**Why LVDT linear position sensors deserve a second look**

by Lee Hudson

Advanced manufacturing techniques, new construction materials and microelectronics have revolutionized the LVDT linear position sensor. The basic operating principle of the LVDT remains unchanged over the years. An electromechanical sensor, the LVDT (see cutaway of LVDT) consists of two basic elements: a stationary coil assembly consisting of a primary coil centred 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.

The LVDT linear position sensor now rivals competitive technologies as a cost effective and precise linear position measurement device that can meet the specifications of a wide range of industrial and aerospace applications. Here’s why:

New materials extend LVDT use in different environments

New construction materials enable the LVDT linear position sensor to perform in an expanded range of environments such as those with high and low temperature extremes, radiation exposure and subsea or vacuum pressure conditions. When suitably housed (see Figure 1), LVDTs can perform under very hostile chemical conditions and withstand many years of use in seawater and corrosive acids and very high pressures and temperatures in conjunction with the chemical abuse. As a result, LVDT position sensors are replacing less reliable technology when it comes to position measurement in harsh and deepwater environments such as offshore applications, downhole drilling, and power generation.

When designed from stainless steel and Inconel 718 for pressure and corrosion resistance, an LVDT assembly can provide reliable operations for many years, even if the device is fully exposed to seawater. Monel 400, a special nickel-based alloy, provides excellent resist-
ance against pitting and attack by microorganisms when LVDTs are submerged in shallow or warm water with high levels of oxygen. Titanium and Hastelloy offer resistance to pressure and corrosion when measurements must be obtained in seawater depths down to 7,500 feet and with an external pressure of approximately 3,800 psi.

**Microprocessors enhance LVDT accuracy and reliability**

Microelectronics enable the incorporation of signal conditioning and complex processing functions inside an LVDT rather than requiring an external box. In the past, AC-operated LVDT linear position sensor needed separate signal conditioner to output displacement. Now a DC-operated LVDT can provide digital output directly compatible with computer-based systems.

Microprocessor-enhanced, linear position sensors are also more accurate as errors caused by the sensor’s characteristics or environment are corrected. While a standard LVDT linear position sensor may have a linearity of ±0.25 percent of full scale output, a microprocessor-enhanced LVDT can linearize its output to ±0.05 percent of full scale output.

ASIC and microprocessors, combined with new LVDT materials and manufacturing processes, make it possible to achieve performance by as much as an order of magnitude better than LVDTs of ten or 20 years ago.

**Shorter strokes/smaller diameters mean LVDTs offer a better fit**

LVDTs linear position sensors use to be too long for applications with limited space. New computerized layer winding and improved microprocessors have considerably reduced the length of the linear position sensor body compared to its measurable stroke length. Offering an improved stroke to length ratio (now up to 80 percent), the linear position sensor becomes a viable position measurement device for machine tool positioning, hydraulic cylinder positioning, valve position sensing and automatic assembly equipment. Unique coil winding configurations also support a compact diameter design, enabling the LVDT linear position sensor to serve as an integral part of devices with tight space restrictions. Unique coil winding configurations also support a compact diameter design, enabling the LVDT linear position sensor to serve as an integral part of devices with tight space restrictions. A lightweight low mass core makes the linear position sensors ideal for applications having high dynamic response requirements or where weight is a premium such as aircraft and satellite.

**LVDTs are cost effective**

The total cost of using an LVDT often prohibited its use in many applications. Electronics necessary to operate the LVDT properly were complicated and expensive. Now, through the use of powerful, low-cost micro-electronics and microprocessors, LVDT costs are much more attractive and performance has significantly enhanced.

Reduced LVDT costs and enhanced performance has opened the door to many applications where this technology had previously been considered too expensive.

**Macro Sensors**

From its introduction as a laboratory measurement device with limited use more than 60 years ago, the LVDT linear position sensor now provides highly reliable displacement feedback in a variety of applications, capable of measuring movements as small as a few millionths of an inch up to ±20 inches (±0.5 m).