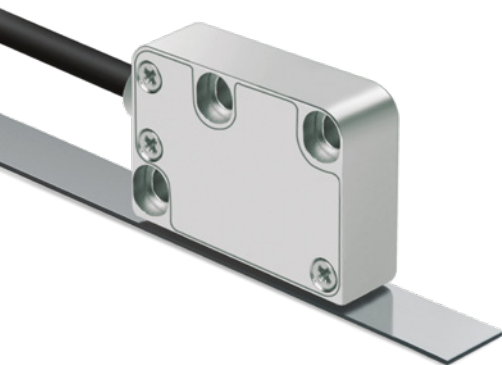
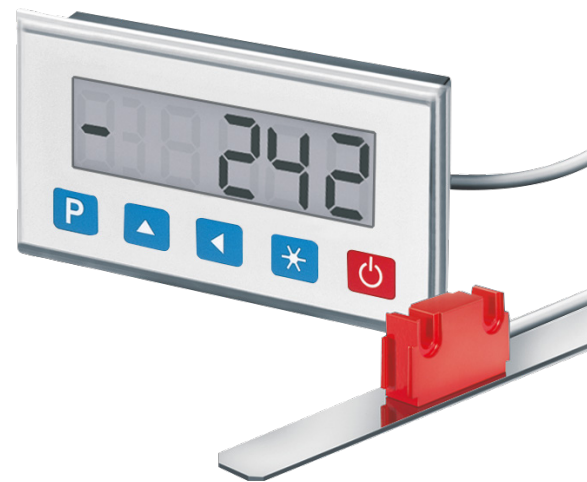
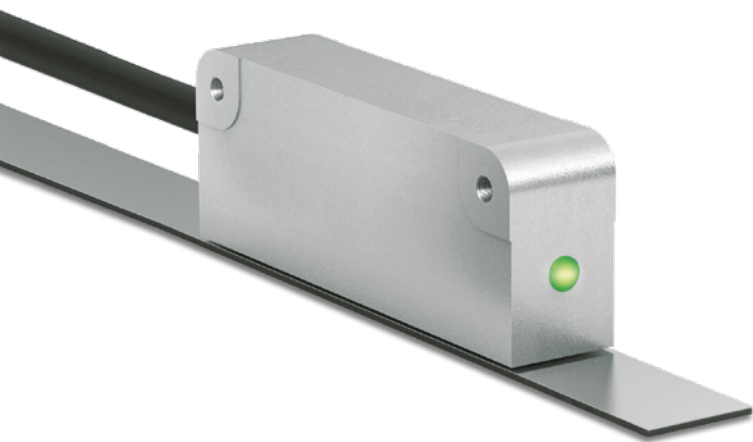


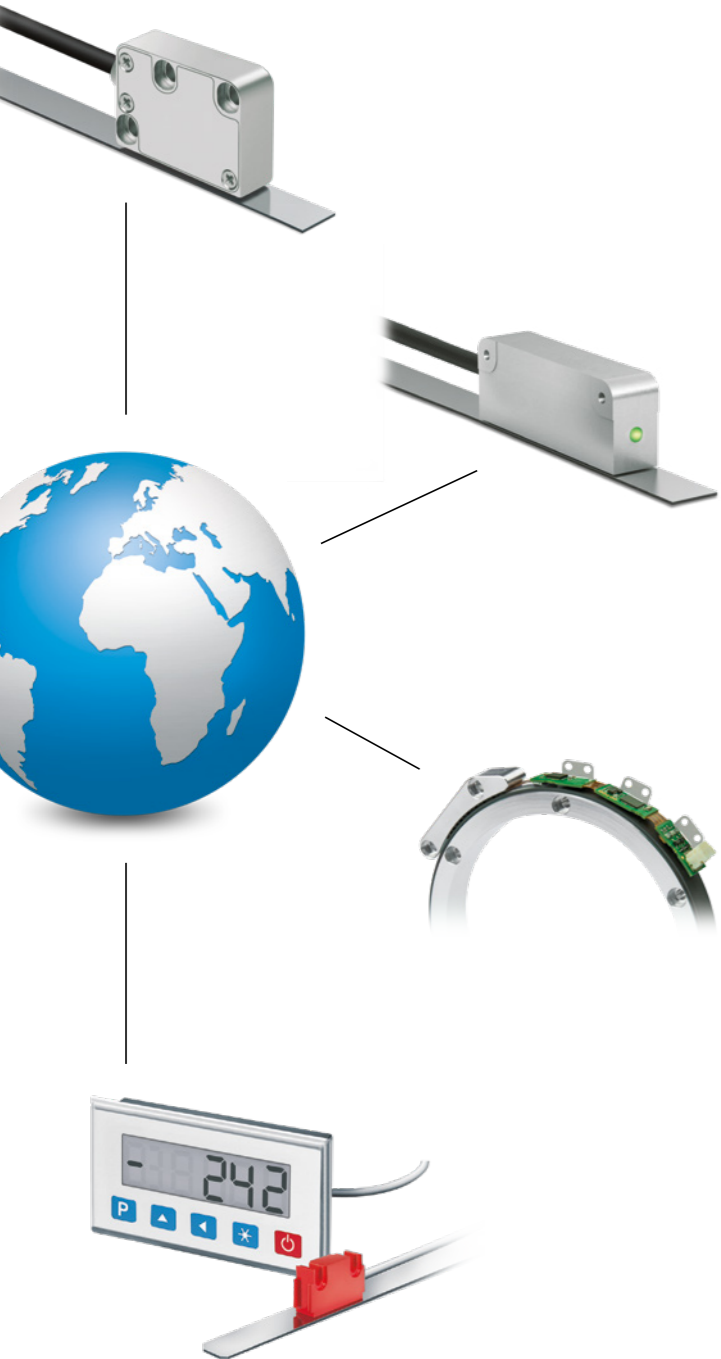


## MAGLINE

# MAGNETIC LENGTH & ANGLE MEASURING SYSTEMS, POSITION DETECTION



# SENSORS AND POSITIONING SYSTEMS PRECISE & VERSATILE



## Technical Lead and Long-Standing Competence

Today, SIKO stands for almost six decades of experience in position, angle and speed detection. The highest demands of our customers from industry and mechanical engineering ensure the quality, precision and functionality of our products and services.

SIKO is certified according to DIN ISO 9001:2015. The careful handling of raw materials and resources is a matter of course for us.

## MAGLINE CONTENT

### Company

- 4 SIKO Milestones
- 5 Foundation & Development
- 6 Company Profile



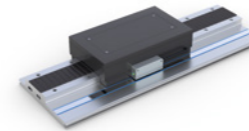
### The Magnetic Measuring Principle

- 8 MagLine
- 10 Incremental & Absolute Measuring Methods



### Products

- 14 High-Precision Encoder Solutions
- 16 Flexible Encoder Solutions
- 18 Robust Encoder Solutions
- 20 Rotative Encoder Solutions



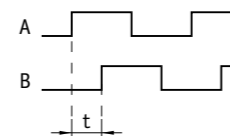
### Solutions

- 22 Magnetic Measurement Technology in a Variety of Applications



### Further Information

- 25 Technical Basics
- 26 Accuracy Specifications
- 28 Specification of the Output Signals from Encoders
- 29 Specification of Magnetic Bands



### Service

- 31 Sales – Personal Advice, Service & Solution Center – Training, Installation & After Sales



# Company

## SIKO MILESTONES

### THEN & NOW

1963

The first product idea: a handwheel with integrated analog display invented by D.Eng. Günther Wandres.



1992/1993

Launch of the magnetic measuring principle and start of magnetic band production.



1995/1996

Expansion to include magnetic incremental encoders and absolute length measurement.



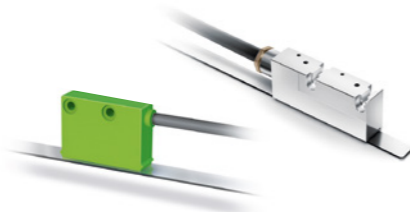
2000

Introduction of the first linear encoders for direct drives.



2006/2008

Invention of the first high-resolution absolute encoder. Introduction of the patented compact encoder solution with a reading distance of 20 mm.



2015

Absolute, high-resolution encoder with safety certification according to SIL2.



2016

First pluggable linear encoder for easy assembly.



2017

Introduction of the ultra-compact LEC series.



2020

New flexCoder technology for rotary absolute measurement in the smallest installation space.



### FOUNDATION & DEVELOPMENT

#### COMPANY

1963

Foundation of SIKO GmbH by D.Eng. Günther Wandres at Buchenbach.



1981

An important step toward the global market: Foundation of the subsidiary SIKO Products in the USA.



1999

Introduction of brand "MagLine".



2001

Foundation of the subsidiary SIKO Italia in Milan.



2005

Foundation of the subsidiary SIKO Trading Shanghai in China.



2008

Foundation of the subsidiary SIKO MagLine AG in Switzerland.



2012

Establishment of the subsidiary SIKO Products Asia in Singapore.



2020

Completion of the new production plant for electrical products and the administration building in Bad Krozingen.



2020

SIKO is once again distinguished as a top-rate employer.



# Company

## COMPANY PROFILE

### DYNAMIC & INNOVATIVE

Our measurement technologies from Buchenbach on the edge of the Upper Black Forest are successfully represented worldwide and in the entire mechanical engineering industry. Approximately **60 representatives** ensure direct contact and technical support for our customers, both nationally and internationally. Our **five successful subsidiaries** in the USA, China, Singapore, Switzerland and Italy strengthen the global presence of SIKO GmbH.



Global success is no coincidence.

#### Direct contact to our product specialists

We are happy to answer any questions you might have.

- Personal and qualified advice
- Worldwide accessibility with sales offices and representatives
- Technical support
- International trade fair presence
- Multilingual website, with download area for latest brochures and data sheets,
- 3D design data and much more

#### The human element

At SIKO, you find motivated employees who personally identify with the products they manufacture. The necessary technical know-how and a portion of pride in our own products are a factor not to be underestimated. In addition, SIKO provides its employees with a modern workplaces and an extensive package of social benefits.

The promotion of cross-departmental communication is also in the foreground. Teamwork and the appreciation of each individual employee are fundamental values that are lived at SIKO.

Excellent products can only be produced with this spirit, in which "the last 2%" are also perfect.



#### Products and Solutions

SIKO specializes in high-quality products and solutions for industry and mechanical engineering:

**Positioning systems:** Mechanical and electronic position indicators and positioning drives

**Linear sensors:** Bearingless linear encoders (MagLine), draw-wire encoders and position sensors for hydraulic cylinders

**Rotary sensors:** Bearingless rotary encoders (MagLine), rotary encoders and inclination sensors

#### Customized solutions

#### Quality Characteristics

Continuous product optimization is a matter of course for SIKO. Competence as well as state-of-the-art work equipment and facilities ensure the best possible quality:

- Integrated 3D CAD design
- Rapid prototyping
- In-house testing and experiment laboratories for endurance tests and material testing
- Use of programs for simulations and collision tests
- Quality management DIN EN ISO 9001

#### Into the future with a vision

Graduated Industrial Engineer Horst Wandres, son of the company founder, has led the company into the future with a vision since 1990. Mr. Sven Wischnewski was appointed to the Executive Board in August 2014 for reinforcement. Already today, Buchenbach and Bad Krozingen are consistently setting the course for the coming decades.

#### Working for you

From a global perspective, more than 250 SIKO employees are working hard for you today, with a lot of team spirit and know-how in the field. Continuously and with the necessary level of ambition and passion, we want to "do it even better." The steady and healthy company growth of SIKO GmbH is a real team achievement.



#### Production in Germany and Switzerland

SIKO relies on resource-saving lean production, which implements customer requirements on time thanks to on-demand production. Automated and specialized manual work are carried out at our production sites in Germany and Switzerland.

# The Magnetic Measuring Principle

## MAGLINE

### CONTACTLESS & MAGNETIC

#### From the Idea to the Solution

MagLine pursues the idea of replacing mechanically acting measuring systems, consisting of rotary encoder, rack and pinion, with a non-contact system on a magnetic basis.

To date, 4 product groups cover the entire range of industrial measurement tasks. Essential distinguishing features are accuracy, resolution and the reading distance. MagLine's magnetic SIKO technology is the first choice in terms of precision, reproducibility and, above all, robustness of the measuring processes.

The main areas of application are the acquisition of linear and radial positions, angle values and rotational numbers.

#### Benefit with MagLine ...

... especially industries with high requirements for the repeatability of linear or rotary measuring processes (even under adverse environmental conditions)

These include:

- Automation and handling systems
- Bearing technology
- Medical technology
- Linear direct drives and torque motors

#### The Magnetic Measuring Principle

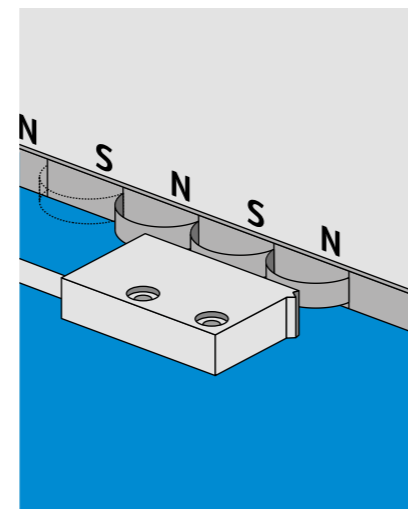
The core of the magnetic measurement is a fixed magnetic band (also called a scale). This band is contactlessly scanned by an encoder that is fastened to the movable part of the respective machine.

The encoder converts the measured values into digital or analog signals via integrated electronics. These signals are optionally available for evaluation electronics, higher-level controllers (PLCs) or measurement displays connected directly on site.

The actual magnetic measurement results from the change in resistance due to magnetic influence. The magnetic bands are coded in specially developed processes at SIKO.

- Wood, metal and plastic processing
- Textile machines
- Machine tools
- Robotics
- Mobile automation
- Renewable energy sources
- Special machine construction

The resulting band codings enable incremental or absolute measuring methods with different fineness resolutions.



Contactless measurement technology replaces susceptible, mechanically acting systems.

#### Benefits

- Precise, repeat-accurate and robust encoders
- Wear-free and insensitive to external influences such as dust, moisture, oil, grease, etc.
- Extremely robust when exposed to shocks and vibration
- Easy handling and installation
- Durable and economical

#### Operating Conditions

MagLine systems can be mounted directly on the positioning or machining process and thus prevent, for example, measurement errors that may arise due to gear play or spindle tolerances.


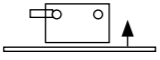
The reading distance (distance encoder/band) has a large tolerance range. It can vary over the entire measuring range and within the defined limits (e.g., due to radial run-outs or imprecise guidance). Accuracy and reproducibility of the position values do not deteriorate as a result.

The robust measuring equipment withstands soiling and mechanical stress in industrial applications. The greatest advantage is the magnetic measuring process itself, since it cannot be negatively affected by typical machine

impact (vibration, shock) nor by other influences (solids or liquids).

Demanding operating conditions require robust technology. Above all, the durability of the materials and functional units used guarantee reliability. To do justice to the mechanical demands, the flexible encoders can be additionally protected by a stainless steel cover strip. The sensors themselves do not have any moving parts, because the electronic components are fully encapsulated. Robust plastic and all-metal housings are mainly used to this purpose.

# INCREMENTAL & ABSOLUTE MEASUREMENT METHOD

Incremental to absolute measurement		
	The system must be re-referenced at ...	
	... Power interruption	... Reading distance exceeded Encoder/Band, Encoder/Ring
incremental	Yes 	Yes 
quasi-absolute $\boxed{+-}$	No	Yes
real-absolute	No	No

A "quasi-absolute" measurement results from battery buffering of measurement data. Even an adjustment of the encoder along an incrementally coded band in the currentless state is detected. Referencing is only necessary if the encoder has exceeded the maximum band distance.

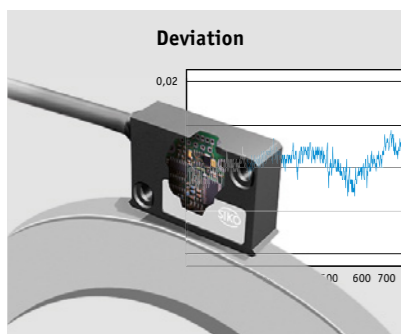
A "real absolute" measurement is given if the magnetic band used is absolutely coded and thus, despite currentless adjustments of encoder/band after switching on the system, an absolute position can be output directly by reading out the magnetic band.

The magnetic measurement is carried out either incrementally, quasi-absolutely or real-absolutely.

## Incremental Systems

In the incremental system, the magnetic band is magnetized in uniform periods with north and south poles, whereby the pole length determines the max. resolution and accuracy, among other things.

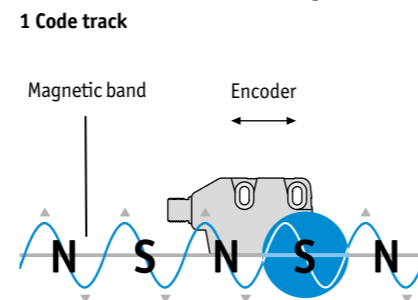
If the encoder is moved over the band, the path information is generated from the periods and is displayed as a digital square-wave signals (counting pulses) or analog sine, cosine signals. The counting of the impulses allows a statement to be made about the distance covered.




In an incremental system, at least one absolute reference is required – the reference point. This point serves to realign the system and can be coded as additional information on the magnetic band. This reference point is important because in the incremental system after a power interruption (e.g., after switching the system off and on again) and if the encoder position has changed in the meantime, the actual position value is usually lost.


In the case of a system without a buffer battery, a renewed reference run is then required. Battery-buffered systems are considered to be quasi-absolute systems.


## Incremental Band Encoding



Incrementally coded track

LE / LS encoder —  — SPS  
Analog signals

MSK encoder —  — SPS  
Digital signals

MS sensors —  — SPS  
System signals for  
SIKO measuring displays and  
SIKO evaluation electronics

## Incremental systems: Reference signals from encoders and magnetic bands

**1** An encoder with characteristic "0" (without index) is equipped with only one sensor element, which takes over the length measurement. An encoder version without index works with single-track magnetic band without an additional reference point.

**2** An encoder with characteristic "I" (index signal) is also equipped with only one sensor element, which takes over the length measurement. An index signal is generated by the encoder per period by means of additional electronics. To generate such a signal, no second track on the band is necessary. This encoder type therefore works with a single-track magnetic band without an additional reference point.

**3** An encoder with feature "R/RB/RD" (one-time, periodic reference point) is equipped with an additional sensor element, which scans a second track on the band parallel to the first, on which a reference point is located. Its position is determined when ordered (see data sheet of the respective magnetic band).

**4** An encoder with feature "FR" (reference flexible) is equipped with an additional sensor element that scans the flexible reference mark (optional accessories). For this encoder, only one track is necessary for the magnetic band. The flexible reference mark can be glued on at any point of the magnetic band according to the brief instructions.

**It should only be noted** that a magnetic pole is covered centrally with the flexible reference mark. For this purpose, the flexible reference mark is already prepared in a template with magnetic magnifier.

**1 / 2** If an encoder has the characteristic I / 0, it works with ...



Magnetic band characteristic 0 (without reference point/1 track)

**3** If an encoder has the characteristic R / RB / RD, it works with ...



Magnetic band characteristic E (one-time reference point/2 tracks)

or with ...



Magnetic band characteristic P (periodic reference point/2 tracks)

**4** If an encoder has the characteristic FR, it works with ...



Magnetic band characteristic 0. (with flexible reference mark)

## Possibilities for Referencing an Incremental System

### 1. You use a system consisting of encoder without reference signal and a magnetic band with one track

The system can be referenced either by moving to a defined position, e.g., a stop block or by linking a specific position to an external encoder (limit switch, light barrier, etc.). Problem: depending on the design of the stop block or the external sensor, the repeatability of this method is not sufficient.

### 2. You use a system consisting of encoder with index signal "I" and a magnetic band with one track

In this variant, you link an external encoder (limit switch, light barrier, etc.) with an index signal that the encoder outputs with each magnetic period. The external encoder only assumes the function of determining the correct period here. The accuracy of the referencing corresponds to the repeatability of the encoder (see the respective data sheet).

#### Note that:

- The referencing can be carried out at any desired point of the travel path.
- The switching distance of the external encoder must be shorter than the distance between the index impulses.

#### For information:

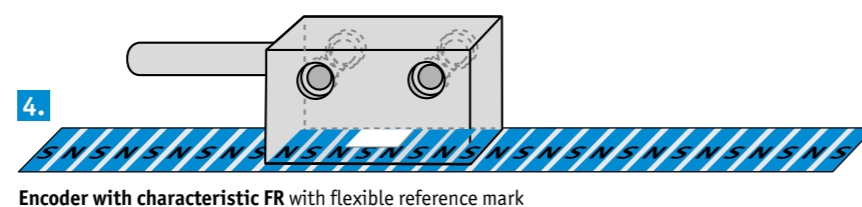
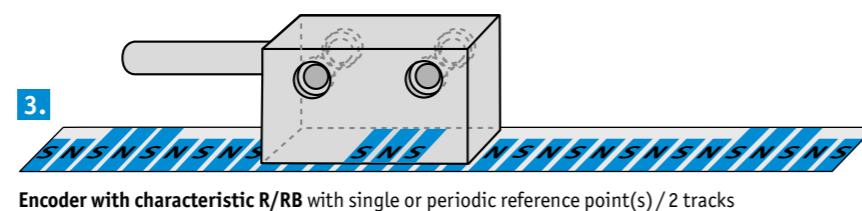
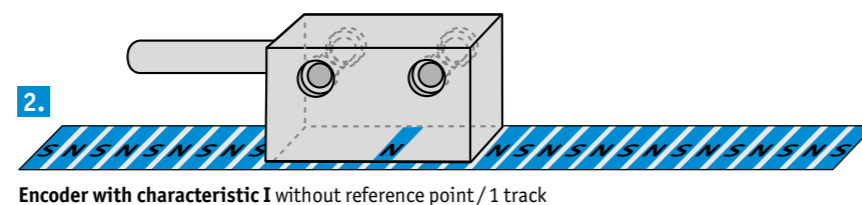
The index pulse spacing is 5 mm for MB500/1, and it is only 1 mm for MB100/1.

### 3. You use a system consisting of encoder with reference signal "R/RB" and a magnetic band with two tracks (one-time, periodic reference point, magnetized on the second track)

In this variant, no external encoder is usually necessary; referencing is only carried out with the reference signal of the encoder. Realignment can only take place at the point where a corresponding reference point is magnetized onto the band. For long measuring distances, it is recommended to work with periodic reference points and to identify them by external sensors. The referencing takes place with the repeatability of the encoder (see the respective data sheet).

### 4. You use a system consisting of encoder with reference signal flexible FR and a magnetic band with one track.

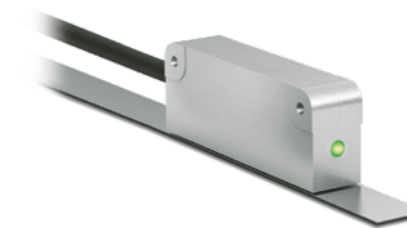
With this variant, an external encoder is usually not necessary. Referencing is only performed with the reference dial of the encoder. The reference point for the reference signal of the encoder is determined by gluing the flexible reference mark on the magnetic band at the point selected by the customer. The accuracy of the referencing corresponds to the repeatability of the encoder (see the respective data sheet).



## Absolute Systems

In contrast, no reference run is necessary for linear measurements with magnetic bands coded absolutely. The flexible plastic band is magnetized with a special, absolute code.

Commissioning is carried out by calibrating the system once. No buffer battery is necessary thanks to the absolute coding of the magnetic band, because the current position value is available again immediately after switching on the system at any point.

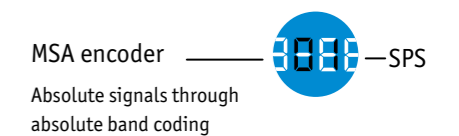
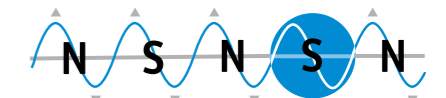
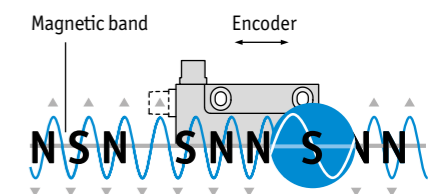


Even a change in position in the voltage-free state has no influence on the correctness of the displayed measured value, since the position is absolutely stored at every point in the coded magnetic band. A reference run is not required either if the encoder is lifted off the magnetic band for maintenance, for example.

Commissioning is carried out by calibrating the system once. No buffer battery is necessary thanks to the absolute coding of the magnetic band, because the current position value is available again immediately after switching on the system at any point.

## Absolute band coding

### 2 different code tracks



## The Quasi-Absolute Method

This method is based on incremental measurement technology. The measured values are buffered in evaluation electronics belonging to the system in such a way that they are available as absolute values. An integrated battery ensures that currentless adjustments are also detected. The specially developed low-power technology enables reliable operation without battery changes of up to 10 years.

When battery-buffered systems are installed, it must be ensured that the specified max. reading distance encoder/band is not exceeded; otherwise the measurement information can be lost with this method. If this is the case, a reference run is required.

## Remains to Be Noted

Each of the measuring methods described above has its advantages. With the knowledge of the application to be equipped and its field of application, it can be decided, for example, whether for economic reasons the incremental procedure or for time and safety reasons the absolute procedure is the preferred system.

The path and angle measurement is one of the standard tasks in plant engineering and construction. With modern and proven solutions, the products from SIKO MagLine have been in use for many years. Regardless of whether incremental or absolute, the contactless measuring principle is superior to conventional

solutions such as rotary encoders with toothed racks, cable pull transmitters or optical systems in many areas thanks to its extreme robustness. With large measuring lengths, high accuracy and easy handling, MagLine is always an economical solution for a variety of tasks. All interfaces common in industry are available for connection to control, regulation or bus systems.

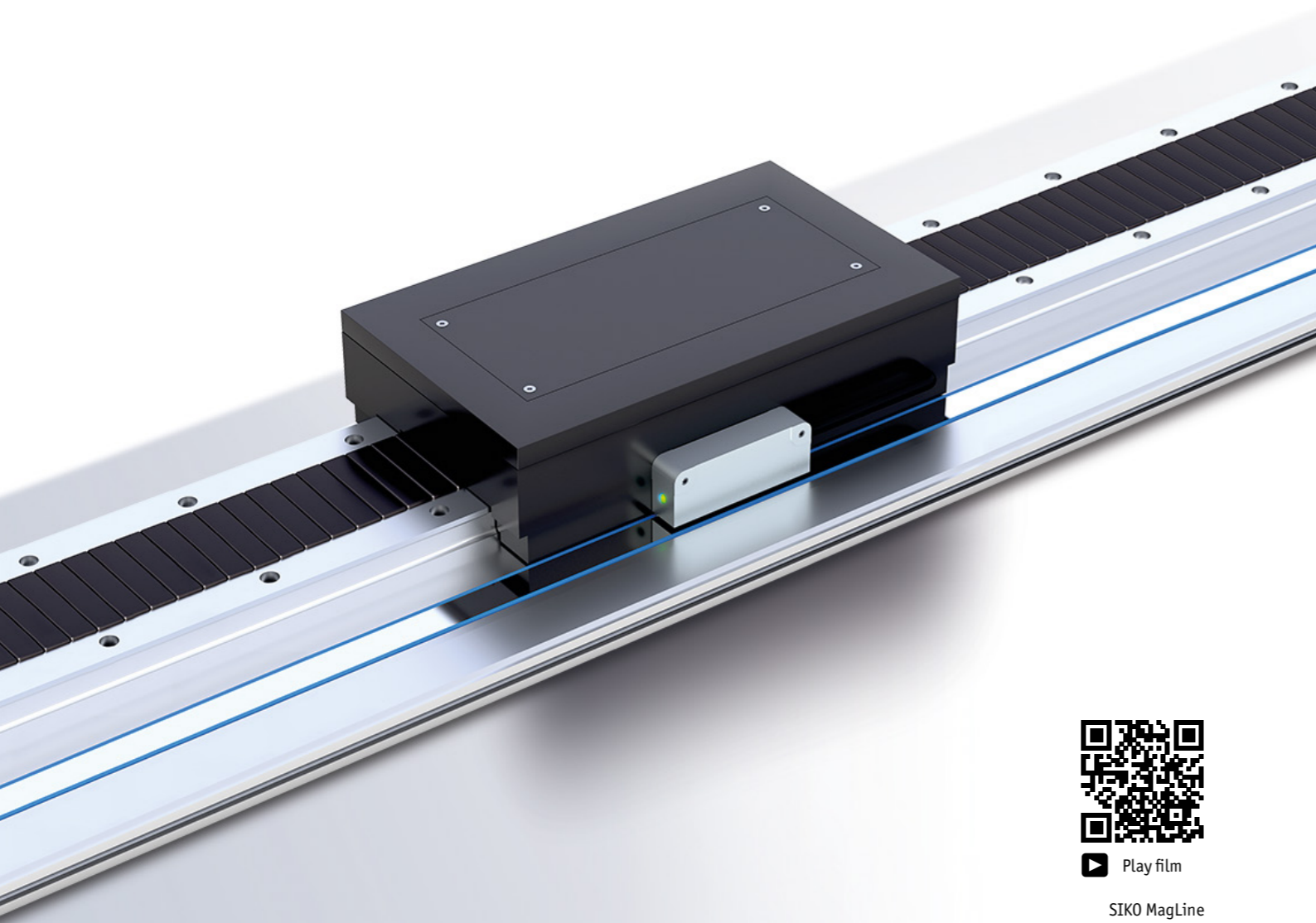
# Products

## HIGH-PRECISION ENCODER SOLUTIONS

ACCURACY CLASS 10  $\mu\text{m}$

TYPICAL RESOLUTION 1  $\mu\text{m}$

The high-resolution feedback system is designed for **precise** and **highly dynamic processes** with special requirements for measuring values in the  $\mu\text{m}$  range.



Play film

SIKO MagLine  
"Easy Installation"

### Features

- High accuracy for exact position detection and optimum control quality
- Primary use: drive technology
- Systems for incremental and absolute measurement
- Extensive selection of interfaces and signal output in real time
- Measurement length to 100 m





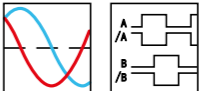






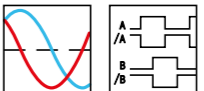
### Advantages

- High-resolution
- Incremental and absolute
- Economical
- Small and compact

### Specifications

- Resolution: 0.1 ... 5  $\mu\text{m}$
- Linearity deviation:  $\pm 10 \mu\text{m}$
- Repeatability:  $\pm 1 \mu\text{m}$
- Encoder band spacing: up to 0.4 mm

### Combinations

Measurement method	Scale	Magnetic encoder	Interface	Downstream electronics
incremental	MB100/1	LE100/1	analogue 	Regulator / Controller*
		MSK1000	digital 	PLC, counter*
		MS100/1	Point-to-point 	MA100/2 
	MB100/1, MB160, MB200/1	LEC100, LEC160, LEC200	analogue, digital 	Regulator / Controller*, PLC, Counter*
		MB200/1	MSK200/1	digital, PAN, YAS 
real-absolute	MBA111	MSA111C  	SSI, DRIVE-CLiQ, analogue 	Regulator / Controller*
	MBA213	MSA213C, MSA213K 	SSI, Biss, IO-Link, analogue, digital  	Regulator / Controller*

\* Customer-supplied downstream electronics



# Products

## FLEXIBLE ENCODER SOLUTIONS

ACCURACY CLASS 50  $\mu\text{m}$

TYPICAL RESOLUTION 10  $\mu\text{m}$

Tried and tested and technically mature, this product series offers a particularly wide range of coordinated components. The cost-effective solutions open up a variety of **individual applications** that meet all standard requirements in terms of measurement accuracy.

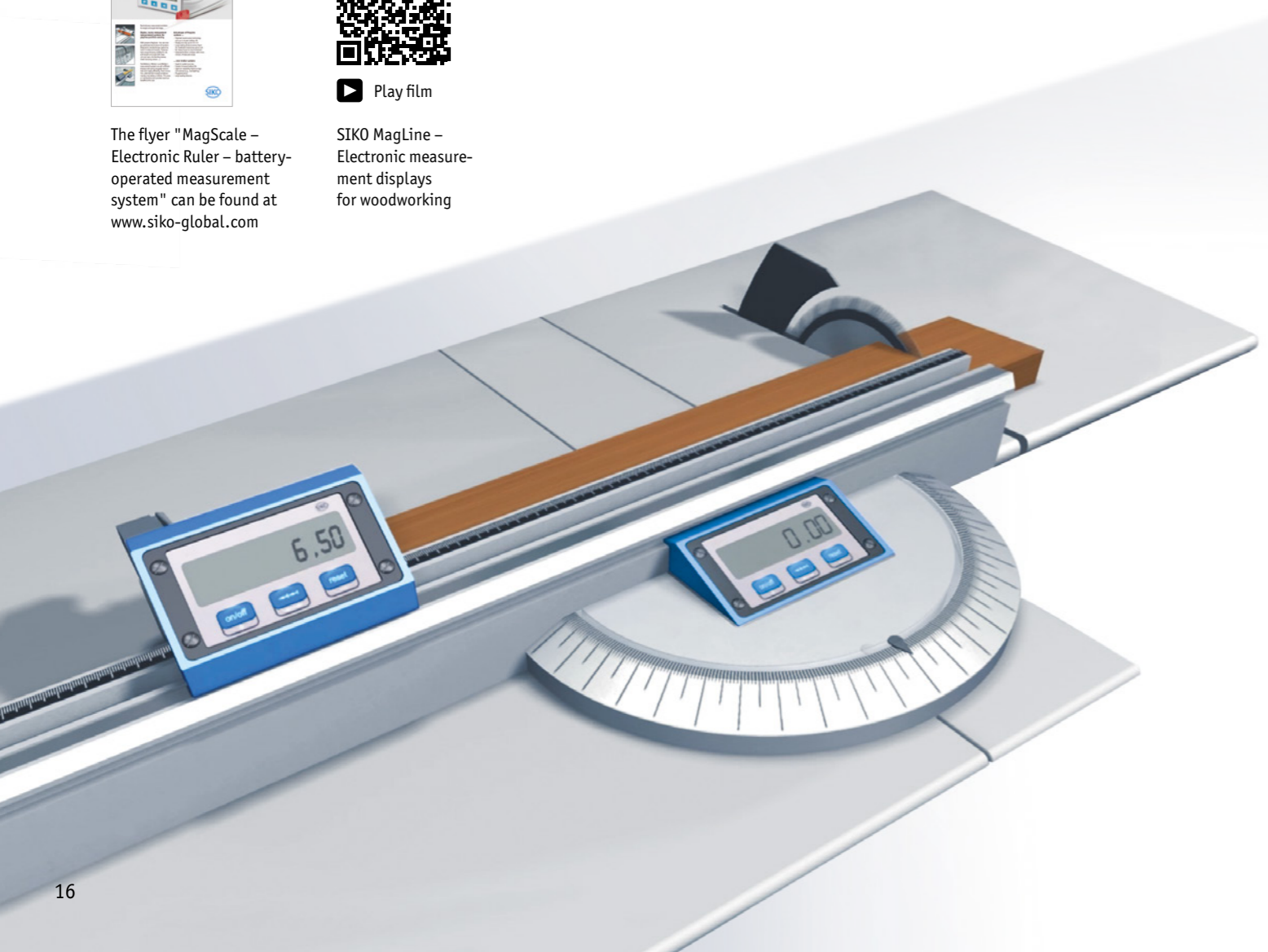


The flyer "MagScale – Electronic Ruler – battery-operated measurement system" can be found at [www.siko-global.com](http://www.siko-global.com)



Play film

SIKO MagLine – Electronic measurement displays for woodworking



### Features

- Systems for incremental and absolute measurement
- Complete systems with encoder and display
- Measurement lengths over 100 m
- Robust in assembly tolerances and ambient conditions

### Advantages

- Versatile system
- Easy to assemble
- Ideal for use in series production
- Easy retrofitting

### Specifications

- Resolution: 1 ... 100  $\mu\text{m}$
- System accuracy:  $\pm 25 \mu\text{m}$
- Linearity deviation:  $\pm 5 \mu\text{m}$
- Encoder band spacing: bis 2.5 mm

### Combinations

Measurement method	Scale	Magnetic encoder	Interface	Downstream electronics
incremental	MB320/1 	MSK320 	digital 	PLC, counter*
	MB500/1 	MSC500, MSK5000 	digital 	PLC, counter*
	MB500/1 	MS500H 	Point-to-point 	MA504/1, MA503/2 
quasi-absolute	MBR500, MB500/1 	ASA510H 	SSI, analogue, digital 	Regulator/Controller*
real-absolute	MBA501 	MSA501 	SSI, digital, CANopen 	Regulator/Controller*
	MBA 	MSA 	Point-to-point 	MA505 

\* Customer-supplied downstream electronics

# Products

## ROBUST ENCODER SOLUTIONS

ACCURACY CLASS 1 mm

TYPICAL RESOLUTION 0.25 mm

Specially designed for very **long measuring distances** with large tolerances, these systems enable **safe, millimeter-precise position detection.**



### Features

- Infinite measurement lengths
- Height differences in the measuring distance can be compensated with a reading distance of up to 20 mm
- Systems for incremental measurement
- Particularly suitable for long detection distances such as in warehouse and conveyor technology

### Advantages


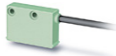

- High resolution with very long measuring distances
- High degree of protection (IP67)
- Large installation tolerances permitted

### Specifications

- Resolution: 0.25 ... 2 mm
- Linearity deviation: ±1 mm
- Repeatability: ±1 mm
- Encoder band spacing: up to 20 mm



### Combinations

Measurement method	Scale	Magnetic encoder	Interface	Downstream electronics
incremental	MB2000, MB4000	MSK2000, MSK4000	digital	PLC, counter*
				

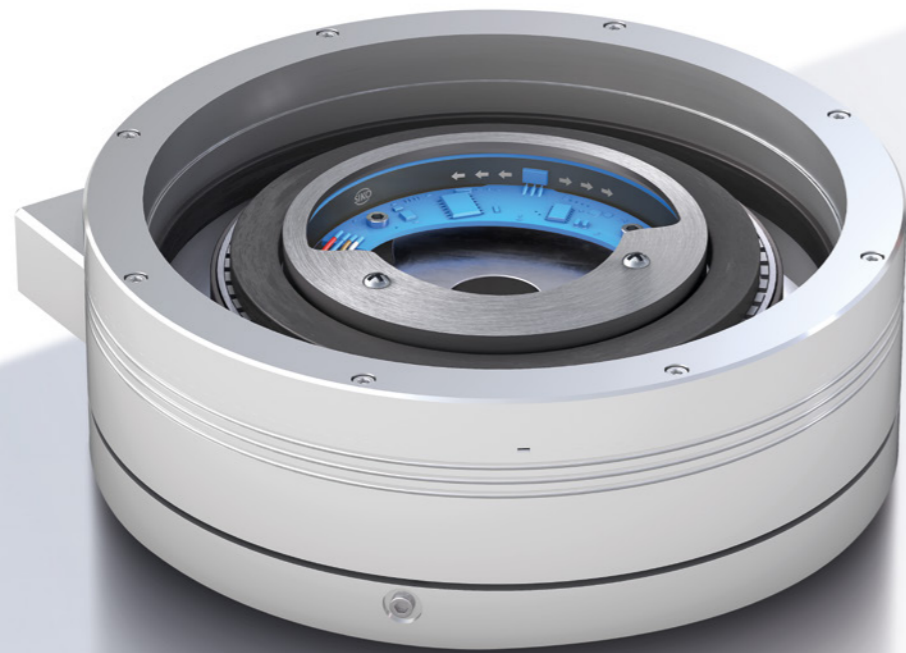
\* Customer-supplied downstream electronics

# Products

## ROTATIVE ENCODER SOLUTIONS

### PRECISE & DURABLE

The magnetic encoder solutions are the ideal alternative to conventional optical rotary encoder systems, especially when it comes to **exact rotational speed or angle measurement under demanding application conditions.**



Play film

SIKO MagLine –  
Sensors for linear and  
rotary motor feedback

#### Features

- High positioning accuracy and resolution
- flexCoder technology – flexible ring diameters and customer-specific designs
- Measurement under difficult environmental conditions
- Wear and maintenance free: insensitive to dirt, moisture or condensation

#### Advantages

- High operational reliability
- Long service life
- Flexible, customized ring solutions

#### Specifications

- Linearity deviation:  $\pm 0.05^\circ$
- Repeatability:  $\pm 1$  increment
- Encoder ring spacing: up to 2 mm

#### Combinations

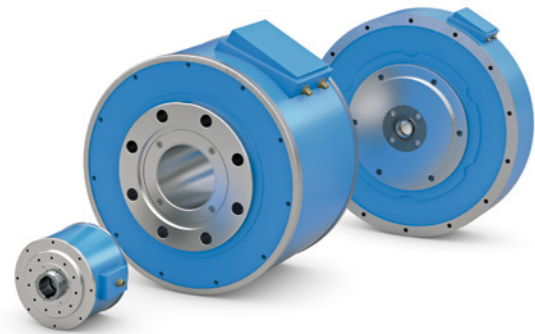
Measurement method	Scale	Magnetic encoder	Interface	Downstream electronics
incremental	MBR200, MR200 	MSK200/1 	digital 	PLC, counter*
	MR320, MBR320, MRI01 	MSK320 	digital 	PLC, counter*
	MBR500, MR500 	MSC500, MSK5000 	digital 	PLC, counter*
quasi-absolute	MBR500, MR500 	ASA510H 	SSI, analogue, digital 	Regulator/Controller*
real-absolute	MRAC501 	MSAC501 	SSI, digital 	Regulator/Controller*
	MRAC506 	MSAC506 	SSI, analogue 	Regulator/Controller*
	MRAC200 	MSAC200 flexcoder 	SSI, BISS, analogue, digital 	Regulator/Controller*

\* Customer-supplied downstream electronics

# Solutions

## MAGNETIC MEASUREMENT TECHNOLOGY IN A VARIETY OF APPLICATIONS

SIKO encoders have been used for decades in the field of **motor feedback on linear and torque motors.**



SIKO MagLine –  
Sensors for linear and  
rotary motor feedback



Play film



The flyer "Motor &  
Position Feedback"  
can be found at  
[www.siko-global.com](http://www.siko-global.com)

- Real-time detection of motor feedback on linear motors
- Ensuring high control quality in dynamic processes
- Integration of open PCB solutions in small installation spaces and compact drive solutions
- Speed and angle measurement in robotics
- Speed and angle measurement even under extreme conditions (e.g., in an oil bath)

Building on our **many years of experience**, we provide our customers from the fields of **medical, analytical and laboratory technology** precise length, angle and speed measurement technology.

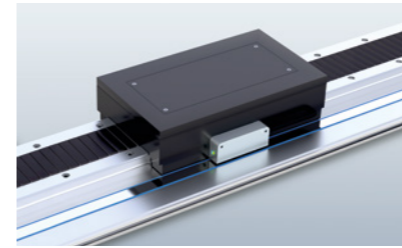


The flyer "Medical & Laboratory  
Technology" can be found  
at [www.siko-global.com](http://www.siko-global.com)

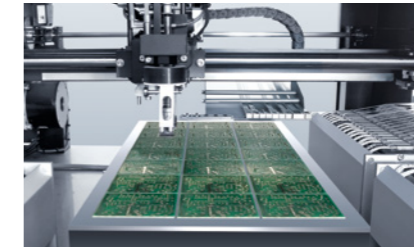
- Tomographs and X-ray equipment
- Operation tables and patient tables
- Laboratory and analytical technology
- Robotics
- Rehabilitation machines

### HIGH-PRECISION ENCODER SOLUTIONS

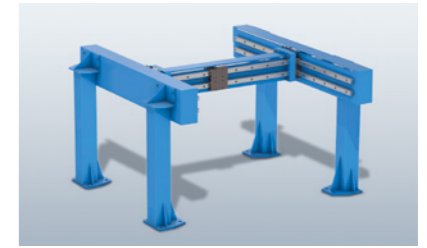
Even under particularly difficult environmental conditions, high-precision measurement and position detection can be reliably implemented.



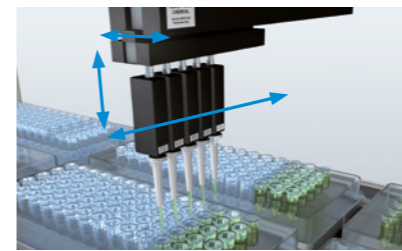
Incremental and absolute position feedback for a wide range of designs of linear motors



Application in the printed circuit board industry



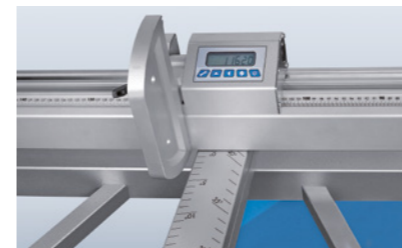
Synchronization of the feed motors for gantry drives with a separate measuring system



Position feedback in pipetting systems (laboratory and analytical technology)

### FLEXIBLE ENCODER SOLUTIONS

MagLine successful in use – display, magnetic encoder measuring band fit perfectly into the application.



Magnetic measurement technology as a customer-specific solution in a format circular saw



Accurate speed measurement even in demanding applications



Direct display of the measured values on a vertical panel saw

**ROBUST**  
**ENCODER SOLUTIONS**

The systems provide reading distances of up to 20 mm and accuracy data that are also adapted to particularly long detection distances.



Monitoring of height and length adjustments even under harsh environmental conditions



MagLine encoder used in warehouse and conveyor technology

**ROTATIVE**  
**ENCODER SOLUTIONS**

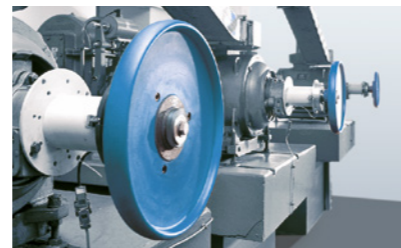
Extremely robust and designed for direct angle and speed detection – the applications of rotary encoder solutions benefit from the non-contact, magnetic measuring method.



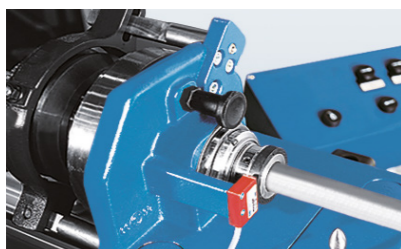
Combination of encoder and bearingless magnetic ring



High-precision angle and position measurement in robotics and automation technology



Speed measurement in applications with high requirements for shock and vibration



Easy integration of the measuring system for mechanical and plant engineering



Speed and position monitoring of tire balancing systems

# Further Information

## TECHNICAL BASICS

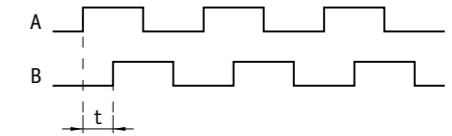
### BACKGROUND INFORMATION

**Context: resolution to pulse interval**

You can select the parameters resolution and pulse interval for encoders of the MSK series. The interfaces of these encoders supply digital output signals (counting pulses), which can be further processed in a higher-level controller with counter input.

**Definition: Pulse interval**

The pulse interval,  $t'$  is the shortest time between two edges, which can occur during the movement of the encoder. Possible triggers can also be micro-vibrations, for example.



**The calculation formulas**

Resolution and pulse interval must be adjusted to the maximum possible counting frequency of the controller. With the **maximum travel speed** specified by the system, the **counting frequency** of the downstream electronics can be determined using the formulas on the right.

**1 Determine pulse interval:** The next smaller, parametrizable value is selected, in this case **1 μs**.

**2 Determine the counting frequency of the downstream electronics:** The downstream electronics must be able to detect a frequency of **250 kHz** at the input.

$$\text{Pulse interval} = \frac{\text{Resolution}}{\text{Max. travel speed}} \times 0.8$$

$$\text{Counting frequency} = \frac{1}{\text{Pulse interval} \times 4}$$

**1**

$$\text{Pulse interval} = \frac{0.025 \text{ mm}}{15 \text{ m/s}} \times 0.8 = 1.33 \mu\text{s}$$

**2**

$$\text{Counting frequency} = \frac{1}{1 \mu\text{s} \times 4} = 250 \text{ kHz}$$

**Calculation example**

A measurement distance is to be calculated with a resolution of 0,025 mm. The travel speed is a maximum of 15 m/s. The pulse interval and counting frequency must be determined.

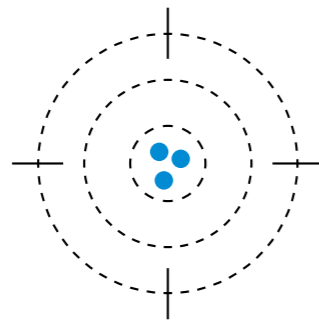
For this example, the values in the following table are highlighted in blue. The data sheets of all encoders contain specific tables, so that no manual calculation is necessary.

**Example table MSK5000**

Resolution [mm]	Travel speed Vmax [m/s]								
	0.01	0.03	0.05	0.10	0.20	0.32	0.80	1.60	4.00
0.001	0.01	0.03	0.05	0.10	0.20	0.32	0.80	1.60	4.00
0.005	0.06	0.13	0.25	0.50	1.00	1.60	4.00	8.00	20.00
0.010	0.12	0.25	0.50	1.00	2.00	3.20	8.00	16.00	25.00
0.025	0.30	0.63	1.25	2.50	5.00	8.00	20.00	25.00	25.00
0.050	0.61	1.25	2.50	5.00	10.00	16.00	25.00	25.00	25.00
0.100	1.211	2.50	5.00	10.00	20.00	25.00	25.00	25.00	25.00
<b>Pulse interval [μs]</b>	66.00	32.00	16.00	8.00	4.00	2.50	1.00	0.50	0.20
<b>Counting frequency [kHz]</b>	3.79	7.81	15.63	31.25	62.50	100.00	250.00	500.00	1250.00

Repeatability

The deviation, which is measured by repeatedly approaching a position, is called repetition accuracy. If the position is approached unilaterally, it is referred to as "unidirectional" and if it is approached from both directions, it is referred to as "bi-directional". SIKO repeatability is given as a unidirectional value in the data sheet for each encoder.



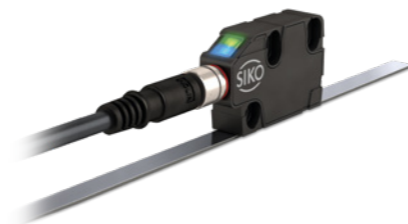
Example: ±1 µm at MSK1000

Linearity deviation

The maximum deviation of a measurement characteristic curve, based on its reference point, is the linearity deviation. This refers to any meter within

the measurement length: The linearity deviation **X of the encoder** is the result of an accuracy measurement over several magnetic poles.

Magnetic encoder	Pole length	Temperature	Linearity deviation
MSK1000	1 mm	20 °C	±2 µm
LEC160	1.6 mm	20 °C	±3 µm
MSK200/1	2 mm	20 °C	±5 µm
MSK320	3.2 mm	20 °C	±30 µm
MSK5000, MSC500	5 mm	20 °C	±20 µm
MSA213C	2 mm	20 °C	±10 µm



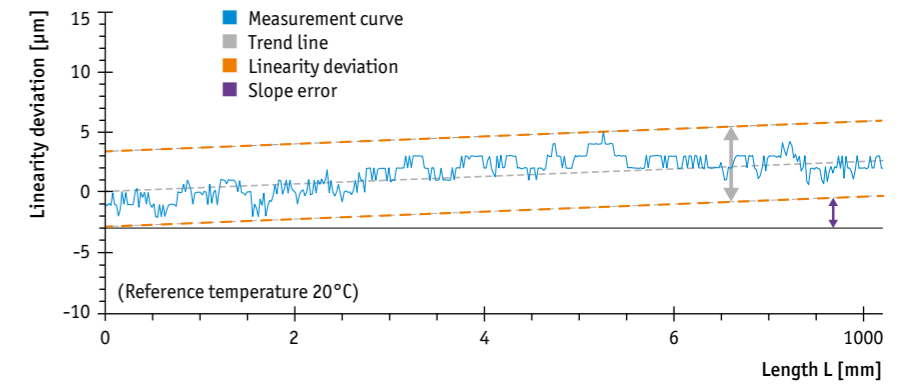
The result of the accuracy measurements of the magnetic band taking into account the regression line with

respect to 1 m results in the linearity deviation **R of the magnetic band**. This is specified without slope error.

Magnetic band	Pole length	Temperature	Linearity deviation
MB100/1	1 mm	20 °C	±8 µm / ±20 µm
MB160	1.6 mm	20 °C	±15 µm / ±25 µm
MB200/1	2 mm	20 °C	±20 µm
MB320/1	3.2 mm	20 °C	±50 µm
MB500/1	5 mm	20 °C	±35 µm / ±50 µm
MBA213	2 mm	20 °C	±30 µm



Example: Measurement curve linearity deviation (symbolic)



Calculation of the linearity deviation Z



**X**  
Linearity deviation of the encoder (6-pole measurement)



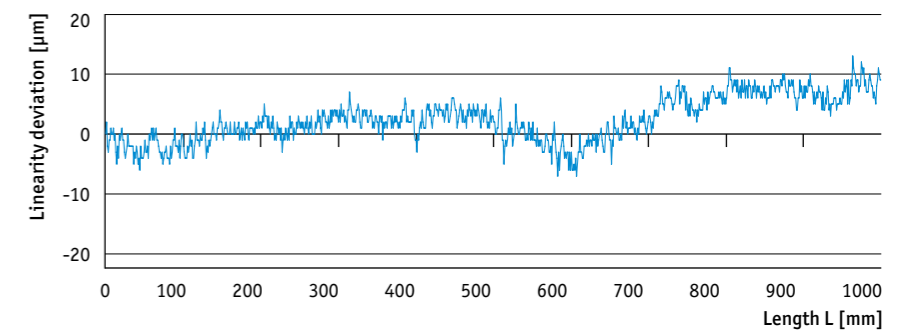
**R**  
Linearity deviation of the magnetic band (over one meter)

$Z = X + R$   
 $Z = \pm 2 \mu\text{m} + \pm 8 \mu\text{m} = \pm 10 \mu\text{m}$

Example: Encoder MSK1000 and magnetic band MB100/1

Measurement curve

- MSK1000 ±2 µm
- MB100/1 ±8 µm



Overall Accuracy

For the overall accuracy G over the entire measurement length L of the application, the slope error S must also be taken into account.

$S = (L - 1 \text{ m}) * s$

- Pole lengths 1 mm and 1.6 mm with high accuracy:  $s = \pm 1 \mu\text{m}/\text{m}$
- All pole lengths and standard accuracy:  $s = \pm 10 \mu\text{m}/\text{m}$

Calculation of total accuracy G:

$G = Z + S$   
 $G = \pm 10 \mu\text{m} + 4.5 \text{ m} * \pm 1 \mu\text{m}/\text{m} = \pm 14.5 \mu\text{m}$

Explanation: Total measurement length 5.5 m with components from example above (linearity deviation Z over 1 m and additional slope error S over 4.5 m).

Influence of temperature on linearity deviation

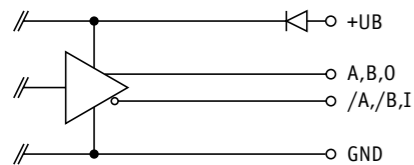
The change in ambient temperature affects the relative change in length of the magnetic band, which is glued to a steel band at 11 µm/m/K.

**SPECIFICATION**  
**OF OUTPUT SIGNALS**  
**OF ENCODERS**

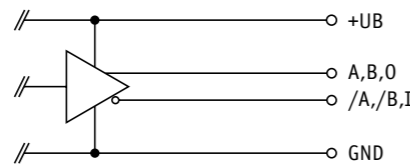
**Encoder with digital signal output**

Rectangular design			
Output circuitry	PP (Push-Pull)	LD (Line-Driver)	TTL
Output signals	A, B, I Reverse-polarity protected	A, B, I inverted	A, B
Terminating resistor	—	120 Ohm	—
Operating voltage	24 V	5 V und 24 V	5 V and 24 V
Output signal level high	>UB - 2.5 V	RS422 spec.	>2.4 V
Output signal level low	<0.8 V	RS422 spec.	<0.4 V
I <sub>max</sub> (each channel)	<25 mA	RS422 spec.	<5 mA

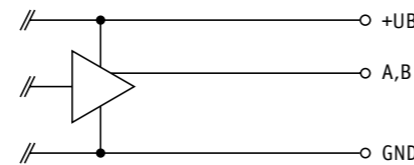
**PP (Push-Pull), inverted**



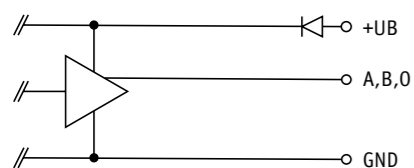
**LD (5 V), inverted**



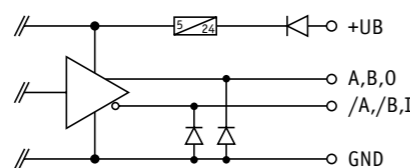
**TTL (5 V), not inverted**



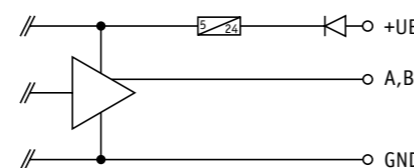
**PP (Push-Pull), not inverted**



**LD (24 V), inverted**



**TTL (24 V), not inverted**



**Encoder with analog 1 V<sub>ss</sub> signal output**

Signal differential 1 V <sub>ss</sub> ±10 %		
Operating voltage	5 V	24 V
Reference voltage	UB/2 ±200 mV	2.5 V ±200 mV
Temperature	at 20 °C	at 20 °C

**SPECIFICATION**  
**OF MAGNETIC TAPES**

**Technical Specifications**

Mechanical data		
Dimensions	See data sheets	MB100/1, MB200/1, MB320/1, MB400, MB500/1, MB2000, MB4000, MBA111, MBA213, MBA501
Bending radius	>50 mm	
Delivery length	≤100 m	On request

Band materials		
Carrier band	Spring steel	
	VA (stainless steel band)	
Magnetic material	Plastic-bonded ferrite	
Masking band	Stainless steel	

Ambient conditions	
Recommended working temperature:	-40... +100°C
Storage temperature	-40... +100°C

Resistance to chemicals, dirt and liquids (qualitative classification)		
high	average	low (can be increased by additional protection)
Water, water vapor	Acetone	Xylene, toluene
Formic acid	Stearic acid 70° C, anhydrous	Trichloroethylene
Formaldehyde, 40%	Oleic acid	Tetrahydrofuran
Glycerin 98° C	Isopropyl ether	Carbon tetrachloride
n-Hexane	Acetic acid	Turpentine
Iso-octane	Gas	Nitric acid
Lactic acid	Kerosene	Nitrobenzene
Mineral oil	Ammonia	Paint solvent
Linseed oil	Acetylene	Benzole
Cottonseed oil	Sea water	Aromatic hydrocarbons
Vegetable oil		Ketone
Wood dust, chips		Inorganic acids (HCL, H2SO4)
Rock meal		Drilling emulsions
Metal dust, shavings		

Field strength	
MB100/1	30 kA/m
MB200/1	28 kA/m
MB320/1	40 kA/m
MB400	38 kA/m
MB500/1	36 kA/m

Accuracy data		
Magnetic band	Linearity deviation	
MB100/1	±8 µm / ±20 µm	
MB160	±15 µm / ±25 µm	
MB200/1	±20 µm	
MB320/1	±50 µm	
MB400	±50 µm	
MB500/1	±35 µm / ±50 µm	
MB2000	±1 mm	
MB4000	±1 mm	
MBA111	±10 µm	
MBA213	±30 µm	
	<b>Coefficients of expansion</b>	
	Spring steel	11 µm/K
	VA-carrier	16 µm/K

#### Photo Credits

Page 1, 2 Earth (modified)  
© OxfordSquare – istockphoto.com  
Page 5 Row 1 Center (modified)  
© upthebanner – istockphoto.com  
Row 2 left (modified)  
© fotoVoyager – istockphoto.com  
Row 2 Center (modified)  
© VogelSP – istockphoto.com  
Row 2 right (modified)  
© fazon1 – istockphoto.com  
Row 3 left (modified)  
© intek1 – istockphoto.com

Page 18 Logistics center (modified)  
© Chesky\_W – istockphoto.com  
Page 22 CT scan machine (modified)  
© luismmolina – istockphoto.com  
Page 23 Row 1 Center (modified)  
© thiel\_andrzej – istockphoto.com  
Row 3 left (modified)  
© FELDER KG, Österreich  
Row 3 Center (modified)  
© danishkhan – istockphoto.com  
Page 24 Row 1 left (modified)  
© Dushlik – istockphoto.com

Page 24 Row 1 right (modified)  
© Baloncici – istockphoto.com  
Row 3 left (modified)  
© JUTEC Biegesysteme GmbH & Co. KG  
Row 3 right (modified)  
© sergeyryzhov – istockphoto.com  
Page 31 Row 1 right (modified)  
© Halfpoint – istockphoto.com

## Service

### SALES & PERSONAL ADVICE

### SERVICE & SOLUTION CENTER – TRAINING,

### INSTALLATION & AFTER SALES

#### Sales / Personal Contact

Our inhouse sales department as well as our employees and sales partners in the field are at your disposal for your inquiries.

**+49 7661 394-0**  
**reception.de@siko-global.com**



#### Service & Solution Center

Do you have questions about the integration of our products or do you need help with commissioning? Our Service & Solution Center will be happy to assist you with your automation tasks.

**+49 7661 394-444**  
**support.de@siko-global.com**



#### Website with download area

PDF files and program routines for our programmable devices are available on the SIKO homepage.

You can find them at **www.siko-global.com:**

- Specifications sheets
- Catalogs
- Manuals
- User information
- Integration Files
- 3D design files
- Product films
- Distributor directory
- Programming software

#### 3D-models for mechanical engineering

We provide designers with dimensionally accurate, reduced 3D data in detail. This enables the configuration of features that affect the appearance of the respective SIKO device. After logging in via our product pages on the internet, this service is available online around the clock at: **www.siko-global.com.**

#### The advantages are:

- Native and neutral data formats, suitable for your CAD system
- Preview function and direct download

- Full text search
- 24 h access to product catalog
- Wide range of display options
- Complimentary service

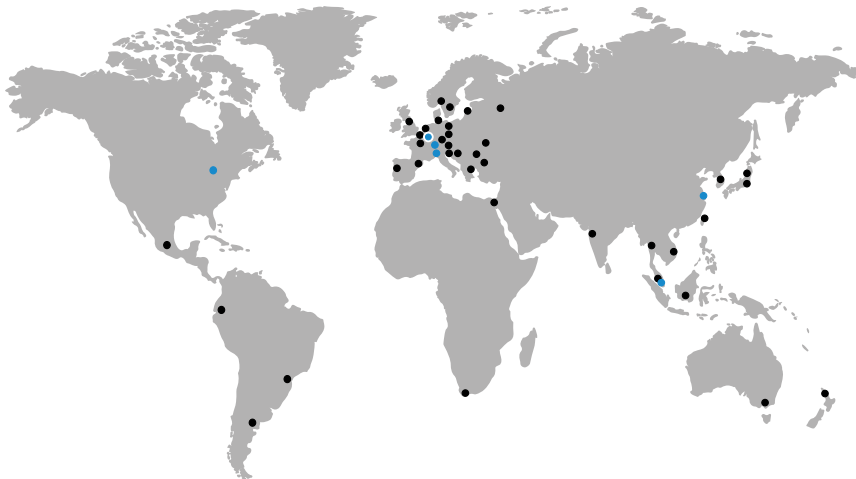




We are available for you.

**Regardless of whether it is locally ...**  
Are you looking for a representative in your area? Our website will help you. At [www.siko-global.com](http://www.siko-global.com) you can find current contact details of a German SIKO representative in your area via your zip code. Or give us a call, we will be happy to provide you with the appropriate contact details.

**... or internationally.**  
SIKO is represented worldwide by subsidiaries and commercial agencies. You can find a SIKO partner in your area at [www.siko-global.com](http://www.siko-global.com).



### SIKO Global



**SIKO GmbH**



**SIKO Products Inc.**



**SIKO Italia S.r.l.**



**SIKO MagLine AG**



**SIKO International Trading (Shanghai) Co., Ltd.**



**SIKO Products Asia Pte. Ltd.**

**SIKO GmbH**

Weiherrmattenweg 2  
79256 Buchenbach

Am Krozinger Weg 2  
79189 Bad Krozingen

**Phone** +49 7661 394-0  
**Fax** +49 7661 394-388  
**E-Mail** [info@siko-global.com](mailto:info@siko-global.com)

[www.siko-global.com](http://www.siko-global.com)

Follow "SIKO-global" and stay up to date!

