The LVDT – a truly versatile performer

Greater performance and design versatility make modern LVDTs ideal for a broader range of demanding applications, says **John Matlack**, global business development manager at Macro Sensors

Since its humble beginnings as a laboratory measurement device, the linear variable differential transformer (LVDT) has evolved into a versatile and cost effective position sensor for providing highly accurate and reliable displacement feedback for military, aerospace and industrial applications.

Capable of measuring movements as small as a few millionths of an inch up to ±20in (±0.5m), the LVDT linear position sensor addresses the need for real-time data.

In recent years, low-cost microelectronics and microprocessors, along with new manufacturing techniques and construction materials, have revolutionised LVDTs, significantly enhancing performance while making the technology more cost effective in meeting specifications for a wider range of demanding applications.

Through the use of ASIC and microprocessors, more complex processing functions as well as signal conditioning are now embedded within the sensor housing rather than requiring a secondary external box. In addition, DC-operated LVDTs now produce digital outputs directly compatible with computer-based systems and standardised digital buses.

For applications requiring an AC-operated sensor and separate electronics, push-button zero and span controls, and improved software, reduce the time and expense associated with calibration.

Two basic elements

An electromechanical sensor, the LVDT consists of two basic elements: a stationary coil assembly comprising a primary coil centered between two identical secondary coils and a movable core or armature. The LVDT produces an electrical output directly proportional to the displacement of its core. AC carrier excitation is applied to a primary coil. Secondary coils, symmetrically spaced from the primary, are connected externally in a series-opposing circuit. Motion of the non-contacting magnetic core varies the mutual inductance of each secondary to the primary, which determines the voltage induced from the primary to each secondary.

If the core is centered between the secondary windings, the voltage induced in each secondary is identical and 180° out of phase, so there is no net output. If the core is moved off centre, the mutual inductance of the primary with one secondary will be greater than the other and a differential voltage will appear across the secondaries in series. For off-centre displacement within the range of operation, this voltage is essentially a linear function of displacement.

Usually this AC output voltage is converted by electronic circuitry to high level DC voltage or current that is more convenient to use.

The LVDT offers certain physical attributes that make the technology ideal for linear position measurements. These sensors offer unlimited mechanical life as the core and coil are not in contact and hence are used where long-term reliability is important. Featuring frictionless operation, LVDT linear position sensors are ideal in applications when mechanical resistance cannot be tolerated.

Offering infinite resolution due to its purely analogue signal, the LVDT can measure infinitesimally small changes in core position.

Inherently robust, LVDT linear position sensors are able to withstand a wide range of temperature variations, high shock and vibration.

With the advent of ratiometric LVDT and variable reluctant coil designs and digital signal processing techniques, the linear position sensors have greatly improved in temperature stability and accuracy, ensuring greater precision in fuel level monitoring and aircraft positioning. All modern fly-by-wire aircraft and space flight actuators use LVDTs along with computers in their primary flight control systems. As position feedback components for closed-loop servo systems, these sensors can serve as single or multiple channel devices, depending on redundancy and reliability requirements.

As an ATM can be used hundreds of times during the course of a day, the repeatability and reliability of the linear position sensors are of key importance

Power and subsea use

Mounted on steam and gas turbine valves either redundantly or triredundantly, LVDTs improve the operating efficiency of the turbine. For gas turbine applications, they are approved for use through FM, CSA and ATEX for use in intrinsic environments.

LVDTs can also obtain measurements in seawater depths down to 7500ft, even when exposed to external pressure of approximately 3800psi. Materials such as 316SS and Inconel 625 offer pressure and corrosion resistance, enhancing the already high-reliability of a LVDT assembly to ensure operation for minimum life requirements (often 20 years), even if the device is fully exposed to seawater.

Typical subsea applications include monitoring structural movement for a long-term finite element analysis of pipelines, derricks, moorings and other critical high stress members on offshore oil platforms.

Industrial solutions

Because LVDTs can be configured in a variety of mechanical and electrical designs, they meet the measurement and environmental requirements of most industrial applications.

Repeatability and long-term operation make them the sensor of choice where reliability is critical. Low mass and compact contactless linear position sensors can be found in applications having high dynamic response requirements such as automated teller, copy and plastic injection moulding machines; automatic inspection equipment; and robotic applications requiring displacement feedback to ensure proper machine operation.

From its initial limited use in process control, the LVDT now offers essential, mission-critical solutions in many applications.

Macro Sensors
www.macrosensors.com