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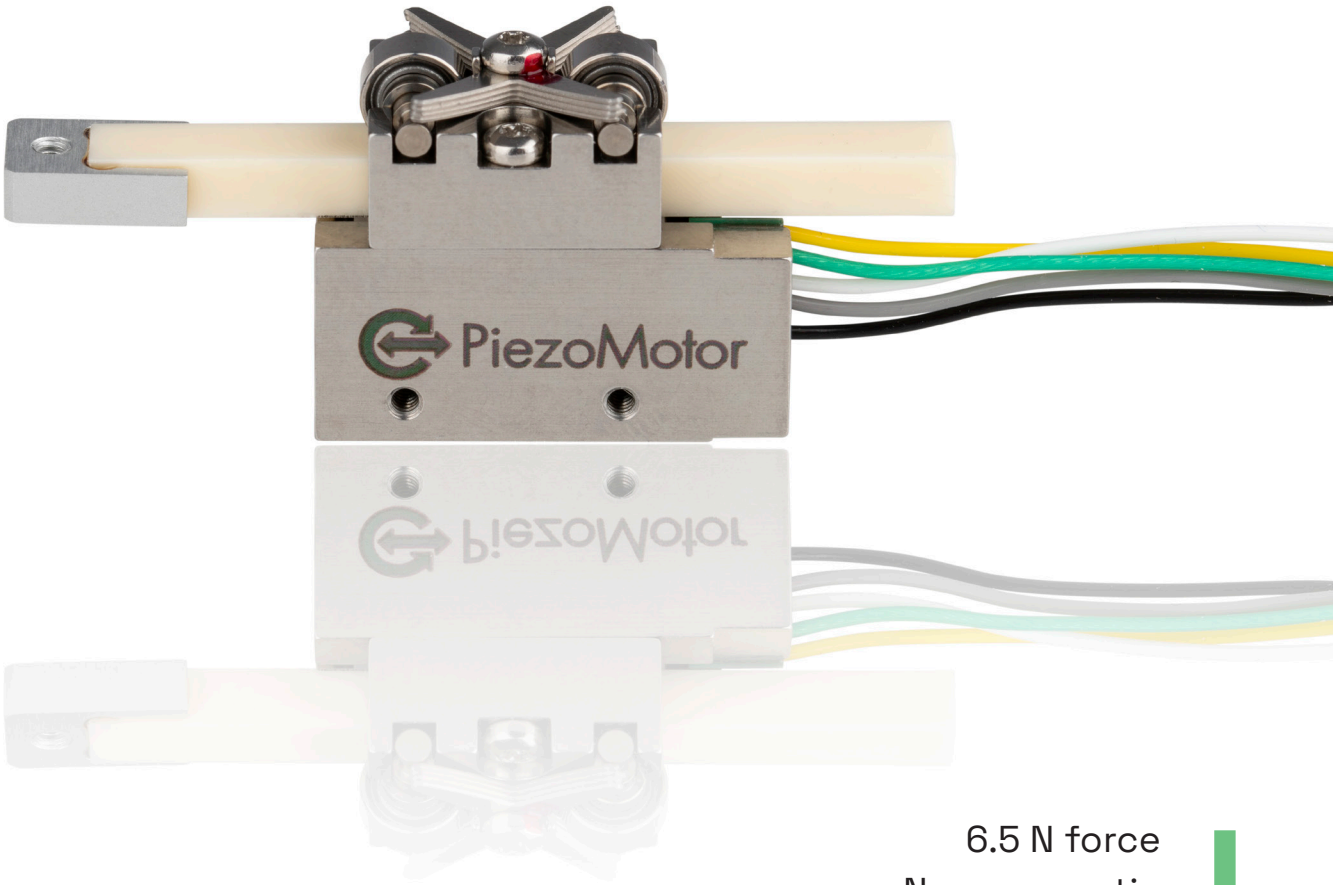
Piezo LEGS® LL10D

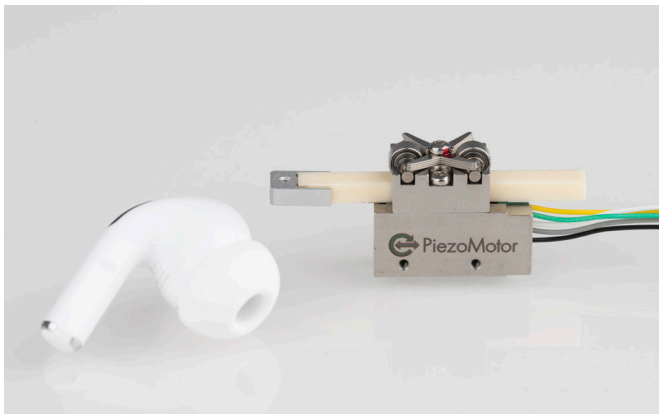
Data Sheet



6.5 N force
Non-magnetic
Vacuum compatible
Sub nanometer precision
Direct drive – backlash free
No power draw in hold position
Compact - unparalleled size to force ratio

Piezo LEGS® Linear LL10D

The LL10 linear motor is intended for a large range of OEM applications with focus on precise positioning in environments that require a completely non-magnetic and/or a vacuum-compatible motor. The direct drive principle of the Piezo LEGS ensures motion without any mechanical play or backlash. Sub-micrometer movement is made easy with this very compact and strong motor. It replaces stepper motor assemblies when there is a need for better resolution and smooth linear movement.



Vacuum compatible

For vacuum compatibility the motor contains components, and is specially prepared, such that outgassing is minimized and that the motor can be baked at temperatures up to 125°C.

Non-Magnetic

The piezoceramic actuators at the core of the motor are inherently non-magnetic and the motor housing and other parts are made from non-magnetic alloys. The magnetic flux density is less than 1 nT (sensor sensitivity in reference measurements) at a distance of 10 mm from the motor housing.

Outstanding precision

The Piezo LEGS technology is characterized by its outstanding precision and fast response and settling time. Small footprint, low weight, and modest power consumption are other benefits. In combination with the nanometer resolution the technology is quite unique.

Self locking without power draw

The motor is ideally suited for move and hold applications since it is stiff by design and does not consume any power when holding a position. The drive technology is direct, meaning no gears or lead screws are needed to create linear motion. The motor moves by microstepping, dividing a full waveform-step into nanometer size increments. Speed ranges from nanometers per second to millimeters per second, can be seamlessly controlled in the whole dynamic range with no need to alter the driving mode.

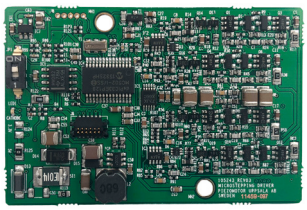
Controlling the motor

We offer a range of drivers and controllers. The PMD301 micro-step controller/driver can be used either as a driver connected to an external motion controller, or as a closed loop controller to handle precise positioning with commands over serial RS485 or USB interface. Multiple units can be chained and controlled over the same serial line. The microstepping feature divides the wfm-step into thousands of small increments which results in nanometer resolution.

The PMD401 board level controller/driver also communicates over RS485 serial interface, and is the most compact solution. For many OEM applications with demand for close integration, this board is the right selection for one or multiple axis of motion.

Some customers prefer to design their own driver for ease of integration. We provide information to assist in the design.

Summary	
Motor LL10	
D-type	Non-Magnetic Vacuum
Controller	
PMD301-01	1-axis controller/driver
PMD401-01B	1-axis stackable board level controller



PMD-401

PMD-301

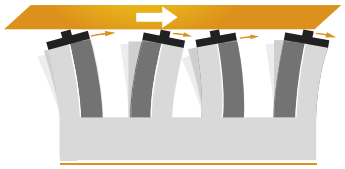
Operating Principle

The Piezo LEGS walking principle is of the non-resonant type, i.e. the position of the drive legs is known at any given moment. This assures very good control of the motion over the whole speed range.

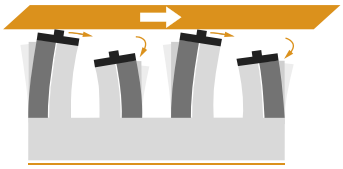
The performance of a Piezo LEGS motor is different from that of a DC or stepper motor in several aspects. A Piezo LEGS motor is friction based, meaning the motion is transferred through contact friction between the drive leg and the drive rod. You cannot rely on each step being equal to the next. This is especially true if the motor is operated under varying loads, as shown in the diagram below.

For each waveform cycle the Piezo LEGS motor will take one full step, referred to as one wfm-step (~7.5 µm at no load with waveform Rhomb). In the schematic illustrations to the right, you can see one step being completed. The velocity of the drive rod is wfm-step length multiplied with waveform frequency (7.5 µm x 2 kHz = 15 mm/s).

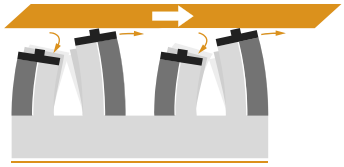
Micro-stepping is achieved by dividing the wfm-step into discrete points. The resolution will be a combination of the number of points in the waveform, and the load. Example: at 3 N load the typical wfm-step length with waveform Delta is ~4 µm, and with 8192 discrete points in the waveform the micro-step resolution will be ~0.5 nm.



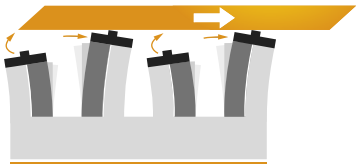
When all four legs are electrically activated they are elongated and bending. As we shall see below, alternate legs move as pairs. Arrows show the direction of motion of the tip of each leg.



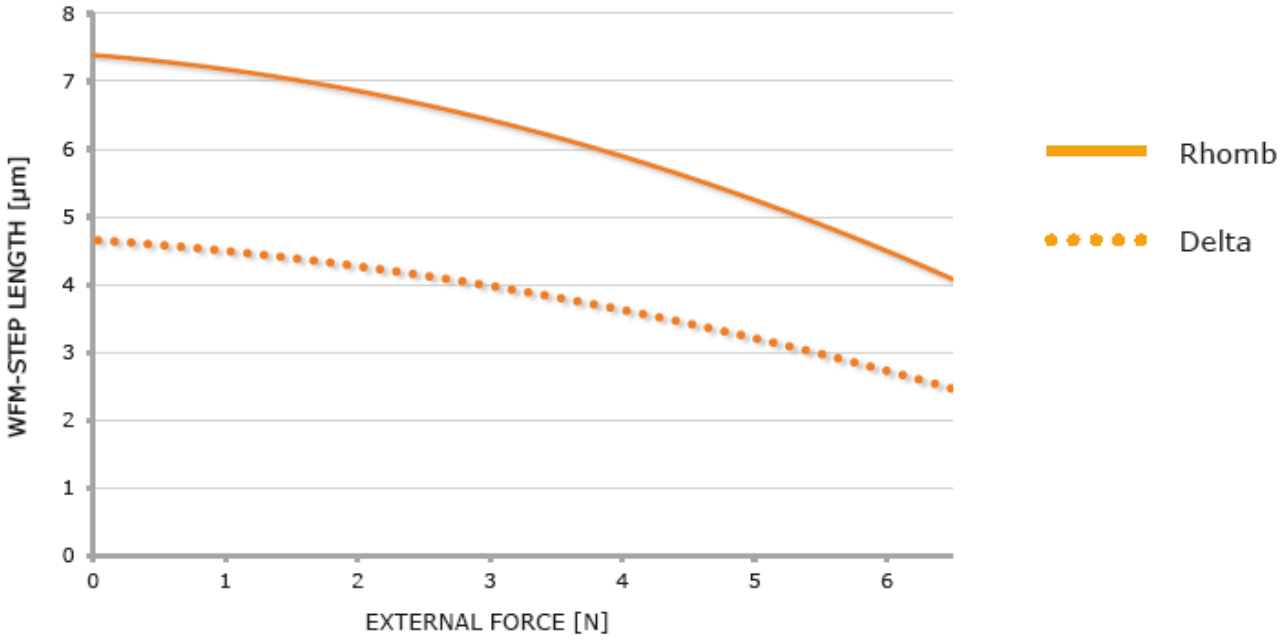
The first pair of legs maintains contact with the rod and moves towards the right. The second pair retracts and their tips begin to move left.



The second pair of legs has now extended and repositioned in contact with the rod. Their tips begin moving right. The first pair retracts and their tips begin to move left.

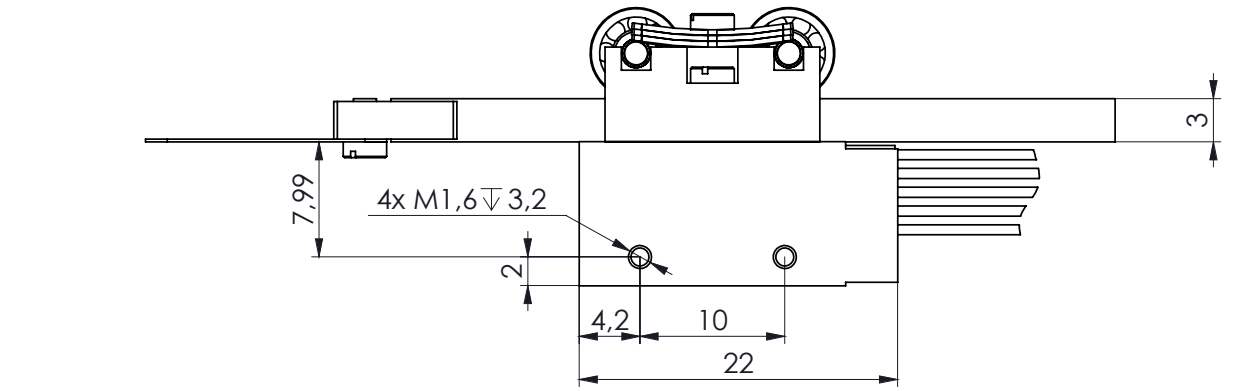


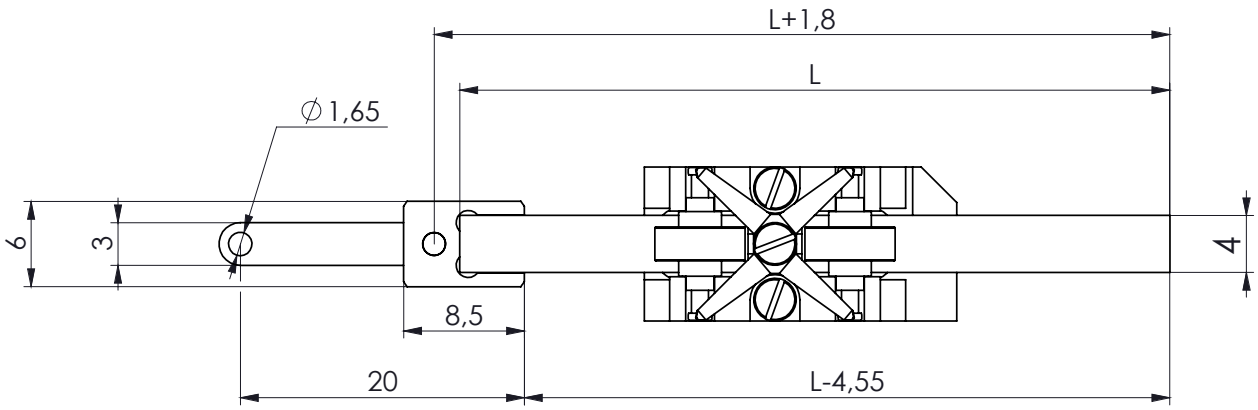
The second pair of legs has moved right. The first pair begins to elongate and move up towards the rod.

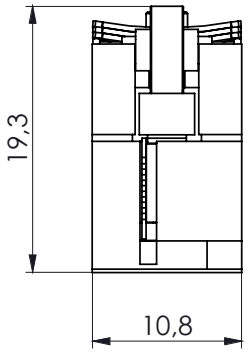


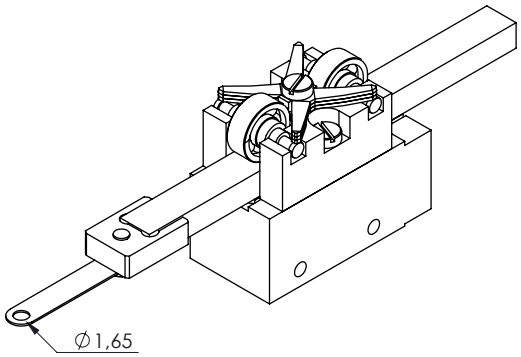
Motor performance with waveform Rhomb (filled) and waveform Delta (dotted). Wfm-step length is the average distance the drive rod moves when the legs take one wfm-step (i.e. for one waveform cycle).
Note: Standard deviation σ of 0.5 µm should be taken into account. Typical values are given for 20°C.

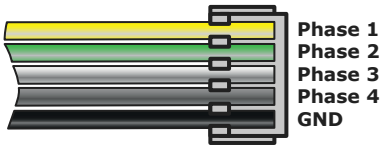
Main Dimensions LL1011D
Non-magnetic Vacuum











Motor Wiring	
Terminal	Cable Color
Phase 1	Yellow
Phase 2	Green
Phase 3	White
Phase 4	Grey
Ground (GND)	Black or brown

Stroke range	
Stroke (mm) with one adapter	Drive rod length (mm)
0-3.4	30
0-13.4	40
0-23.4	50
0-33.4	60
0-43.4	70
0-74.5	101

Technical Specification

Type	LL1011D non-magnetic vacuum	Unit	Note
Maximum Stroke	74.5 (L−22)	mm	101 mm rod, no mechanical adapter
Speed Range [a]	0-15	mm/s	no load, depending on waveform and driver
Step Length [b]	4	µm	one wfm-step
	0.0005 [c]	µm	one micro-step [c]
Resolution	< 1	nm	driver and encoder dependent
Recommended Operating Range	0-3	N	for best micro-stepping performance and life time
Stall Force	6.5	N	
Holding Force	7	N	
Vacuum	10^{-7}	torr	
Maximum Voltage	48	V	
Power Consumption [d]	5	mW/Hz	zero when not moving, during movement it is depending on the exitement frequency and completed cycles. Example: 0.5 W at 100 Hz wfm-step frequency
Connector	soldered cable with JST 05SR-3S		
Mechanical Size	22 x 19.3 x 10.8	mm	see drawing for details
Material in Motor Housing	Non-Magnetic		
Weight	23	gram	approximate
Operating Temp.	−20 to +70	°C	

Note: All specifications are subject to change without notice.

a. Max value is typical for waveform Rhomb at 2 kHz, no load, temperature 20°C.
b. Typical values for waveform Delta, 3 N load, temperature 20°C.
c. Driver dependent; 8192 micro-steps per wfm-step for driver in the PMD200-series.
d. At temperature 20°C, intermittent runs.

Item no.

LL1011D-xxx xx xxx

Family name
LL

Series
10

Version
11

Motor type
D = NMV / Non-Magnetic Vacuum

Drive rod (standard lengths)

030 = 30 mm	060 = 60 mm
040 = 40 mm	070 = 70 mm
050 = 50 mm	101 = 100.8 mm

Mechanical adapter
A0 = No adapter
D1 = One adapter - Front

Connector/Cable
B10 = 1.0 m PTFE AWG28 with JST 05SR-3S connector

Starter Kit Piezo
LEGS® LL10D

With the Starter kit you can easily get started with Piezo LEGS®. With the free PiezoMotor DriveLab application, you can run the motor in closed loop and with controlled position from a variety of of supported external encoders (not included).

The Starter kit is delivered with a PMD401 controller and a Piezo LEGS LL10D. It's a fully featured miniature connector board for open loop and closed loop operation that can be easily stacked to form a multi-axis controller system. It can be connected to the customer's mainboard for integration in OEM applications. The PMD401 provides a resolution of up to 8192 microsteps, which means a positioning resolution in the sub-nano-meter range. Host communication is done via 2-wire RS485 through ASCII commands.

The Starter kit is delivered with power supply for all regions and a USB (RS85) connection to a Windows computer running DriveLab. Download Piezo DriveLab from the PiezoMotor official website.
Note that each motor will have a specific maximum speed and step length, depending on the controller.

To get in contact with an engineer or place an order:
info@acuvi.com

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