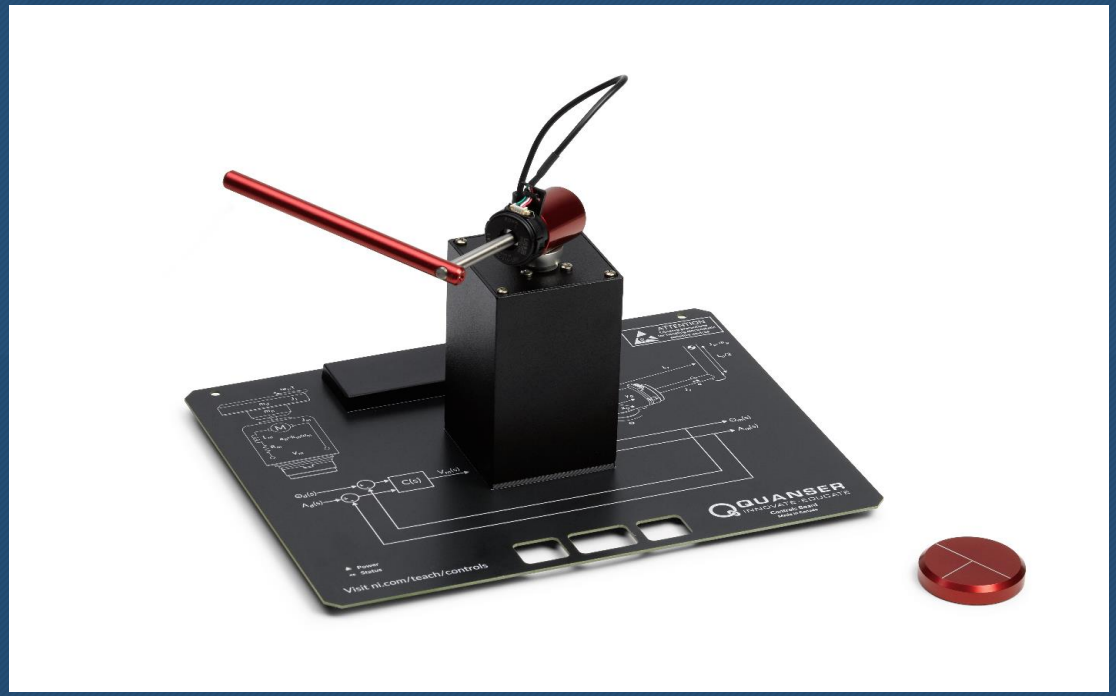
Displacement and Velocity Sensors

MEMS 1049 Mechatronics

7	April 15 Angular Displacement	April 20 Lab 1
8	April 22 Distance and Proximity	April 27 Lab 2
9	April 29 Inertial Measurement	May 10(May 4) Lab 3
10	May 6 DC Motor Modelling	May 11 Lab 4

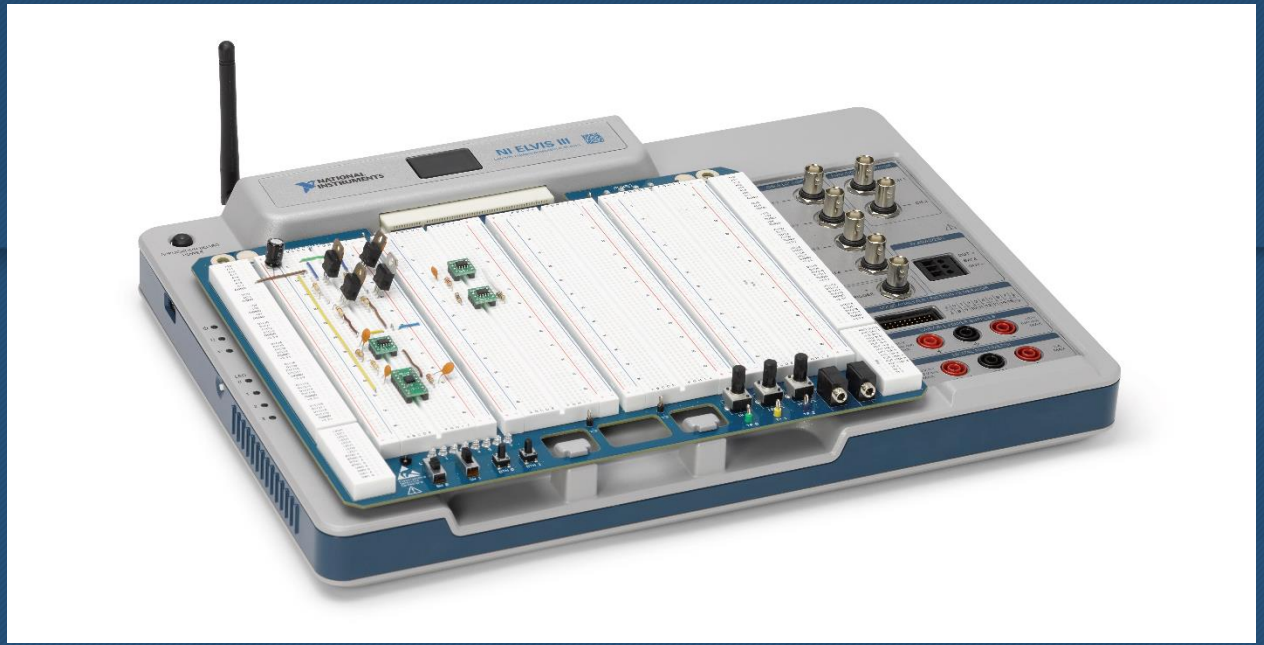
Outline

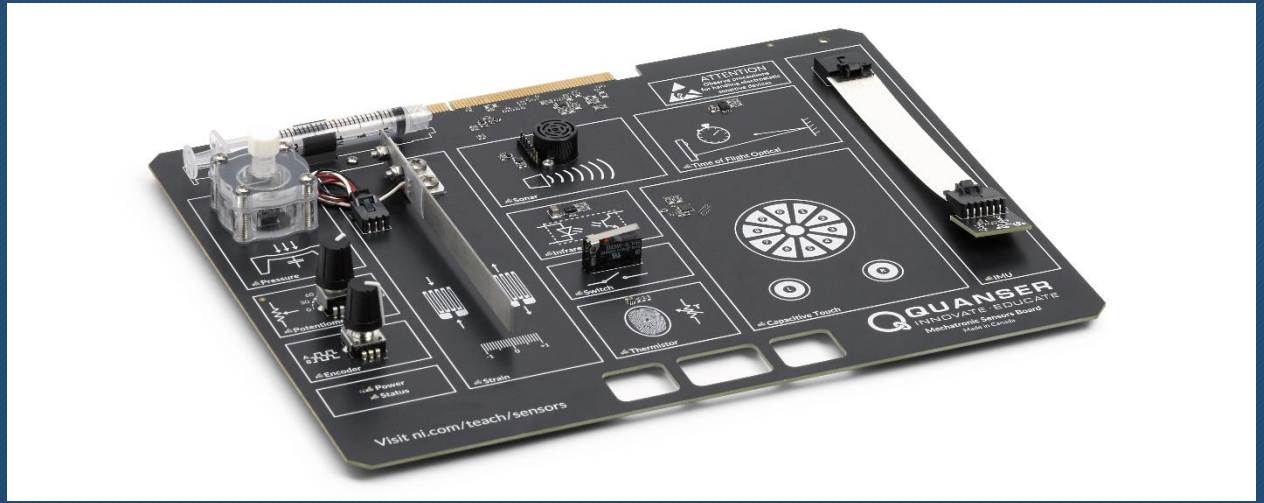
- Displacement sensors
  - Linear Potentiometers
  - Linear Variable Differential Transformers (LVDT)
  - Rotary Potentiometer
- Velocity sensors
  - Centrifugal Tachometers
  - DC Tachometer
  - Electromagnetic Tachometer
  - Stroboscopic Tachometer
  - Encoders



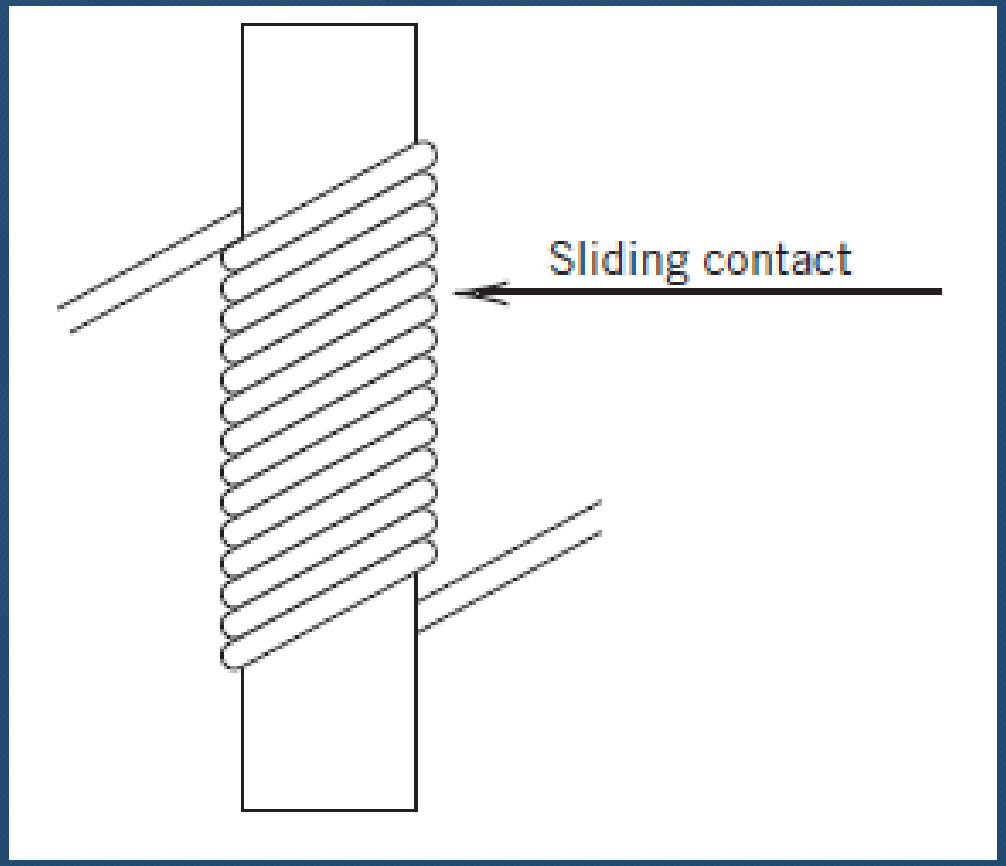
Sensor Board

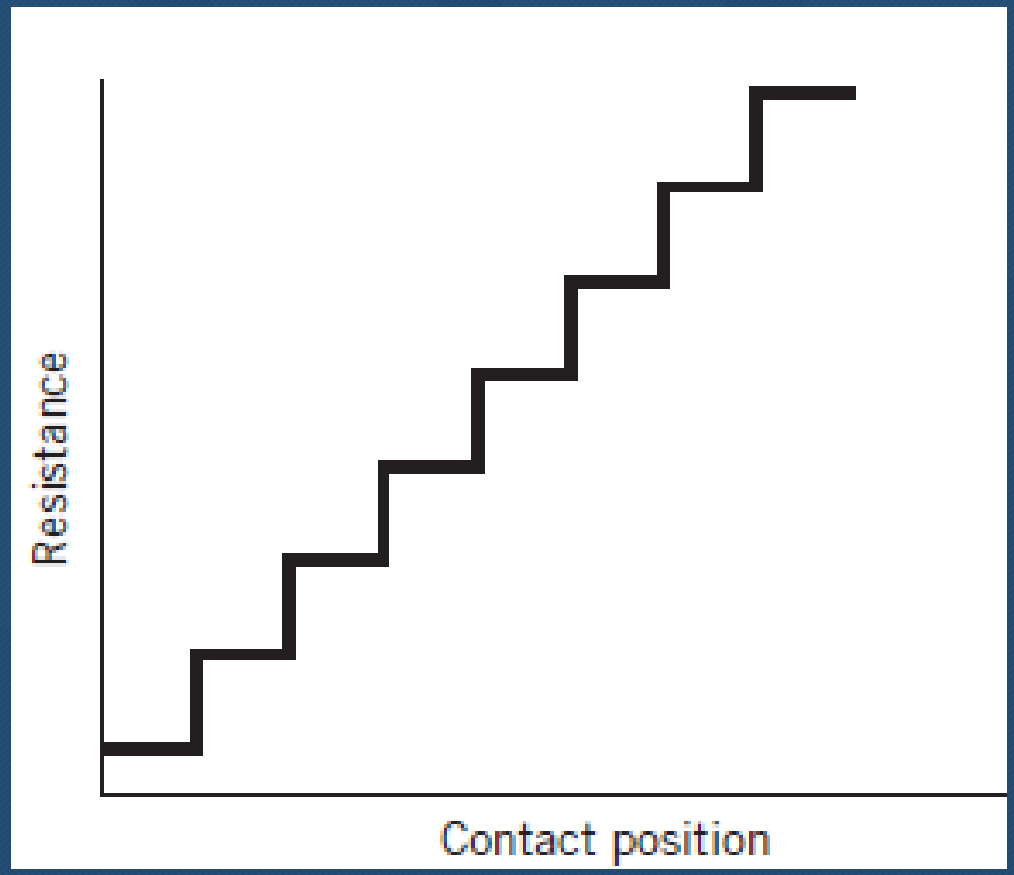
- Angular Displacement
- Distance and Proximity
- Temperature
- Strain
- Pressure
- Contact
- Inertial Measurement



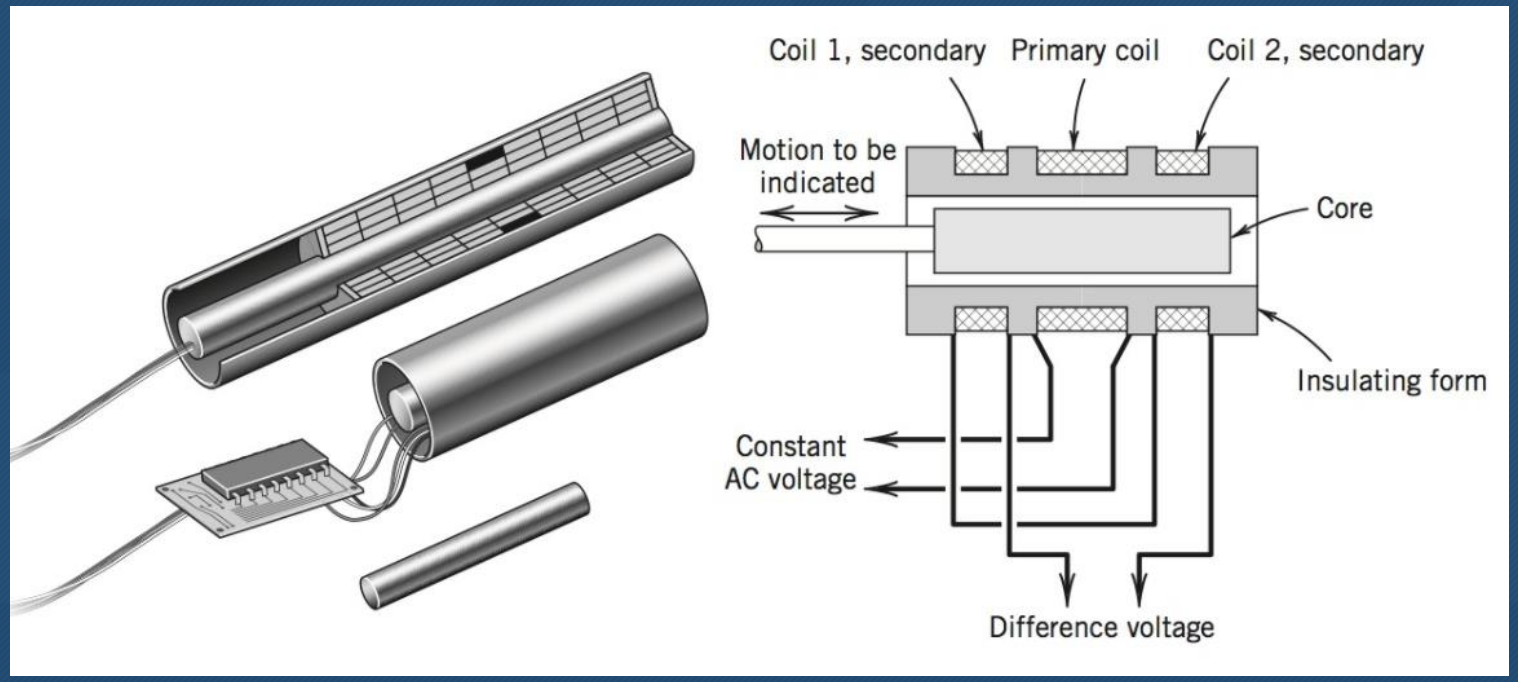


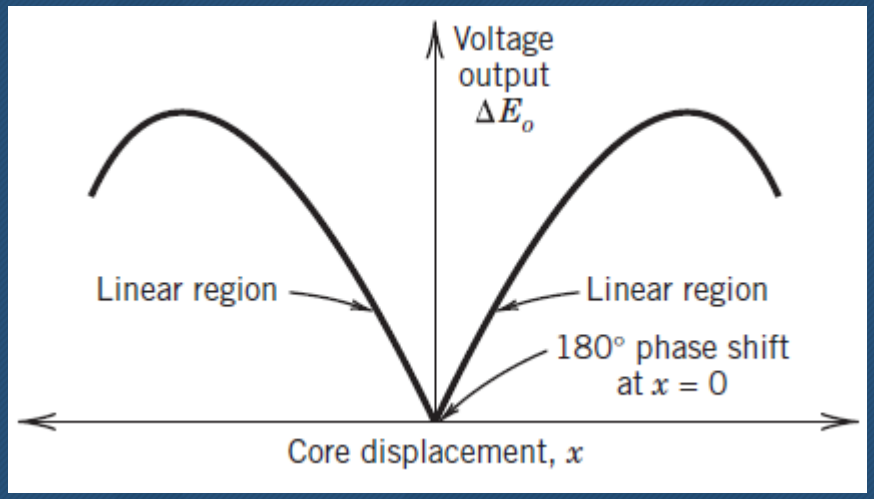
Linear Potentiometers





Linear Variable Differential Transformers (LVDT)





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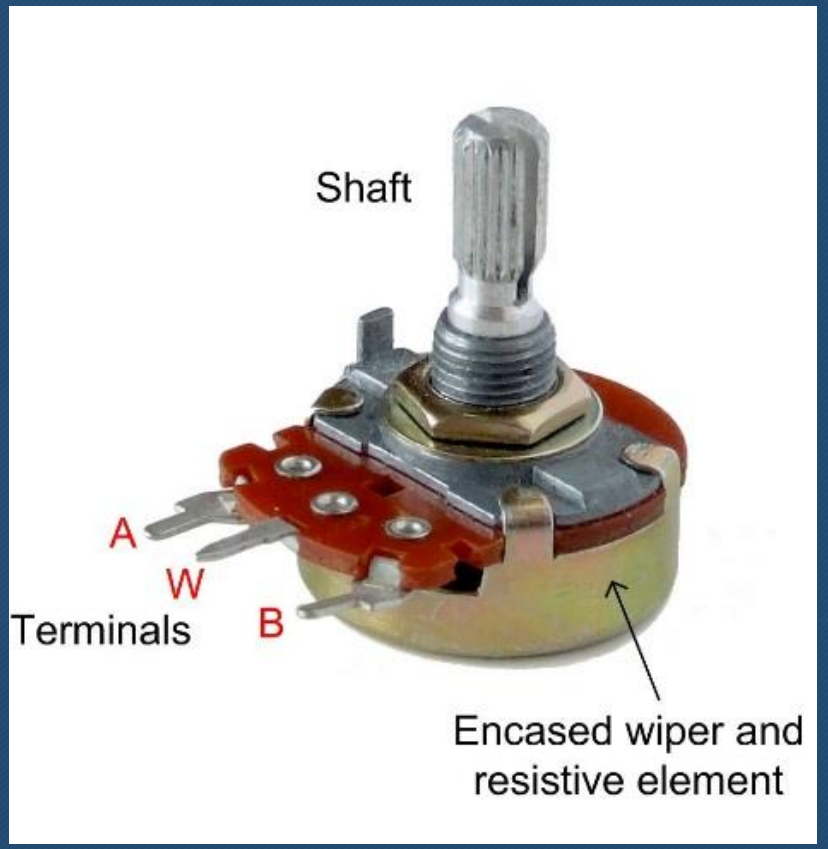
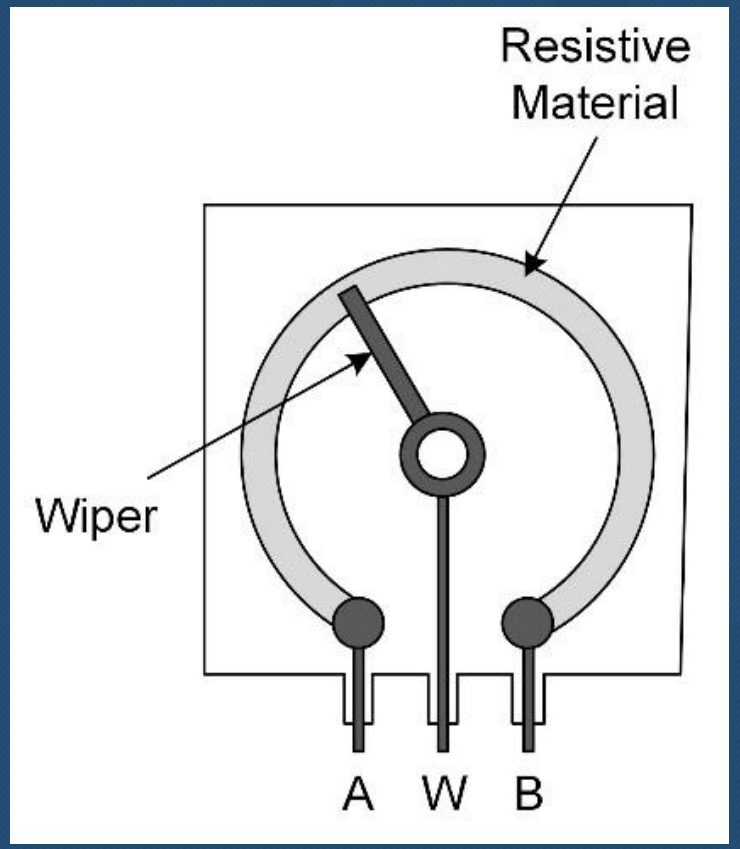
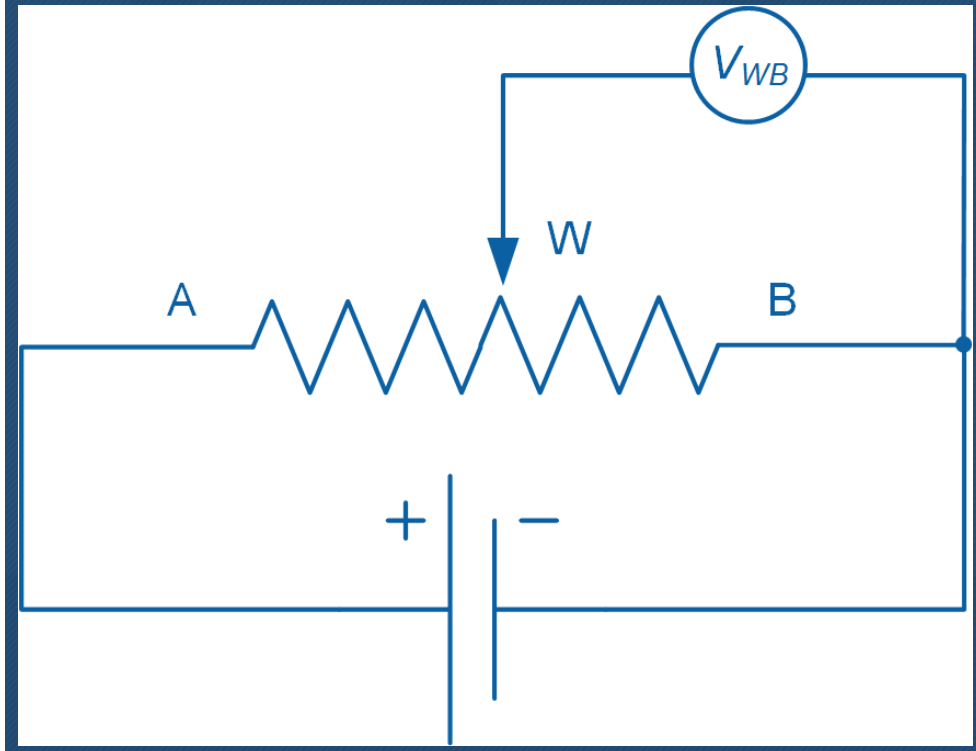
Rotary Potentiometer

$$V_{AB} = V_{AW} + V_{WB}$$

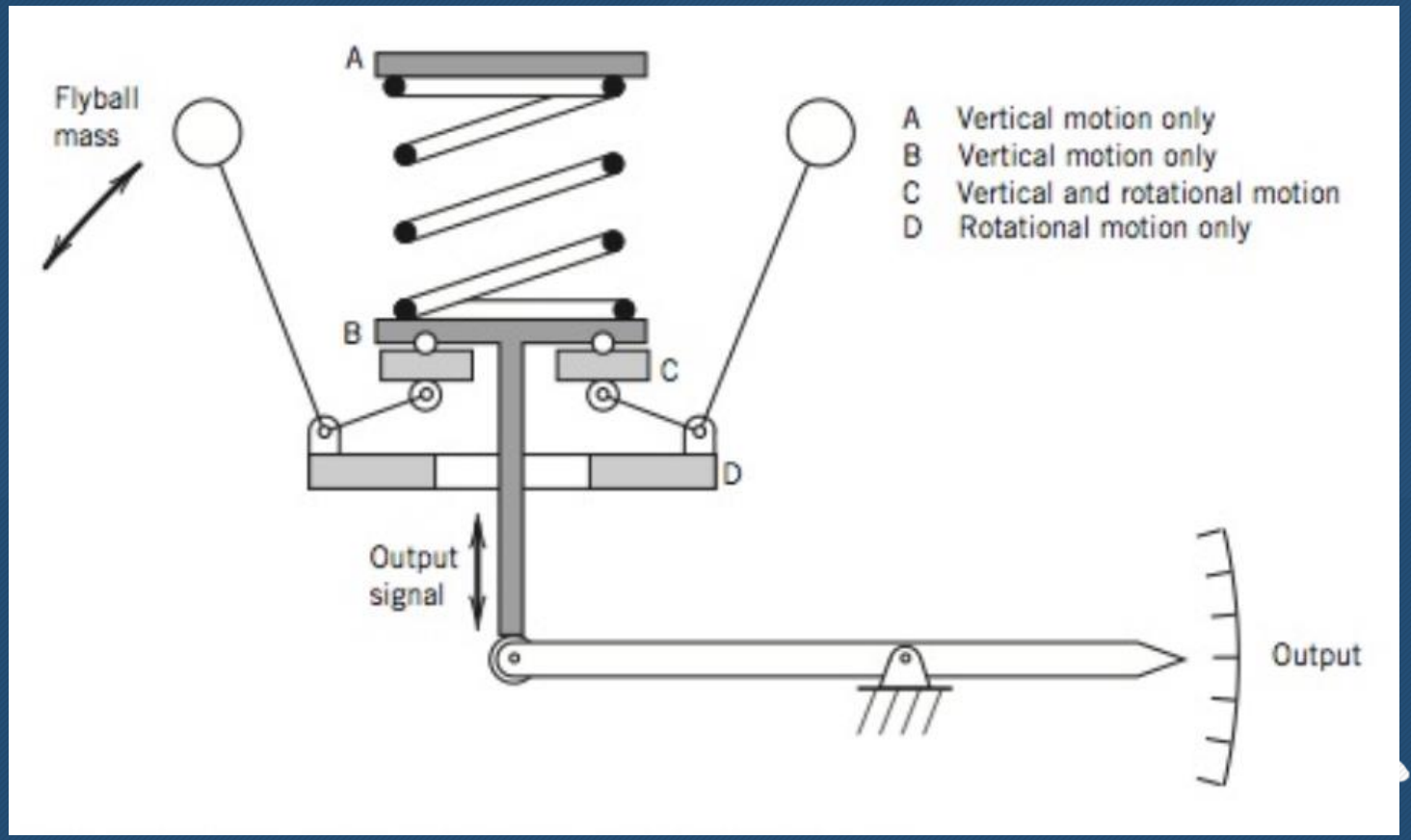




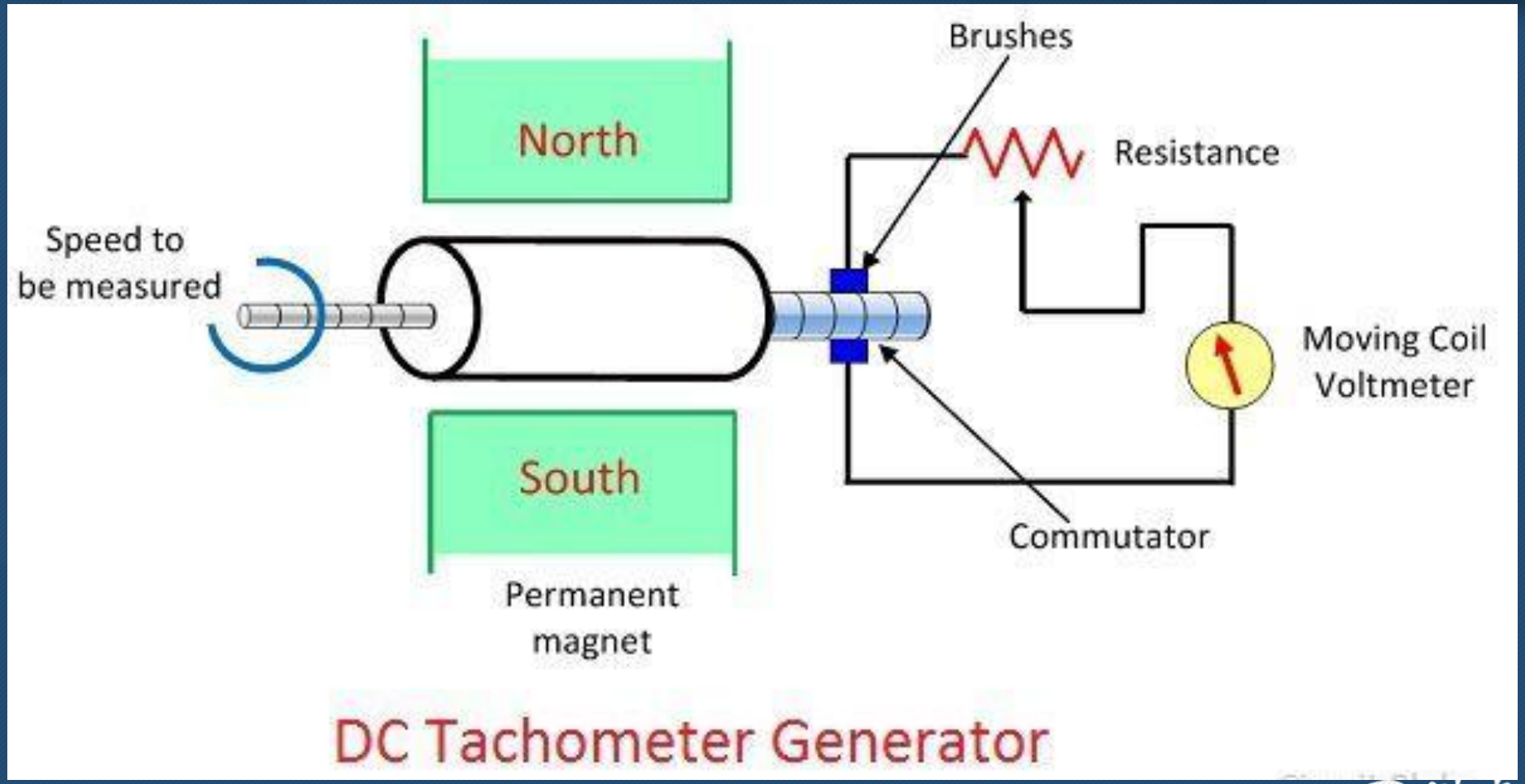


Centrifugal Tachometers

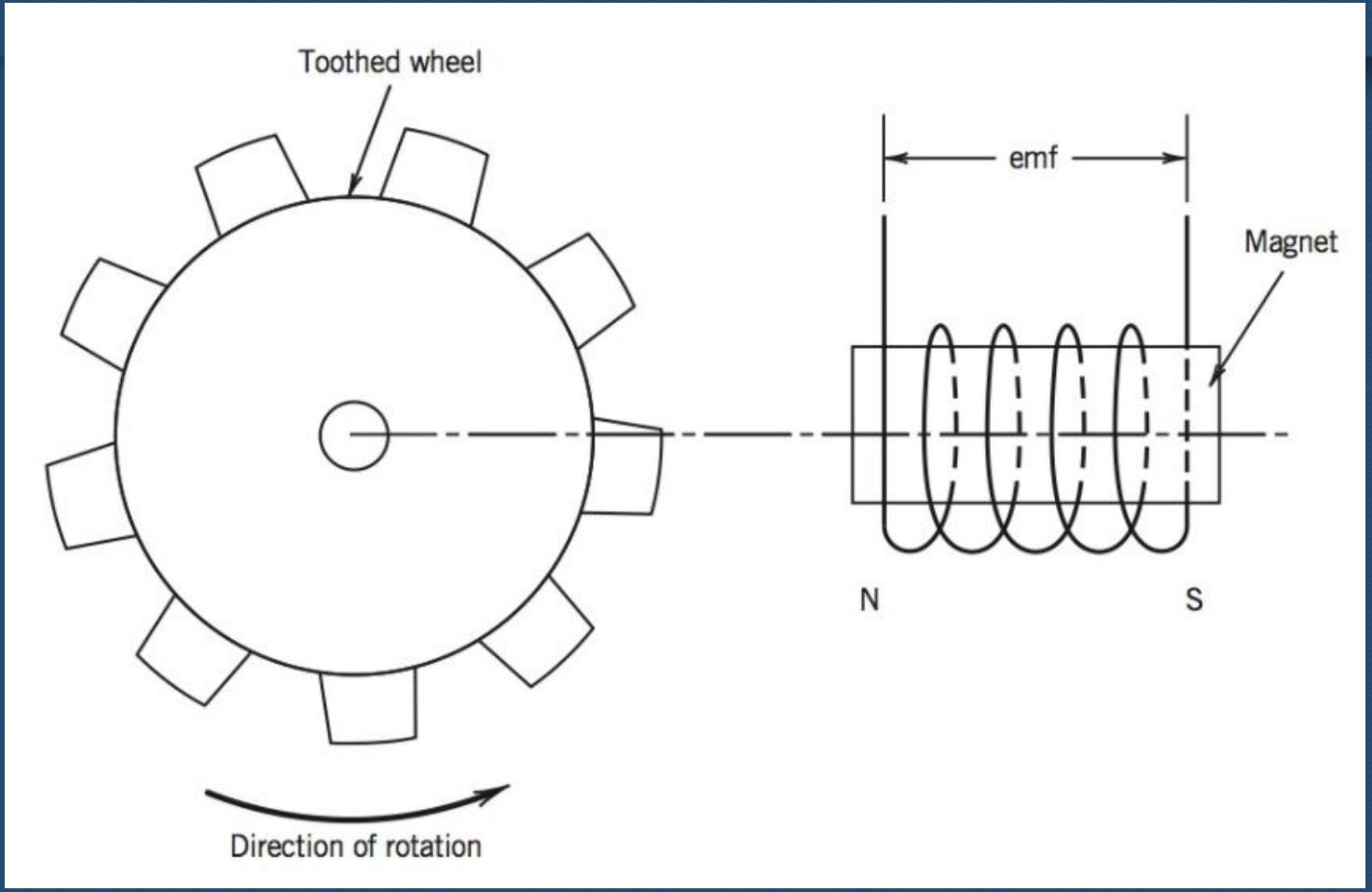
The centripetal acceleration of the flyball masses result in a steady-state displacement of the spring, which provides a control signal or is a direct indication of rotational speed.



DC Tachometer

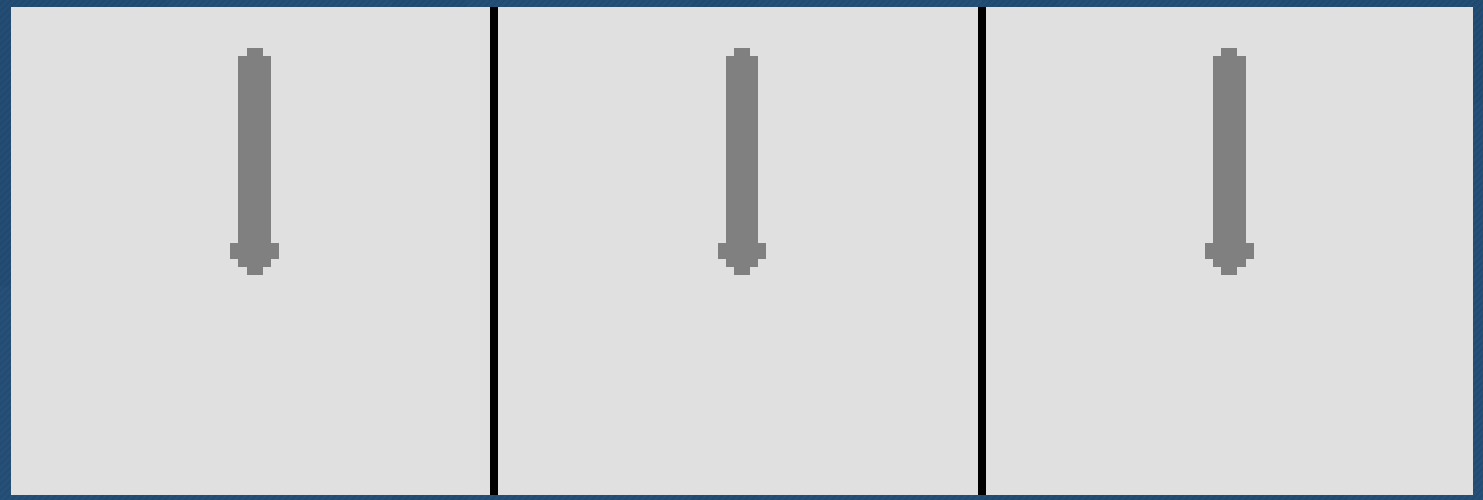


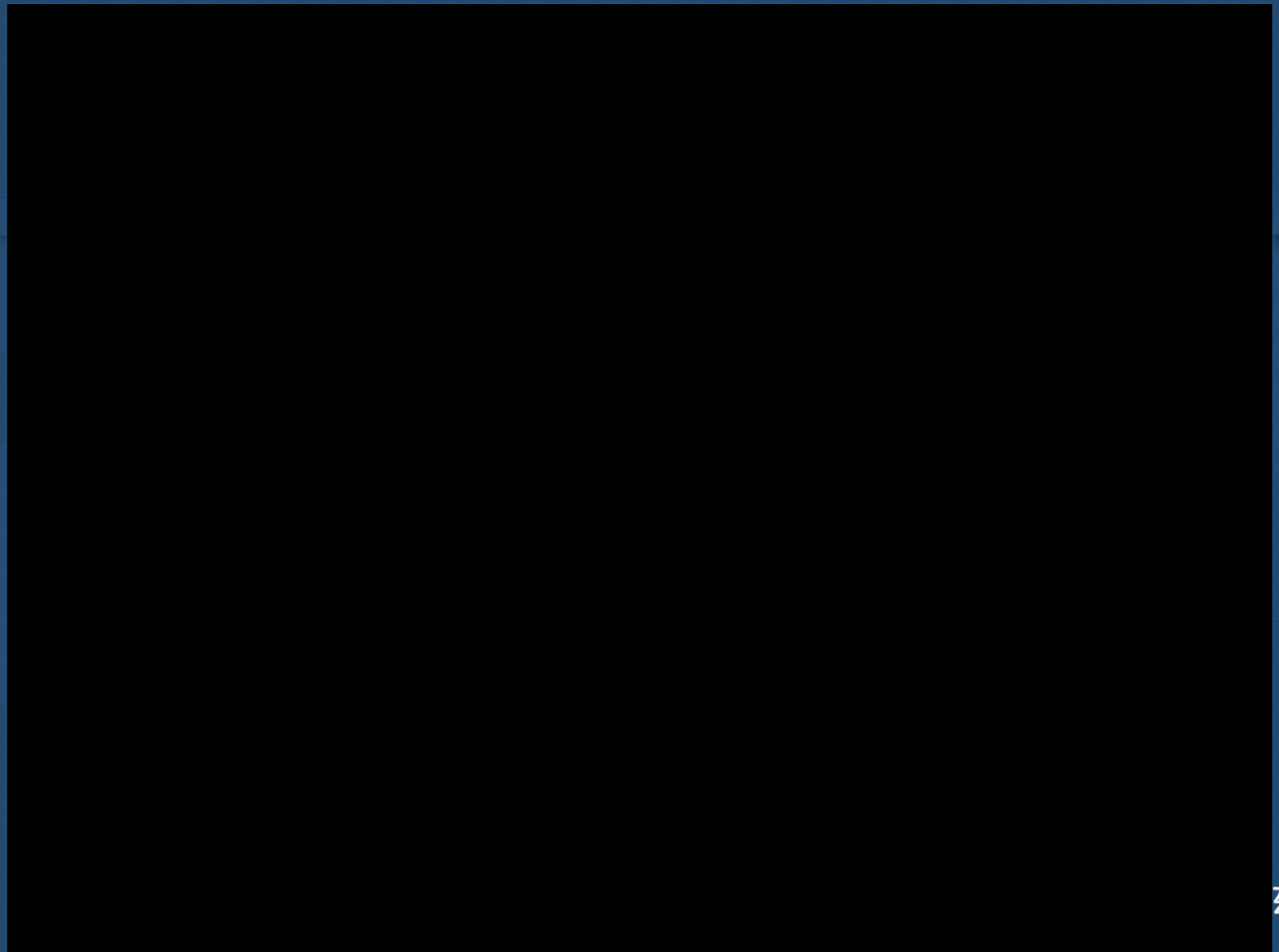
Electromagnetic Tachometer



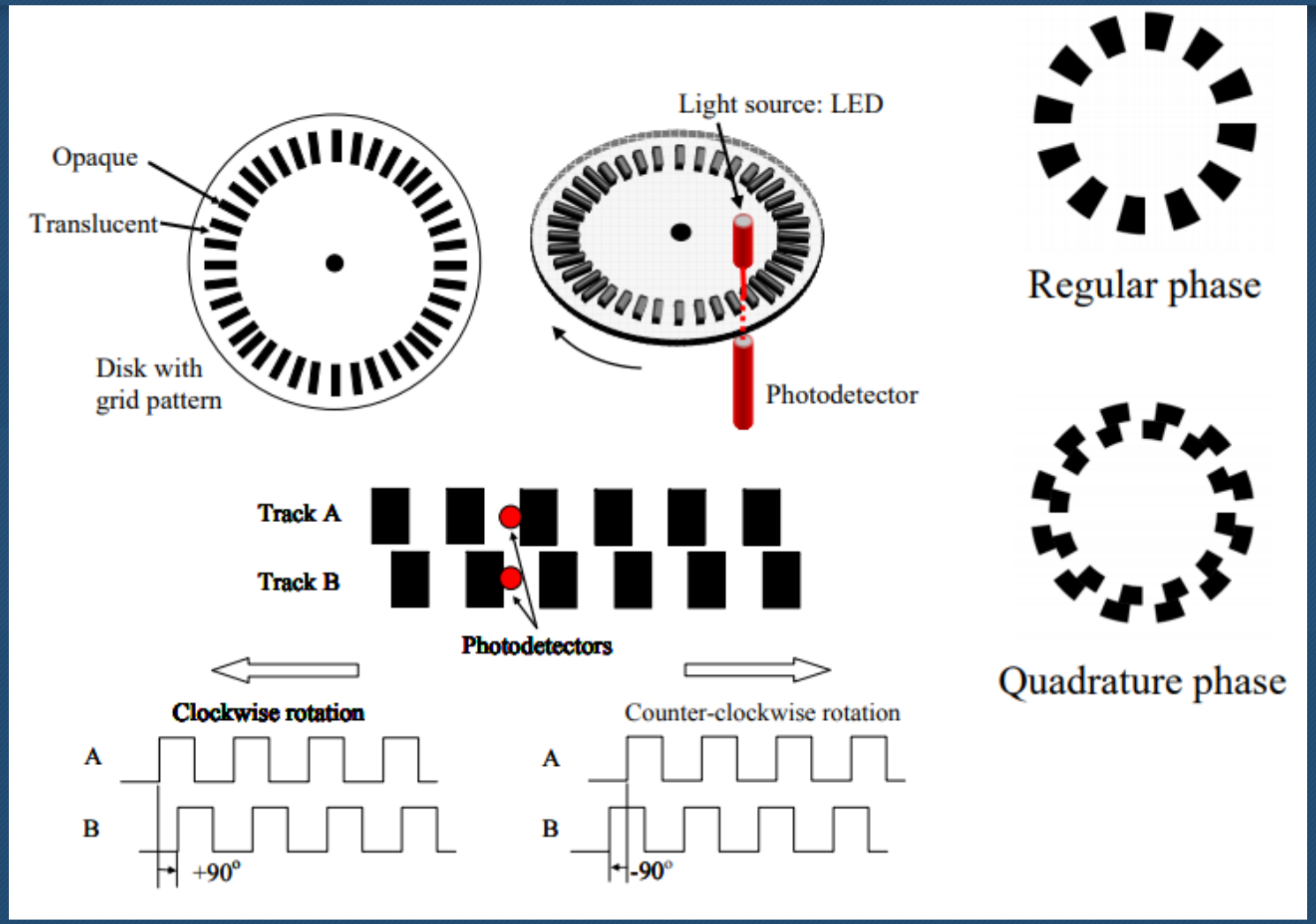
$$E = C_B N_t \omega \sin N_t \omega t$$

Stroboscopic Tachometer

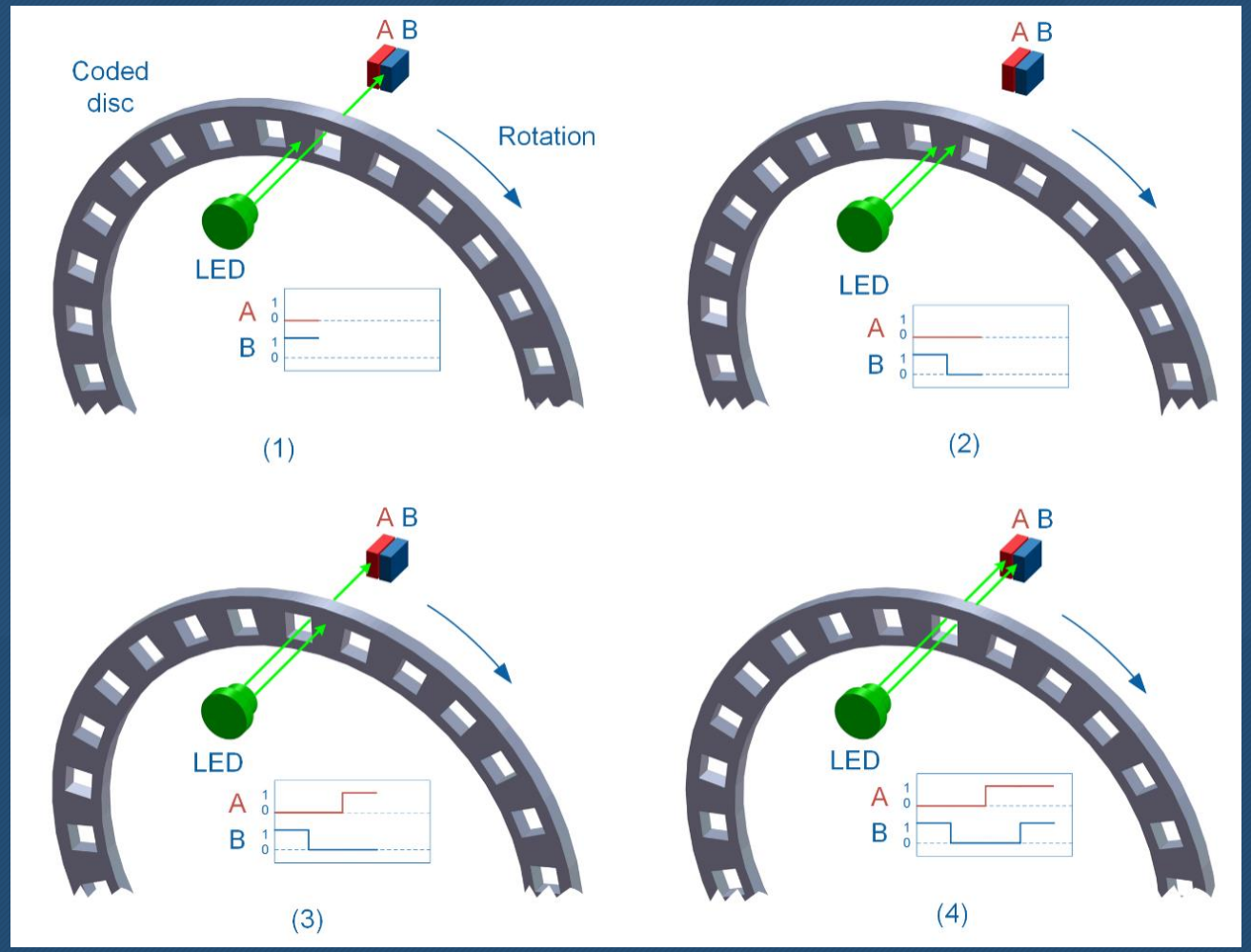




Encoder


Opaque
Translucent
Disk with
grid pattern
Light source: LED
Photodetector
Regular phase
Quadrature phase
Track A
Track B
Photodetectors
Clockwise rotation
Counter-clockwise rotation
A
B
+90°
A
B
-90°

Encoder

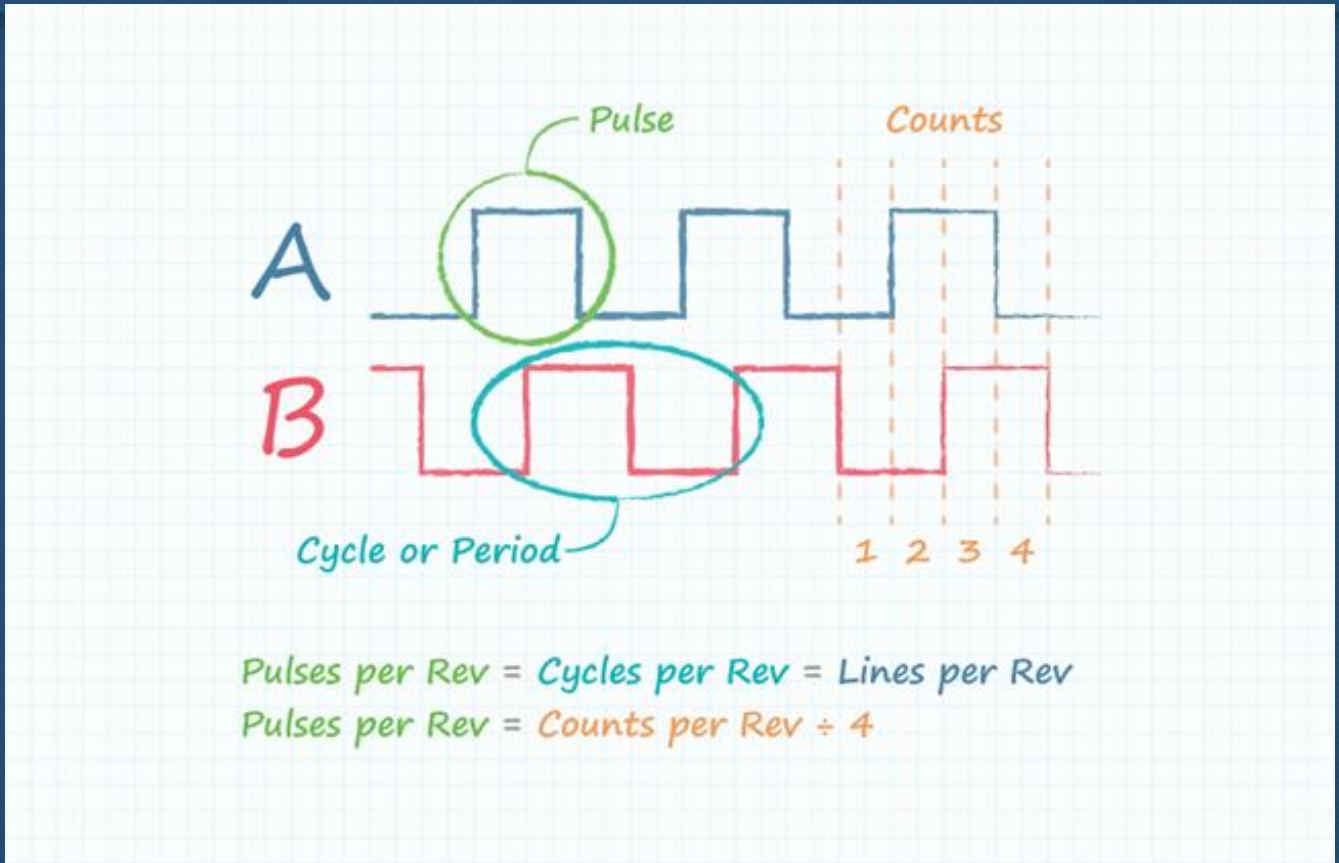


State	Signal A	Signal B
1	OFF	ON
2	OFF	OFF
3	ON	OFF
4	ON	ON

Encoder

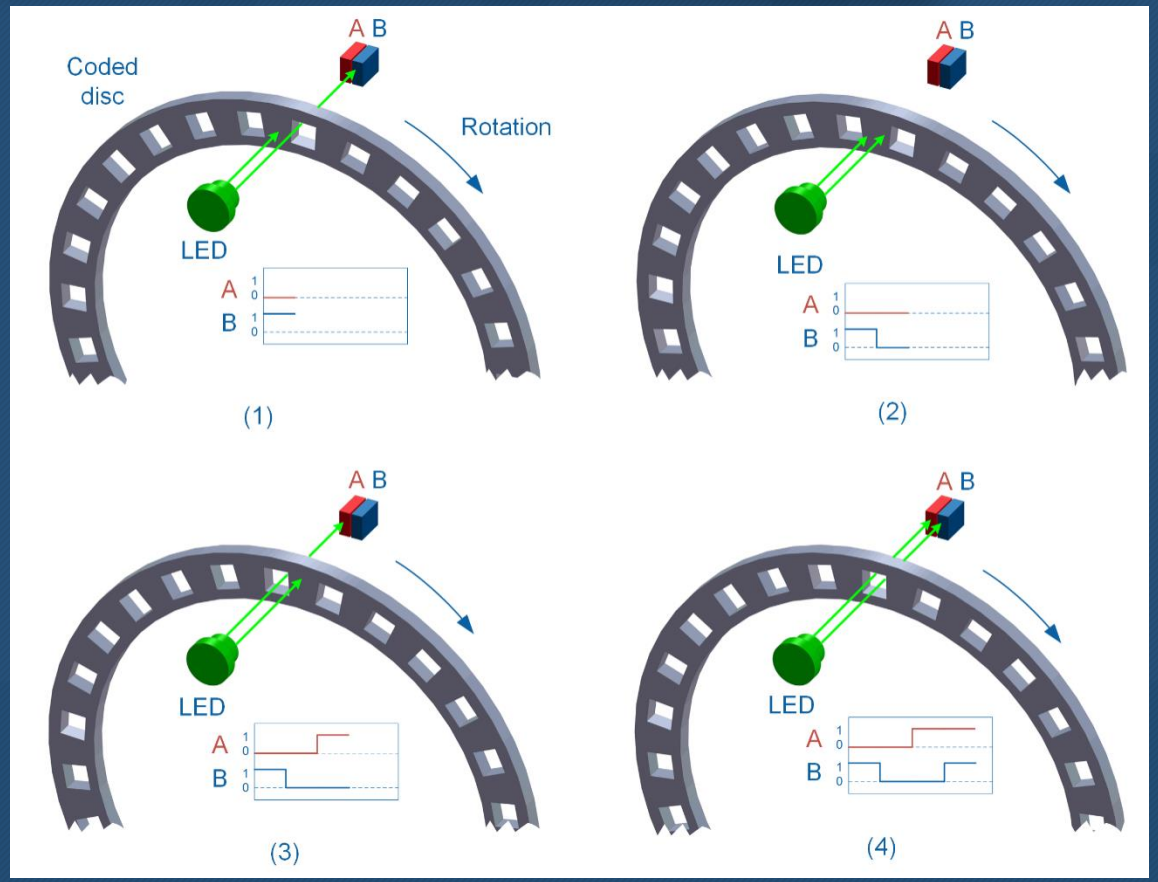
- Pulse per revolution (PPR or LPR): the number of light or dark patterns on the disk

- Count per revolution (CPR): the number of quadrature decoded states per revolution



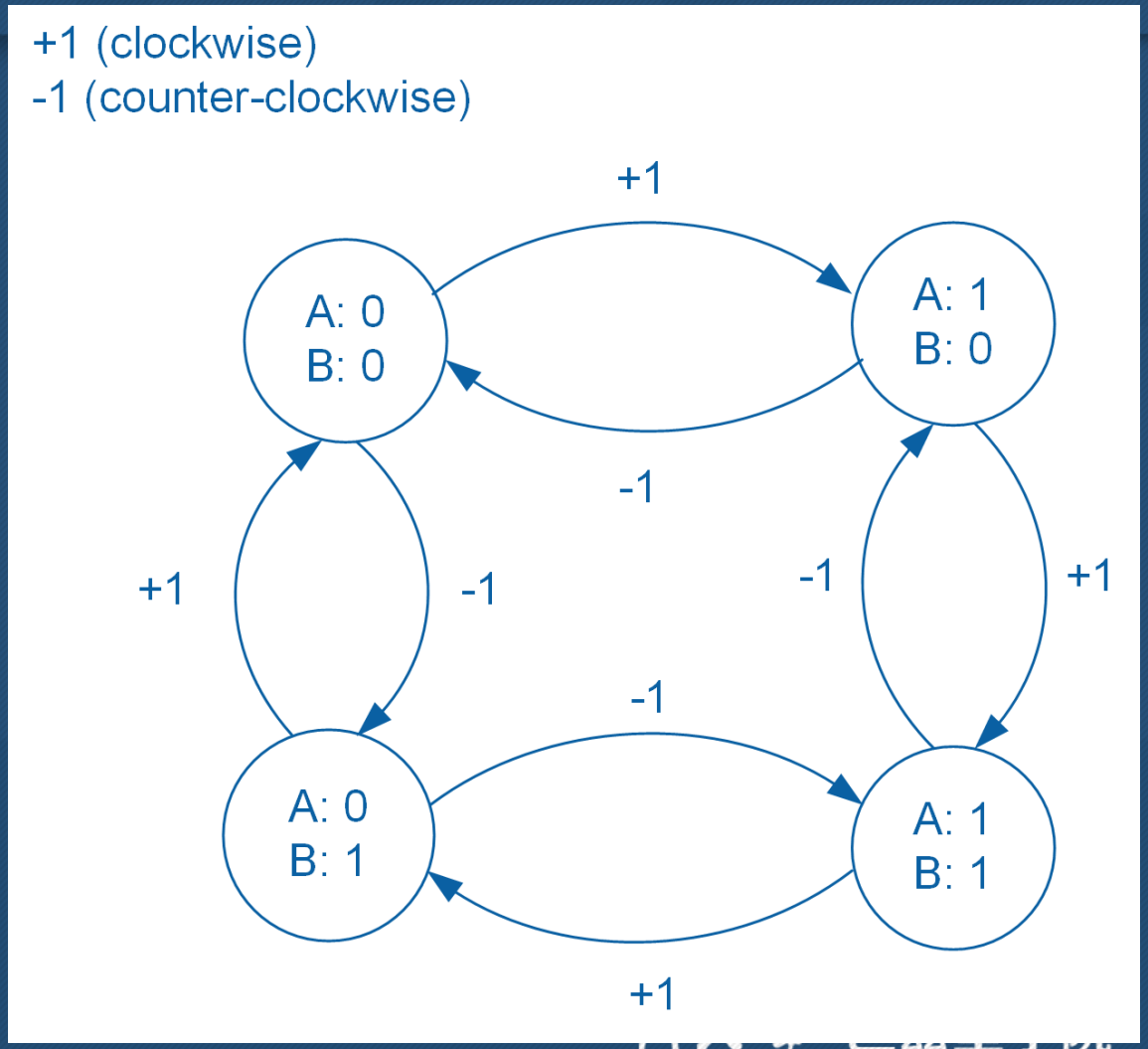
Encoder Decoding

- Non-quadrature
  - Rising edge of signal A
  - 9 CPR
- X1 Decoder
  - Rising edge of signal A
  - State of signal B
  - 9 CPR
- X2 Decoder
  - Rising and falling edges of signal A
  - State of signal B
  - 18 CPR



Encoder Decoding

- X4 Decoder
  - Rising and falling edge of signal A
  - Rising and falling edge of signal B
  - 36 CPR



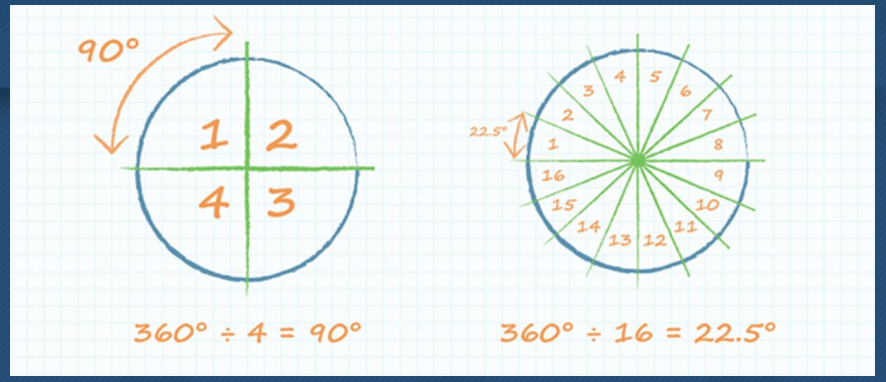
Angular Displacement and Resolution

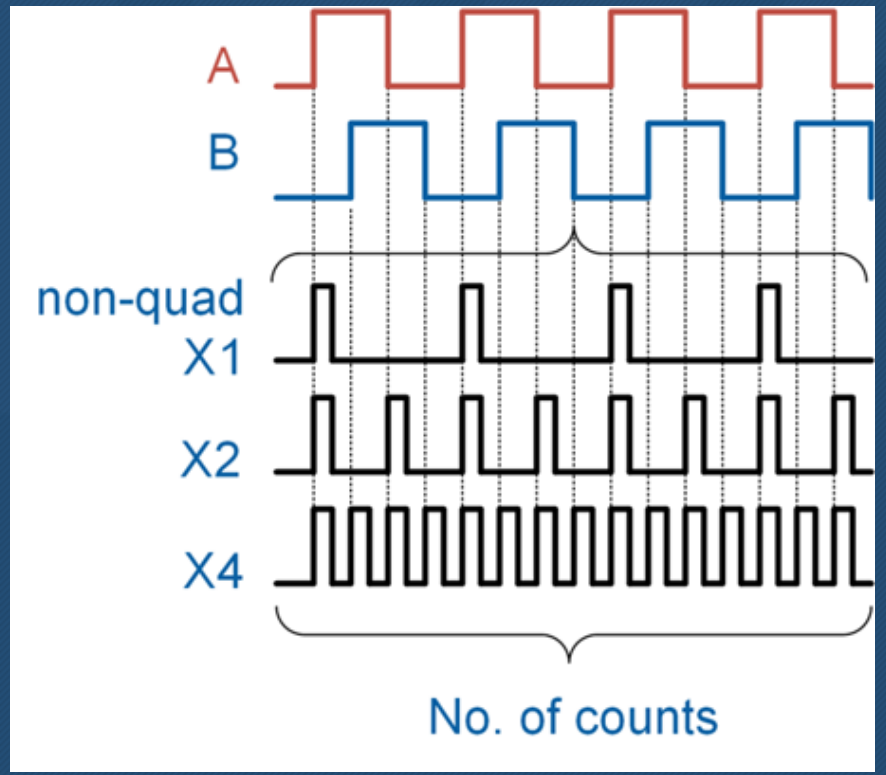
- Angular Displacement

$$\theta = \frac{Counts}{N \cdot PPR} \cdot 360°$$

- Resolution

$$\Delta\theta = \frac{360°}{N \cdot PPR}$$





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