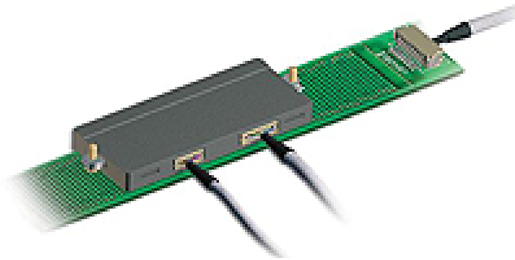
Know Your Position: New Technology In Automation Sensors

By Les Schaevitz, CEO, Everight Position Technologies Corp.



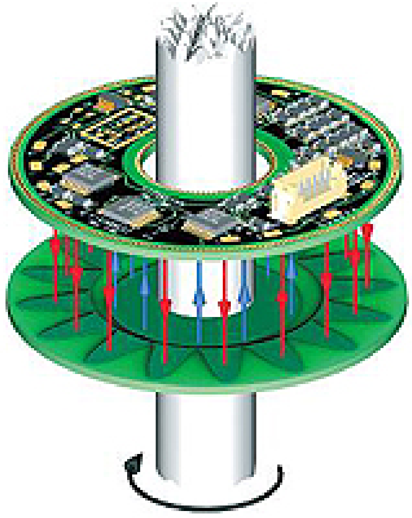
Netzer transmit/receive read head over a modulating active linear stator strip with coarse/fine pattern shown.

Providing real time linear and angular position feedback of actuated components in motion based systems is becoming increasingly important as more and more operations and processes are controlled by computers. Today's world of factory automation is, of course, wholly dependent upon linear and angular position (sometimes called displacement) sensors to situate work pieces and control all manner of automated operators and operations. Beyond the factory, position sensors enable fly-by wire and drive-by wire systems in transportation equipment, advanced engine control systems, automated medical devices, automatic process control valves…virtually any mechanical device with moving parts that requires position control.

There are a number of technologies used to create linear and angular position sensors. Potentiometers, differential transformers, inductive transducers, as well as magnetostrictive, magnetoresistive, Hall effect, capacitive, and encoder based sensors (among others), all serve the industrial market according to the specific requirements of the applications. Each of these technologies has a set of operating, environmental, and economic parameters that makes it particularly appropriate for a set of uses. Because of their inherent digital nature, great stability, and potential for very fine measurement over relatively large measuring ranges, encoder based sensors have particularly become the instrument of choice in robotics and machining applications. Encoders are also very widely used for high speed motor or simple multi-turn rotating shaft situations where an incremental output is adequate but directional information as provided by quadrature may be needed. Encoders are either incremental or absolute.

Absolute, Incremental, Or Electric Capacitive?

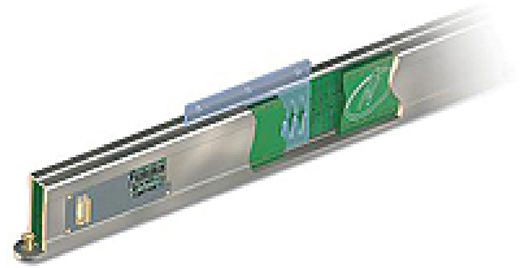
Absolute encoders are able to power-off and power-on, and still "know" where they are, while incremental encoders only know where they are relative to where they started. In a power-off/power-on situation, the incremental encoder has to be "homed" before it can be used again so that it is able to re-establish its relative position.



Exploded view of two-part rotary Electric Encoder where top plate transmits/receives and bottom plate modulates the field.

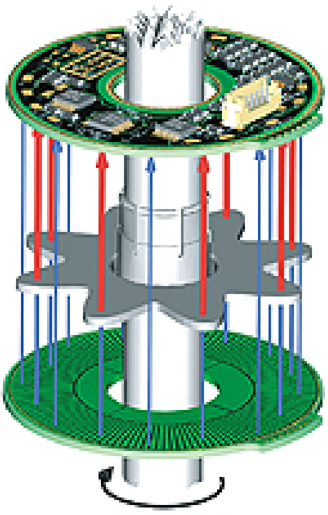
An encoder typically works by "reading" a geometric pattern of either visual (optical) or magnetic marks on a plate or tape arranged either linearly or radially as required for the measurement type. The physical action being measured causes a read head to pass over the mark pattern and feeds back a digital data stream that indicates position. Many magnetic encoders use a series of Hall effect magnetoresistive elements to produce the desired pattern and are "read" by a permanent magnet. Magnetic encoders are generally used where cost trumps overall accuracy and environmental conditions are difficult, while optical encoders provide ultimate accuracy at a high cost, but only where relatively benign environmental operating conditions allow.
Into this mix comes the "electric capacitive" encoder, a new technology commercialized by Netzer Precision Motion Sensors, Ltd. of Misgav, Israel. This insurgent technology delivers the extreme accuracy of the optical encoder in a very small package, while operating in severe environments at an economical cost comparable to magnetic encoders. Invented by Yishay Netzer, formerly of Israel's Rafael Armament Development Authority and a holder of over twenty international patents in sensors and related electronics, the capacitive Electric Encoder® was first created to provide extremely reliable rotary position accuracy for fire control and reconnaissance operations in defense/aerospace applications.
The severe requirements for these applications included rotary measurement tolerance to .001 degrees, low weight, very low section width, up to 7" shaft acceptance, high shock and vibration resistance, extreme operating temperatures and frequent temperature cycling, low power consumption, high tolerance to condensation and contaminants, and no magnetic signature or sensitivity to EMI/RFI or magnetic fields. The company that followed the invention, Netzer Precision Motion Sensors, has created a multitude of both linear and rotary sensor forms based upon its technology.
How They Work

Netzer's non-contact position sensor technology relies upon the basic principle of the variance of RF signal attenuation as a function of capacitance. Within a Netzer three-part rotary Electric Encoder, a dielectric rotor rotates (in synch with the shaft motion) between two stationary printed boards. One board serves as a space/time modulated electric-field transmitter, and the other as a field receiver. The rotor interaction with the electric field is influenced by the shaft rotation angle. The received, integrated field is converted to a proportional current which is processed to provide DC output signals, proportional to the Sine and Cosine of the shaft angle.
The Netzer two-part rotary Electric Encoder comprises a fixed stator board that includes field transmitting and receiving plates on its bottom side, and processing electronics on its top side. The bottom side faces the rotor, which in turn modulates and redirects the field. The received integrated field is converted to a proportional current which is processed to provide DC output signals proportional to the Sine and Cosine of the shaft angle.



A cutaway view of linear Electric Encoder with a passive "cable-less" spoiler gliding between active transmitter and receiver plates.

The capacitive linear encoders are constructed similarly to both the three- and two-part rotary encoders. The three-part linear allows for a cable-less dialectric spoiler to be used, gliding between linear transmitter and receiver plates, thus providing a similar user experience to that of magnetostrictive sensors. With a read head moving over a linear receiving plate, the two-part type linear sensors most resemble conventional optical, magnetic, and magnetoresistive type linear sensors, but possess some advantages in terms of performance and/or price over competitive technologies.
All Netzer Electric Encoders employ a dual, coarse/fine code pattern that enables extraordinarily fine resolution and accuracy even in a very inexpensive rotary device. The basic theory behind this coarse/fine scheme is that if the total measuring range of a sensor device can be broken up into a series of small, equal, distinctly identifiable segments, the incremental scale of each small segment can be much finer than it would be if that same incremental scale were set over the entire measuring range.



A three-part rotary Electric Encoder with a dialectric rotor altering capacitance between the transmitter and the receiver plates.

To further enhance the overall accuracy of their rotary Electric Encoders, Netzer designers took a holistic approach to the interaction of the rotor and the sensing element. The rotor induces capacitance over its entire 360 degree symmetric pattern, so there is no need for a bearing to maintain shaft, and thus there is rotor concentricity with respect to the sensor elements in order to assure sensor repeatability. It isn't a measuring instrument if its not repeatable, and this design aspect of the rotary Electric Encoder assures this vital aspect of sensor operation.

A Look To The Future

Relying on the interaction between the absolute position or displacement of an object and a space/time modulated electric field, capacitive encoder based position sensing has the potential to bring extremely high accuracy to applications where cost and environmental barriers have been limiting.

Everight Position Technologies Corporation, Moorestown, NJ, will represent Netzer Precision Motion Sensors in North America: www.everightsensors.com. *[1]*

Links:
[1] http://www.everightsensors.com/