



## LINEAR ENCODERS 101



## Linear Encoders 101 March 2019

A linear encoder is a sensor or device that provides a signal, digital or analog, to a controller based on a position measurement. There are various technologies which are used for measuring linear position including:

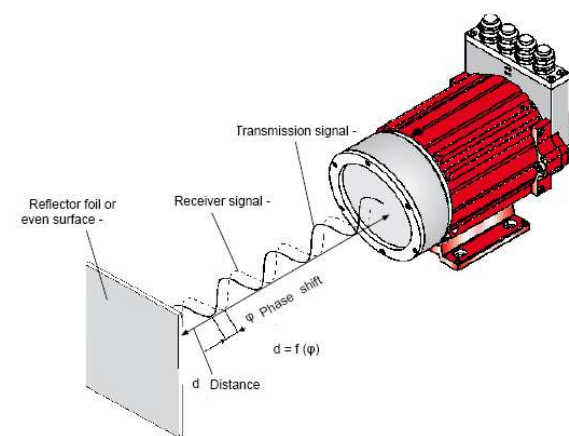
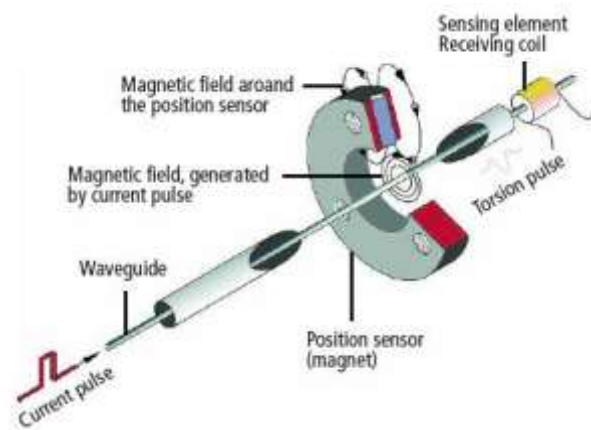
**Magnetostriction, Laser and Transformation.** TR Electronic has been designing, developing and manufacturing quality linear encoders, using these technologies, for over 20 years.

### TECHNOLOGIES

**Magnetostriction** is the measuring principle based on a travel time delay measurement (ultrasonic range).

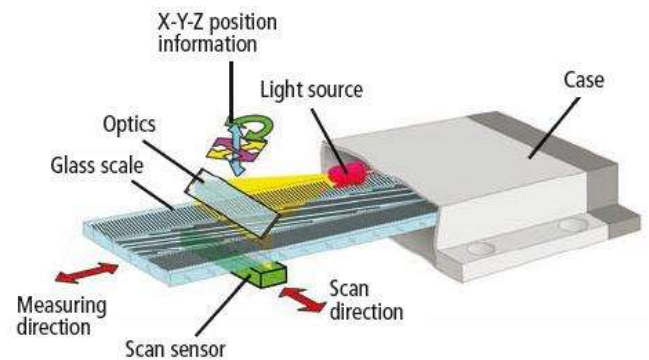
Current pulses are sent through a magnetostrictive wire, positioned inside a protective tube, creating a ring shaped magnetic field around the wire. A non-contact permanent magnet serves as a position sensor. The magnetic field of the magnet interfaces with the magnetic field of the magnetostrictive wire. This interference causes a magnetostriction, resulting in a torsion pulse. The torsion pulse leaves the point of interference with constant ultrasonic speed, moving along the waveguide in both directions.

The time difference between the transmission of the torsion pulse and its arrival at the sensing element (receiving coil) at the detector head is converted electrically into a distance proportional signal, which is provided either as a digital or analog output signal. These signals are then available for communication to the controller via **Point to Point, Fieldbus** and **Ethernet** interfaces. Magnetostriction linear encoders come in two standard housing (construction) designs: **Cylinder Mount (Rod)** and **Profile Mount**.



targets, with cycle times of 1ms. TR Electronic also manufactures laser distance measurement devices which do not require a reflector. These units are capable of detecting position of quasi-static objects with or without a reflector. For linear applications with curves and bends, TR Electronic can provide a laser solution which will work using a laser barcode reader.

**Transformation** measurement systems work on the principle of photoelectric scanning of an absolute coded glass scale. A sensor array scans several tracks that contain high resolution measurement information, measurement steps of  $0.1\mu\text{m}$ , on the 3D coordinates and angular position between the glass scale and the scanning unit. While evaluating the measurement signals, the coded measurement position is determined by the sensor signal, and due to the additional measurement information, guidance and adjustment errors are completely corrected.



## Construction

### MAGNETOSTRICTION

**Cylinder Mount** or rod style linear encoders are designed to mount inside the cylinder. They are manufactured to withstand high pressures, up to 8700 psi (600 bar), using stainless steel tubing. Cylinder mounted linear encoders have the magnet fixed on the piston of the cylinder. The rod of the encoder is positioned up through the center of the rod of the cylinder. As the cylinder piston moves through the length of the cylinder, the encoder tracks position information and feeds it back to the controller. Cylinder mounted encoders are constructed on individual orders with measuring lengths from 150 mm to 3000 mm (3 m). They are available in specialized housing for extreme environmental conditions.



**Profile Mount** linear encoders have the magnetostrictive rod mounted inside an aluminum housing with the position sensor (magnet) mounted externally. Under typical installation the magnet is moved along the length of the housing, however it is possible to install the magnet in a fixed position and move the encoder over the magnet. Profile mount encoders are available in a low profile design which allows for installation in small spaces. Standard magnetostrictive linear encoders are typically restricted to a maximum measuring length of 5000 mm (5 m). However, TR Electronic can manufacture cascadable absolute linear encoders to measure from 5000 mm (5 m) to 20,000 mm (20m).



## LASER

**Laser** distance measurement systems are constructed using designs which best accommodate the operating technology. The standard laser measuring systems, LE200, are constructed in cylindrical style housings. This allows for maximum surface area for heat dissipation, as well as providing for multiple mounting, installation and heating/cooling options. The LLB60, for use with or without a reflector, is constructed in a rectangular aluminum housing allowing for flexibility in mounting. For linear measurement around a radius, the BE90 is constructed in a rectangular, aluminum housing similar to the LLB60. TR Electronic is able to work with our customers to provide a solution which will work best for their application.



## TRANSFORMATION

**Transformation** or glass scale encoders have similar housing constructions as the Magnetostriction linear encoders. The glass scale, optics, sensing head and evaluation electronics are all mounted inside the housing. Housing styles include a standard rectangular cylinder, low profile aluminum and heavy duty aluminum cylinders for more rugged applications.



## Encoder Output Formats

Communication between an encoder and control system can happen using one of many different formats. These formats can be divided into 3 Major Categories: **Point to Point**, **Fieldbus** and **Ethernet**.

**Point to Point** interfaces include Parallel, Serial Synchronous (SSI), Incremental Serial Interface (ISI), Analog, Asynchronous Serial Interface and others. The majority of these interfaces require a point to point connection from encoder to controller. Most of these interfaces use the above encoding methods to transmit their data to the controller. Analog is unique in that it provides a varying signal to the controller, typically (0)4-20mA or 0-10Vdc.

**Fieldbus** interfaces include ProfiBus, DeviceNet, CANOpen and others. These protocols use a BUS type topology which requires individual addressing of each unit or node on the BUS. The encoder data is read by the controller on the same line as other devices on the BUS. This output format requires a higher level of intelligence in the controller, but adds greater flexibility with less wiring.

**EtherNet** interfaces include ProfiNet, EtherCAT, PowerLink, and EtherNet/IP. These protocols use a network topology which requires individual addressing of each device on the network. The encoder data is available on the network to be accessed by the controller. Ethernet interfaces utilize the newest communication technology. They are based off the standard office network protocol, refined to meet industrial requirements.

**TR** Electronic Center of Technical Excellence will work with you  
to develop the best solution for your Application.

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