Whether implemented as a standalone component or as part of a control or safety system, the linear position sensor, also often known as an LVDT, is capable of providing linear displacement measurements from micro inches to several feet, under various operating and environmental conditions with high accuracy and reliability. Essentially, the LVDT linear position sensor plays an important role in machine control by providing feedback about product location. To some extent, it is the LVDT linear position sensor that ensures proper machine operation.

Mechanics of an LVDT

In basic terms, an LVDT linear position sensor is an electromechanical device that converts linear position or motion to a proportional electrical output (see Fig. 1).

It can be seen that the basic LVDT design consists of three elements:

- One primary winding
- Two identical secondary windings
- A movable magnetic armature or “core”

The primary winding is excited with an AC supply generating a magnetic field which, when the core is placed in the central or “null” position, includes equal voltages in both of the secondaries. The secondaries are wired series opposed so that their combined output represents the difference in voltage indicated in them, which in this case, is zero. As the core is moved left or right, the difference in inducted voltages produces an output that is linearly proportional in magnitude to the displacement of the core. Its phase changes 180° from one side of the null position to the other.

The LVDT linear position sensors’ electrical output signal is the differential AC voltage between two secondary windings, which varies with the axial position of the core within the LVDT coil. Usually this AC output voltage is converted by suitable electronic circuitry to high level DC voltage or current for convenient use by a computer or other digital output device.

Because there is normally no contact between the LVDTs core and coil structure, no parts can rub together or wear out. This means that an LVDT linear position sensor features unlimited mechanical life. This factor is highly desirable in many industrial process control and factory automation systems.

New electronics/construction materials enhance LVDT use in process control apps

Recent innovations in construction materials, manufacturing techniques as well as low-cost microelectronics have revolutionised the LVDT linear position sensors into a more reliable and cost-effective technology for process control applications. In the past, electronics necessary to operate LVDT linear position sensors properly were complicated and expensive, prohibiting its wide use in process control applications for displacement measurement.

Modern ASIC and microprocessors give LVDT technology more complex processing functions and enable signal conditioning within the sensor housing so LVDTs generate digital outputs directly compatible with computer-based systems and standardised digital buses. As a result, today’s linear position sensors can provide more accurate and precise measurement of dimensions in a wider variety of quality control, inspection equipment and industrial metrology applications including online parts inspection, servo-loop positioning systems, and manufacturing process control.

For applications where sensors must operate in extreme environments, the sensing element can be segregated from the electronic circuitry, unlike capacitive, magnetostrictive and other high frequency technologies. Connected by long cables up to 31 m AC-operated LVDTs can work with remotely-located electronics that
As the sensor coil assembly can withstand the pressure of the non-conductive mediums, the assembly is vented (pressure balanced) to allow the mechanical configuration of the coil to continue working properly. The combination of high pressure, elevated temperatures, shock and vibration, the LVDT is able to make measurements in down-hole drilling equipment possible where space is at a premium and the environment is hostile.

LVDTs are also configurable in a variety of mechanical and electrical designs to meet the measurement and environmental requirements of various process control applications. New corrosion-resistance/high-temperature materials such as Monel or Inconel enable the LVDT linear position sensor to operate in more hostile environments including those with high and low temperature extremes, radiation exposure or vacuum pressure conditions. For applications where sensors must withstand exposure to flammable or corrosive vapours and liquids, or operate in pressurised fluid, its case and coil assembly can be hermetically sealed using a variety of welding processes.

For example, in power generation applications (see Fig. 3), linear position sensors designed for high temperature and mild radiation resistance can perform in power plants to provide feedback on the position of nuclear steam and gas turbine control valves for increased plant efficiency and reduced operating costs.

In a typical power plant, steam turbines contain a number of control valves - a reheat stop valve, an interceptor valve, a governor valve, and a throttle valve. Typically, plants have very precise control schemes for valve position to increase operating efficiency and save fuel. Operating within the harsh environment of a power or steam plant, linear position sensors can determine if valves are fully opened or closed to within a thousandth of an inch, providing output to remote electronics that can be monitored by operators if something is not working properly. The combination of LVDTs with modern computerised turbine control systems saves power companies millions of dollars per year.

Sensors also play an important role in the predictive maintenance of gas turbines as part of process control systems used to monitor shell expansion and bearing vibration. Installed on turbine shells, hermetically-sealed LVDT position sensors measure shell expansion, providing linear output that operators can utilise to determine proper thermal growth of a turbine shell during startup, operation and shutdown.

LVDTs designed to withstand shocks and heavy pounding are used in the press and dye industry for the mechanical control of machine operations as improper operation can lead to broken dyes that result in downed machines while ambiguous force of presses can lead to mishapen and out-of-spec parts. Spring-loaded LVDT position sensors are installed on presses so that the plunger of the sensor is compressed as the punch press comes in contact with the metal being shaped. The output of the LVDT is fed back into the machine’s control system, providing feedback on how far a press has moved and when to stop.

For more than six decades, LVDT linear position sensors have served as part of measurement and control systems, providing essential information without which may process control systems couldn’t function. From its limited use as a laboratory tool more than three decades ago, the LVDT linear position sensor has evolved into a highly reliable and cost-effective linear feedback device, making it the preferred technology for critical and reliable linear displacement measurements in a wide array of industrial process control applications.

Contact Bruce Felix, Alipronix, Tel 011 795-9500, sales@alipronix.com