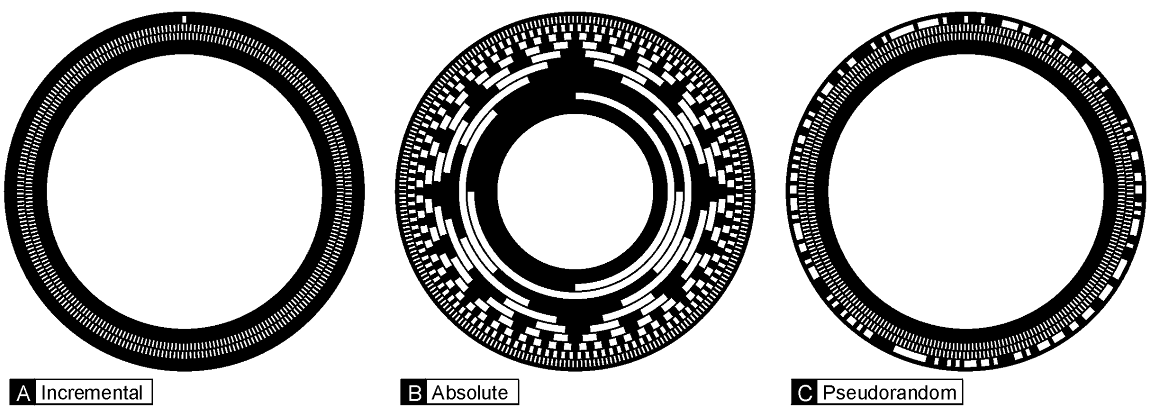
Encoder Innovation

Readers are probably familiar with both incremental and absolute encoders. However, they may be less aware of new technological developments in pseudorandom encoding. A pseudorandom encoder is neither incremental nor absolute. It's a new kind of device which is similar in construction to an incremental encoder, but behaves more like a conventional absolute encoder. Though like the two traditional encoder types in some ways, these new encoders have aspects of design and behavior which are unique. Thus, while incremental and conventional absolute encoders are hardly obsolete, they're also no longer your only choice.

How It Works

In its simplest form, the new encoder uses cyclic and index tracks, a single LED light source, and the same number of detectors as an incremental encoder. However, the index track looks something like a bar code, instead of just a single mark. Its pseudorandom code structure provides a unique nonvolatile optical code for each and every position of the disk or scale. Thus, absolute position is encoded serially along one track, rather than being dispersed over multiple parallel tracks.

A series of code bits must be accumulated to determine position. The incremental track signals provide direction sense and spatial timing only. Position immediately on power-up is unknown, but after a very short travel in either direction and starting from anywhere, absolute position is determined. In a rotary encoder, the initialization angle is typically 1 - 2°, depending on the encoder's line count (arbitrary resolutions like 3600 are easily handled); a linear encoder needs less than 1 mm motion.



Pseudorandom output codes picked off the disk or scale need translation into a natural binary format. The necessary decoder can be implemented in an inexpensive programmable logic device that stands in place of the quadrature decoder and up/down counter used with an incremental unit. Since it doesn't count position increments from the cyclic track(s), it can't unwittingly gain or lose "counts" under duress like an incremental encoder system can. Thus, although this type of unit costs little more than an incremental system of comparable resolution, it's effectively absolute.

In addition to the binary position output, the decoder provides a status bit. This bit is logic high whenever the supply voltage is interrupted, when the initializing motion is not yet complete, or when some other effect such as electrical noise, damage, or fouling of the disk interferes with the proper code sequence from the indexing track. When these self-tests are all satisfied and the encoder is initialized, the status bit is low, indicating the position output data is valid. Full-time position verification with real-time reporting of any problem is the most important feature of this new encoder in the opinion of some machine designers.

The decoder circuit is preferably located in the host system, as an incremental up/down counter would be, to preserve frequency response. However, in low speed applications, the decoder may be located inside the encoder housing and the absolute position data transmitted serially along with the status bit.

The principal advantages of pseudorandom encoding technology may be summarized thus:

- The initialization distance or angle is a fixed and very small motion, regardless of the starting position or direction of travel. Just "bump" it to find out where you are.
- The encoder generates the same information as a conventional absolute, so interfacing to digital signal processors, computers, PLCs, servo controls, etc., is straightforward.
- Self-test functions not found in any conventional device report various malfunctions, and may also help detect system problems such as excessive heat, noise, and speed.
- Simpler optics allow a rotary pseudorandom encoder to be smaller than a conventional absolute of equal resolution, or to have a larger through-hole.
- Compared to conventional absolute encoders, simpler readout electronics, reduced parts count, and forgiving internal alignments translate into higher intrinsic reliability.

Applications

Pseudorandom encoders don't belong in mice and trackballs, nor are they appropriate if you really must know position immediately on power-up, without even the slightest motion. However, the following table lists a few types of applications where this technology may prove ideal.

Application	*Rule*	*Examples*
Very slow motion	Machine moves ponderously; homing to an index takes considerable time	astronomical observatories heliostats / communications lasers
Very fast motion	Machine has high top speed but also wants high resolution for tight low speed control and high stopping accuracy	manufacturing robots pick-and-place machines
Safety	Machine could hurt someone when the encoder malfunctions; self-testing can keep the machine from getting out of control	medical equipment transportation / gantries weapons systems
Efficiency	Machine is operating on costly materials; self-testing can halt operation, reduce waste	exotic machine tools IC wafer handlers
Reliability	Machine cannot afford down time or is hard to repair; simpler construction is better	military / aerospace systems large manufacturing systems
Remote control	Machine controller is far from the encoder; number of wires from the encoder is small	radar / communications antennas radioactivity / explosives handling
Vacuum	Minimum parts count and low heat dissipation in the machine are important	IC manufacturing equipment spacecraft
Large through-hole	Available disk annulus has little room for tracks, but incremental is considered undesirable	telescopic gimbals portable equipment
Price sensitive	High accuracy absolute devices are desirable, but cost too much	high-end consumer products mass-produced items
Linear encoders	Few absolutes are available and they're expensive	any linear application with the concerns above

Most incremental encoders can be retrofitted to use pseudorandom pattern technology. For high resolution / high speed applications, the decoder is usually a separate circuit which also enhances the resolution of the encoder by absolute interpolation, and monitors analog signal quality to provide early warning of a range of optical and mechanical problems.

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