

Linear Variable Displacement Transducers

An LVDT is an electromechanical device used to convert mechanical motion or vibrations, specifically rectilinear motion, into a variable electrical current, voltage or electric signals, and the reverse. Actuating mechanisms used primarily for automatic control systems or as mechanical motion sensors in measurement technologies. The classification of electromechanical transducers includes conversion principles or types of output signals.

Conversion Principles:

- Electromagnetic
- Magnetoelectric
- Electrostatic

Output Signals:

- Analog and discrete output
- Digital

Evaluating Electromechanical Transducers:

- Static and dynamic qualities
- Sensitivity or transfer ratio - $E = \Delta y / \Delta x$ or Δy is the change in output quantity y when input quantity x is changed by Δx
- Output signal—range of operating frequency
- Static error of conversion or of the signal

What is a Linear Variable Displacement Transducer (LVDT)?

Linear Transducer: A device that provides voltage output quantity, related to the parameters being measured, for example, force, for simple signal conditioning. Transducer Position Sensor devices are sensitive to electromagnetic interference. Reduction of electrical resistance can be improved with shorter connection cables to eliminate significant errors. A transducer requires three to four connection wires for power supply and output signal delivery.

Transducers differ from transmitters because a transducer is a voltage-output device, transmitters are current-output devices. Transmitter/Linear devices have less signal degradation related to long cables and transmission distance.

TYPES OF LVDTs

Linear Position Sensors - determine whether you need to measure a relative current: C-in, AC-out, DC-in, DC-out; or measuring resonant frequencies of coils as a function of coil position, frequency based devices.

LVDT's Have Three Armature Mechanism Types as Well:

Captive Armatures: These mechanisms are better for long working ranges. Captive armatures help prevent misalignment because they are guided and restrained by low friction assemblies.

Unguided Armatures: Infinite resolution qualities, the unguided armature mechanism is a no-wear design that doesn't restrict the resolution of measured data. This mechanism type is attached to the specimen to be measured, fitting loosely in the tube, requiring the body of the LVDT to be supported separately.

Force-Extended Armatures: Use internal spring mechanisms, pneumatic force, or electric motors to push the armature continuously to its fullest extension possible. Force-extended armatures are used in LVDT's for slow moving applications. These mechanisms require no connection between the specimen and armature.



LD400 Miniature DC Output LVDT Transducers.

Linear Variable Displacement Transducers are commonly used in modern machining tools, avionics, robotics, and computerized or motion control, Automation manufacturing. The selection of an applicable type of LVDT can be considered using the following specifications:

Linearity: Maximum deviation from direct proportion between distance measured and output distance over measuring range.

- $> 0.025 \pm \% \text{ Full Scale}$
- $0.025 - 0.20 \pm \% \text{ Full Scale}$
- $0.20 - 0.50 \pm \% \text{ Full Scale}$
- $0.50 - 0.90 \pm \% \text{ Full Scale}$
- $0.90 - \pm \% \text{ Full Scale \& Up}$

Operating Temperatures: > -32°F, -32 to 32°F, 32 to 175°F, 175 to 257°F, 257°F and up. Range of temperature within which the device must accurately operate.

Measurement Ranges: 0.02", 0.02 to 0.32", 0.32 to 4.0", 4.0 to 20.0", ±20.0" (range of measurement or maximum distance measured)

Accuracy: Describes percentage of deviation from the actual/real value of measurement data.

Output: Voltage, Current, or Frequency

Interface: Serial—Standard digital output protocol (serial) like RS232, or Parallel—Standard digital output protocol (parallel) like IEEE488.

LVDT Type: Current Balance AC/AC, or DC/DC, or Frequency Based



LD320 AC LVDT Displacement Sensors.

DISPLACEMENT

A linear variable displacement transducer, or LVDT, is an electrical transducer used in measuring linear position. Linear displacement is the movement of an object in one direction along a single axis. Measuring displacement indicates the direction of motion. The output signal of the linear displacement sensor is the measurement of the distance an object has traveled in units of millimeters (mm), or inches (in.), and can have a negative or positive value.



LD500 LVDT Precision DC Gaging Transducers.

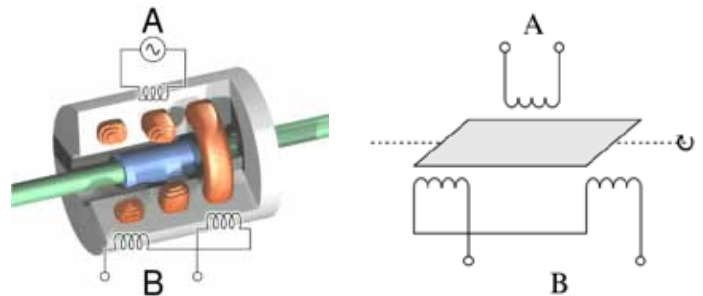
Precision manufactured LVDT displacement transducers are mounted on most modern product lines for automatic gaging in sorting, "go-no go" applications, and quality operations. Construction of hardened steel shafts, O-ring seals, and titanium push rods optimize precision function in most industrial conditions. Utilizing hybrid IC modules provide linear mV/V/mm or mV/V/inch output to interface with standard DC input meters, industrial controllers, recorders, and data interfaces.

LVDT's are engineered and designed to accommodate many industry applications:

- General Purpose
- Aerospace
- Flush Diaphragm
- Heavy Duty/Industrial
- Hazardous Location
- PC Board Mountable
- High Accuracy
- Submersible
- Sanitary
- Customized for Special Purposes

BASIC LVDT DIAGRAMS

Principle of Rotary Variable Differential Transformer



Free Diagrams courtesy of Wikipedia
https://en.wikipedia.org/wiki/Linear_variable_differential_transformer

How Do They Work?

A typical LVDT has three solenoid coils lined end-to-end, surrounding the tube. Primary coil is in the center and secondary coils are top and bottom. The object of position measurement is attached to the cylindrical ferromagnetic core, and slides along the axis of the tube. Alternating current drives the primary coil causing voltage induced in the two secondary coils proportionate to the length of the linking core. Range of frequency is usually from 1 to 10 kHz.

Movement of the core triggers the linkage from primary to both the secondary coils, which changes the induced voltages. Top and bottom secondary output voltage differential is the movement from calibrated zero phase. Using a synchronous detector reads a signed output voltage that relates to the displacement. LVDT linear displacement can be up to several inches long, working as an absolute position sensor which is repeatable and reproducible. Other actions or movements will not alter measurement accuracy. The LVDT is also highly reliable because the sliding core does not touch the inside of the tube, and allows the LVDT to be in a completely sealed environment.

INNOVATIONS AND APPLICATIONS

Some applications such as municipal water and waste water operations, pulp and paper, industrial waste water neutralization, and other process control systems use multi-parameter controllers. For measuring pH, conductivity, transmitters, and ORP controllers, typically require microprocessor-based controllers.



LD620 DC Voltage Output Displacement Transducers.

Power Turbines: Power generation turbine applications for power plants around the world use linear variable differential transducers as position sensors with signal conditioners to provide the necessary operating power. The AC voltages and frequencies needed for inductive or LVDT types of position sensors are not available from power line sources.

Hydraulics: Linear position sensors serve as charge sensors in hydraulic accumulators, special external sensors in harsh environments with high immunity to vibration and shock, and includes all stroke lengths within our sensor capabilities. If you require longer stroke lengths, call our professional engineering staff at OMEGA, for custom design information.

Automation: LVDT automation applications make use of hermetically sealed dimensional gaging probes to perform beyond your R & D laboratories, fabrication workshops, and into the harsh environmental working conditions of factory automation, process control environments, TIR measurements, and industrial gaging.

Aircraft: The majority of aerospace/aircraft applications use miniature or sub-miniature position transducers. They are cable-actuated displacement sensing mechanisms. OMEGA can develop precision products for applications in commercial aircraft, space, aviation and environmental systems for space habitats. Products are mounted to a fixed position, the displacement cable is attached to a moving object like landing gear or an aileron. The cable retracts and extracts when movement occurs. Depending on signal conditioning, and mounting system, the electrical output will indicate various rates, angles, lengths, and motions.

Satellites: Consider the applications in satellite technology and related areas, in addition to satellite production, position transducers are needed for space vehicles, cargo aircraft, military fighters, drones, experimental aircraft, missiles, nuclear reactors, flight simulators, or high speed railways.

The engineering staff at OMEGA are trained and experienced in design and manufacture specifics for industries including industrial automation controls, motion controllers, power turbines, linear servo actuators, robotics, and proportional actuators. If we do not have your industry specific LVDT measurement mechanisms in stock, we will discuss our solutions and ideas for custom designed systems for the optimal standards for your company. From satellites, aircraft, nuclear reactors, to hydraulics and power turbines, we have state-of-the-art capabilities to update, modernize and build-in the highest precision measuring, sensor functions and industrial automation controls for your production standards.

Source

1. http://opencourseware.kfupm.edu.sa/colleges/ces/me/me413/files%5C2-Chapters_Chapter_6_Electrical_and_Electromechanical_Systems_2.pdf
2. <http://www.omega.com/pptst/LD500.html>
3. https://en.wikipedia.org/wiki/Linear_variable_differential_transformer
4. <http://www.omega.com/section/sensors-transducers.html>