Electronics
DC Motor with Shaft Encoder

Terry Sturtevant

Wilfrid Laurier University

November 1, 2018

Shaft encoders

Shaft encoders

- *Incremental rotary* encoding

Shaft encoders

- *Incremental rotary* encoding

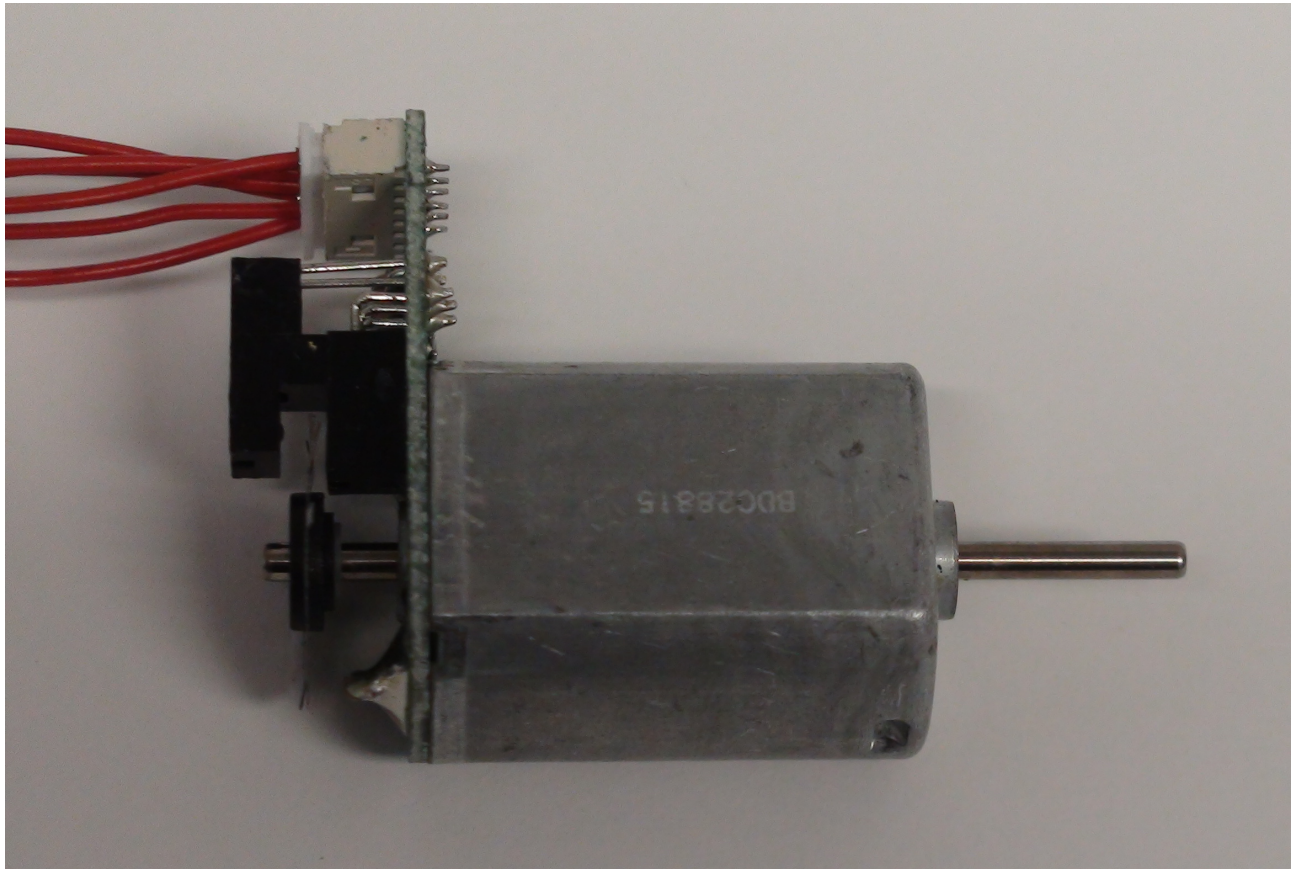
  two channels

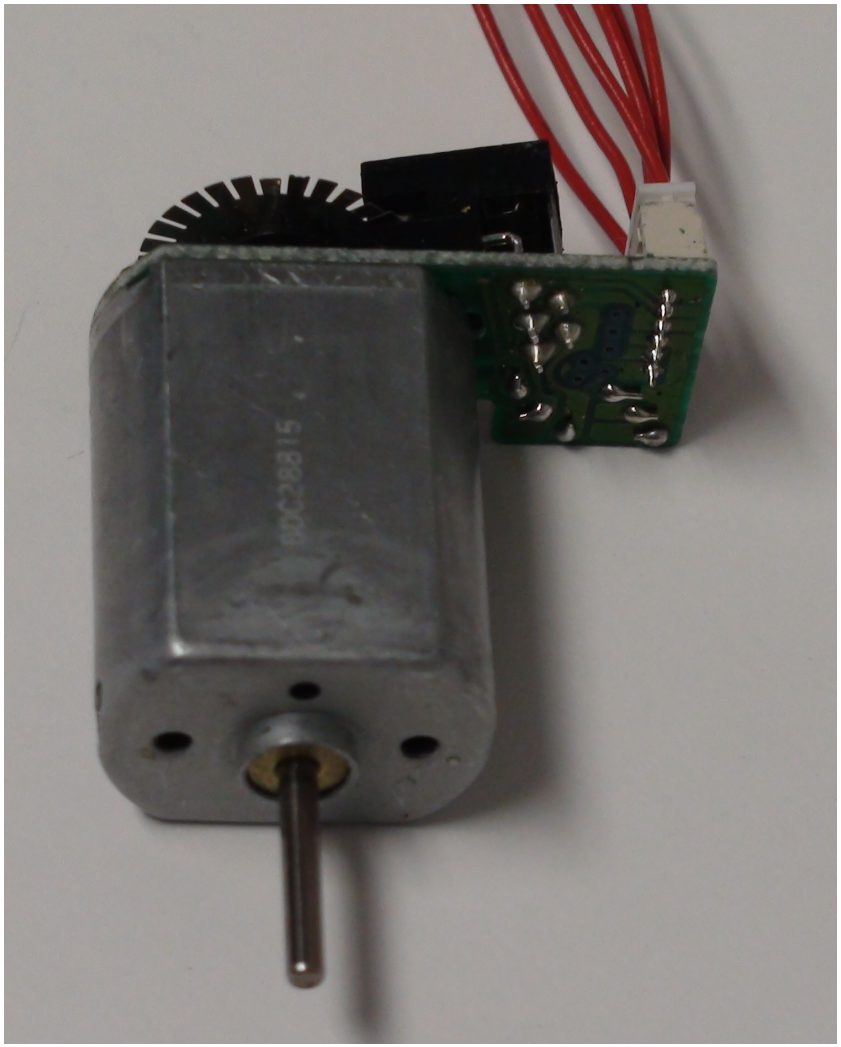
Shaft encoders

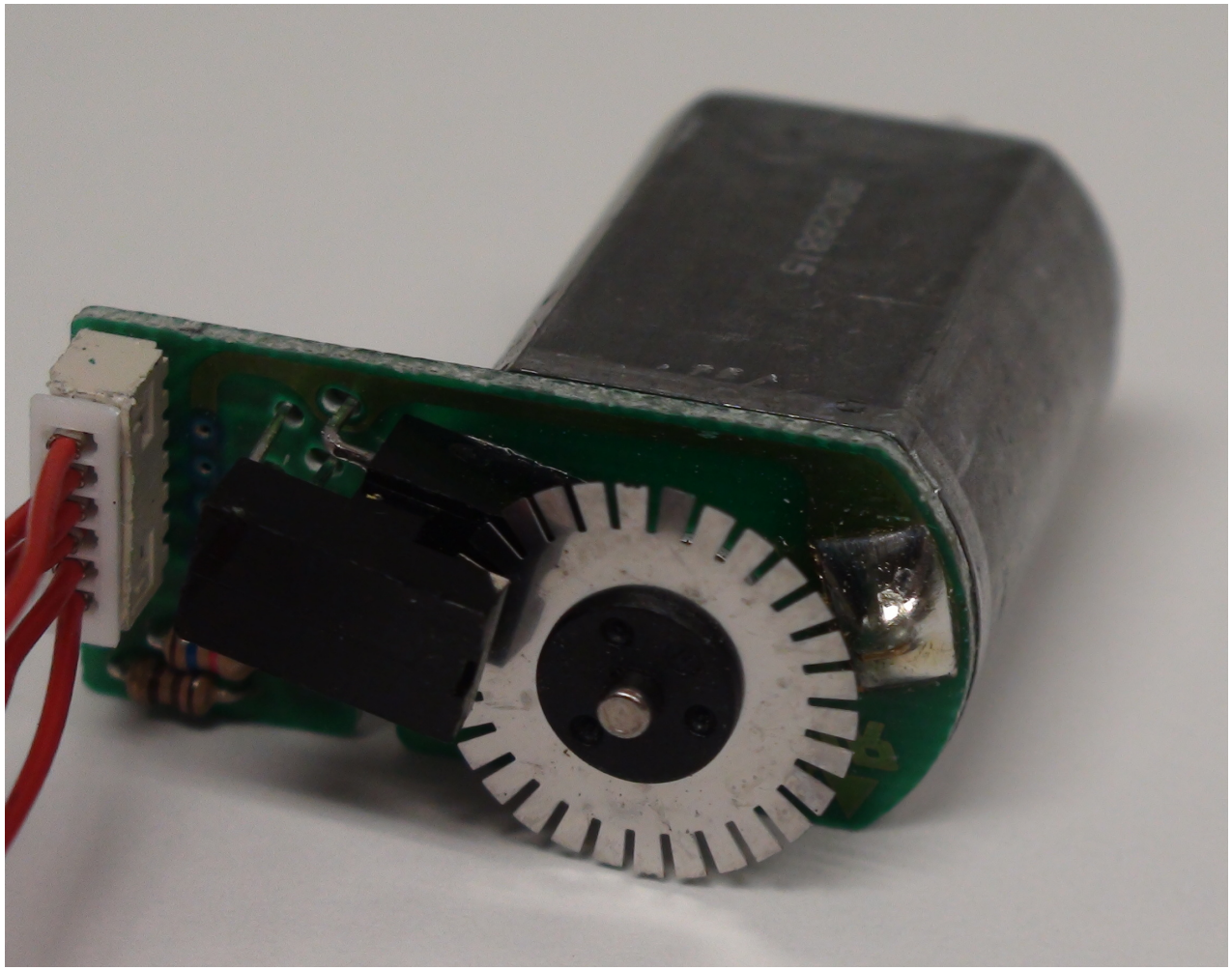
- *Incremental rotary* encoding

  two channels

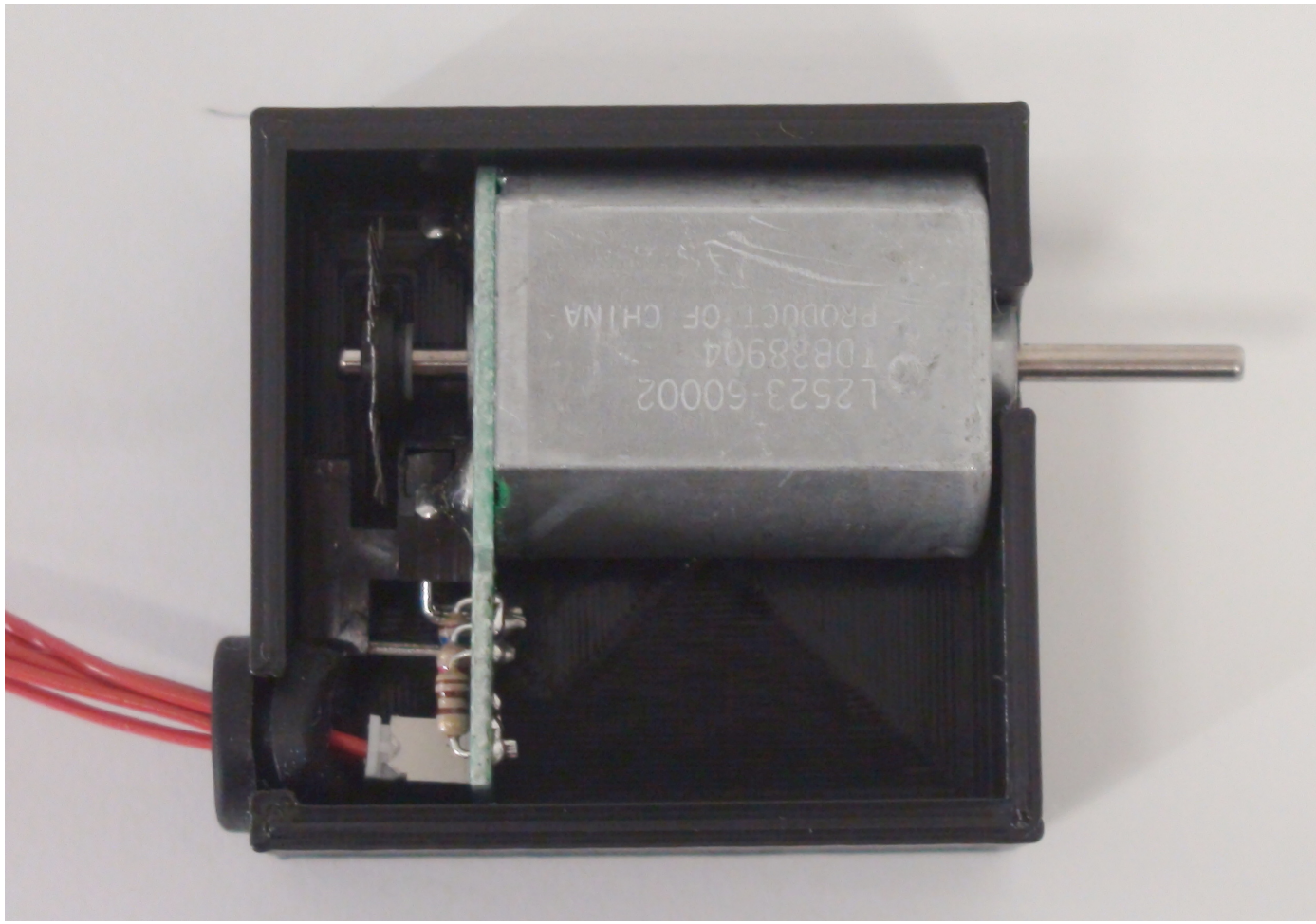
As long as you know the initial position, you can update if you can sense changes.



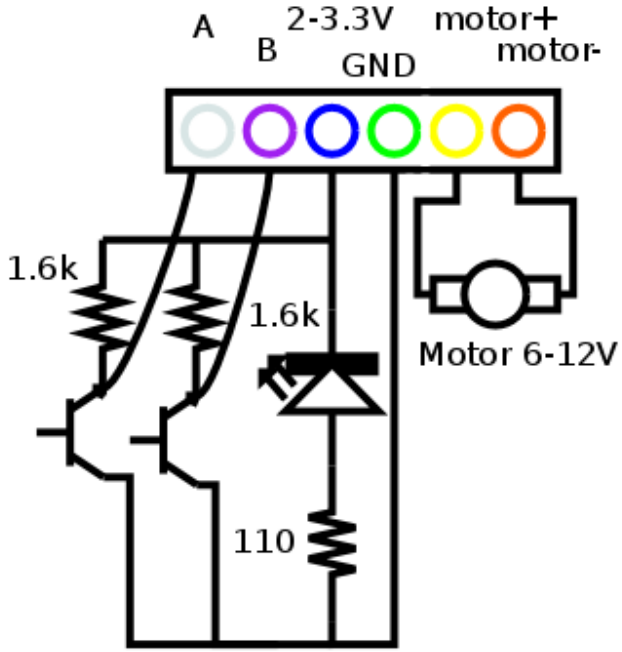




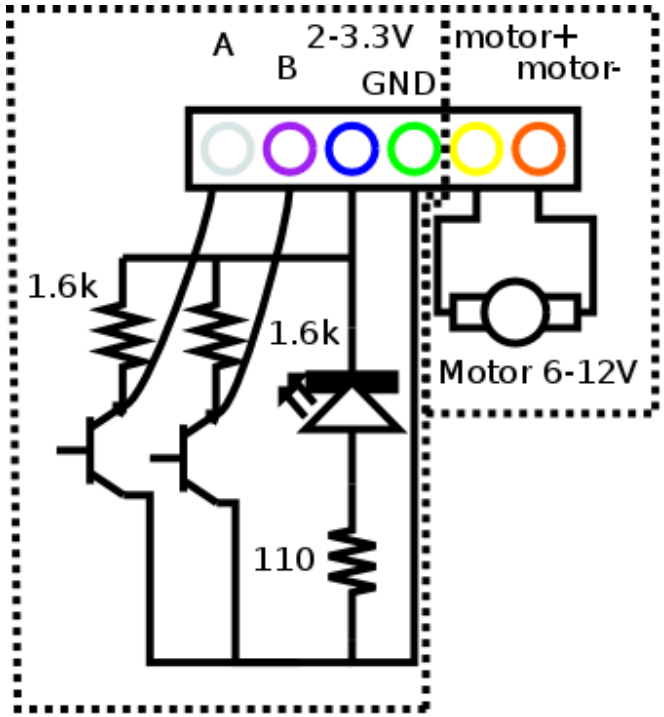
There are 30 teeth, so the encoder has 12° resolution.



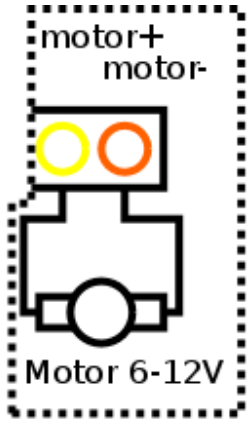
Here's how it fits in the case.



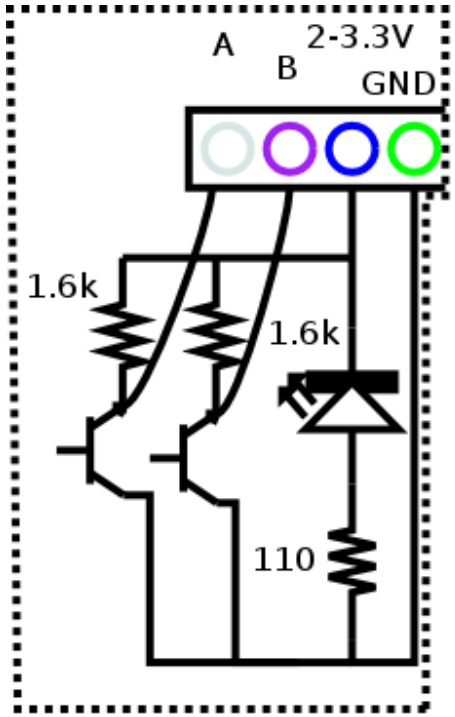
There's no electrical connection between motor and shaft encoder.



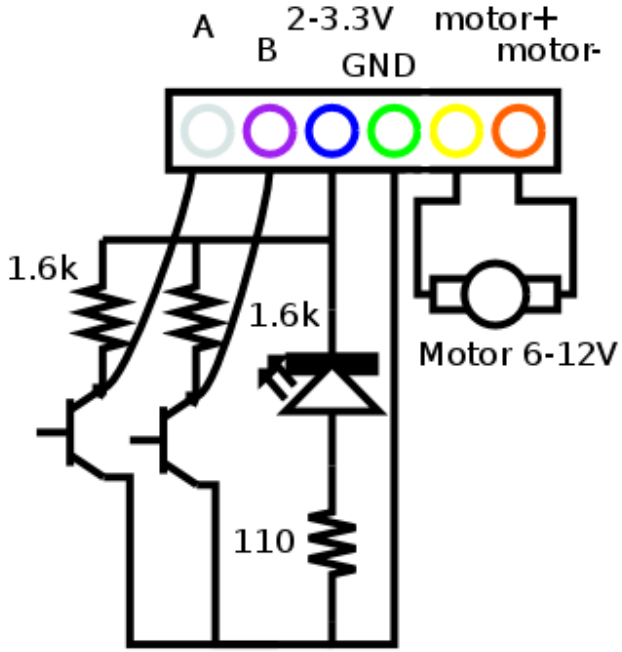
Here are the two parts identified.



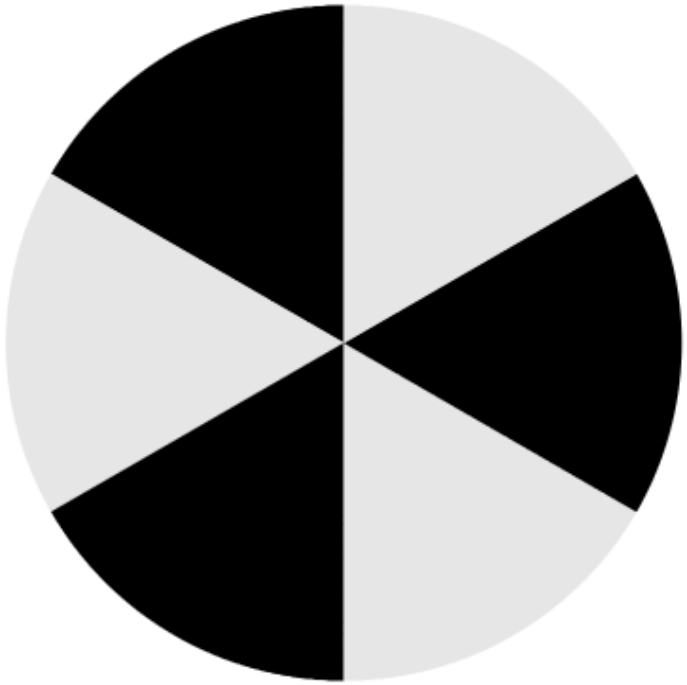
Here are the motor connections.

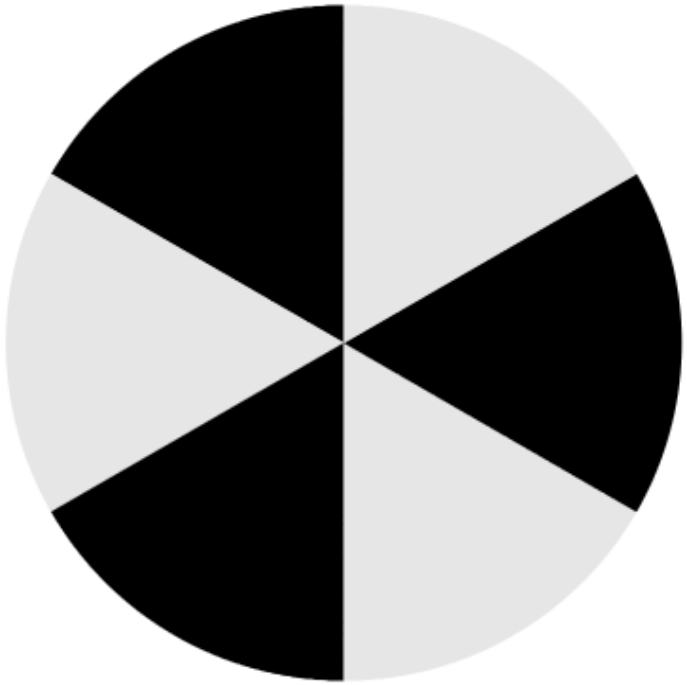


Here are the shaft encoder connections.

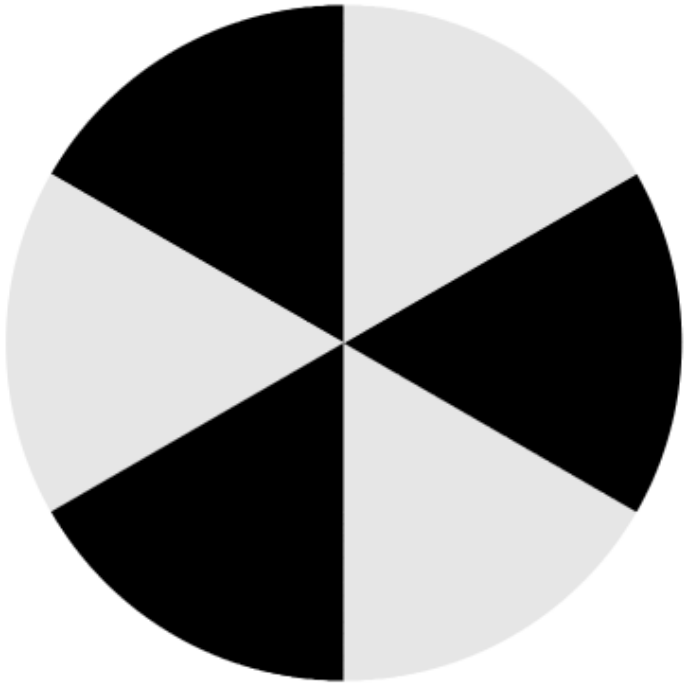


There is not even a common ground.

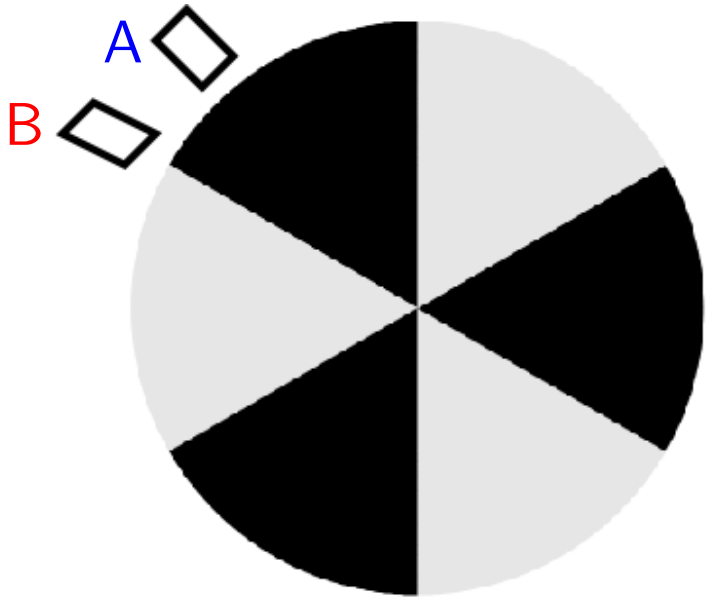




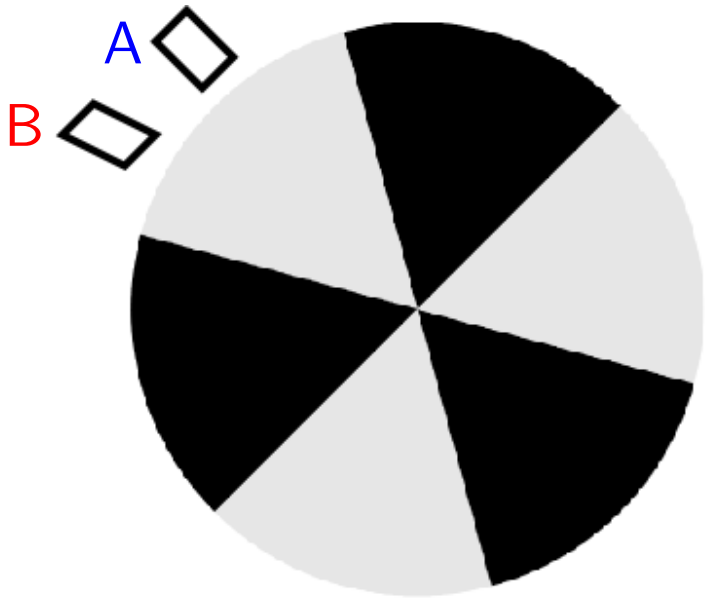
- Shaft encoder wheel



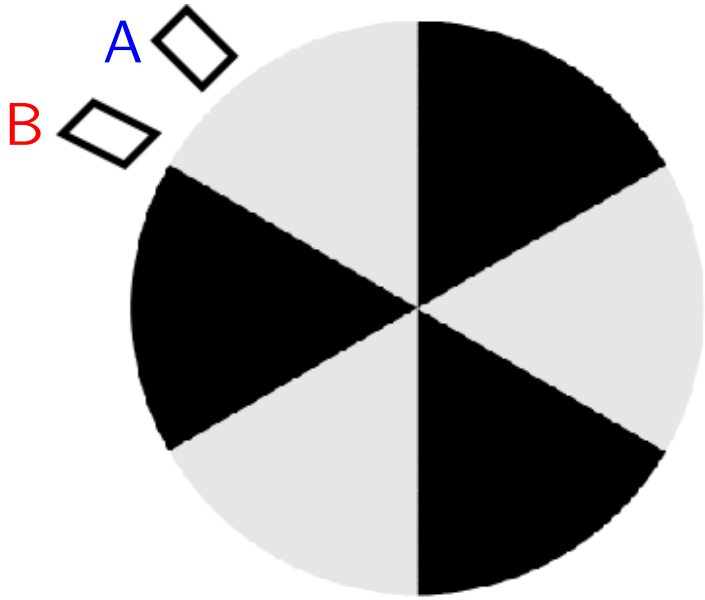
- Shaft encoder wheel
- Two sensors will allow determination of rotation *speed* and *angle*



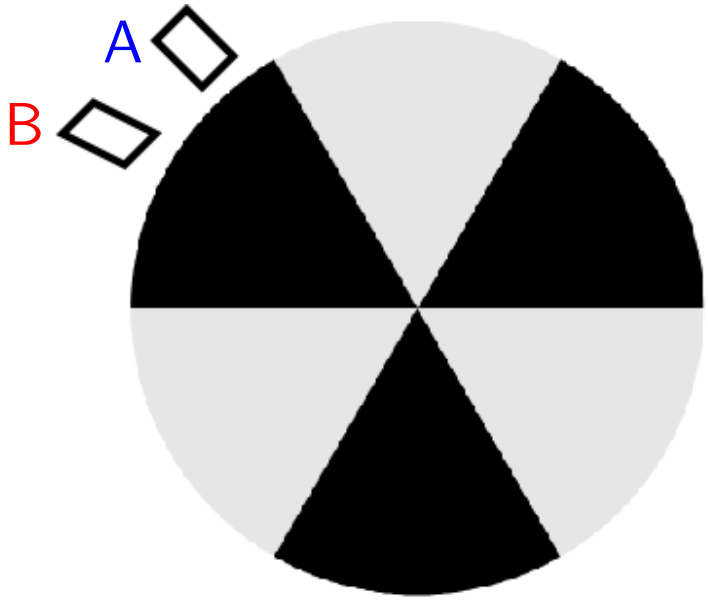
- Clockwise



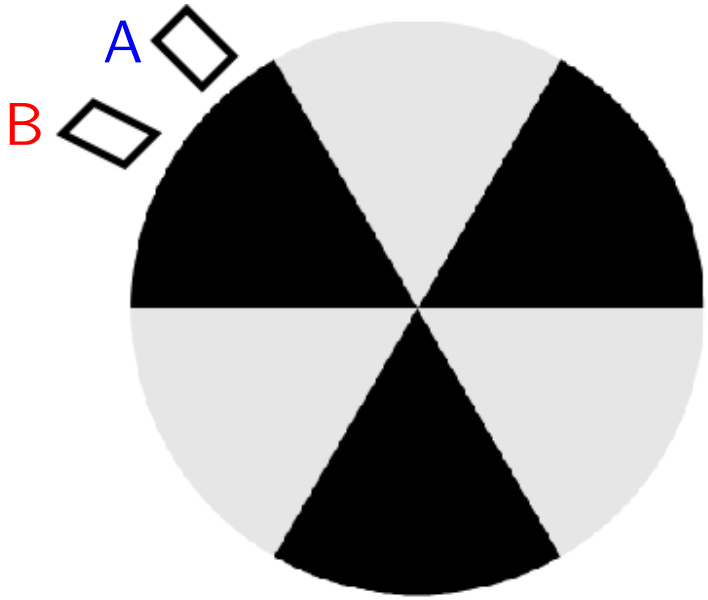
- Clockwise



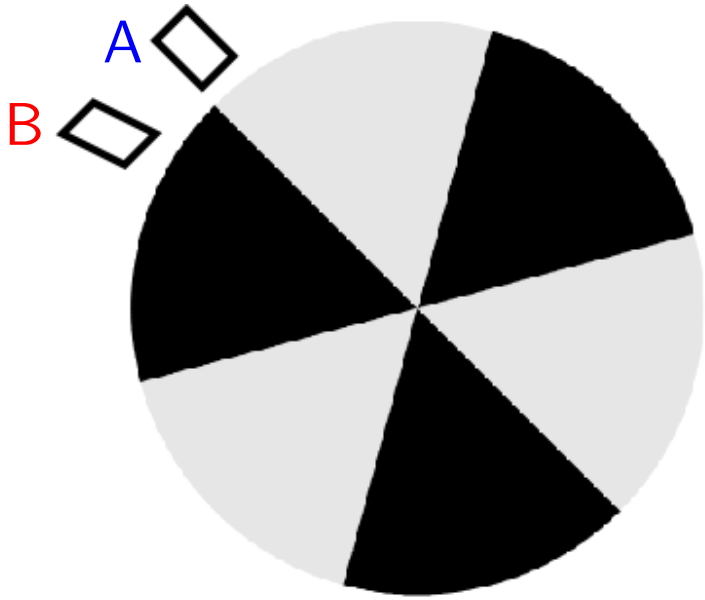
- Clockwise



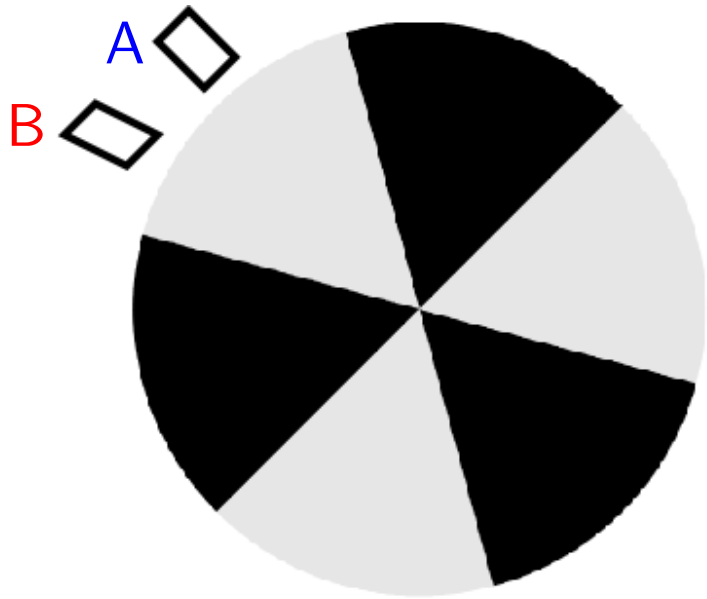
- Clockwise



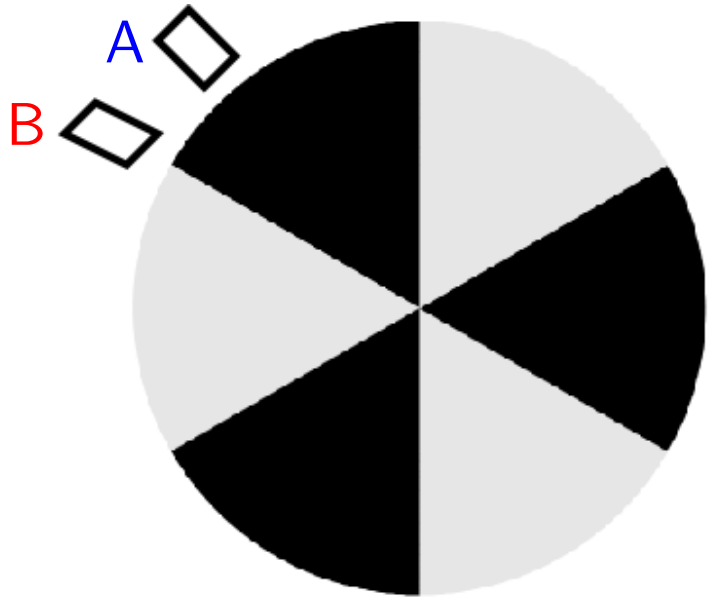
- Counter-clockwise



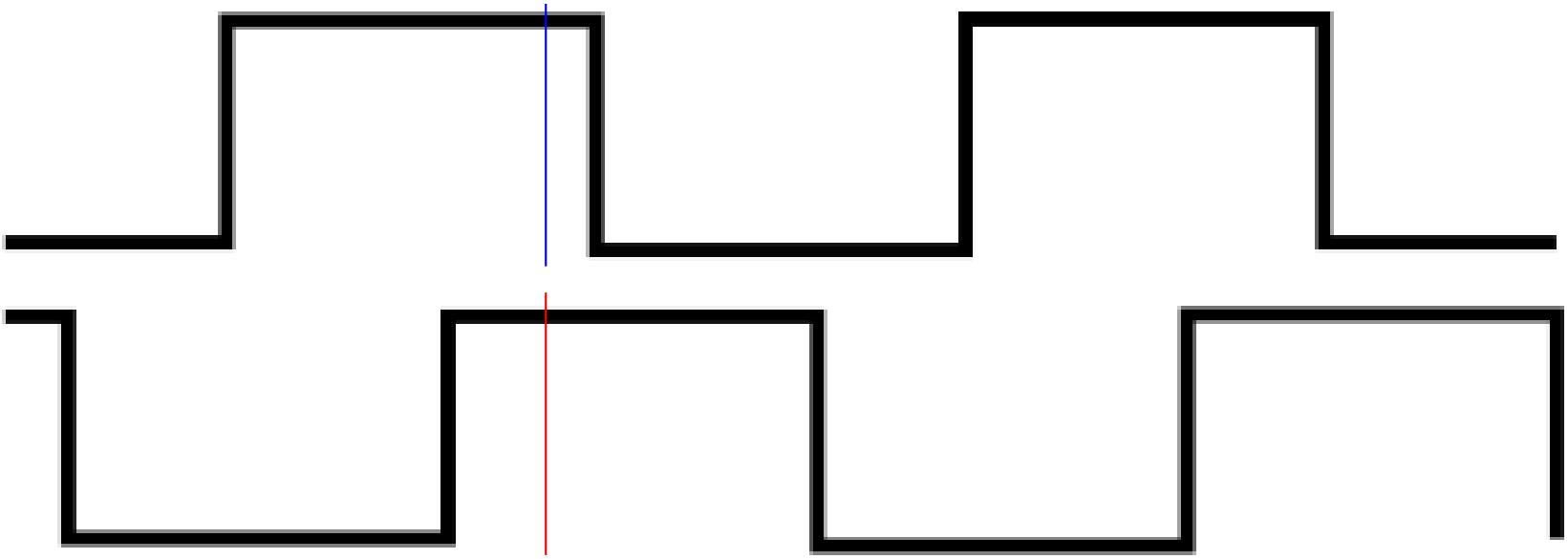
- Counter-clockwise



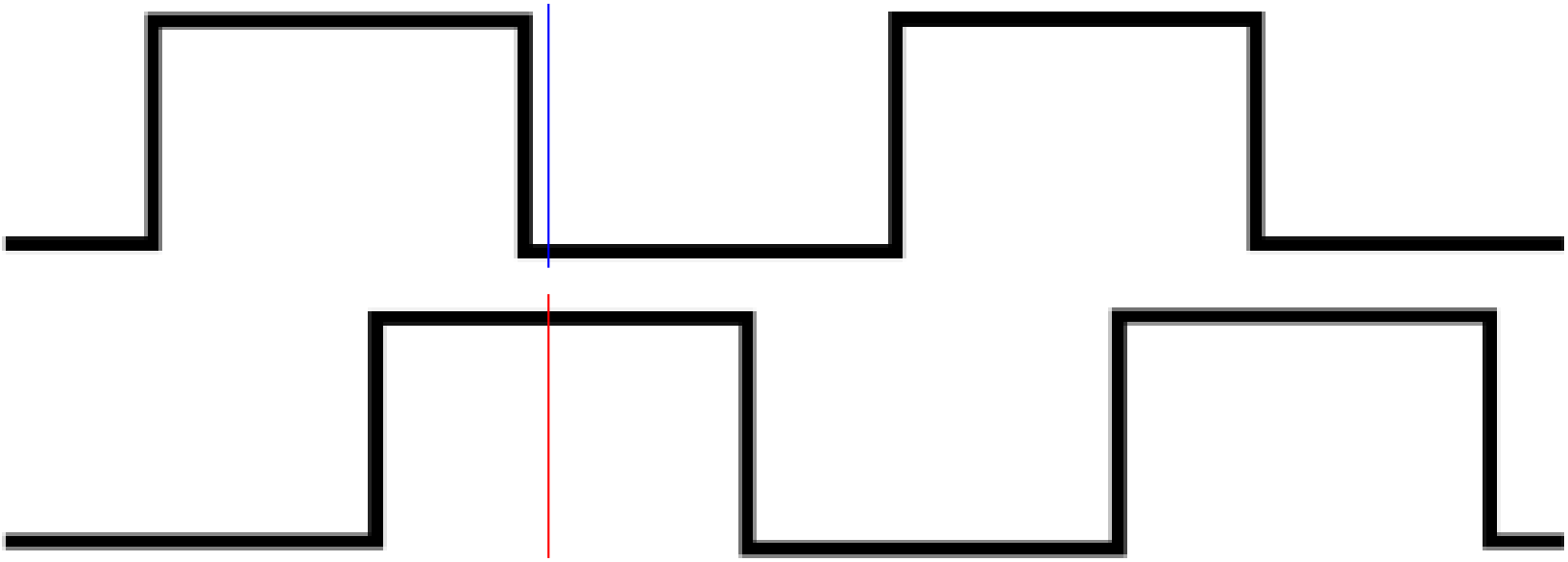
- Counter-clockwise



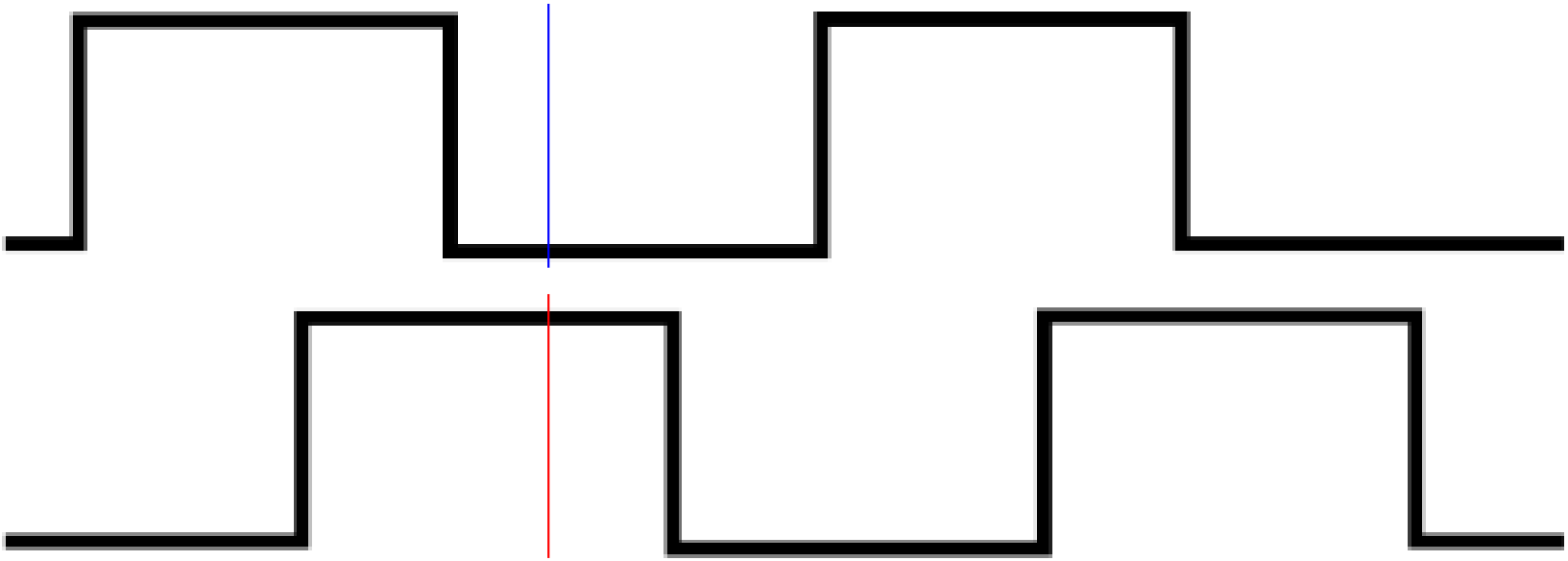
- Counter-clockwise



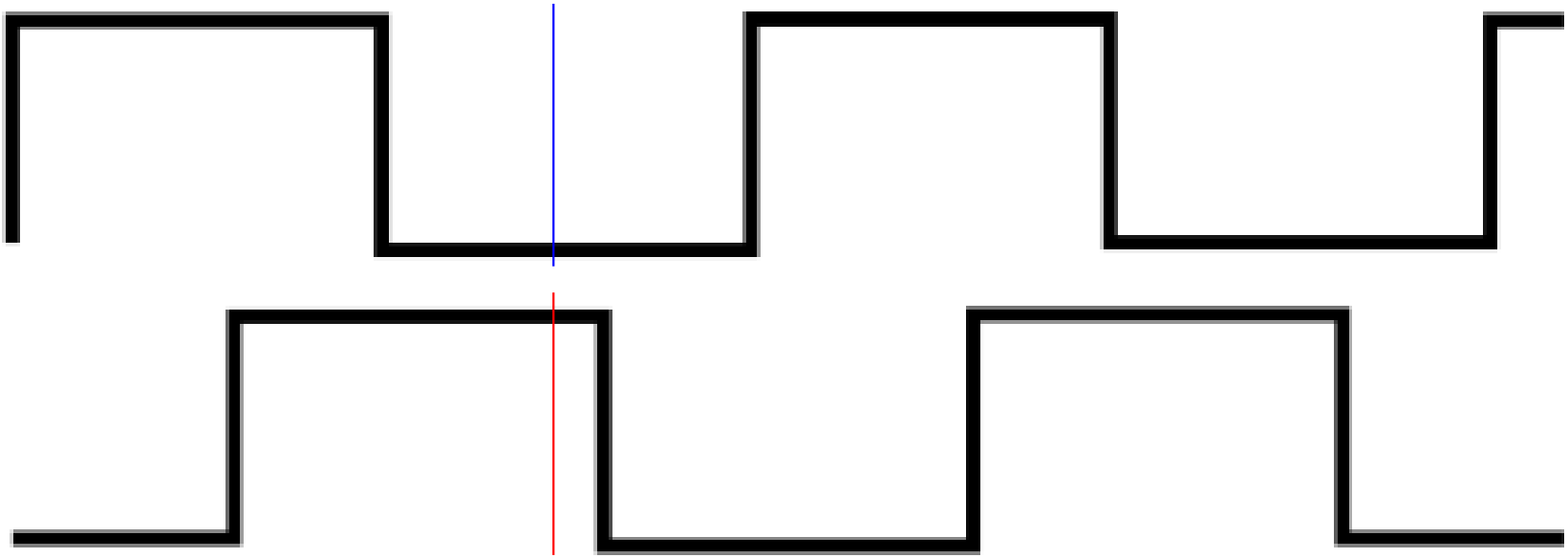
- Shaft encoder timing
- 1
- 1



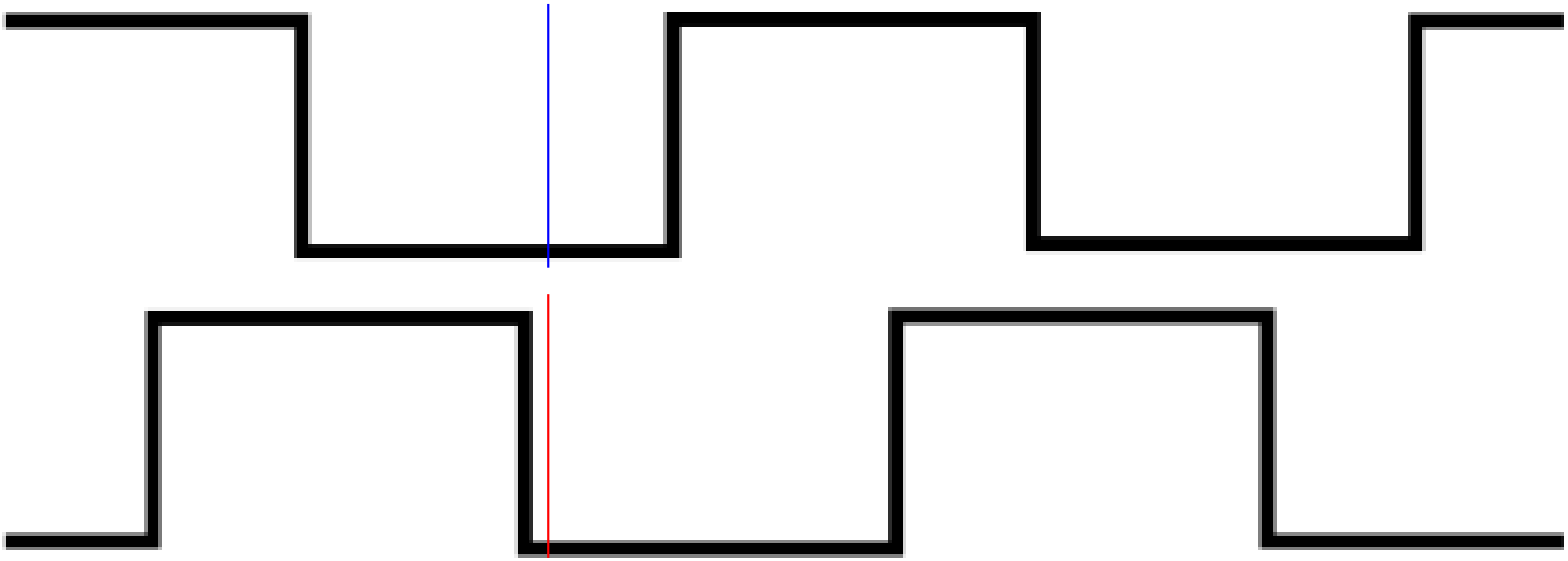
- Shaft encoder timing
- 0
- 1



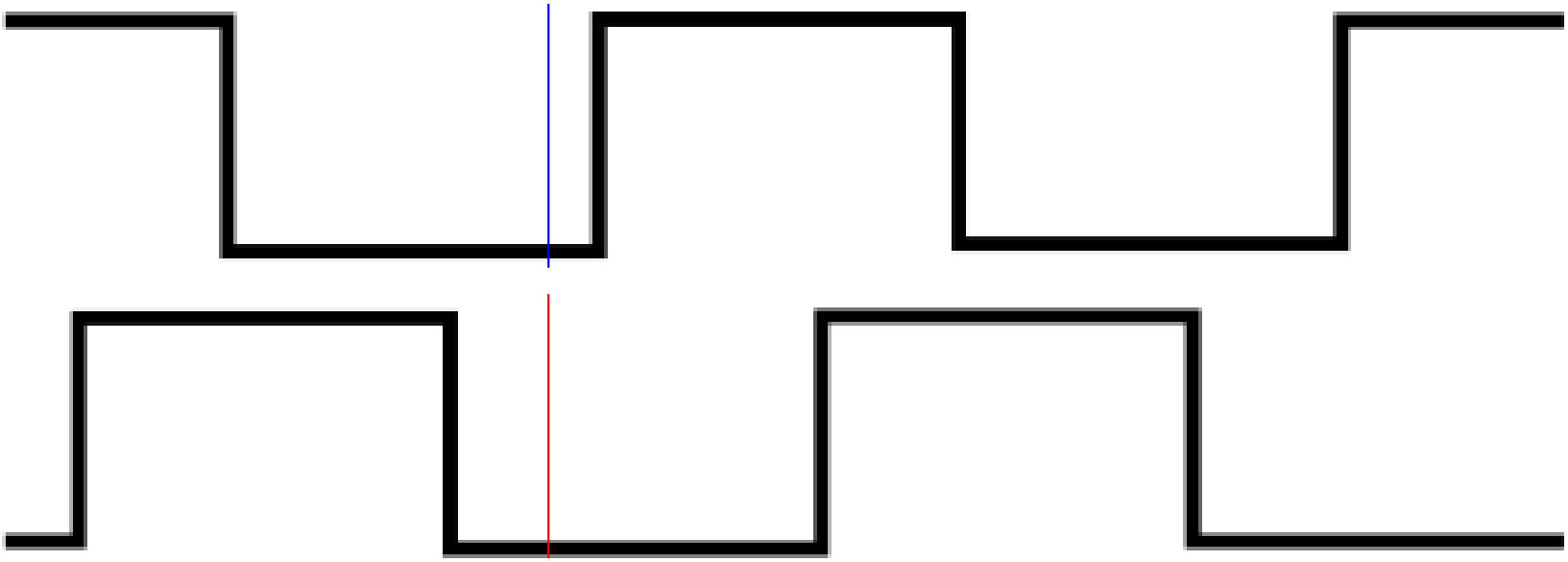
- Shaft encoder timing
- 0
- 1



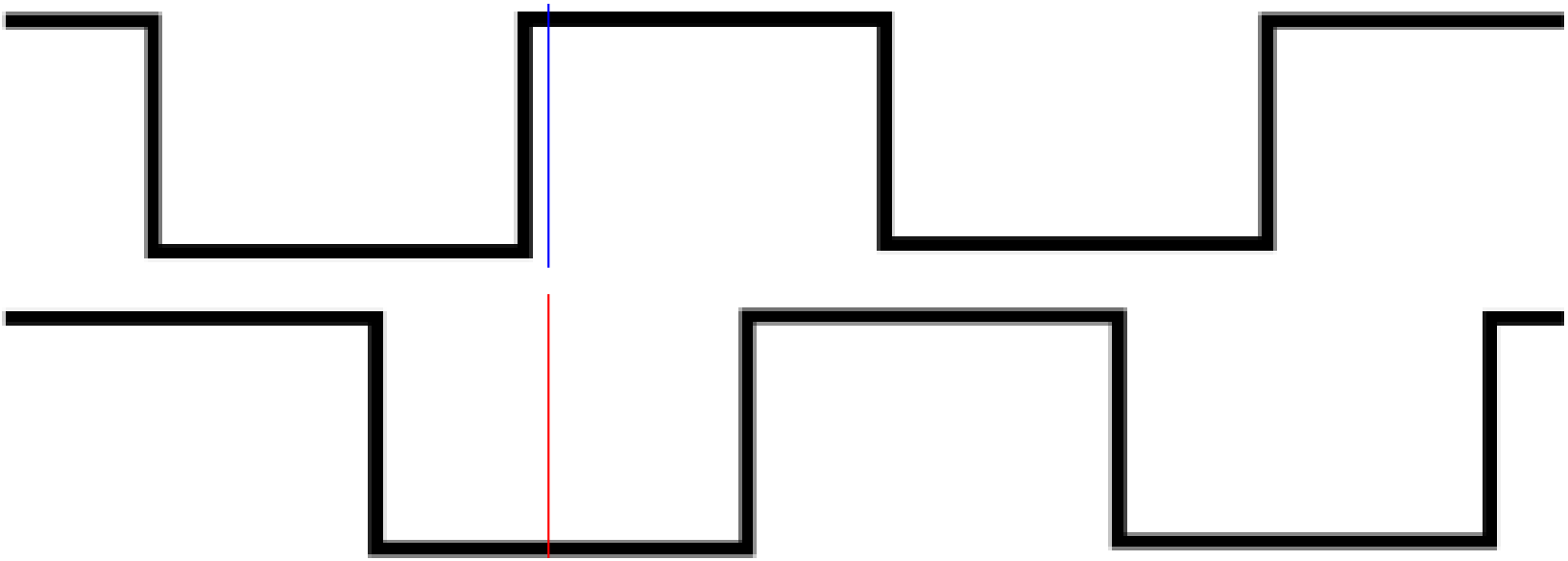
- Shaft encoder timing
- 0
- 1



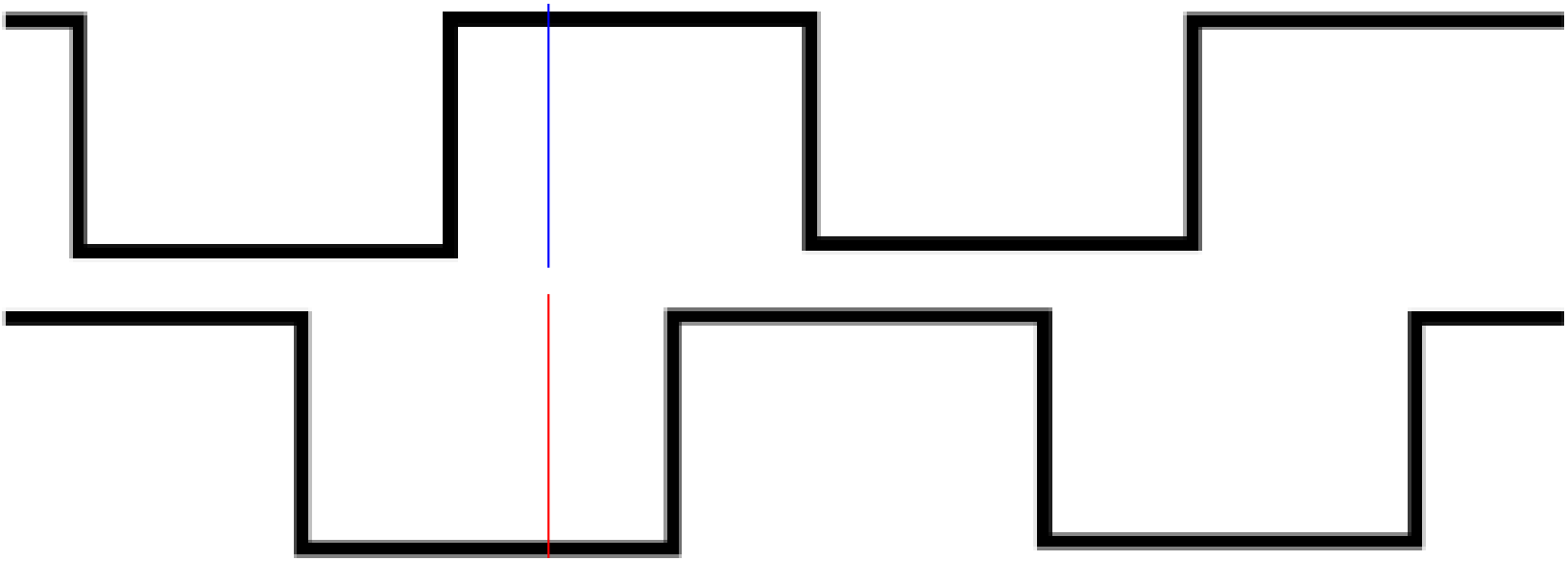
- Shaft encoder timing
- 0
- 0



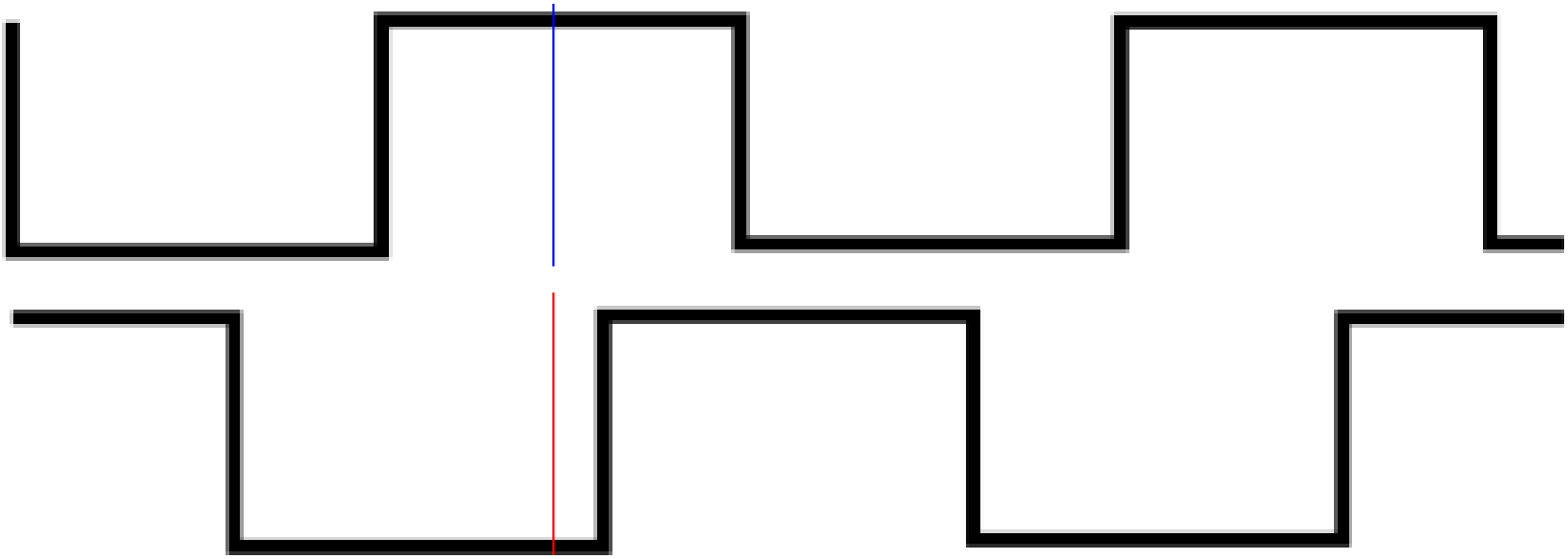
- Shaft encoder timing
- 0
- 0



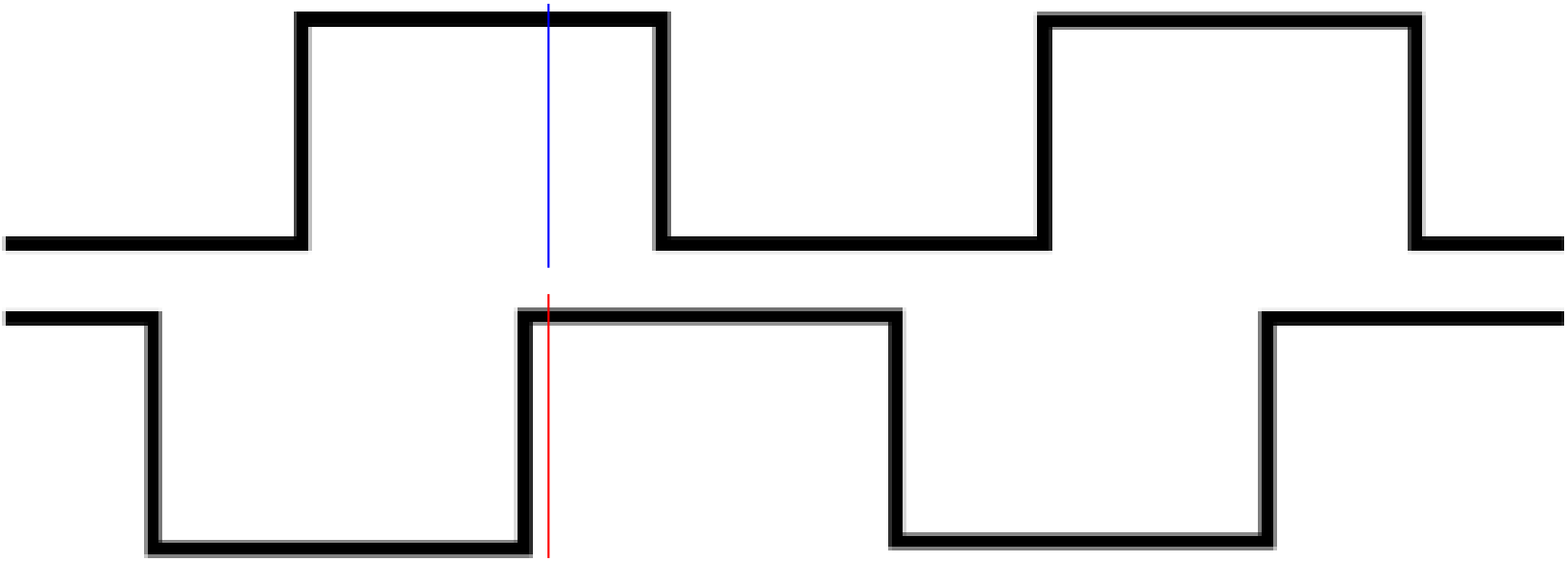
- Shaft encoder timing
- 1
- 0



- Shaft encoder timing
- 1
- 0



- Shaft encoder timing
- 1
- 0



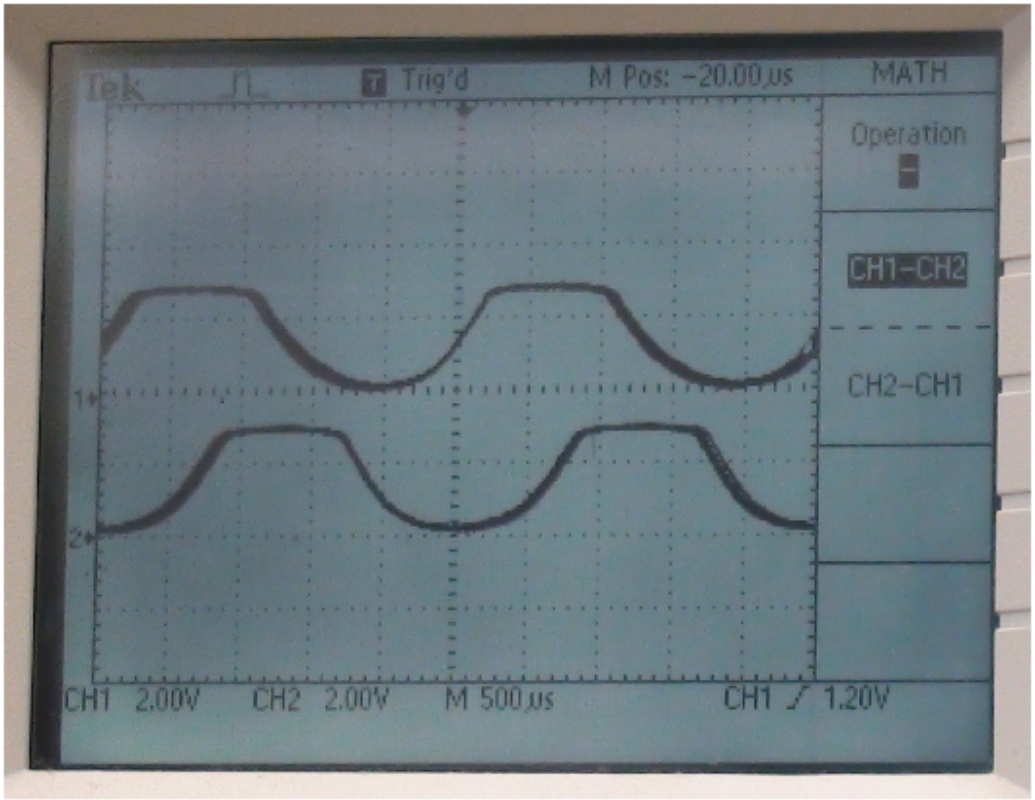
- Shaft encoder timing
- 1
- 1

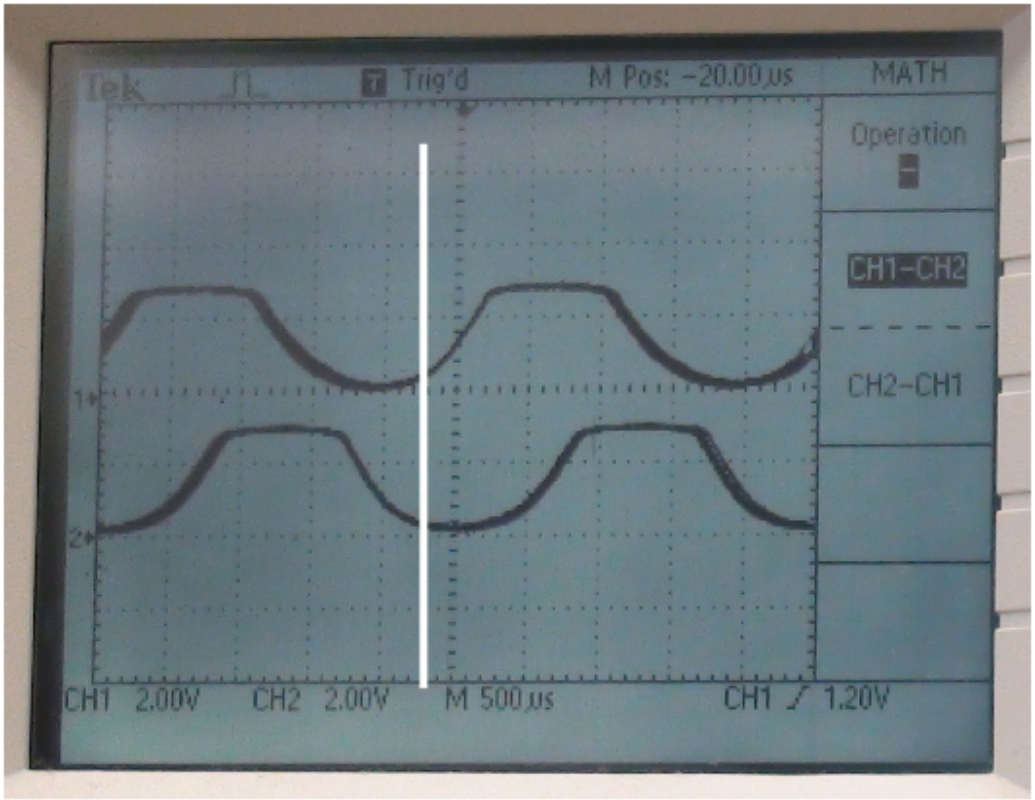
- *Speed* of rotation from frequency of either channel

- *Speed* of rotation from frequency of either channel
- *Angle* of rotation from combination

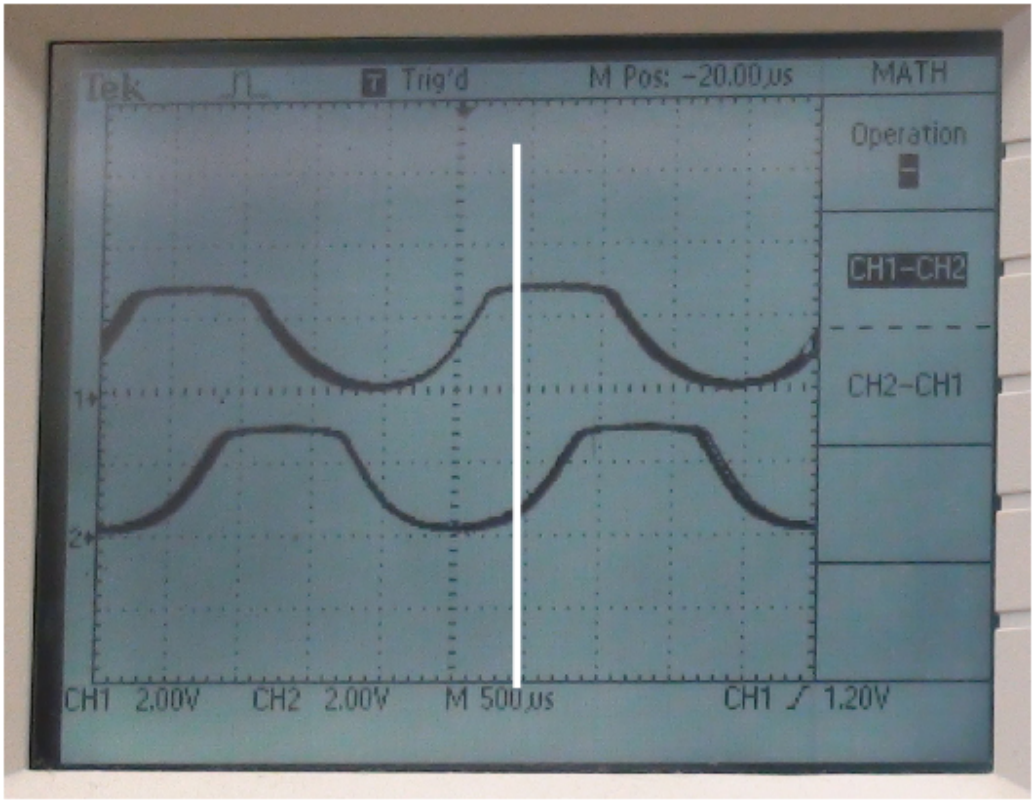
- *Speed* of rotation from frequency of either channel
- *Angle* of rotation from combination

Here's an example from an actual motor.

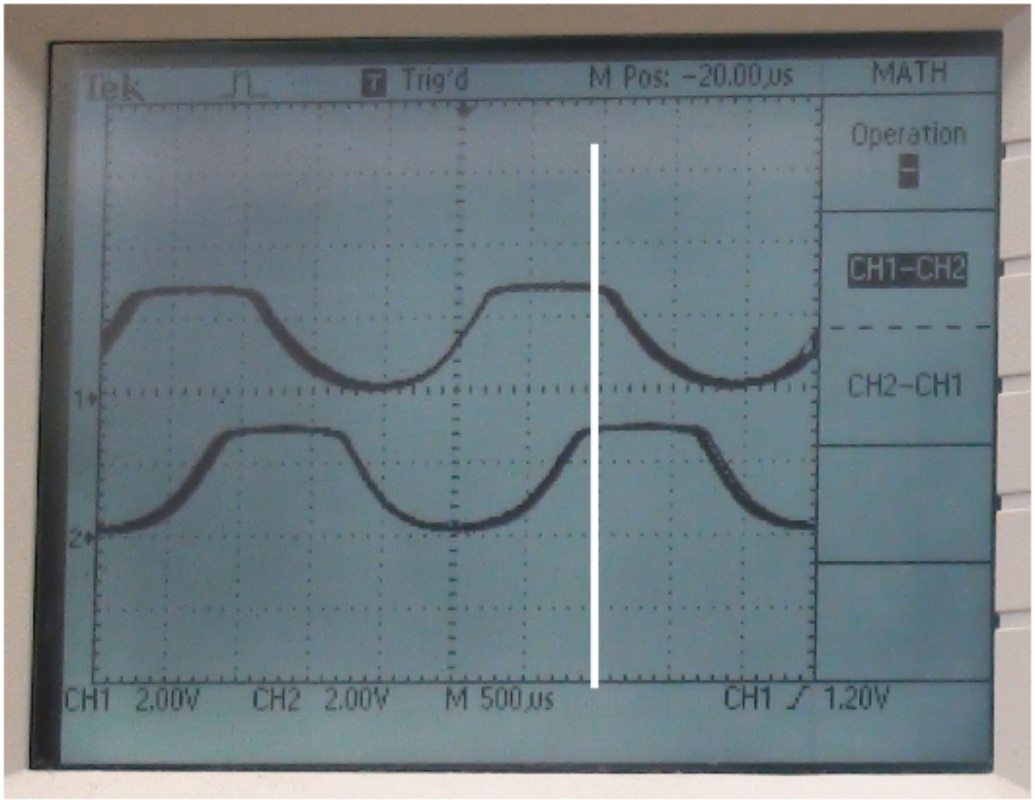

Tek
Trig'd
M Pos: -20.00µs
MATH
Operation
CH1-CH2
CH2-CH1
CH1 2.00V
CH2 2.00V
M 500µs
CH1 1.20V


Tek
Trig'd
M Pos: -20.00µs
MATH
Operation
CH1-CH2
CH2-CH1
CH1 2.00V
CH2 2.00V
M 500µs
CH1 1.20V

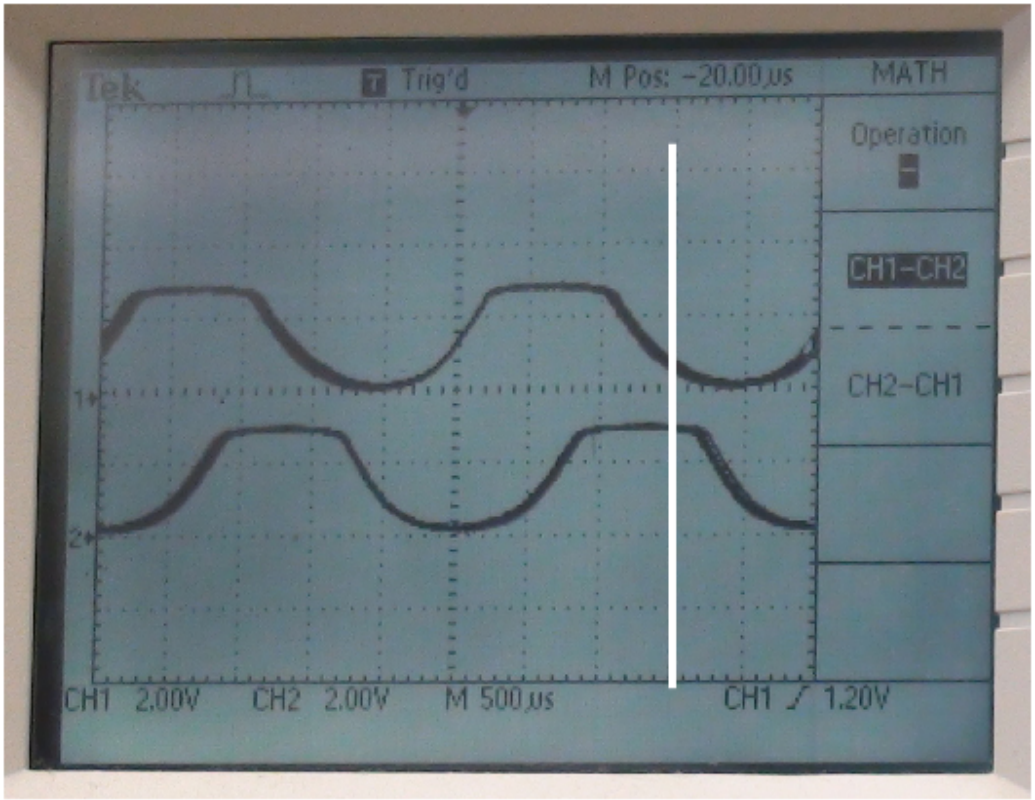
00


Tek
Trig'd
M Pos: -20.00µs
MATH
Operation
CH1-CH2
CH2-CH1
CH1 2.00V
CH2 2.00V
M 500µs
CH1 1.20V

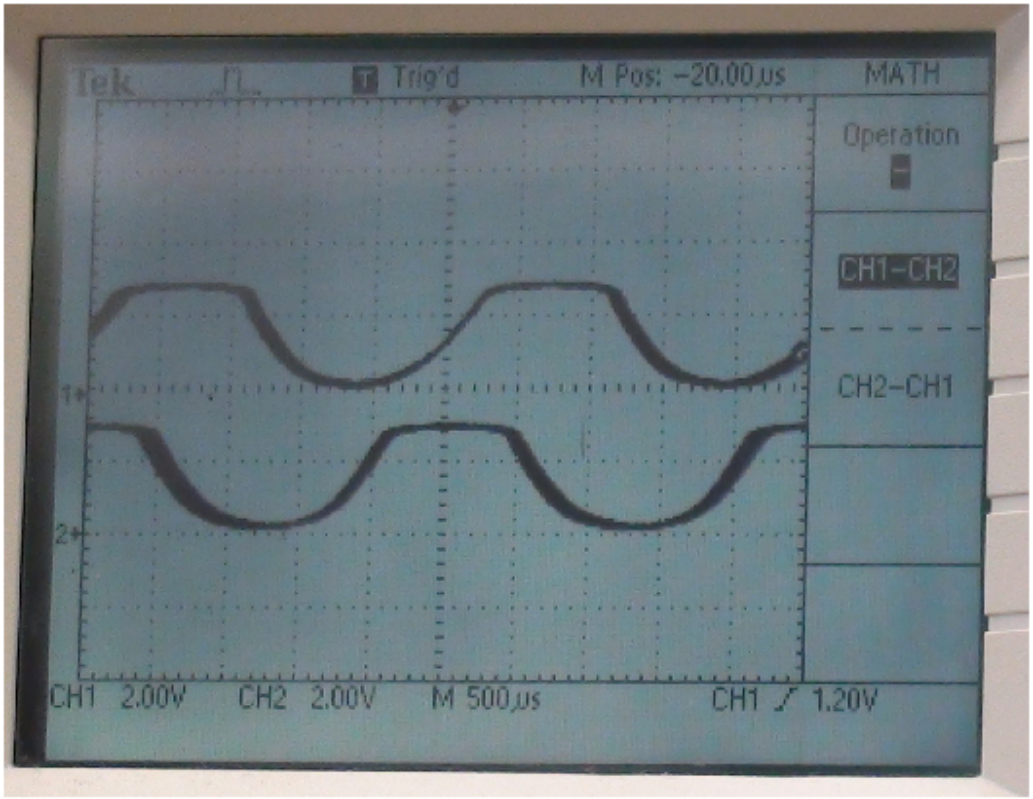
10

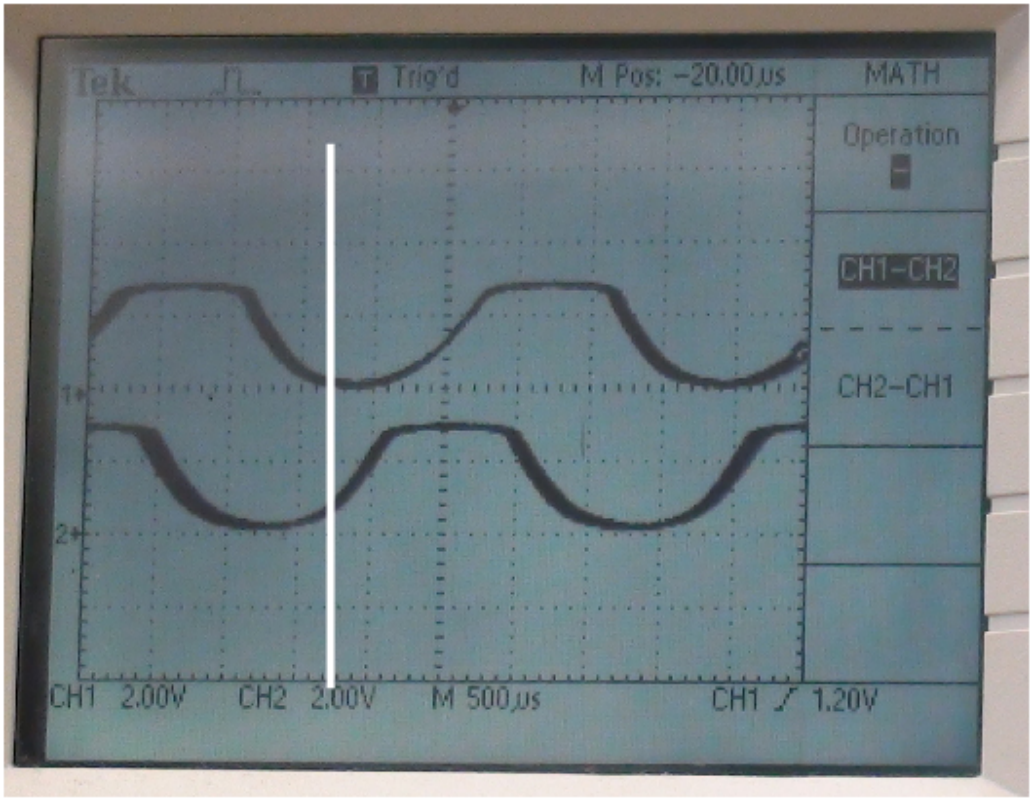

Tek
Trig'd
M Pos: -20.00µs
MATH
Operation
CH1-CH2
CH2-CH1
CH1 2.00V
CH2 2.00V
M 500µs
CH1 1.20V

11

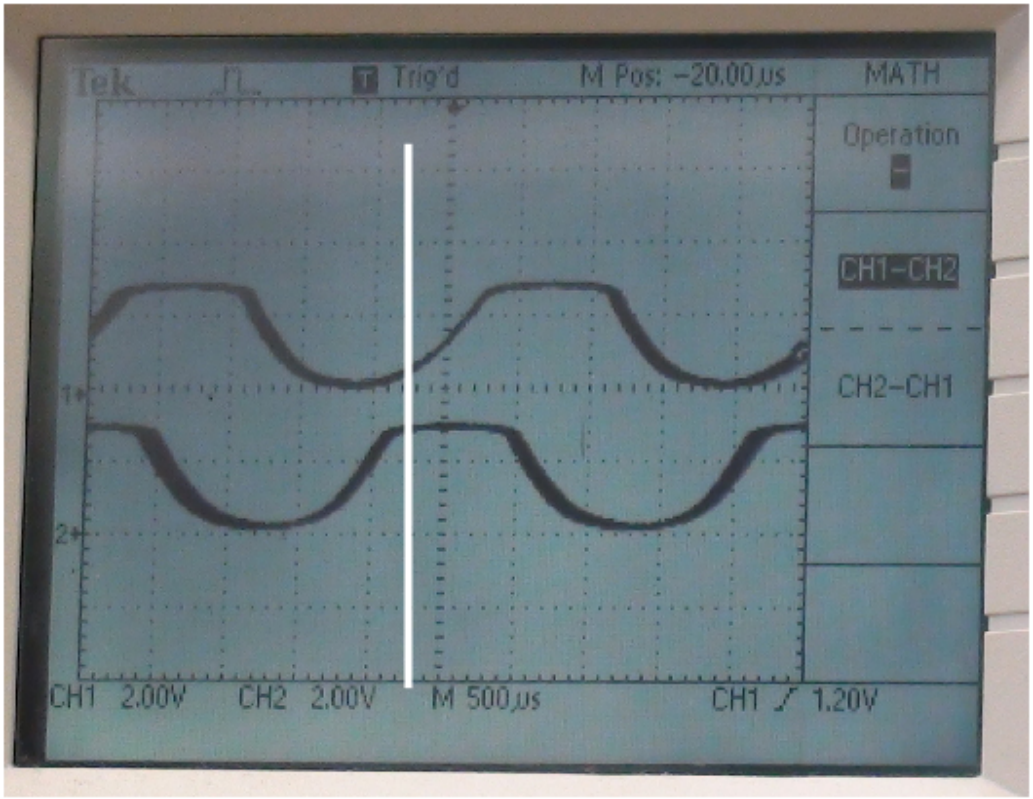

Tek
Trig'd
M Pos: -20.00µs
MATH
Operation
CH1-CH2
CH2-CH1
CH1 2.00V
CH2 2.00V
M 500µs
CH1 1.20V

01

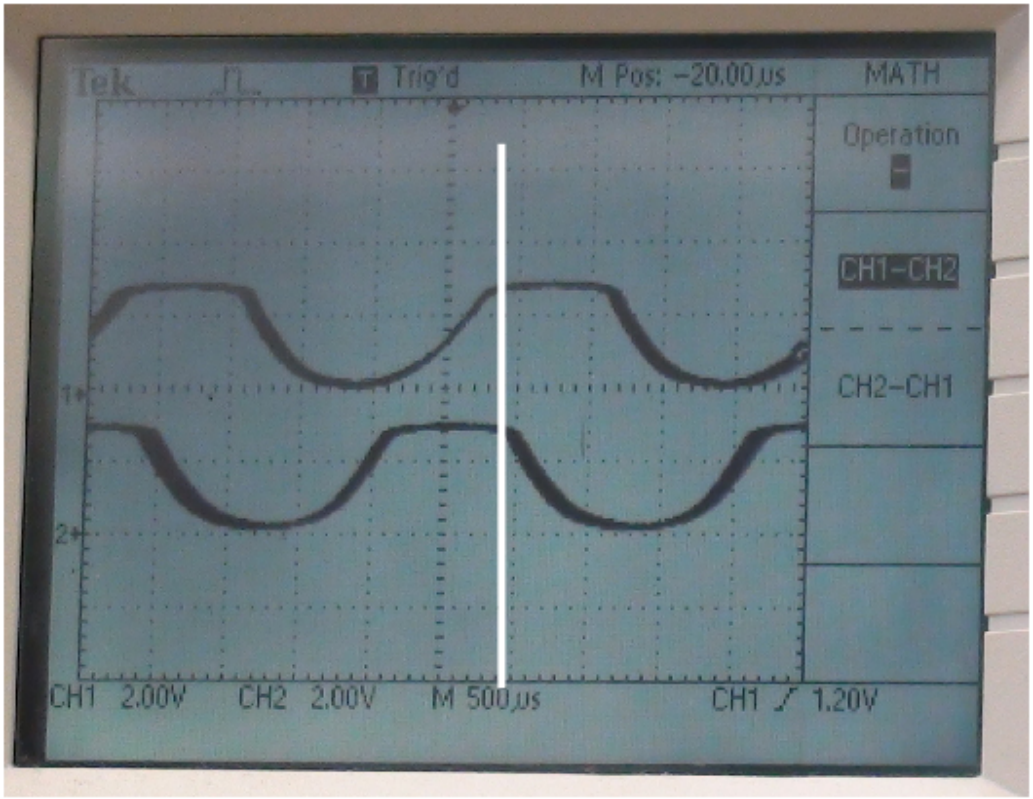

Tek
Trig'd
M Pos: -20.00µs
MATH
Operation
CH1-CH2
CH2-CH1
CH1 2.00V
CH2 2.00V
M 500µs
CH1 1.20V


Tek
Trig'd
M Pos: -20.00µs
MATH
Operation
CH1-CH2
CH2-CH1
CH1 2.00V
CH2 2.00V
M 500µs
CH1 1.20V

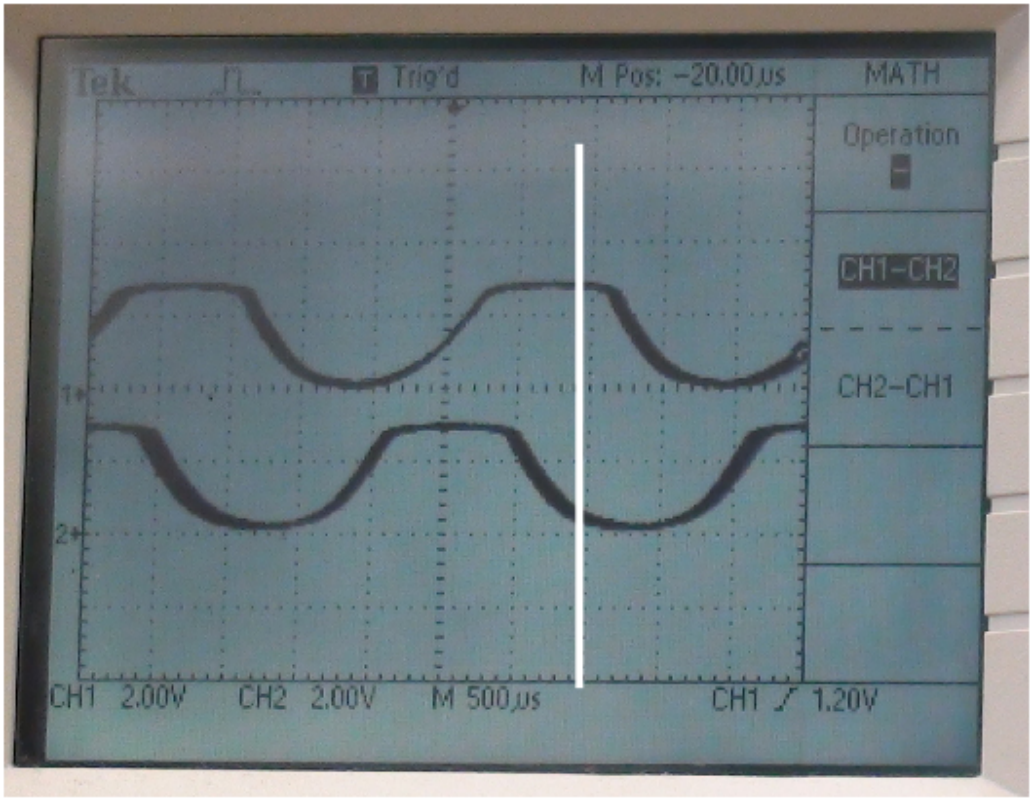
00


Tek
Trig'd
M Pos: -20.00µs
MATH
Operation
CH1-CH2
CH2-CH1
CH1 2.00V
CH2 2.00V
M 500µs
CH1 1.20V

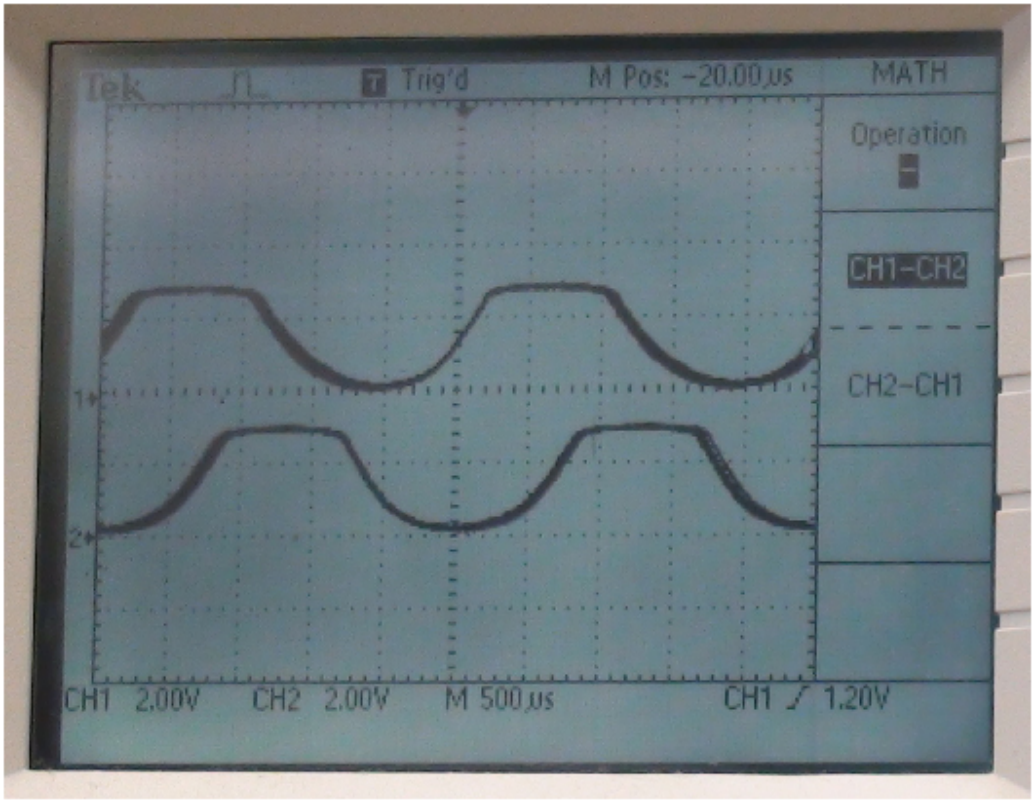
01


Tek
Trig'd
M Pos: -20.00µs
MATH
Operation
CH1-CH2
CH2-CH1
CH1 2.00V
CH2 2.00V
M 500µs
CH1 1.20V

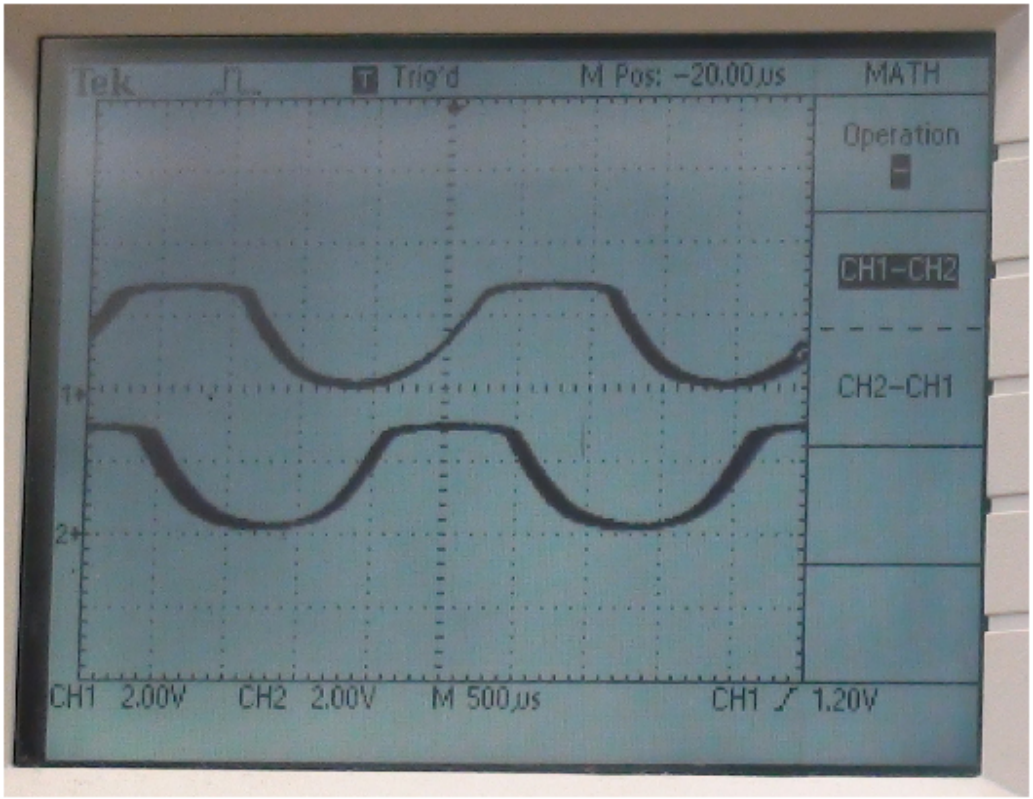
11


Tek
Trig'd
M Pos: -20.00µs
MATH
Operation
CH1-CH2
CH2-CH1
CH1 2.00V
CH2 2.00V
M 500µs
CH1 1.20V

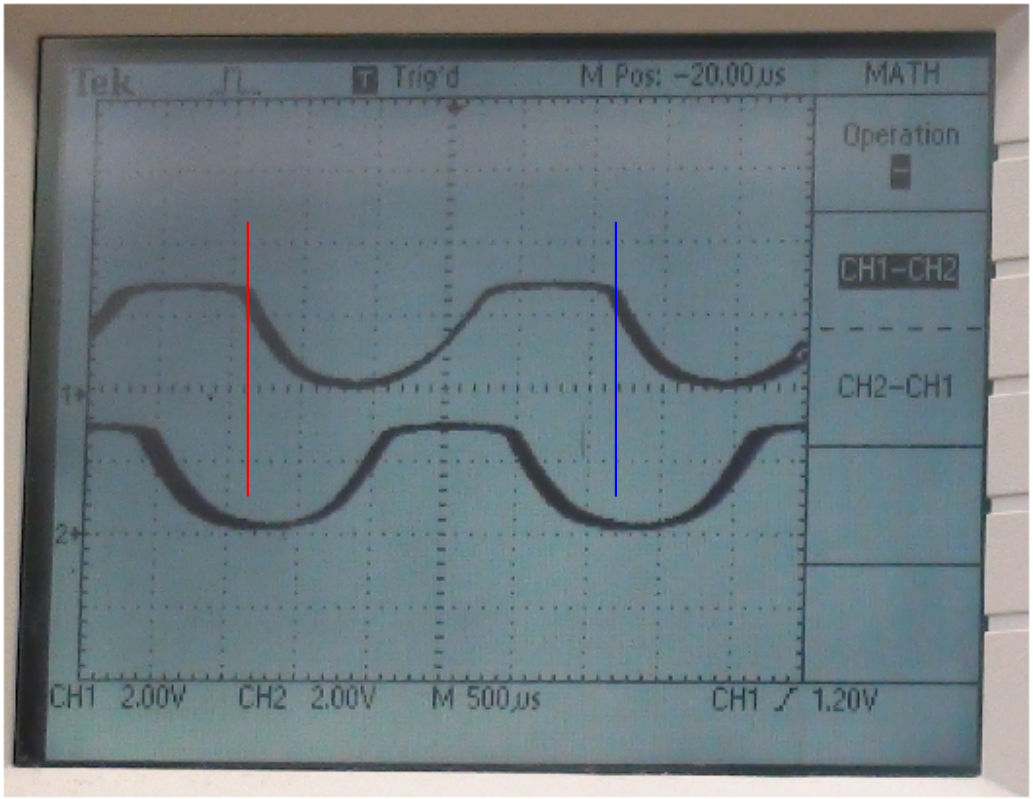
10



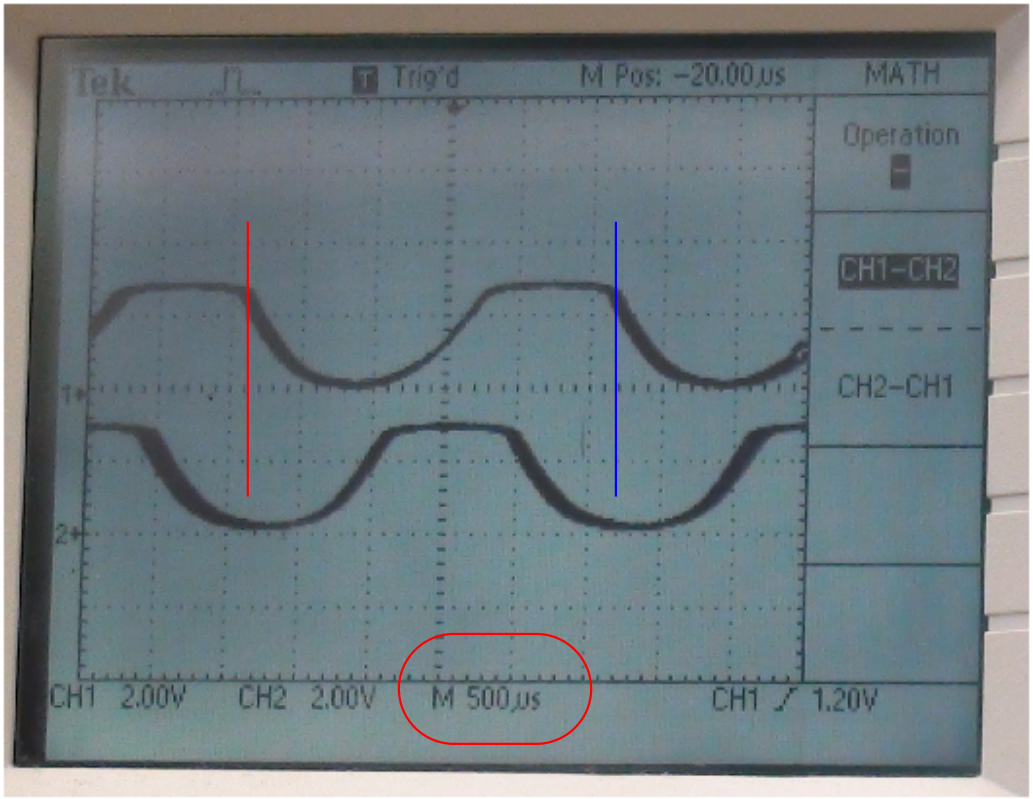
One direction



Other direction

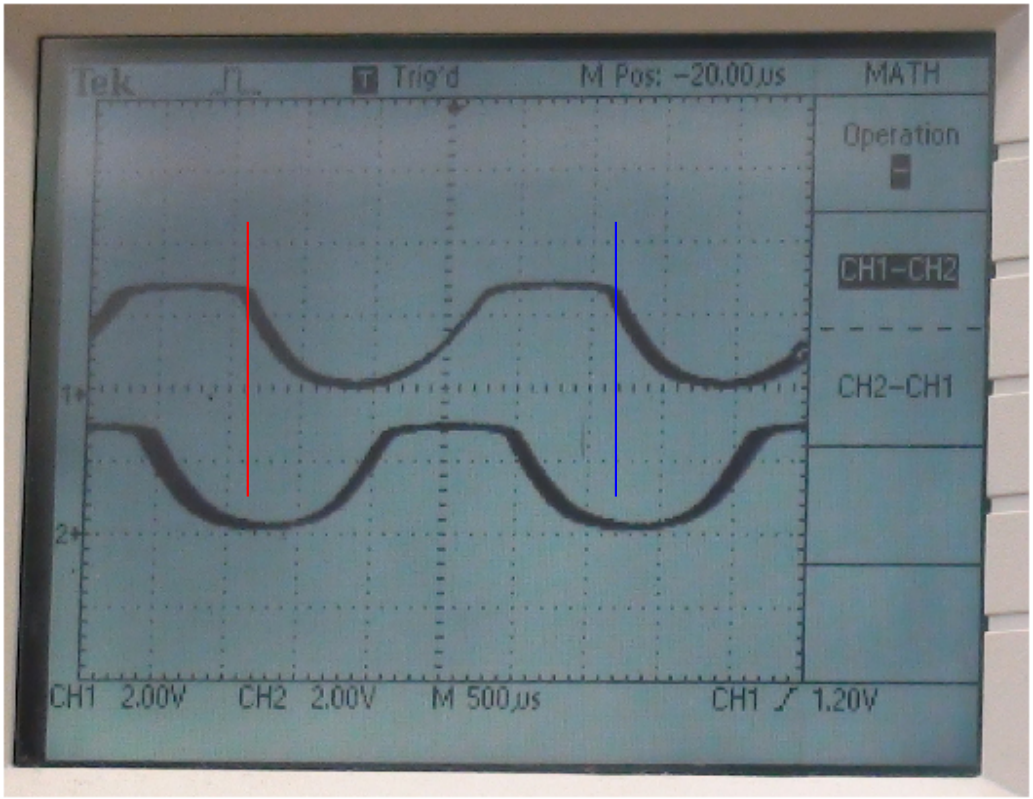


Period is 5 divisions



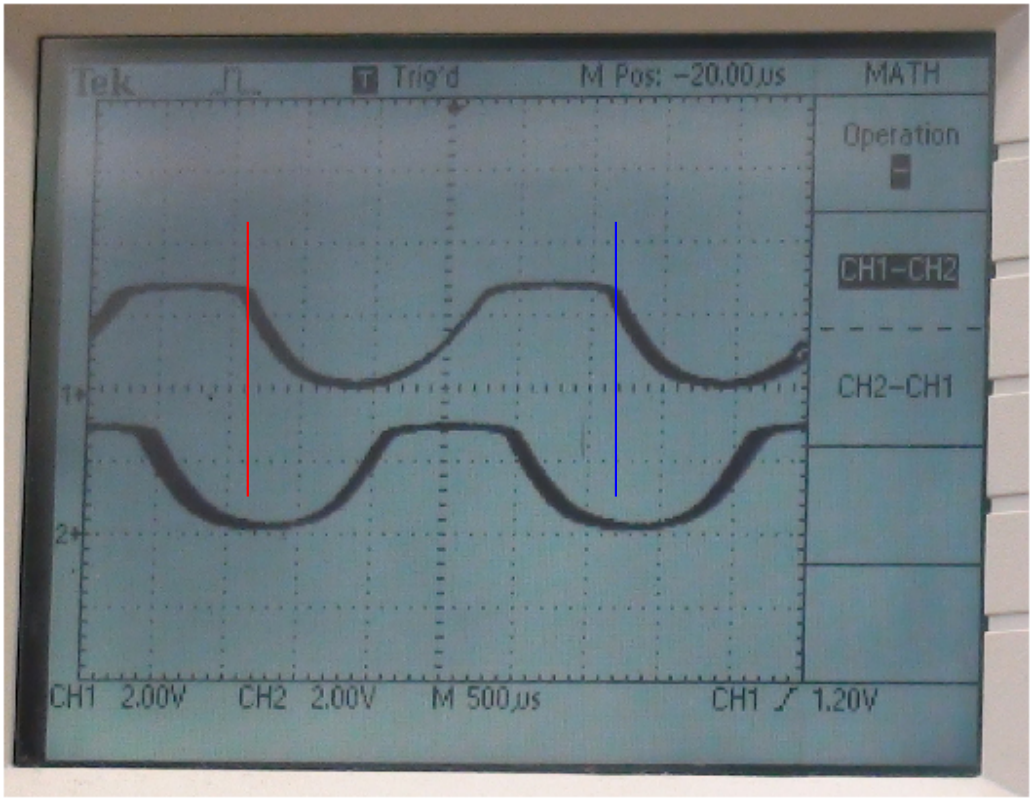
Period is 5 divisions

Time scale is 500μS per division



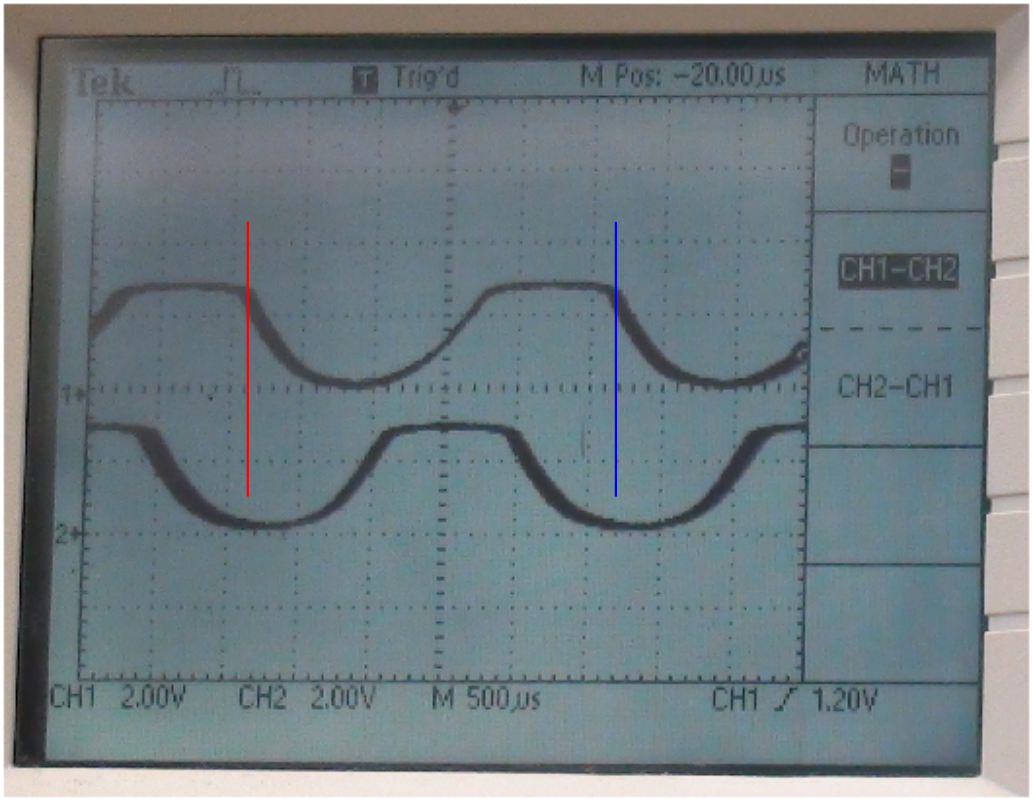
Period is 5 divisions $\rightarrow$ 2500μS = 2.5mS

Time scale is 500μS per division



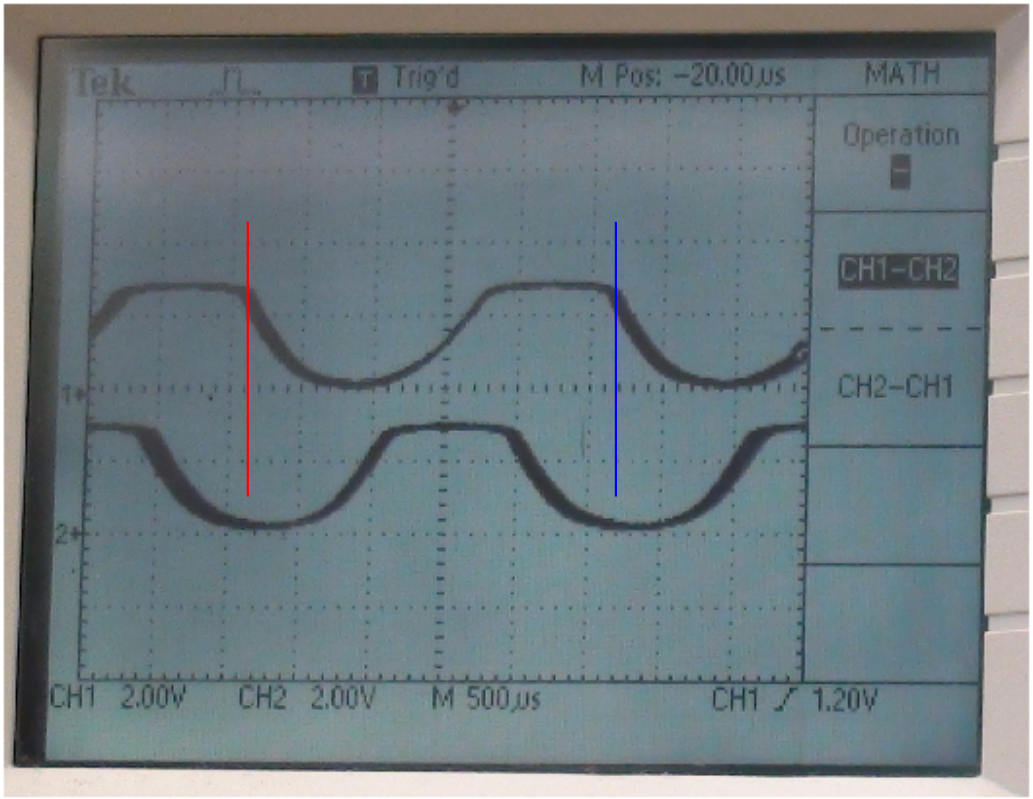
Period is 5 divisions $\rightarrow$ 2500μS = 2.5mS

30 slots per revolution $\times$ 2.5mS



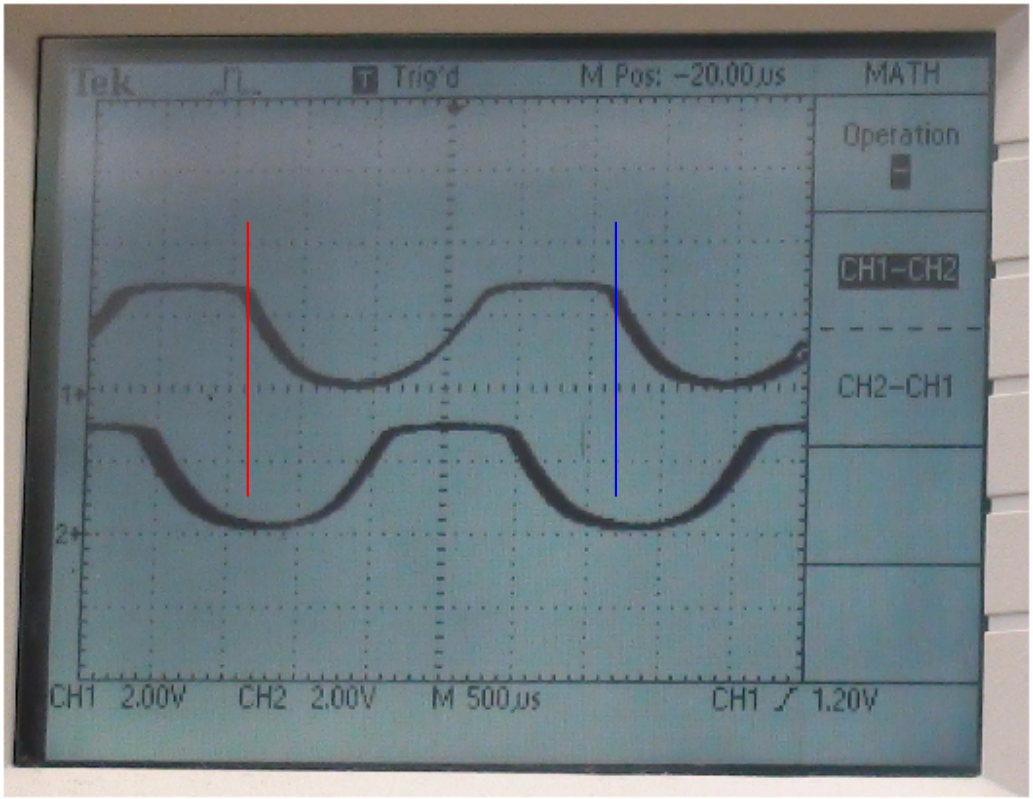
Period is 2.5mS

30 slots per revolution $\times$ 2.5mS $\rightarrow$ 75ms per revolution



Period is 2.5mS $\times$ 30 $\rightarrow$ 75ms per revolution

75/1000 seconds per revolution $\rightarrow$ 13.33 rev./second



Period is 2.5mS $\times$ 30 $\rightarrow$ 75ms per revolution

75/1000 seconds per revolution $\rightarrow$ 13.33 rev./second

$\times$ 60 $\rightarrow$ 800 RPM