

Piezoelectric Rotary Stage PRS-1

Accurate angular positioning is extremely important in many fields including: photonics, life sciences, microelectronics and defense/security. Currently all commercial rotary positioning stages fall into one of three main classes depending on motor type: stepper-motor, vector-motor or DC servo-motor.

DTI's newly developed precision piezoelectric rotary stage (PRS-1) is a unique software controlled rotary stage incorporating a proprietary direct-drive motor coupling mechanism. The PRS-1 does not use a conventional electromagnetic motor; instead it uses an advanced piezoelectric actuator under direct digital signal processor (DSP) control. The result is a superior rotary stage that eliminates the well known disadvantages of all previous rotary stage technology, while at the same time providing other intrinsic advantages.



New Class of Piezoelectric Rotary Stages with Zero Backlash

Operation

The PRS-1 stage works on a direct drive principle in which the rotary motion of a highly advanced piezoelectric motor is directly coupled to the rotating stage platform. The combination of high torque, variable speed, and high angular resolution using a shaft-mounted optical encoder, enables the piezoelectric motor to be used in either continuous or stepper mode, therefore providing accurate angular positioning. When the piezoelectric motor is de-energized, it operates as a position holder (brake) with practically undetectable backlash and drift. These characteristics facilitate a smooth transition from an angular step of less than 5 μrad (1 arcsec) to continuous motion, and a wide range of angular velocities from 5 $\mu\text{rad}/\text{sec}$ up to 2.1 rad/sec (120 deg/sec), equivalent to approximately 5 orders of magnitude dynamic range.

An additional benefit of the piezomotor design is the elimination of heat dissipation as well as virtually undetectable drift in the steady-state mode, which makes the PRS-1 stage ideal in a number of critical applications. The long-term stability of the PRS-1 is less than 5 $\mu\text{rad}/\text{hour}$. The basic principle of the motor makes the PRS-1 less vulnerable to potentially interfering electromagnetic fields.

Key Features

- High absolute angular accuracy and resolution
- Elimination of the "Stick/Slip" effect, allowing substantial improvement of angular positioning accuracy and resolution
- Zero rotational backlash or hysteresis
- Automatic self-locking when unit de-energized
- Low temperature drift
- Dynamic response and tracking bandwidth superior to that of currently existing systems
- Low operating power consumption
- High torque, high load capacity

Flexible Design

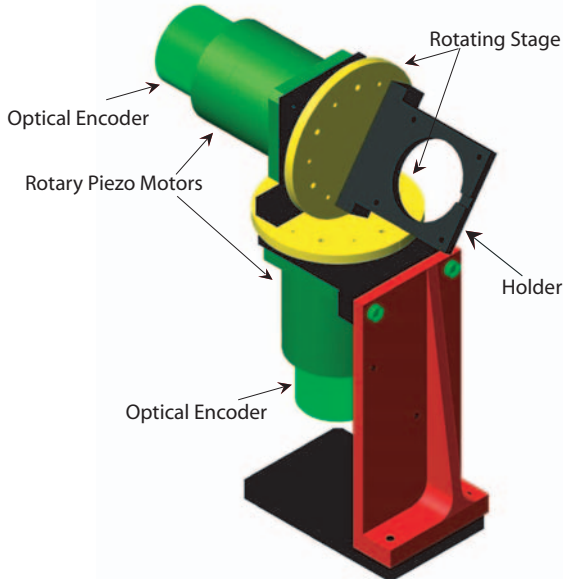
The PRS-1 provides significantly improved performance over traditional motorized angular positioning systems. Innovative piezoelectric motor technology is used to eliminate the disadvantages of conventional systems, resulting in superior dynamic performance and tracking bandwidth (2 kHz) without the need for a high-voltage power supply.

The complete system is highly portable and operates from a single 12 Volt DC power supply. An optional rechargeable battery pack is also available providing complete system portability, when used with a laptop PC.

Elimination of the "Stick-Slip" Effect

The "Stick/Slip" is one of the major factors that limit resolution in conventional motors. The effect is caused by the fact that the coefficient of static friction is greater than the coefficient of dynamic friction. When a driving force is applied to a rotary stage, movement from steady position is slightly delayed on the applied force. Initially, with finite force, there is no movement until the force exceeds the static friction. At this point there is a jump in position, after which a lesser force maintains smooth motion. Only frictionless devices, such as solid-state actuators (piezo actuators), exhibit zero measurable friction and therefore provide resolution superior to classical mechanical devices.

However, the PRS-1 overcomes the "Stick/Slip" effect due to a unique start-stop characteristic of the rotary piezoelectric motor. Any angular position of the rotor is "locked" (held) by the self-decelerating torque of the motor. The same force "locks" the whole friction system of the translation stage. To limit the effect of any jump when initiating motion the unlocking process must occur almost instantaneously (with a time constant in the range of 10-100 μ sec). This timing results in complete elimination of any static friction effects.



2D configuration consisting of two rotary stages mounted at 90 degrees is shown in the figure. This configuration allows a tool mounted on the holder to be pointed towards any point in space.

Ordering Information

Part Number: B14-3401

Description: PRS-1 Piezoelectric Rotary Stage

Digital Signal Processor (DSP) Design

An integral part of the PRS-1 is the NanoDirect controller (available in 1, 2 or 3-channel configurations). The internal architecture of the controller is based entirely on embedded DSP, therefore enabling a wide dynamic range of signal handling combined with very high measurement accuracy. The controller is the communication and control link between the PRS Stage and the computer operating under Windows2000/XP software. The menu driven software prompts the operator to select or enter parameters for the chosen mode of operation. The application processes the digitized input signal and applies the operator-selected information for real-time display and control. A LabView driver software development kit is also available.



NanoDirect Controller

Technical data

Rotational Range	Full revolution (360 deg)
Angular Accuracy	10 μ rad (2 arcsec)
Min. Angular Increment	Less than 20 μ rad (4 arcsec)
Unidirectional Repeatability	Less than 10 μ rad (2 arcsec)
Bidirectional Repeatability	Less than 10 μ rad (2 arcsec)
Backlash	Less than 10 μ rad (2 arcsec)
Hysteresis	Less than 10 μ rad (2 arcsec)
Max. Torque	0.5 Nm
Self-braking Torque	0.5 Nm
Reaction Time - Demand to Max. Speed	300 μ sec
Reversal Time at Max. Speed	500 μ sec
Velocity Range (Stepped-Continuous)	5 μ rad/sec – 2.1 rad/sec
Tracking Bandwidth	2 kHz
Load Capacity	20 kg
Supply Voltage	12 VDC
Max. Power Consumption	10 W
Nominal Power Consumption	5 W
Long Term Stability (@ 20 C)	Less than 5 μ rad/hour (1 arcsec/hour)
Controller	Digital Signal Processor (DSP) based
Dimensions	5.5"(incl. encoder) x 3.15" (OD of stage) 6.5" x 4.5" (with supporting frame)

For further information and OEM inquiries please contact Discovery Technology International or your local distributor



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