LVDT Design and Benefits

A Linear Variable Differential Transformer (LVDT) is common type of position sensor that converts the linear position or motion of a measured object to a proportional electrical output that can be read by operators and control systems. LVDTs are most frequently used where measuring ranges vary from ±0.010 inches (±0.254 mm) to ±10 inches (±254 mm). LVDTs can be designed for temperatures from cryogenic ranges -238°F (-150°C) to as high as 1000°F (537°C). The LVDT features frictionless operation, is very rugged in harsh environments, possesses excellent accuracy and repeatability, and has a near-infinite expected service life.

An LVDT has two components: a fixed ***housing*** containing the single primary winding with two secondary windings *S1* and *S2*, and a movable ***core*** constructed of ferromagnetic material and mechanically linked to the measured object. There is no physical contact between the housing and the core.

The single primary coil is centered in the housing and energized with an AC signal. Magnetically coupled by the core, a voltage is induced in each of two symmetrical secondary windings connected in a series-opposing circuit. The effective voltage and LVDT output is the difference between each secondary.

When the core moves away from the center of the LVDT, known as the null point, the signal from the

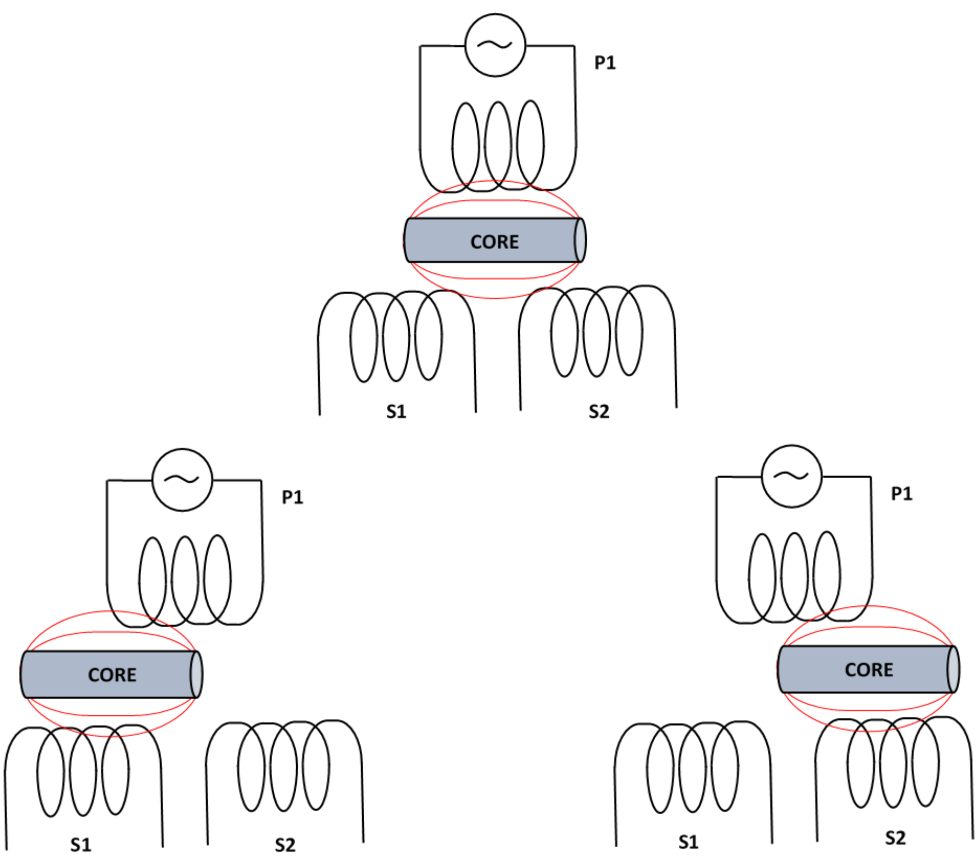

Figure 1 – As the core moves within the LVDT, it further engages with the secondary winding it is entering and disengages from the winding opposite. The difference between S1 and S2 gives an electrical signal proportional to the core position.

primary will be coupled to one secondary more than the other. In Figure 1**,** as the core moves over *S1*, the voltage output of *S1* increases. As the core moves over *S2*, the output of *S2* increases. The value of (*S1* - *S2*) and (*S2* – *S1*) becomes a linear function of the core position as it moves toward *S1* and *S2*, respectively.

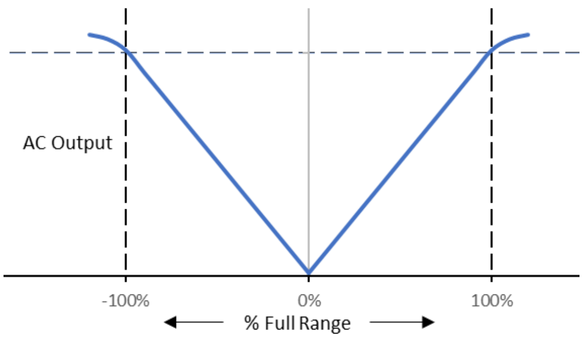

Figure 2 – The AC output increases as the core moves away from the null point in either direction.

The typical output of AC an LVDT is shown in Figure 2. As the core moves away from the null point in either direction within the LVDT range, the voltage outputs (*S1* - *S2*) and (*S2* – *S1*) increase proportionally.

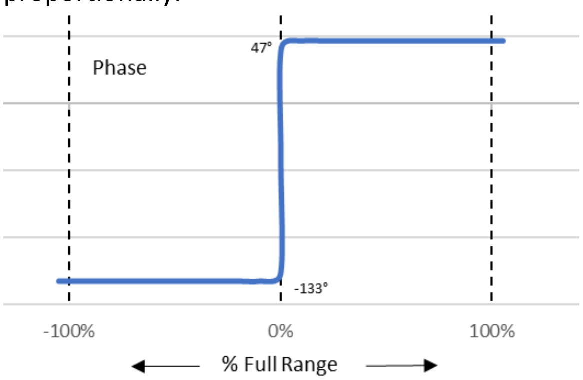

Figure 3 – The phase of the LVDT output abruptly shifts 180° as the core travels through the null point.

Figure 3 shows the relationship of the core to the phase angle between the primary and secondary windings. As the core travels across the null point the phase of the output signal abruptly shifts by 180° as shown in Figure 3, allowing a user or signal conditioning electronics to determine which side of null the core is on.

Being an inductive transformer, the LVDT requires an AC excitation voltage across the primary and produces an AC output across the secondaries. In modern LVDTs, excitation signal requirements are around 3 Vrms and frequencies ranging from 1kHz to 10 kHz. Support electronics and signal conditioners supply the excitation signal and measure output. Signal conditioners demodulate the low-amplitude AC output and produce DC voltage, current, or digital output that can be measured by most meters and control systems.

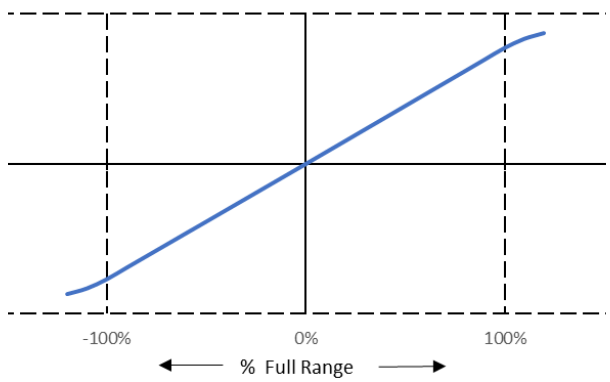

Figure 4 – The output from an LVDT signal conditioner is a linear DC signal that can be accepted by most control systems and meters.

In addition to an external component, signal conditioners can also be built into the LVDT. Often referred to as *DC LVDTs*, the user can supply a DC input, and measure a DC output corresponding to the core position. DC LVDTs offer many of the benefits of LVDT technology with the convenience of supplying and reading a DC signal.