METIRIO

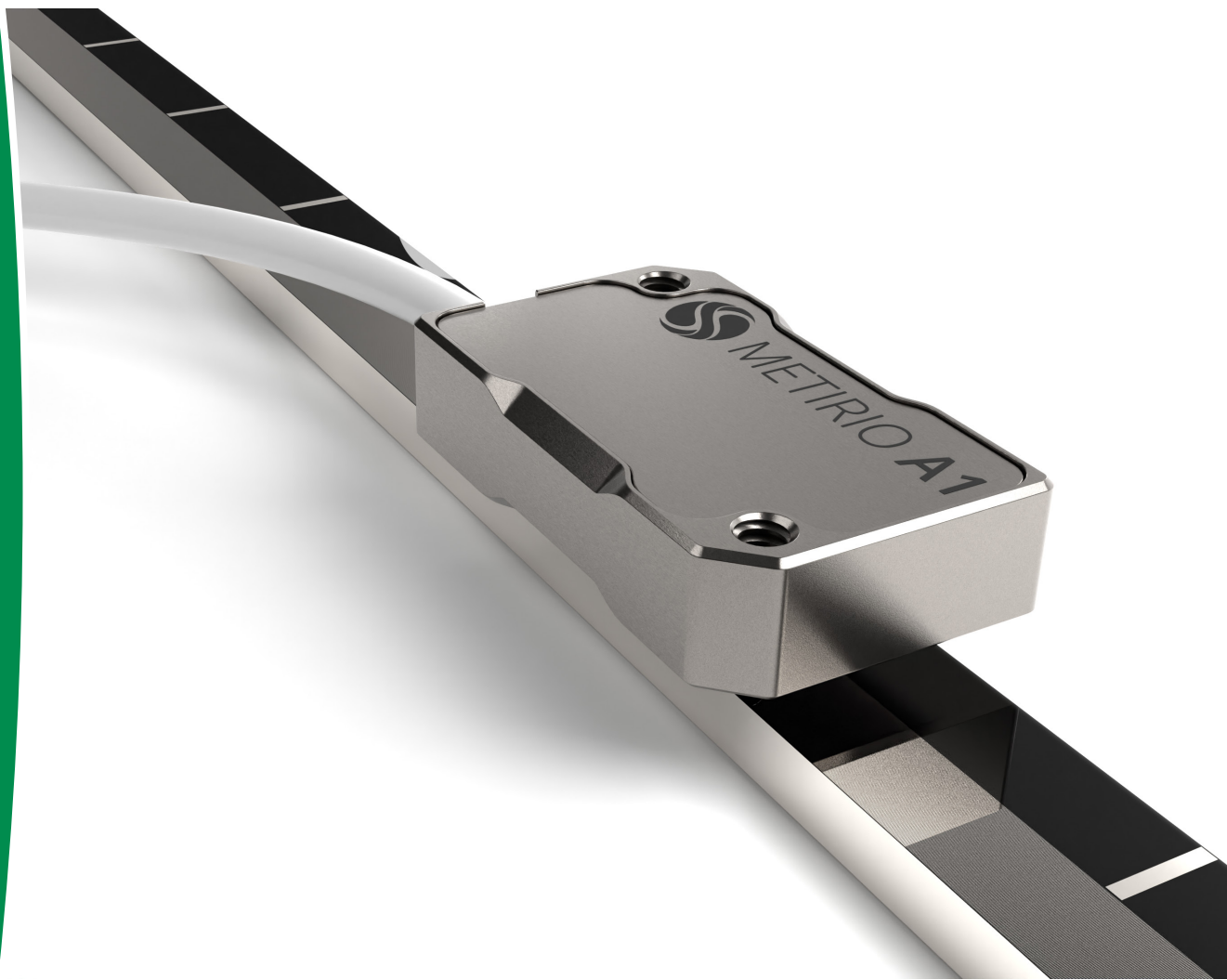## Optical Encoder

Metirio Optical Encoder Series

SmarAct has developed a new optical encoder for closed-loop positioning with sub-nanometer resolution and extremely compact size. Thanks to the modular housing concept, the encoder can be tailored to customer requirements. Metirio is available as OEM component or as stand-alone optical encoder with diverse mounting options and various scales. Due to its low outgassing materials, low power consumption and high operating temperature range, Metirio encoders are suitable for various environments and applications.

Metirio is the most versatile encoder in its class.

Key Benefits
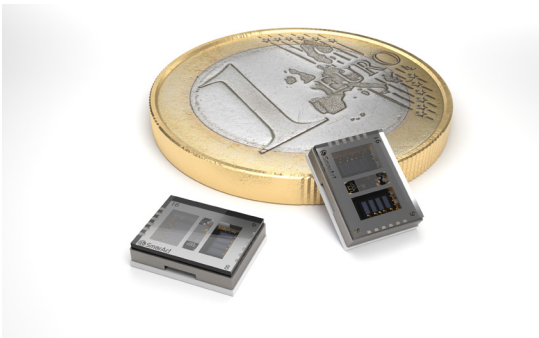
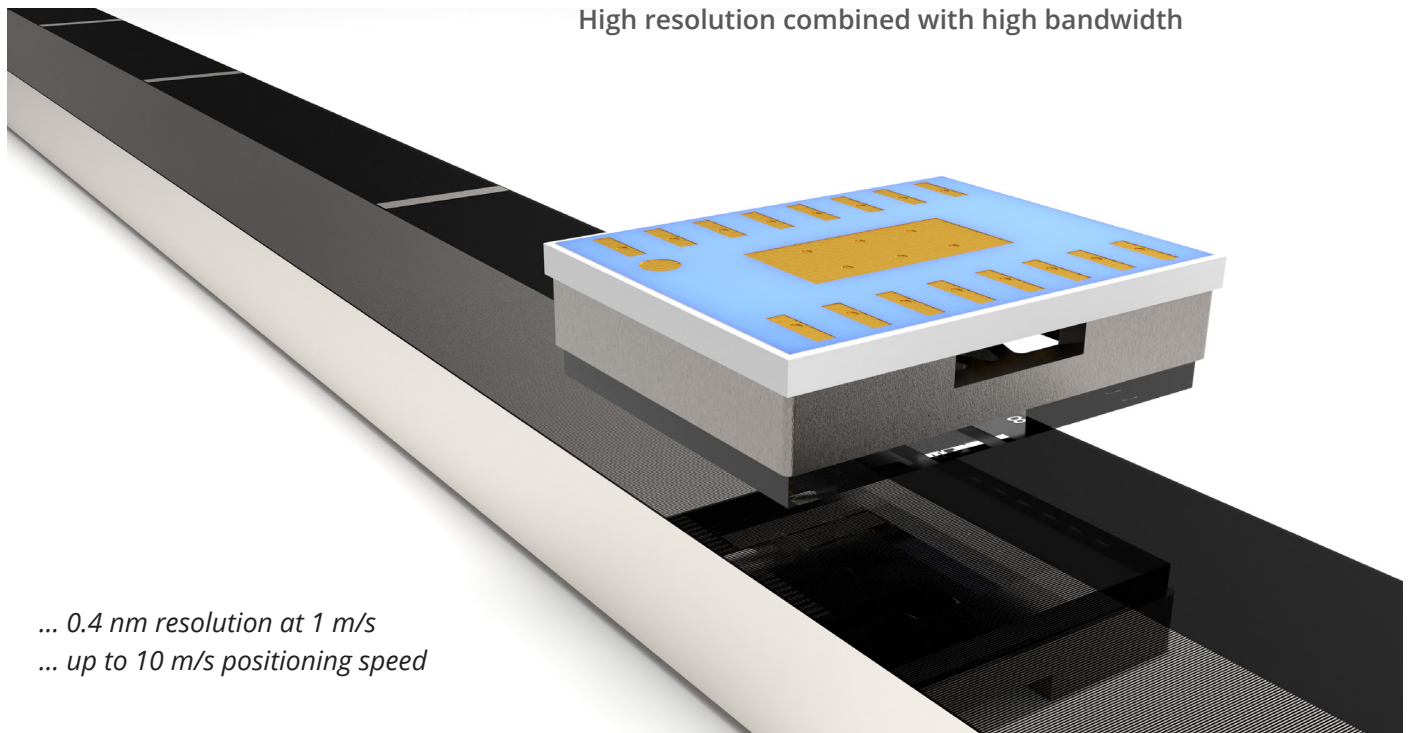### Tiny size
The compact design is based on grating imaging and does not require any imaging optics. The size of the OEM read head is only 6.6 x 5.1 x 1.7 mm³.

Cost-efficient
The advanced chip-design and the Metirio read head package concept allows for effective manufacturing.

High resolution combined with high bandwidth

... 0.4 nm resolution at 1 m/s
... up to 10 m/s positioning speed

Various environments

- Operating temperature range from 0 °C to 80 °C
- 160 °C baking possible
- Low outgassing ultra-high vacuum compatible
- Non-magnetic materials
- IR center wavelength for scientific environments
- Rough environments with mechanical vibrations
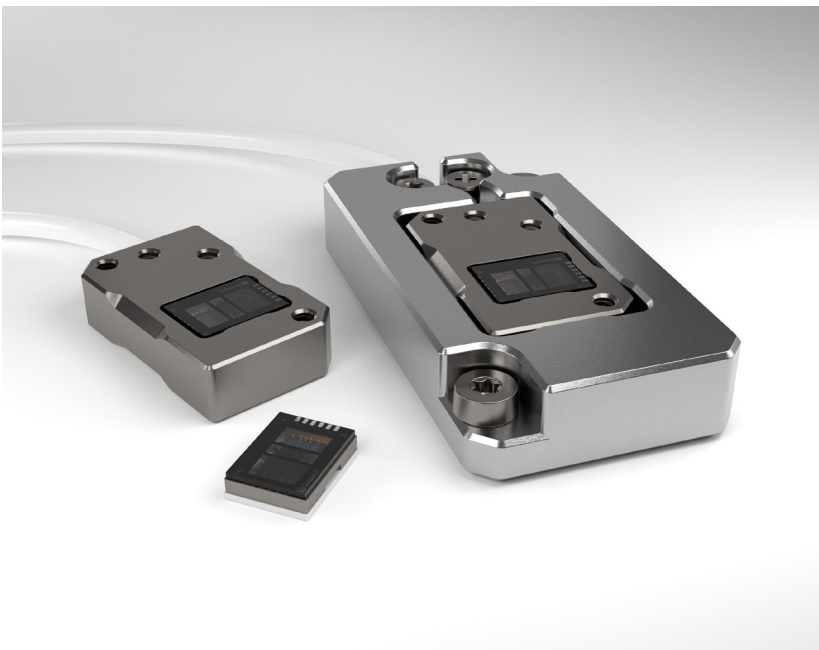- Low power consumption and low heat dissipation
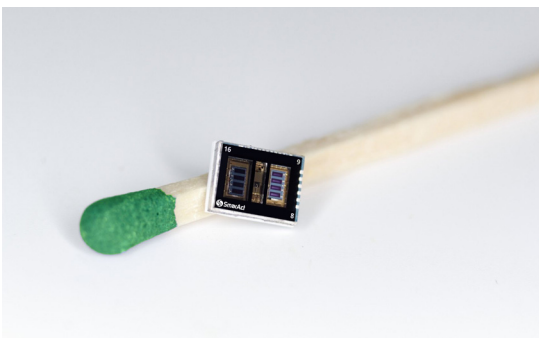
One encoder for many scales
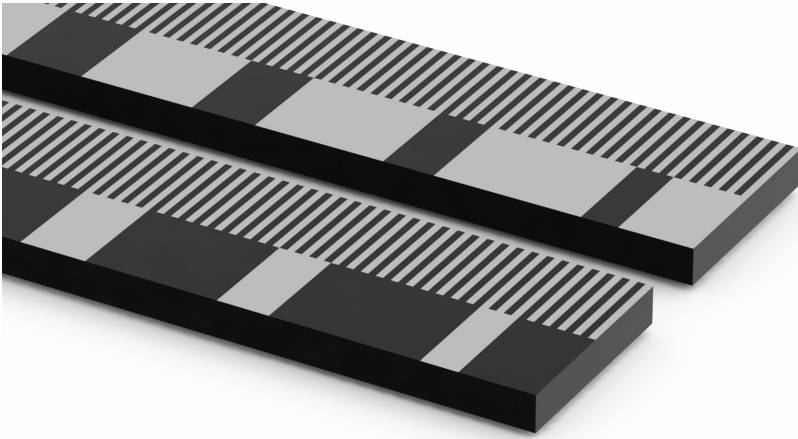
- Linear, rotary and goniometer scale compatibility
- Scale Pitch 20 µm
- High precision incremental track
- Distance Coded reference marks for absolute position
- Reflective and absorbing reference marks

Modular Concept for Metirio Products

The Metirio product portfolio is consistently modular. Core product is the Metirio Read-Head, which can be used on its own, e.g. by OEM customers.

If requested, the read head can be purchased with additional functions and housings, so that a wide range of customer requirements can be met.

The choice between Metirio Read Head and other modular housing variants opens up a wide range of installation options for Metirio encoders:

- Direct soldering
- Soldering on PCB
- Mounting via screws
- Adhesive mounting

Additional Features
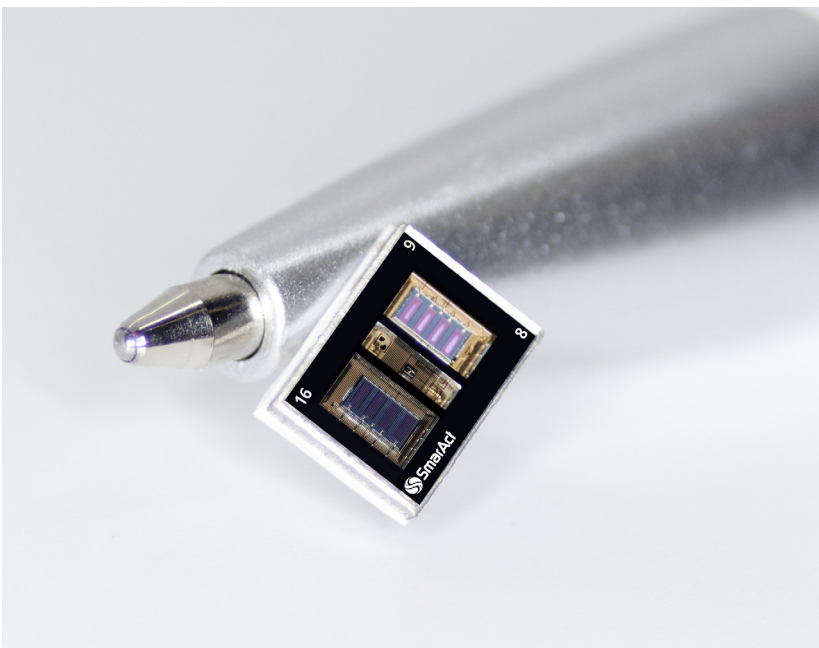
- Three different working distances
- Variable Power Supply 3.3 V or 5 V
- Power saving for low heat dissipation
- GPI / GPO pins available
- Digital interface modules with BiSS or ABZ interface on request
- Evaluation-Kit available for quick and easy installation, diagnostics and adjustment

Metirio Working Principle

Pin 1

Incremental Track
Reference Track

Direction of relative movement
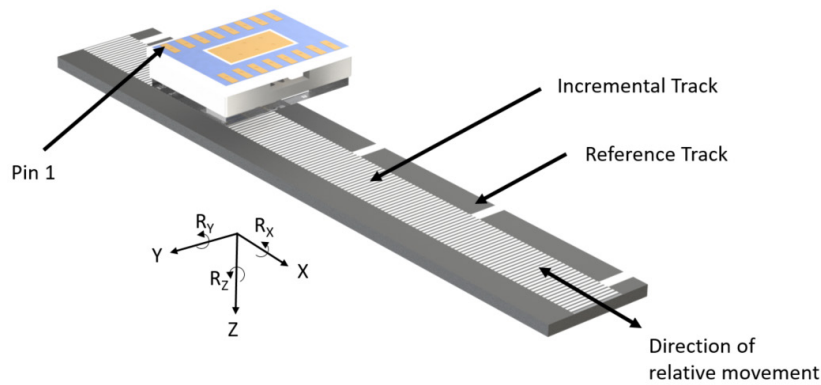
The integrated light source illuminates a scale comprising an incremental grating with 20 μm pitch and a track with reference marks for absolute positioning. The reflected light generates an interference pattern which is detected by the diode array within the read head. A relative movement between the scale and the read head leads to analog sine and cosine signals as well as a TTL-shaped reference mark.

Typical Encoder Output Signals

- Sine
- Cosine
- Reference

$$\frac{x}{20 \text{ μm}} = \frac{\varphi}{2\pi}$$
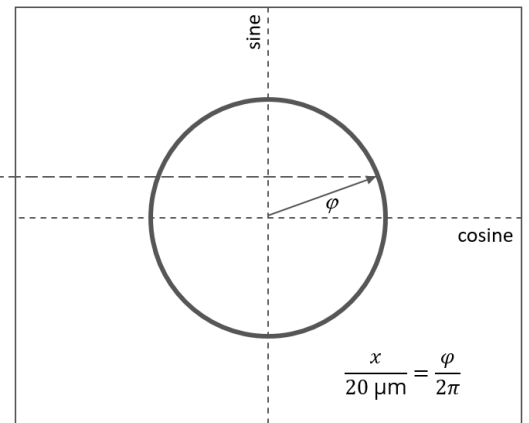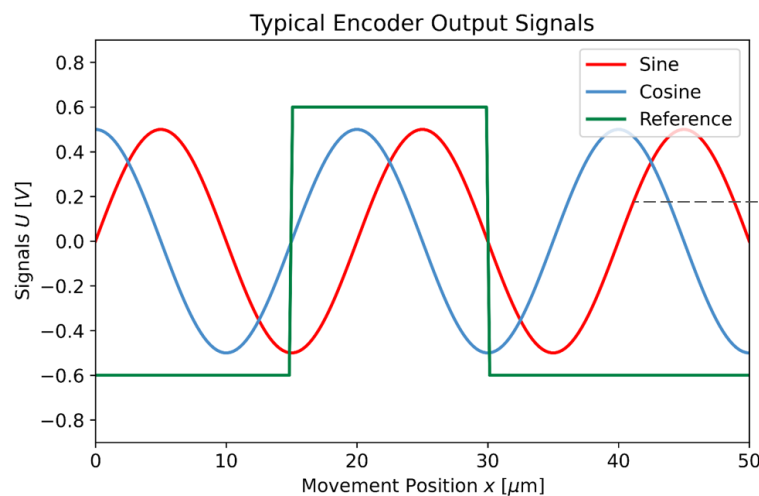
Metirio Encoder Variants

Metirio Basic Read Head

Tiny Size: 6.4 x 5.1 x 1.7 mm³

Metirio A1

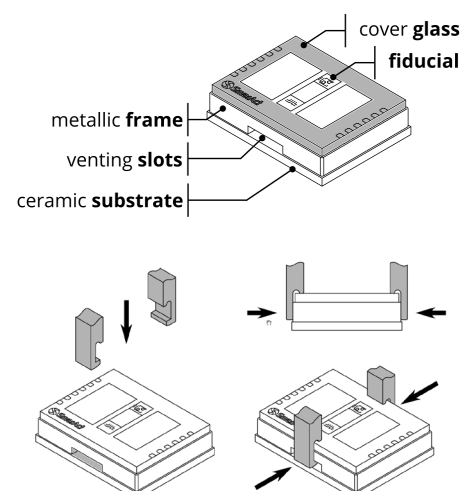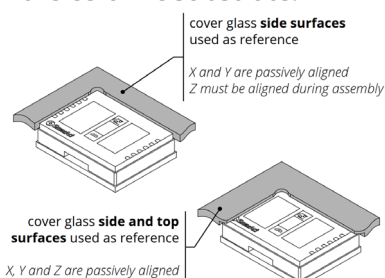Size: 17 x 10 x 4 mm³

Customized Mounting Options

Variable Size

Metirio Read Head

The heart of the Metirio encoder product line is the basic Metirio read head. All optoelectronic parts are fully integrated in this SON like package. Venting slots guarantee a quick evacuation in vacuum and can be used for gripping. Direct soldering onto a circuit board is also possible, since all connecting PINs are on the bottom side of the ceramic substrate.

The Metirio read head can be mounted via various ways to any mechanical housing. This gives high freedom to operate the Metirio encoder. For optomechanical alignment, either the glass surface or the metal frame can be used.

cover **glass**
fiducial
metallic **frame**
venting **slots**
ceramic **substrate**

cover glass **side surfaces** used as reference

X and Y are passively aligned
Z must be aligned during assembly

cover glass **side and top surfaces** used as reference

X, Y and Z are passively aligned

Metirio A1 – A ready to use housing option

Metirio A1 is the ready to use option with mounting threads, cable and plug. Signal adjustment is quickly done with the Encoder-Evaluation-Kit. All settings can be permanently stored to the internal memory.

After optomechanical alignment the Metirio A1 can be directly connected to a motion controller and used as intended.
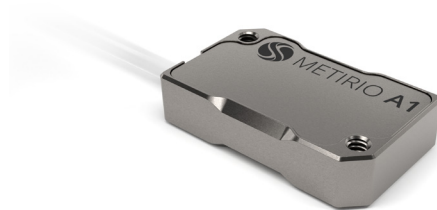
Metirio Customization

Special adaptations, such as hole patterns and threads, and other housing shapes for Metirio can be implemented without further ado. If customers use a mechanical interface that should not or cannot be adapted, we or the customer can integrate the Metirio sensor into a compatible housing. Please do not hesitate to contact us with any requests or questions.

Optomechanical Alignment

The Metirio encoder has comparatively large alignment tolerances, which makes integration quite easy. The encoder is mounted to the fixed or moveable part of your motion system and the scale to the opposite side. The scale can be attached with adhesive and comprises two tracks for position measurement. One track for high-resolution incremental signals and the other track for reference mark detection.

For fixing the Metirio A1 it is possible to use M1.6 mounting threads.
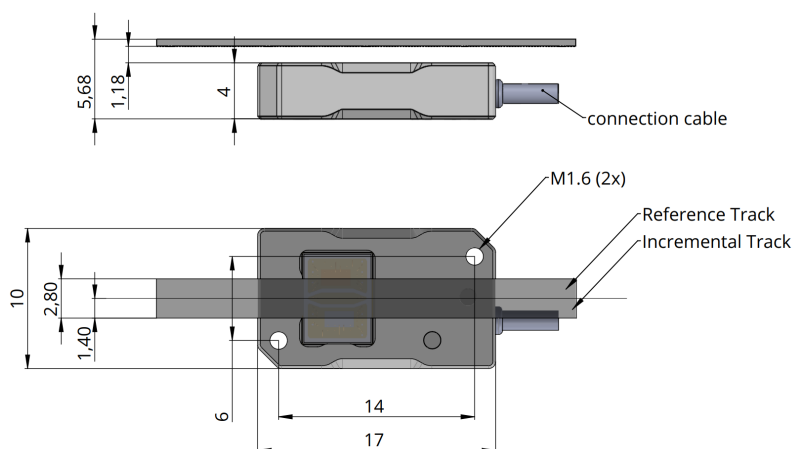
Regardless of the chosen housing option, the installation position and tolerances are given with respect to the optical read head. The Metirio encoder has comparatively large alignment tolerances.
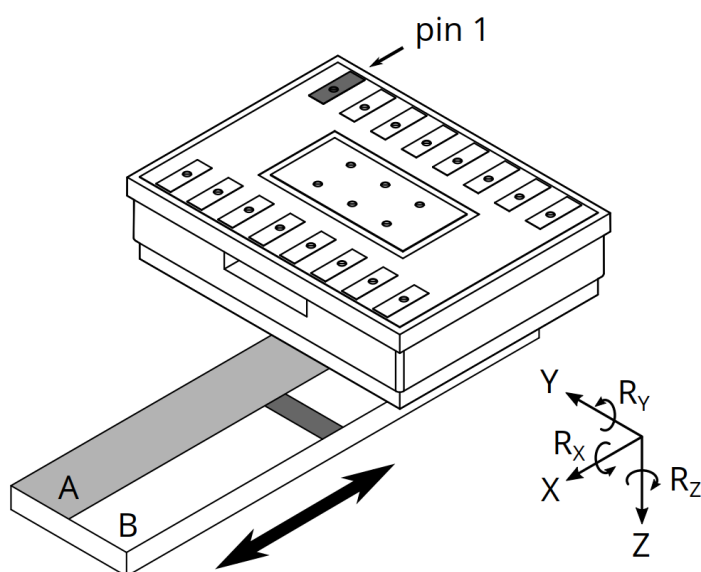
Three working distances:
- 0.4 ± 0.15 mm (minimum distance for compact requirements)
- 1.2 ± 0.15 mm (recommended optimum working distance)
- 2.1 ± 0.15 mm (maximum distance)

Optimum Mounting Position

Axis	Nominal Position	Alignment Tolerance
X	direction of motion	
Y	0 mm	± 0.50 mm
Z	1.2 mm	± 0.15 mm
Roll R_X	0 °	± 1.10 °
Pitch R_Y	0 °	± 2.50 °
Yaw R_Z	0 °	± 0.85 °
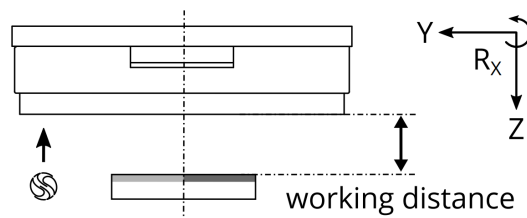
Metirio Working Principle

Metirio is your versatile solution for linear, rotary and goniometer stages.

Encoders of the Metirio family are compatible with a broad variety of reflective scales. As long as the pitch equals 20 µm, the scales can be linear, circular or curved to convex shape. One read head can be used for all types of scales. SmarAct Metrology offers a variety of different scales:

Linear	Rotary	Goniometer
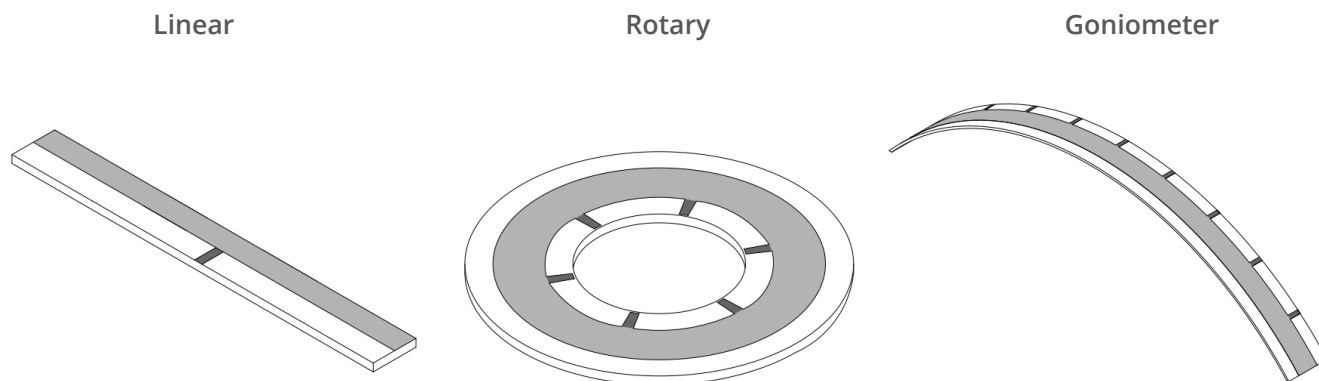
Glass with reflective chrome coating is the best suitable material for Metirio encoder measuring scales. Each scale comprises an incremental track with high accuracy and an additional track carrying reference marks. Due to its diversity, Metirio will also work with different materials and with custom scale geometries tailored to your special application.

| Standard Scales	Material	Reference Marks
10 x 3 x 0.5 mm³	black glass	single
50 x 3 x 0.5 mm³	black glass	single
100 x 3 x 0.5 mm³	black glass	single
200 x 6 x 2 mm³	soda lime glass	distance coded
500 x 6 x 2 mm³	soda lime glass	distance coded
1000 x 6 x 2 mm³	soda lime glass	distance coded

Available on request:

- Lengths up to 2 m
- Tailored dimensions (such as length, width, thickness, diameter)
- Flexible curved material
- Different substrate material
- Special reference mark codes

Available Rotary Scale Diameters

Optical Diameter d_{OC}	CPR: Counts per Revolution
13.0 mm	2048
22.9 mm	3600
38,2 mm	6000
63.6 mm	10000
95.5 mm	15000
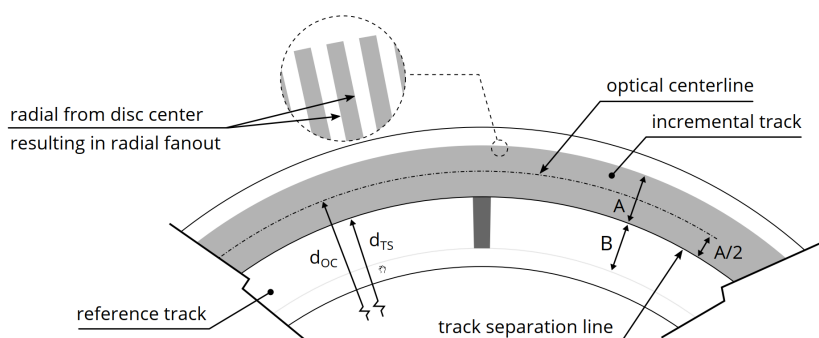
Following some simple scale design rules, the customer might even use Metirio with his own scale designs or already existing scales. Metirio is thus an easy replacement for established systems.
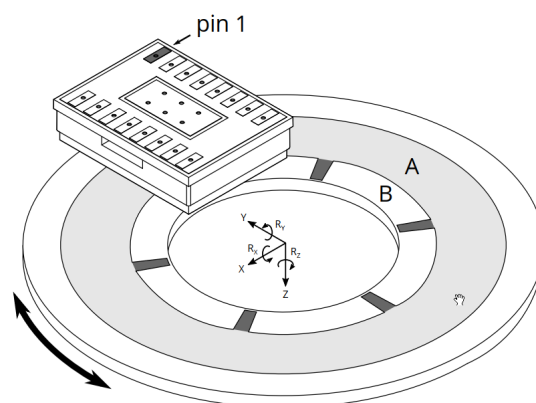
Starter Kit for easy configuration
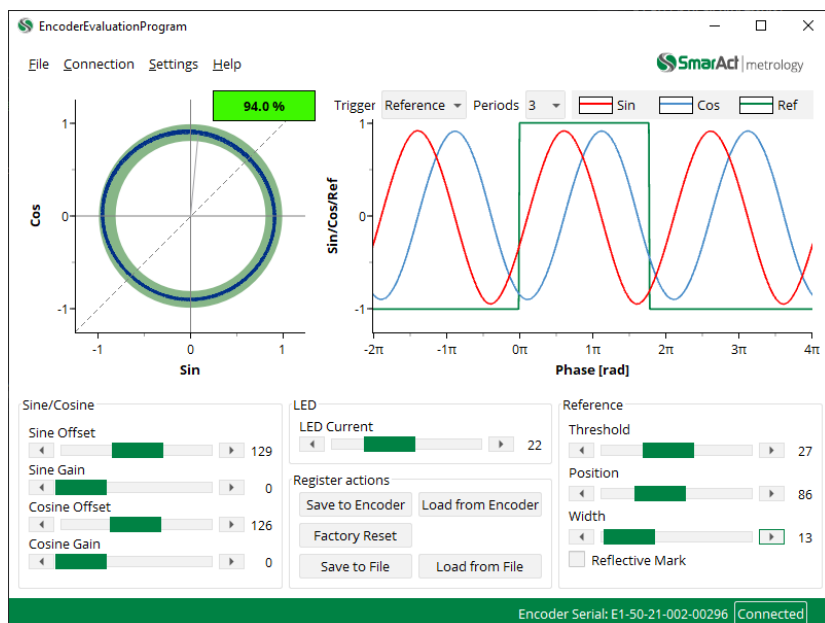
Encoder Evaluation Kit for easy step-by-step integration:

1. Mount the scale and the encoder to your motion system.
2. Connect the encoder to the evaluation module and simply adjust the raw signals with our software while moving your stage open-loop.
3. Store the setting permanently to the memory of the encoder.
4. Now you can connect the encoder to your motion controller and start the closed-loop movement.

SmarAct provides additional digital 14 bit interface modules for example with ABZ or BiSS-C interface.

Electrical Connections

Top View

Bottom View
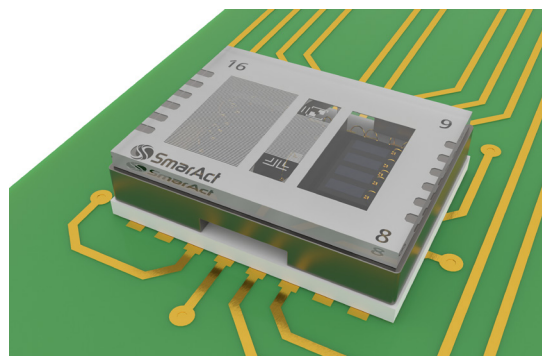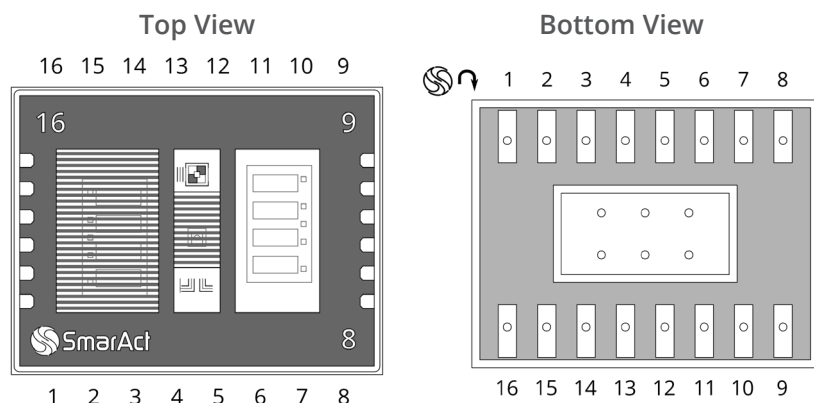
Pin Description							
01	02	03	04	05	06	07	08
U_{cos+} (out)	U_{cos-} (out)	U_{sin+} (out)	U_{sin-} (out)	V_{DD} (in)	U_{Ref+} (out)	U_{Ref-} (out)	GND
16	15	14	13	12	11	10	09
GND	d.n.c.	GPI (in)	GPO (out)	GND	PD (in)	SDA (i/o)	SCL (in)

A1 Connector (15-PIN D-SUB male)

The A1 version of the Metirio read head is delivered with a D-SUB 15 male connector providing differential analog signals and the I2C-Interface Pins. Additionally an Interpolation Module can be attached to the A1 plug. This module provides BiSS-C Interface and typical ABZ-signals.
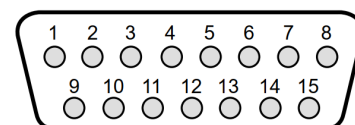
PIN	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Metirio A1	-	-	-	GND	U_{sin+}	U_{Cos+}	U_{Ref+}	PD	-	SCL	SDA	U_{Sin-}	U_{Cos-}	U_{Ref-}	U_{DD}
Out (BiSS-C)	-	FAULT	CALIB	GND	SLO+	SLI+	MA+	PD	-	SCL	SDA	SLO-	SLI-	MA-	U_{DD}
Out (ABZ)	-	FAULT	CALIB	GND	A+	B+	Z+	PD	-	SCL	SDA	A-	B-	Z-	U_{DD}

SmarAct Metrology GmbH & Co. KG develops sophisticated equipment to serve high accuracy positioning and metrology applications in research and industry within fields such as optics, semiconductors and life sciences. Our broad product portfolio – from miniaturized interferometers and optical encoders for displacement measurements to powerful electrical nanoprobers for the characterization of smallest semiconductor technology nodes – is completed by turnkey scanning microscopes which can be used in vacuum, cryogenic or other harsh environments.

We maintain the complete production in house for a high level of customization so that we can always provide you the optimal individual or OEM solution. We also offer feasibility studies, measurement services and comprehensive support to accompany you along your projects.

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