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Improved impulse magnetization of magnetic measurement scales

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Summary:
Magnetic measurement scales, in the form of linear scales or multi-pole rings, are a key component in magnetic sensor systems for angle or length. Demands for longer scale lengths, increased accuracy, higher resolution and larger air gaps are pushing new developments, both in the field of new magnetic materials, and in the area of the magnetization technology used to encode the scales. A newly developed intelligent impulse magnetization head helps fulfil these new requirements and offers ways to remove some errors typically associated with magnetic measurement scales.

Keywords: measurement scales, magnetic sensors, angle measurement, length measurement, magnetization

Motivation

For several years, there has been a steadily increasing demand for magnetic-based measuring systems in industrial automation. Such measuring systems are characterised by a high degree of robustness and, at the same time, high cost-effectiveness [1]. In numerous areas of application, e.g. in semiconductor manufacturing, magnetic measuring systems have become the preferred solution for position and speed detection in moving machine axes.

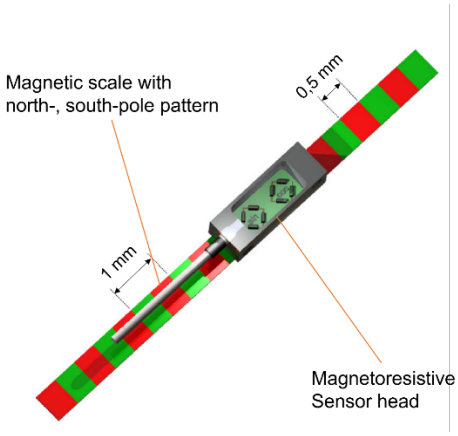

Fig. 1. Typical magnetic length measurement system

These measurement systems typically consist of magnetic sensors based on either magneto-resistive or Hall-effect technology, in conjunction with magnetic scales for linear and rotary motion. A pole pattern of north and south poles is written or encoded on the scale to enable both incremental and absolute distance or angle measurement (see Figure 1).

Different materials are used for the magnetic layer that can be written on. There have been some promising new developments in this area based on thin layers of hard magnetic materials that guarantee significantly better measurement accuracy and are even more resistant to contamination, high operating temperatures and high mechanical loads [2].

However, new requirements are emerging. There is a tendency towards larger measuring lengths, caused, among other things, by the trend towards the use of larger wafer formats in the semiconductor industry, which leads to longer travel distances for the testing machines used. In addition, even higher accuracies with a further improved price-performance ratio are required to make completely new applications accessible.

This could displace optical and inductive-based linear and angle measurement systems. To meet these market needs and to fully exploit the potential of new magnetic materials, the machines used to describe and encode the scales require significant further development.

In the BMBF-funded research project ELM2 ‘Development of a high-precision linear magnetising system for the description of magnetic scales’, which ran from July 2022 to December 2024, the Lahnau-based SME ITK Precisioning GmbH set itself the goal of enabling a higher level of

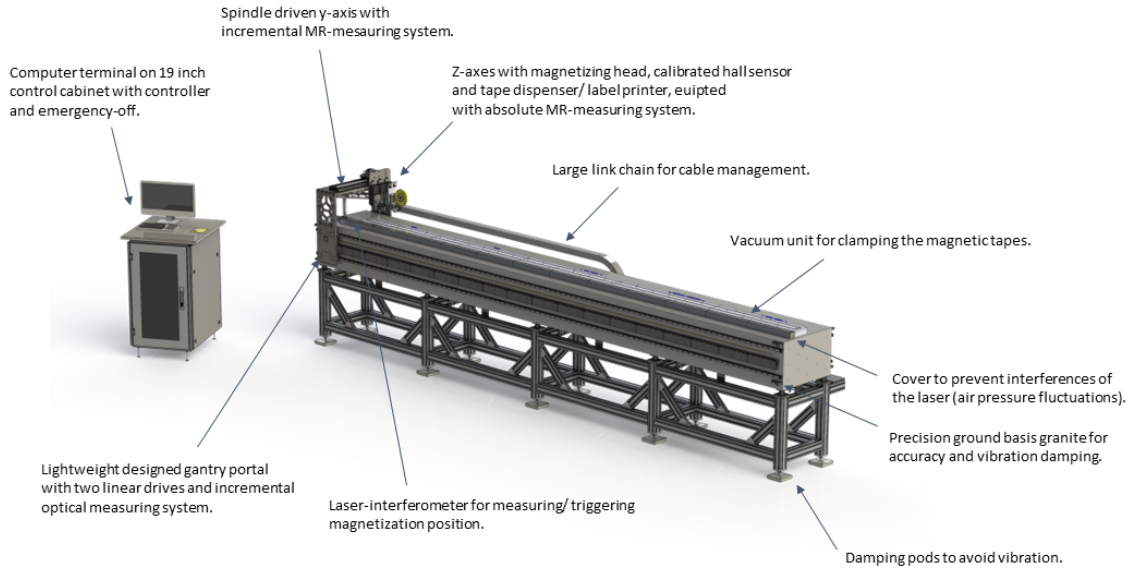

Fig. 2. Demontrator linear magnetization machine (Source: ITK Precisioning GmbH

magnetic measuring systems through the development of a new, high-precision linear magnetizing system.

Four essential developments were combined:

1. Based on FEM simulations, a thermally stable and rigid machine structure was designed to quickly and accurately describe scales up to 5 m in length (see Figure 2).

2. Direct drive technology, in the form of linear motors, in conjunction with lightweight structural elements, is intended to ensure higher machine dynamics and optimized throughput.

3. A new writing method has been established to enable pole correction and thus significantly higher scale precision.

4. Continuous writing and simultaneous writing and measuring (i.e. testing) should achieve a significant increase in productivity.

Development of a new impulse magnetization head

In order to deal with the third development area ITK approached ELSOMA GmbH, based in Schwerte, with the task of developing a new impulse magnetization head to be used in the ELM2 demonstrator machine.

The resulting ELSOPULS® IIM2k impulse-magnetization head (see Figure 3) is a microprocessor-controlled magnetizing device with integrated diagnostic and measuring functions. It is particularly suitable for magnetizing plastic-and elastomer-bonded hard ferrite magnets. The ability to emit very short magnetizing pulses enables the production of multi-pole magnets with pole pitches in the range of 1 to 5 mm. The short pulses lead to low thermal losses, which in turn, enables fast writing speeds.

Fig. 2. ELSOPULS IIM2k impulse-magnetization head (Source: ELSOMA GmbH

The new impulse head features a significantly higher magnetization field than previous solutions, so enabling the encoding of more coercive materials. Furthermore, the programmable current profile helps eliminate common errors e. g. by avoiding the start-pole error typically associated with multi-pole rings [3]

References

[1] Dixon, R.; „A market perspective on the opportunities for magnetoresistive technology “, Proc. of 15th xMR-Symposium, Wetzlar, 2019

[2] Bandorf, R., Ortner, K. & Krau, M.; „PVD-Abscheidung von CoSm-Schichten für magnetische Maßstäbe“, Vakuum in Forschung und Praxis, Vol. 32, No. 5, Oktober 2020

[3] Knoll, H. *et al*; Investigation and Assessment of the Magntization Accuracy for different Magnetization Technologies for long magnetic scales, 25th XMR-Symposium, Wetzlar, March 2025