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CEDRAT TECHNOLOGIES
Innovation in Mechatronics

LONG STROKE ACTUATOR WITH HIGH RESOLUTION POSITIONING

PRESENTATION

The presented motor is a linear stepping motor so called Fine Stepping Piezo Actuator (FSPA) able to support large external force without losing its holding position whether powered or unpowered. FSPA are based on inertial stepper piezo motors. They are composed of four main elements: an actuator, a lever arm, a mass and a clamp. The principle of such motors is simple and relies on stick-slip effect and dissymmetrical accelerations. The Fig 1 shows the two phases needed to produce one step. First, a slow contraction of the actuator makes the mass moving, without any motion of the shaft, because of clamping friction. Then, a fast actuator expansion gives dynamic forces to mass and shaft and, because of the inertia of the mass, overcomes the friction forces. This moves the shaft into the clamp and one step is completed. By repeating this operation, stroke of several millimetres can be reached. The opposite motion is done by inversing the two sequences. This motion is called “Stepping Mode”.

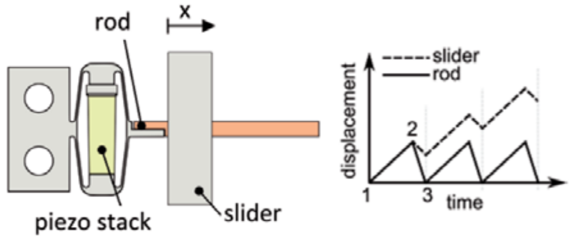

Fig 1: Motor stepping principle

HIGH RESOLUTION LINEAR CONFIGURATION

Proposed configuration is combining advantages of stepping mode, with a high resolution, irreversible, reduction mechanism. The internal structure allows decoupling high external forces from actuation mechanism. Therefore, it makes the motor compatible with high loads and high levels of vibration.

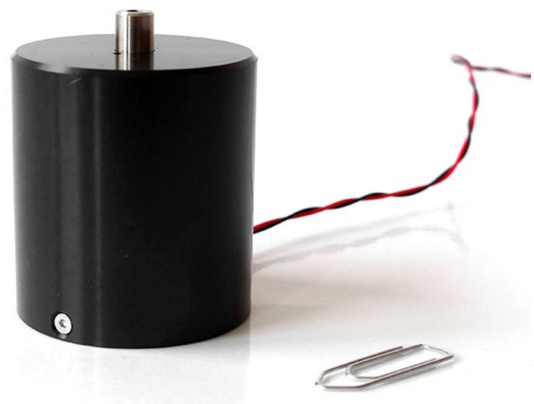

Fig 2: FSPA35XS

PERFORMANCES

REFERENCE	UNITS	FSPA MOTOR
Resolution (Stepping mode)	nm	<40
Resolution (Deformation mode)	nm	<10
Stroke	mm	5
Actuation force	N	>100
Holding force	N	500
Typical speed	µm/s	200
Total mass	kg	180

It is highlighted that resolution/speed/stroke is result of fully customisable internal configuration of the motor. Presented performances can be adapted upon request.

MOTOR NANOMETRIC RESOLUTIONS

Holding force is naturally provided by the FSPA. In order to test the motor resolution, a step by step signal is applied while position output is controlled using a capacitive sensor. Fig 3 presents results obtained on a motor, using a 1 Hz stepping frequency combined with reduced excitation voltage. Step size below 20 nm is achieved. This corresponds to a 1.2 µm/min speed.

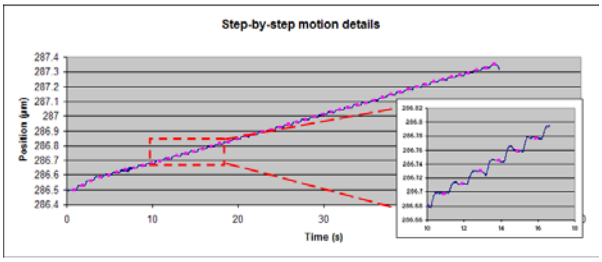

Fig 3: Motor stepping acquisition, mean step size is about 20 nm

MOTOR APPLICATIONS

FSPA motor is well suited for example to tune arms' lengths of interferometers, to align sensitive elements, to control shape of optical components (adaptative optic), ... The motor being self-locking and vacuum compliant, it is well suited for demanding environments as found in space applications where unpowered locking is required during launch. Non-magnetic version of FSPA can also be used in high magnetic field (MRI) or high sensitivity applications.

FSPA is a complement to the Linear Stepping Piezoelectric Actuators (LSPA) from CEDRAT TECHNOLOGIES.

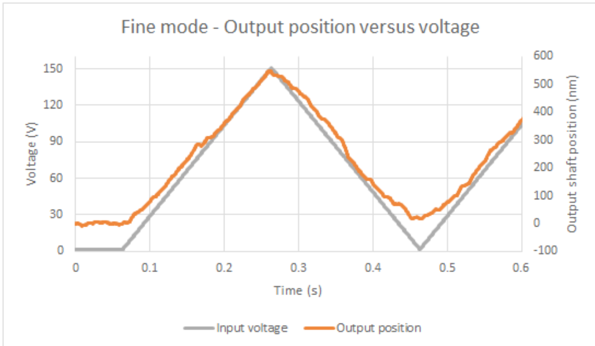

Fig 4: Fine mode - Output position versus voltage

KEYWORDS

Motor, holding force, nanometer, resolution, linear, positioning, optics...