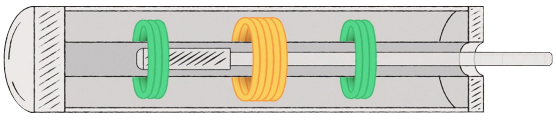
LinACE™ with digital outputs
vs. LVDT sensor

LinACE™ is an electromechanical sensor used to convert the linear motion of an object into an electrical signal.

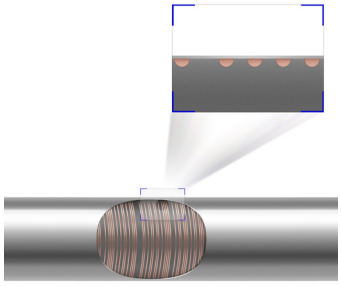
Digital outputs have several advantages over analogue as they are less susceptible to electromagnetic interference, allow built-in self-monitoring and can even employ error detection codes such as CRC. All this leads to higher reliability, especially when longer cables are used.

LVDT usually consists of three coils arranged around a tube. The middle coil is the primary coil and the two outer coils are the secondary coils. A ferromagnetic core slides along the axis.



When the core moves, the magnetic connection between the primary coil and the two secondary coils changes, resulting in a change in the induced voltages. The difference in the induced voltage in the secondary coils is converted into position information.

Unlike the LVDT sensor, the **LinACE** sensor reads an absolute code written in a hard-chrome plated solid steel rod and converts the encoded position into a digital signal.



Reading the coded shaft offers several advantages over evaluating the change in position based on the change in induced voltage.

Why choose LinACE instead of LVDT

- Low weight (no heavy coils are needed)
- Compact design
- Digital output and high level of diagnostics and reliability
- Temperature stability
- Low output ripple – signal noise
- Accuracy at measuring lengths 20 mm or more
- No pre- or post-travel

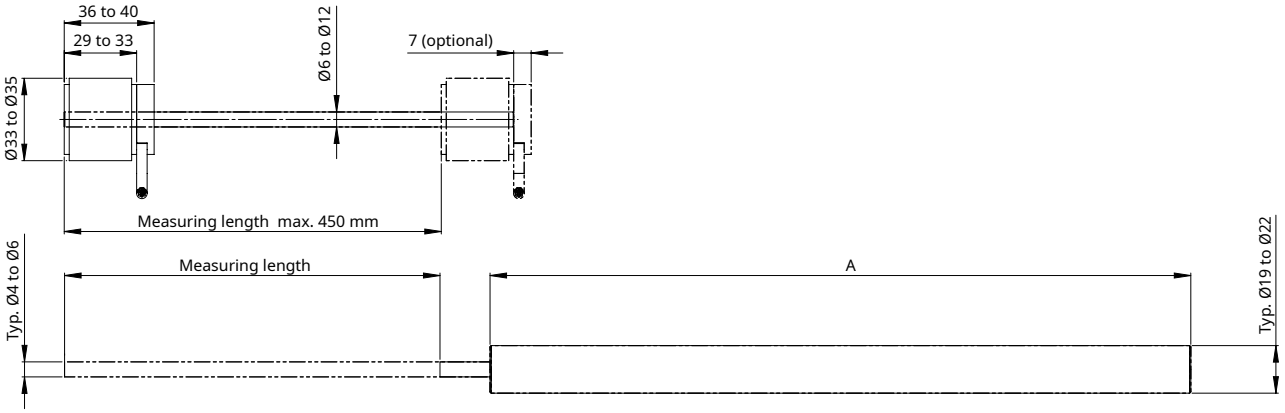
For more information on LinACE, visit **LinACE website**.

Compact design

Unlike LVDT, the length of the LinACE readhead does not depend on the measuring length. LinACE has a readhead length of 29 mm to max. 40 mm and a diameter of max. 35 mm.
LVDT transducers require a coil length that is greater than the measuring length. Therefore, the length of the sensor head increases parallel to the measuring length.
LVDT with a measuring length of 20 mm or more has a typical diameter of 19 mm or 22 mm. It can have integrated or separate processing electronics. With integrated processing electronics, the length of the sensor head is even greater. If the processing electronics are separate, this requires:

- Additional wiring,
- Space for installation, and
- Additional costs.

LinACE vs. LVDT: readhead length and mass



Measuring length (mm)	Length (mm)		Mass (g)	
	LinACE	LVDT (A)	LinACE	LVDT
20	29	140	94	130
100	29	230	111	265
150	29	280	122	325
300	29	450	144	520

For LVDT: Estimated typical value (with integrated processing electronics).
For LinACE: With axial cable output, 1 m cable and 6 mm coded shaft diameter.

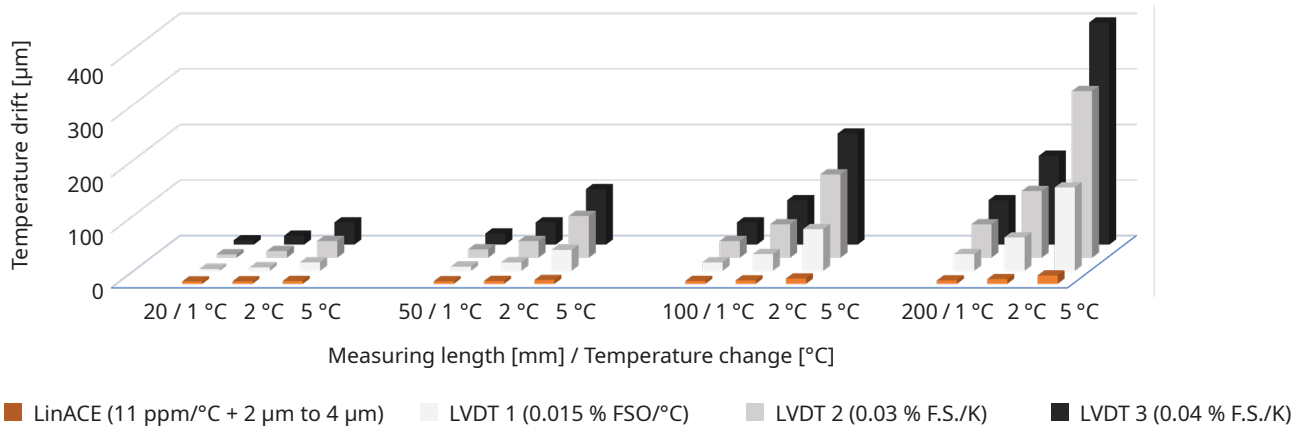
Digital output and high level of diagnostics and reliability

LinACE encoders are available in asynchronous serial, PWM, SSI and BiSS output versions and offer a range of selectable resolutions from 10 µm to 0.5 µm at speeds up to 5 m/s.
The LinACE encoder has a built-in advanced self-monitoring function that continuously checks various internal parameters. Error reports, warnings and other status signals are available on all digital interfaces. No signal conditioner or additional electronics are required.
LVDT transducers normally have only analogue or LVDT outputs and no status information. In the case of an LVDT output, separate processing electronics (or a signal conditioner) is required.

Example of an LVDT signal conditioner by **DEWESoft**, DSI-LVDT Adapter:

Temperature stability

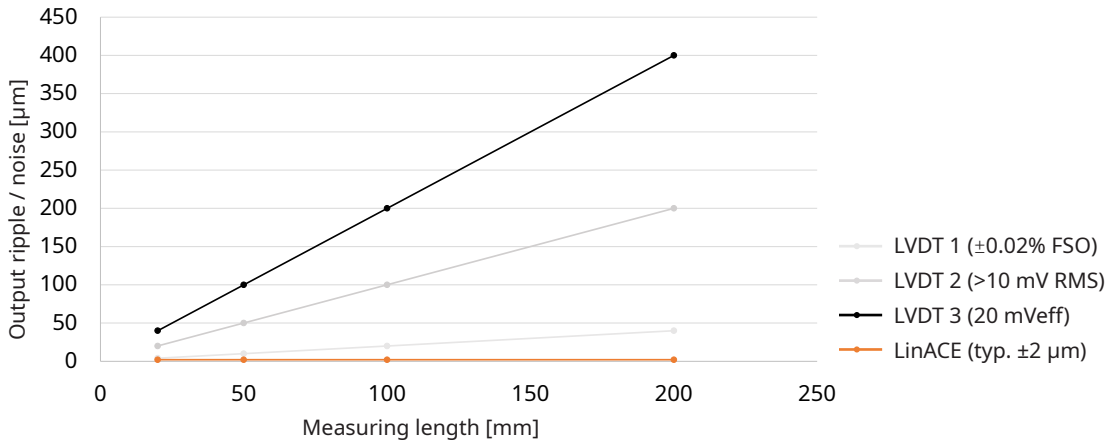
With temperature fluctuations, we can expect some positional drift. LVDT sensors typically give a temperature coefficient of 0.015% /K to 0.04%/K, which leads to considerable temperature drift, especially at longer measurement lengths.
The LinACE position measurement changes with temperature only due to the thermal expansion of the encoded carbon steel shaft and the aluminium housing of the read head. This is normally in the range of the thermal expansion of the device frame.



Output ripple – signal noise

LVDTs typically give the output ripple or signal noise in mV (RMS) or mV (eff). The longer the measurement length, the greater the effect on accuracy. The output ripple or noise is usually lower in the middle of the measurement length and higher at the ends. For a measurement length of 150 mm, the noise level can be between 30 µm and 300 µm. For high-end LVDTs, it can be as low as 3 µm in the middle of the measurement range.
The signal noise of the LinACE sensor does not depend on the measuring length. The normal noise value is less than 2 µm.

Signal noise vs. measuring length of sensor

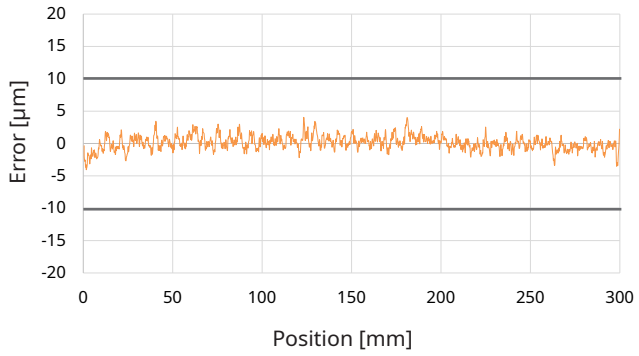


Accuracy for measuring lengths 20 mm or more

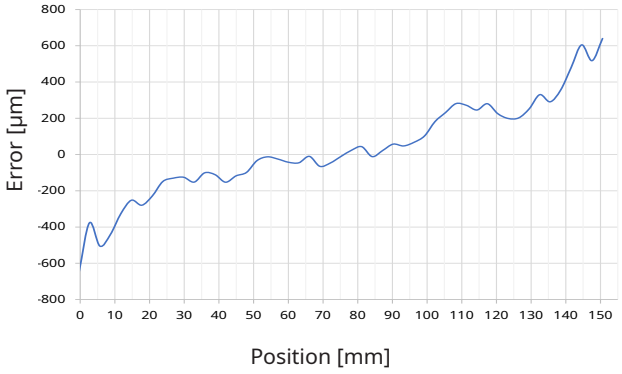
LinACE encoders are available with a resolution of 10 µm to 0.5 µm and an accuracy of ±100 µm to ±5 µm. An accuracy of ±5 µm is available up to a measuring length of 100 mm. And an accuracy of ±10 µm is available up to a measuring length of 450 mm. The LinACE accuracy diagram below shows a typical accuracy for a measuring length of 300 mm and an accuracy of ±10 µm.
However, we have to take into account the temperature drift due to the thermal expansion of the coded shaft and the aluminium housing.

LVDT transducers have a typical non-linearity of 0.1 % to 0.5 %. Accuracy and resolution are therefore excellent up to a measuring range of 10 mm (±5 µm at ±5 mm travel with 0.1% non-linearity). At 100 mm travel, however, a non-linearity of 100 µm or more is to be expected. To achieve better linearity, additional calibration can be performed on the customer side.
The LinACE vs. LVDT accuracy graph below shows LVDTs with non-linearity of 0.1%, 0.15% and 0.2%. As we can see, LinACE has a clear advantage in terms of accuracy at longer measurement lengths.

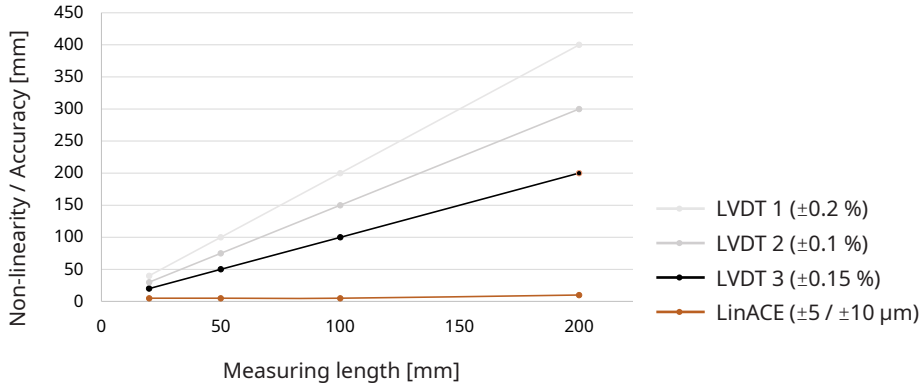
LinACE accuracy graph



LVDT accuracy graph



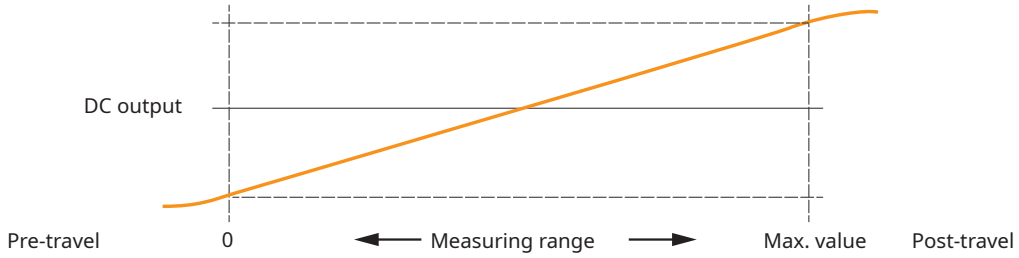
LinACE vs. LVDT accuracy graph



Pre- or post-travel

The LinACE encoder has no pre- or post-travel. The entire stroke from the beginning to the end of the coded shaft can be used without restrictions.
LVDT transducers have a very linear output over the specified range of core motion, but the sensor can be used over an extended range with reduced output linearity. This range is typically within a few mm.

- Pre-Travel: The mechanical movement from the fully extended position of the LVDT transducer (where the moving element is against a mechanical stop) to the start of the LVDT measurement range.
- Post-Travel: The mechanical movement from the end of the LVDT measuring range (inwards) to the fully retracted position where the movable element is against a mechanical stop.



Specifications comparison

	LinACE	LVDT
Measuring length	From 20 mm to 450 mm	From 0.254 mm to 700 mm
Encoder length	Measuring length + 29 mm to 40 mm	Approx. measuring length × 2
Resolution	To 0.5 µm (>15 bit on 20 mm range)	<15 bit
Accuracy	To ±5 µm	
Non-linearity	< 0.01 % on 100 mm range	0.1 / 0.2 / 0.25 / 0.5 (% of full scale)
Repeatability	1 µm	0.01 % to 0.1 % (10 µm to 100 µm on 100 mm range)
Output bandwidth	2000 Hz	15 Hz to 500 Hz
Output	Asynchronous serial, PWM, SSI, BiSS	Analogue, RS485
Supply voltage	5 V	5 V to 12 V or 10 V to 30 V
Power consumption	Typ. 500 mW* Max. 600 mW*	300 mW to 700 mW
IP protection	IP40	IP40 to IP68
Temperature	From –30 °C to +105 °C	From 0 °C to +65 °C or From –40 °C to +200 °C

* Without output load.

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