

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 inverting the two sequences. This motion is called "Stepping Mode".

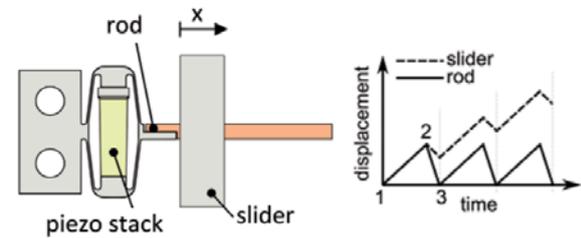


Fig 1: Motor stepping principle

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.

PERFORMANCES

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

See table next page.

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 2: FSPA35XS

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 $\mu\text{m}/\text{min}$ speed.

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.

KEYWORDS

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

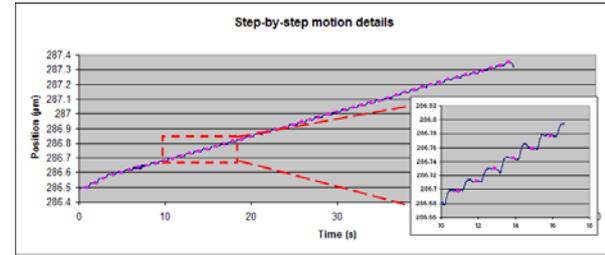


Fig 3: Motor stepping acquisition, mean step size is about 20 nm

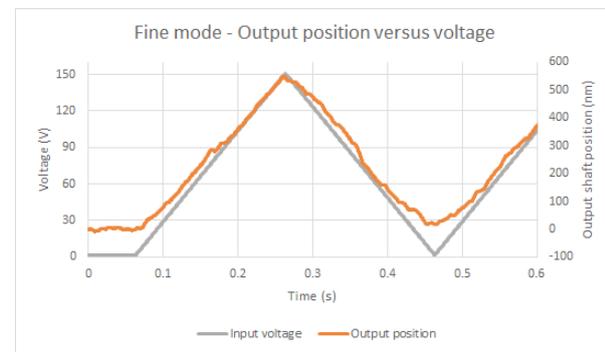


Fig 4: Fine mode - Output position versus voltage

> Preliminary data for FSPA35XS

PARAMETER	TYPICAL VALUE	UNIT
> Forces		
Actuation force ⁽¹⁾	>100	N
Holding force ⁽²⁾	200	N
> Stepping mode		
Travel range	5	mm
Typical min step size ⁽²⁾	< 100	nm
Typical max speed ⁽³⁾	200	$\mu\text{m}/\text{s}$
> Mechanical properties		
Typical lifetime ⁽³⁾	100	cycles
Dimensions	Diam 40 x54	mm
Total mass	160.00	g

> Annotations

(1) Blocked force, no more displacement

(2) Unpowered

(3) 1 mm stroke, static load