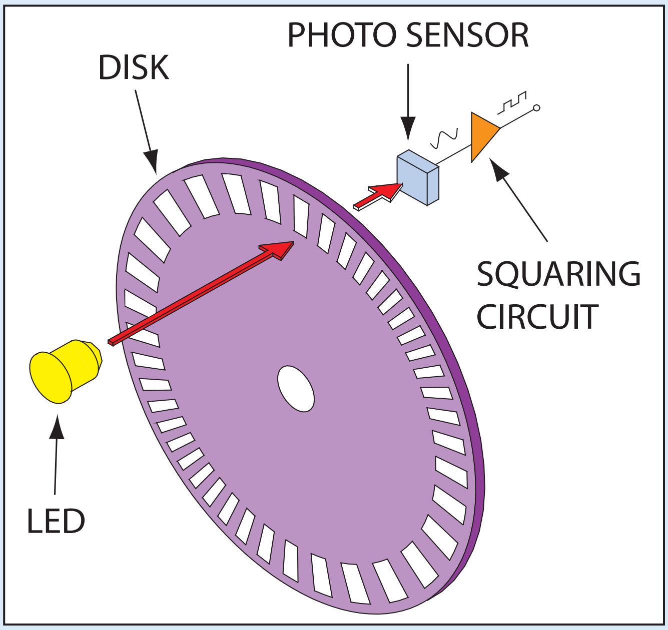
Encoder Basics

Encoders provide motion control systems information on position, count, speed and direction. As the encoder shaft rotates, output signals are produced, proportional to the distance (angle) of rotation. The signal may be in the form of a square wave (for an incremental encoder) or an absolute measure of position (for an absolute encoder).

Due to the performance and reliability advantages of the semi-conductor technology they incorporate, optical encoders are the preferred solution in many common computer, industrial, and automotive applications. Optical encoders also benefit from ease of customization, are suitable for numerous environments and suffer no effects from high levels of magnetic fields.

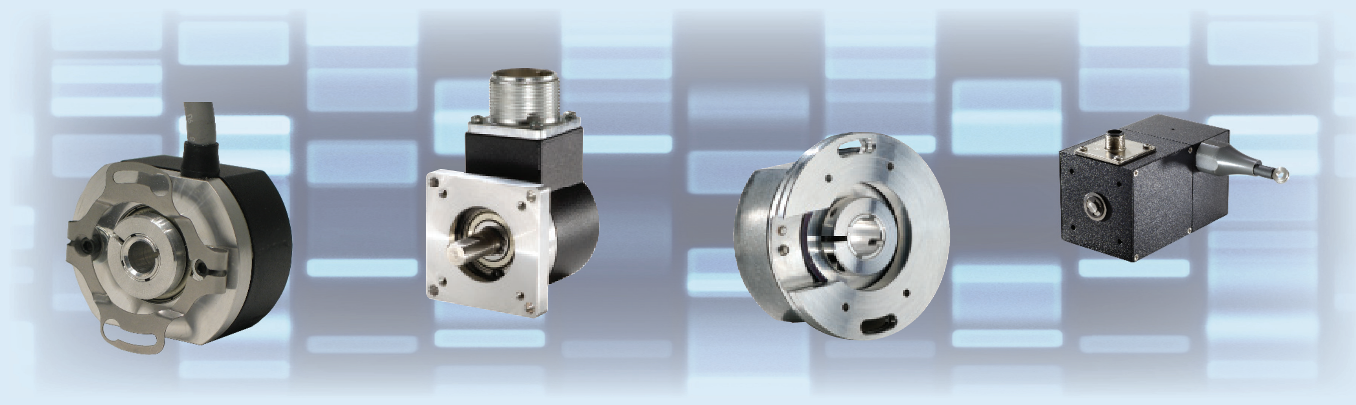
The basic construction of an incremental encoder is shown below. A beam of light emitted from an LED passes through a transparent disk patterned with opaque lines, and is picked up by a photo diode array. The photo diode array (called a photosensor) responds by producing a sinusoidal waveform which is transformed into a square wave or pulse train.



Incremental encoders are available in two basic output types, single channel and quadrature. A single channel encoder, often called a tachometer is normally used in systems that rotate in one direction only and require simple position and velocity information. Quadrature encoders have dual channels (A and B), phased 90 electrical degrees apart. These two signals can be used to determine the leading or lagging signal by their phase relationship. Quadrature encoders provide very high speed bidirectional information for very complex motion control applications.

Incremental encoders can provide a once-per-revolution pulse (often called index, marker or reference) that occurs at the same mechanical point of encoder shaft revolution. This pulse is on a separate output channel (Z) from the signal channel or quadrature outputs. The index pulse is often used to position motion control applications to a known mechanical reference.

Resolution is a term used to describe the Pulses Per Revolution (PPR) for incremental encoders, or the total number of unique positions per revolution for an absolute encoder. Each incremental encoder had a defined number of pulses that are generated for each full 360 degree revolution. These pulses are monitored by a counter or motion controller and converted to counts for position or velocity control. Absolute encoders generate a unique code word for every resolvable shaft angle (often called bits or counts per revolution).

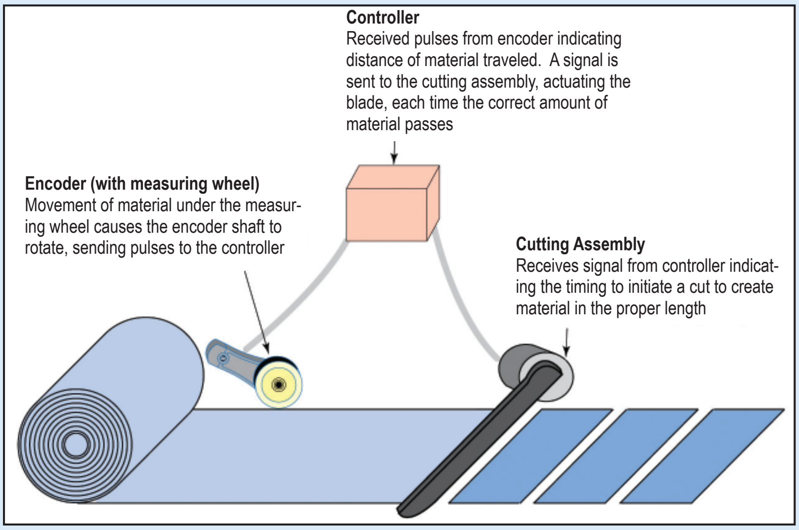


Typical Usage

Motor feedback is the most common use for rotary encoders. In this type of application, an encoder is either mounted directly to the motor or indirectly using a measuring wheel or chain-and-sprocket arrangement. The parameter of interest is primarily the speed of the motor.

Web tensioning is an application in which the encoder is not usually mounted to the drive motor but to one of the tensioning arm rollers. Any unevenness in the speed of this roller indicates that proper web tension is not being maintained and must be adjusted. The rotating speed of the tensioning roller is fed back to the controller, which then adjusts the drive motor so that web material is kept at an even tension.

Cut-to-Length is a very practical application of an encoder combined with simple mathematics. If, for example a system were to be designed with a roller that is exactly one foot in circumference, the roller would feed one foot of material for every revolution of the roller. An encoder mounted to the roller would reflect this situation and could tell a controller how much material had been fed through the roller. The resolution of the encoder would also directly reflect the accuracy of the cut. In the above example, 96 PPR would yield cuts to an 1/8" accuracy.



Elevators are just one example where encoders can perform a dual role. They can determine the position of the elevator through a mathematical calculation similar to the above, and they can determine the speed of travel of the elevator.

Registration Mark Timing uses encoders to determine the position of a unit relative to a known point, and then to determine the unit's speed relative to that mark. Radar antenna rotation is a good example of this type of application.

In **Backstop Gauging** the encoder is used to make sure that the unit, typically a machine tool does not exceed a preset position or direction of travel. Very often, this is combined with a determination of the speed of travel of the table, tool head or similar component. A typical filling application is just one example where Table Positioning is critical since the item being filled must arrive at filling tube at the same time the fluid control is turned on.

Conveying is another common industry where encoders are widely used. They may be attached to the motor, to intermediate axle shafts or to both. Encoders are an especially effective feedback device where the positioning and/or speed of multi-element conveying systems must be carefully coordinated.

Spooling (sometimes referred to as Level Wind) is another application where encoders can prove invaluable. Not only is it necessary that the speed of the supply and take-up reels be kept in proper relation to each other, but the amount of material being spooled must also often be tracked.

Electronics is just one industry that widely uses encoders in Pick and Place applications. Here many of the capabilities of encoders (rate, position, speed, velocity) can often be found combined in a single system.