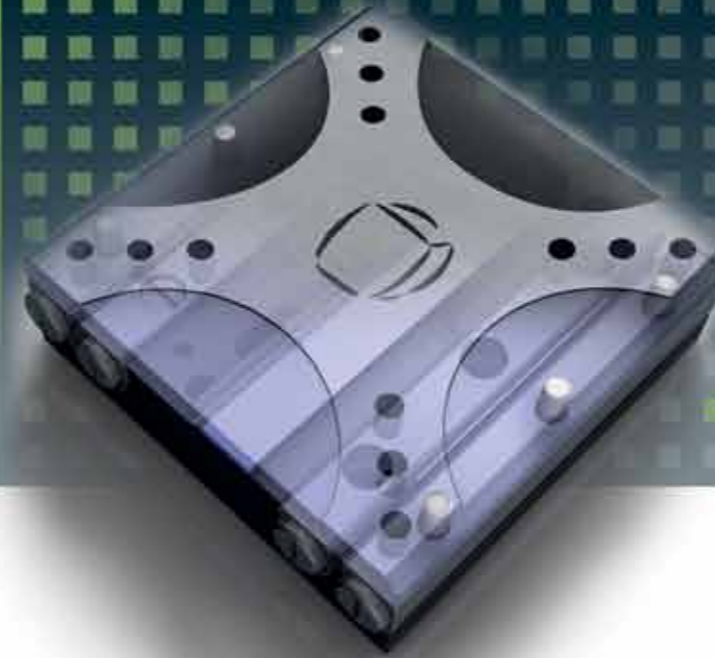


□ □ □ **NANOPOSITIONING**  
AT AMBIENT TEMPERATURE

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atto **EcoSmart Drive**  
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micro  
price

nano  
precise

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# attoEcoSmart Drive

Ultimate Economic Nanopositioners



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# 01

## ECOSMART DRIVE SERIES

### NANOPRECISE POSITIONING AT AMBIENT TEMPERATURE

With the attoECS series of positioners, attocube has genuinely combined highest precision piezodrive technology with extremely rugged yet cost efficient design. Positioners of the attoECS series are dedicated for operation at room temperature, at pressures ranging from ultra-high vacuum to ambient. With their crossed roller bearing-based guiding, ECS positioners are capable of loads of up to several kg and guiding errors of less than 0.1 mrad in pitch, yaw and roll. This powerful performance is supplemented by travel ranges up to 50 mm, step sizes as small as 50 nm, and optional position sensors for closed-loop operation with 10 nm resolution. ECS positioners are available in a full range of sizes 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 attoECS series, attocube now launches a new class of positioners dedicated for operation at ambient temperature and at pressures ranging from atmospheric to UHV.

The attoECS 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>1)</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 room temperature. The ECS series is capable of step sizes as small as 50 nm over the full travel range and drive velocities of up to 4.5 mm/s. Optional optical encoders with 10 nm resolution and  $\pm 200$  nm repeatability top off the specifications of the ECS series.

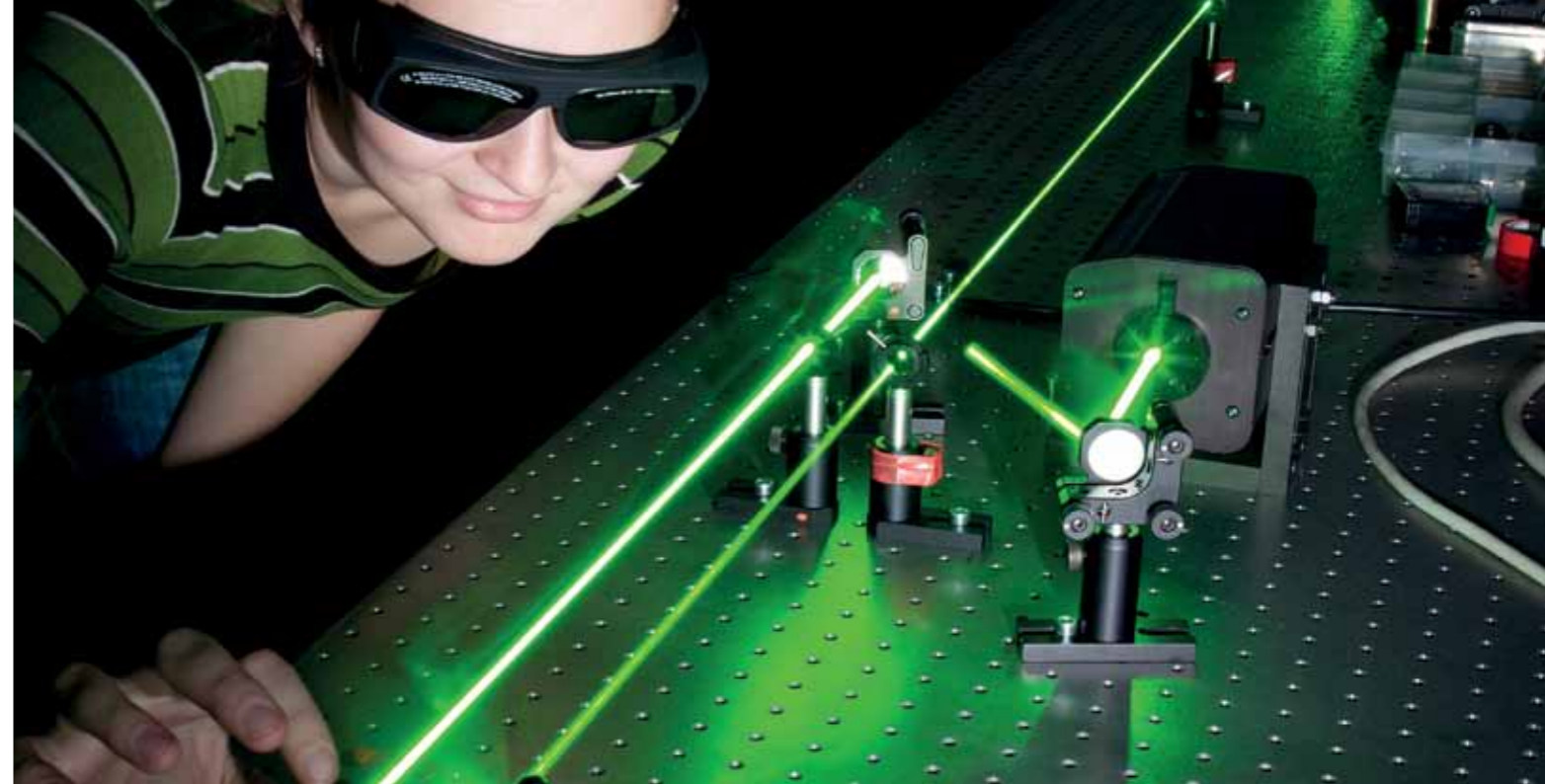
Special emphasis was put on cost efficient manufacturing. The room temperature optimized drive mechanism, combined with the choice of Aluminum or stainless steel as main body material, enable a significant cost reduction compared to positioners for extreme environments, while achieving ultimate performance.

attocube's ECS positioners are available in a wide variety of 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> 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**
- **Superior mechanical stability combined with cost efficient design**
- **Drive electronics operating at < 45 V, no need for specific high-voltage shielding (rated for low voltages)**
- **Optical Encoders with 10 nm resolution,  $\pm 200$  nm repeatability, and < 0.01% absolute accuracy**
- **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, economic positioning solution from the leaders in nanopositioning.



# PRODUCT QUICK FINDER

ECS NANOPOSITIONERS OFFERED BY ATTOCUBE SYSTEMS

Product Name	ECS3030	ECS3040	ECS3050	ECS3060	ECS3070	ECS3080
Encoder Option	optoelectronic (/NUM)	optoelectronic (/NUM)	optoelectronic (/NUM)	optoelectronic (/NUM)	optoelectronic (/NUM)	optoelectronic (/NUM)
Pressure Options	/HV, /UHV	/HV, /UHV	/HV, /UHV	/HV, /UHV	/HV, /UHV	/HV, /UHV
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>
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>
Materials	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
Stainless Steel	51 g	71 g	90 g	110 g	129 g	147 g
Blocking Force	4 N	4 N	4 N	4 N	4 N	4 N
Maximum Load <sup>1)</sup>	90 N	120 N	150 N	180 N	210 N	240 N
Maximum Velocity (@45V)						
@1kHz	1 mm/s	1 mm/s	1 mm/s	1 mm/s	1 mm/s	1 mm/s
@5kHz	4.5 mm/s	4.5 mm/s	4.5 mm/s	4.5 mm/s	4.5 mm/s	4.5 mm/s
Travel Range	20 mm	25 mm	30 mm	35 mm	40 mm	50 mm
Minimum Step Size	50 nm	50 nm	50 nm	50 nm	50 nm	50 nm
Fine Positioning Range	1.6 µm	1.6 µm	1.6 µm	1.6 µm	1.6 µm	1.6 µm
Guiding Accuracy						
Roll	Crossed Roller Bearing < 0.1 mrad	Crossed Roller Bearing < 0.1 mrad	Crossed Roller Bearing < 0.1 mrad	Crossed Roller Bearing < 0.1 mrad	Crossed Roller Bearing < 0.1 mrad	Crossed Roller Bearing < 0.1 mrad
Pitch	< 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
Sensor						
Resolution	/NUM 10 nm	/NUM 10 nm	/NUM 10 nm	/NUM 10 nm	/NUM 10 nm	/NUM 10 nm
Repeatability	± 200 nm	± 200 nm	± 200 nm	± 200 nm	± 200 nm	± 200 nm
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
						

<sup>1)</sup> Maximum drive performance applicable for horizontal mounting only.



# 04 Glossary

## PRECISION AND CONTROL

### 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 1kHz.

### 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.

### 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

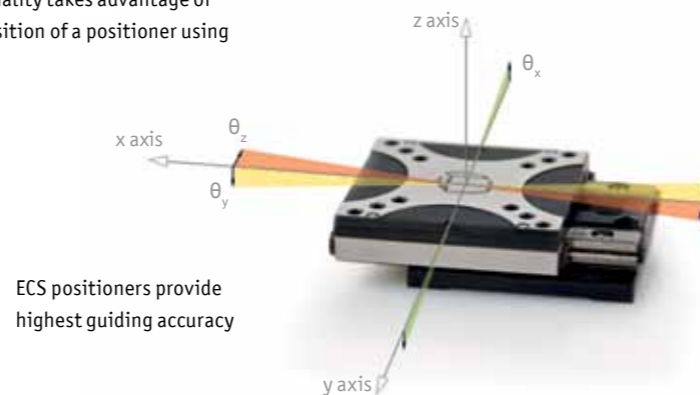
The closed-loop functionality takes advantage of measuring the actual position of a positioner using

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



# 05 Satisfied Customers

## CREATING WORLD WIDE SCIENTIFIC IMPACT

NASA - Jet Propulsion Laboratory (JPL) und Goddard Space Flight Center (GSFC), CalTech - California Institute of Technology, Cornell University, UC Berkeley, UC Santa Barbara, UC Los Angeles, UC San Diego, Yale University, Stanford University, Sandia National Lab, Livermore National Lab, Berkeley National Lab, Los Alamos National Lab, NIST - National Institute for Standards and Technology, University of Texas at Austin, IBM Almaden Research Center, Harvard University, K.U.Leuven - Katholieke Universiteit Leuven, CEA - Commissariat à l'Énergie Atomique, ENS Cachan, ESRF - European Synchrotron Radiation Facility, GHMFL - Grenoble High Magnetic Field Laboratory,

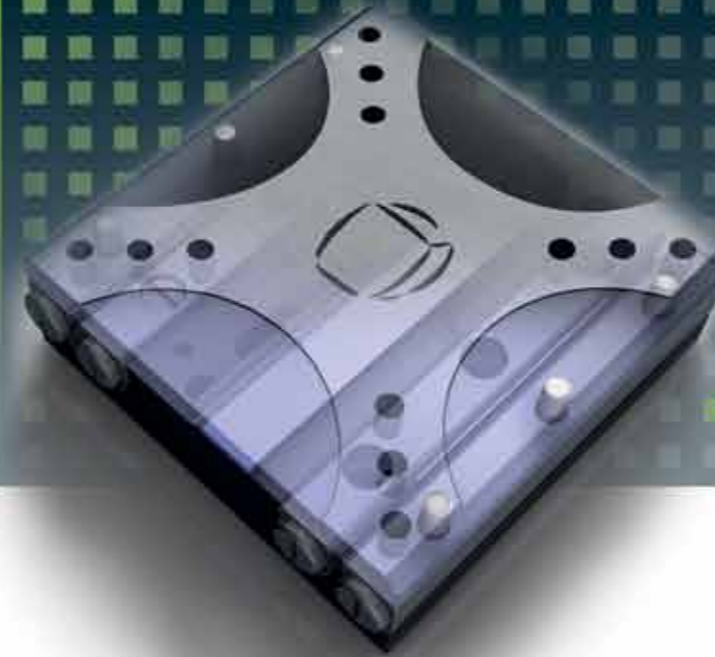
UJF - Université Joseph Fourier, UPS - Université Paul Sabatier, IRSAMC - The Institute of Research on Complex Atomic and Molecular Systems, CNRS Toulouse, CNRS Grenoble, EPFL - École Polytechnique Fédérale de Lausanne, UNIGE - Université de Genève, IBM Rueschlikon, ETH Zürich, Universität Zürich, DFG - Deutsche Forschungsgemeinschaft, Forschungszentrum Rossendorf, Universität Augsburg, FHI - Fritz-Haber-Institut der Max-Planck-Gesellschaft, TU Berlin - Technische Universität Berlin, UH - Universität Hamburg, PTB - Physikalisch-Technische Bundesanstalt, LMU - Ludwig-Maximilians-Universität München, TUM - Technische Universität München, FRMII - Forschungsreaktor Mün-

chen, MPI - Max-Planck-Institut für Polymerforschung, Toshiba Research Europe, Cambridge Research Laboratory, Cavendish Laboratory, UCL - University College London, Heriot-Watt University Edinburgh, University of Nottingham, RAL - Rutherford Appleton Laboratory, University of Surrey, TMU - Tokyo Metropolitan University, KEK - High Energy Accelerator Research Organization, NUS - National University of Singapore, Technion Haifa Israel, TATA Institute of Fundamental Research, ANU - Australian National University, ...

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