Hall Effect Encoders

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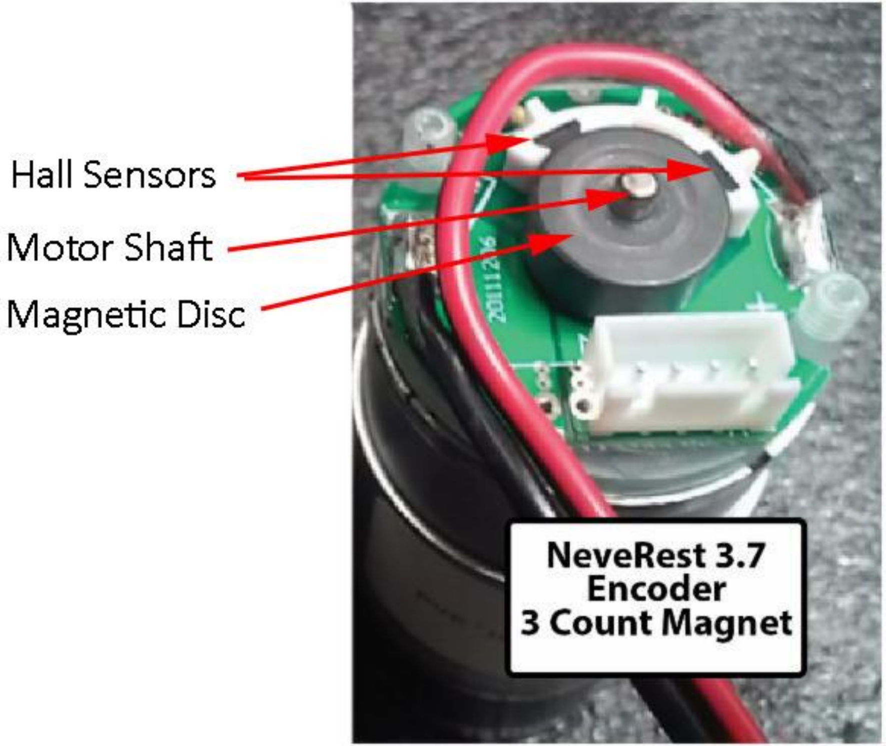
AndyMark 2 channel Hall Effect encoder am-2816a

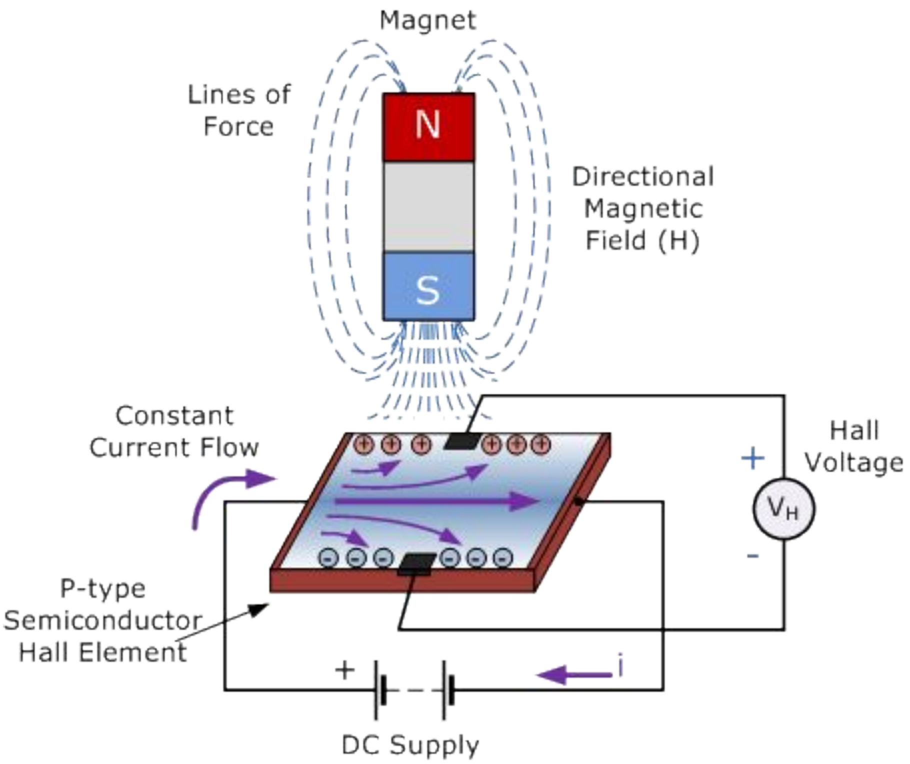
These are the parts of the encoders GEAR has that can be installed on AndyMark motors

Encoder Mounted on motor



This is not the same encoder we have in GEAR inventory, but is very similar. It is an AndyMark brand 2 channel Hall Effect encoder for a NeverRest motor.

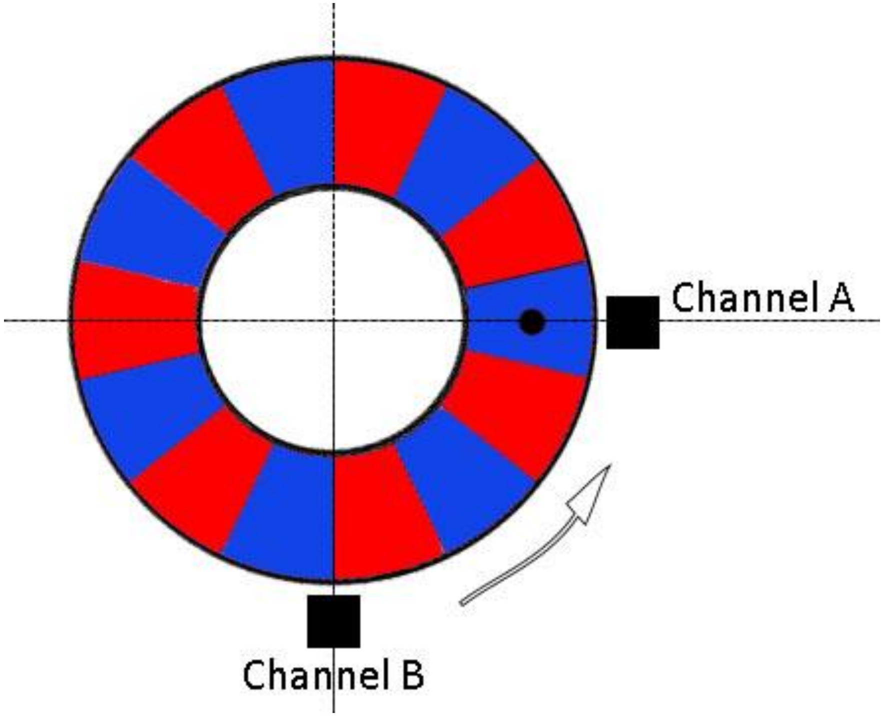
How does the Hall Effect sensor work?



The Hall Effect sensor is a semiconductor, as depicted in the diagram. When aligned with the pole of a magnet (usually designed to work with south pole), positive and negative charges in the semiconducting material move to opposite edges and thus develop a voltage known as the Hall Voltage. This voltage is used in the AndyMark sensors to output a 5 volt DC pulse as the magnet passes by the sensor.

Photo source: https://www.electronics-tutorials.ws/electromagnetism/hall-effect.html

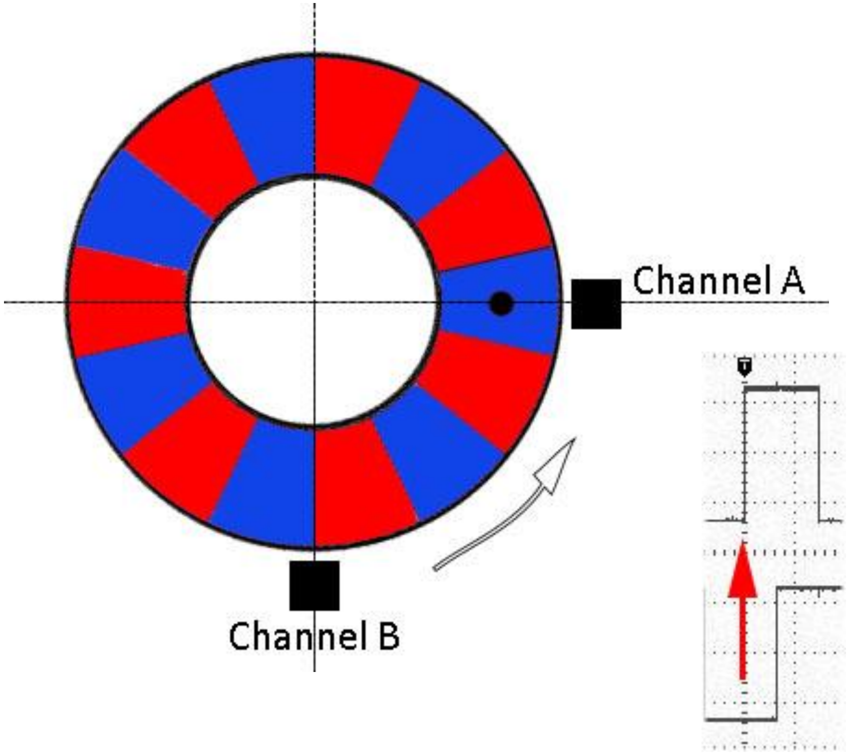
Diagram of AndyMark Encoder



The disc with red and blue sectors represents the south (blue) and north (red) poles of 7 magnets. I do not know the exact design of the magnetic disc, but this diagram will suffice for the purposes of this discussion. Encoder specifications state that 7 pulses are developed by this encoder (at each sensor) per revolution. Therefore, I assume there are 7 magnets in the disc, although I don’t know the orientations.

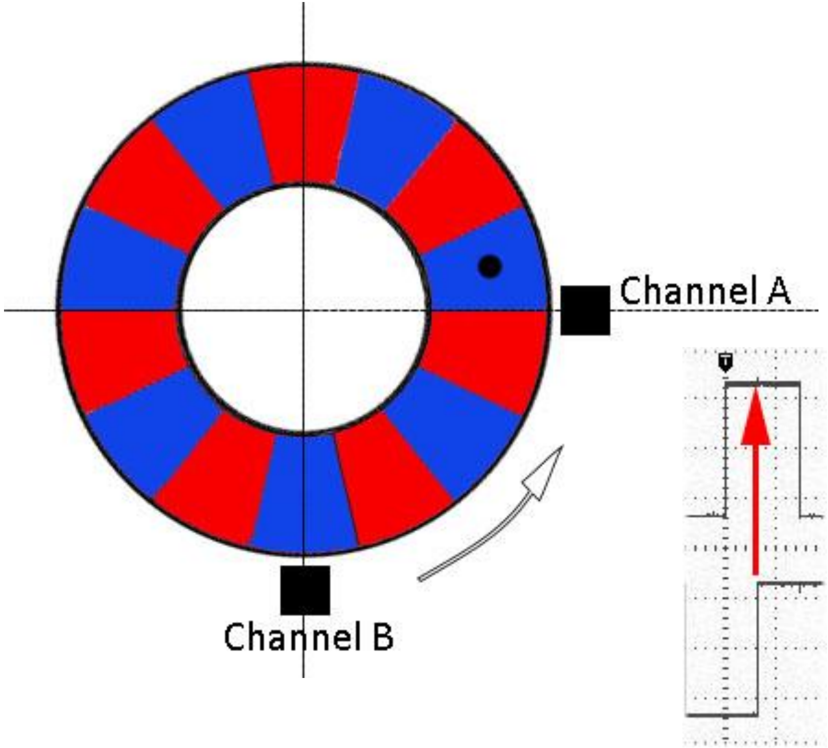
As the disc rotates, a positive pulse will develop at each sensor as each of the 7 magnets pass by. If the magnetic disc is rotating in a counterclockwise direction, then a pulse will occur first at channel A and then a pulse at channel B at a phase separation of 90 degrees.

Diagram of AndyMark Encoder



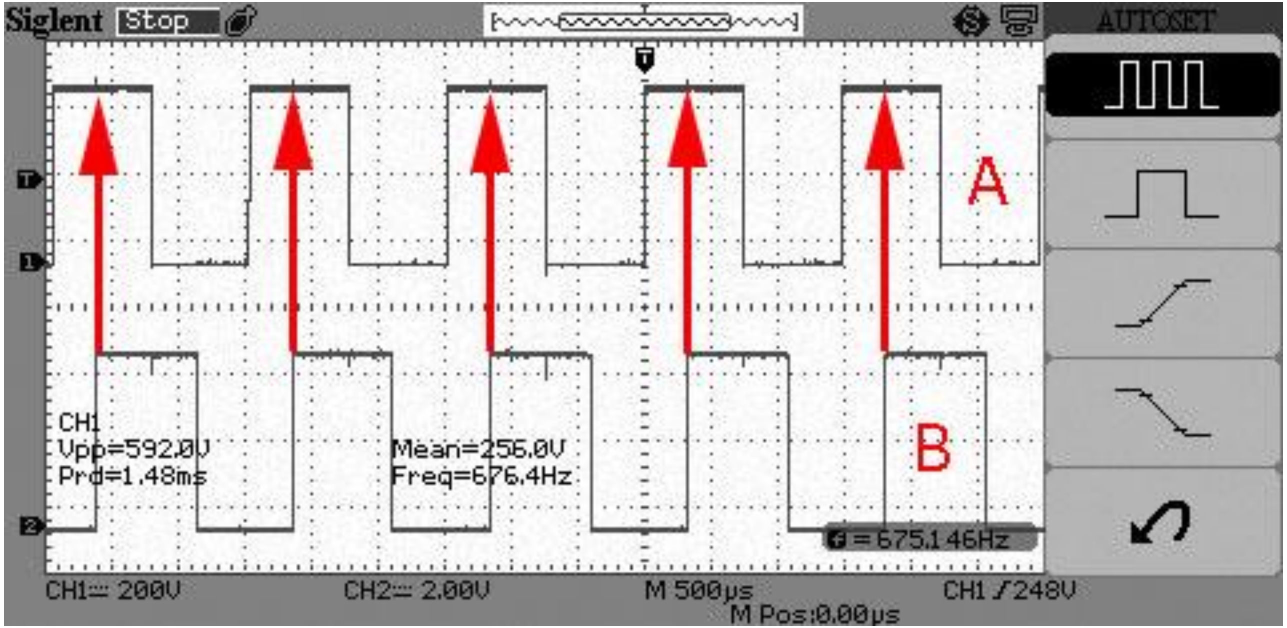
Let us suppose that a channel goes from low to high, 0 volts to 5 volts, exactly when the south pole of a magnet is centered on the sensor (we don't know this to be exactly true, but for purposes of this discussion, it does not matter). Then in the diagram, the south pole of the magnet centered on channel A sensor (the one marked with a black dot) is in the correct position to cause the channel A sensor to go from 0 volts output to 5 volts output. This point in time on an oscilloscope trace of both channels is depicted in the image just to the bottom-right of the magnet diagram. The red arrow points to the place where the channel A trace goes HIGH. At that same point in time notice that the bottom trace, of channel B, is LOW. Notice that channel B sensor is at the border of the north and south poles of a magnet. When the encoder turns an additional 12.86 degrees, then channel B sensor will be centered on a south pole (360/7 = 51.43 degrees per magnet, 51.43/4 = 12.86 degrees per quarter of magnet).

The magnetic disc has rotated 12.86 degrees



In this diagram notice that the magnetic disc has rotated 12.86 degrees counterclockwise from the previous diagram. Now channel B will go HIGH. Again I have added an image of the oscilloscope traces with a red arrow marking the point in time that represents the magnet position in the diagram. Channel A is the top trace. Notice that channel B has just changed from LOW to HIGH and that channel A is about half-way through its HIGH portion of the cycle (it appears just less than half, which would indicate this encoder is slightly off in positioning of the sensors). In any case, we can divide one cycle more or less into four equally spaced events: 1) channel A goes HIGH, 2) channel B goes HIGH, 3) channel A goes LOW, 4) channel B goes LOW. The the events repeat in the same order.

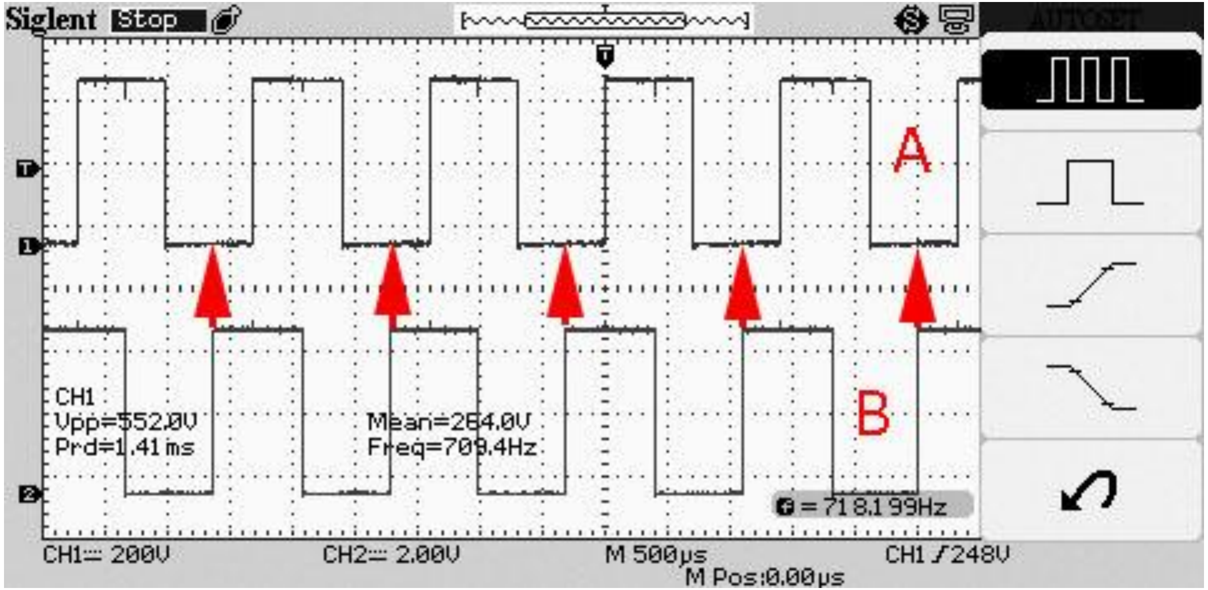
Oscilloscope trace
encoder running counterclockwise



Notice that the start of pulses from channel B (marked with red arrows), occur later than the pulses from channel A (time progresses from left to right on traces).

Note that the frequency of pulses is 676 Hz which equals a rotation rate of 5790 RPM (676/7) X 60 which is close to 5700 RPM in specifications for motor.

Oscilloscope trace encoder running clockwise



Now with the encoder running in the opposite direction (clockwise), we see that the pulses from channel B occur BEFORE the pulses of channel A.

This shift in phase of the signals with change in direction is a feature of the quadrature design (sensors at 90 degrees separation). Thus, it is possible to determine the direction of rotation in addition to speed.