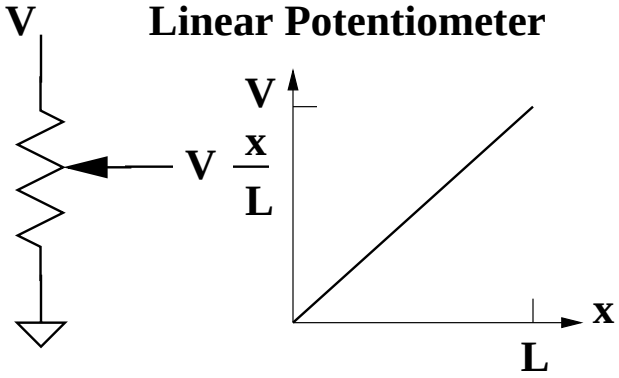
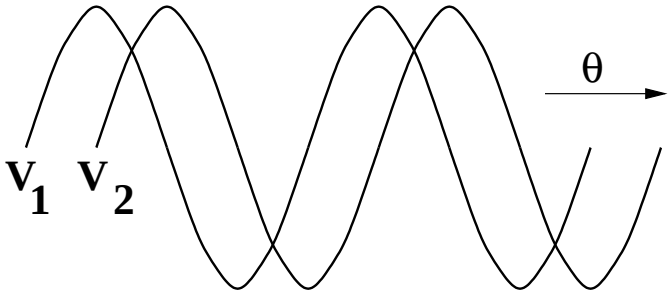
Position Sensing: Analog

Linear Potentiometer

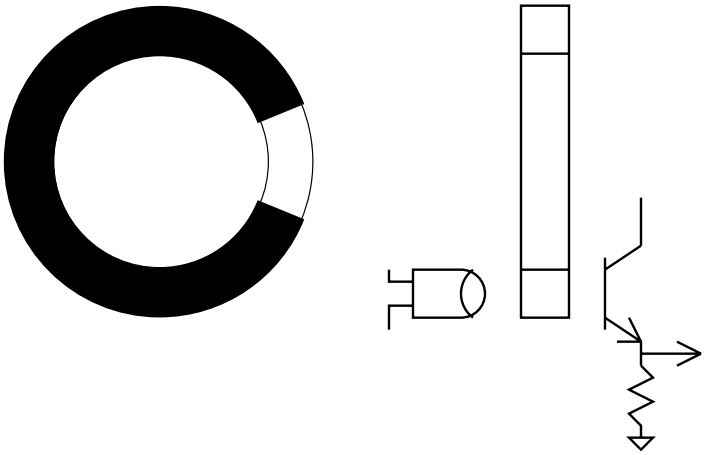


Sinusoidal Potentiometer



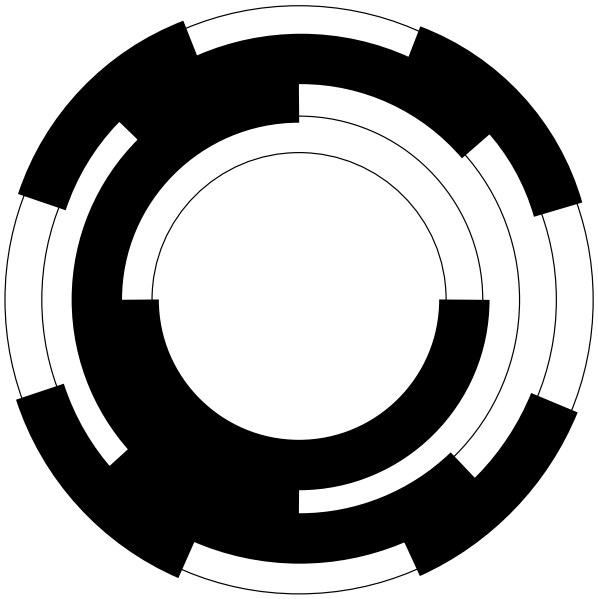
Direct (digital!) Sensing: Optical

Photosource/Photodiode



T sense N positions, you need N source/sensor combinations

Absolute Position Sensor:



Here is a 4-bit (22.5 degree) resolution wheel. One source per sensor bit.

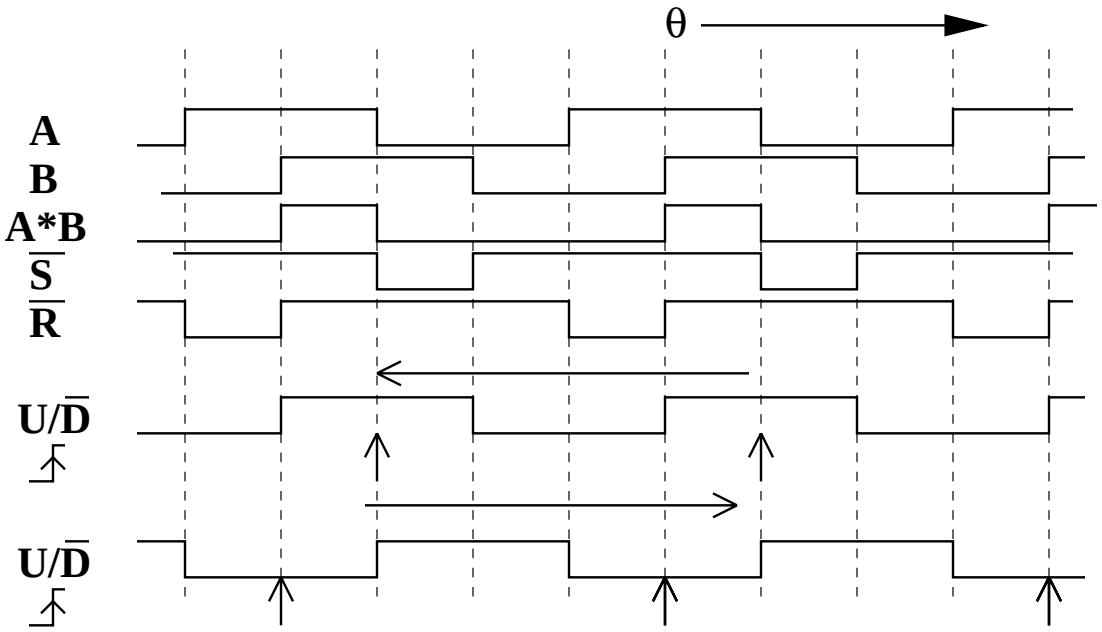
Can make these wider: Resolution is

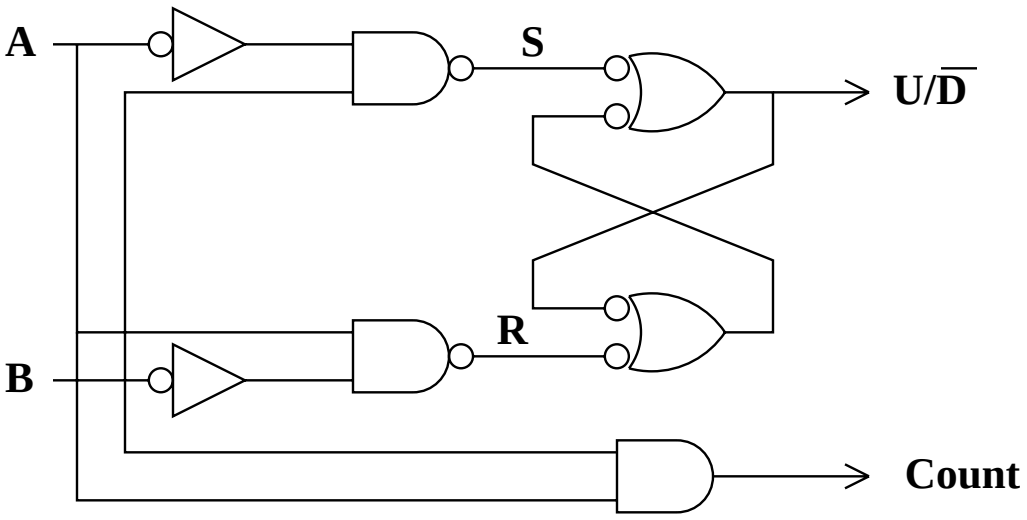
$$\frac{360^{o}}{2^{N}}$$

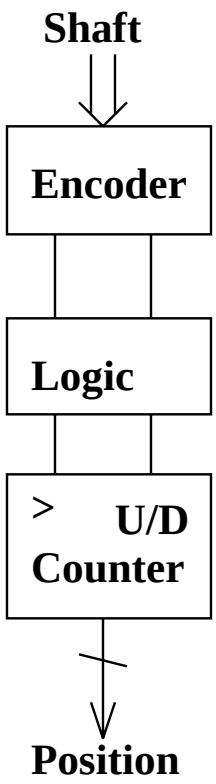
Use a Gray Code to eliminate chatter

0	0	0	0
0	0	0	1
0	0	1	1
0	0	1	0
0	1	1	0
0	1	1	1
0	1	0	1
0	1	0	0
1	1	0	0
1	1	0	1
1	1	1	1
1	1	1	0
1	0	1	0
1	0	1	1
1	0	0	1
1	0	0	0

Here is a "Two Phase" Encoder



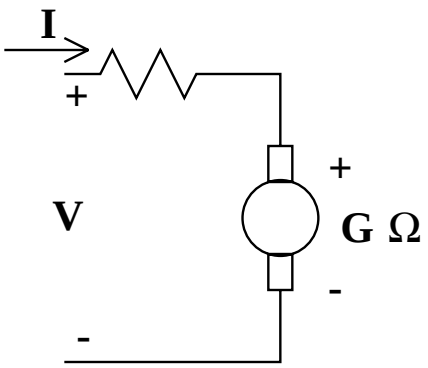


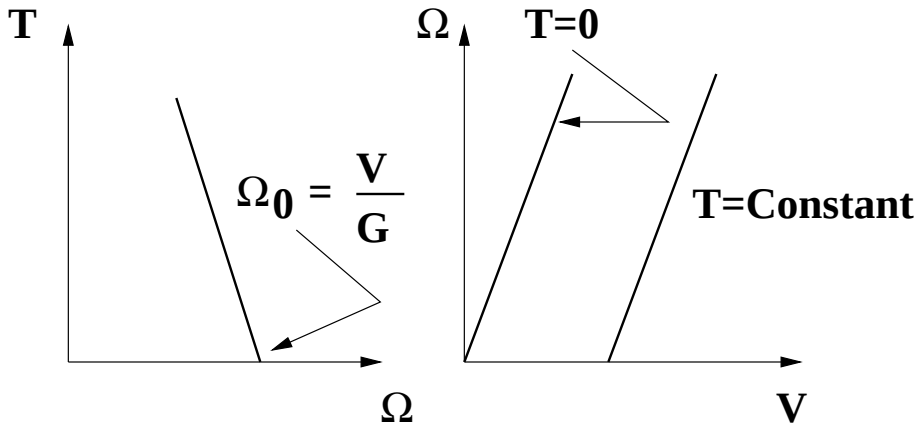


2 Source/Sensor Combinations Required
Can be made to have high precision

Often come with a second, absolute position pulse, use to clear the counter

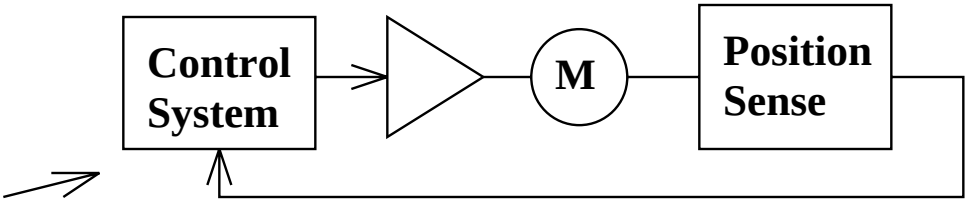
DC Motors





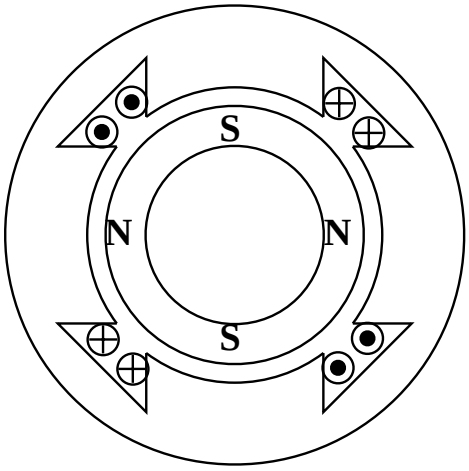
Torque T = G I

V = G Ω + R I

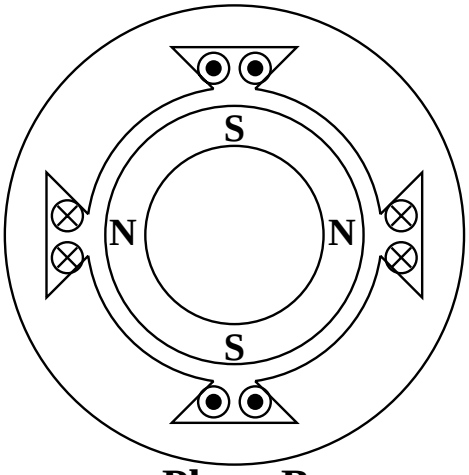


Servomechanism

Stepper Motors are Digital Devices



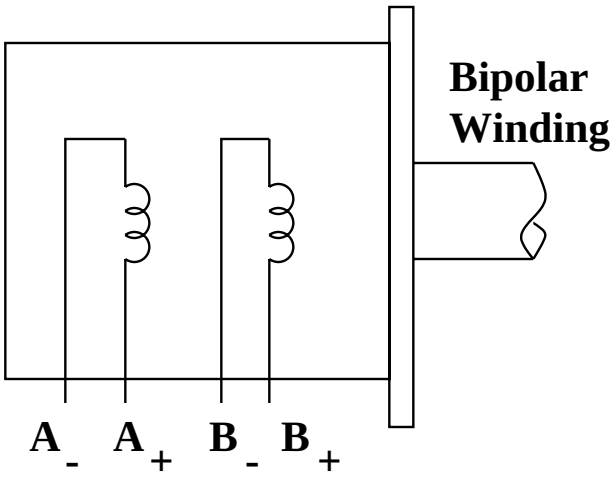
Phase A



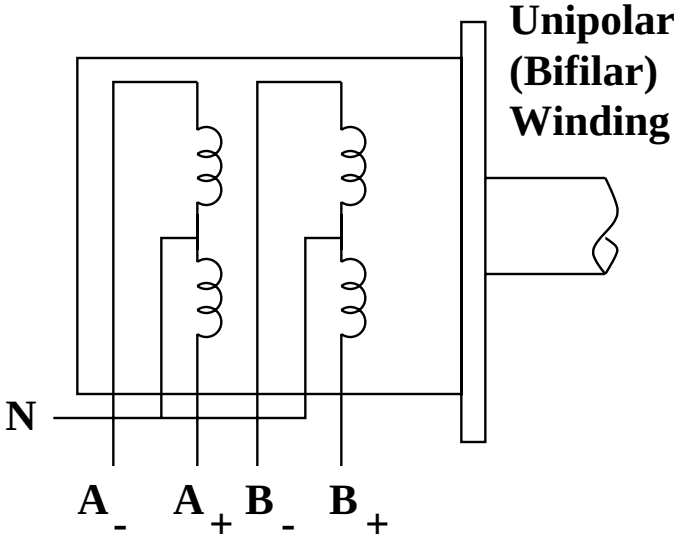
Phase B

Usually, these are biased by a permanent magnet.

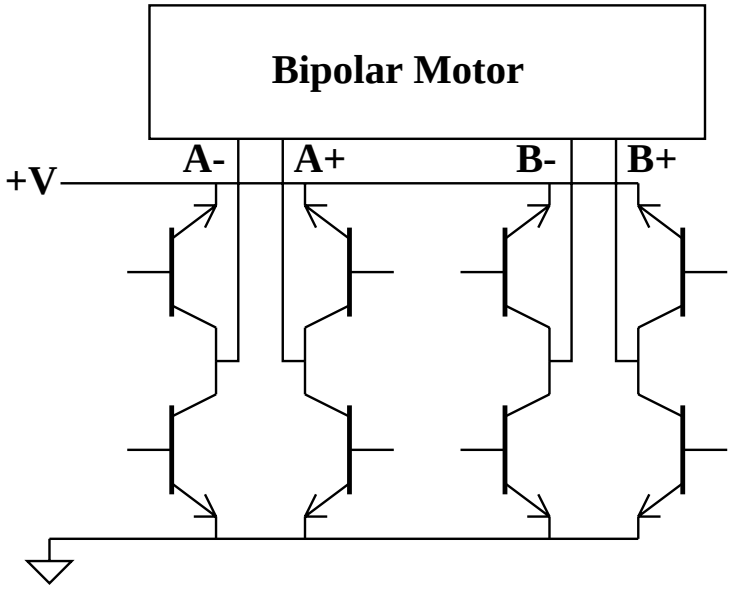
Two "stacks", or "phases", are axially separated

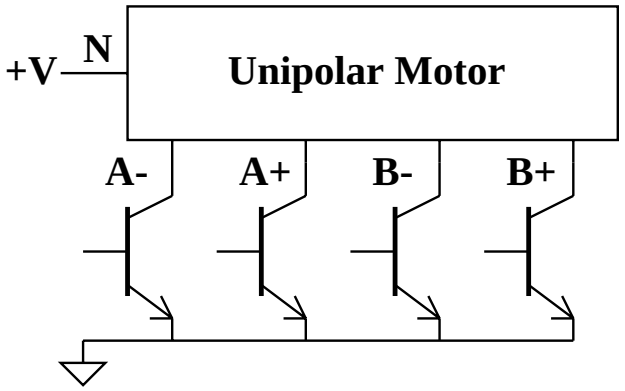


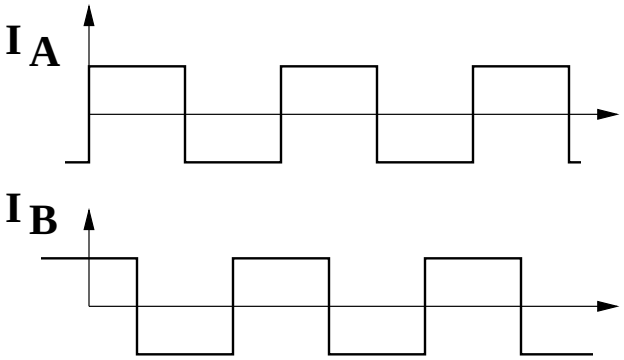
Bipolar Winding

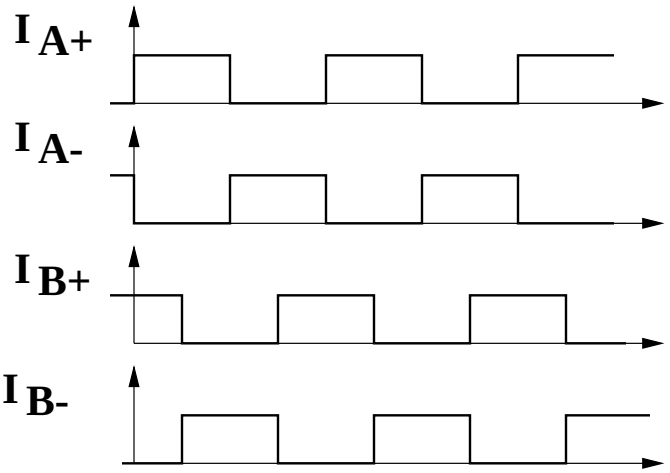


Unipolar (Bifilar) Winding









Step	I_A	I_B
1	+	+
2	+	-
3	-	-
4	-	+

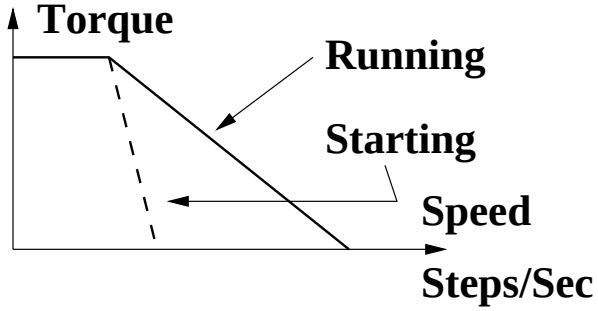
Clockwise

Counter-Clockwise

Step	I_{A+}	I_{A-}	I_{B+}	I_{B-}
1	1	0	1	0
2	1	0	0	1
3	0	1	0	1
4	0	1	1	0

Clockwise

Counter-Clockwise



Must sometimes ’ramp up’ speed
Holding torque is limited by heating and by saturation