Overview

EcoSmart Drives are engineered for room temperature application, where large travel distances combined with significant load are often required. Crossed roller bearings provide the necessary mechanical rigidity in combination with highest guiding accuracy.

EcoSmart Drives are typically fabricated from high-quality aluminum. An anodized finish makes them most suitable for optical applications, where low reflectivity of the body material is advantageous. For optimum durability and low outgassing rates, stainless steel versions are available as well.

EcoSmart Drives can be used to rotate, tilt, or linearly displace a sample or device. In addition, they can be combined to form stacks with multiple degrees of freedom. Each EcoSmart Drive is available as open-loop and closed-loop device.

EcoSmart Drives are powered with attocube's dedicated EcoSmart Controller ECC100. Other models of attocube's controller product line, such as ANC150, ANC300 or ANC350 also drive the EcoSmart Drives. The ECC100 and the ANC350 are capable to read the out the sensor signals from the optoelectronic position sensor.

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pioneers of precision

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ECS3030, ECS3040, ECS3050, ECS3060, ECS3070, ECS3080
ECS3030/NUM, ECS3040/NUM, ECS3050/NUM, ECS3060/NUM,
ECS3070/NUM, ECS3080/NUM
ECS5050, ECS5050/NUM
ECR3030, ECR4040, ECR5050
ECR3030/NUM, ECR4040/NUM, ECR5050/NUM
ECGp5050, ECGt5050, ECGp5050/NUM, ECGt5050/NUM

Specifications: /RT, /HV, /UHV

User Manual
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Safety Information

For the protection of the equipment, the operator should take note of the **Cautions**, and **Notes** throughout this handbook.
The following safety symbols may be used throughout the handbook:

Caution. An instruction which draws attention to the risks of damage to the product, process, or surroundings.

Note. Clarification of an instruction or additional information.

Important Warnings – Read this Section First!

Switch the electronics to GND mode during baking out of the EcoSmart Drives.
When the temperature changes, piezos may change their length and therefore, charges may accumulate. To avoid static charges that might damage the EcoSmart Drive, we suggest connecting the cabling to the controller (GND mode or switched off).

Never attempt to operate the EcoSmart Drive in a condensing atmosphere.
Never operate EcoSmart Drives when condensation of water or ice may occur, e.g. when the EcoSmart Drive is significantly colder than the surrounding environment.

Avoid overheating of the piezos.
At room temperature, overheating of the piezos poses a risk, especially with reduced cooling in vacuum environments. Please take care not to apply more than 45 V and 1000 Hz in such cases. Please note that the heating scales with P ~ U2 C f.

Do not use any grease to lubricate the friction surfaces.
The travel mechanism of the EcoSmart Drives relies on friction and this friction is precisely adjusted by attocube systems' engineers. Any change of this friction may prevent the EcoSmart Drives from working. If you use vacuum grease in your setup, please take care that no grease is dropped onto the EcoSmart.

Never attempt to clean the EcoSmart Drive by immersion into any liquid.
The piezo elements are sensitive to any kind of liquid. Ion currents can cause leakage paths in the piezo causing irreversible damage.
Please note that all parts of EcoSmart Drives are cleaned in our production facility. If any surface is contaminated nevertheless, please clean all surfaces as follows only:

- In case there are dust particles on the surface, please use dust and oil free air to clean them off.
- In the rare event of dirt on the surface, please use a dust-free tissue or a cotton swab slightly tinctured with isopropanol or acetone to clean the surface. Please clean only the metallic parts of the surface, otherwise the lubrication of the axis or the glued parts may be damaged. Please make sure that no droplets of solvent get into contact with the friction surfaces, the piezo, or the glued parts of the EcoSmart Drives.

Because of the inherent fragility of the ceramic piezo stacks used in the EcoSmart Drives, no responsibility can be taken by the manufacturer for breakdowns of the ceramic piezo stacks. In case of breakage, please contact the manufacturer for details of the repair service.

The Positioning Technology
Working Principle

The slip-stick travel mechanism is a technology which enables motion of objects by repeated expansion of a piezo actuator. The slip-stick mechanism utilizes static friction and impulsive forces caused by a rapid displacement of the actuator to switch between different states of motion, namely "slip" and "stick". The design of the positioner basically consists of three parts: the main body, the actuator, and the clamped table.

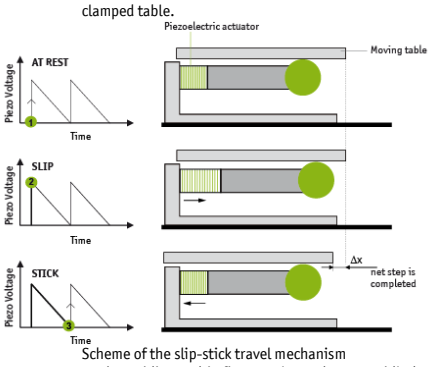

Figure 1: *Slip-stick mechanism. Rapid backward movement of the actuator as the table remains stationary (1-2). Slow forward movement of the actuator as the clamped table is moved along (2-3).*

Scheme of the slip-stick travel mechanism
1 .The guiding rod is first accelerated very rapidly by a ceramic piezo over a short period of time so that the inertia of the sliding block overcomes the friction. (Figure 1.1)
2. This way, the sliding block disengages from the accelerated rod and remains nearly stationary. (Figure 1.2)
3. Subsequently, the guiding rod moves back to its initial position slowly enough so that the sliding block this time sticks to it, thus causing a net step. (Figure 1.3)
The sum of several of these steps allows a theoretically infinite workspace with very high resolution. Smooth control of the actuator enables fine positioning of the clamped table. The resolution, which is determined exclusively by the (frictionless) actuator and the electric circuitry (for piezoelectric elements), reaches the nanometer range.

The step size is typically a linear function of the applied voltage (beginning at a minimum starting voltage), and is only slightly dependent on the step frequency. Please note that the onset of motion does not occur at 0 V, but rather at a certain threshold. Additional measurements show that at a given frequency and applied voltage, the step size repeatability is typically better than 5 %. At the onset of the motion, this asymmetry might be higher. The step size in forward motion is usually higher than in backward motion.
As the operating principle is based on friction, attocube systems cannot guarantee any certain step size at a given voltage and frequency. Please refer to the specification sheet for a typical step size range at a given temperature and environment. Note that the step sizes may vary from one EcoSmart Drive to the other.

General Handling of EcoSmart Drives

EcoSmart Drives can be combined modularly. It is typical to build e.g. an XYZ stage by mounting three EcoSmart Drives on top of each other: One ECS3030 attached to an L-Holder on top of two ECS3030 with perpendicular orientation. This way, an XYZ stack is created (see Figure 2).

The rules and hints given for this set are also applicable for other combinations of EcoSmart Drives.

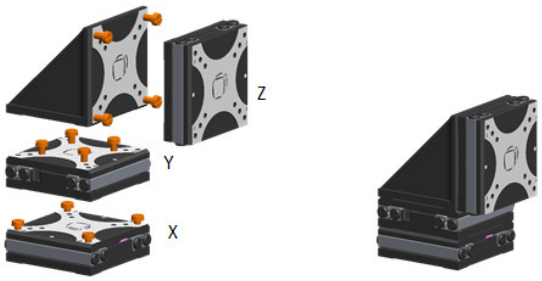

Figure 2*: XYZ EcoSmart Drive stack with three axis of motion assembled from three ECS3030 and an L-holder.*

Unpacking and Mounting

Please have a soft foam plate or a similar shock-absorbing pad underlying when handling the EcoSmart Drives. The pad helps to avoid damage and/or breakage of the piezo electric element in case is the positioner is accidentally put down too hard!

The piezoelectric stack elements are unipolar and can only be used in the specified range of positive voltages. Please refer to the specification sheets delivered with the EcoSmart Drives.

In the following an XYZ stack, exemplary consisting of three ECS3030, is assembled with illustrations. The first step for assembling this stack is to mount one of the ECS3030, Y, on top of a second ECS3030, X, as displayed in Figure 3.

Next, mount the third ECS3030, Z, on the L-holder using the second set of M2x8 screws (see Figure 4). Finally this assembled part is mounted on top of the XY stack assembled before (see Figure 5).

It is essential to assemble these two parts in such a way that the Y axis does not interfere with the Z axis. That means that only the X axis may move underneath the Z axis (see Figure 6).

Do not interfere with the setscrew indicated in Figure 7 as this may cause malfunction in the positioner.

Connecting the EcoSmart Drive to the Controller

For detailed information about the control electronics, please refer to the CONTROLLER USER MANUAL.

Any axis of the electronic unit should be turned to "GND" before connecting the EcoSmart Drives!

Please exercise great care in using the proper polarity on the piezo actuators.

If you have purchased the attocube controller with your EcoSmart Drive system, a controller cable is delivered with the system. For information about this cable and the connection to the controller please refer to the CONTROLLER USER MANUAL.

All EcoSmart Drives are equipped with electric cables which directly emerge from the main positioned body. Cabling for the EcoSmart Drive for ambient environments is displayed in Figure 8 and 9. A cable with a Sub D Mix connector is used to connect to the controller.

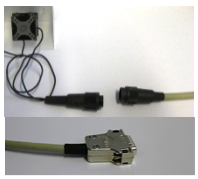

Figure 8: *Cabling at the EcoSmart Drive and further cabling to connect to the controller.*

Figure 9: *Cabling to connect to the controller.*

The EcoSmart Drives for vacuum applications are fitted with a capton insulated twisted pair copper wires terminated with a flat 2-pin connector (PEEK). The polarity of the connector is illustrated in Figure 10.

When the temperature changes during bakeout, the piezo will change its length and therefore, charges may accumulate. To avoid static charges that might damage the EcoSmart Drive, we suggest connecting the cabling to the controller and switch it to GND mode or off.

Figure 10*: 2-pin connector for vacuum applications. The chamfered side indicates the polarity.*

Switch the electronics to GND mode during baking out of the EcoSmart Drive.

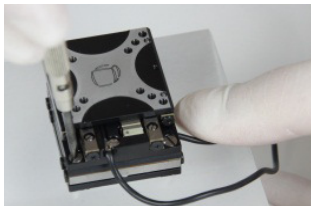

Figure 3: *Mounting the x-axis on the y-axis.*

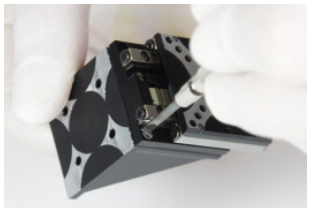

Figure 4*: Mounting the z-axis on the L-holder.*

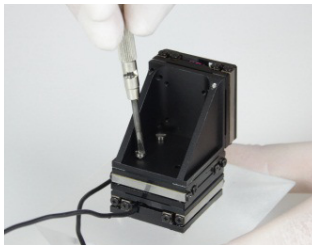

Figure 5: *Mounting the Z stack on top of the XY stack.*

Figure 6: *Only the X axis at bottom of the stack is allowed to move underneath the Z axis. The Y axis in the middle has to move parallel to the Z axis.*

Do not touch or change these screws as this may cause the EcoSmart Drive to fail!

Figure 7: *Drawing of the setscrews in the bottom flange of the ECS3030. Please NEVER change the setscrews shown in the picture as this may cause malfunction of the positioner.*

System Components

All EcoSmart Drives are delivered with additional stainless steel screws.
In accordance to different types of EcoSmart Drives we also offer appropriate electronic control units. As default, we deliver controller cables as well as a USB cable and mains cable with all controllers.

List of Parts

EcoSmart Drive
8 stainless steel screws (M2x3)
1 controller cable
1 USB cable

Special Notes for Specific EcoSmart Drives

Specific EcoSmart Drives require special advice for handling, mounting, and usage.

EcoSmart Drives with /NUM Optoelectronic Encoder

The closed-loop functionality takes advantage of measuring the actual position of an EcoSmart Drive using an optoelectronic encoder (/NUM). The readout position is then compared to a position setpoint, where any difference between the two values is compensated for using a feedback loop. For EcoSmart Drives equipped with an encoder, positioning setpoints are adjusted in a software interface. The working principle of the sensor system is illustrated in Figure 11.

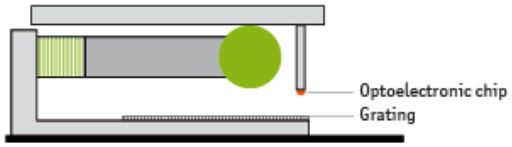

Figure 11: *The optoelectronic encoder consists of an optical grating and an optochip for sensing.*

Caution. Make sure not to connect cabling longer than 3m. Longer cabling may increase the sensitivity of the sensor signal to external influences.

Goniometers ECGt5050, ECGp5050

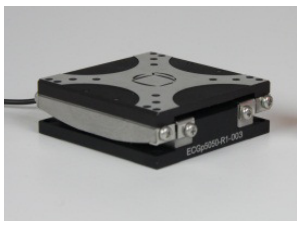

Figure 12: *The ECGt5050 is supposed to be mounted with perpendicular orientation on top of the ECGp5050 so that θ,ϕ-positioning around one point is achieved.*