DC Motor Drives

- The current used to drive the DC motor typically come from one of these sources:
  - Fixed voltage:
    - a ____________ (voltage changes with discharge)
    - a voltage ___________ (from rectified AC or battery)
  - Adjustable voltage:
    - a linear power _______________ (or power op-amp),
    - a pulse-width-modulated (______) current source, or
    - a silicon-controlled-rectifier (________) modulated AC source.

LM 317 Voltage Regulator

- Current Rating:
  LM317T – 1.5 A
  (with heat sink)

R1 = 260Ω
R2 = 1kΩ

Motor Leads
1 kΩ potentiometer
+12 to +24 VDC

Linear Power Op-Amp

- Linear power transistors and power op-amps are generally limited to low power (<100 W) applications

Pulse-Width Modulation

- Base voltage turned "ON"
  Transistor "switch" turns ON, allows current to flow
- Base voltage turned "OFF"
  Transistor "switch" turns OFF, no current flows

From: Apex Microtechnology, Tuscon, AZ
PWM Motor Drive

- If the time period $T$ is ________ compared to the ___________ of the system, the motor response will be the same
  - PWM switching frequencies in the 10 kHz (or higher) range are frequently used.
- Relatively high drive efficiency (up to 80%)
  - inefficiency creates heat in the amplifier that must be dissipated!

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Low Cost, Pulse Width Modulator for 12 to 24 volt Applications

- U1: LM324 Quad Op-Amp
- R1-R4: 100kΩ
- R5: 4.7kΩ
- C1: 0.001 to 0.01 µF
- Q1: IRF521 FET (3 amps)
- Q1: IRFZ34N FET (10 amps with heat sink)

U2: 7812 Voltage Regulator
Half-Wave Rectifier

\[
\begin{align*}
V_{\text{AC}} & \rightarrow V_a \\
0 & \rightarrow -
\end{align*}
\]

Full-Wave Rectifier

\[
\begin{align*}
V_{\text{AC}} & \rightarrow V_a \\
- & \rightarrow -
\end{align*}
\]

Silicon Controlled Rectifier

\[
\begin{align*}
V_{\text{AC}} & \rightarrow V_a \\
\text{Gate} & \rightarrow -
\end{align*}
\]

Delay time is adjustable by gate signal.

Silicon-Controlled Rectifier Drive

\[
\begin{align*}
V_{\text{AC}} & \rightarrow V_a \\
\text{Gate} & \rightarrow -
\end{align*}
\]

Form Factor

- Form factor (FF) is a measure of departure from pure direct current (DC)
  - half-wave rectified AC
    - unfiltered FF = 1.6-2.0, filtered FF = 1.1-1.5
  - full-wave rectified AC
    - unfiltered FF = 1.1-1.6, filtered FF = 1.0-1.1

DC Motor Current Drives

- Most higher power application use either the PWM or SCR drive methods
- SCR drives are rated at 90 VDC (for use with 115-120 VAC) or 180 VDC (for use with 230 VAC)