Motion & Sensing
piezo-based nanopositioners
attocube is the technology leader in piezo-based nanopositioning. The company stands out with patented technologies and years of experience in nanopositioning for extreme environments such as ultra-high vacuum, cryogenic to elevated operating temperatures, and high magnetic fields. The nanopositioner division focuses on the design, engineering and manufacturing of piezoelectric motor-driven stages and integrated nanopositioning solutions for applications with the highest requirements on resolution, precision and stability.

The portfolio covers linear, rotary, and goniometric positioners and scanners and combines motion over centimeter ranges with proven nanometer precision. Customized engineering solutions complete the portfolio. All components are developed, manufactured, and tested at the company’s headquarters in Germany. Years of experience and a highly skilled team guarantee highest levels of consulting competence and excellent after-sales support.
ambient & vacuum

attocube ambient and vacuum nanopositioners all incorporate a piezoelectric motor to achieve motion with nanometer precision and are available in a variety of different materials depending on the customer’s application. Nanopositioners for use in ambient conditions are made of lightweight and strong aluminium, while a stainless steel housing is compatible with vacuum conditions up to $5 \times 10^{-11}$ mbar and titanium is employed for nonmagnetic requirements. Different sizes and types of positioners are available for versatile needs. The bearing-based ECS series is a more rugged and cost efficient option, while the ANP series is suitable for special requirements such as limited space or non-magnetic demands. Use the product finder on the following pages to identify the most suitable model for your requirements.

## Ambient & Vacuum Nanopositioners

### Flexible Positioning

- Linear positioners: vertical/horizontal
- Gonimeters: $\Theta$ & $\Phi$ positioning
- Rotators: up to $360^\circ$
- Stacks: multi-axis positioning

### Extreme Environments

- Down to $5 \times 10^{-11}$ mbar UHV pressure
- Up to 350 Class 4 low particle generation
- Up to 150 °C bakeable
- Up to 35 T magnetic fields

### Precise & Powerful

- Down to 1 nm resolution
- Up to 240 N maximum load

### Clean Room

- Down to ISO Class 4 low particle generation
- Down to $5 \times 10^{-11}$ mbar UHV pressure
- Up to 360 °C
Customized Nanopositioning Solutions
nanopositioning tailored to your application

Many high precision applications have specific requirements concerning e.g. certification, travel range, or clean room compatibility. For these applications, attocube offers a broad range of customized components and sub-modules as well as integrated systems solutions, exactly tailored to the customers specific needs.

Combining attocube’s competencies in nanopositioning and interferometry with years of experience in challenging and extreme environments guarantees highest levels of consulting competence and products that work with highest reliability, pushing the limits of technical feasibility.

How do customizations work at attocube?
where ideas become results

Customer

Technical Team
application profiling

Application Development
feasibility study
prototyping

Engineering Development

Production Team
manufacturing & delivery

Integration

OEM

Design

 Manufacture

Expertise from design to manufacturing

Customized Solutions Examples

Spectroscopy Stage
Microscopy Stage
Multiaxis Solution
Imaging System

$\frac{\Delta f_{0}}{f_{0}}$

$\frac{\Delta f_{0}}{f_{0}}$

$\Delta f$

$\Delta f$

$\frac{\Delta f_{0}}{f_{0}}$

$\Delta f$

$\frac{\Delta f_{0}}{f_{0}}$

$\Delta f$

$\Delta f$

$\frac{\Delta f_{0}}{f_{0}}$

$\Delta f$

$\frac{\Delta f_{0}}{f_{0}}$

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$\Delta f$

$\frac{\Delta f_{0}}{f_{0}}$

$\Delta f$

$\frac{\Delta f_{0}}{f_{0}}$

$\Delta f$

$\Delta f$

$\frac{\Delta f_{0}}{f_{0}}$

$\Delta f$

$\frac{\Delta f_{0}}{f_{0}}$
Product Finder
which positioner fits your application?

The product finder helps you to identify the most suitable model for your requirements. It indicates the respective positioner series (ECS or ANP) and the suffix in the naming scheme of attocube nanopositioners (e.g. "/StSt" for stainless steel, "/Al" for aluminium etc.).

In step 1 you can opt for the respective working environment, while step 2 leads you to the desired direction of movement and step 3 indicates whether internal position control is required or not.

Step 1

attocube Nanopositioners

For Ambient Temperatures & Vacuum Conditions

Vacuum Nanopositioners

High Vacuum "/HV" down to 1e-8 mbar
ECS Series "/StSt/HV"

Ultra-high Vacuum "/UHV" down to 5e-11 mbar
ECS Series "/StSt/UHV"

Ambient Nanopositioners

Ambient Conditions "/RT" up to 1e-4 mbar
ECS Series "/Al/RT"

ANP Series "/RT, "/HV" or "/UHV"

Special Requirements "Space Constraints or Nonmagnetic Demands"

Step 2

Type of Motion

Scanning
Linear Movement
Rotary Movement
Goniometric Movement

Scanner "ANS"
Lin. Positioner "ANP" or "ECS"
Rotators "ANR" or "ECR"

Step 3

Position Control

Internal position control needed
No or external position control

Encoder

No Encoder

For ANP
Resistive Encoder "/RES"
Optoelectronic Encoder "/NUM" or "/NUM+"

For ECS
### Linear Positioners

#### Options
- Environment: /RT, /HV, /UHV
- Encoder: /NUM, /NUM+
- High Load: /HL(*)

#### Dimensions
- **Footprint; Height**
  - ECSx50180: 50 x 180; 11.5 mm
  - ECSx50120: 50 x 120; 11.5 mm
  - ECSx5050: 50 x 50; 9.5 mm
  - ECSxy5050: 50 x 50; 16.4 mm
  - ECSz5050: 50 x 50; 32 mm

#### Positioning Mode @ Ambient Conditions
- **Travel Range**
  - ECSx50180: 125 mm
  - ECSx50120: 80 mm
  - ECSx5050: 30 mm
  - ECSxy5050: 25 x 25 mm²
  - ECSz5050: 8 mm
- **Drive Velocity**
  - ECSx50180: 3 mm/s
  - ECSx50120: 3 mm/s
  - ECSx5050: 4.5 mm/s
  - ECSxy5050: 4.5 mm/s
  - ECSz5050: 2 mm/s
- **Maximum Load**
  - ECSx50180: 150 N
  - ECSx50120: 150 N
  - ECSx5050: 1 N
  - ECSxy5050: 2 N
  - ECSz5050: 8 N
- **Dynamic Drive Force**
  - ECSx50180: 5 N
  - ECSx50120: 5 N
  - ECSx5050: 1 N
  - ECSxy5050: (High Load * 5 N)
  - ECSz5050: 8 N

#### Closed Loop Features
- **Resolution**
  - ECSx50180: 1 nm
  - ECSx50120: 1 nm
  - ECSx5050: 1 nm
  - ECSxy5050: 1 nm
  - ECSz5050: 1 nm
- **Precision**
  - ECSx50180: 50 nm
  - ECSx50120: 50 nm
  - ECSx5050: 50 nm
  - ECSxy5050: 50 nm
  - ECSz5050: 100 nm

#### Naming Scheme
- **Type of Positioner**:
  - ECS: linear nanopositioner
  - x: enabling movement in x direction
  - y: enabling movement in y direction
  - z: enabling movement in z direction
- **Dimension**
  - Positioner Width in mm: 50 x x
  - Positioner Length in mm: 50 x x50

### Linear Positioners

#### Options
- Environment: /RT, /HV, /UHV
- Encoder: /NUM, /NUM+
- High Load: /HL(*)

#### Dimensions
- **Footprint; Height**
  - ECSx3080: 30 x 80; 9.5 mm
  - ECSx3050: 30 x 50; 9.5 mm
  - ECSx3030: 30 x 30; 9.5 mm
  - ECSx3030: 31 x 30; 11.5 mm

#### Positioning Mode @ Ambient Conditions
- **Travel Range**
  - ECSx3080: 125 mm
  - ECSx3050: 80 mm
  - ECSx3030: 50 mm
  - ECSx3030: 25 x 25 mm²
  - ECSx3030: 5 mm
- **Drive Velocity**
  - ECSx3080: 3 mm/s
  - ECSx3050: 3 mm/s
  - ECSx3030: 4.5 mm/s
  - ECSx3030: 4.5 mm/s
  - ECSx3030: 2 mm/s
- **Maximum Load**
  - ECSx3080: 150 N
  - ECSx3050: 150 N
  - ECSx3030: 1 N
  - ECSx3030: 2 N
  - ECSx3030: 8 N
- **Dynamic Drive Force**
  - ECSx3080: 5 N
  - ECSx3050: 5 N
  - ECSx3030: 1 N
  - ECSx3030: (High Load * 5 N)
  - ECSx3030: 8 N

#### Closed Loop Features
- **Resolution**
  - ECSx3080: 1 nm
  - ECSx3050: 1 nm
  - ECSx3030: 1 nm
  - ECSx3030: 1 nm
- **Precision**
  - ECSx3080: 50 nm
  - ECSx3050: 50 nm
  - ECSx3030: 50 nm
  - ECSx3030: 50 nm
  - ECSx3030: 50 nm

#### Naming Scheme
- **Type of Positioner**:
  - ECS: linear nanopositioner
  - x: enabling movement in x or y direction
  - xy: enabling movement in x and y direction
  - z: enabling movement in z direction
- **Dimension**
  - Positioner Width in mm: 50 x x
  - Positioner Length in mm: 50 x x50

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### Linear Positioners

<table>
<thead>
<tr>
<th>Options</th>
<th>ANPx341</th>
<th>ANPx321</th>
<th>ANPx312</th>
<th>ANPx311</th>
<th>ANPz102</th>
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<tr>
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<td>/RES</td>
<td>/RES</td>
<td>/RES</td>
<td>/RES</td>
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<tr>
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<td>/HL(*)</td>
<td>/HL(*)</td>
<td>---</td>
<td>/HL(*)</td>
<td>---</td>
</tr>
</tbody>
</table>

| Dimensions | footprint; height | 40 x 45; 11.5 mm | 40 x 41.6; 11.5 mm | 30 x 30; 12 mm | 30 x 30; 10 mm | 24 x 24; 27 mm |

<table>
<thead>
<tr>
<th>Positioning Mode @ Ambient Conditions</th>
<th>travel range</th>
<th>20 mm</th>
<th>15 mm</th>
<th>6 mm</th>
<th>6 mm</th>
<th>5 mm</th>
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<tr>
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<td>3 mm/s</td>
<td>3 mm/s</td>
<td>3 mm/s</td>
<td>3 mm/s</td>
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<td>20 N</td>
<td>20 N</td>
<td>20 N</td>
<td>2 N</td>
<td>2 N</td>
<td></td>
</tr>
<tr>
<td>dynamic drive force</td>
<td>2 N</td>
<td>2 N</td>
<td>2 N</td>
<td>2 N</td>
<td>2 N</td>
<td></td>
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<th>resolution /RES</th>
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<th>200 nm</th>
<th>200 nm</th>
<th>200 nm</th>
<th>200 nm</th>
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<tr>
<td></td>
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<td>1-2 μm</td>
<td>1-2 μm</td>
<td>1-2 μm</td>
<td>1-2 μm</td>
<td>1-2 μm</td>
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<table>
<thead>
<tr>
<th>Naming Scheme</th>
<th>Type of Positioner</th>
<th>Direction of Movement</th>
<th>Dimension</th>
</tr>
</thead>
<tbody>
<tr>
<td>ANP</td>
<td>linear nanopositioner</td>
<td>x enabling movement in x or y direction</td>
<td>3x positioner series with smallest available footprint</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2 enabling movement in z direction</td>
<td>5x positioners designed for 1” clear bore size</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>30x positioners designed for a 2” clear bore size</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3xx linear positioners with integrated bearings</td>
</tr>
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</table>

### Linear Positioners

<table>
<thead>
<tr>
<th>Options</th>
<th>ANPz101</th>
<th>ANPz101</th>
<th>ANPz51</th>
<th>ANPz51</th>
<th>ANPz30</th>
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<tbody>
<tr>
<td>encoder</td>
<td>/RES</td>
<td>/RES</td>
<td>/RES</td>
<td>/RES</td>
<td>---</td>
</tr>
<tr>
<td>high load</td>
<td>/HL(*)</td>
<td>/HL(*)</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
</tbody>
</table>

| Dimensions | footprint; height | 24 x 24; 20 mm | 24 x 24; 11 mm | 15 x 15; 13.5 mm | 15 x 15; 9.2 mm | ø 11; 12 mm |

<table>
<thead>
<tr>
<th>Positioning Mode @ Ambient Conditions</th>
<th>travel range</th>
<th>5 mm</th>
<th>5 mm</th>
<th>2.5 mm</th>
<th>3 mm</th>
<th>2.5 mm</th>
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<tbody>
<tr>
<td>drive velocity</td>
<td>3 mm/s</td>
<td>3 mm/s</td>
<td>1 mm/s</td>
<td>1 mm/s</td>
<td>1 mm/s</td>
<td></td>
</tr>
<tr>
<td>maximum load</td>
<td>2 N</td>
<td>1 N</td>
<td>0.5 N</td>
<td>0.25 N</td>
<td>0.1 N</td>
<td></td>
</tr>
<tr>
<td>dynamic drive force</td>
<td>5 N</td>
<td>2 N</td>
<td>1 N</td>
<td>1 N</td>
<td>0.2 N</td>
<td></td>
</tr>
</tbody>
</table>

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<thead>
<tr>
<th>Closed Loop Features</th>
<th>resolution /RES</th>
<th>200 nm</th>
<th>200 nm</th>
<th>200 nm</th>
<th>200 nm</th>
<th>---</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>precision /RES</td>
<td>1-2 μm</td>
<td>1-2 μm</td>
<td>1-2 μm</td>
<td>1-2 μm</td>
<td>---</td>
</tr>
</tbody>
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<table>
<thead>
<tr>
<th>Options</th>
<th>Environment</th>
<th>Encoder</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>/RT room temperature</td>
<td>/RES closed loop control based on a resistive encoder</td>
</tr>
<tr>
<td></td>
<td>/HV high vacuum</td>
<td></td>
</tr>
<tr>
<td></td>
<td>/UHV ultra-high vacuum</td>
<td></td>
</tr>
</tbody>
</table>
## Scanners

<table>
<thead>
<tr>
<th>Scanners</th>
<th>ANSx150</th>
<th>ANSxyz100/std</th>
<th>ANSxyz100/hs</th>
<th>ANSxy100/std</th>
<th>ANSxy100/fr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Options</td>
<td>environment</td>
<td>/RT, /HV, /UHV</td>
<td>/RT, /HV, /UHV</td>
<td>/RT, /HV, /UHV</td>
<td>/RT, /HV, /UHV</td>
</tr>
<tr>
<td>Dimensions</td>
<td>footprint; height</td>
<td>24 x 24; 9 mm</td>
<td>24 x 24; 10 mm</td>
<td>24 x 24; 10 mm</td>
<td>24 x 24; 10 mm</td>
</tr>
<tr>
<td>Scan Mode</td>
<td>fine positioning range @ 300 K</td>
<td>80 μm</td>
<td>125 μm</td>
<td>2 μm</td>
<td>40 μm</td>
</tr>
<tr>
<td></td>
<td>fine positioning range @ 4 K</td>
<td>50 x 50 x 24 μm³</td>
<td>30 x 30 x 15 μm³</td>
<td>9 x 9 μm³</td>
<td>9 x 9 μm³</td>
</tr>
<tr>
<td></td>
<td>maximum load</td>
<td>1 N</td>
<td>1 N</td>
<td>1 N</td>
<td>1 N</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Scanners</th>
<th>ANSz100/std</th>
<th>ANSz100/1r</th>
<th>ANSxyz50</th>
<th>ANSxy50</th>
<th>ANSz50</th>
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</thead>
<tbody>
<tr>
<td>Options</td>
<td>environment</td>
<td>/RT, /HV, /UHV</td>
<td>/RT, /HV, /UHV</td>
<td>/RT, /HV, /UHV</td>
<td>/RT, /HV, /UHV</td>
</tr>
<tr>
<td>Dimensions</td>
<td>footprint; height</td>
<td>24 x 24; 10 mm</td>
<td>24 x 24; 12 mm</td>
<td>15 x 15; 7 mm</td>
<td>15 x 15; 6 mm</td>
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<tr>
<td>Scan Mode</td>
<td>fine positioning range @ 300 K</td>
<td>24 μm</td>
<td>15 μm</td>
<td>30 x 30 x 4.3 μm³</td>
<td>2 μm</td>
</tr>
<tr>
<td></td>
<td>fine positioning range @ 4 K</td>
<td>15 μm</td>
<td>30 μm</td>
<td>0.5 N</td>
<td>0.5 N</td>
</tr>
<tr>
<td></td>
<td>maximum load</td>
<td>1 N</td>
<td>1 N</td>
<td>0.5 N</td>
<td>0.5 N</td>
</tr>
</tbody>
</table>

### Naming Scheme

<table>
<thead>
<tr>
<th>Type of Positioner</th>
<th>Direction of Movement</th>
<th>Dimension</th>
<th>Options</th>
<th>Environment</th>
</tr>
</thead>
<tbody>
<tr>
<td>ANS scanner</td>
<td>x</td>
<td>enabling movement in x direction</td>
<td>/std standard range option</td>
<td>/RT room temperature</td>
</tr>
<tr>
<td></td>
<td>xy</td>
<td>enabling movement in x and y direction</td>
<td>/lr large range option</td>
<td>/HV high vacuum</td>
</tr>
<tr>
<td></td>
<td>z</td>
<td>enabling movement in z direction</td>
<td>/hs high stability option</td>
<td>/UHV ultra-high vacuum</td>
</tr>
<tr>
<td></td>
<td>xyz</td>
<td>enabling movement in x, y and z direction</td>
<td>/std standard range option</td>
<td>/RT room temperature</td>
</tr>
<tr>
<td></td>
<td>5x</td>
<td>positions designed for a 1&quot; clear bore size</td>
<td>/lr large range option</td>
<td>/HV high vacuum</td>
</tr>
<tr>
<td></td>
<td>5sx</td>
<td>positions designed for a 2&quot; clear bore size</td>
<td>/hs high stability option</td>
<td>/UHV ultra-high vacuum</td>
</tr>
<tr>
<td></td>
<td>150</td>
<td>scanner with extended scan range at cryogenic temperatures</td>
<td>/std standard range option</td>
<td>/RT room temperature</td>
</tr>
</tbody>
</table>

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## Goniometers

### Options

<table>
<thead>
<tr>
<th></th>
<th>ECGp5050</th>
<th>ECGp5050</th>
<th>ANGt101</th>
<th>ANGp101</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environment</td>
<td>/RT, /HV, /UHV</td>
<td>/RT, /HV, /UHV</td>
<td>/RT, /HV, /UHV</td>
<td>/RT, /HV, /UHV</td>
</tr>
<tr>
<td>Encoder</td>
<td>/NUM, /NUM+</td>
<td>/NUM, /NUM+</td>
<td>/RES</td>
<td>/RES</td>
</tr>
<tr>
<td>High Load</td>
<td>/HL(*)</td>
<td>/HL(*)</td>
<td>---</td>
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### Dimensions

<table>
<thead>
<tr>
<th></th>
<th>footprint</th>
<th>height</th>
</tr>
</thead>
<tbody>
<tr>
<td>ECGp5050</td>
<td>50 x 50</td>
<td>17 mm</td>
</tr>
<tr>
<td>ECGp5050</td>
<td>50 x 50</td>
<td>17 mm</td>
</tr>
<tr>
<td>ANGt101</td>
<td>24 x 24</td>
<td>11 mm</td>
</tr>
<tr>
<td>ANGp101</td>
<td>24 x 24</td>
<td>11 mm</td>
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</tbody>
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### Positioning Mode @ Ambient Conditions

<table>
<thead>
<tr>
<th></th>
<th>travel range</th>
<th>drive velocity</th>
<th>maximum load</th>
<th>dynamic drive torque</th>
</tr>
</thead>
<tbody>
<tr>
<td>ECGp5050</td>
<td>10°</td>
<td>approx. 3°/s</td>
<td>10 N</td>
<td>7 Ncm (*)</td>
</tr>
<tr>
<td>ECGp5050</td>
<td>10°</td>
<td>approx. 3°/s</td>
<td>10 N</td>
<td>10 Ncm</td>
</tr>
<tr>
<td>ANGt101</td>
<td>6.6°</td>
<td>1°/s</td>
<td>1 N</td>
<td>1 N</td>
</tr>
<tr>
<td>ANGp101</td>
<td>5.4°</td>
<td>1°/s</td>
<td>1 N</td>
<td>10 Ncm</td>
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</tbody>
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### Closed Loop Features

<table>
<thead>
<tr>
<th></th>
<th>resolution</th>
<th>precision</th>
</tr>
</thead>
<tbody>
<tr>
<td>ECGp5050</td>
<td>1 µ° (NUM)</td>
<td>50 µ° (NUM)</td>
</tr>
<tr>
<td>ANGp101</td>
<td>0.1° (RES)</td>
<td>2 m° (RES)</td>
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</tbody>
</table>

### Naming Scheme

<table>
<thead>
<tr>
<th>Type of Positioner</th>
<th>Direction of Movement</th>
<th>Dimension</th>
<th>Options</th>
<th>Environment</th>
<th>Encoder</th>
</tr>
</thead>
<tbody>
<tr>
<td>ECG goniometer</td>
<td>p</td>
<td>50x</td>
<td>/HL</td>
<td>/RT</td>
<td>/NUM</td>
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<tr>
<td>ANG goniometer</td>
<td>t</td>
<td>x50</td>
<td>/HL</td>
<td>/HV, /UHV</td>
<td>/RES</td>
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</tbody>
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**Motion & Sensing**

Precision Engineering Components
## Rotators

### Options

<table>
<thead>
<tr>
<th>Dimensions</th>
<th>footprint; height</th>
<th>Env.</th>
<th>Encoder</th>
<th>High Load</th>
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</thead>
<tbody>
<tr>
<td>ECR5050hs</td>
<td>50 x 50; 15 mm</td>
<td>/RT, /HV, /UHV</td>
<td>/NUM, /NUM+</td>
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</tr>
<tr>
<td>ECR4040</td>
<td>40 x 40; 14.5 mm</td>
<td>/RT</td>
<td>/NUM</td>
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<tr>
<td>ECR3030</td>
<td>30 x 30; 13.5 mm</td>
<td>/RT, /HV, /UHV</td>
<td>/RES</td>
<td>---</td>
</tr>
<tr>
<td>ANR240</td>
<td>35 x 35; 13.5 mm</td>
<td>/RT, /HV, /UHV</td>
<td>/RES</td>
<td>---</td>
</tr>
<tr>
<td>ANRv220</td>
<td>27 x 12; 27 mm</td>
<td>/RT, /HV, /UHV</td>
<td>/RES</td>
<td>---</td>
</tr>
</tbody>
</table>

### Positioning Mode & Ambient Conditions

<table>
<thead>
<tr>
<th>Positioning Mode</th>
<th>Travel Range</th>
<th>Drive Velocity</th>
<th>Max Load</th>
<th>Dynamic Drive Torque</th>
</tr>
</thead>
<tbody>
<tr>
<td>@ Env.</td>
<td>approx. 10°/s</td>
<td>20 N</td>
<td>20 N</td>
<td>5 N cm</td>
</tr>
<tr>
<td>@ High Load</td>
<td>approx. 10°/s</td>
<td>20 N</td>
<td>20 N</td>
<td>5 N cm</td>
</tr>
<tr>
<td>@ Ultra-High</td>
<td>approx. 10°/s</td>
<td>20 N</td>
<td>20 N</td>
<td>5 N cm</td>
</tr>
</tbody>
</table>

### Closed Loop Features

<table>
<thead>
<tr>
<th>Resolution</th>
<th>Precision</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.01 m° (NUM)</td>
<td>1 m° (NUM)</td>
</tr>
<tr>
<td>0.04 m° (NUM)</td>
<td>4 m° (NUM)</td>
</tr>
<tr>
<td>0.02 m° (NUM)</td>
<td>1 m° (NUM)</td>
</tr>
<tr>
<td>0.06 m° (RES)</td>
<td>50 m° (RES)</td>
</tr>
<tr>
<td>0.1 m° (RES)</td>
<td>50 m° (RES)</td>
</tr>
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</table>

### Naming Scheme

- **ECR**: rotator
- **ANR**: rotator
- **v**: horizontal rotation axis

---

## Rotators

### Options

<table>
<thead>
<tr>
<th>Dimensions</th>
<th>footprint; height</th>
<th>Env.</th>
<th>Encoder</th>
<th>High Load</th>
</tr>
</thead>
<tbody>
<tr>
<td>ANR101</td>
<td>24 x 24; 15.2 mm</td>
<td>/RT, /HV, /UHV</td>
<td>/NUM, /NUM+</td>
<td>---</td>
</tr>
<tr>
<td>ANRv51</td>
<td>10 x 20; 21 mm</td>
<td>/RT, /HV, /UHV</td>
<td>/RES</td>
<td>---</td>
</tr>
<tr>
<td>ANR51</td>
<td>15 x 15; 9.5 mm</td>
<td>/RT, /HV, /UHV</td>
<td>/RES</td>
<td>---</td>
</tr>
<tr>
<td>ANR31</td>
<td>ø 10; 7.5 mm</td>
<td>/RT, /HV, /UHV</td>
<td>/RES</td>
<td>---</td>
</tr>
</tbody>
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## Naming Scheme

- **hs**: high stability option
- **/RT**: room temperature
- **/HV**: high vacuum
- **/UHV**: ultra-high vacuum
- **/NUM**: closed loop control based on an optoelectronic encoder
- **/RES**: closed loop control based on a resistive encoder
Controller Overview
piezo positioning electronics and accessories

Highest-precision piezo positioning systems require state-of-the-art control electronics. attocube’s FPGA-based motion controllers are adapted to the technical challenges of positioners and scanners dedicated for cutting-edge applications and experiments. The AMC100 tabletop controller is the model of choice for applications with ECS-series positioners, while the ANP-series nanopositioners are accompanied by 19” rack electronics for laboratory environments. Suitable accessories for attocube’s positioners are listed below.

AMC100
• OEM board available (JMC)
• Ethernet or USB (with adapter) connectable
• optional I/O upgrade
• optional Pro upgrade

ANC250
• ultra low noise scan voltage amplifier (20 μV rms)
• three channels with up to 200 V (differential)

ANC300
• modular design
• slots for up to 7 plug-in modules
• combined stepping & scanning possible
• controlling via frontpanel or PC

ANC350
• position readout
• piezo grounding on target position
• controlling via frontpanel or PC
• combined stepping and scanning possible

Toolbox
• including titanium screws, pin plugs, wires, base plates, screwdrivers and a tweezer
• available for ambient or vacuum conditions or as RES toolbox (integration of an ANP/RES)

Vacuum Feedthrough Solution
• for connecting positioners mounted in a vacuum chamber to the motion controller
• different sizes are available
• suitable cabling is available

Adapters Plates AAP & EAP
• for vertical mounting of ANP positioners
• for cross-mounting of differently sized ANP & ECS positioners

ECS Lift 3030/5050
• suitable for ECSx3030 and ECSx5050
• for lifting high loads exceeding the capabilities of the ECSx3030 or ECSx5050
• ultra-high vacuum compatible

ECS Lift 3030/5050
• suitable for ECSx3030 and ECSx5050
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Vacuum Feedthrough Solution
• for connecting positioners mounted in a vacuum chamber to the motion controller
• different sizes are available
• suitable cabling is available

Accessories

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High precision applications in science and technology require nanotechnology solutions that deliver highest resolution and stability. Additionally, they are often conducted under extreme conditions such as ultra-high vacuum, high magnetic fields or radiation harsh environments.

attocube positioners are designed for a broad range of applications where highest precision, reliability, space constraints, or challenging environmental conditions are key. In this section you will find a snapshot of the main application fields and some dedicated application examples. Contact us to discuss your special requirements and setup.

**Microscopy Application**
precise motion for microscopes

**Nanoprecise Positioning**
multiple axis positioning stages

**Synchrotron**
precision motion control

**Semicon**
ultra-high precision components

**Quantum Optics**
reliable and precise positioning
In lithography and metrology processes, the precise alignment and filtering of the beam is directly related to the wafer’s quality. The laser beam produces photons that are collected via a gathering mirror and directed via different apertures to hit, e.g., the reflection mask.

**attocube’s solution:**

attocube’s nanopositioners are designed to operate with low particle generation at high temperatures and vacuum with nanometer precision. These features make them the perfect choice for reliable aperture control under extreme conditions.

**Benefits:**
- nanometer precision
- UHV compatibility down to $5 \times 10^{-11} \text{ mbar}$
- coarse & fine movement

During the metrology process in the wafer production, the light or laser beam path have to be precisely and continuously adjusted to perform the relevant controls over the whole wafer surface in order to detect imperfections and provide certain results on the wafer’s quality.

There are different kinds of inspections:
- Unpatterned wafer inspection where the goal is to identify particles and pattern defects and link those to a specific position on the wafer.
- Patterned wafer inspection which identifies geometry imperfections via the comparison with a “golden” dye and lasts the reticle inspection which helps to identify single defects on a wafer reticle. This last inspection is usually performed by using UV illumination.

**attocube’s solution:**

attocube’s nanopositioners are used in critical, ultra-precise motion applications due to the superior accuracy, repeatability & resolution. These unique features together with high reliability are providing a solution for a continuous and stable beam alignment within the metrology process.

**Benefits:**
- high stability
- goniometer resolution $1 \mu^\circ$
- rotator resolution $10 \mu^\circ$

**Challenge:**

Laser Beam Adjustment

During the metrology process in the wafer production, the laser beam path have to be precisely and continuously adjusted to perform the relevant controls over the whole wafer surface in order to detect imperfections and provide certain results on the wafer’s quality.

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Experiments at large-scale facilities often require beamlines which offer flexible and accurate positioning options. Multiple stages carrying different optical components or samples are being moved in and out the beam repeatedly. Therefore, it is key condition to operate the stages with high speed, but also to fine position the sample with highest accuracy and repeatability with respect to the beam.

Challenge:
attocube’s solution:
attocube’s positioner portfolio offers multiaxial solutions for these experiments, combining long travel ranges and high speed with maximum precision for coarse positioning. The positioners can be stacked to multi-axis devices and are available for vacuum conditions up to 5 x 10⁻¹¹ mbar.

Benefits:
• nanometer accuracy
• extra long travel ranges
• harsh environment compatibility

Sample Motion Control in the Beamline

Measurements in Synchrotron Radiation

Challenge:
attocube’s solution:
attocube’s positioners can be combined for multidimensional configurations, and are compatible with variable temperatures, high magnetic fields and radiation. In this particular example, the nanopositioners serve as key elements of the Hall bar bench achieve the necessary accuracy of the Hall-probe orientation relative to the undulator’s magnetic axis.

Benefits:
• high size flexibility
• radiation compatibility
• high stability

At large-scale facilities, there are a number of generic nanopositioning tasks to be performed under harsh environments such as ultra-high vacuum or radiation. Undulators are the key assemblies for generating synchrotron radiation in light sources. In order to optimize the resulting photon energy, the magnetic properties of cryogenic undulators need to be characterized precisely at different temperatures by movable Hall probes.

Benefits:
• high size flexibility
• radiation compatibility
• high stability

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In order to perform microscopy and spectroscopy experiments achieving image resolution at the nm level it is necessary to control and maintain temperature, humidity and pressure as stable as possible over time. Mounting a complete system into a controlled environment is often limited by the dimension of the setup itself. Therefore, it is necessary to minimize the footprint and enhance the instrument performance to achieve a nanometer resolution.

**Challenge:**

attocube’s solution:

A combination of small sized piezo positioners and scanners provides the necessary millimeter travel range for alignment and imaging the sample with the required resolution. Using a laser interferometer as feedback allows the customer to monitor the motion with a resolution of 1pm ensuring nanometer precise closed-loop positioning.

**Benefits:**

- nanometer resolution
- harsh environment compatibility (ultra high vacuum or radiation)
- limited footprint of only several square centimeters

**Challenge:**

Raman signals can be enhanced by placing a sample in a microcavity. In order to acquire high-resolution Raman images, ultra accurate positioning of the microcavity is necessary. Each Raman spectrum is contributing to the final step-scanned image. Therefore, the microcavity has to be moved with nanometer sized steps.

**attocube’s solution:**

attocube nanopositioners combine movements over millimeters with nanometer accuracy. Typical samples are of the millimeter size. Hence it is possible to navigate and find a micrometer sized region of interest, perform there step scans with nanometer step size, and thus create high-resolution images.

**Benefits:**

- accurate movement on different scales: millimeter – micrometer – nanometer
- coarse & fine movement
- step size in the nm-range
Positioners for Microscopy

**Challenge:**
Target motion in optical imaging requires fast and highly accurate sample positioning. The relative and precise positioning of samples with respect to an objective or probe head such as an AFM cantilever is a key condition for reliable and reproducible measurement results.

**attocube’s solution:**
attocube’s customizable monolithic xy microscopy stage offers highest precision motion on the nanometer scale over several centimeter travel range, making it the perfect solution for OEMs in the microscopy sector. Furthermore, this piezo driven stage offers high drive velocity (up to 25 mm/s) combined with a bi-directional repeatability of better than 50 nm.

**Benefits:**
- Velocity > 25 mm/s
- Repeatability < 50 nm
- Monolithic

3D Imaging System

**Challenge:**
Optical studies in life science typically require investigating samples over cm ranges with sub-micrometer resolution. In addition, fast acquisition times are a key requirement to avoid drift and hence blur during the acquisition process. Last but not least, high position repeatability enables precisely retrieving regions-of-interest and navigation on known samples.

**attocube’s solution:**
attocube’s ECS series are used to move and align the sample under the microscope. Thanks to the ultraprecise motion, superior resolution (down to 1 nanometer) and repeatability (50 nm), the nanopositioners are perfectly suited for these applications providing the necessary stability to avoid scattering and blur images.

**Benefits:**
- High stability
- Resolution 1 nm
- Repeatability 50 nm
Nanoprecise Positioning

Extending human touch with a haptic interface to enable manual exploration and manipulation of micro and even nanostructures is one key goal for robotics on small scales. In this example, precise movement of 10 – 100 µm large objects in 3D space, and a high degree of stability of the positioning setup is required. Furthermore, any external noise to the haptic device has to be below the feedback in the µN-range of the sample.

**Challenge:**
attocube’s solution:
attocube nanopositioners perform nanometer sized individual steps in three dimension. The small step size is suitable for macroscopic movement when performed at a high repetition rate. Meanwhile, each individual step is only a tiny disturbance to the microgripper of the sample due to the differences in size of three orders of magnitude.

**Benefits:**
- nanometer accuracy
- vacuum compatible
- stackable positioners (up to 6 degrees of freedom if required)

Micromechanical Testing on Silver Nanowires

The small specimen size often imposes significant difficulties for preparation and testing. This challenge can be overcome with a micro-electromechanic system that allows mechanical testings on nanowires. The possibility to develop such system passes also through the micromanipulation of the nanowires with a nanometer precision.

**Challenge:**
attocube’s solution:
A stack of 3 ECS piezo positioners allows the micromanipulation of the nanowires in 3 different axis (XYZ) ensuring nanometer repeatability in order to perform simultaneously four point electric measurement by enabling the piezo-resistivity via a micromechanical testing system.

**Benefits:**
- smooth movement
- high accuracy positioning readout
- programmable functions through .vi and .dll
Scanners and Stepping Positioners

All attocube scanners and stepping positioners are driven via piezoceramics made from lead zirconate titanate (PZT) for voltages < 150 V. The PZT for cryogenic scanners and steppers is optimized for maximal performance under these conditions.

Working Principle of Stepping Positioners

1. At Rest
   - Fixed frame axis
   - Flexible membrane
   - Clamped table
   - Guiding rod connected to piezo element
   - No voltage applied
   - Table at rest

2. Sticking Phase
   - Sawtooth shaped voltage is applied to piezo
   - With the slow flank, table sticks to guiding rod
   - Table overcomes friction and disengages from drive element
   - Table completed net step

3. Slipping Phase
   - Steep flank of voltage, the rod is accelerated fast
   - Table overcomes friction and disengages from drive element
   - Step is completed

Environmental Conditions

attocube’s nanopositioners can be used in different environmental conditions such as ultra-high vacuum. One or more suitable suffixes in the article name describe the environment for which a nanopositioner is designed and tested in-house. Moreover, all ANP nanopositioners are suitable for measurements in a magnetic field as they are built of completely non-magnetic materials.

Position Control

Most of attocube’s nanopositioners are available in open and closed loop versions.

- RT – Room Temperature
  - RT positioners are manufactured for use at ambient conditions (room temperature, dry atmosphere, pressure above 10^-6 mbar).

- /HV – High Vacuum
  - At attocube the high vacuum range is specified down to 10^-6 mbar.

- /UHV – Ultra-High Vacuum
  - The ultra-high vacuum range is specified down to 5x10^-10 mbar for most of our positioners. A few rotators and goniometers use UHV compatible grease. Due to the increased outgassing of these types at elevated temperatures we specify them for 10^-3 mbar as a precaution (noted in specification sheets). Most of our positioners can be baked out up to 150 °C.

- /UUT – (Ultra-) Low Temperature
  - These positioners are suitable for repeated cooling and operation in cryogenic temperatures.

Resistive Encoder (/RES)

A Resistive encoder (/RES) is used for our ANP nanopositioners. The working principle of this encoder type is based on a potentiometer. It is the method of choice for applications at cryogenic temperatures, ultra high vacuum and highest magnetic fields. The /RES encoder measurement refers to the absolute sample position, for most linear steppers a repeatability of 3 μm is achieved. For ultra low temperatures (T < 1 K) a special /RES+ sensor is available which is included in all our /ULT models.

Optoelectronic Encoder (/NUM)

The usage of a glass grating and the interpretation of the generated Moiré pattern characterizes the working principle of the /NUM and /NUM+ encoder. The measurement refers to the relative sample position with a position resolution of 1 nm and a repeatability of typically 50 nm for most linear stepping positioners. An absolute position information is also available via a reference mark. The + version /NUM+ features a reduced thermal dissipation of only 50 mW making it especially suited for /HV and /UHV positioners. The /NUM and /NUM+ encoders are available for our ECS series positioners.
For the standard ANPxyz-configuration, two x-positioners (one rotated by 90°) are mounted on top of a z-positioner.

Terminology
glossary

The modular concept of attocube positioners in combination with a consequent use of similar mounting patterns enables the assembly of multi-axis positioning units composed of (several) different types of nanopositioning stages. By merging several positioning units with distinct travel ranges and motion options, motor assemblies with up to six degrees of freedom can be built.

Each size of goniometer is available in two versions which are usually used as a pair for theta ($\Theta$) and phi ($\Phi$) motion. The theta positioner mounted on top of the phi positioner they form a tip-tilt stage with a common center of rotation. Mounting is done directly via two or four screws.

Cross mounting rules
Following general rules apply for building multi-dimensional setups:

- A positioner with a lower number should not be used to support one with a larger number, e.g. an ANPx51 should not carry an ANPz101.
- Cross mounting between two differently sized models (e.g. a 51 series positioner on top of a 101 positioner) may necessitate an adapter plate (see adapter plates overview in accessories section on our webpage).
- All bearing-based positioners (ANPx3*1 series) can be mounted on a L-bracket which enables vertical positioning with loads corresponding to the specified dynamic force for the respective positioner.

Combining Goniometers
Each size of goniometer is available in two versions which are usually used as a pair for theta ($\Theta$) and phi ($\Phi$) motion. The theta positioner mounted on top of the phi positioner they form a tip-tilt stage with a common center of rotation. Mounting is done directly via two or four screws.

Combinations with other positioners are explained above respectively in the accessories sections on our webpage.

Sensor Resolution
The measurement resolution is the smallest increment of displacement that the sensor can read.

Sensor Accuracy
Measurement accuracy describes the closeness of agreement of the displacement measurement value of the used sensor compared to the true target displacement value (see Figure 1). A high accuracy of the measured values implies minimized systematic errors. The accuracy of the sensor is dependent on different environmental factors.

Sensor Repeatability
The sensor precision is the position uncertainty when approaching a certain target value from one side (uni-directional precision, e.g. /RES). At attocube, the sensor precision is specified for a positioner and a measurement bandwidth. That means positioner-specific parameters contribute to the sensor precision. The precision is defined as the measurement’s standard deviation ($\sigma$).

Additional Info

glossary

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Combinations with other positioners are explained above respectively in the accessories sections on our webpage.
What is the difference between the ANP-series and the ECS-series?
• The ECS-series is a dedicated industrial series which is bearing based, cost efficient and convinces with a rugged design and high load capacities. The ECS/RT models are made out of aluminum and the ECS/(U)HV out of stainless steel. The ANP-series is more research focused with smaller footprints and a nonmagnetic positioner body out of titanium.

What is meant with “open loop” and “closed loop”?
• The positioners without an encoder are driven in “open loop” – those positioners can only be driven forward or backward without an actual readout of the position. Whereas the positioners with an /NUM or /RES encoder are driven in “closed loop” mode, which means that a feedback loop integrated into the control electronics minimizes the difference between target position and actual position.

What is the difference between NUM and NUM+?
• The NUM+ encoder features a reduced thermal dissipation of only 50 mW making it especially suited for /HV and /UHV positioners. The necessary amplifier has been detached from the sensor itself and placed in the connector of the cable outside of the vacuum chamber.

Is the controller included with the purchase of a positioner? What else do I need?
• A motion controller is not included with the positioner. attocube’s sales engineers help you to find the suitable motion controller as well as cables. Moreover, there are different kinds of accessories like feedthroughs or adapter plates.

What is the difference between /HV and /UHV positioners?
• For the /UHV positioners special UHV compatible (i.e. not outgassing) materials are used. Moreover, a test in a baked out UHV environment is performed for all UHV positioners to guarantee full functionality usually down to 5x10⁻¹¹ mbar. Please note, our ECS-series rotators and goniometers are specified for 10⁻⁹ due to a special UHV compatible grease.

What is the temperature range for the positioners? Are they bakeable?
• All attocube open loop positioners and all closed loop positioners of the ANP-series (/RES & /RES+) are specified from 0°C to 100°C (dedicated low temperature positioners are specified down to the mK range). ECS positioners with a /NUM encoder work up to a temperature of 100°C (/NUM+ up to 95°C). All UHV positioners can be baked out up to 150°C.

What is the load capacity in a specific environment or mounting direction?
• All positioners are specified at ambient conditions. For specific requests please contact attocube’s sales engineers.

There is only limited space available for my setup, are there positioners with a comparatively small footprint?
• Yes, the ANP-series positioners all have a relatively small footprint starting at 15 x 15 mm.

What is the difference between accuracy and precision?
• Please refer to the glossary.