

Basics – Incremental Encoders

Closed Loop Systems

In closed loop systems, incremental encoders generate the vital data required to establish angular position, provide velocity feedback information and determine direction of rotation. Basically, a rotary encoder converts angular motion into a digital output format that's easily interfaced with computers and programmable controllers.

Basic Operation of an Incremental Encoder

A rotary incremental optical encoder has five main components:

1. **LED light source.**
2. **Rotating encoder disk.**
3. **Stationary mask.**
4. **Photodetector.**
5. **Electronics to amplify and square the output signals from the photodetector.**

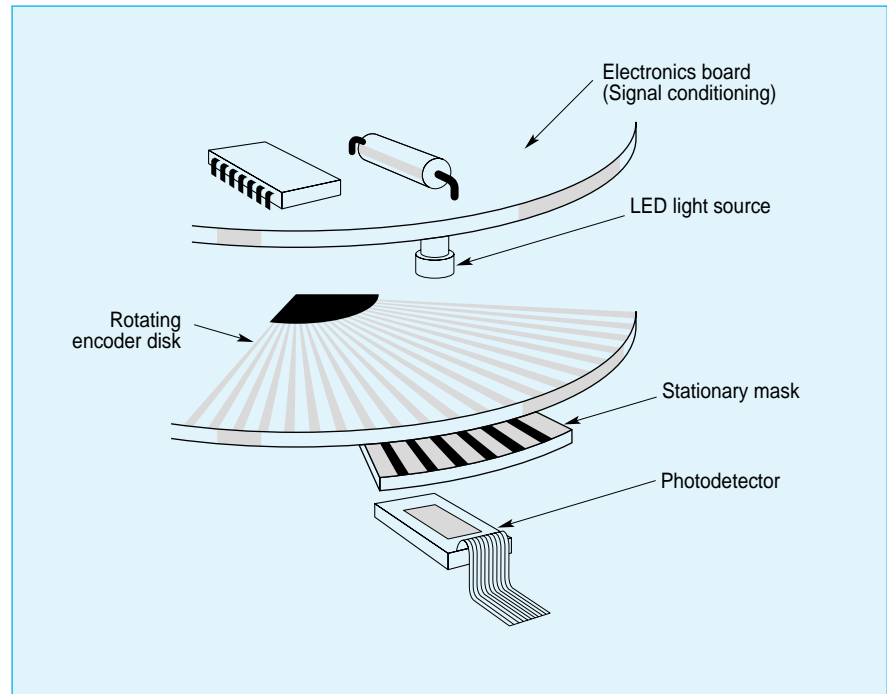
As the encoder disk rotates in front of the mask, it shutters the light from the LED light source. The light energy that passes through the mask is received by the photodetector which produces pulses in the form of a quasi-sine wave output. The encoder electronics convert the sine wave output into a square wave form, ready for transmission to a counter.

All Ledex standard encoders also include a single marker which provides one pulse every 360° of mechanical rotation for reference to determine a home base position.

Encoder Disk

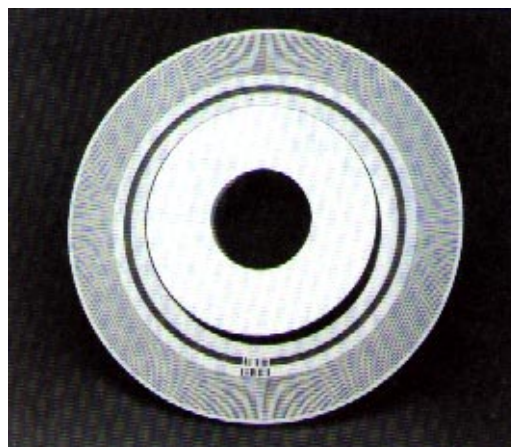
The encoder disk is the critical component in determining the overall performance of the encoder. The position and spacing of the lines on the disk requires a high degree of precision. The number of lines is equal to the number of pulses per revolution. While physical limitations determine the number of lines that can be established on any given disk, multiplication techniques make it possible to increase the resolution of quadrature type encoders by a factor of four (see page 7).

Incremental Rotary Encoder



Incremental Encoder Benefits

- Digital output.
- Angular or linear position sensing.
- Angular or linear direction of movement.
- Marker pulse for home base reference or error detection.
- Outputs compatible with control interfaces.
- Broad product range to meet application cost targets and performance requirements.



Tachometer Encoders

A single output incremental encoder, often referred to as a tachometer, is normally used in systems requiring accurate, but simple position or velocity information. Velocity data is generated by looking at the time interval between pulses or the number of pulses within a given time period.

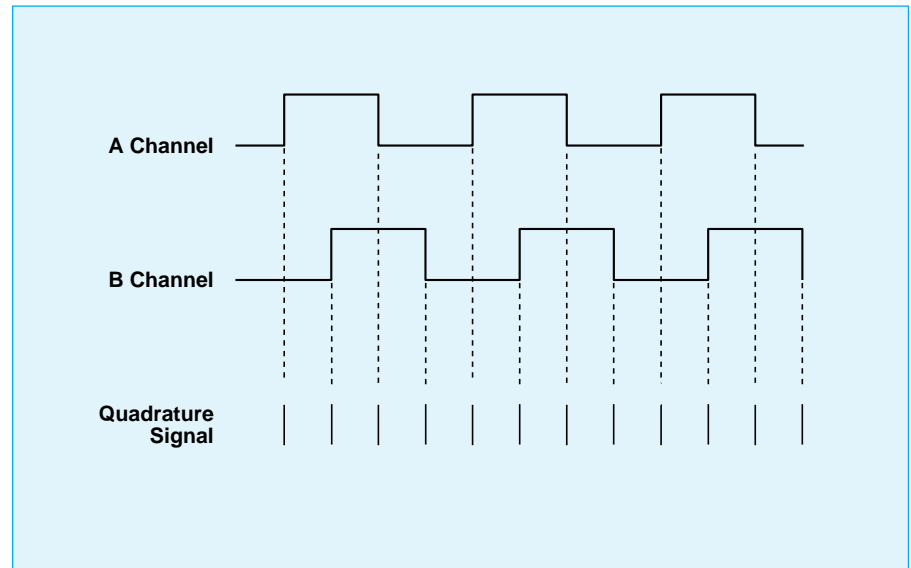
Quadrature Encoders

Quadrature encoders have dual channels, A and B, which are phased 90° electrically apart. An important benefit of having two output signals is that the direction of rotation can be determined by monitoring the phase relationship between these two channels.

Resolution Multiplication

Another important benefit of quadrature encoders is the capability of providing very high resolutions by multiplying the number of output pulses. In a dual channel encoder, a four times multiplication of the output count or resolution can be achieved by externally counting the rising and falling edges of each channel (A and B). A 5,000 pulses per revolution quadrature encoder, for example, can generate 20,000 pulses per revolution by employing this technique.

Dual Channel – Quadrature Encoders



Complementary Outputs

In addition to the need to count pulses accurately, correct position feedback depends on eliminating any false signals resulting from electrical noise. Incremental encoders are susceptible to noise, especially when the encoder cable is in the proximity of large electrical motors or switching gear. Noise problems can be eliminated or greatly reduced by using an encoder that provides complementary outputs. As shown here, a correct signal will generate two simultaneous outputs. As channel A goes high, channel \bar{A} goes low. If this doesn't occur, the signal is assumed to be the result of electrical noise and is ignored.

Complementary Outputs

