*Virtual Absolute*Ò *Technology*

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Gurley Precision Instruments has developed a unique encoding method that combines the opto-mechanical simplicity of an incremental encoder with the system reliability and interfacing ease of an absolute encoder. This document refers mostly to rotary encoders, but the technique is equally useful in linear encoders. The reason for the selection of the name *Virtual Absolute* (*VA*™) will become apparent later in the discussion.

Let's begin with a short review of encoders. In an ***Incremental*** encoder, the primary track consists of uniformly spaced alternating opaque and clear lines. The typical incremental encoder output consists of two square waves 90° out of phase with each other. Most commonly, the user's circuitry decodes the relative phase to determine direction of travel, and counts the four *quadrature* states in each cycle. This provides a resolution equal to four times the line count on the disk. (Techniques exist to electronically increase this resolution, but that's another subject.) An up/down counter must be dedicated to watching the output at all times so that no information is lost.

To generate absolute position information from an incremental encoder, a second track is added to the disk to provide an index signal that occurs once per revolution. (It is also sometimes called a marker, reference, or zero signal.) When a homing procedure is executed on power-up to find this signal, absolute position is then discovered, but sometimes that can require up to a full revolution from the power-up starting position. If electrical noise or encoder damage later produces false counts in the up/down counter, this often goes undetected until the next index is seen, whenever that may be.

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In a conventional ***Absolute*** encoder, the pattern on the disk consists of a series of concentric incremental tracks, with the number of cycles per revolution doubling on each track of increasing radius. Each track has its own photodetectors, and the tracks are arranged so that reading all the detectors generates a parallel binary word, usually in Gray code. For example, an encoder with 12 tracks would generate 4096 words per revolution. (As with incrementals, techniques exist to increase resolution beyond the number of tracks, but many tracks are still required for high-resolution encoding.) The opto-mechanics and track detection electronics of such an encoder are significantly more complex and expensive than an incremental encoder, and all track channels must function perfectly in concert to avoid reporting false position information. However, it does have the compelling advantage of providing position information immediately on start-up, without a homing procedure.

Two other distinguishing features of an absolute encoder are:

1. Because the encoder generates parallel binary data, it is easy and straightforward to interface to any microprocessor-based controller or display.
2. Because the encoder "stores" non-volatile position data in the code pattern of the disk, it is not necessary to constantly accumulate data from its output; you just read it whenever you want to find its position at that instant.

Now for the good stuff: A *Virtual Absolute* encoder uses just cyclic and index tracks, like an incremental encoder. However, the index track is a serial code similar to a bar code instead of just a single line. You do not know position immediately upon start-up, as you do in a conventional absolute, but after a very short travel, *in either direction and starting from anywhere*, you know exactly where you are. In a rotary *VA* encoder, this *initialization* angle is typically about one degree, depending on the encoder's line count; in a linear *VA* encoder, about 1/2 mm motion is needed. From then on, the encoder is truly absolute in the sense of both #1 and #2 above.

In addition to the natural binary position output, a *status* bit is provided to tell you when the encoder is initialized. This bit is at a 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 index track. When these self-tests are all satisfied and the encoder is initialized, the status bit is low, indicating the position data output is valid.
As we have said, the opto-mechanics of such a device are as simple and reliable as those of an incremental encoder, but its digital electronics are more sophisticated. That's why the *VA* encoder costs more than an incremental, but not a lot more, and much less than a conventional absolute.

To summarize, the advantages of our *Virtual Absolute* technology are:

1. 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.
2. The encoder contains inherent built-in-test functions not found in any conventional encoder. It reports not only various encoder malfunctions, but can also help detect system problems such as too high a temperature or excessive speed.
3. The encoder generates the same whole-word information as a conventional absolute, so it is very easy to interface to computers, PLC's, servo controls, etc.
4. With its simpler optics, a rotary *VA* encoder can be smaller than a conventional absolute of equal resolution. And you can use a linear *VA* encoder for applications where a suitable conventional absolute linear would be very hard to find.
5. Because of its simpler electronics, reduced parts count, and less critical internal alignments, a *VA* encoder is inherently more reliable than a conventional absolute.
6. A *VA* encoder is usually dramatically less expensive than a conventional absolute.

GPI manufactures conventional incremental and absolute encoders, too. We have learned that no one kind of encoder is right for every job. If you choose to work with us, you will find that we understand the strengths and weaknesses of each kind of encoder and how they relate to your application. *Virtual Absolute* encoding is just another way of getting the job done, but one we are proud to say is finding exciting applications in the most advanced fields of robotics, satellite communications, semiconductor and flat panel manufacturing, and many more. Contact Gurley Precision Instruments or your local representative today to find out how *VA*™ technology can solve *your* motion measurement problem.

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For more information, please visit our web site dedicated solely to *Virtual Absolute* technology at www.virtualabsolute.com, or call (800) 759-1844.