H - Bridge

Switch types:
- relays
- transistors

PWM input

75% duty cycle

25% duty cycle

$V_{avg}$

$t_{on}$

$T_{period}$
Inductive Load Switching

\[ +V \]

\[ L \rightarrow \text{flyback diode} \]

\[ v = L \frac{dI}{dt} \]

H-Bridge MOSFET implementation
Servo (Hobby)

~ 5V operation  stall ~ 1A

PWM control

1-2 ms per 20ms \(\Rightarrow\) 1 end \(\Rightarrow\) other end

\(\Rightarrow\) position determined by internal rotary potentiometer
Encoders

"ticks" event: rising/falling edges

Quadrature Encoder

<table>
<thead>
<tr>
<th>Forward</th>
<th>Backward</th>
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<tbody>
<tr>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
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<tr>
<td>0</td>
<td>1</td>
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<td>1</td>
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90° out of phase
Encoders (Continued...)

Encoder w/ index <-> channel that pulses once per revolution

**Absolute Encoder**
- has coded disk
- outputs absolute angular position
- # of channels -> resolution
- output via parallel or serial interface

**Figure 1** Gray Code

**Figure 2** Natural Binary
Power Considerations

- Isolate controller to its own power source
- External Drive Motor Power
- External Servo Power
- External sensor Power

⇒ Use of 5v regulator may be required for some sensors