PIEZO
MOTOR COMPANY

APPLICATION GUIDE

Precision Beam Control Using Piezoelectric Rotary and Linear Motors

Improving Stability, Accuracy and Integration in Modern Photonic Systems

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Introduction

Modern photonic instruments rely on far more than simply generating laser light. Whether used in spectroscopy, microscopy, semiconductor inspection, optical communications or quantum research, the laser beam must often be switched, steered, aligned, focused or directed through multiple optical paths with exceptional precision.

These seemingly simple movements place demanding requirements on the motion system. Even small amounts of backlash, vibration, thermal drift or power dissipation can degrade optical performance and reduce measurement accuracy.

Traditional motion technologies_including stepper motors, DC servo motors and galvanometers_continue to serve many applications well. However, when compact size, nanometre-scale positioning, low power consumption and long-term stability become the primary design objectives, piezoelectric motors offer a compelling alternative.

This application guide examines how miniature piezoelectric rotary and linear motors can simplify the design of modern photonic instruments while improving positioning accuracy, optical stability, thermal performance, and overall system integration.

MOTION REQUIREMENTS IN PHOTONIC SYSTEMS

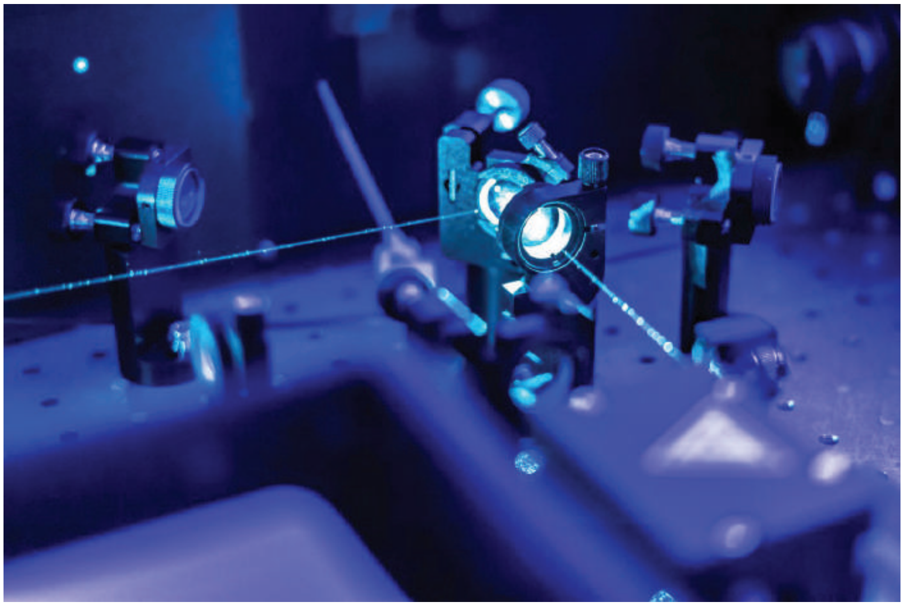
Motion is fundamental to many optical instruments. One of the defining advantages of ultrasonic piezoelectric motors is their exceptional dynamic response. Typical response times of 30–40 µs are more than an order of magnitude faster than conventional electromagnetic motors, whose response is fundamentally limited by coil inductance and rotor inertia. This enables rapid start-stop positioning, extremely fast settling, and high closed-loop bandwidth, allowing optical systems to perform beam steering, optical switching, adaptive optics, and active stabilization at speeds that are difficult to achieve using conventional motor technologies.Typical functions include:

Beam Manipulation

- Laser beam switching
- Beam steering
- Optical shutter operation
- Beam splitter positioning

Optical Alignment

- Fiber optic alignment
- Objective lens focusing
- Filter wheel positioning
- Polarizer and waveplate rotation
- Delay line positioning



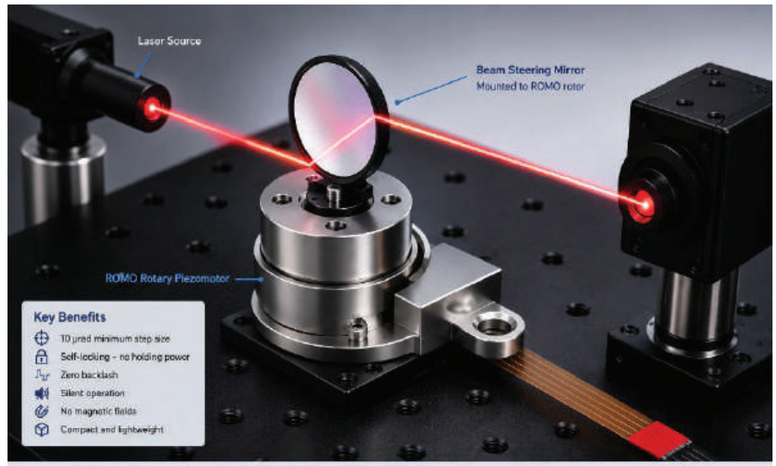
Rotary Motion for Optical Beam Control

INTRODUCTION

Miniature piezoelectric rotary motors provide precise angular positioning for optical components requiring exceptional stability, repeatability and compact integration.

Typical applications include:

- Beam steering mirrors
- Fold mirrors
- Beam splitters
- Optical shutters
- Filter wheels
- Polarizers
- Waveplates
- Prism assemblies
- Fiber optic switches



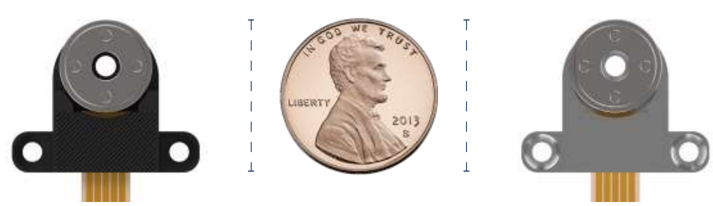
Precise Optical Beam Steering with ROMO Rotary Piezomotor
Mirror mounted to rotor for accurate, repeatable angular positioning

Piezo Motor Company's unique ROMO series of miniature rotary motors combines extremely fine angular positioning with self-locking operation. Once positioned, the motor naturally maintains its position without requiring holding current, eliminating heat generation and improving long-term optical stability.

KEY ADVANTAGES

- High resolution with models offering to 10 µrad minimum step size (approximately 625,000 steps per revolution)
- Self-locking without power
- Silent operation
- Non magnetic magnetic fields
- Compact, lightweight construction

ROMO Series (With Encoder) in Plastic & Metal Enclosures



Size comparison of the ROMO Series miniature rotary motor.

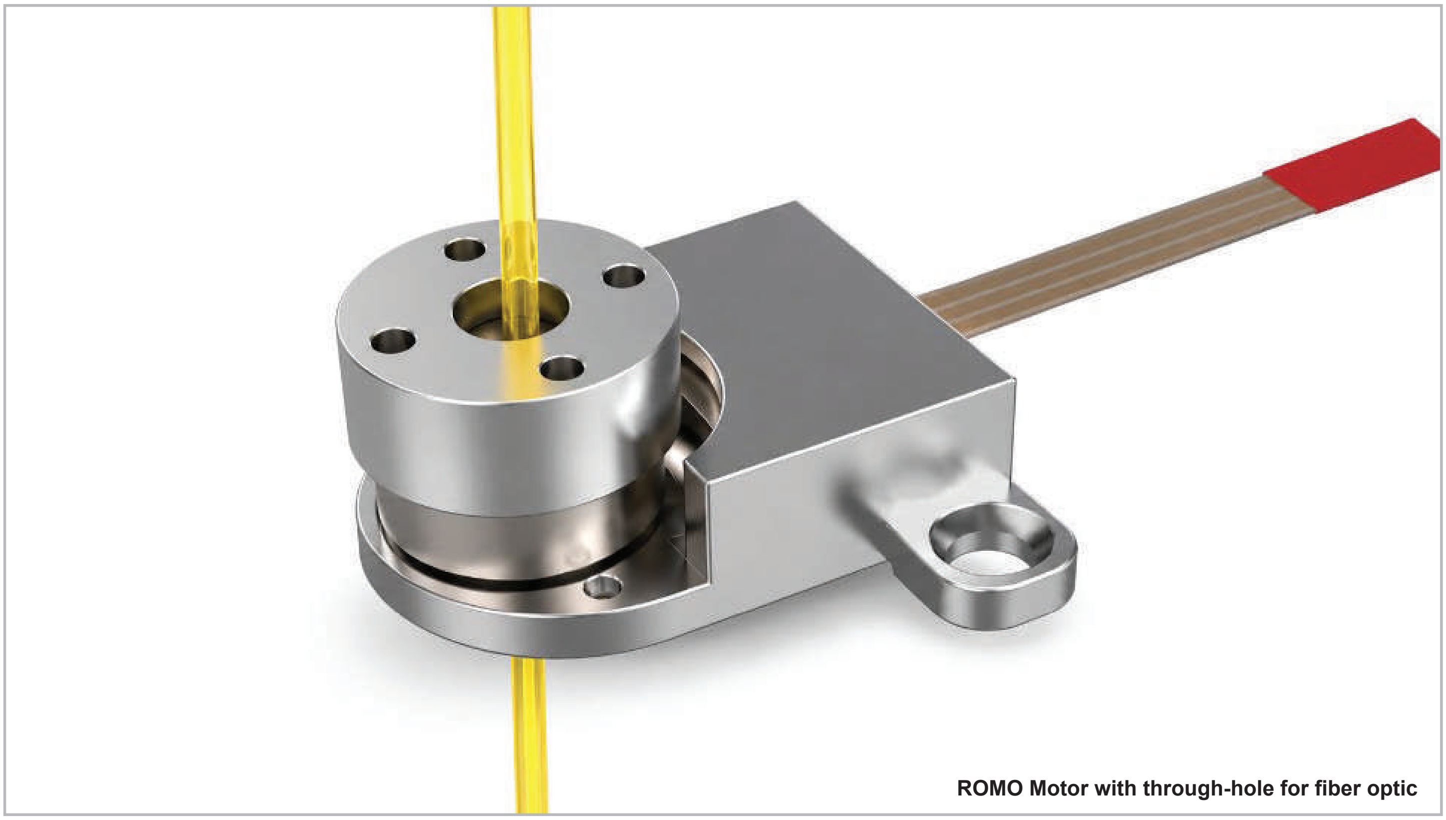
Hollow Shaft Design Enables Compact Optical Integration

A distinguishing feature of the ROMO series is its optional hollow-shaft configuration. The clear aperture through the center of the motor allows optical fibers, electrical connections, lenses, and other optical components to be routed directly through the axis of rotation.

This coaxial design can improve optical alignment, simplify cable management, and eliminate many of the brack-ets, couplings, and offset mechanisms typically required with conventional motors. The result is a more compact, structurally rigid system with reduced mechanical complexity and easier integration into spacecon-strained optical instruments.

TYPICAL APPLICATIONS

- Fiber-optic rotary joints
- Beam-steering mirrors
- Rotating waveplates
- Polarizers
- Filter wheels
- Optical shutters
- Confocal microscopy
- OCT systems
- Optical communications
- Laser-scanning systems



ROMO Motor with through-hole for fiber optic

Linear Motion for Optical Alignment

INTRODUCTION

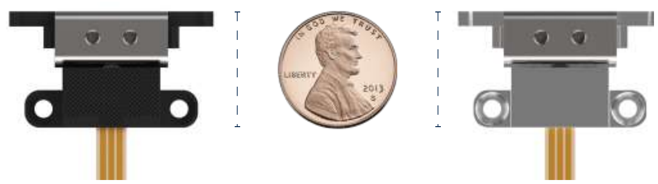
While rotary motion controls beam direction, precision linear positioning is equally important throughout modern photonic systems.

Miniature linear piezoelectric motors provide accurate translation for components including:

- Fiber optic connectors
- Fiber arrays
- Collimators
- Objective lenses
- Focusing optics
- Delay stages
- Mirrors
- Cameras
- Photodetectors
- Precision sample stages

Piezo Motor Company's LRMO series of linear piezomotors delivers sub-micron positioning resolution while maintaining an exceptionally compact footprint, making them ideal for automated optical alignment.

LRMO Series (Without Encoder)
in Plastic & Metal Enclosures



Size comparison of the
LRMO series miniature rotary motor.

APPLICATIONS INCLUDE

Fiber Alignment – Accurate positioning of single-mode Fibers, Fiber arrays and collimators for maximum optical coupling efficiency.

Laser Focusing – Precise movement of objective lenses and focusing optics for microscopy, spectroscopy and laser processing.

Optical Path Length Adjustment – High-resolution positioning for interferometers, delay lines and optical coherence tomography (OCT).

Precision Sample Positioning – Stable, low-vibration movement of samples beneath a stationary laser beam.

Compact Multi-Axis Positioning Systems

Modern photonic systems demand more than precision in a single direction. Applications such as optical alignment, beam steering, fiber coupling, and laser delivery often require tightly coordinated motion across multiple axes—without sacrificing speed, stability, or nanometre-level positioning performance. Piezo Motor Company addresses these demanding requirements with a novel range of miniature multi-axis positioning systems, each with a footprint of less than one square inch.

ROMO-3AX — THREE-AXIS ROTARY POSITIONING

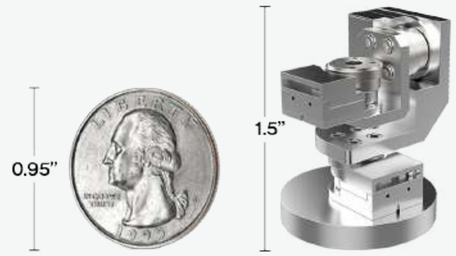
The ROMO-3AX integrates three miniature ROMO rotary piezomotors into a compact assembly, providing independent angular motion about three orthogonal axes—roll, pitch, and yaw.

Typical applications include:

- Beam steering mirrors
- Laser beam pointing
- Optical alignment
- Gimbal-mounted optics
- Free-space optical communications
- Adaptive optics
- Precision mirror positioning

The self-locking nature of each axis maintains precise optical alignment without continuous power, eliminating thermal drift associated with conventional servo systems.

ROMO-3AX-SYS



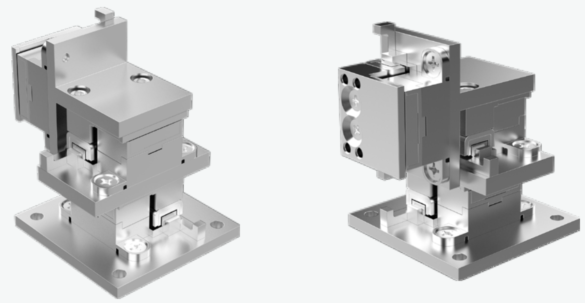
LRMO-XYZ — THREE-AXIS LINEAR POSITIONING

The LRMO-XYZ combines three miniature LRMO linear piezo motors into a compact XYZ positioning platform capable of nanometre-scale translation in three orthogonal axes.

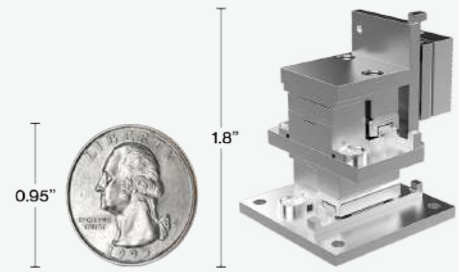
Typical applications include:

- Fiber optic alignment
- Collimator alignment
- Laser diode alignment
- Camera positioning
- Photodetector alignment
- Objective lens positioning
- Precision sample positioning

The extremely compact footprint enables complete optical alignment systems to be integrated directly into space-constrained photonic instruments.



LRMO-XYZ



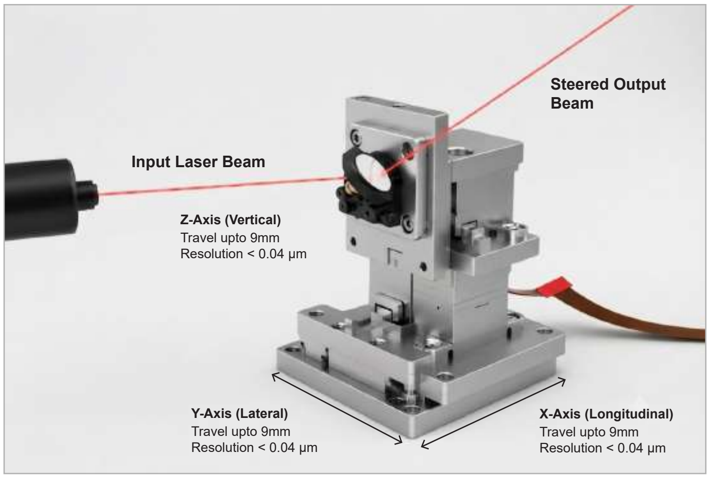
Why Piezoelectric Motors?

Unlike conventional electromagnetic motors, piezoelectric motors generate motion through ultrasonic vibrations within a piezoelectric ceramic element. This operating principle enables exceptionally high positioning resolution, zero backlash, quiet operation, high structural stiffness, and excellent long-term positional stability, all within a compact mechanical design. Because the motors are self-locking, they require no power to maintain position and generate negligible heat while stationary. They also produce no magnetic interference, making them particularly well suited to sensitive optical, photonic, and scientific instrumentation.The self-locking nature of each axis maintains precise optical alignment without continuous power, helping to eliminate the thermal drift commonly associated with conventional servo systems.

TYPICAL PHOTONICS APPLICATIONS

Piezoelectric motion systems are increasingly used in:

- Raman spectroscopy
- Confocal microscopy
- Optical coherence tomography (OCT)
- Semiconductor inspection
- Optical communications
- Quantum optics
- Laser materials processing
- Biomedical instrumentation
- Scientific research
- Metrology
- Fiber optic test equipment



CONCLUSION

Modern photonic instruments must deliver ever-greater positioning precision while becoming smaller, faster, more stable, and more energy efficient.

From compact rotary actuators for beam steering and precision linear motors for optical alignment to fully integrated three-axis systems for advanced optical manipulation, miniature piezoelectric motors provide designers with a highly versatile motion-control platform.

Their unique combination of exceptional resolution, zero backlash, self-locking operation, negligible stationary heat generation, and compact size enables greater optical stability, simpler mechanical architectures, and outstanding positioning performance.As photonic systems continue to push the limits of miniaturization and precision, piezoelectric motion technology provides the performance, flexibility, and stability required to power the next generation of scientific, medical, and industrial instrumentation.

Contact the Author
For further information, application guidance, or to discuss how piezoelectric motion technology could be integrated into your photonic system, please contact:

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