

Hermetically-Sealed Dimensional Gaging Probes Perform in Harsh Environments with Reliable Performance

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Spring-loaded LVDT Linear Position Sensors, often referred to as dimensional gaging probes, provide the data collection capability for many of today's automated data acquisition systems. Widely used in machine tool inspection and gaging equipment, dimensional gaging probes serve as important components of quality assurance systems, supplying the dimensional feedback used for online quality control and post-process statistical analysis. Machine manufacturers and quality control departments typically use dimensional gaging probes as part of complete systems for "go/no-go" inspection of complex mechanical parts.

Dimensional Gaging Probe Construction

Dimensional gaging probes incorporate a non-contacting, inductive position sensor, either an LVDT or half-bridge, that includes a spring-loaded movable armature coupled to a shaft supported in a high-precision linear bearing (see Figure 1).

Typically, gaging probes are cylindrical, with diameters of 0.315" or 0.375" (8 mm or 9.5 mm) and lengths ranging from 2.50" to 4.00" (65mm to 100mm). When physically contacting the part under measurement, LVDT gaging probes generally have a range of $\pm 0.020"$ to $\pm 0.200"$ (± 0.5 mm to ± 5.0 mm). While the resolution of an LVDT is considered to be infinitely small, the resolution of a gage head is somewhat limited by the mechanical repeatability of the bearing system and its supporting electronics.

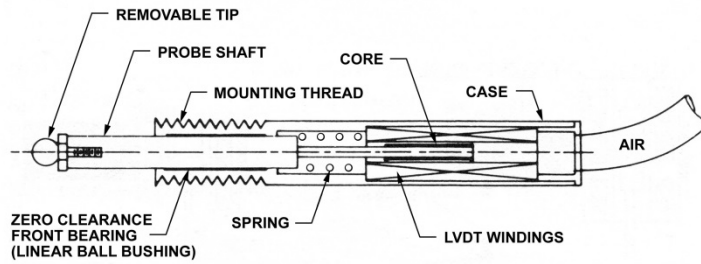


Figure 1 The diagram provides a cross-sectional view of a typical 0.315" or 0.375" (8 mm or 9.5 mm) diameter gaging probe.

Providing good performance at a moderate price in relatively benign environments such as quality assurance labs or in a protected inspection fixture located away from machines and manufacturing processes, spring-loaded LVDT position sensors are ideal for cost-sensitive applications such as low overhead machines, fabrication shops, and R&D labs on a limited budget. In the harsh environment of the shop floor, however, standard gaging probes may not be the best solution.

Hermetically-Sealed LVDT Gaging Probes Operate in Harsh Environments

More rugged and robust than standard gage heads, hermetically-sealed versions operate in adverse environments containing moisture, dirt, corrosive elements and other contaminants without affecting performance. These sensors feature a slightly larger $\frac{3}{4}$ " diameter, a hermetically-sealed stainless steel LVDT with integral connector and a clearance-fit sleeve bearing (See Figure 2). Use of a precision sleeve bearing results in excellent measurement repeatability of 0.00005" (1.2 microns) or better, and maximum linearity error of $\pm 0.25\%$ of full range output. The sleeve bearing offers nearly the repeatability of a zero-clearance linear ball bearing, but is less susceptible to jamming.

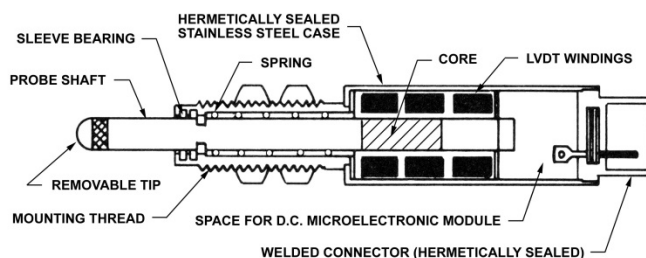


Figure 2 Cross-sectional view of a gaging probe with a hermetically-sealed LVDT. Units have a maximum gaging range of 4.0" (100mm).

Air-Extend/Spring-Retract Versions

Hermetically-sealed, spring-loaded LVDTs are available in air-extend/spring-retract versions possessing probes that retract out of the way during loading/unloading operations in a gaging fixture or inspection jig, but extend immediately when pressurized by air. The probe shaft of the position sensor is fully retracted by a spring exerting a nominal force of 6 to 20 ounces depending upon total range. For these air extend/sprint-retract units, an outflow of air through the probe's bearing inhibits the ingress of grit, dirt, dust, oil, solvents or other contaminants, increasing reliability and probe life. These units are designed for a wide range of cycled position measurement and automated dimensional gaging applications where it is necessary or desirable to move the probe out of the way between readings.

AC and DC-operated Versions

Hermetically-sealed gaging probes are available in AC- or DC-operated versions. When electronics are built into the spring-loaded assembly of a DC-operated unit, there is no need for external electronics, making the mechanical setup of the sensor into automated machinery less complicated and more cost effective. DC-operated versions typically provide a 4-20mA, single-ended or bipolar DC output compatible with most standard PLCs, digital indicators, and data acquisition systems. However, temperature exposure is limited by the properties of the materials in the electronic signal conditioning module that is contained within the sensor.

For applications where sensors must operate at temperatures as high as 425° F (220°C), the sensing element of an AC-operated LVDT gage head can be segregated from the electronic circuitry. Connected by cables, AC-operated, spring-loaded LVDTs work with electronics remotely located in a box outside of hostile conditions. This enables gaging probes to operate where temperature, vibration and other parameters exceed the limits of electronics. Because of the long life expectancy of AC-operated LVDT gage heads, most maintenance will not require replacing the LVDT, only the electronics. Output is displayed on a suitable readout and/or input into a computer-based data acquisition system for statistical process control. (See photos 1 & 2)



Photo 1: AC-operated LVDT gaging probes interface with single channel LVDT signal conditioners that provide either a low noise 0-10V DC or 4-20mA output for computer readout of dimensional or position measurement.



Photo 2: Constructed entirely of stainless steel, hermetically-sealed LVDT gaging probes provide long service life in various industrial uses such as industrial gaging systems, electronic dial indicators, fabricated metal products gaging, materials testing apparatus as well as large shaft TIR measurement.

Applications for Hermetically-Sealed Gaging Probes

Because of their ability to operate in harsh industrial environments like shop floors where dirt, oil, water and machine coolants may be present, hermetically-sealed LVDT-based dimensional gaging are often used for dimensional or position measurement, industrial process automation and all types of motion control systems in automotive factories, forges and foundries (large shaft TIR measurements), metal fabricating shops as well as paper and plastic film plants.

Specific applications for these spring-loaded LVDTs include gaging position feedback for pinch and gap roller alignment in printing operations, gaging the thickness of sheet metal during metal forming and stamping operations and ensuring critical dimensions of components as part of control systems for automotive assembly lines. Gaging probes are also used as integral components in control systems such as elevators to ensure the accurate landing of elevator cars at building floors.

Gaging Probes in Elevator Control Systems

As passengers travel in elevators at speeds upwards of 2,000 feet/minute, electromechanical control systems rely on rugged, hermetically-sealed, spring-loaded LVDT gaging probes to provide the necessary feedback for proper alignment of elevator cars at building floors upon arrival.



Photo 4: *Hermetically-sealed, spring-loaded LVDT Position Sensors serve as integral components in control systems that ensure the accurate landing of elevator cars at building floors.*

To ensure a smooth and comfortable ride, elevator cars are suspended by springs within an outer frame that provide cushioning against the effects of acceleration/deceleration and the initial starting and stopping 'jerks' caused by inertia. As an elevator is loaded with passengers, these springs compress, changing the car position within the frame that can affect final car position at the destination floor. To ensure that both elevator cars and building floors properly align upon arrival, hermetically-sealed LVDT gaging probes are used to measure the difference between the frame and car position. Specifically, these spring-loaded LVDT position sensors are measuring 'spring deflection' as a result of the passenger load (see photo 4).

Depending upon the elevator manufacturer, sensors are mounted either under or above the elevator car. When measurement is made from above, the probe of the spring-loaded LVDT position sensor is normally compressed and extends as the load increases. When installed below the elevator platform, the hermetically-sealed gaging probe is normally extended and compresses as load increases. Output is fed into a control system that uses the displacement feedback to adjust the travel of the frame, so that

when the elevator car doors open, the car floor is level with the building floor on which passengers are exiting.

Hermetically-Sealed, Spring-Loaded LVDT Sensors on Automotive Parts Production Line

Hermetically-sealed, spring-loaded LVDT gaging probes are used on automated auto part production lines as part of quality control systems that ensure the precise dimensions of components manufactured for use in different cars. In one application, a spring-loaded LVDT sensor is ensuring the internal diameter of hydraulic valve adjusters used on car engines. If dimensions are not within specification, the valve adjuster is removed from the manufacturing line.

So the hermetically sealed, spring-loaded LVDT sensor can tolerate the high production volume of 300K units per day, springs are manufactured with high strength steel that is 3x to 4x stronger than standard units. The LVDT gage head also contains a 90° radial connector to provide 2" to 3" more clearance for the sensor and mating connector

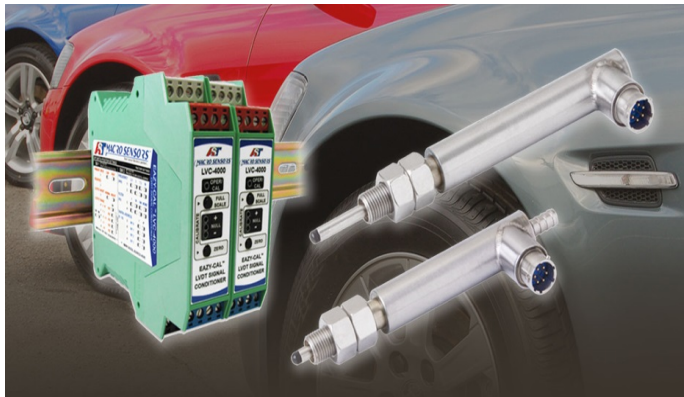


Photo 5: Hermetically-sealed, spring-loaded LVDT gage heads with a high strength steel spring are being used on an automated auto part production line as part of a quality control system that ensures precise dimensions of hydraulic valve adjusters.

As an AC-operated sensor, electronics of the gage head are remotely located in a box outside the hostile conditions of the production area. An LVDT signal conditioner provides electronic excitation to the sensor, and can convert the position measurement to an RS-485 digital output that enables a host computer to retrieve measurement data for viewing by operators remotely on computers in real time or input into a computer-based data acquisition system for statistical process control (see photo 5).

Hermetically-Sealed Gaging Probes Ensure Proper Machine Control in Presses and Dies

In the press and die industry, hermetically-sealed, spring-loaded LVDT position sensors are used to ensure proper machine operation. Improper machine operations can lead to broken dies that result in downed machines, while ambiguous forces of presses can lead to misshapen and out-of-spec parts. A hermetically-sealed LVDT gaging probe can survive the heavy pounding and shocks common on punch presses. Air extend/spring-retract versions are installed so that the plunger of the LVDT is compressed as the punch press comes in contact with the metal being shaped. The output of the LVDT is fed into the machine's control system, providing feedback on how far a press has moved to ensure proper alignment.

In modern sawmills, hermetically-sealed gaging probes work in unison with computer-controlled systems to ensure a correct sawing pattern for a given log or timber segment to optimize lumber yield. Once a servo system is used to coarsely position the saw blade carriage against a stop, an air-extend / spring-retract gaging probe touches the (nonrotating) blade. The probe's position signal is fed to another servo system for final blade positioning.

When the blade position is set, the carriage is clamped tight and air pressure directed to the LVDT gaging probe is reduced enough to allow the probe shaft to retract. In addition to being exposed to flying sawdust and chunks of timber or wood, the saw carriage experiences high levels of vibration during a cut and severe shocks as heavy logs are dropped into the carriers. Ruggedness and air-purged bearings are key to LVDT probe survival.

For measuring the thickness of sheet lumber products, gaging probes are placed in pairs, one above and one below some point on the sheet, to control lamination presses and planer cutter or roller position. The thickness at that point on the sheet is the difference between the dimensions as indicated by each LVDT probe of the pair. Typically, many gaging probe pairs are used to sample sheet thickness over some statistically valid area. A computer-based data acquisition system evaluates the output from all the probes to provide the thickness data that controls the process.

For more information on Macro Sensors Spring-Loaded LVDT Position Sensors, visit:

http://www.macrosensors.com/spring_loaded_lvds.html

ABOUT TE CONNECTIVITY

TE Connectivity (NYSE: TEL) is a \$12 billion global technology leader. Our connectivity and sensor solutions are essential in today's increasingly connected world. We collaborate with engineers to transform their concepts into creations – redefining what are possible using intelligent, efficient and high-performing TE products and solutions proven in harsh environments. Our 72,000 people, including over 7,000 engineers, partner with customers in close to 150 countries across a wide range of industries. We believe EVERY CONNECTION COUNTS – www.TE.com.

In 2013, TE Connectivity Ltd. (NYSE: TEL), completed the acquisition of American Sensor Technologies, Inc., a manufacturer of pressure and position sensing solutions, and its sister company, Macro Sensors, a U.S. manufacturer of linear and rotary LVDT sensors used for position measurement and feedback in a variety of industrial applications including factory automation, motion control systems, metal fabricating, automotive assembly as well as power plants, gas/steam turbines.

Macro Sensors serves all major industries including energy/power generation, factory automation, subsea/marine, industrial OEM, civil engineering/R&D as well as aerospace/military with standard and custom linear and rotary position sensors. In recent years, the company has expanded its technology's reach into higher pressures, extremely high and low temperatures, digital signal conditioning and miniature sizes.

A product selection guide is available at: http://www.macrosensors.com/position_sensor_selection_guide.html

Stock sensors available for same day shipment: <http://www.macrosensors.com/lvdt-position-sensors-in-stock.php>

Please direct all product inquiries to Eileen Otto, Eileen.Otto@te.com, 856-662-8000, sales@macrosensors.com

<http://www.te.com/usa-en/products/sensors.html>

