

SMARSLIDE®

Introduction

SMARSLIDE® stages offer ultra-high resolution, typical of piezo drives, combined with a large positioning range from a few mm to over a meter. **SMARSLIDE** offers several series of positioning stages. Each one was developed with our customers' requirements in mind. The full compatibility between the components of the different product lines facilitates easy combination into sophisticated multi-axis systems. Those form the backbone of turn-key solutions which SmarAct delivers for your specific and demanding positioning task.

High Resolution and Long Travel Range

SMARSLIDE piezo stages provide closed-loop positioning resolution of below one nanometer with high positioning repeatability even over long travel ranges.

Compact and Versatile

Most stage designs work independent of their mounting orientation. Even very complex and space constrained requirements can be met. For example, the **SMARSLIDE** SLC-1720 positioner with a size of 22 x 17 x 8.5 mm is the world's smallest linear closed-loop piezo stage with nanometer resolution and macroscopic travel range.

Low Thermal Drift and High Resonance Frequencies

A high degree of miniaturization combined with perfect material selection and optimized control modes ensure low thermal drift and high resonance frequencies.

Non-Magnetic Materials

Most of the **SMARSLIDE** stages are available as complete non-magnetic versions.

Self-Clamping and Backlash-Free

Since the movable parts of the stages are permanently coupled to the piezo drives via friction elements, **SMARSLIDE** piezo stages are backlash-free by design and keep their position even if the control electronics are switched off. Moving the slide by hand does not harm the stage or piezo drive.

Vacuum Compatibility

Nearly all **SMARSLIDE** stages and positioning systems are available in vacuum compatible versions down to 10^{-11} mbar.

Cost-Effective and Future-Proof

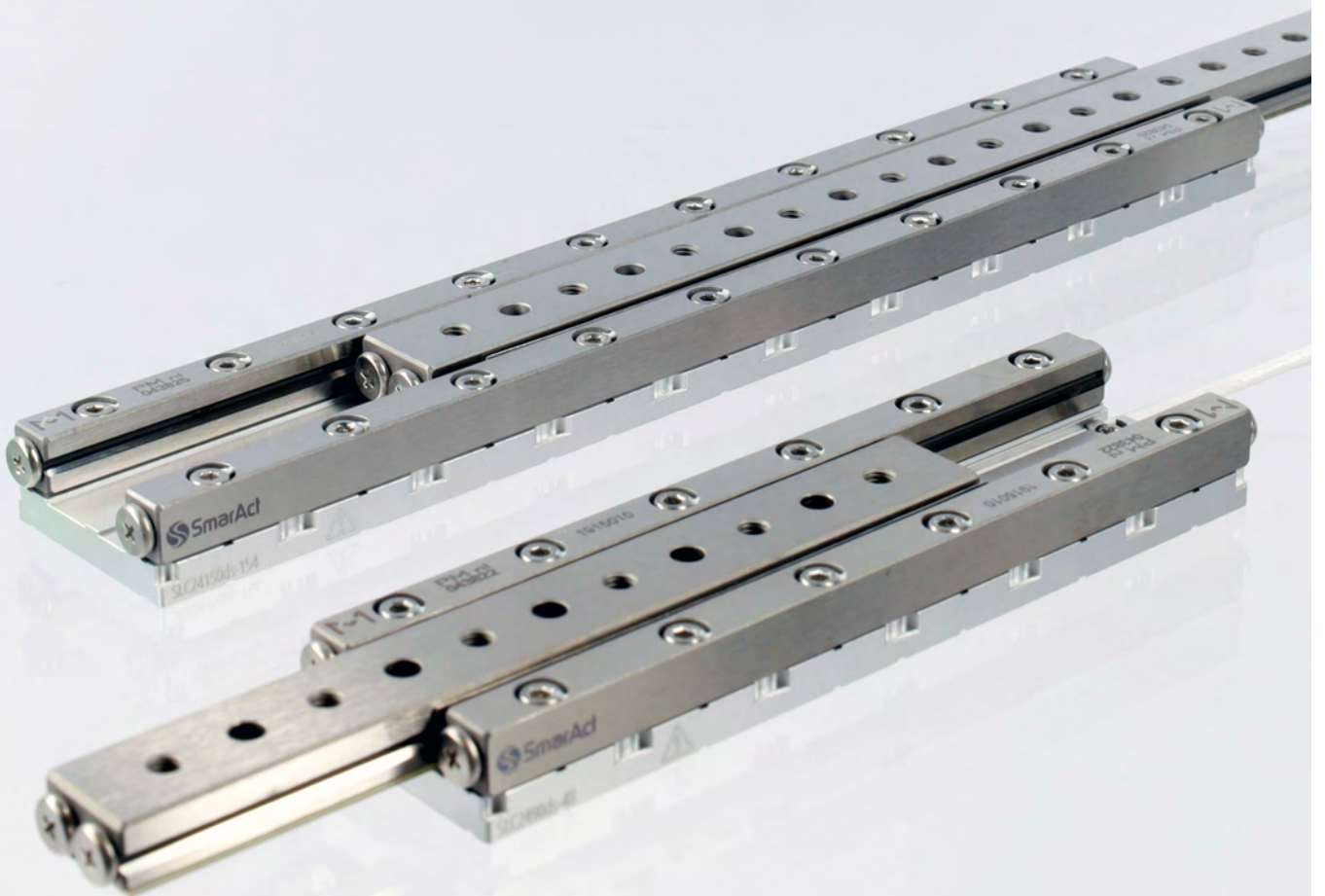
Due to the in-house development and manufacturing of all core components, **SMARSLIDE** provides you with positioning systems of the highest quality, precision and reliability at a reasonable price. The variety of available options allow highly specific positioning solutions and future upgradability.



Series Overview

SMARSLIDE offers a full portfolio of different stages based on the stick-slip piezo drive. This comprises four different kinds of linear stages, a comprehensive range of rotary stages with different sizes and apertures, goniometers and high-load lifting tables.

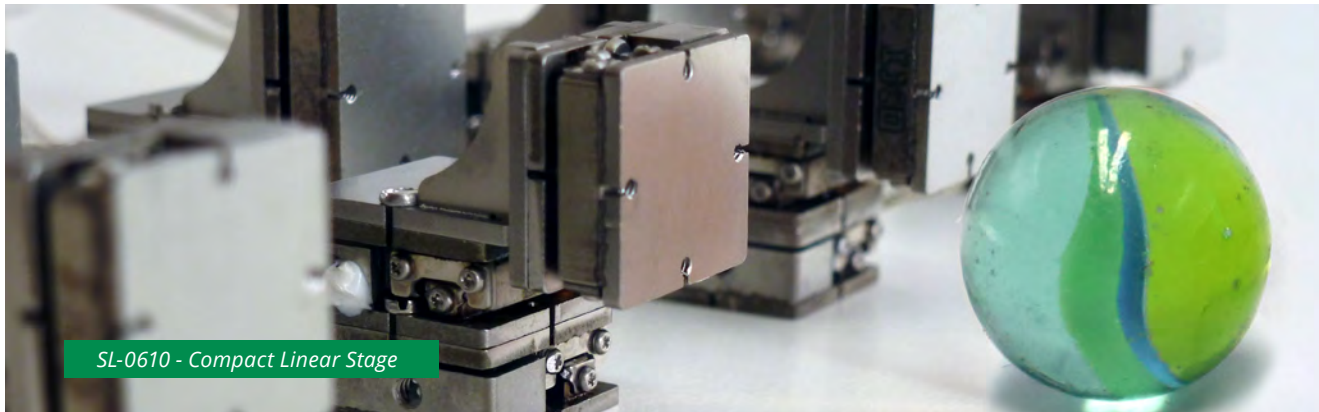
SMARSLIDE® LINEAR STAGES



Linear Stages

SMARSLIDE offers four ranges of linear stages. The SLC series combines compactness and stiffness with the full range of possible options. The CLS series offers exchangeable drives and the option to stack them without the need for adapter plates. This makes them a great choice for industrial automation,

but also a versatile addition to your lab equipment. The CLL series are rail-based positioners for very long travel ranges. On the small end of the scale, the SL series offers open-loop nanopositioning on a tiny 10 x 11 mm footprint.



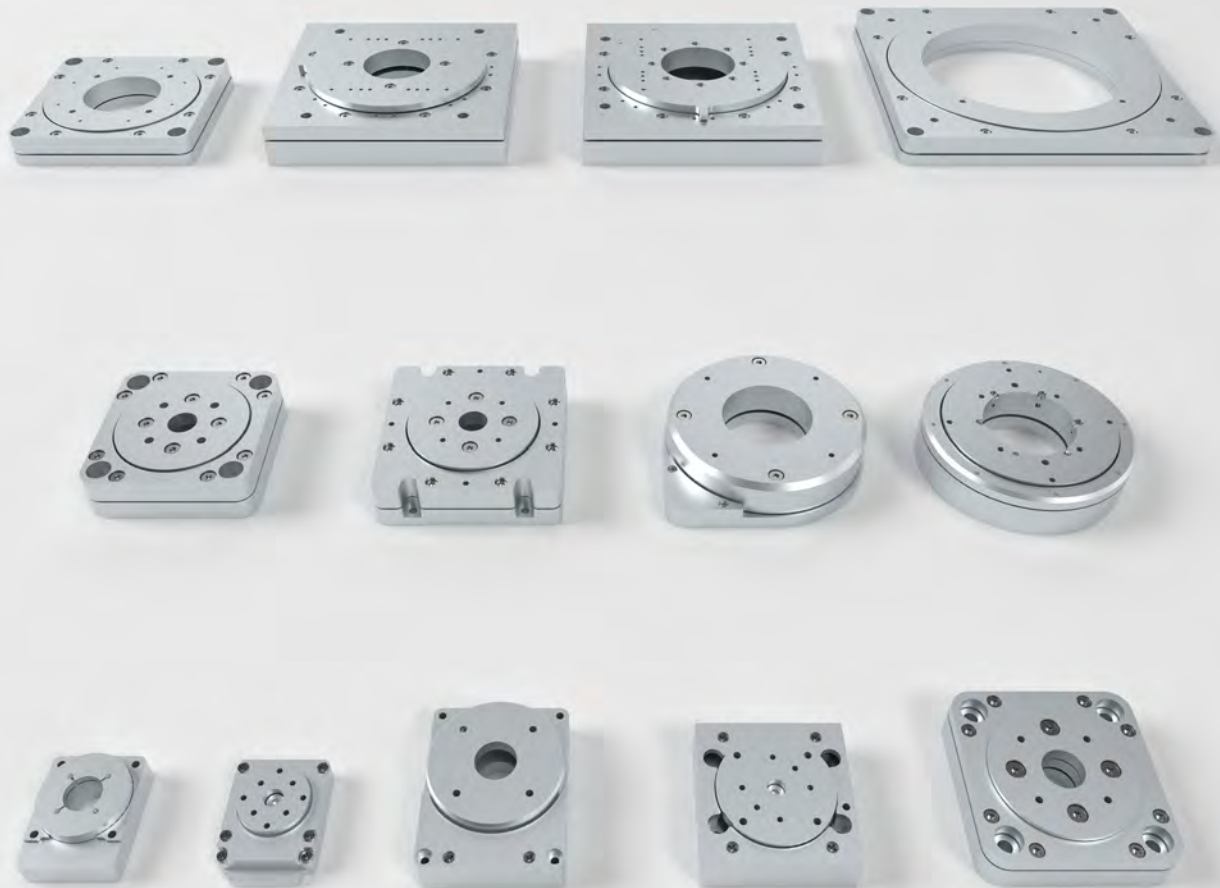
		SLC		CLS			SL	CLL
Mechanical	Series	SLC-17	SLC-24	CLS-32	CLS-52	CLS-92	SL-06	CLL V42
	Travel [mm]	12 ... 51	16 ... 123	21 ... 51	31 ... 51	63 ... 103	4.5 ... 16	160 ... 680
	Blocking Force [N]	≥ 3.5 / 5.5					≥ 1.6	≥ 5
	Max. Normal Force [N]	10 ... 30	20 ... 30	30	20		1	30
	Max. Lift Force [N]	1.5 / 2.2			1.0	--	0.35	--
	Cross Section W x H [mm]	17 x 8.5	24 x 10.5	32 x 11	52 x 14	92 x 17	11 x 5.2	60 x 16
Open-Loop	Velocity [mm/s]	> 20					> 10	> 15
	Open-Loop Resolution [nm]	MCS2: < 1 (H)CU: < 50						
Closed-Loop	Sensor Resolution [nm]	MCS2: 1 (S), 4 (L) (H)CU: 100 (L)					--	MCS2: 1 (S), 4 (L)
	Uni-Directional Repeatability [nm]*	MCS2: ± 40 (S,L) (H)CU: ± 200 (L) **					--	MCS2: +/- 250 (S)
Vacuum Compatibility		HV (10 ⁻⁶ mbar); UHV (10 ⁻¹¹ mbar)						

* Measured 10 mm above the top surface of the slide and along the line of symmetry. Measured over the complete travel range. An improvement can be expected for shorter travel ranges.

** This specification can be improved by using the advanced stepping mode.

Closed-loop resolution and repeatability differ depending on the sensor type selected.

SMARSLIDE® ROTARY STAGES



Rotary Stages

For positioning tasks requiring ultra-precise rotation, **SMARSLIDE** offers a wide range of rotary positioning stages. Those vary in size, aperture and bearing technologies. Ceramic bearings offer ultimate precision and suit applications requiring UHV compatibility or non-magnetic positioners. When it comes to

steel bearings, thin-section ball bearings achieve low cross-sections and large apertures, whereas sturdy crossed-roller bearings achieve maximum stiffness. Our application specialists are happy to assist you with selecting the right solution for your application.

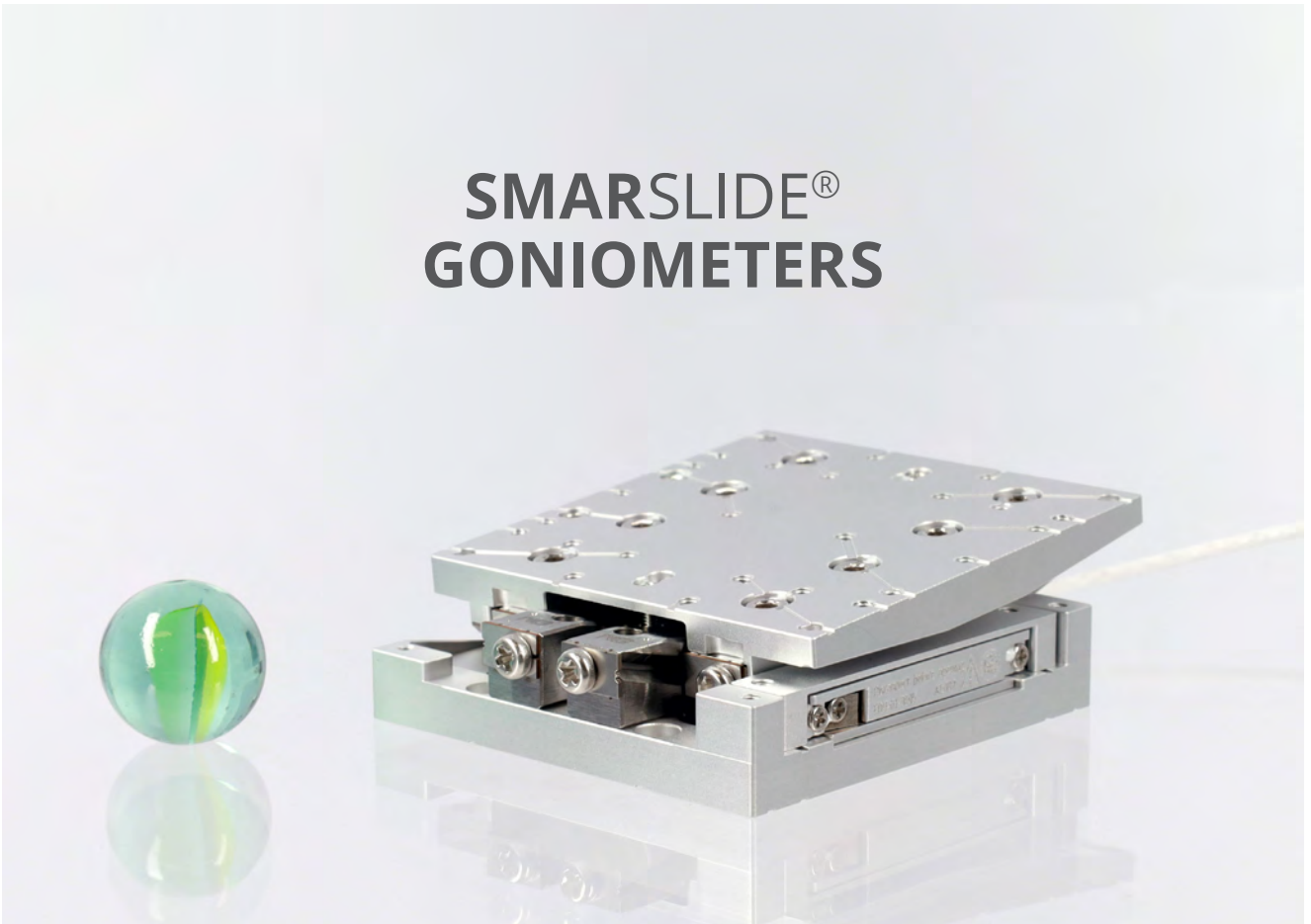
		SR-1908	SR-2013	SR-2812	SR-3211	SR-4011	SR-4513	SR-5014	SR-5714	SR-5714C	SR-7012	SR-9219	SR-9219C	SR-12012
Mechanical	Blocking Torque [Ncm]	≥ 0.5		≥ 3	≥ 2	≥ 3	≥ 5		≥ 7			≥ 10	≥ 10	≥ 15
	Max. Normal Force [N]	5	3			10	20		25			20		
	Dimensions [mm], L x W x H	25 x 20 x 8.5	22.5 x 20 x 10.2	37.5 x 30 x 12	32 x 32 x 11	40 x 40 x 11	45 x 45 x 12.5	50 x 50 x 14	57 x 57 x 14	57 x 57 x 13.75	70 x 70 x 12	92 x 92 x 19		120 x 120 x 12
	Weight [g]	13	11	35		60	89	100	110	105	100	450	250	320
	Aperture [mm]	8	--	9	--	9	8		25		30	27	30	82
Open-Loop	Angular Velocity [°/s]	> 45		> 30				> 15			> 5			
	Open-Loop Resolution [μ°]	< 3	< 4	< 2	< 4	< 2			< 1.5		< 1		< 0.5	
Closed-Loop	Sensor Types	--	S		S, L					S	S, L		S	
	Sensor Resolution [μ°]	--	25 (S)		25 (S), 100 (L)	15 (S), 60 (L)		15 (S), 60 (L)		15 (S)	15 (S), 60 (L)		15 (S)	5 (S)
Material Options		--	Aluminum as standard; Steel base (-ST); Titanium base (-TI);											
Vacuum Options		HV (10 ⁻⁶ mbar)	HV (10 ⁻⁶ mbar); UHV (10 ⁻¹¹ mbar)			HV (10 ⁻⁶ mbar)				HV (10 ⁻⁶ mbar); UHV (10 ⁻¹¹ mbar)	HV (10 ⁻⁶ mbar)		HV (10 ⁻⁶ mbar); UHV (10 ⁻¹¹ mbar)	HV (10 ⁻⁶ mbar)
Non-Magnetic Options		--	Yes (-NM)			--				Yes (-NM)	--		Yes (-NM)	--



Application Example: Gimbal Mount

Two **SMARSLIDE** SR-2013 positioners form a gimbal mirror mount that precisely defines the polar and azimuthal angle of an optical element. By combining the gimbal mirror mount with our typical or custom positioning systems, a five-axis positioning system can be easily realized.

SMARSLIDE® GONIOMETERS



Goniometers

Goniometers are akin to linear stages, but with curved guideways. They are a strong and stiff solution to achieve tilting motion. **SMARSLIDE** offers two separate guideway-based designs with different distances to the axis of rotation which can be directly stacked to form a Euler goniometer with a common center of rotation. **SMARSLIDE** also offers two very

compact and cryo-compatible goniometers based on a novel flexure design, which can also be stacked in a Euler cradle configuration. SmarAct goniometer stages can be operated by any of our control units and are available with integrated positioning sensors for closed-loop operation.

CGO Series

Due to the usage of high precision crossed roller bearings, **SMARSLIDE** CGO stages are very rigid and their angular accuracy is very high. They are equipped with exchangeable drive units which allows for excellent serviceability. Their mechanical interface perfectly fits the CLS-52 series stages, allowing the creation of compact and stiff multi-axis systems by direct combination of linear, rotation

and goniometer stages. Furthermore, the CGO series goniometer stages are available for different environmental conditions, such as high vacuum and ultra-high vacuum environments. The two different versions have pivot point heights of 60.5 and 77.5 mm, allowing for a stacked configuration with common center of rotation.

SGF Series

Traditional goniometer stages are based on steel contact bearings, which limit their adaptability for extreme environments such as cryogenic temperatures, or applications requiring non-magnetic materials. The SmarAct SGF series goniometers overcome these limitations by utilizing a flexure-based hinge mechanism as a guideway. This allows for excellent adaptability to diverse environments while minimizing parasitic motion across a deflection range of up to $\pm 3^\circ$. Additionally, the pivot point height can be fully customized

within a range of 25 to 100 mm above the top plate, available upon request. The standard versions have pivot point heights of 33 and 58 mm respectively which allows a common center of rotation in a stacked configuration.

With a footprint of just 32 x 32 mm², the SGF goniometer seamlessly integrates with SmarAct's CLS-32 series stages, allowing for versatile multi-axis systems that combine linear, rotational, and goniometer motion.



		SGF-33	SGF-58	CGO-60.5	CGO-77.5
Mechanical	Travel [°]	± 2.8		± 5	
	Blocking Torque [Ncm]	18		30	38
	Max. Normal Force [N]	1		5	
	Dimensions [mm], L x W x H	32 x 32 x 25		50 x 50 x 17	
	Weight [g]	52		140	
	Center of Rotation [mm]	33	58	60.5	77.5
Open-Loop	Angular Velocity [°/s]	10		4	
	Open-Loop Resolution [μ°]	< 1			
Closed-Loop	Sensor Types	S, L			
	Sensor Resolution [μ°]	MCS2: 2 (S), 8 (L) (H)CU: 100 (L)			
	Uni-Directional Repeatability [μ°] *	MCS2: ± 100 (S,L) (H)CU: ± 250 (L)**			
Material Options		Non-Magnetic Materials (-NM)		--	
Mechanical Options		--		Cage-creep-free guideways as standard	
Vacuum Compatibility		HV (10 ⁻⁶ mbar), UHV (10 ⁻¹¹ mbar)			

SMARSLIDE® HIGH-LOAD TABLES



For positioning tasks that require to move high payloads, **SMARSLIDE** offers special high-load tables. They combine wedge designs with a wide range of constant-force springs to tailor the stage to the required payload. In many cases, the constant-force springs can be exchanged on-site to change the ideal payload range. Stages to lift up to 40 N with a travel of 20 mm have been realized.

		CHS-3232	CHS-5237	CHS-9257	SHL-1D80N-1
Mechanical	Travel [mm]	5	10	20	1
	Max. Lift Force [N]	5	10	15*	80
	Dimensions [mm], L x W x H	32 x 32 x 32	52 x 52 x 37	92 x 92 x 57	41 x 86 x 50
	Weight [g]	100	270	935	340
Open-Loop	Velocity [mm/s]	> 5	> 2		> 1
	Open-Loop Resolution [nm]	MCS2: < 1			
Closed-Loop	Sensor Resolution [nm]	MCS2: 1 (S), 4 (L); (H)CU: 100 (L)			
	Uni-Directional Repeatability [nm]**	MCS2: ± 40 (S,L); (H)CU: ± 200 (S, L)			
Material Options		Aluminum base as standard; Steel base (-ST); Titanium base (-TI); Black anodized (-BK)			
Vacuum Options		HV (10 ⁻⁶ mbar); UHV (10 ⁻¹¹ mbar)			

* Max. lift force can be increased upon request.

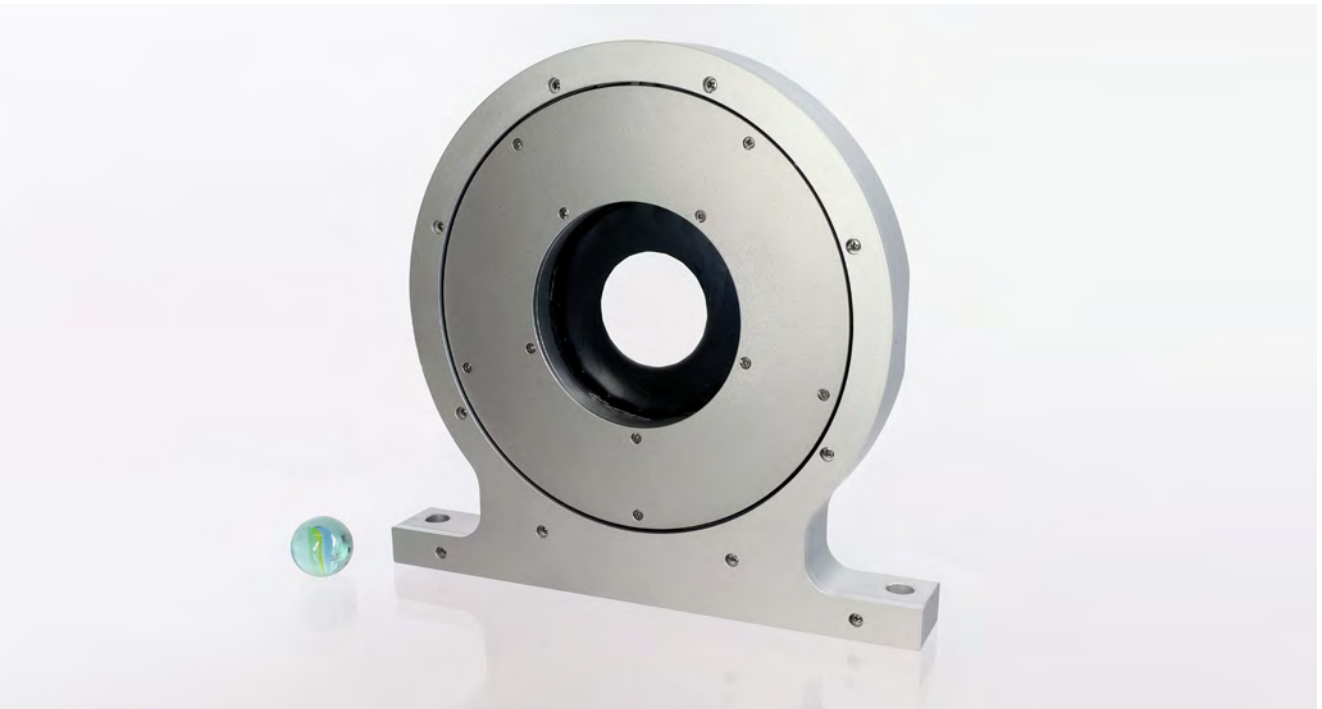
** Measured over the entire travel range. Lower values can be expected

OPTOMECHANICS



SMARSLIDE offers a dedicated range of optomechanical components based on the stick-slip piezo drive. They are the ideal solution to automate your optical setups or achieve motion in closed environments, such as UHV chambers. **SMARSLIDE** motorized optomechanics comprise tip-tilt mirror mounts, iris diaphragms, adjustable slits and filter wheels. **SMARSLIDE** optomechanics are

the most compact solutions in their field, allowing for tight folding of optical paths on typically densely populated optical tables. At the same time, they offer high stiffness and in-position stability. One highlight is the tip-tilt mirror mount with a very compact integrated inductive encoder, achieving resolution and repeatability in the single millidegree range.



SMARSLIDE® EXCHANGEABLE DRIVE UNITS



Exchangeable Drive Units

SMARSLIDE exchangeable drive units (EDUs) are specifically designed for industrial and scientific applications where the time for maintenance or repairs must be as short as possible. The stick-slip piezo drive is housed in a robust drive unit that you can easily replace yourself. With **SMARSLIDE** EDUs, downtime for piezo motor replacement is reduced to a few minutes.

Plannable On-Site Service

The exchangeable drive units are factory tested and preset. To replace the unit, only two screws have to be removed which makes replacement a very simple task. Due to the EDU's simplicity, their exchange can be planned and synchronized with other maintenance tasks. Since the EDUs are supplied in sealed and stockable packaging, they can be stored safely until the next maintenance.

Reduced Downtime

Stages with EDUs do not have to be removed from the positioning system when replacing a drive unit. Therefore, taught poses, stored positions and calibration data remain valid. Complete systems can remain assembled and payload does not need to be removed.

The unique and patented drive units are available for linear stages of the CLS series, CGO goniometer stages, CHS high load stages and long travel rail-based CLL stages. **SMARSLIDE** exchangeable drive units provide you with direct benefits in various ways:

Cost and Time Efficiency

Compared to the cost of buying complete stages as spare parts, EDUs carry only a fraction of the cost. Tedious repair or service shipments can be dispensed with.

Compatibility

EDUs are available in SmarAct product series of CLS linear stages, CGO goniometer stages, CHS high load stages and rail-based CLL stages. Complete positioning systems, from serial multi-axis systems up to parallel kinematics such as the hexapod-like **SMARPOD**® can also be equipped with **SMARSLIDE** EDUs. This allows you to keep a stock of one type of EDU for multiple types of positioners and systems.

Position Sensors

Optical and inductive sensors can be integrated into our stages for closed-loop position control, allowing to define the desired travel distance or the target position and the velocity of the stage.

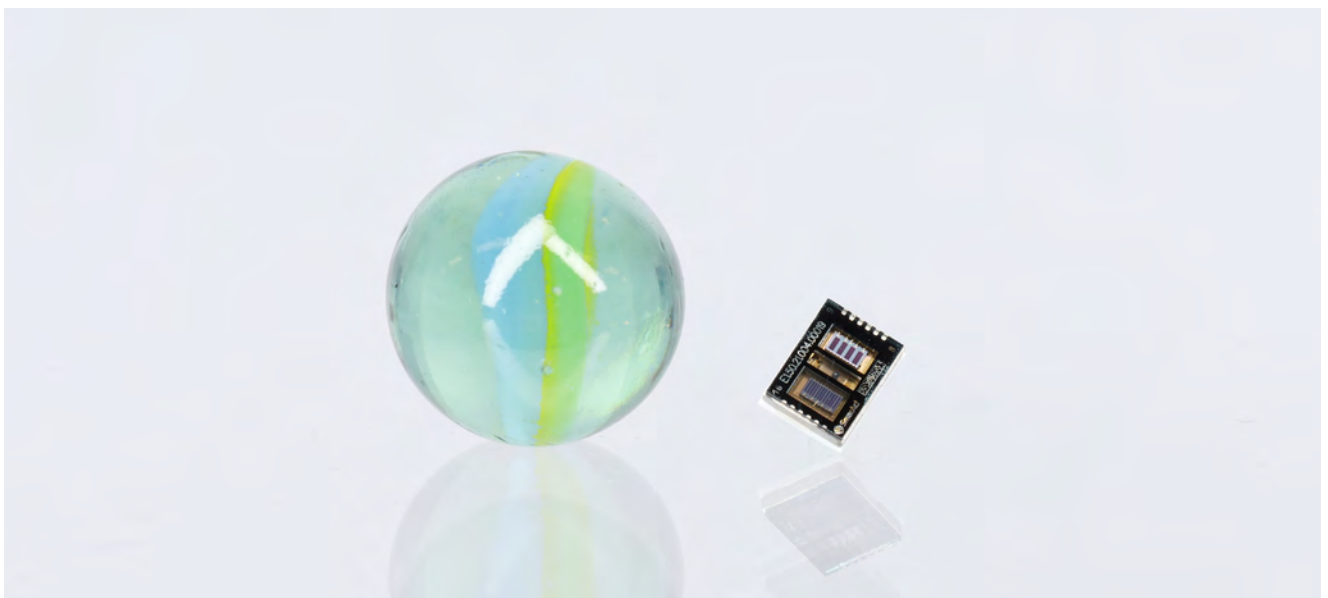
Sensor Type	S	SC	L	LC	I
Working Principle	Optical				Inductive
Resolution [nm]	1		4		300
Reference Positions	Single reference mark	Multiple reference marks	Single reference mark	Multiple reference marks	Endstop
Control System Compatibility	MCS2, SDC2	MCS2	MCS2, SDC2, CU	MCS2, CU	EMS, CU
Vacuum Compatibility	Down to 10 ⁻¹¹ mbar		Atmospheric pressure only		Down to 10 ⁻⁶ mbar

To achieve closed-loop motion, stick-slip piezo stages have to be equipped with nano sensors. **SMARSLIDE®** is offering two infrared optical encoders and one inductive encoder for closed-loop piezo stages.

With the Metirio Encoder developed and marketed by the SmarAct Metrology GmbH, we are using the most compact encoder available on the market to achieve single nm resolution. This ensures the best possible repeatability and accuracy for **SMARSLIDE®** nanopositioning stages. The -L and -LC options offer a cost-effective closed-loop solution with a slightly

lower resolution. If an optical encoder can't be used in the application, the -I option comprises an inductive sensor which does not emit any light.

Single or multiple distance-coded reference marks are available to facilitate the homing of the stages.



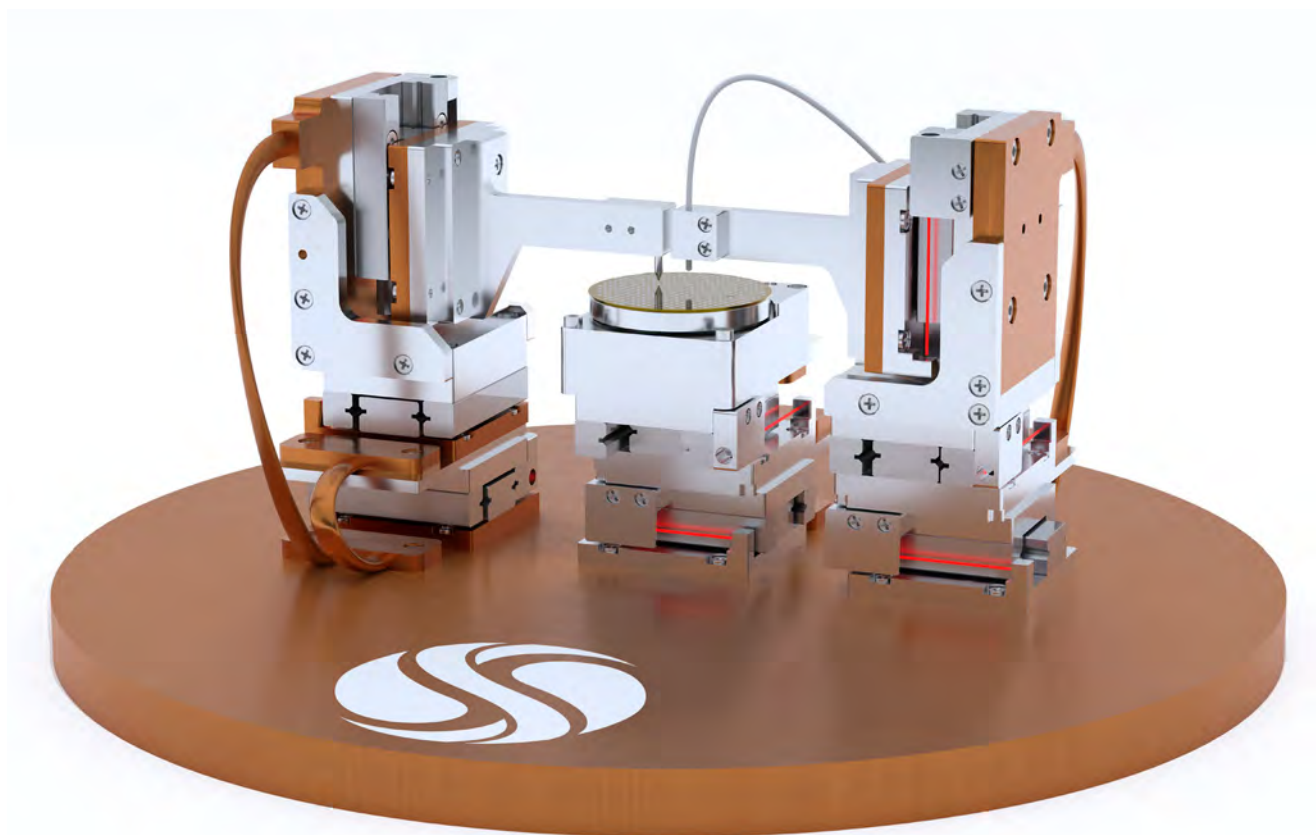
Cryogenic Positioning

In many cases it is not only necessary to cool the samples but also to mechanically manipulate them precisely within the cryostat. **SMARSLIDE**[®] cryogenic stages with low-heat profiles and ultra-high vacuum compatibility allow sample manipulation at temperatures down to the mK range. Additionally, they can be used up to 330K and can be baked out just like the regular **SMARSLIDE** UHV systems. Nonmagnetic versions are available as well.

Cryogenic compatibility is achieved by carefully selecting materials with matching thermal coefficients for stages and systems. Resistive cabling (based on phosphor bronze) is optionally available to reduce the heat load on the positioning stages. Thermal management solutions such as cooling braids can be integrated upon request. Multi-

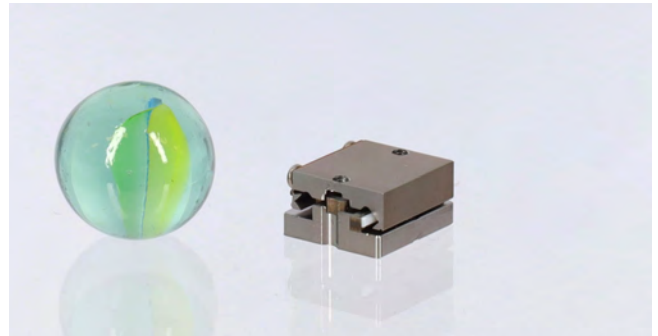
axis cryo-compatible stages are designed to be as compact as possible in order to fit the tight space constraints that cryostats confer by design. A prime example is the SLT-1213 linear stage, which has just a 12 x 13 mm footprint.

For repeatable high precision positioning under cryogenic conditions, SmarAct has developed cryogenic positioning stages with integrated interferometric sensors featuring unmatched closed-loop positioning performance with resolutions below 0.5 nm and unidirectional repeatability of 5 nm over a travel range of 1 mm and 20 nm over a travel range of up to 49 mm. This precision allows a whole range of new applications in the fields of quantum computing and material science.





In comparison to standard SLC series stages the bases of linear cryo stages are made of titanium



SLT-1213 is a miniature non-magnetic cryogenic linear stage

		SLC17 (20-60)	SLC24 (30-60)	SLC24-F	SLT-1213
Mechanical	Travel [mm]	6 ... 41	16 ... 35	16 ... 49	5
	Scan Range [μm]	--	--	~ 1 @ 4 K; 5 @ 300 K	--
	Blocking Force [N]	≥ 2	≥ 2	≥ 2	≥ 1
	max. Normal Force [N]	20 ... 30	30	30	1
	max. Lift Force [N]	≤ 1	≤ 1	≥ 1	0.35
	Dimensions [mm]	22 x 17 x 8.5 ... 60 x 17 x 8.5	30 x 24 x 10.5 ... 60 x 24 x 10.5	30 x 28 x 14 ... 75 x 28 x 14	13 x 12 x 6.5
	Weight [g]	20 ... 60	60 ... 110	60 ... 137.5	--
Open-Loop	Velocity [mm/s]	up to 20	up to 20	> 1 @ 4K; > 20 @ 300K	> 1 @ 4K; > 5 @ 300K
	Resolution [nm]	< 1	< 1	MCS2; < 1	MCS2; < 1 (H)CU: < 50
	Step Width [nm]	≥ 50	--	--	--
Closed-Loop	Sensor resolution [nm]	--	--	MCS2; < 0,5 (P)	--
	Uni-Directional Repeatability [nm]*	--	--	MCS2; ± 25 (P)	--
Material Options		--	--	--	Titan base (-Ti)
Vacuum Option		HV (10^{-6} mbar), UHV (10^{-11} mbar)			
Non-Magnetic Option		Yes	Yes	Yes	--

Options

Each stage can be customized with a wide range of available options to tailor them to the specific task at hand.

Higher Blocking Force

Most stages can be modified to increase the force by 50% without changing the external dimensions.

Non-Magnetic Materials

Many stages are available as non-magnetic versions. In most cases their outer dimensions remain unchanged.

U-Shaped Base

SMARSLIDE® linear stages from the SLC series can be equipped with a U-shaped base that allows lateral pretension for higher resistance to torques or thermal gradients.

Vacuum

SMARSLIDE® standard stages are configured to operate at atmospheric pressure. Specialized versions are available for high vacuum (HV, 10^{-6} mbar) and ultra-high vacuum (UHV, 10^{-11} mbar) applications.

Constant Force Spring

If the application requires the stage to lift a constant, vertically arranged load, a constant force spring can be integrated to serve as a counterweight and thus increase the maximum force.

Cryogenic

For applications that require very low temperatures down to 2K, specialized versions of our linear, rotary, goniometer and tip-tilt stages are available. For high-performance positioning under cryogenic conditions, SmarAct offers closed-loop cryogenic stages with interferometric feedback.





Control Systems

SmarAct offers 3 principal control architectures that can be used in combination with **SMARSLIDE®** stick-slip piezo positioners. The **MCS2** and **SCU** both offer powerful Python® and LabVIEW™ APIs to allow you to build your own software, as well as proprietary control software for easy testing and prototyping. Optional hand-control units allow to intuitively control positioners with the help of knobs and joysticks.

The **MCS2** is the most versatile system which offers the widest range of features. It can work with all kinds of surrounding devices via optional analog

or digital I/O and offers USB, Ethernet or EtherCAT communication interfaces. Housing options include various tabletop options and a 19" rack insert.

The **SCU** is a low-cost system that can control up to three positioners and is available with USB or RS232 interface.

The **EMS** is a very compact control board for OEM integration and is only controlled via I²C.

Typical Applications for SMARSLIDE® Stages

SMARSLIDE® stages are suitable for a wide range of applications in high-precision technology. The following overview shows some of the possibilities, but we are sure that there are many more. We are confident that we can also help with your application to achieve your goals. For your laboratory experiments, industrial automation or as an OEM part of your sophisticated product, SmarSlide stages are the ideal addition to your high-precision toolkit.

Semiconductor Industry

- Wafer inspection and metrology
- Mask alignment in lithography
- Die bonding and micro-assembly

Photonics & Optics

- Laser beam steering and alignment
- Optical fiber positioning
- Tunable optics and interferometry

Microscopy & Life Science

- Sample scanning in atomic force microscopy (AFM)
- High-resolution positioning in super-resolution microscopy
- Microfluidics and biomedical sample handling

Nanotechnology & Materials Science

- Dedicated sample stages in scanning electron microscopy (SEM)
- X-ray diffraction and synchrotron applications
- Sample positioning or wavelength selection in spectroscopy

Quantum & Cryogenic Research

- Positioning of sensors and samples in cryogenic environments
- Quantum computing

Industrial Automation & Precision Assembly

- Automated component gripping and alignment and micro-assembly



With the development and production of market-leading solutions in the field of high-precision positioning, automation and metrology, the SmarAct Group reliably accompanies their customers in achieving their goals. The broad product portfolio – from single positioning stages to complex parallel kinematics, miniaturized robots, control systems and measurement technology – is complemented by automated microassembly solutions. Even the most challenging customer requirements can be met by maximum adaptability and complete in-house production.

Since its founding in 2005, SmarAct has steadily grown from a small team of engineers to a group of companies with three independent business units and over 270 highly skilled members. Today, SmarAct relies on years of experience and, above all, on a very passionate team with unconditional customer focus.

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