H - Bridge

1, 4 on
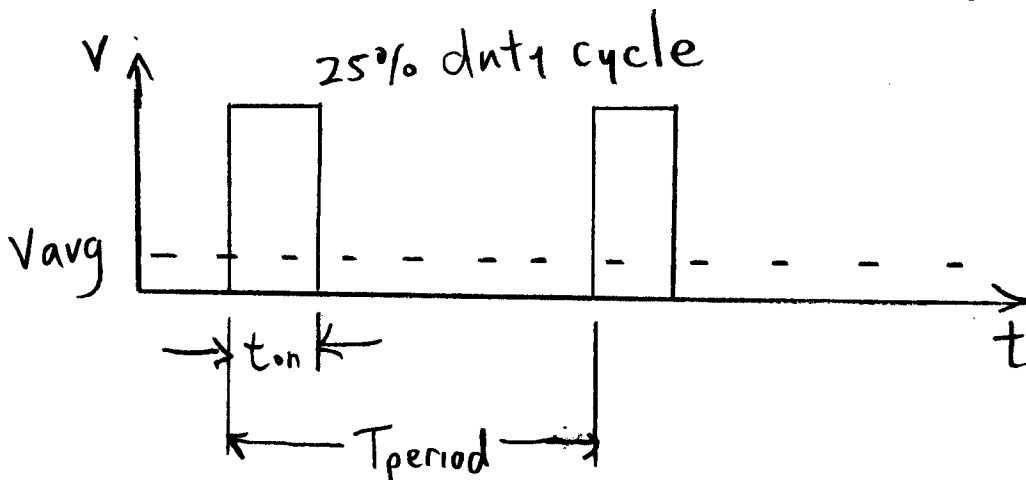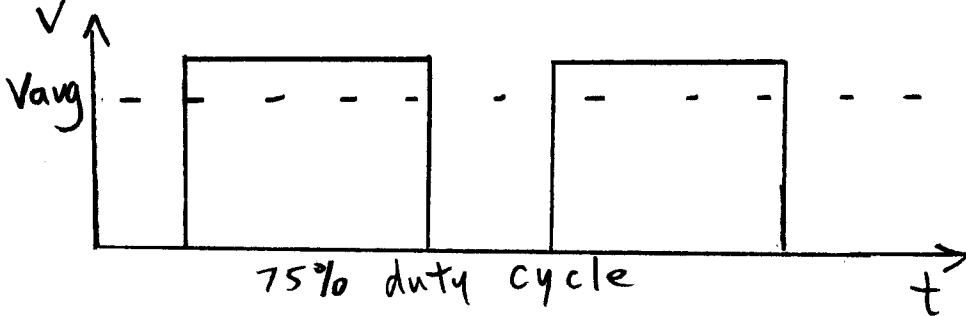2, 3 off $\rightarrow$

2, 3 on
1, 4 off $\rightarrow$

switch types
relays
$\Rightarrow$ transistors

PWM input

75% duty cycle

25% duty cycle

V_{avg}

t_{on}

T_{period}

Inductive Load Switching

flyback diode!

$$V = L \frac{dI}{dt}$$
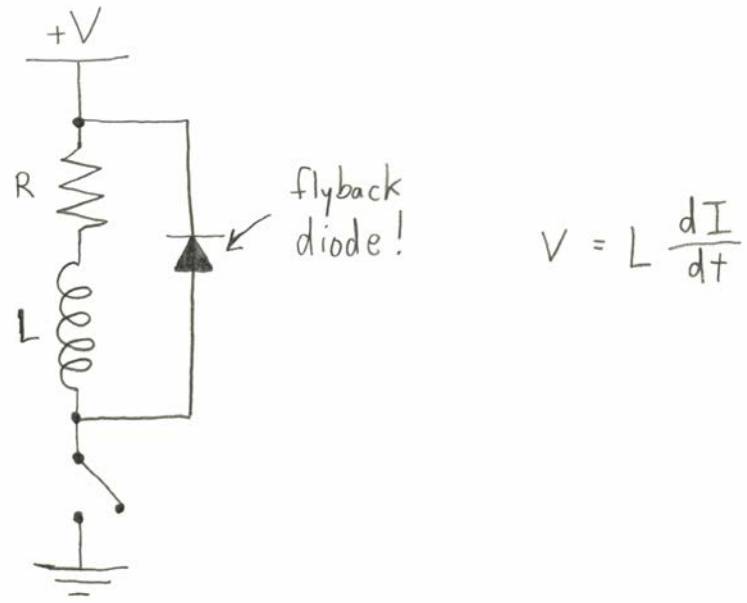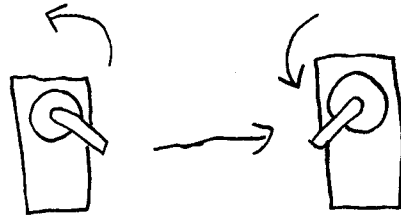
H - Bridge MOSFET Implementation
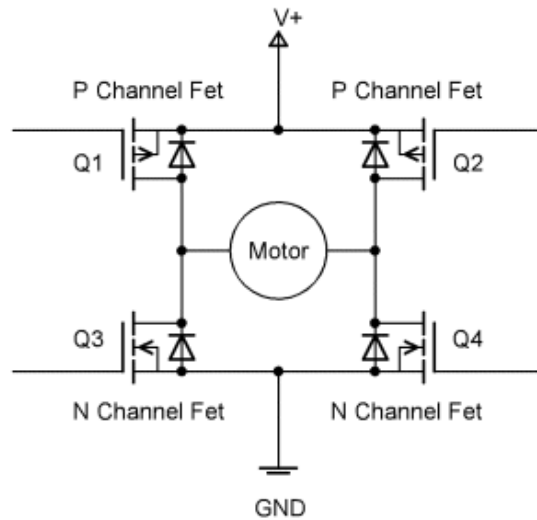
Servo (Hobby)

~ 5V operation   stall ~ 1 A

PWM control

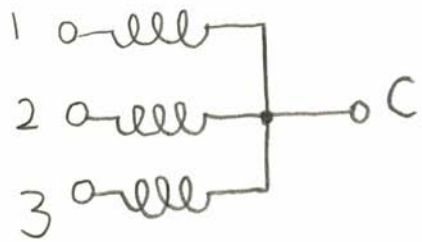1-2 ms per 20 ms $\Rightarrow$
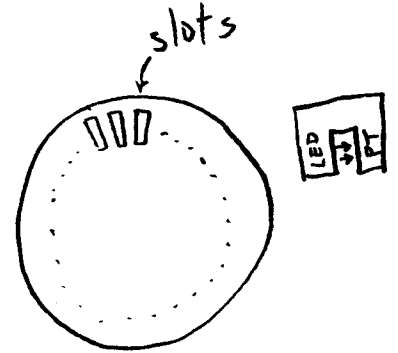
1 end $\Rightarrow$ other end
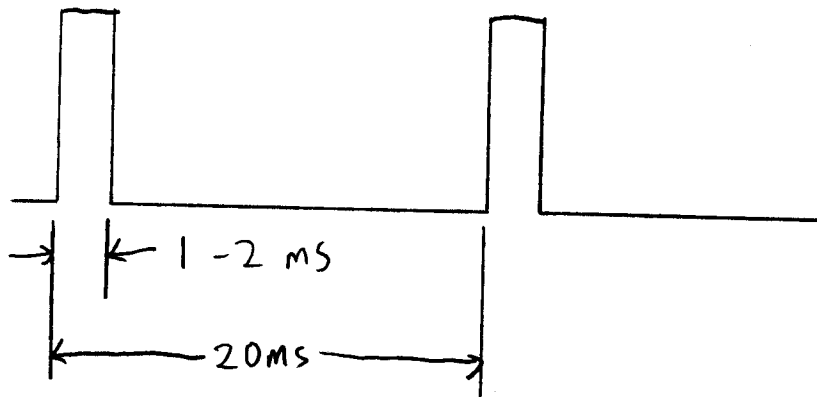
$\Rightarrow$ position determined by internal
rotary potentiometer

Stepper Motor

Encoders

"ticks"

"event": rising/falling edges

IR reflective sensor
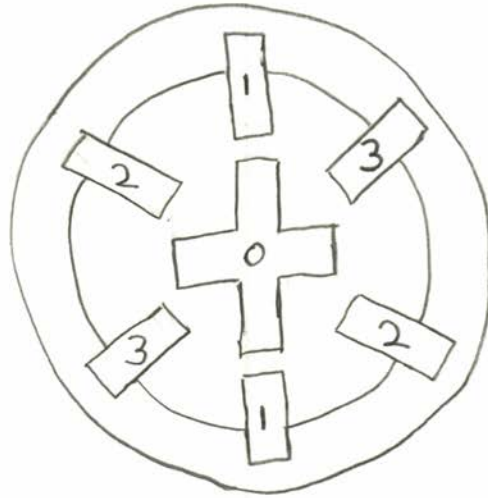
slots
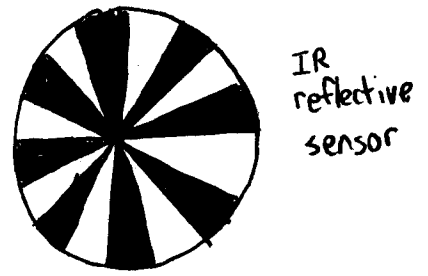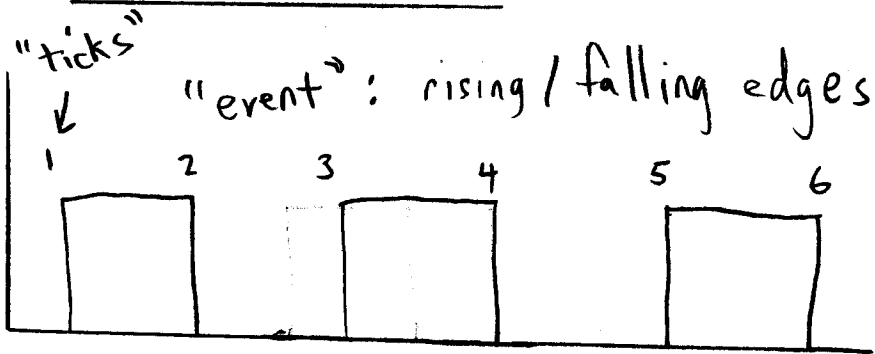
QUADRATURE ENCODER

A

1 3   5 7   9 11   13

B

2 4   6 8   10 12
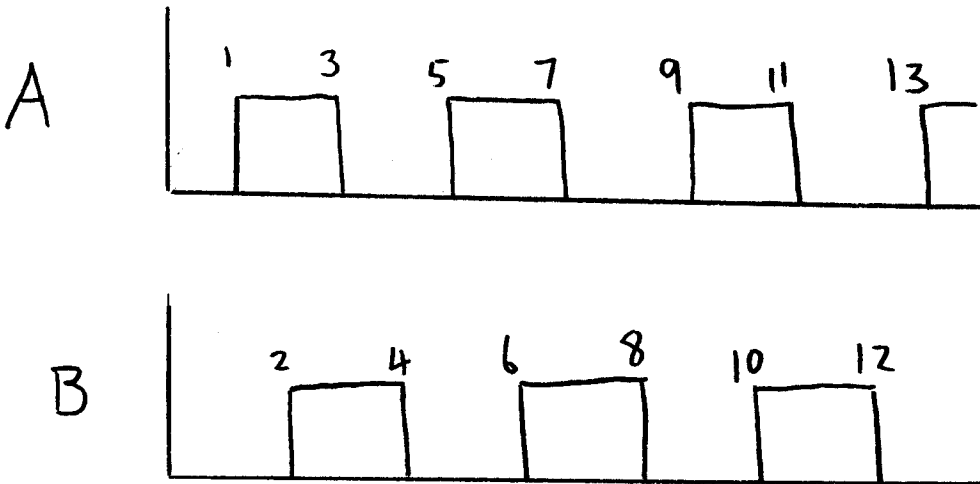
90° out of phase

Forward	
A	B
0	0
1	0
1	1
0	1
0	0

Backward	
A	B
1	0
0	0
0	1
1	1
1	0

Encoders (Continued...)

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

ABSOLUTE ENCODER

- has coded disk
- outputs <u>absolute</u> angular position
- # of channels → resolution
- output via parallel or serial interface
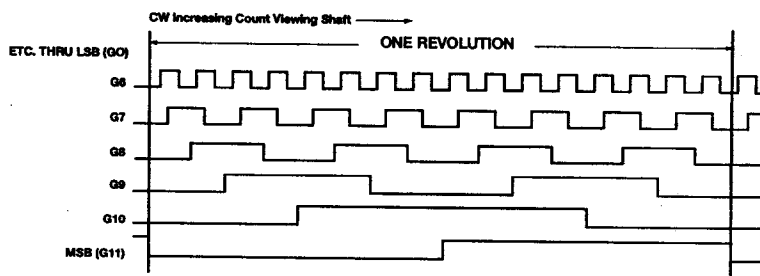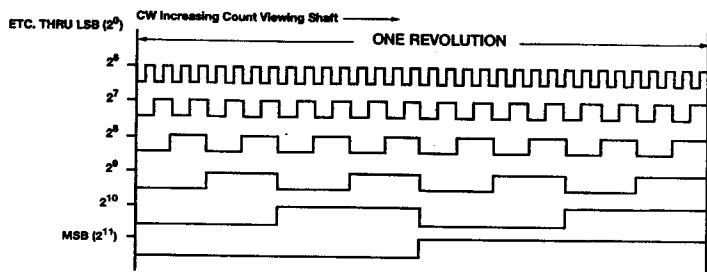
Figure 1 Gray Code

CW Increasing Count Viewing Shaft ─────→

ETC. THRU LSB (G0)   ONE REVOLUTION

G6
G7
G8
G9
G10
MSB (G11)

Figure 2 Natural Binary

CW Increasing Count Viewing Shaft ──→

ETC. THRU LSB (2^6)   ONE REVOLUTION

2^6
2^7
2^8
2^9
2^{10}
MSB (2^{11})

Power Considerations

Battery Types
- Internal Resistance
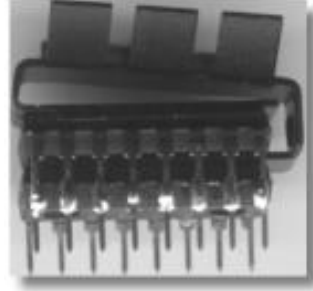- Capacity
- Recharge vs. Dispose

? Separate Power for Controllers / sensors

? Separate Power for Motors / Servos

5 V regulator may be required for some sensors.
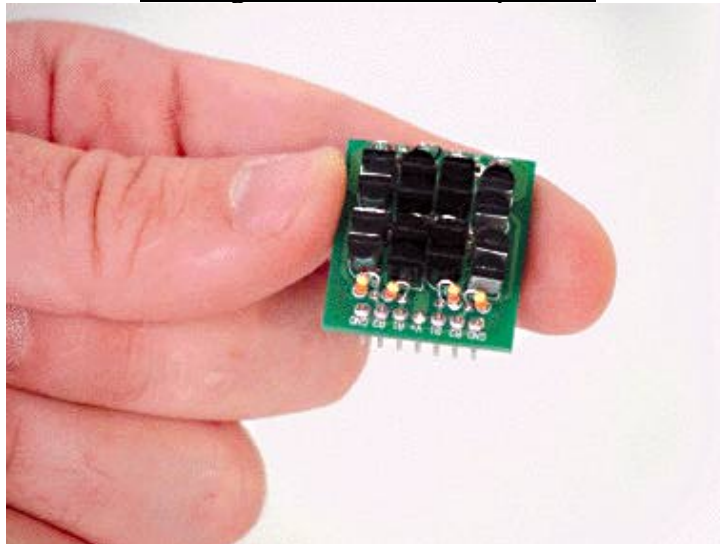
H-Bridges

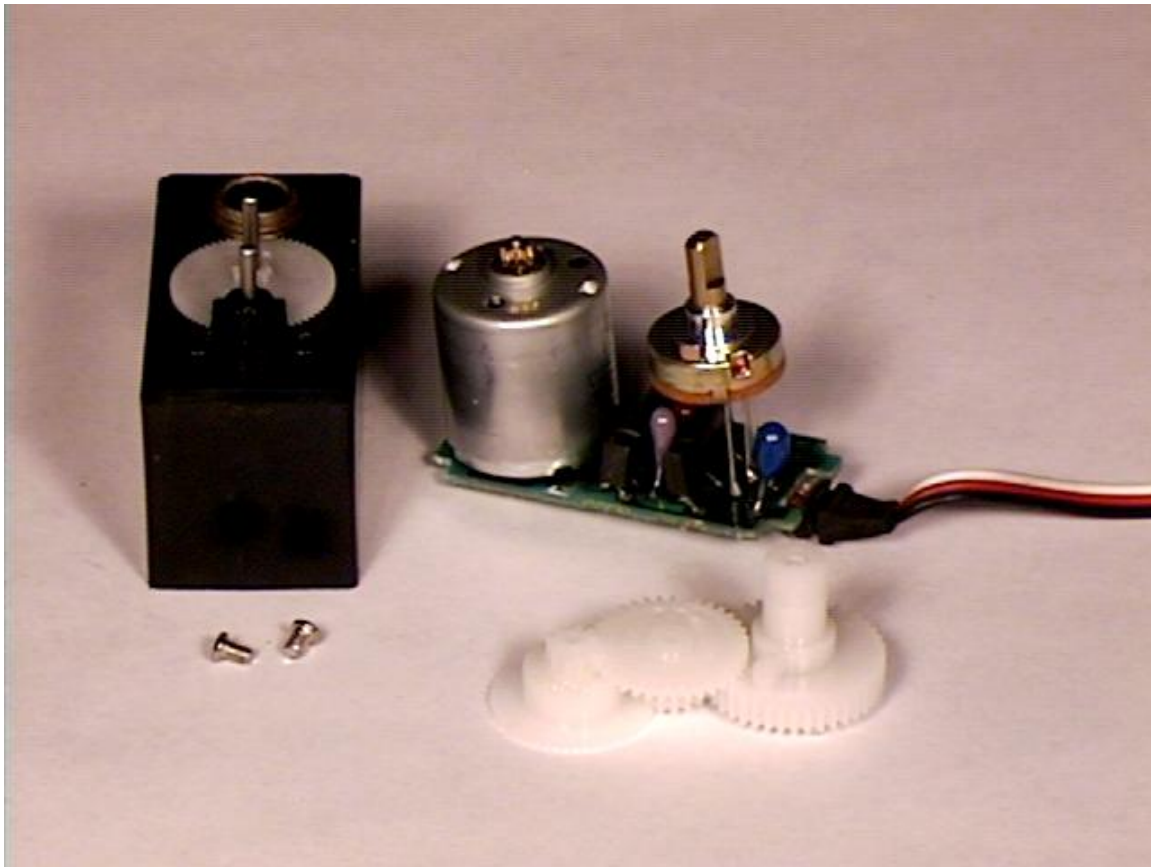1 Amp H-Bridges (on Handy Board) (right: stacked chips with heat sink)
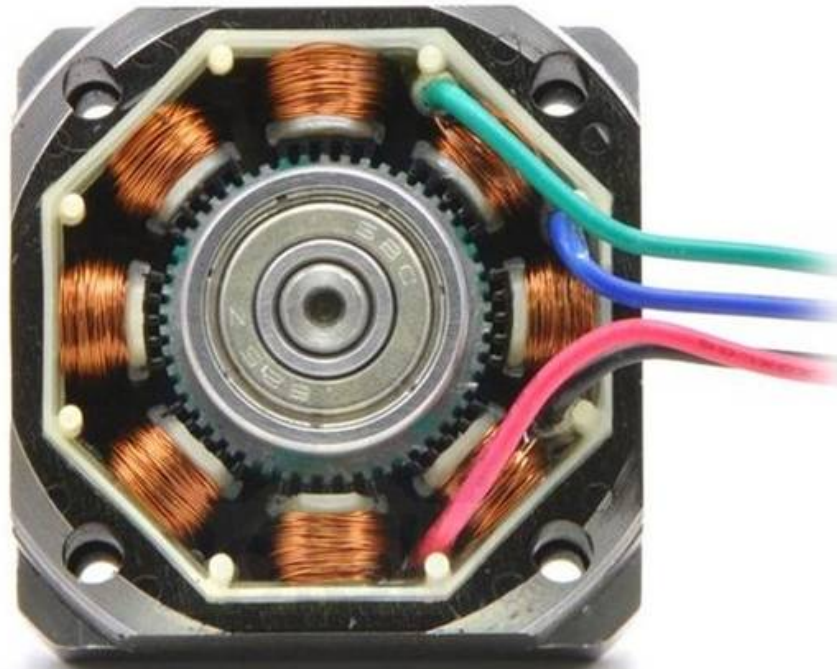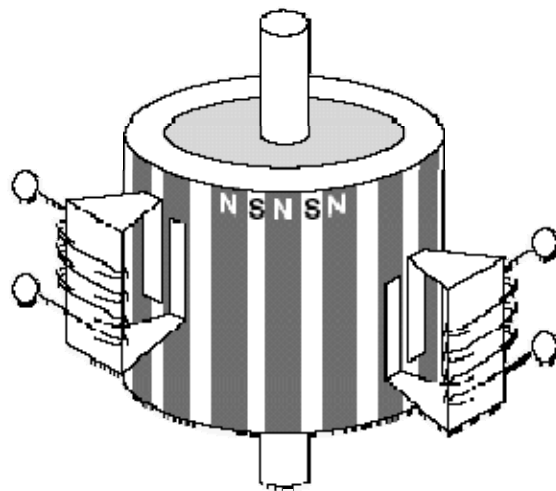

3 Amp H-Bridge

H-Bridge with discrete components

Servos

Stepper Motors

Encoders