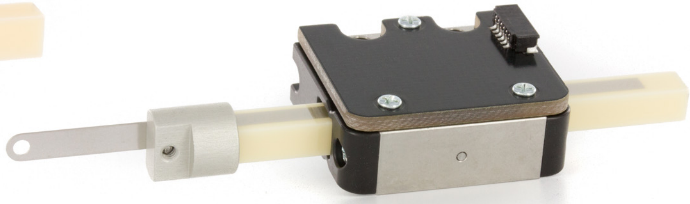
PiezoMotor

Piezo LEGS® Linear 6N

New Generation



- **Direct drive – backlash free**
- **High resolution optical encoder**
- **No power draw in hold position**
- **Quick response and high speed dynamics**

The LL06 linear motor is intended for a large range of OEM applications with focus on precise positioning. The direct drive principle of 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 conventional stepper motor assemblies when there is need for better resolution and smoother linear movement.

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 capabilities the technology is quite unique.

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, and can be seamlessly controlled in the whole dynamic range with no need to alter the driving mode.

The LL06 linear motor is available with a high resolution position sensor, and with drive rods of different lengths (30, 40, 50, 60 and 100.8 mm). The motor is easily integrated and will most likely simplify and reduce the size of your system.

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.

The most advanced alternative is the DMC-30019 which is a fully featured PID controller with Galil architecture. It can handle speed control and trajectory following, and it has script programming capability with multitasking for concurrent execution of four programs.

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

PMD301

PMD401

DMC-30019

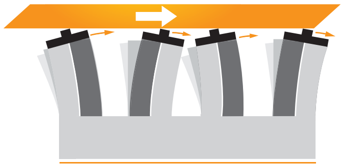
Summary	
Motor LL06	
Basic	Most compact design
Guided	With drive rod guides
Guided w. sensor	Including high resolution sensor
Controller	
PMD301-01	1-axis controller/driver
PMD401-01B	1-axis board level controller
DMC-30019-01	1-axis Galil controller

Operating Principle

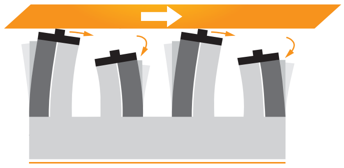
The Piezo LEGS walking principle is of the non-resonant type, i.e. the position of the drive legs is known at any given moment. This assures very good control of the motion over the whole speed range.

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).

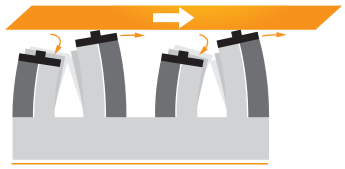
Micro-stepping is achieved by dividing the *wfm-step* into discrete points. The resolution will be a combination of the number of points in the waveform, and the load. Example: at 3 N load the typical wfm-step length with waveform *Delta* is ~4 µm, and with 8192 discrete points in the waveform the micro-step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



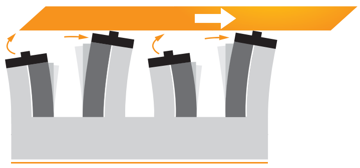
1 *When all four legs are electrically activated they are elongated and bending. As we shall see below, alternate legs move as pairs. Arrows show the direction of motion of the tip of each leg.*



2 *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.*



3 *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.*



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

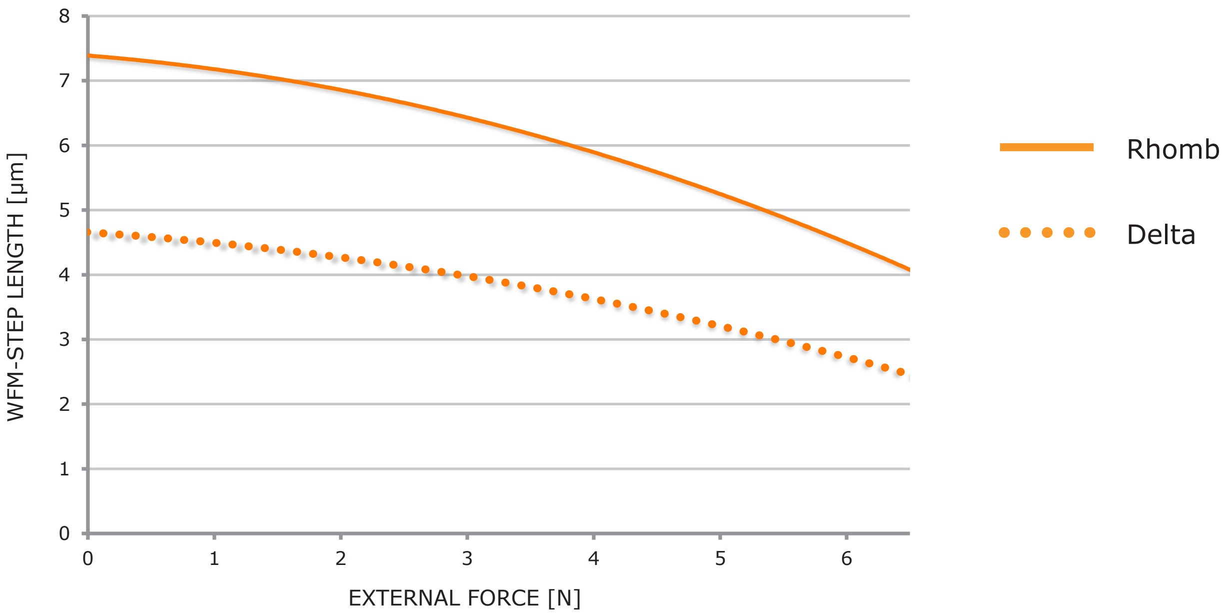
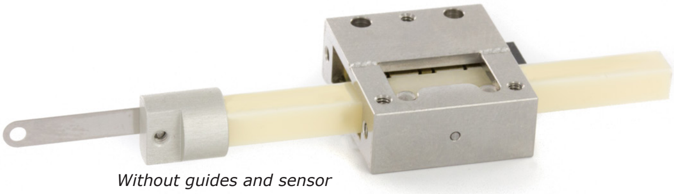
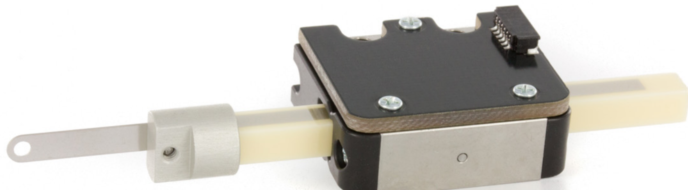


Figure 1 *Motor performance with waveform Rhomb (filled) and waveform Delta (dotted). Wfm-step length is the average distance the drive rod moves when the legs take one wfm-step (i.e. for one waveform cycle). Note: Standard deviation σ of 0.5 µm should be taken into account. Typical values are given for 20ºC.*

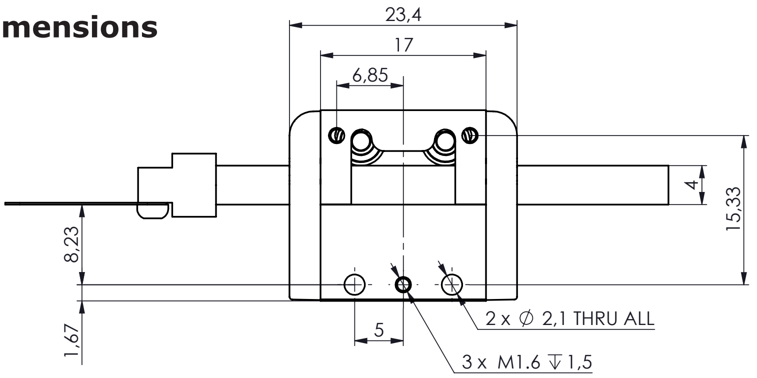


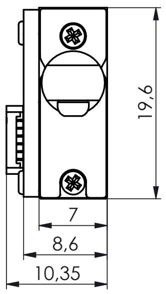
Without guides and sensor

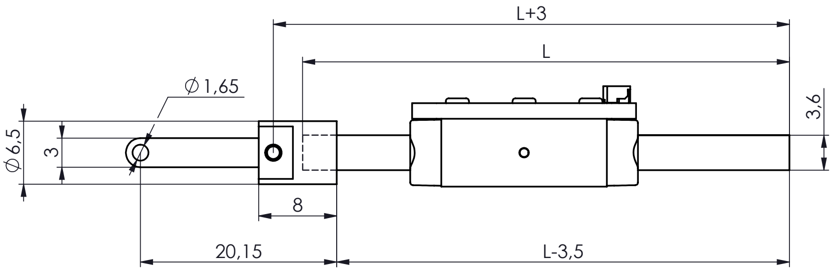


With guides and sensor

Main Dimensions







L = Drive rod length
Stroke = L−26.9 mm

Not to Scale
Enlarged for Clarity

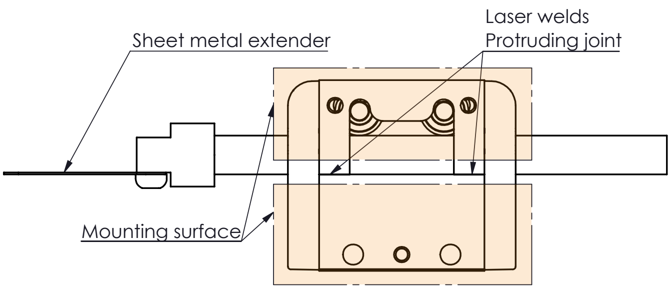
Mounting Instructions

Option 1: Fasten motor using 2x M2 screws (or similar) inserted from sensor side into the Ø2.1 mm thru holes.

Option 2: Fasten motor using 3x M1.6 screws into the threaded M1.6 holes on motor side. Beware of short hole depth 1.5 mm and use appropriate screws.

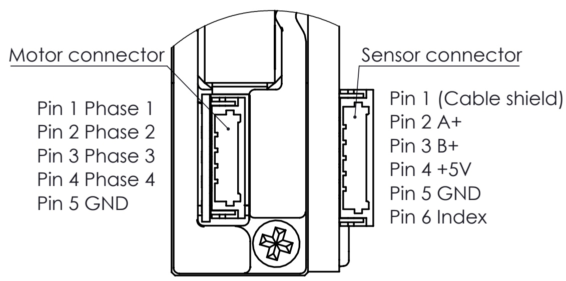
Note the protruding joint and only let motor rest against the mounting surfaces (see figure below).

The sheet metal extender of the mechanical adaptor will compensate for minor mounting misalignments so that forces and torques are not transferred into the motor. Connect using a M1.6 screw (or similar) inserted into the Ø1.65 mm thru hole of the sheet metal extender.



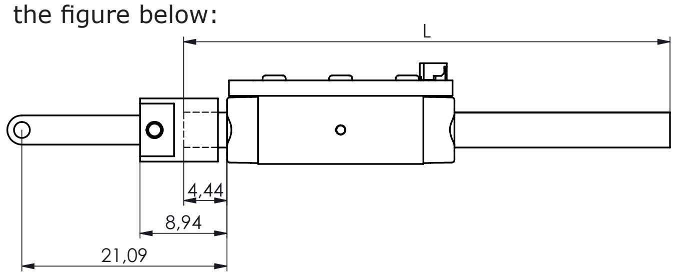
Electrical Connectors

Motor cable is connected to the 5 pole receptacle (Hirose DF52-5S-0.8H) and sensor cable is connected to the 6 pole receptacle (Hirose DF52-6S-0.8H). Mating plug connectors are from the Hirose DF52 series and should be connected with the following pin layout:



Sensor Information

The sensor is of reflective optical type with quadrature output (ABZ). Drive rod position at index is indicated in the figure below:



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Technical Specification			
Type	**LL06**	**Unit**	**Note**
Maximum Stroke	73.9 (L−26.9)	mm	for drive rod L=100.8 mm, guides G1, and mechanical adapter M1
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	motor resolution 0.5 nm; one micro-step [c]
Sensor Resolution	1.25 (sensor E1)	µm	quadrature sensor ABZ
Sensor Accuracy	±3	µm	
Sensor Repeatability	1.25	µm	sensor E1 with guides G1
Stall Force	6.5	N	
Holding Force	7	N	
Recommended Operating Range	0-3	N	for best micro-stepping performance and life time
Maximum Voltage	48	V	
Power Consumption [d]	5	mW/Hz	=0.5 W at 100 Hz wfm-step frequency
Connectors	Hirose DF52-5S-0.8H Hirose DF52-6S-0.8H		- motor - sensor
Mechanical Size	23.4 x 19.6 x 10.35 17 x 19.6 x 7	mm	- with guides and sensor - without guides and sensor
Material in Motor Housing	Stainless Steel		
Weight	16	gram	with 50 mm rod, guides and sensor
Operating Temp.	−20 to +70	ºC	

a. Max value is typical for waveform *Rhomb* at 2 kHz, no load, temperature 20ºC.
b. Typical values for waveform *Delta*, 3 N load, temperature 20ºC.
c. Driver dependent; example with 8192 micro-steps per wfm-step.
d. At low duty cycle when motor is not heated. Sensor power consumption not included.

Note: *All specifications are subject to change without notice.*

Item no. LL06A0-xxxM1GxEx

Family name
LL

Series
06

Motor type and version
A = Standard 0 = Version number

Drive rod lengths (L)
030 = 30 mm* 060 = 60 mm
040 = 40 mm 101 = 100.8 mm
050 = 50 mm

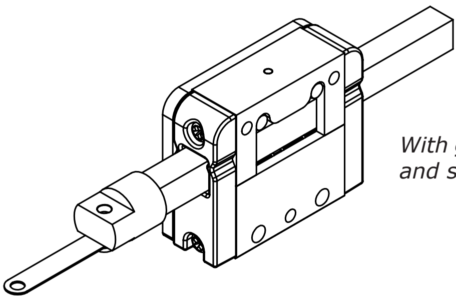
Mechanical adapter
M1 = One adapter - Front

Guides
G0 = Without guides
G1 = With guides

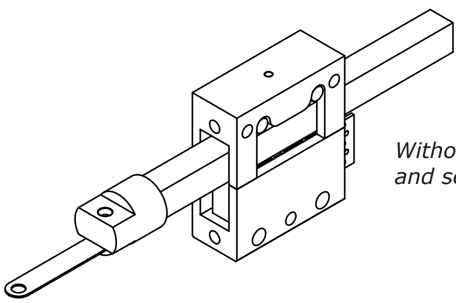
Encoder (position sensor)* - only available together with guides
E0 = Without position sensor
E1 = 1.25 µm incremental optical encoder with index

* Sensor not available with the 30 mm drive rod

Note:
All combinations are **not** available!
Motor and sensor cables ordered separately.



With guides and sensor



Without guides and sensor

www.piezomotor.com

Visit our website for application examples, CAD files, videos and more...

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