

How New Angular Positioning Sensor Technology Opens A Broad Range of New Applications



WhitePaper

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A new generation of touchless position sensors solves a number of new problems while simplifying existing on-line control applications by providing design engineers with an opportunity to reduce implementation and maintenance costs. This technology can solve problems from measuring through materials to existing shaft alignment issues.

Novotechnik's new generation of touchless sensors utilize a magnetic field Hall Effect element. The Hall Effect is the production of a potential difference (the Hall voltage) across an electrical conductor in which an electric current flows in the presence of a magnetic field. The direction of the potential difference is perpendicular to both the magnetic field and the current.

In a touchless position sensor, a permanent magnet attached to the rotating shaft is used as a position marker. The orientation of the magnetic field is captured using an integrated circuit. The analog output represents the calculated angle.

Since the rotating shaft with the position marker is separate from the sensor, these touchless systems are ideal for applications that require an extended maintenance-free life, mounting flexibility, or transmissive measurement through air or non-magnetic materials.

Touchless angle sensors are also ideal in applications where torque must be kept to a minimum, for example devices used to measure wind direction or dancer arm applications (e.g. wiring, textile, and printing). In the past this application required expensive sensors with special bearings to dampen torque to levels as low as 0.002 to 0.003 Ncm. Since there are no axial or radial forces to adversely affect the accuracy or the life of touchless sensors, they are ideal for demanding applications. There's no friction and no mechanical parts to wear out. As a result, Novotechnik touchless angle sensors have unlimited mechanical lifetimes. In contrast to conventional low-torque angle sensors that require an intricate manufacturing process and expensive materials, touchless sensors are simpler to manufacture and consequently less expensive.

How Touchless Sensors Work– Vert-X Technology

Novotechnik U.S. touchless position sensors are based on Novotechnik’s the proprietary Vert-X (Vertical Hall Sensor) technology to measure 360-degree movement. In a conventional Hall Sensor a semiconductor measures the

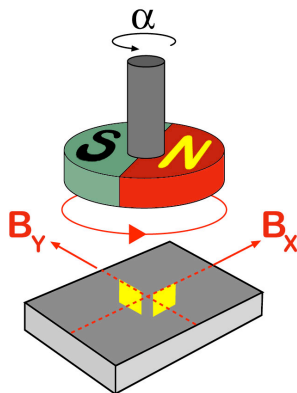


Figure 1 - Vert-X sensors employ a novel cross-shaped structure directly affixed to the silicon chip. This enables the sensor to measure the magnetic field in the X and Y directions.

strength of a magnetic field perpendicular to the element itself. The rotation of the position marker creates a sinusoidal output voltage on the element to measure angles up to 180-degrees. With Vert-X technology, Novotechnik U.S. touchless sensors measure the full 360 degrees spectrum. A cross-shaped Hall element produces both sinusoidal and cosinusoidal output signals – see figure 1. By normalizing these two signals, the microprocessor built into the sensor determines the field orientation of the magnetic position marker. This eliminates the aging effects on the magnetic position marker encountered in single in sensors with a single Hall element that simply measure magnetic field strength. Reliable linkage of an angle sensor to a rotating element is not always as simple as it might seem particularly in applications where there are

axial offsets between the rotating component and the sensor axis attributable to design features and manufacturing tolerances. High-resolution, precision rotary sensors cannot tolerate torsion in the linkage and, when this is in evidence, it has a negative influence on the measurement results, since a twist of the axis generates erroneous angle data.

Figure 2 shows the XYZ coordinates for a touchless angle sensor. The working distance between magnet and measurement system and the permissible installation tolerance in the Z-axis can be optimized by choosing a suitable magnet. Depending on the size of the magnet, a range of axial offset distances is possible in the XY direction while maintaining constant linearity. Actual configurations represent a trade-off between magnet size and the possible axial offsets. Axial offsets in X, Y and Z, however, do not change reproducibility within the limits of laws of physics.

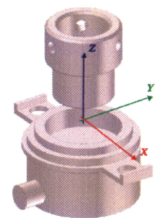


Figure 2 – System of XYZ coordinates in a Vert-X.

Where You Need Touchless Sensing

Besides the benefit of unlimited mechanical life, touchless technology opens up a number of applications that were difficult or impossible to implement using conventional sensors. These include applications that require a physical barrier between rotating shaft and the sensor. For example, a touchless sensor may be used to measure the position of a valve sealed in a non-magnetic metal or plastic housing. The position marker is mounted on an internal shaft and the sensor is placed outside. It's also possible to measure thought pressurized housings without moving seals.

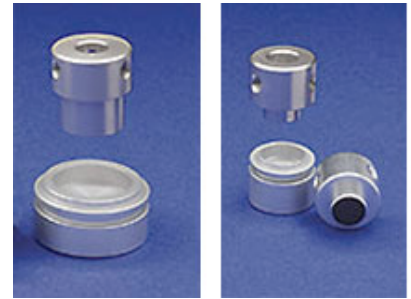


Figure 3 - The Vert-X 22E and Vert-X 13E are typical of Novotechnik's complete line of touchless angle sensors.

Vert-X technology sensors are integrated with optional features such as switches and analog outputs that can substantially reduce parts and manufacturing costs. Here are five practical examples:

- Using 4 to 20 mA or 0 to 10 V outputs virtually eliminates the need for external signal conditioners to cover long wiring distances.
- As a touchless technology, Vert-X sensors have no shaft. Consequently, tolerance and play of the drive shaft and bearings on an application will not affect Vert-X sensors. As a result there is no need for an expensive mechanical coupling in an application.
- Vert-X sensors are available with very small housing diameters and 14-bit resolution. In some cases, sensors using this technology can replace expensive encoders.
- The microchip containing the Vert-X technology is available in versions with embedded switches. These are customer programmable and can take the place of PLCs in providing signals turn devices on or off at specific angles.

Touchless sensors are also ideal for applications in hazardous environments as they can be sealed up to IP69K and as there is no wear due to torsion or vibration in the absence of a mechanical linkage.

Novotechnik U.S. Vert-X touchless sensors provide absolute linearity. This means that linearity is maintained over 360°. These sensors also maintain full resolution and accuracy at any programmed electrical angles so they can be installed without the need for any error prone calibration or other time consuming adjustments.

Vert-X touchless sensors are available in standard and custom designs that offer up to 14-bit resolution and repeatability to $\leq 0.1^\circ$, a programmable angular range to 360° and are available with body diameters from 13 to 37 mm, resolution up to 14-bit with linearity of $\pm 0.3\%$. Sensors sealed to IP69K are available and can operate in temperatures between -40°C and +125°C. Output options from Novotechnik touchless sensors include analog (voltage and current), incremental, SPI, and PWM. Non-linear customer specific output curves are also available.

Software linearization provides benefits of calibration and customization. It often uses the ability to create custom output curves (transfer functions) with different outputs including custom slopes, polarity, and adding deadbands among the options.

These sensors are currently being used to solve a wide range of application problems in industrial, automotive, off-highway vehicles, robotic, aerospace, materials handling, injection molding, medical equipment, and laboratory devices. Application information is available at www.novotechnik.com.

For more information log on to www.novotechnik.com or email info@novotechnik.com.