Absolute encoders

Simplified machine design, increased efficiency

With the ongoing trend of integrating more components into single units, the addition of absolute encoders can eliminate sensors and reduce machine startup time, increasing efficiency while lowering cost.

Lexium MDrive integrated motor products are available with multi-turn absolute encoders for rotary and linear motion. These compact all-in-one motion systems are designed and assembled in the USA by Schneider Electric Motion.

Encoders are used for control and feedback purposes across an extremely wide range of applications including industrial, packaging and medical.

With a number of ways to classify encoders, primary is by the output type they provide, either incremental or absolute. Secondary is their sensing method, either optical or magnetic, with non-contact designs offering improved reliability, performance and life expectancy.

Incremental encoders

Incremental encoders determine relative position by generating a pulse each time an increment, or line, is reached. Simple and inexpensive, these encoders are also limited, require sensors and only provide change information.

Optical incremental encoders function by having a contactless optical sensor read the markings on an encoder wheel: the opaque lines and transparent spaces between. The number of lines per revolution define the encoder's resolution.

Magnetic incremental encoders, compared to optical, offer several advantages including smaller size, increased accuracy and robustness. These devices use magnets and sensors placed around the edge of a wheel to detect movement and position. This encoder's resolution is defined by the number of north-south poles (magnets placed on opposite edges of the wheel) and magnetic sensors.

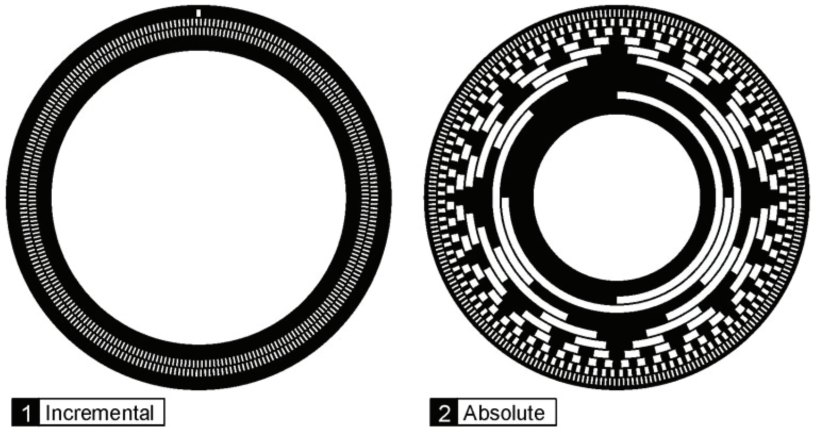
Absolute encoders

The strength of absolute encoders is in how their positioning accuracy affects overall performance.

Absolute encoders can be single-turn or multi-turn. Single-turn encoders measure displacement in one turn from a starting position across 360 degrees. Multi-turn encoders measure this way as well, plus additional tracking of the total number of revolutions through unique codes assigned each shaft position.

Optical absolute encoders have historically been mechanical devices using an optical code wheel and gearing to record positions. Absolute position is determined by the binary values coded on the wheel, read by passing light through the openings.

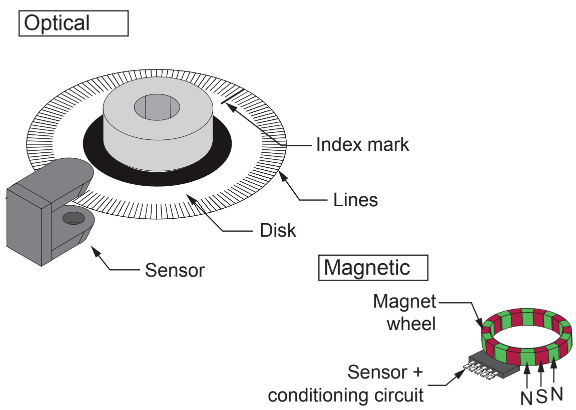
Magnetic absolute encoders use a magnetic sensor array similar to an incremental magnetic encoder, but are connected to circuitry for position encode, multi-turn counting, position storage and backup voltage monitoring. These encoders are typically smaller and lower cost than optical options.



Encoder wheel representations highlight the difference of how positions are indicated between an incremental and an absolute encoder.

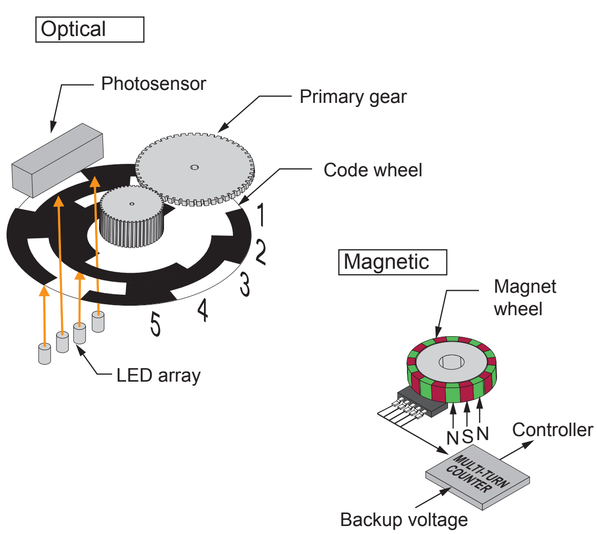
Incremental encoders

Incremental encoders are typically less expensive than absolute encoders, with two types available: magnetic and optical. The magnetic is smaller, which can reduce impact on a product's footprint.



Absolute encoders

Absolute encoders benefit users by recording unique position values, whether or not a system is powered. This eliminates the need for external sensors and re-homing after planned or unplanned shutdowns.



Key performance

From the user's perspective, the technology behind an encoder is less relevant than the performance that can be achieved. The key performance difference between incremental and absolute encoders being retention of position information by absolute encoders, even when a system is without power.

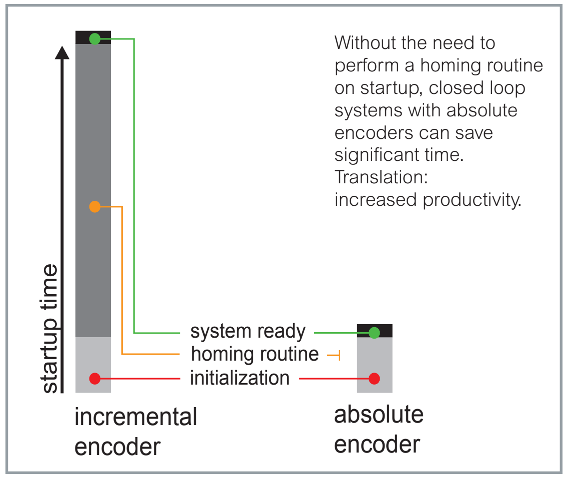
In application, absolute encoders are best if a particular setting must be recognized and available after a planned or unplanned system shutdown. Their advantage being that they provide unique position values as soon as they are switched on by scanning the position of a coded element. Even movements that occur while there is no power are recorded into accurate position values once the encoder is turned on again. This feature eliminates the need for external sensors and a lengthy homing routine.

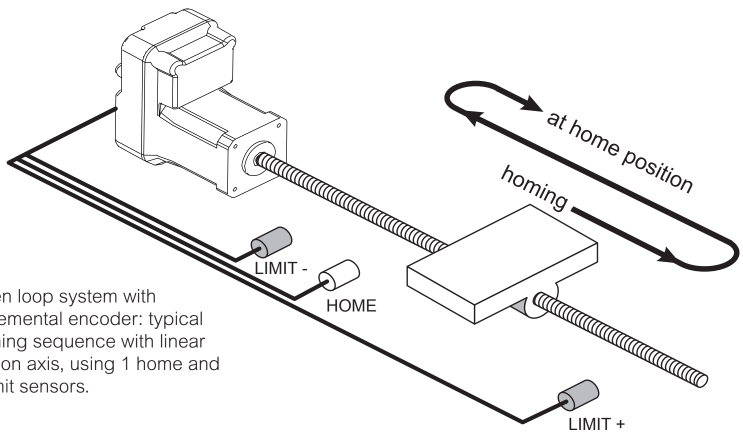
Magnetic absolute encoders are typically smaller and lower cost than optical absolute encoders. An additional advantage of magnetic absolute encoders is their support of special closed loop functionality.

Open vs. closed loop systems

Open loop systems, or systems with an incremental encoder, only measure what direction and how far a motor traveled. Any power interruption, planned or unplanned, will require a homing routine to calibrate the system at startup. The simple reason is that, until the controller knows exactly where the load is positioned, it cannot begin normal operation.

When powered on, a machine begins its startup up routine: the electronics will initialize, then motion axes begin the homing process by slowly moving between limit sensors before settling on the home sensor. In a multi-axis machine, that time will only be as fast as the slowest axis takes to home.

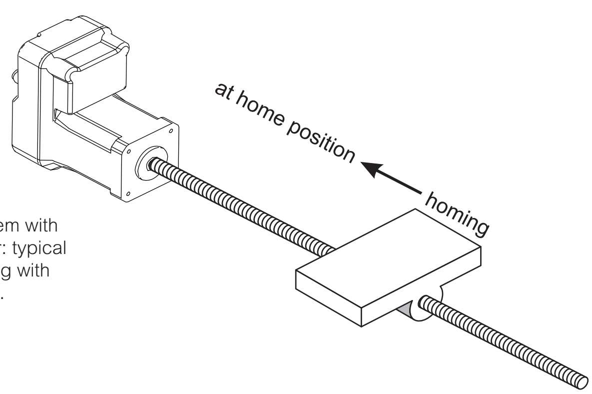




Open loop system with incremental encoder: typical homing sequence with linear motion axis, using 1 home and 2 limit sensors.

In applications sensitive to time and motion, an unplanned homing execution could lead to failure and loss of samples. An example would be a sample analyzer using costly, short lived reagents.

This same application in a closed loop system with absolute encoder reduces the risk of failure. When power is applied, operation can start right where it stopped, as that precise location is known. If returning to home is desired, this can be achieved more rapidly without searching for sensors.



Closed loop system with absolute encoder: typical sensorless homing with linear motion axis.

Saving time

Faster machine startups can also increase system productivity. As an example, hours of production time can be gained by operating a bottle capping machine as a closed loop system that does not require homing routines at startup.

If the slowest axis of an open loop bottle capping machine takes 45 seconds to home at startup each weekday, lost productivity per machine adds up to almost 4 hours/year. Or, at 5 seconds each, some 2700 additional bottles that could be capped, multiplied by the number of operational machines.

Saving money

Designing an absolute encoder based system can eliminate three sensors, the wiring from three sensors and the design and labor overhead needed to install, harness and maintain three sensors.

With photo or proximity sensors that savings can be substantial, especially when measured across multiple axes. With mechanical switches, the cost is less, but mechanical contacts degrade and can fail over time.

Cost savings primarily derive from the material and labor costs associated with developing and deploying elaborate harnesses, associated conduit and mounting hardware to support the sensors.

Additional cost savings can come in the form of reduced downtime due to maintenance.

Simpler, more efficient machines

Time spent on homing routines leads to loss of production, which can be costly. This has led to more intelligent motion solutions, supported by the ongoing trend of integrating more components into single units.

Lexium MDrive products, from Schneider Electric Motion, integrate multiple motion components into single units. The addition of absolute encoders provides more robust intelligent feedback, can eliminate sensors, and reduce machine startup time.

Automation and robotics designers will appreciate the simplified design and increased efficiency from a smaller package for a lower cost. This can be delivered by Lexium MDrive products with absolute encoder.

To learn more, visit www.motion.schneider-electric.com

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