

Lesson 21: Operation and Control of Dc Motors

ET 332a

Dc Motors, Generators and Energy Conversion
Devices

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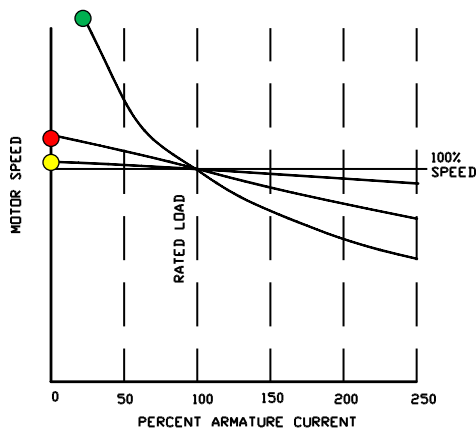
Learning Objectives

- Compare and contrast the torque-speed characteristic of dc motor connections
- Compare and contrast the torque-current characteristics of dc motor connections.
- Match mechanical loads to motor characteristics
- Explain how simple motor control systems operate.

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Speed-Torque Characteristics Compared



Motor Speed Characteristics

Shunt - constant speed due to constant flux. Regulation approx. 5%

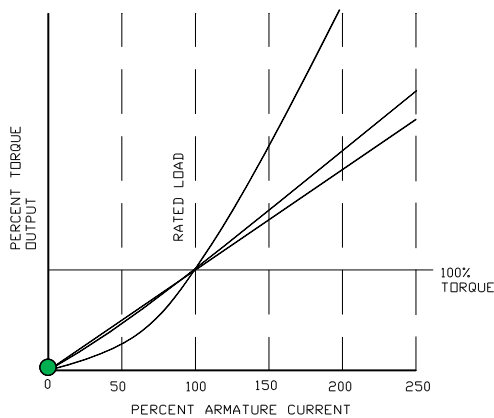
Compound - speed varies as load changes Regulation approx 15-25%

Series - variable speed. No load condition causes motor to accelerate to very high speeds

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Current-Torque Characteristics Compared



Shunt - constant field flux causes torque to vary linearly with the armature current.

Compound - higher torques at I_a values above rated. Higher torques developed at lower speeds.

Series - High starting torques. Torque is proportional to the square of I_a . Require load torque to prevent run away.

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Characteristic-Load Match-ups

Shunt Motor

- **Applications**
 - Centrifugal pumps
 - Fans
 - Winding reels
 - Conveyors
 - Machine tools
- **Characteristics**
 - Constant speed
 - Moderate starting torque

Compound Motor

- **Applications**
 - Metal stamping machines
 - Reciprocating pumps
 - Hoists
 - Compressors
- **Characteristics**
 - Reduces load pulsations
 - Lower speed/higher torque
 - Less variation in electric demand

Series Motor

- **Applications**
 - Hoists
 - Locomotives
- **Characteristics**
 - High starting torques
 - Wide speed range from no-load to full-load

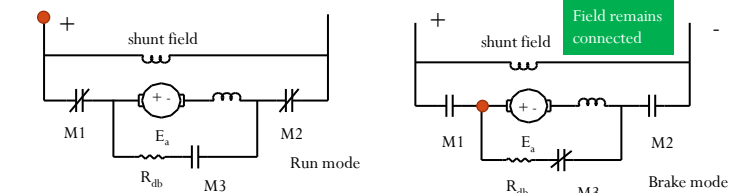
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Dc Motor Control-Braking

Braking - slowing high inertia loads that will cause motor-load system to coast for long time periods. Required for safety - e.g. power saws

Dynamic braking (resistive braking) Disconnect V_T . Connect resistor across armature E_a drives I_a through R dissipating energy



M is a control relay that starts the braking operation

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Dc Motor Control-Braking and Plugging

Regenerative braking - turn motor into generator by spinning motor faster that required to develop E_a . This is called overhauling.

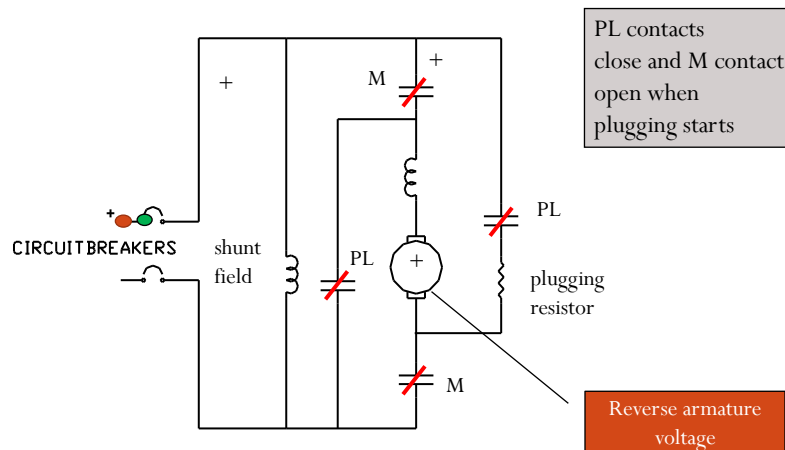
Plugging - Reversing the polarity of the source connections to a motor. This produces a large opposing torque that rapidly slows motor. Requires series resistor to limit current. Additional control (speed switch required to prevent reverse rotation.)

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Dc Motor Control-Plugging

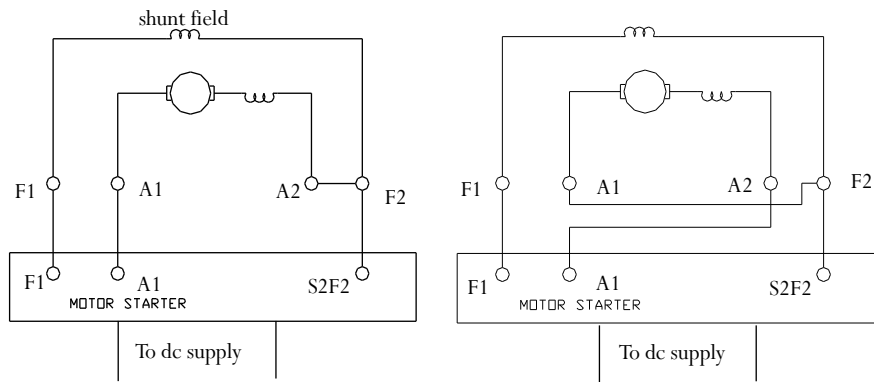
Plugging reverses the current in the armature



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NEMA Standard Connections and Markings



For counter clockwise rotation

For clockwise rotation

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End Lesson 21

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Dc Motors, Generators and Energy Conversion Devices

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