Accurate position feedback

Karmjit Sidhu, VP, Business Development at **Macro Sensors** and **American Sensor Technologies**, considers how position sensing offers different performance attributes for demanding industrial and Mil-aero applications

Traditional linear position sensing technologies such as potentiometers, LVDTs (Linear Variable Differential Transformers), VRTs (variable reluctance transducers), magnetostrictive sensors and optical encoders are still the preferred technology for providing linear position feedback in a variety of industrial and military/aerospace applications.

Each technology offers different performance attributes suitable for certain applications. Comparisons of different linear position sensing technologies are as follows:

A potentiometer is basically a three-terminal voltage divider powered from an AC or DC source. Two terminals are fixed while an output terminal, connected mechanically to a moving member, moves up or down to represent displacement. Supply voltage is applied to the fixed terminals. Output signal is a ratiometric with respect to the applied voltage.

While linear potentiometers are attractive due to low price, easy implementation and short body length, the biggest drawback is that devices rely on mechanical contact to provide position feedback. As contacting devices, potentiometers exhibit poor repeatability, larger hysteresis, and outputs tend to deteriorate over time due to contact wear out, particularly under high vibration conditions, often rendering them unacceptable for long-term reliability.

LVDTs consist of three windings, a core and a housing (see cutaway in figure 1). Voltage is applied to a primary winding from an AC source whose frequency and amplitudes are stable over temperature. Two secondary windings pick up the signal that is mutually induced from the primary via the core position. The core is usually attached to a moving member to represent the displacement being measured.

If the core is in the middle of the LVDT, both coils have equal and opposite signals that produce a null voltage. At this point, the phase angle will also change by 180^0 as the core moves from one coil to another. This phase angle determines the polarity of the signal.

Both sensors require AC signal conditioning or support electronics that may either be contained within the sensor, like a DC-operated LVDT, or removed to a location more amendable to the electronics, while the sensor remains in a harsher environment.

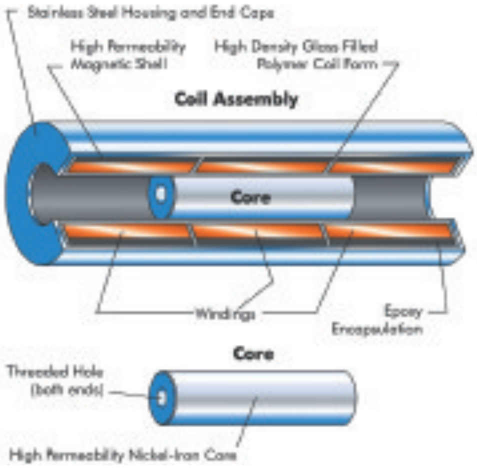

Figure1: Cutaway diagram of an LVDT showing the internal three windings, a core and housing

These inductance sensors are very versatile, offering a range of performance characteristics and operating options. Both are contactless and robust, offering long-term reliability in harsh or hostile environments.

Frictionless operation translates into higher repeatability and resolution. In the past, these technologies suffered from two problems: cost and space requirements. Modern layer winding techniques and low cost ASIC/microcontroller based electronic compensation techniques are addressing these issues.

Linear encoders employ optical or magnetic gratings that supply a stream of digital signal that is decoded to provide absolute or relative measurements resolved by complex electronics. Low cost encoders provide resolution from 10 to 12 bits while high-end units provide 18 bit resolution.

These incremental sensors rely on optically reading linear graduations on a glass scale or sensing magnetic poles deposited with uniform spacing on a ferromagnetic material. While known for high precision, limited frequency response often makes encoders ideal for slower dynamic applications.

Devices also require complex electronics for use in absolute measurements and tend to be expensive. Linear encoders are used in specific applications such as instrument tables and labs. They are also popular in motion control systems, robots, and machine tools, where their relative fragility and high cost can be accommodated.

Magentorestrictive sensors employ a position-sensing magnet, a wave guide, pick up coil and complex electronics to precisely measure position.

The position magnet is attached to the machine tool, hydraulic cylinder, or whatever is being measured. The waveguide wire is enclosed within a protective cover and attached to the stationary part of the machine, hydraulic cylinder, etc.

The location of the position magnet is determined by first applying a current pulse to the waveguide. At the same time, a timer is started.

A current pulse causes generation of a sonic wave at the location of the position magnet, Wiedemann effect. The sonic wave travels along the waveguide until detected by the pickup, which stops the timer.

The elapsed time indicated by the timer represents the distance between the position magnet and pickup. The sonic wave also travels in the direction away from the pickup. To avoid an interfering signal from waves travelling in this direction, energy is absorbed by a damping device. The pickup makes use of the Villari effect.

A small piece of magnetostrictive material, called the tape, is welded to the waveguide near one end. This tape passes through a coil and is magnetised by a small permanent magnet called the bias magnet. When a sonic wave propagates down the waveguide, then the tape, stress induced by the wave causes a wave of changed permeability (Villari effect) in the tape.

This, in turn, causes a change in the tape magnetic flux density. As a result, a voltage output pulse is produced from the coil that is detected by the electronic circuitry and conditioned into the desired output.

Widely used for long stoke measurements in cylinders, actuators and simulators, magnetostrictive technology is very accurate but typically expensive and limited to benign applications.

Units suffer from a relatively large temperature coefficient, which is not acceptable in many applications.

Sensors do offer high resolution, high repeatability, and exhibit good temperature stability over a limited temperature range. They are particularly useful for relatively long ranges, typically from six inches to 120 inches (150 mm- 3 m) or more. **Enter 220**

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