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.

Summary

<table>
<thead>
<tr>
<th>Motor LL06</th>
<th>Controller</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic</td>
<td>PMD301-01</td>
</tr>
<tr>
<td>Guided</td>
<td>PMD401-01B</td>
</tr>
<tr>
<td>Guided w. sensor</td>
<td>DMC-30019-01</td>
</tr>
</tbody>
</table>
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.

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.
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.
### Technical Specification

<table>
<thead>
<tr>
<th>Type</th>
<th>LL06</th>
<th>Unit</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum Stroke</td>
<td>73.9</td>
<td>mm</td>
<td>for drive rod L=100.8 mm, guides G1, and mechanical adapter M1</td>
</tr>
<tr>
<td>Speed Range</td>
<td>0-15</td>
<td>mm/s</td>
<td>no load, depending on waveform and driver</td>
</tr>
<tr>
<td>Step Length</td>
<td>4</td>
<td>µm</td>
<td>one wfm-step</td>
</tr>
<tr>
<td>Sensor Resolution</td>
<td>1.25</td>
<td>µm</td>
<td>quadrature sensor ABZ</td>
</tr>
<tr>
<td>Sensor Accuracy</td>
<td>±3</td>
<td>µm</td>
<td>sensor E1 with guides G1</td>
</tr>
<tr>
<td>Sensor Repeatability</td>
<td>1.25</td>
<td>µm</td>
<td>for best micro-stepping performance and life time</td>
</tr>
<tr>
<td>Stall Force</td>
<td>6.5</td>
<td>N</td>
<td></td>
</tr>
<tr>
<td>Recommended Operating Range</td>
<td>0-3</td>
<td>N</td>
<td></td>
</tr>
<tr>
<td>Maximum Voltage</td>
<td>48</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Power Consumption</td>
<td>5</td>
<td>mW/Hz</td>
<td>=0.5 W at 100 Hz wfm-step frequency</td>
</tr>
<tr>
<td>Connectors</td>
<td>Hirose DF52-5S-0.8H</td>
<td>- motor</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Hirose DF52-6S-0.8H</td>
<td>- sensor</td>
<td></td>
</tr>
<tr>
<td>Mechanical Size</td>
<td>23.4 x 19.6 x 10.35</td>
<td>mm</td>
<td>- with guides and sensor</td>
</tr>
<tr>
<td></td>
<td>17 x 19.6 x 7</td>
<td></td>
<td>- without guides and sensor</td>
</tr>
<tr>
<td>Material in Motor Housing</td>
<td>Stainless Steel</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weight</td>
<td>16</td>
<td>gram</td>
<td>with 50 mm rod, guides and sensor</td>
</tr>
<tr>
<td>Operating Temp.</td>
<td>−20 to +70</td>
<td>ºC</td>
<td></td>
</tr>
</tbody>
</table>

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

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.

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**Item no. LL06A0-xxxM1GxEx**

- **Family name**
  - L
- **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)**
  - 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.

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

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