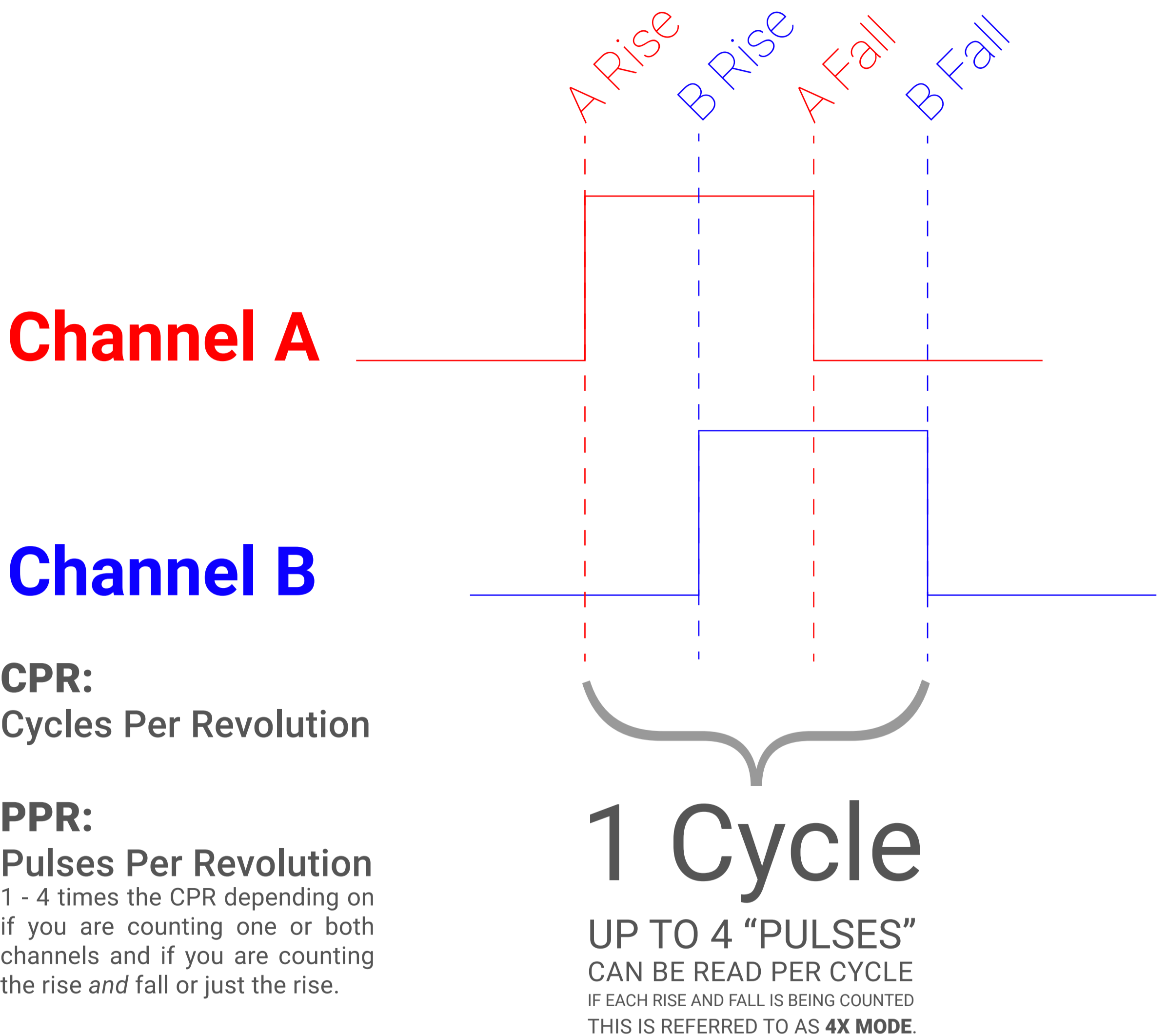# Quadrature Encoders: *Decoded*

Quadrature encoders are incremental encoders that produce a square wave signal that can be counted by whatever is monitoring the signal (an Arduino for example). They actually produce singals on 2 channels (A and B) which are 90° out of phase. This way you can determine the direction of rotation... if channel A is leading channel B you are rotating in one direction, else you are rotating the other direction.

A Rise   B Rise   A Fall   B Fall

Channel A

Channel B

CPR:
Cycles Per Revolution

PPR:
Pulses Per Revolution
1 - 4 times the CPR depending on if you are counting one or both channels and if you are counting the rise *and* fall or just the rise.

1 Cycle

UP TO 4 "PULSES"
CAN BE READ PER CYCLE
IF EACH RISE AND FALL IS BEING COUNTED
THIS IS REFERRED TO AS **4X MODE**.

Max Resolution:

Max PPR:
The number of "pulses" that get counted in a cycle is up to the electronic device or code doing the counting (the decoder). Up to 4 pulses can be counted in a cycle; this is called 4x Mode.

Gear Ratio:
If the encoder is attached on a motor's shaft and then the motor is geared down, the maximum usable "resolution" on the output shaft (after it has been geared down) would need to take into account the gear ratio.

The Equation:
Max PPR = CPR x 4
Max Resolution *(on the output shaft)* **= Max PPR x Gear Ratio**

Example:
Let's say we have a motor w/encoder that has a 721:1 gear ratio and 12 CPR.
12 x 4 x 721 = 34,608 Max Resolution

This means that for every pulse counted, the output shafts turns about 0.01°