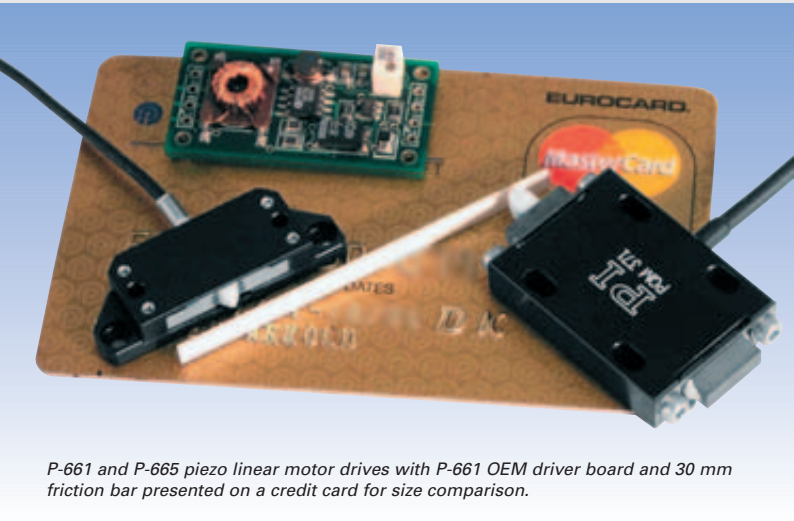


**P-661
P-665**

PIline™ OEM Ultrasonic Piezo Linear Motors



P-661 and P-665 piezo linear motor drives with P-661 OEM driver board and 30 mm friction bar presented on a credit card for size comparison.

Ordering Information

P-661.2P0
PIline™ ultra-compact OEM Piezo Linear Motor, OEM Driver, 10 mm Travel Friction Bar

P-661.4P0
PIline™ ultra-compact OEM Piezo Linear Motor, OEM Driver, 20 mm Travel Friction Bar

P-661.6P0
PIline™ ultra-compact OEM Piezo Linear Motor, OEM Driver, 50 mm Travel Friction Bar

P-665.2PM
PIline™ ultra-compact OEM Piezo Linear Motor, OEM Driver, 10 mm Travel Friction Bar

P-665.4PM
PIline™ ultra-compact OEM Piezo Linear Motor, OEM Driver, 20 mm Travel Friction Bar

P-665.6PM
PIline™ ultra-compact OEM Piezo Linear Motor, OEM Driver, 50 mm Travel Friction Bar

Optional:
C-182.P0
Bench-top Driver, Power Supply and Motor Cable

- **Smallest Linear Piezo Motors on the Market**
- **New Design boasts Significantly Higher Forces**
- **Velocity to 800 mm/s**
- **Acceleration to 20 g**
- **Resolution to 0.1 μm**
- **AutoLock Feature**
- **20,000 h MTBF**

PIline™—OEM Business in Motion

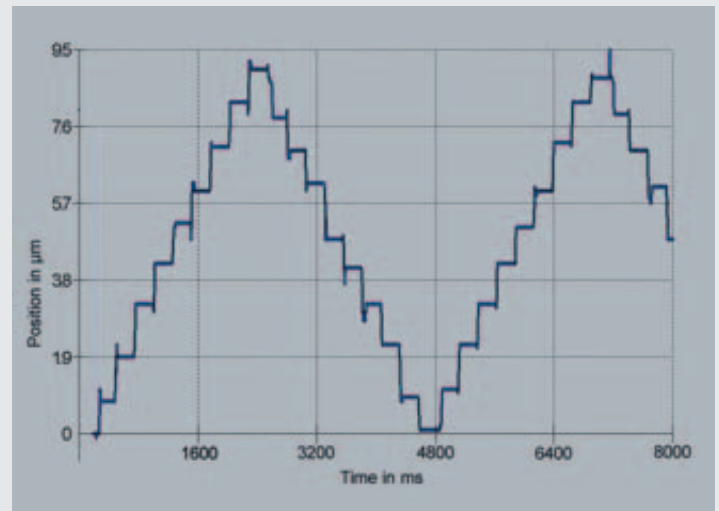
PIline™ P-661 and P-665 are the smallest piezo linear motor drives currently available on the market. In addition to being ultra-compact they also boast significantly higher drive and holding forces than conventional piezo motors.

Both versions incorporate a novel, ultra-small, high-speed ultra-sonic piezo-drive, developed and manufactured by PI and PI Ceramic. The ultrasonic piezo motor operating principle is based on the simultaneous longitudinal and bending oscillation of a special piezoelectric ceramic plate, creating an elliptical motion at the ceramic tip.

Each cycle produces a tiny step, as small as a few nanometers, allowing continuous smooth motion with virtually unlimited travel when installed in an appropriate-length translation (or rotation) stage.

High Speed & Acceleration, Self-Locking

PIline™ piezo linear motors can be operated in any orientation. The lightweight, low-profile drive combines extremely high acceleration (up to 20 g) and velocity up to 800 mm/s with excellent position resolution and high holding forces. Since the ceramic tip of the motor is preloaded against the moving part of the stage, it creates a braking force while at rest. The benefits are the elimination of heat dissipation and servo dither (if used with a closed-loop system) in steady-state mode. Note that there will not be a position shift in holding mode, as is common with mechanical motor brakes!



Typical step response of a P-661 integrated into a small translation stage, in this example operated in closed-loop mode.

PZT Actuators
PZT Flexure NanoPositioners
PZT Active Optics / Steering Mirrors
Tutorial: Piezoelectrics...
Capacitive Position Sensors
PZT Control Electronics

MicroPositioners / Hexapod Systems

Photonics Alignment & Packaging Systems

Motor Controllers

Index

<http://www.pi.ws>
info@pi.ws

Application Examples

- Bio Technology
- Micromanipulation
- Microscopy
- Quality control
- Semiconductor test equipment
- Metrology
- Disk drive test assemblies
- R&D
- Photonics Packaging

There are no gears, lead-screws or other mechanical components to contribute play or backlash.

Integration

P-661 and P-665 series piezo motors can be mounted in any orientation, horizontally or vertically. To achieve the best performance, the motor and friction bar have to be mounted on even surfaces to avoid torsion of the basic profiles. The

P-661 and P-665 series motors and associated electronics should be operated in clean environments, protected from metal dust and liquid spray.

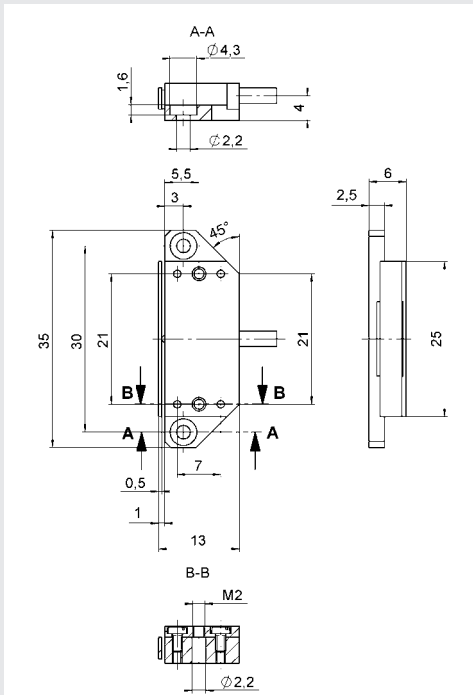
Driver Included

PIline™ piezo linear motors are powered by a small external driver board (included) that converts PWM input signals into ultrasonic oscillations for the piezo motor. An optional bench-top driver, motor cable and power supply “starter package” is also available.

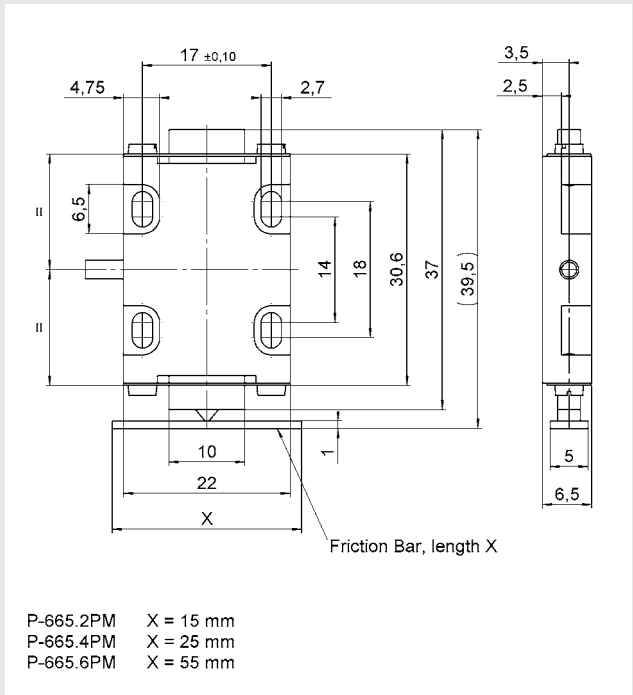
The drivers are controlled through a 12 V PWM (Pulse Width Modulation) signal. The distance moved by the motor corresponds to the width of the pulse. The smallest achievable step is on the order of 0.1 µm and corresponds to a 10 µs input pulse (shorter pulses are not recognized). By varying the length of the input-active period, the step length and thus the velocity can be controlled.

Lifetime

PIline™ drives are based on PI’s 30+ years of experience with piezo nanopositioning technology and offer exceptional precision and reliability with an MTBF of > 20,000



P-661.xP0 dimensions (in mm)



- P-665.2PM X = 15 mm
- P-665.4PM X = 25 mm
- P-665.6PM X = 55 mm

P-665.xPM dimensions (in mm)

hours. Components such as gears, shafts and moving cables that are prone to failure in conventional motion systems, are simply not part on the PIline™ design.

Translation Stages?

Should you be interested in a complete translation stage, talk to our engineers! We offer a line of standard open and closed loop piezo motor driven translation stages and actuators and also provide custom solutions tailored to our customer’s requirements.

Technical Data

Models	P-661.xP0	P-665.xPM	Units	Notes
Travel range)*	unlimited	unlimited	mm	
Min. incremental motion)**	0.1	0.1	µm	
Max. velocity	800	300	mm/sec	
Max. push/pull force	3	5	N	B2
Max. holding force	5	8	N	
Weight	10	20	g	
Operating Voltage	12	12	V	
Operating Current	200	200	mA	

* The travel range of piezo linear motors is virtually unlimited and depends on the length of the friction bar. PI currently offers the following standard packages: P-661.2P0: 10 mm; P-661.4P0: 20 mm; P-661.6P0: 50 mm. The same ranges are offered for the P-665.

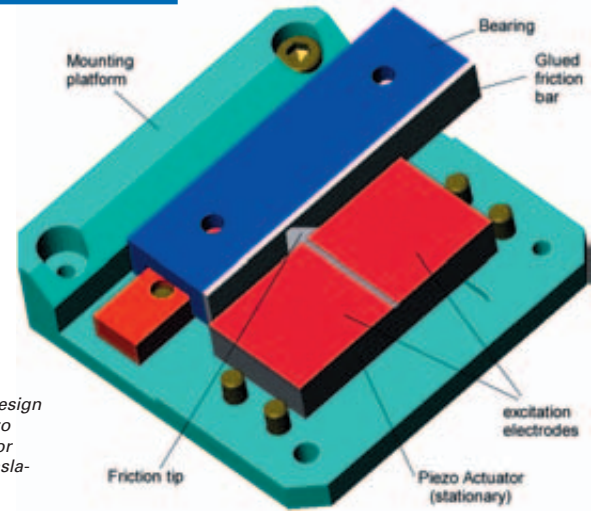
** The minimum incremental motion is a typical value that can achieved in the open-loop mode of a piezomotor stage. To reach the specs it is important to follow the mounting guidelines of the OEM-motors.



The P-661.4P0 (left side in the front) linear piezomotor is integrated into the ultra-compact linear stages such as the PIline™ M-662.4P0 (right side in the front). The standard driver electronics C-862.PMD (right side in the back) can also be used with the OEM P-661 motors under order number C-182.P0.

Ultrasonic Piezo Drives—How do they work?

PI linear ultrasonic drives consist of a piezoelectric oscillator made from a rectangular piezoelectric plate upon which are mounted one, two or more frictional elements. Due to electrical excitation of the actuator, each friction tip installed on it moves along an elliptical trajectory, transmitting pushing forces to a friction bar on the moving portion of the translation stage. The pushing force exerted by the actuator comes basically from the energy of the longitudinal wave, i.e. in the actuator shown, the longitudinal wave is the pushing wave. The bending wave energy in the actuator is used basically for switching the longitudinal motion at regular intervals by pressing the frictional elements against the frictional trunk. The bending wave force regulates the maximal available frictional force between friction tip or tips and the frictional trunk on the moved element, i.e. the bending wave has an engage/disengage function.

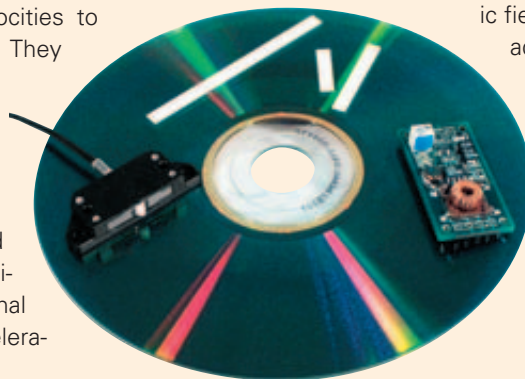


Principle design of a PI piezo linear motor driven translation stage.

Advantages of Pline™ Linear Piezo Motor Drives

Pline™ Linear Piezo Motors are based on a novel solid-state ultrasonic piezoceramic drive. They are lightweight, low-profile and provide a number of features and advantages not available with conventional magnetic motors, such as negligible EMI, ultra-fast response, auto-locking, backlash-free motion and excellent power-to-weight ratio.

- **Compact Size:** The direct-drive principle allows the design of ultra-compact translation stages, with travel/size ratios close to 1. The M-661.4P0 translation stage, for example, provides 20 mm travel in a 25 x 25 x 8 mm³ package.
- **Low Inertia: High Acceleration, Speed and Resolution:** Pline™ drives achieve Velocities to 600 mm/s and accelerations to 20 g. They are also very stiff, a prerequisite for their fast step-and-settle times—on the order of a few milliseconds—and provide resolution to 0.1 μm. The lack of a lead-screw means no lubricant flow and material relaxation to cause sub-micron creep. There is also no rotational inertia to limit acceleration and deceleration.
- **Excellent Power-to-Weight Ratio:** Pline™ drives are optimized for high performance in a minimum package. No comparable drive can offer the same combination of acceleration, speed and precision.
- **Safe:** Pline™ drives do not require limit switches. Even if driven into the hard stop, the motor and stage will not be damaged.



P-661 OEM drive with electronics and different-friction bars (compact disc for size comparison).

The minimum inertia of the moving platform together with the “slip clutch” effect of the friction drive, give excellent protection against damage.

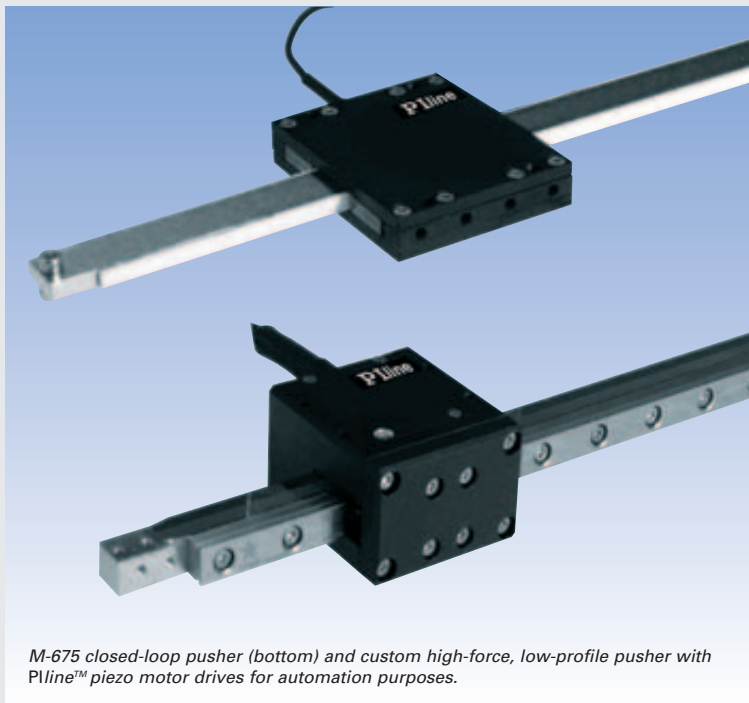
Precision fixtures and devices are much safer than with lead-screw-driven stages. Pline™ drives are also “finger-safe”: Despite the high speeds and accelerations, there is no risk of pinching or worse. This means users do not need interlocks, light curtains or other measures to keep them safe.

- **AutoLock Feature:** Pline™ drives create a braking force when not energized without causing the position shift common with conventional mechanical brakes. Other benefits of the AutoLock feature are the elimination of servo dither and steady-state heat dissipation.
- **Vacuum Compatible:** Pline™ drives are 100% ceramic and can be used in a vacuum without performance loss.
- **Negligible EMI:** Pline™ drives do not create magnetic fields nor are they influenced by them, a decisive advantage in many applications.

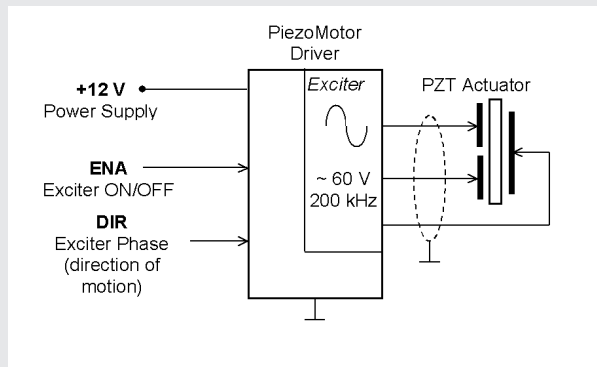
■ **Custom Solutions / Flexibility for OEMs:** Pline™ drives are available in open-loop and closed-loop translation stages and as OEM components. PI develops and manufactures all piezo ceramic components in-house. This gives us the flexibility to provide custom motors (size, force, environmental conditions) for OEM and research applications.

■ **Quality, Lifetime, Experience:** Based on PI’s 30+ years of experience with piezo nanopositioning technology, Pline™ drives offer exceptional precision and reliability with an MTBF of > 20,000 hours. Components such as gears, shafts and moving

cables that are prone to failure in conventional motion systems, are simply not part on the Pline™ design.



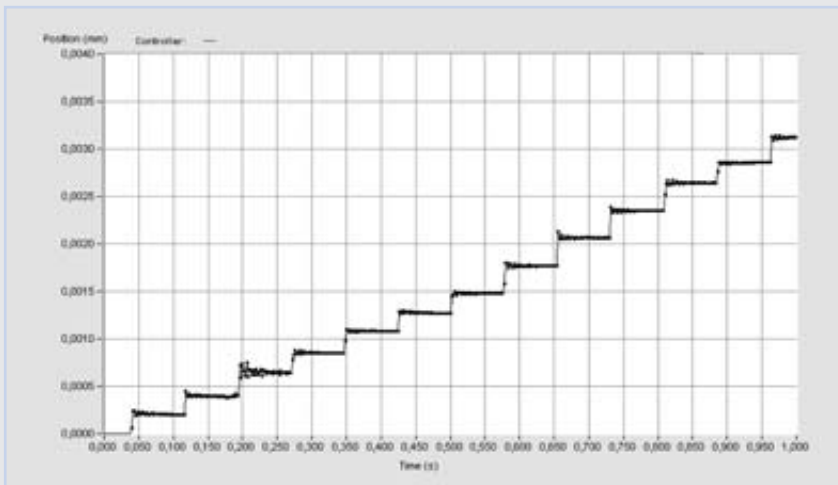
M-675 closed-loop pusher (bottom) and custom high-force, low-profile pusher with PLine™ piezo motor drives for automation purposes.



Piezo driver block diagram



Custom long travel XY microscopy stage (Pline piezo motor driven) with P-527 sub-nanometer resolution XYZ Piezo NanoScanning stage mounted on top. CD for size comparison.



0.3 μm steps performed in open-loop with a P-661.4P0 built into a M-662.4P0 translation stage.

Micro & NanoAutomation Solutions for Emerging Technologies:
<http://www.pi.ws>

USA

Polytec PI, Inc.
Email: info@polytecpi.com
<http://www.polytecpi.com>
USA East (Canada)
Tel: +1 (508) 832-3456
Fax: +1 (508) 832-0506
USA West (Mexico)
Tel: +1 (714) 850-1835
Fax: +1 (714) 850-1831

ITALY

Physik Instrumente (PI) S. r. l.
Tel: +39 (02) 665 011 01
Fax: +39 (02) 665 014 56
Email: info@pionline.it
<http://www.pionline.it>

GERMANY

Physik Instrumente (PI) GmbH & Co. KG
Auf der Römerstrasse 1
76228 Karlsruhe
Tel: +49 (721) 4846-0
Fax: +49 (721) 4846-299
Email: info@pi.ws
<http://www.pi.ws>

FRANCE

Polytec PI S.A.
Tel: +33 (1) 48 10 39 30
Fax: +33 (1) 48 10 08 03
Email: pi.phot@polytec-pi.fr
<http://www.polytec-pi.fr>

JAPAN

PI-Polytec Co. Ltd.
Email: info@pi-polytec.co.jp
Tel: +81 (42) 526 7300
Fax: +81 (42) 526 7301

UK

Lambda Photometrics Ltd.
Tel: +44 (1582) 76 43 34
Fax: +44 (1582) 71 20 84
Email: info@lambdaphoto.co.uk
<http://www.lambdaphoto.co.uk>