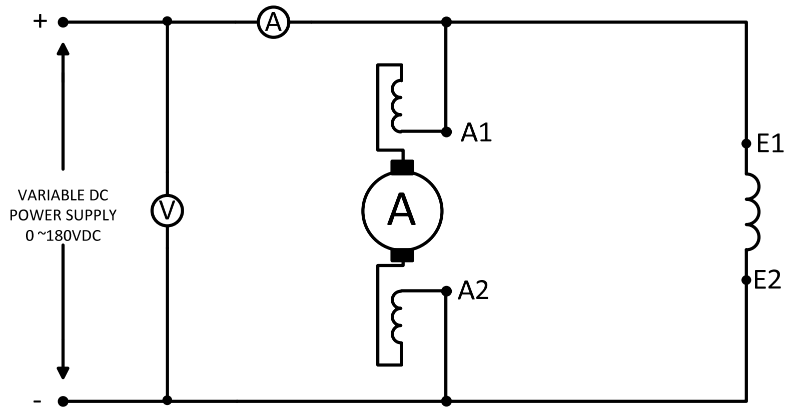


Fig. 1-1: Circuit diagram to study the direction of rotation

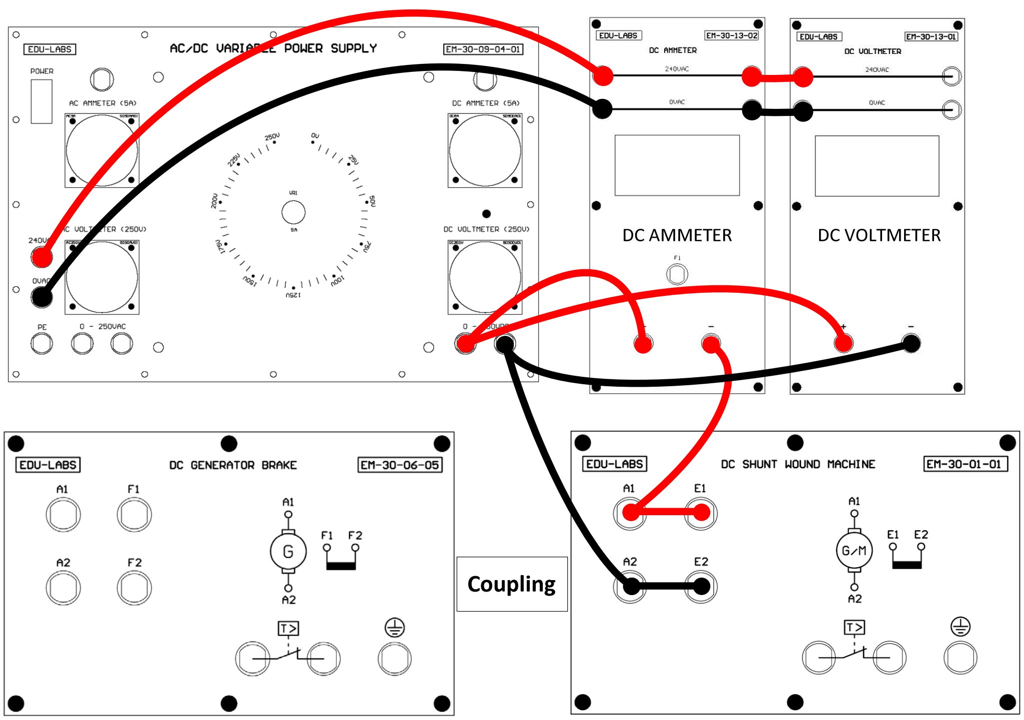


Fig. 1-2: Wiring diagram

2. Adjust the supply voltage to approximately 50V and note the direction of rotation of the motor and record the Table 1-1.

Table 1-1

No	DC Voltage Supply (VDC)	DC Current (ADC)	Direction Rotation	Speed (RPM)
1	50			

3. To reverse the direction of rotation, the polarity of the supply voltage either to the armature terminal or to the field terminals is reversed. Reverse the polarity of the field circuit by exchange the polarity of the E1 and E2 . Note the direction of rotation of the motor and record the Table 1-2

Table 1-2

No	DC Voltage Supply (VDC)	DC Current (ADC)	Direction Rotation	Speed (RPM)
1	50			

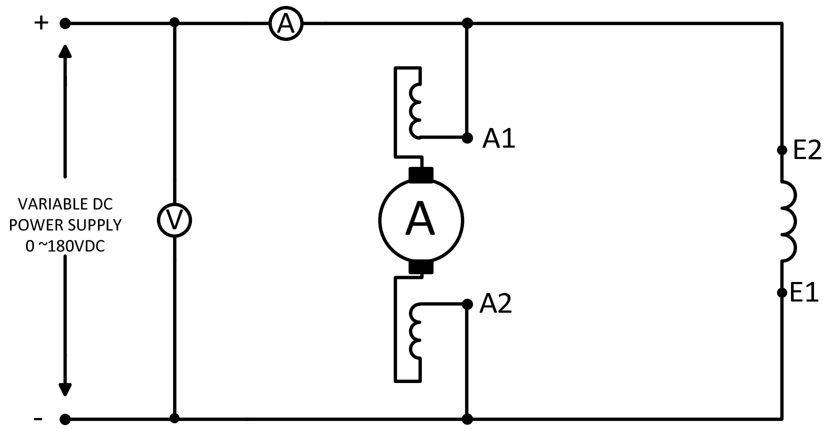


Fig 1-3: Circuit diagram to study the direction of rotation

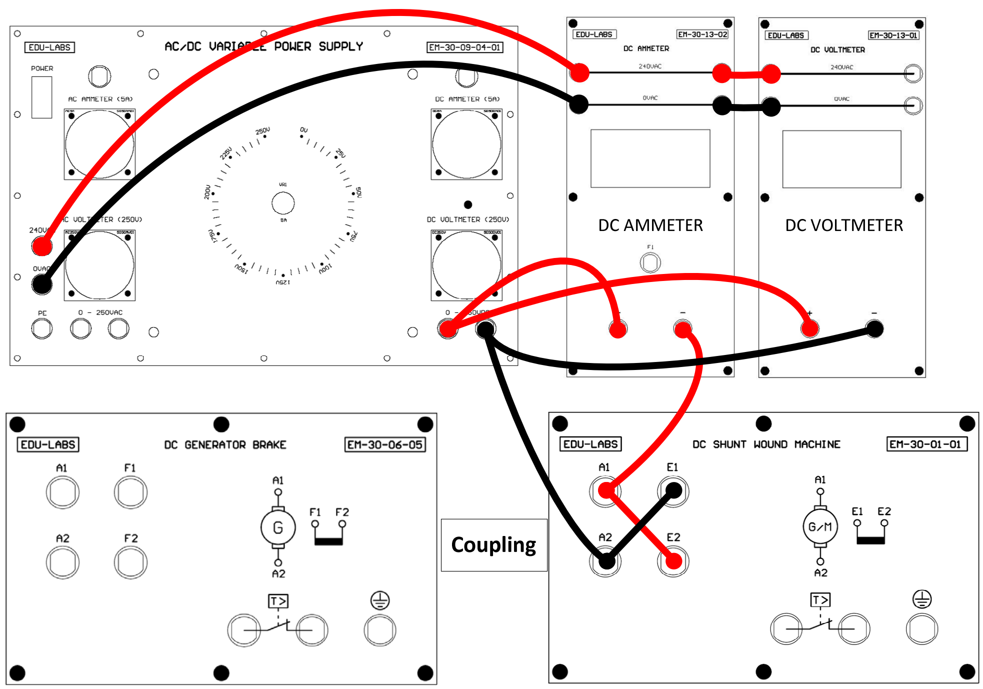


Fig 1-4: Wiring Diagram

4. Reverse the polarity of the voltage to the armature circuit. Note the direction of rotation. Note the direction of rotation of the motor and record the Table 1-3.

Table 1-3

No	DC Voltage Supply (VDC)	DC Current (ADC)	Direction Rotation	Speed (RPM)
1	50			

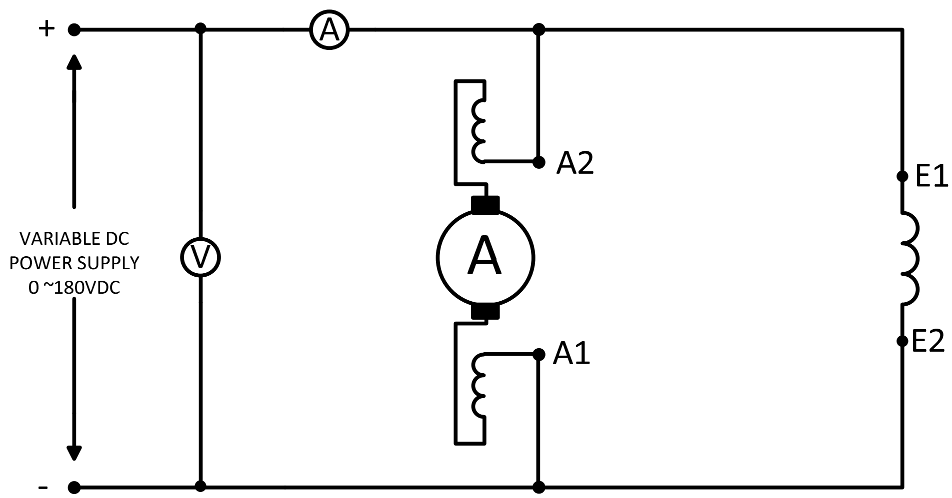


Fig 1-5: Circuit diagram to study the direction of rotation

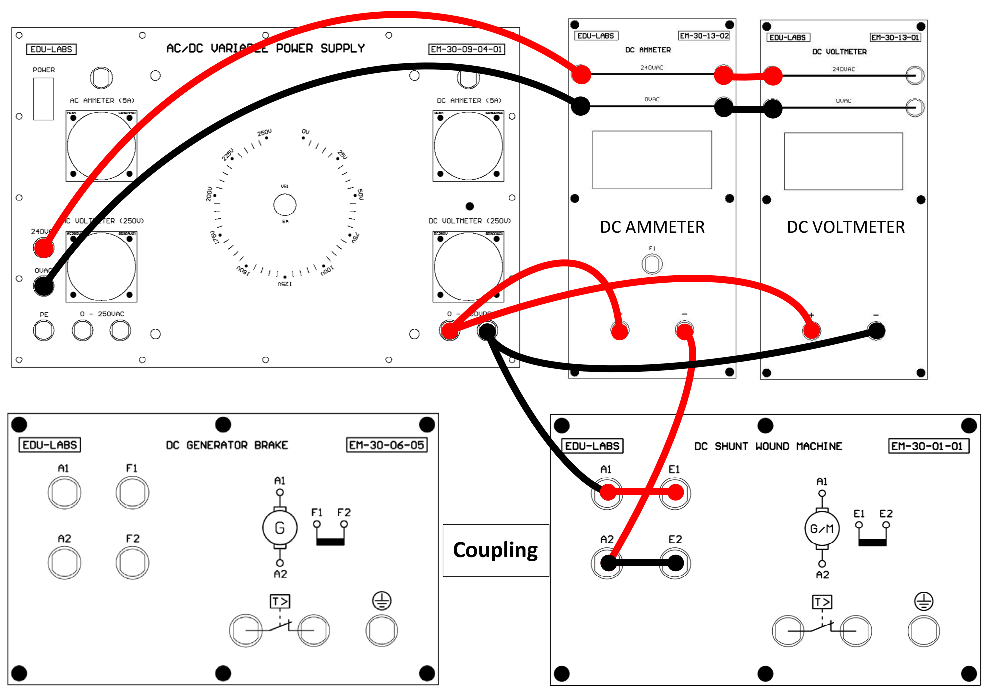


Fig 1-6: Wiring Diagram

TEST 2: To study the variation of speed of a dc shunt motor as a function of armature Terminal Voltage (Armature-voltage control)

The speed of a dc shunt motor can be controlled below the rated speed by adjusting the armature terminal voltage or by inserting variable resistance in series with the armature. As the insertion of a resistance in the armature circuit produces heavy power loss it is not used for large machines. To control the speed above rated speed the field (excitation) current is adjusted.

1. This part requires using a tachometer to measure the motor speed.
2. Construct the circuit shown in Fig 5-1.

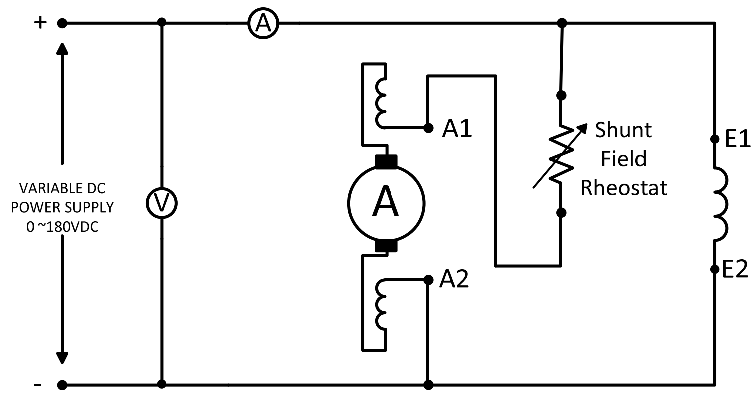


Fig. 5-1: Circuit diagram for armature speed control

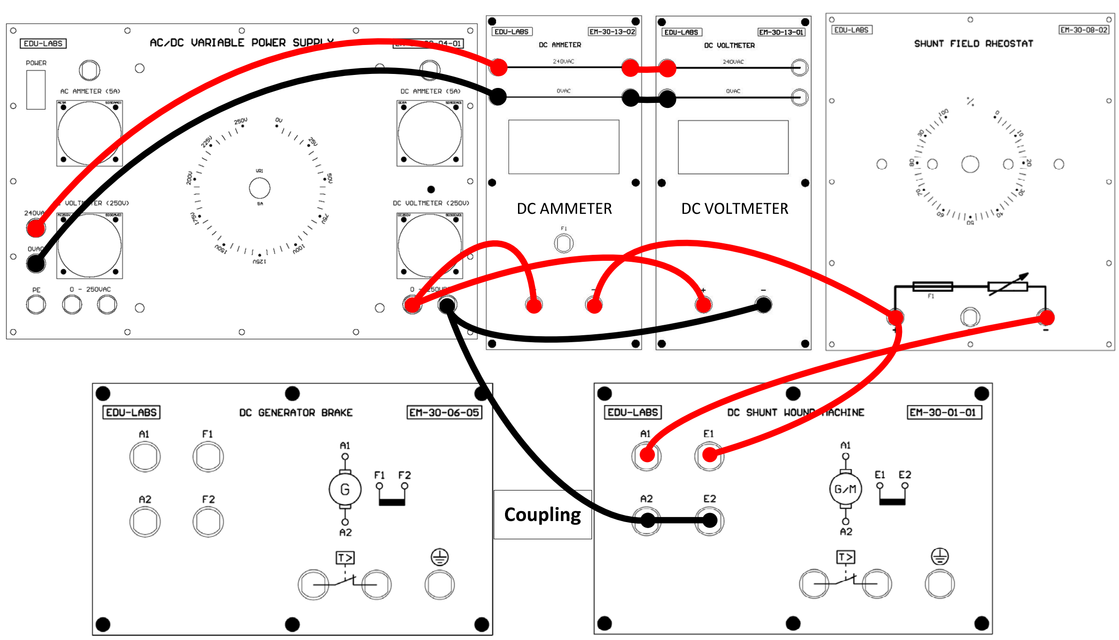


Fig 5-2: Wiring Diagram

3. Connections follow the circuit. Supply 150VDC power supply to the circuit. Measure the speed. Adjust the Shunt Field Rheostat according to the Table 1. Enter the measured values in the table 1.

Table 1: 1

Shunt Field Rheostat	0%	10%	20%	30%	40%	50%
Current (A)						
Speed (RPM)						
Voltage (VDC)						

TEST 3: To study the variation of speed of a dc shunt motor as a function of field current (Field control)

1. This part requires using a tachometer to measure the motor speed.
2. Construct the circuit shown in Fig 6-1.

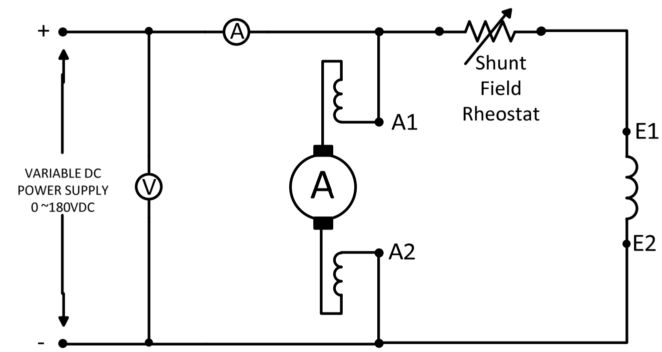


Fig 6-1: Circuit diagram for field speed control

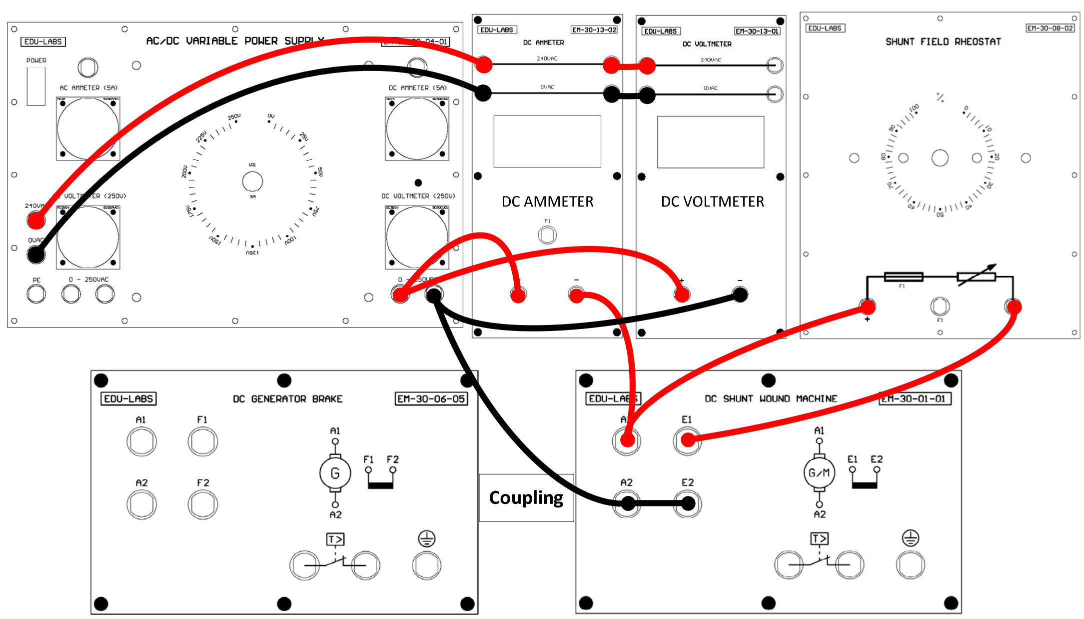


Fig 6-2: Wiring Diagram

3. Connections follow the circuit. Supply 150VDC power supply to the circuit. Measure the speed. Adjust the Shunt Field Rheostat according to the Table 2. Enter the measured values in the Table 2.

Table 2

Shunt Field Rheostat	0%	10%	20%	30%	40%	50%
Current (A)						
Speed (RPM)						
Voltage (VDC)						

QUESTIONS:

1. Discuss the difference between shunt, series, and compound wound motors.
2. How does the speed of shunt, series, and compound wound motor change with varying loads?
3. Can a series wound motor be used in applications where precise speed control is required? Why or why not?
4. How do you select the appropriate motor for a particular application? What factors should you consider when making this decision?

END OF EXPERIMENT