Precision Scales Perfect for Linear Motors

The high resolution and repeatability of HEIDENHAIN’s LF series of encoders are ideal for linear motors on today’s machine tools. This is in part due to a steel measuring standard with a defined thermal behavior equivalent to most of the materials used in manufacturing. [Read more »]

PRODUCT SPOTLIGHT

Absolute Position Up to 28 Meters Available with Fanuc Interface

The LC 200 linear encoder continues to be the ideal solution for measurement on long machine tool axes of up to 28 meters. With the Fanuc interface now available, it continues to work well in high speed machining applications using linear motors. [Read more »]

NEWS

HEIDENHAIN HISTORY– Part 4
Expansion in the 1980s

After Dr. Johannes Heidenhain passed away in 1980, HEIDENHAIN Corporation continued to grow through the acquisitions of ACU-RITE Corporation and Metronics. The product base grew as well, with the introduction of three major products. [Read more »]

Did You Know...

...that the iTNC 530 control has a chatter control feature to sense and eliminate part deformation caused by vibration during machining? [Read more »]

Know the Answer?

Can You Guess Which HEIDENHAIN Encoder... ...provides a maximum positioning error of 30 arc seconds or better on a 3 meter diameter rotary table? [Read more »]
New Sealed Linear Encoders with Steel Measuring Standards for Very High Repeatability

The requirements for accuracy and productivity in precision machine tools are constantly growing more demanding. To rule out mechanical sources of error in the lead screw, machines are increasingly being equipped with linear motors. However, these motors place stringent requirements on the machine’s position measuring devices. HEIDENHAIN has fulfilled these requirements by developing its LF series of sealed incremental linear encoders, and has been able to improve them significantly. They are well known in the market for their very strong capabilities.

Today’s machine tools with linear motors need additional rotary encoders for velocity measurement. Here, position and velocity are both determined through the linear encoder. To ensure both high accuracy and dynamic performance, the linear encoders must feature sufficiently high resolution and repeatability in order to ensure exact velocity control even at slow traversing speeds. The velocity is calculated here from the distance traversed per unit of time. This method, which is also applied to conventional axes, represents a numerical differentiation that amplifies periodic disturbances or noise in the signal. Most notably, high control loop gain on direct drives dramatically increases the influence of signal quality on drive performance.

Linear encoders that generate a high-quality position signal with only small interpolation error are therefore essential for the meaningful operation of direct drives on machine tools. Encoders of the LF series from HEIDENHAIN with photoelectric, interferential scanning are particularly suited here for this task, since very fine graduations can be used as measuring standards by this method.

From a grading period of 8 μm, the interferential measuring principle of the LF generates scanning signals with a signal period of 4 μm. The scanning signals are largely free of harmonics and can be highly interpolated. On the revised LF 185 and LF 485, the position error within one signal period is typically smaller than ±0.04 μm. This is equivalent to less than 1% of the signal period. These improvements have been confirmed in test with pilot customers using encoders of the model LF 185. In many axes, the customers were able to double their loop gain.

Figure 1: Position error within one signal period
In addition to applications on linear motors, these new models are also especially well suited for position encoding on grinding machines, jig boring machines and other precision machine tools.

**Makeup of the encoders**

The new LF Linear encoders, like other series models, are available in both the slimline version LF 185 and a full size version LF 485, the measuring standard, which is produced with the SUPRAJur methode, of a steel. This provides the LF with a defined thermal behavior that is equivalent in its coefficient of linear expansion (attenuation $10 \times 10^{-6}$ K$^{-1}$) to most of the materials used in machine tool manufacture. With the full-size LF 185, the graduation corner of steel is connected additionally with the steel fastener. This special design is responsible for the encoder's high repeatability.

**Figure 2:** Housing design of the LF 185 with measuring standard

**Reliability**

The position information is produced by reading the increment track using the proven single-field scanning method. This type of scanning distinguishes itself dramatically in its signal quality and signal reliability from the three- or four-field methods. A special optoelectronic sensor was developed for this task. The large scanning surface of the single-field scanning principle makes the encoders largely insensitive to local contamination. Even relatively large contaminated areas result only in slightly weaker scanning signals and marginally increased signal deviations.

Particularly in applications such as in precision grinding machines where very high humidity can be expected, HEIDENHAIN recommends introducing clean compressed air into the encoder to produce a slight overpressure and ensure very high reliability. The use of the DA 400 compressed air unit is recommended for dedusting the compressed air.
**Dynamic behavior**

The linear encoders LF 185 and LF 485 are also characterized by their high rigidity in the measuring direction. This is a very important prerequisite for high-quality path accuracy on a machine tool. In addition, the low mass of moving components contributes to their excellent dynamic behavior. In particular, the new LF 185 was significantly improved in its compliance behavior over its predecessor LF 183.

![Graph showing compliance vs frequency for LF 183 and LF 185 encoders](image)

*Figure 3: Low compliance through high rigidity in measuring direction*

Again, particularly on linear motors, high rigidity in measuring direction is decisive for dynamic control behavior. The considerably higher natural frequency of the encoder allows a greater bandwidth of the position and velocity control loop.

**Summary**

The new LF product family of linear encoders is more accurate and reliable than ever before and is therefore the preferred choice whenever very high precision is required. The designs of the LF 185 and LF 485 linear encoders have been oriented to the corresponding LS or LC linear encoder. They can therefore be readily exchanged mechanically.

**Product benefits**

- Accuracy grades as fine as ± 2 µm
- Interferential scanning
- High accuracy (signal period of 4 µm)
- Small interpolation error (max. ± 1% of the signal period, previous model ± 2%)
- Steel graduation carrier, coefficient of thermal expansion same as machine base (α therm = −13 x 10⁻⁶ K⁻¹)
- High signal quality and resistance to contamination through the use of a SUPRADUR steel scale tape together with a special optical sensor with large scanning window
- Increased rigidity in measuring direction (improved applicability for linear motors)
- Mounting compatibility with previous models
HEIDENHAIN Encoders with Fanuc Interface

HEIDENHAIN’s LC 200 linear encoder continues to set the standard in linear measurement on long machine tool axes. Now available with a Fanuc interface, this encoder is increasing its available interface options and meeting further demand.

An absolute type encoder, the LC 200 offers its advantages for measuring lengths of up to 28 meters, such as ensuring that the absolute position value is available immediately upon switch on. And due to the design and use of a smaller scanning unit with increased rigidity in measuring direction, the LC 200 is especially useful in high speed machining applications using linear motors.

It’s also important to note that the LC 200 is assembled on a machine from individual components. The housing sections feature an improved mounting and sealing technology. An integrated seal on the face and a tongue and groove system make it possible to slide the housing sections together with ease. Large mounting tolerances facilitate easy assembly of the entire system.

System accuracy for the LC 200 is ±0.5 μm. It is available with both HEIDENHAIN’s TNC Dat and Fanuc’s interfaces.
HEIDENHAIN HISTORY

HEIDENHAIN has been in existence for over 100 years, with an all-Europe and now with approximately 8,500 employees worldwide. HEIDENHAIN continues to serve as an important and significant force in the precision measurement and motion control industry. This article is the fourth installment in a series to share its background.

The '80s

In 1980, with the vision of the HEIDENHAIN father and son reaching global proportions, Dr. Johannes Heidenhain passes away. The father Wilhelm had started his metalworking company in Berlin 1889, and by now it had evolved into a well-respected non-profit measurement component business with subsidiaries all over the world. More to come.

With a grounded foundation on board, talented management and top-notch R&D department, HEIDENHAIN went on to grow the business in an effort to meet the needs of international manufacturing. In 1985, HEIDENHAIN made a strategic purchase of ALF-1161, Corporation, a well-known American company which had the largest majority of the North American digital readout market for machine tools. Their strong product and impressive knowledge base was a perfect complement to HEIDENHAIN’s product lines.

Then in 1986, ALF-1161 acquired Metronics, the most respected metrology digital readout company in the country. The significance was yet another complement to HEIDENHAIN’s circus development mission.

The product base of HEIDENHAIN has grown, and the commitment to the development of high quality precision measurement products was strong. In the 1980s, three HEIDENHAIN products became significant introductions to the industry:

- The first multi-turn absolute rotary encoder – the KUC 221 S. This rotary encoder for general automation applications quickly became the most widely used type in the world. It boasted 21-bits: 12-bit single and 9-bit multi.
- The most accurate angle encoder with bearing – the RON 955. This angle encoder with bearing became the most accurate in the world and became especially useful in high technology research equipment and particle beam research. Introduced in 1986, this encoder is still on offer and available today.
- The first interferential linear encoder – the IFR 101. HEIDENHAIN developed this linear encoder with this new interferential scanning technology in 1987. Its defraction-gating on the scale produced high accuracy results in a non-contact system. This technology has since blossomed throughout the industry.

On the move, HEIDENHAIN continued its quest to produce and provide precision measurement components to meet the needs of the growing international manufacturing industry.

Stayed tuned for more HEIDENHAIN History in the next quarterly newsletter.

See previous HEIDENHAIN History installments:

HEIDENHAIN History PART 1
HEIDENHAIN History PART 2

DID YOU KNOW...

...that a HEIDENHAIN control offers a new Automatic Chatter Control (ACC) feature? This unique adaptive control function quickly and simply eliminates part deformation caused by vibration during machining.

An option on the HEIDENHAIN HSC1 TNc 530 control, this chatter control is activated. Once applied, the control will sense the chatter and then compensate for it.

As many know, chatter causes unacceptable inconsistencies in part finish when resonant frequencies are generated during machining. These frequencies cause machine vibration which results in oscillation that is then transferred into the part finish. This, in many cases, creates the need for a second operation to remove surface deformation that could have otherwise been smoothed by ACC.

The varying unfortunate outcomes of chatter are often premature tool wear, tool breakage, heat generated in part spindle, an increase in cutting time, and longer second operations such as polishing requirements.
Technical TRL

By, we received this question from a customer...

**QUESTION:**
A Machine Tool OEM would like a maximum amount of positioning error (related directly from the encoder) of their rotary table to be 30 arc seconds or better. Which HEIDENHAIN encoder would the OEM use to achieve these results on a 3 meter diameter rotary table?

a. RD 780
b. RDN 785
c. ERA 4250
d. RCN 8580

**ANSWER:** d. RCN 8580

The diameter of RCN 8580 is 100 mm and the diameter of the rotary table 3000 mm. The first step is to form a direct correlation between the two diameters. The accuracy of RCN 8580 is 1 arc sec or 1/3600th of a degree. (Picture is for visual purposes only and not drawn to scale)

\[
\frac{100 \text{ mm}}{1 \text{ arcsec}} = \frac{3000 \text{ mm}}{x} \\
x = 30 \text{ arcsec}
\]

![Diagram of RCN 8580 and Rotary Table]