

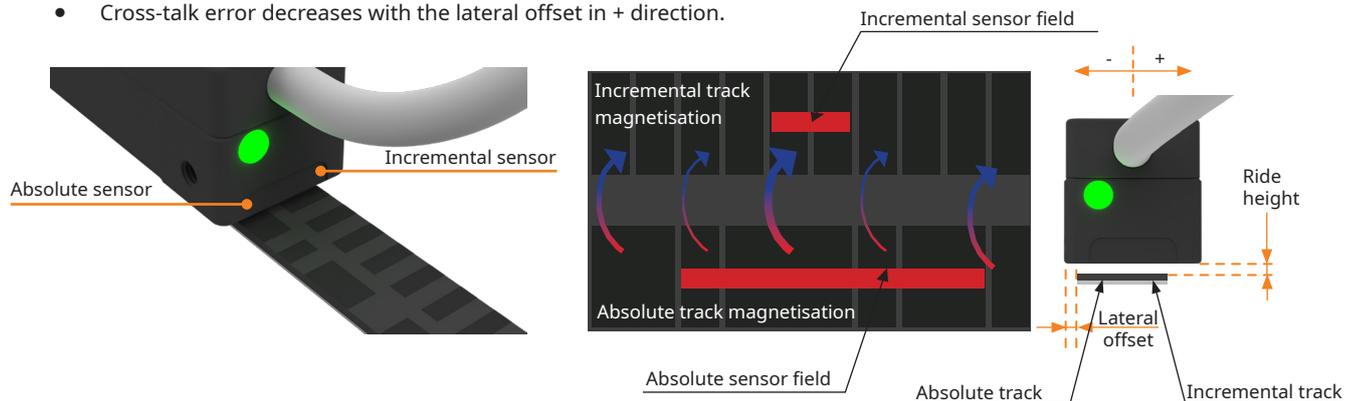
Accuracy of absolute linear encoder systems

This document describes accuracy of the absolute linear encoder systems and factors affecting it. Factors contributing to the inaccuracy of the absolute magnetic scale are slope error, magnetisation error, cross-talk error and sub divisional error (SDE). The dominant factors contributing to the inaccuracy are magnetisation and cross-talk error. The SDE error is considered negligible.

Crosstalk - how absolute track magnetisation affects incremental track sensing

Crosstalk is a disturbance caused by the magnetic field of an absolute track affecting the sensor reading of an incremental track. The readhead has incremental and absolute sensing surfaces. The closer the incremental sensor is to the absolute track in the lateral axis, the stronger the crosstalk effect becomes. Ride-height (distance between the readhead and scale) also affects the intensity of the crosstalk error. As the ride-height increases, the ratio between the incremental sensor distance and the absolute track shifts in favor of the absolute track. We advise to install the readhead in the center of the scale. However, the most optimal installation is when the readhead is slightly laterally shifted toward the incremental track (+ direction) but still inside of specification for the lateral offset. In the chapter General accuracy the accuracy as a function of ride-height and lateral offset can be observed.

- Crosstalk error increases with the ride-height.
- Cross-talk error decreases with the lateral offset in + direction.

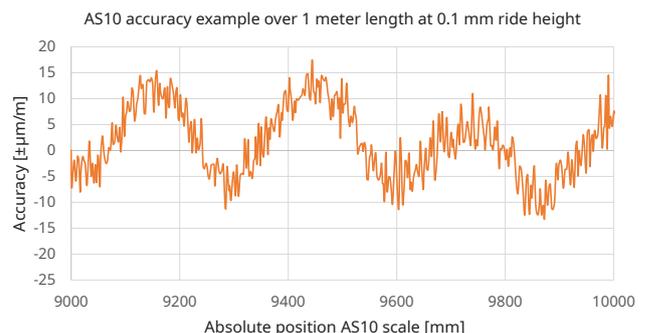


Magnetisation error

The magnetisation error is caused by imperfections in the elasto-ferrite material and possible deviations in the magnetisation process. The magnetisation error is also an aftereffect of handling during production and the method of final packaging. When the scale is rolled on a reel, each layer of the scale touches the adjacent layer and with its magnetic field (~50 mT) impairs the magnetisation of the next layer. The effect goes in both directions. The deterioration of the magnetic properties of the scale is then seen on the accuracy as an undulation (see plot below). The SAS10 type of scale is not affected by this phenomenon since it is not rolled on a reel, hence better yield in total accuracy.

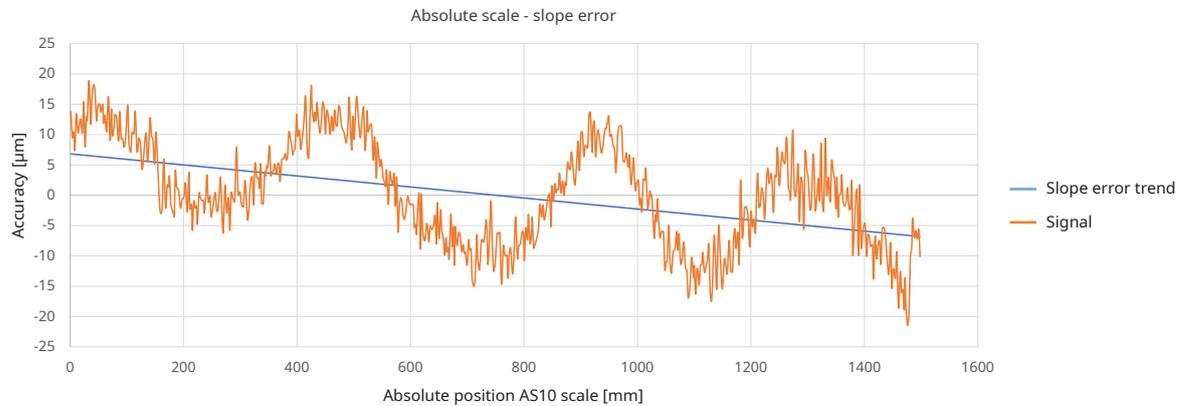
Factors affecting the magnetisation error:

- magnetic inhomogeneity of the elasto-ferrite layer
- deviations in the elasto-ferrite thickness
- handling method during production
- type of final packaging



Slope error

Slope error is a non-periodic error prominent on longer scales. The slope error originates from the thermal expansion or contraction of the scale. The AS10 and SAS10 scales are magnetized at a very controlled environmental temperature, that is 21°C. Any deviation from the “production” temperature will cause slope error.



Sub-divisional-error (SDE) or interpolation error

The sub-divisional or interpolation error is a periodical accuracy error. The period of the SDE is one magnetic pole (in our case 2 mm).

It is influenced by the following factors:

- homogeneity and cycle definition of magnetic poles
- sensing distance (ride-height) between the scale and readhead
- quality of the signal processing
- characteristics of the internal AMR sensor

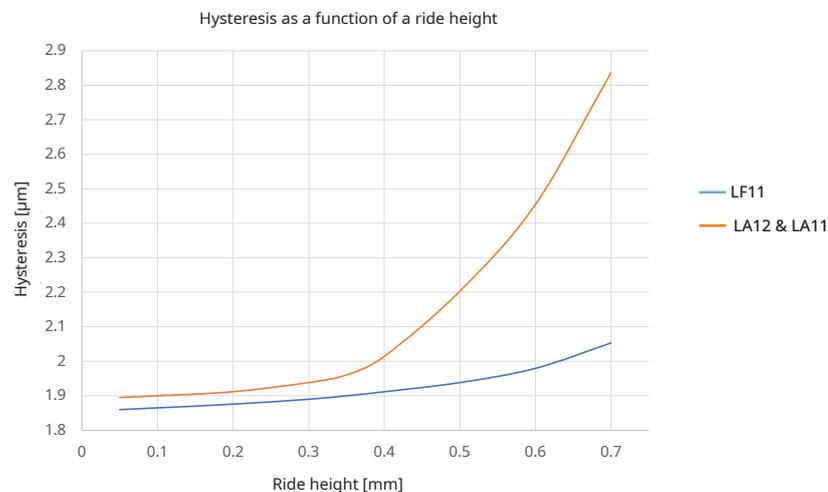
The SDE leads to speed ripples in applications where the encoder is used as speed feedback, e.g. in speed control loops.

Hysteresis

Hysteresis is the difference in the result of measuring the same point when approached from different directions.

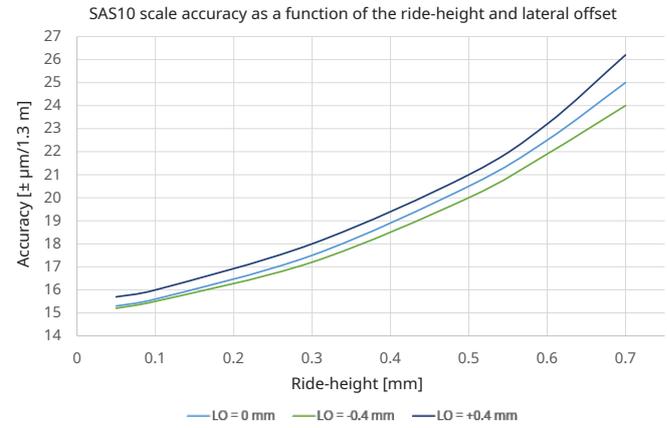
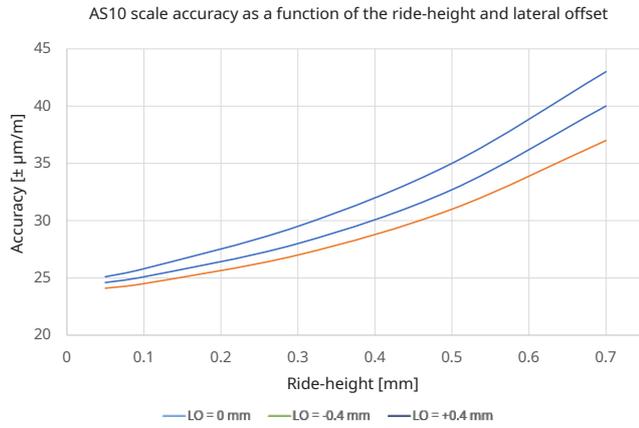
Ferromagnetic materials are known to maintain their magnetized state in response to external fields and attempt to change direction.

Hysteresis in encoder systems depends on the strength of the magnetic field. A stronger magnetic field will result in lower hysteresis and vice versa. Therefore, the hysteresis is strongly influenced by the ride height at which the read head is installed.



General accuracy

The plots below presents the accuracy of the AS10 and SAS10 scale as a function of ride-height and lateral offset. Valid for all readheads (LA11, LA12 and LF11).



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Document issues

Issue	Date	Page	Description
1	11. 3. 2022	General	New document

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