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**For Direct Installation in the Pressure Range of Hydraulic Cylinders**

## **Magnetostrictive Linear Position Sensor in Tunnel Construction Project**

*The London Crossrail project, the perhaps largest European construction site ongoing, is known well beyond the realms of Great Britain. In order to upgrade the subway system for future demands, two new tunnels (each approx. 21 kilometers in length and 6 meters in diameter) are under construction, there. Such a gigantic construction project would be impossible without the help of modern automation solutions. And this involves more than just the now commonly used tunnel boring machines. For instance, the mounting holes for cable systems, cable runs and walkways are no longer manually drilled by construction crews. In the Crossrail project, these tasks are carried out by automated drilling carriages. Magnetostrictive linear position sensors, which can be directly integrated into the hydraulic cylinders of the boring machines, are assisting the subterranean mobile application.*

The utilization of touchless processes in position sensing for mobile machinery is becoming more and more prevalent. There are a number of reasons for this: The magnetostrictive linear position sensor of the TIM series by Novotechnik, for instance, is providing highly accurate, absolute measurements even when faced with extremely rough environmental conditions. In so doing, it shines with high pressure resistance and unlimited mechanical life expectancy, thanks to the touchless measuring principle. Furthermore, it is well-suited for direct installation in the pressure range of hydraulic cylinders. These characteristics are owed, among other factors, to the sensor's touchless measuring principle.

**Touchless measuring principle – unlimited mechanical life expectancy**

The measuring process is initiated by a brief electrical impulse which generates a circular magnetic field around the waveguide. The field lines of the position marker, which marks the measuring position within the waveguide, are running perpendicular to this. Where the two magnetic fields intersect, the magnetostrictive effect creates an elastic deformation in the waveguide. This reversible dimensional change triggers a mechanical impulse, which propagates within the waveguide in the shape of a torsional wave with a speed of approx. 2,800 m/sec. At one end of the waveguide, the torsional wave is converted into an electric signal, at the other, it is attenuated, so that subsequent measurements are not affected by crosstalk. The travel time from the wave's origin to the signal transducer is directly proportional to the distance between position marker and signal transducer.

The magnetostrictive sensors are covering measuring lengths of 50 to 2500 mm; their stainless steel design makes them impervious to practically any hydraulic media. What's more, the sensors are highly accurate and reliable, even under adverse environmental conditions. Linearity is around 0.04% (at measuring lengths of 260 to 2000 mm), and the repeatability, at +/- 0.1mm, is independent of the measuring length. The sensors are (permanently) pressure resistant up to 350bar, effortlessly handle pressure spikes of up to 450 bar, and are easily installed without soldering, crimping or screws, thanks to an innovative plug-in system: The connector block of the M12 connector is already connected to the sensor's signal leads; it runs to the outside through a hole in the cylinder. The connecting flange (M18) can easily be plugged into the connector block and secured to the outside.

**Drilling Carriages Replace Construction Crew**

The sensors have proven themselves in many different applications. This includes mobile construction equipment, such as the drilling carriage for the London tunnel construction project. The complete hydraulic and electronic system solution was designed and developed by ATP Hydraulik. In order to automate the tunnel construction, two drilling carriages were each equipped with 37 Hilti drills and Hilti vacuums, which are used for the automated installation of the mounting holes for cable systems, cable runs and walkways. To this end, any and all parameters of both tunnel bores were surveyed, and the blueprints of the

bores were entered as data sets into the control unit of the drilling carriages. For the construction of the tunnel, the drilling carriage now receive a new data set every 6.4 meters.

Using the USB interface, the control unit now transfers the current set of data for the next tunnel section to the drilling carriages every 6.4 meters. For documentation purposes and subsequent analysis, a log file is created for each bore.

### **Reliable Position Sensing for Mobile Applications**

The magnetostrictive linear position sensors provide the precise position sensing required for proper placement and depth of the bores. They were chosen for several reasons, A significant advantage of these sensors is their direct installation into the hydraulic cylinders driving the drills. The M18 screw flange simplifies the mounting process, and the touchless excitation via the annular position marker makes the sensors quite robust and durable. There are also some additional features which are important for mobile applications. The sensors are meeting the high demands in regards to EMC (EN13309 for construction machinery, as well as ISO14982 for agricultural and forestry machinery), they are isolated against RF fields (up to 200 V/m, per ISO 11452-2), and they work with supply voltages between 8 and 34 VDC. The measuring signal can be transmitted as an analog current or voltage signal or via field bus interface (CAN). For example, on the drilling carriages, the 4...20 mA interface is utilized.

By now, the rod-style sensors have proven themselves in the drilling carriage application at the subterranean major construction site. After completion of this construction project, up to 24 trains per hour will run on the central section of the track during peak traffic times; they will transport around 200 million passengers annually. And the magnetostrictive linear position sensors from Germany will have contributed their share.

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