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# ECS Drive Series

Nanoprecise positioning at ambient temperature

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# attoECS Drive Series

Nanoprecise positioning at ambient temperature

With the ECS series of positioners, attocube has genuinely combined highest precision piezodrive technology with extremely rugged yet cost effective design. Positioners of the ECS series are dedicated for operation at room temperature, at pressures ranging from ultra-high vacuum to ambient. Facilitated by their unique piezodrive technology, their stiff mechanical design, and the application of crossed roller

bearings, ECS positioners are capable of moving and placing loads of up to several kg on the nanometer scale. This powerful performance is supplemented by the ECC100 drive electronics which enables open- and closed-loop positioning with 1 nm/1  $\mu^\circ$  position resolution<sup>1)</sup>. ECS positioners are available in a full range of sizes and drive designs (linear, rotation, and goniometric) and can be stacked for multi-axis operation.

attocube systems is renowned as the pioneer of nanopositioning technology at extreme environments such as ultra-low temperature, ultra-high vacuum, or high magnetic field. With the ECS drive series, attocube now launches a new class of positioners dedicated for operation at ambient temperature and at pressures ranging from atmospheric to UHV.

The ECS series is precisely engineered for today's room temperature applications, where space is frequently constrained while load and torque applied to the positioning units may be significant. For this reason, attocube has equipped ECS positioners with crossed roller bearings, providing ultimate mechanical rigidity combined with highest guiding accuracy. Errors of less than 0.1 mrad in pitch, yaw, and roll, and loads of up to 240 N<sup>2)</sup> demonstrate the superior performance of the ECS series.

Positioners of the ECS series take advantage of a drive mechanism based on attocube's patented inertial drive technology, modified specifically for applications at ambient temperature. In conjunction with the ECC100 three-axis drive electronics, ECS positioners are capable of a clo-

sed-loop<sup>1)</sup> positioning resolution of 1 nm/ $\mu^\circ$  while providing travel velocities of up to 4.5 mms<sup>-1</sup> / 10<sup>0</sup>s<sup>-1</sup>. A position repeatability of 50 nm / 50  $\mu^\circ$  tops off the specification of the ECS series.

For the ECS series, special emphasis was put on both life endurance and cost effective manufacturing. The room temperature optimized drive mechanism, combined with the choice of Aluminum or stainless steel as main body material, enables a significant cost reduction compared to positioners for extreme environments, while achieving a life-duration larger than 250,000 cycles.

attocube's ECS positioners are available in a wide variety of designs, sizes, and travel ranges and can be ordered in anodized Aluminum or stainless steel, satisfying both optical and UHV applications. ECS positioners are stackable for multi-axis operation.

<sup>1)</sup> Position encoders on ECS drives are available as option.

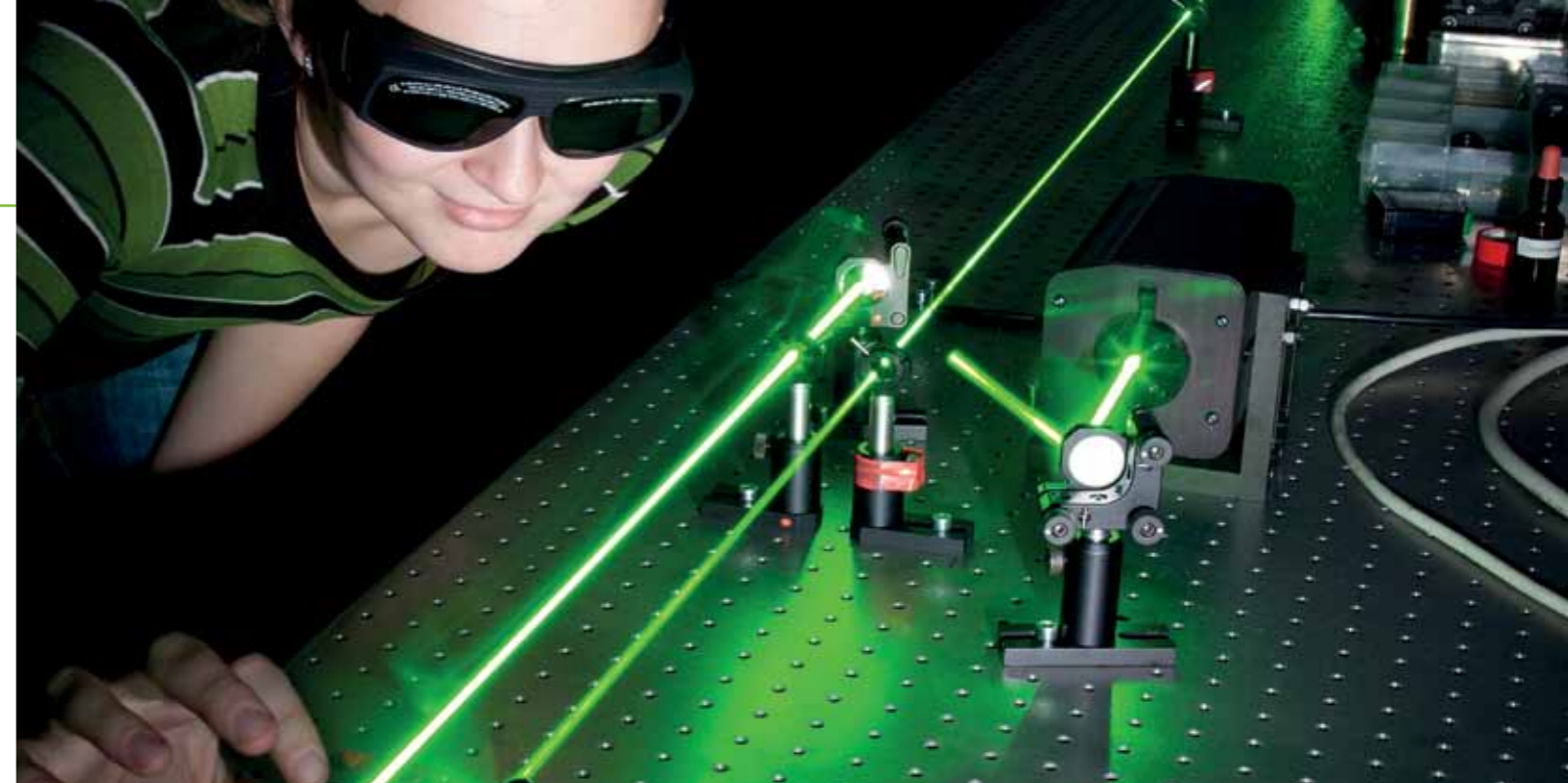
In open loop operation, the smallest physical step size is limited to approx. 50 nm / 0.1 m $^\circ$ .

<sup>2)</sup> For linear positioners, depending on positioner size.

Maximum drive performance applicable for horizontal mounting only.

## MAIN ADVANTAGES OF THE ECS SERIES

- **Highest precision motion on the nanometer scale over centimeter travel range, rated for loads up to several kg.**
- **ECC100 drive electronics operating at < 45 V, no need for specific high-voltage shielding (rated for low voltages)**
- **Optical position encoders with 1 nm/1  $\mu^\circ$  resolution, 50 nm/ 50  $\mu^\circ$  repeatability, and < 0.01 % absolute accuracy**
- **Superior mechanical stiffness and life endurance, combined with cost efficient design**
- **Made from non-reflective anodized Aluminum for optical applications and stainless steel for high/ultra-high vacuum environments**
- **Magnetic quick-exchange sample holder available, e.g. for optical components**



## The ultimate, industrial positioning solution from the leaders in nanopositioning



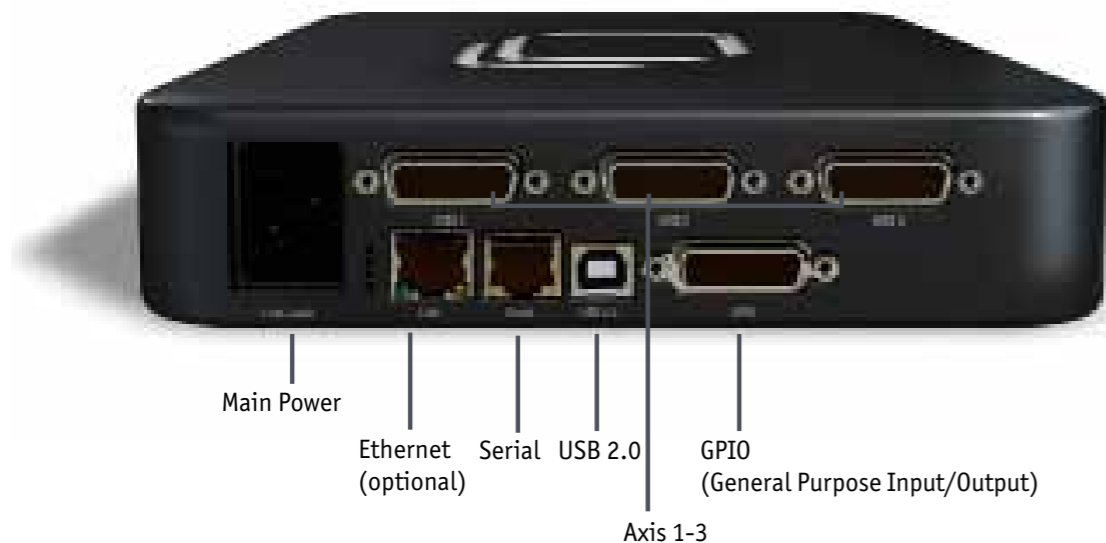
ECC100 Motion Controller with goniometers and linear nanopositioners.

# Product Quick Finder

ECS nanopositioners offered by attocube

Product Name	Linear Positioners						Goniometers		Rotators		
	ECS3030	ECS3040	ECS3050	ECS3060	ECS3070		ECS3080	ECS5050	ECGt5050	ECGp5050	ECR3030
Pressure Options	/HV, /UHV	/HV, /UHV	/HV, /UHV	/HV, /UHV	/HV, /UHV		/HV, /UHV	/HV, /UHV	/HV, /UHV	/HV, /UHV	/HV, /UHV
Encoder Option	optoelectronic (/NUM)	optoelectronic (/NUM)	optoelectronic (/NUM)	optoelectronic (/NUM)	optoelectronic (/NUM)		optoelectronic (/NUM)	optoelectronic (/NUM)	optoelectronic (/NUM)	optoelectronic (/NUM)	optoelectronic (/NUM)
Closed-loop travel properties											
Position Resolution	1 nm	1 nm	1 nm	1 nm	1 nm		1 nm	1 nm	1 μ°	1 μ°	0.01 m°
Position Repeatability	50 nm	50 nm	50 nm	50 nm	50 nm		50 nm	50 nm	50 μ°	50 μ°	1 m°
Accuracy	< 0.01% of travel range	< 0.01% of travel range	< 0.01% of travel range	< 0.01% of travel range	< 0.01% of travel range		< 0.01% of travel range	< 0.01% of travel range	approx. 1 m°	approx. 1 m°	approx. 2 m°
Open-loop travel properties											
Minimum step size	50 nm	50 nm	50 nm	50 nm	50 nm		50 nm	50 nm	0.1 m°	0.1 m°	0.1 m°
Maximum Drive Velocity <sup>2)</sup>	4.5 mm/s	4.5 mm/s	4.5 mm/s	4.5 mm/s	4.5 mm/s		4.5 mm/s	4.5 mm/s	approx. 1 °/s	approx. 1 °/s	approx. 10°/s
Travel Range <sup>2)</sup>	20 mm	25 mm	30 mm	35 mm	40 mm		50 mm	30 mm	10 °	10 °	360 °
Blocking Force	4 N	4 N	4 N	4 N	4 N		4 N	4 N	4 N	4 N	4 N
Maximum Load <sup>1)</sup>	90 N (9 kg)	120 N (12 kg)	150 N (15 kg)	180 N (18 kg)	210 N (21 kg)		240 N (24 kg)	150 N (15 kg)	10 N (1 kg)	10 N (1 kg)	20 N (2 kg)
Footprint x Height	30 x 30 x 9.5 mm <sup>3</sup>	30 x 40 x 9.5 mm <sup>3</sup>	30 x 50 x 9.5 mm <sup>3</sup>	30 x 60 x 9.5 mm <sup>3</sup>	30 x 70 x 9.5 mm <sup>3</sup>		30 x 80 x 9.5 mm <sup>3</sup>	50 x 50 x 9.5 mm <sup>3</sup>	55.4 x 50 x 17 mm <sup>3</sup>	55.4 x 50 x 17 mm <sup>3</sup>	30 x 30; 10.5 mm <sup>3</sup>
Maximum Size	30 x 51.6 x 9.5 mm <sup>3</sup>	30 x 66.6 x 9.5 mm <sup>3</sup>	30 x 81.6 x 9.5 mm <sup>3</sup>	30 x 96.6 x 9.5 mm <sup>3</sup>	30 x 111.6 x 9.5 mm <sup>3</sup>		30 x 131.6 x 9.5 mm <sup>3</sup>	50 x 66.6 x 9.5 mm <sup>3</sup>	50 x 61.1 x 19.4 mm <sup>3</sup>	50 x 61.1 x 19.4 mm <sup>3</sup>	30 x 30; 10.5 mm <sup>3</sup>
Materials	Aluminum stainless steel	Aluminum stainless steel	Aluminum stainless steel	Aluminum stainless steel	Aluminum stainless steel		Aluminum stainless steel	Aluminum stainless steel	Aluminum stainless steel	Aluminum stainless steel	Aluminum stainless steel
Weight											
Aluminium	29 g	39 g	49 g	59 g	69 g		78 g	70 g	137 g	137 g	28 g
Stainless Steel	51 g	71 g	90 g	110 g	129 g		147 g	149 g	247 g	247 g	66 g
Guiding Accuracy	Crossed Roller Bearing	Crossed Roller Bearing	Crossed Roller Bearing	Crossed Roller Bearing	Crossed Roller Bearing		Crossed Roller Bearing	Crossed Roller Bearing	Crossed Roller Bearing	Crossed Roller Bearing	Ball Bearing
Roll	< 0.1 mrad	< 0.1 mrad	< 0.1 mrad	< 0.1 mrad	< 0.1 mrad		< 0.1 mrad	< 0.1 mrad	< 0.1 mrad	< 0.1 mrad	
Pitch	< 0.1 mrad	< 0.1 mrad	< 0.1 mrad	< 0.1 mrad	< 0.1 mrad		< 0.1 mrad	< 0.1 mrad	< 0.1 mrad	< 0.1 mrad	
Yaw	< 0.1 mrad	< 0.1 mrad	< 0.1 mrad	< 0.1 mrad	< 0.1 mrad		< 0.1 mrad	< 0.1 mrad	< 0.1 mrad	< 0.1 mrad	
<sup>1)</sup> Maximum drive performance applicable for horizontal mounting only.											
<sup>2)</sup> Valid for both open- and closed-loop positioners.											





## Three-axis digital motion controller

The ECC100 is a new generation of motion controller, designed specifically for the operation of ECS series of positioners. The ECC100 consists of a fully digital control unit and an analog amplification circuit, enabling the simultaneous operation of up to three ECS units at any one time. The ECC100 is designed for open- and closed-loop control of ECS positioners, yielding a position resolution of 1 nm in case of linear positioners and up to  $1 \mu^\circ$  in case of goniometric/rotative drive units. The ECC100 is PC-connectable via USB and Ethernet\* and is delivered with DLL and LabVIEW drivers for higher integration. The ECC100 operates at low drive voltages below 45 V, compatible with low voltage requirements. The ECC100 is not compatible with classical ANP-series positioners.



### PRODUCT KEY FEATURES

- > quick and easy handling via plug & play design
- > controller driving open and closed loop positioners
- > DLL, Labview™ drivers, stand-alone application for Windows available
- > PC connection via USB 2.0 and Ethernet

### BENEFITS

- > compact
- > cost efficient

### SENSOR RESOLUTION

The term sensor resolution or sensitivity indicates the smallest quantity detectable by a sensor. If the sensitivity is not fundamentally limited due to mechanical properties such as friction, the sensitivity is almost always bandwidth dependent. attocube systems specifies the resolution of optoelectronic (/NUM) sensors at a measurement bandwidth of 1 kHz.

### SENSOR ACCURACY

The term sensor accuracy represents the absolute deviation of any measurement from a calibrated, metrologically traceable standard. Best accuracy is often obtained by interferometric sensors, facilitating well-known laser lines from thermally stabilized single mode gas lasers. Sensor accuracy does not necessarily relate to sensor sensitivity and repeatability, i.e. a sensor may provide a very high sensitivity and repeatability, yet lack a high accuracy.

### SENSOR REPEATABILITY

The sensor repeatability represents the maximum (position) error when repeatably approaching a certain sensor value. At attocube, the sensor repeatability is measured in conjunction with an actual positioner, i.e. parameters such as minimum step size, thermal expansion, and resolution all contribute to the sensor repeatability. We define repeatability as 1 sigma of the Gaussian distributed repositioning error for one thousand repositioning events.

### GUIDING ACCURACY

The guiding accuracy describes the deviation of the motion of a positioner from a purely linear behaviour in terms of roll,  $\theta_x$ , pitch,  $\theta_y$ , and yaw,  $\theta_z$ . Vertical and horizontal runouts are frequently also considered when referring to the term guiding accuracy. In real life, position sensors detect the motion of a positioner but do not provide real-time information on the guiding accuracy.

### MINIMUM POSITIONER STEP SIZE

The minimum step size of a positioner is defined as the smallest repeatable motion which the positioner can achieve in coarse positioning mode. This parameter includes the positioner backlash.

### OPEN-LOOP POSITION CONTROL

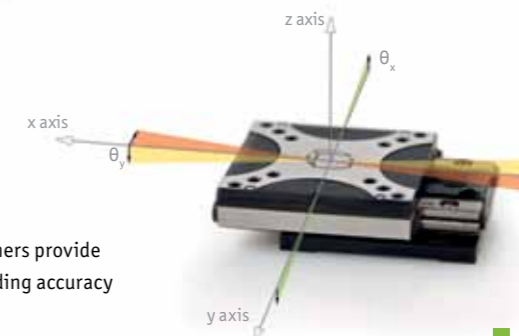
The open-loop functionality of a positioner does not take advantage of a feedback loop in order to determine and control the actual position of a positioner. Depending on the number (frequency) of steps and the adjusted step size (voltage), a rough estimate of the actual position after any motion task can be deduced.

### CLOSED-LOOP POSITION CONTROL

The closed-loop functionality takes advantage of measuring the actual position of a positioner using an encoder. This position is then compared to a setpoint, where any difference between the two values is compensated for using a feedback loop. For attocube positioners equipped with an encoder, positioning setpoints can either be set in a software interface or on the front panel of the closed-loop electronics (depending on type). An additional feature of attocube's closed-loop operation is the control of the step size of the positioner. Hereby, the controller measures the step size and then alters the amplitude of the next step according to any deviation from the target step size. This mode is referred to as "Automatic Amplitude Control" and results in a highly constant speed of positioning.

### OPTOELECTRONIC POSITION SENSOR

This optoelectronic (/NUM) readout allows fully automated, closed-loop positioning operation with high resolution compatible with ambient conditions, ultra high vacuum, and magnetic fields up to 7 T. It delivers a relative position to a reference with a sensor resolution of 10 nm and a repeatability of  $\pm 200$  nm. /NUM sensors are fully integrated into the piezo stepper device.



ECS positioners provide highest guiding accuracy