LVR Temperature Stability

Introduction

The LVR preserves accurate non-contact position feedback in extreme and rapidly changing temperature environments where conventional analog sensors can lose accuracy. Temperature-related error in many position sensors comes from three primary sources:

1. Changes in conductor resistance. Most position sensors are analog devices that produce position-dependent currents or voltages. Temperature-driven resistance changes in internal wiring can shift the output signal and introduce measurement error.
2. Changes in sensor dimensions. Thermal expansion or contraction can alter the sensor's geometry and affect its output.
3. Changes in operating electronics. In many designs, electronics are mounted directly on the sensor and experience the same temperature conditions. LVDTs use remote electronics but have other temperature-related limitations discussed later.

Traditional compensation methods rely on ambient temperature measurements and correction factors developed through testing and calculation. But in real-world applications, the sensor's internal temperature often changes more slowly than the surrounding environment. During rapid temperature swings, this lag can create meaningful measurement error. Even with compensation, many sensors still have significant temperature-related errors.

Technical Background

The LVR is engineered to overcome these limitations through a digital frequency-based measurement architecture. It uses a coil wound around a ceramic tube, with a metal rod passing through the tube and attached to the measured object. As the object moves, the rod changes position inside the coil. The coil connects to remote electronics located outside the harsh environment, forming a resonant circuit that oscillates at a frequency determined by the coil's inductance, L, and capacitance, C but not the resistance as shown by the equation in the figure below.

$$f = \frac{1}{2\pi\sqrt{LC}}$$

As the metal rod moves through the coil, it changes the coil's inductance and capacitance, creating a frequency shift that tracks position. This design provides three important advantages:

1. The output is a digital frequency signal rather than an analog voltage or current output, reducing sensitivity to resistance-driven signal drift.
2. The coil resistance does not factor into the frequency calculation, and the electronics can remain safely outside the harsh environment.
3. The signal voltage, not the frequency, is dependent on the resistance in the coil and that resistance changes linearly with temperature as shown in figure below. The LVR can thus directly measure coil temperature and enables immediate correction without a separate thermocouple or delayed ambient-temperature estimate.

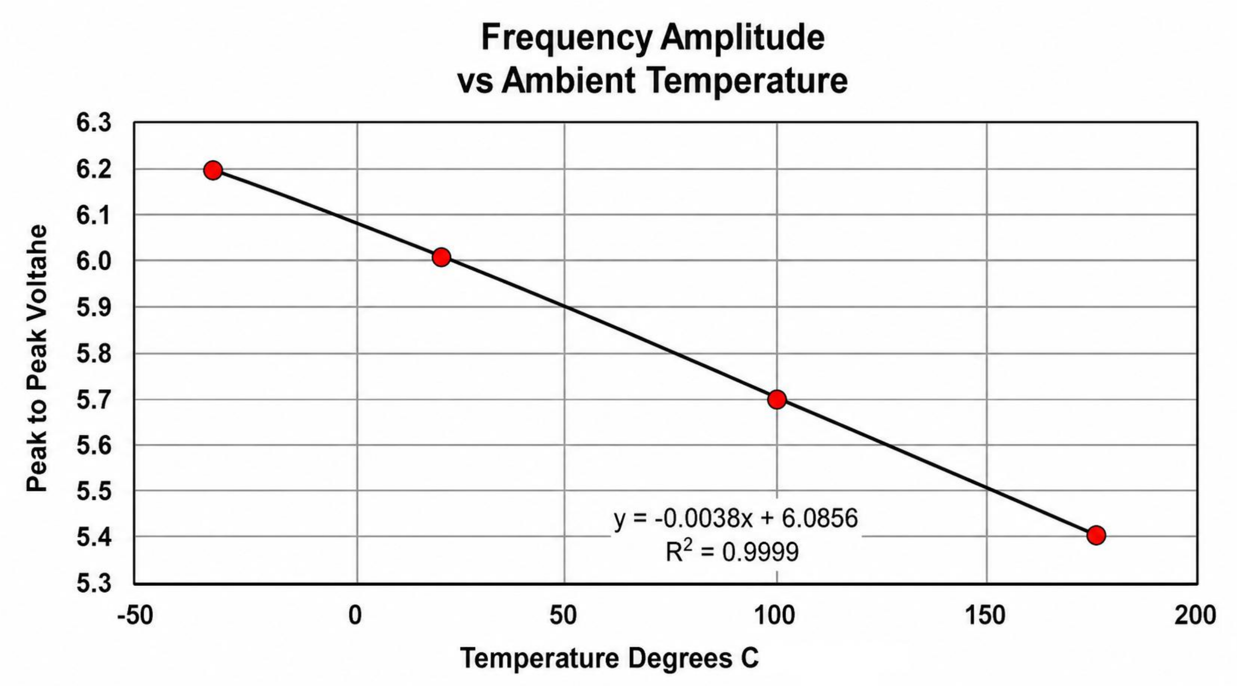

Figure 1: LVR signal-voltage amplitude changes linearly with temperature, enabling direct coil-temperature measurement.

This direct coil-temperature measurement enables precise correction for the small effects of sensor expansion and contraction. Because the measurement reflects the sensor's actual temperature—not just the surrounding environment—the correction can be applied immediately during rapid temperature changes. It also simplifies system design by eliminating the need for a separate temperature detector.

The result is an LVR output that remains effectively independent of temperature, as shown in the graph below. The output stays within the sensor's stated accuracy of 0.1% of full scale across the full -70°C to 200°C operating range.

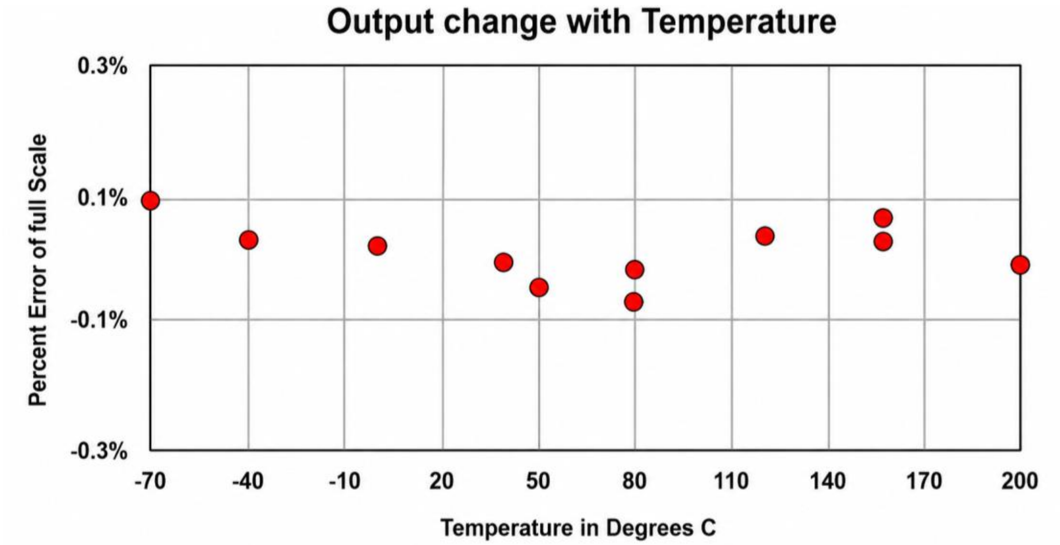

Figure 2: The LVR sensor stays within its 0.1% accuracy operating specification over a broad range of temperatures without any temperature correction.

Practical Benefits - Comparison with LVIT and LVDT Sensors

Compared with LVIT and LVDT sensors used in similar applications, the LVR offers a more robust solution for demanding temperature environments. The key differences are summarized below.

Sensor type	Temperature performance	Accuracy impact	Compensation approach
LVR	Operates across -70°C to 200°C with frequency-based position output.	Maintains stated accuracy within 0.1% of full scale across the operating range.	Uses direct coil-temperature measurement from signal voltage for immediate correction.
LVIT	Typically rated to 125°C.	Offset drift and gain change of approximately 0.01% full scale per °C can reduce accuracy after small temperature changes.	Relies on external temperature sensing and correction factors.
LVDT	Can reach 200°C with remote electronics.	Offset and gain shifts of approximately 0.02% to 0.05% full scale per °C are more pronounced away from the center point.	Relies on external temperature sensing and may respond more slowly because of iron-core thermal lag.

In practical terms, LVITs and LVDTs depend on external temperature sensors to reduce drift, adding cost, complexity, and delayed response during rapid temperature changes.

Conclusion

The LVR is an accurate non-contact digital linear position sensor designed for applications where temperature instability can create operational risk. Its key advantage over conventional analog sensors such as LVDTs is the ability to maintain reliable position measurement during extreme and rapidly changing temperature conditions without the need or delay of waiting for a separate temperature detector to respond. This capability is especially valuable in aviation, power generation, and chemical processing environments, where delayed or inaccurate position feedback during a thermal event can increase safety, reliability, and control-system risk.