Temposonics®

Magnetostrictive, Absolute, Non-contact Linear-Position Sensors

MTS® SENSORS

Primary Considerations When Deploying Position Sensors into Extended Temperature Range Environments

White Paper

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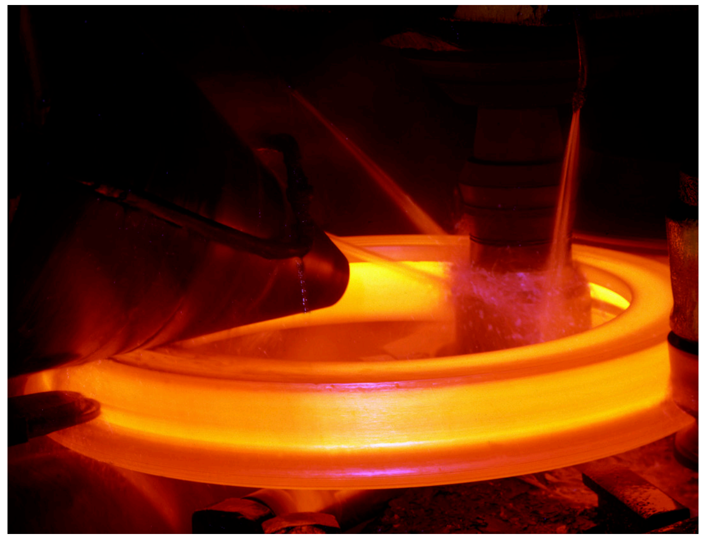
Fundamental to any position measurement implementation is the period of time over which the equipment can function effectively without the need for either repair or replacement, so identifying a suitable sensor device warrants a great deal of thought. The expense associated with carrying out field service can add significantly to the sensing system's total cost of ownership if it proves to be less resilient to its surroundings than was expected. Failure can also result in loss of revenue during downtime. It is therefore essential that engineers are fully aware of the implications of high temperature before choosing a sensor. Furthermore, they need to know the appropriate steps that can be taken to prevent temperature from impinging on the system's ongoing performance.

There are a broad spectrum of applications, in the industrial, aerospace and transportation sectors, amongst others, where position sensing devices have to endure difficult working environments. They may potentially be exposed to high pressures, shocks, vibrations and electromagnetic interference, as well as the presence of caustic or corrosive substances, dust, flames and even explosive atmospheres. The most common factor, however, that will have influence on a sensor's operational longevity is temperature. In steel mills, offshore oil/gas drilling rigs, power generation plants, wood presses, injection molding equipment, thermoforming machinery and countless more scenarios, an extended temperature range will be almost mandatory, and the boundaries are being pushed ever further all the time.



BEST PRACTICES FOR COMBATTING EFFECTS OF EXTENDED TEMPERATURES

One of the primary issues when placing a position sensor into severe operational surroundings is to what extent temperature variations will bring about sensor drift. This can impair the quality of the acquired positioning data significantly and thus lead to a poor state of performance for the equipment into which the sensor has been integrated. It is possible to compensate for this by applying sophisticated algorithms.

High temperature will not just affect the sensing element, but also the electronic circuitry accompanying it, which takes care of signal processing, etc. This is another major concern, as the semiconductor components involved can be highly sensitive and therefore much more vulnerable. The mean time to failure (MTTF) metric for semiconductors will normally be quoted on datasheets at an ambient temperature of 25°C. This figure will be markedly reduced the closer that these components are run to their maximum temperature limit. Generally speaking it can be estimated that MTTF value will be cut in half for every 10°C that the operating temperature is raised above the component's optimal temperature level. Many of the components used for industrial sensors are rated for operating temperatures up to 85°C, but this does not account for the additional heating that occurs within the sensor housing. Employing higher spec semiconductors will allow sensor manufacturers to alleviate the problem, but there are trade-offs to be made when sourcing these items, as they tend to have higher unit prices. This means that although such an approach will enable a wider temperature range to be supported, it will also raise the overall cost of the sensor system that can be offered to the customer.

In order to mitigate the risk failure, often both the sensor and the supporting electronics are enclosed inside a sealed housing or cylinder that can be cooled to remain within the operating temperature range. The whole system can thereby be protected from potential damage that high temperatures could pose. In a growing number of cases an alternative methodology is being used to tackle the problem. This is to physically remove the supporting electronics from the high temperature setting and locate that part of the system far enough away that it is not exposed to the heat effects. One application where this is commonly done is in steel mills, which can prove to be extremely demanding environments.

THE NEED FOR ADVANCED SENSING TECHNOLOGY

Position sensing can be accomplished in a variety of different ways, but as the demands placed upon sensor devices have continued to increase, conventional techniques have become outdated. Electromechanical sensors and potentiometers will have relatively short lifespans because they are increasingly susceptible to wear and tear as the number of operation cycles builds up, while optical sensor system can be hampered by dirt and dust, so constantly cleaning is required. Magnetostriction is now widely used - as this presents engineers with an extremely accurate non-contact method by which to measure position. It is far from new - the magnetostrictive property of a certain class of materials was studied by James Prescott Joule nearly two centuries ago - but through a series of innovations over the years it is now the most reliable means by which to accurately measure position. The basic principles of magnetostriction are simple enough to understand. When an object made from a ferromagnetic material (such as iron, nickel and cobalt) is placed into a magnetic field microscopic distortions of it molecular structure take place. These will lead to its dimensions being altered in direct relation to the strength of the magnetic field. As position measurement based on magnetostrictive sensing mechanism does not rely on moving parts it is not subject to mechanical stress. This means that magnetostrictive sensor devices have considerable advantages over traditional sensors types already mentioned. It allows magnetostrictive sensors to exhibit considerably longer life spans and much higher reliability in even the harshest of working conditions.

SUPERIOR MAGNETOSTRICTIVE SENSORS

MTS Sensors' proprietary Temposonics® position sensing technology, thanks to employment of magnetostriction, is highly suited to use in the most demanding of industrial applications. A Temposonics position sensor system consists of a ferromagnetic waveguide, position-determining permanent magnet which is mobile, a strain pulse converter and supporting electronics. The mobile magnet is rigidly connected to the object of position measurement. It generates a longitudinal magnetic field at its location on the waveguide. A short current pulse is generated by the sensor element and applied to the waveguide. This has a radial magnetic field associated with it. When the pulse comes into close proximity with the mobile magnet, the two magnetic fields interact with one another. Magnetostriction causes the waveguide to be distorted elastically and this results in the generation of an ultrasonic torsion wave which travels back down the waveguide. When the wave reaches the end of the waveguide it is converted into an electrical signal. As the ultrasonic wave maintains a constant speed as it travels along the waveguide, the exact position of the mobile magnet which created it can be determined (given the correlation between the magnet position and the time between when the current pulse was generated and the arrival of the ultrasonic torsion wave in response). As the output from sensors employing this technology corresponds to an absolute position rather than a relative value, it is possible for recalibration work to be avoided. Another advantage is that this arrangement permits the ascertaining of multiple positions simultaneously using a single sensor - allowing fewer devices to be used.

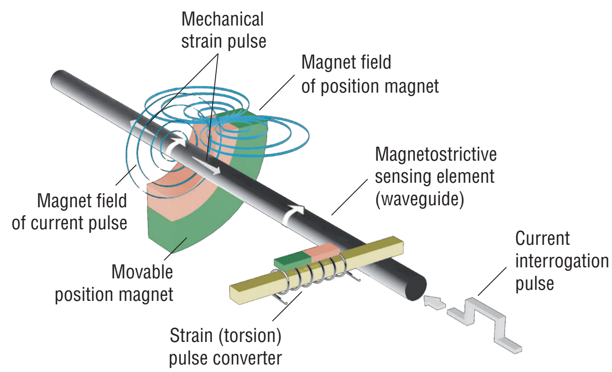


Fig. 1: Time-based magnetostrictive position sensing principle

SPECIFYING SUITABLE POSITION SENSING DEVICES

Recently added to MTS Sensors' product portfolio is the ET-Series of small rod magnetostrictive position sensor devices. Supporting 105°C operation, these sensors offer a combination of industry-leading temperature performance and exceptional cost-effectiveness. ATEX certification is available when they are needed in hazardous areas. Furthermore, a 316L stainless steel housed version is available if deemed necessary.

Fig. 2: MTS Sensors' ET-Series

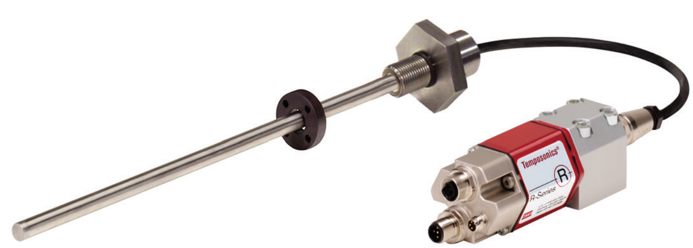


Fig. 3: MTS Sensors' RD4 with Detachable Electronics

The company's Model GTE embedded magnetostrictive sensor is another highly robust device optimized for use in applications with elevated temperatures. The rod housing can withstand the extended temperature ranges and pressures that are typically found in hydraulic cylinder implementation. By incorporating redundant sensors, with two completely independent measuring systems contained inside the housing, long term functional integrity is assured. Each measuring system contains its own channel with sensor element, power and evaluation electronics and output signal, so that the outputs can both be accessed as needed.

From MTS Sensors' highly popular R-Series, the Model RD4 sensor has a detached electronics design, where the sensing element is connected to the electronics via a cable and pipe. This allows sensitive semiconductor technology that makes up the supporting electronics for advanced outputs to be kept away from potentially harmful phenomena such as extended temperatures ranges while the sensing element can withstand up to 100°C.

The GBS-Series of rod-style magnetostrictive sensors have been designed (like the GTE) to the address exacting demands of hydraulic cylinders, such as those used in power generation applications. These products offer an operational temperature range reaching up to 100°C. The supporting electronics for these devices are specially designed for extended temperature ranges and housed inside a flat, compact enclosure which permits the sensor device's deployment into even the most confined of spaces.

CONCLUSION

As we have seen, ground-breaking innovations in position sensing technology now mean that precision measurements can be taken in a wear-free, non-contact manner. The magnetostrictive approach is highly optimized for a broad spectrum of challenging modern industrial metrology tasks. Next generation magnetostrictive sensors based on MTS Sensors' game-changing Temposonics technology deliver high degrees of reliability and repeatability to sensing system deployments in extended temperature conditions without compromising on performance. As a result, engineers have the hardware they need to implement position measurement systems that exhibit protracted lifespans, with virtually no maintenance required. This vital characteristic, as well as the resilience of these devices to phenomena like vibrations, impacts and high pressures, ensures that comprehensive system ruggedness is upheld.

ABOUT MTS SENSORS

MTS Sensors is a division of MTS Systems Corporation (NASDAQ: MTSC) and is recognized worldwide as a leader in the design and manufacture of high precision, robust position sensing solutions for industrial, mobile hydraulic and liquid level sensing applications. Among the key sectors it serves are industrial machines, power generation, construction/agricultural vehicles, textiles, paper production, steel plants and saw mills. Sensors from MTS are often implemented in safety-critical applications, including hazardous areas. MTS Sensors has manufacturing facilities in the United States, Germany and Japan. Customers are supported by an extensive global partner network including cylinder manufacturers. Through its research, development and production of leading-edge sensing technologies, MTS Sensors provides its customers with a comprehensive and constantly expanding product portfolio and is continually working with them to improve performance and reduce downtime in their operations.

For more information on MTS Sensors, please visit
www.mtssensors.com or contact a local MTS representative.

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LEGAL NOTICES

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