- **Direct drive – backlash free**
- **Simple drive electronics**
- **No power draw in hold position**
- **Quick response and high speed dynamics**

The LL10 linear motor is intended for a large range of OEM applications. Design focus has been for ease of integration. The very high speed dynamics and nanometer resolution makes it ideal for numerous applications.

The Piezo LEGS technology is characterized by its outstanding precision. Fast speed and quick response time, as well as long service life are other benefits. In combination with the nanometer resolution the technology is quite unique.

The motor is ideally suited for move and hold applications or for automatic adjustments. When in hold position it does not consume any power. The drive technology is direct, meaning no gears or lead screws are needed to create linear motion. The motor has no mechanical play or backlash. The LL10 linear motor is available in a standard version, and in a non-magnetic vacuum version.

Mechanical connection

The motor is easily integrated in your application using the drive rod mechanical adapter. Drive rods are supplied in different lengths (30, 40, 50, 60, 70 and 100.8 mm).

Operating modes

The motor can move in full steps (waveform-steps), or partial steps (micro-steps) giving positioning resolution in the nanometer range. Speed is adjustable from single micro-steps per second up to max specified.

Controlling the motor

We offer a range of drivers and controllers. The most basic one is a hand-held push button driver. A more advanced option is the PMD101 micro-step driver/ controller. This can be used either as an analogue driver that regulates the motor speed by means of an ±10V analogue interface, or handle internal closed loop control and precise positioning. The micro-stepping feature divides the wfm-step into thousands of small increments which results in micro-steps in the micrometer range. The most advanced alternative is the DMC-30019 which is a fully featured PID controller. It can handle speed control and trajectory following, and it is programmable for standalone operation.

PMD101

DMC-30019

Design your own driver

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

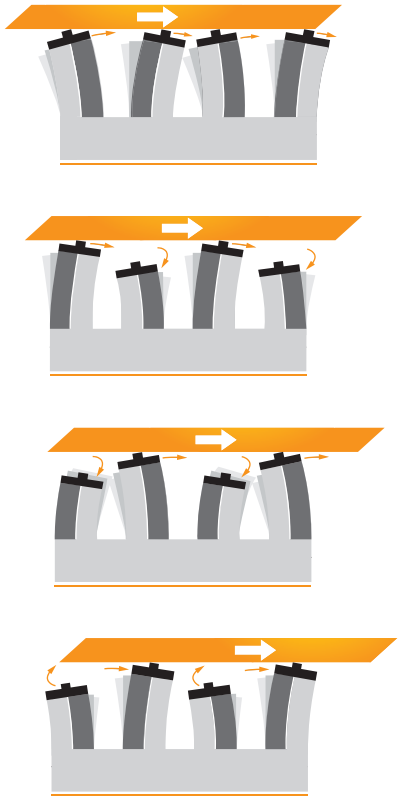
Ordering information	
Motors	
LL1011A-	Stainless Steel
LL1011D-	Non-Magnetic Vacuum
Drivers and Controllers	
PMCM21	Hand-held push button driver
PMD101	1-axis micro-stepping driver
PMD206	6-axis micro-stepping driver
DMC-30019	Motion Control
Linear Encoders	
See separate data sheet	

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.*

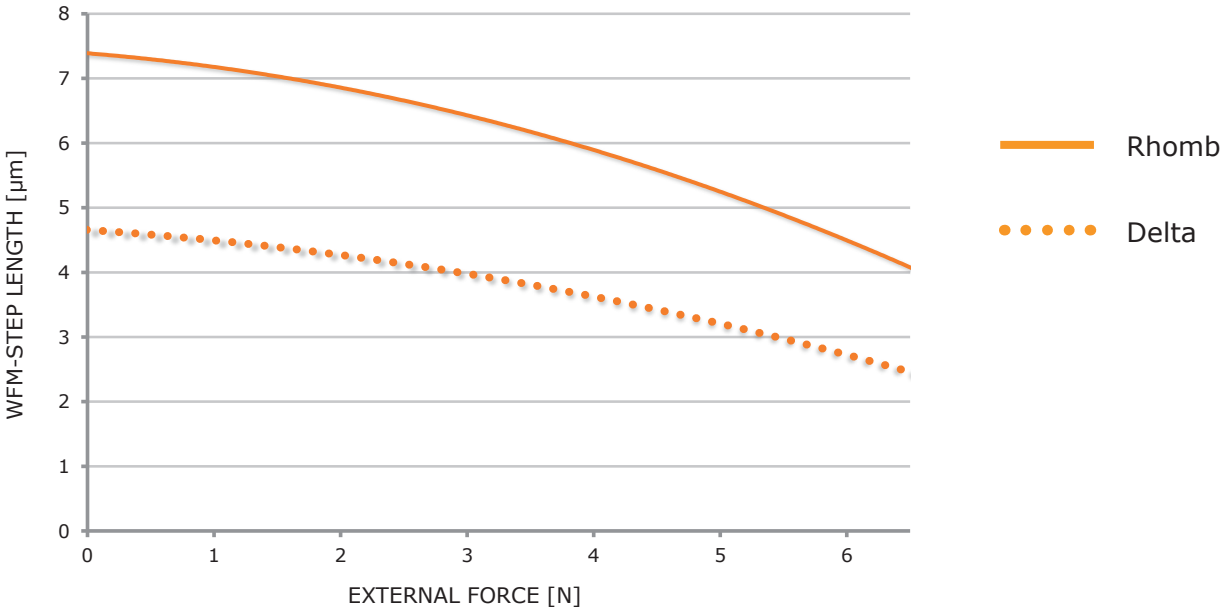
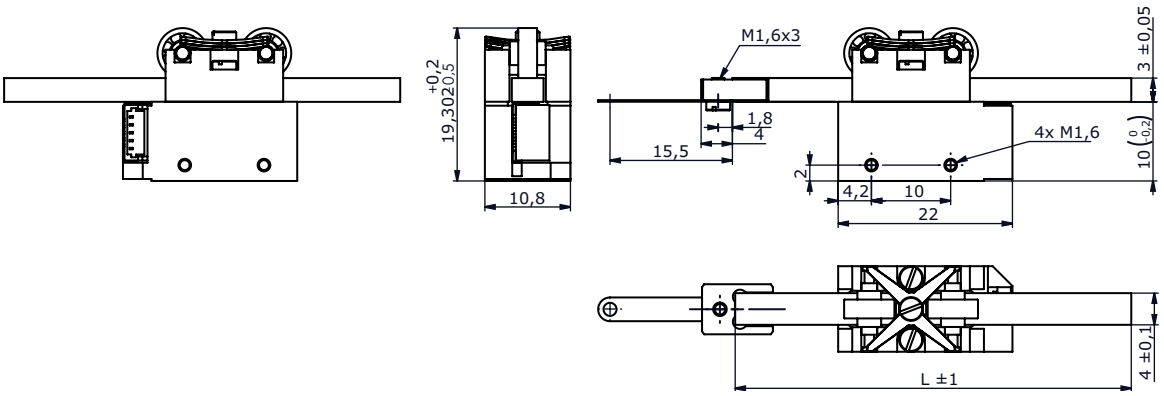
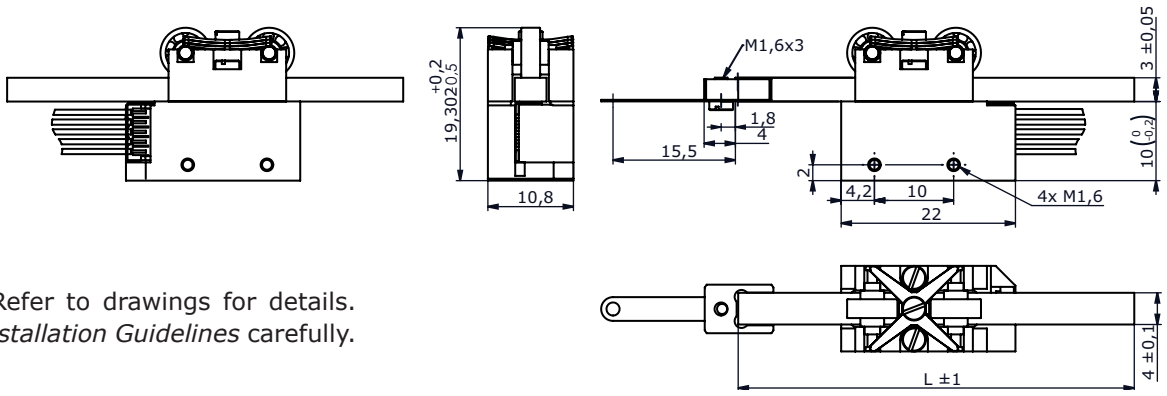


Figure 1 *Motor performance with waveform Rhomb (filled) and waveform Delta (dotted). Wfm-step length is the average distance the drive rod moves when the legs take one wfm-step (i.e. for one waveform cycle). Note: Standard deviation σ of 0.5 µm should be taken into account. Typical values are given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

Main Dimensions LL1011A
Stainless Steel



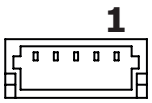
Main Dimensions LL1011D
Non-Magnetic Vacuum



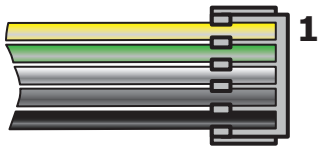
Note: Refer to drawings for details.
Read *Installation Guidelines* carefully.

Electrical Connector Type

On motor type A (standard version) the connector is JST BM05B-SRSS-TB.



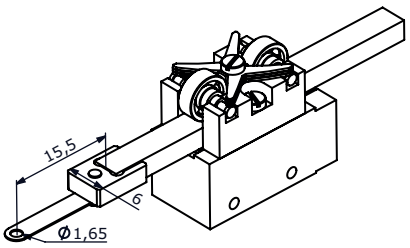
Motor type D (non-magnetic ,vacuum version) has a soldered cable with connector of type JST 05SR-3S.



Pin Assignment		
Pin	**Terminal**	**Cable Color**
1	Phase 1	Yellow
2	Phase 2	Green
3	Phase 3	White
4	Phase 4	Grey
5	Ground (GND)	Black or brown

Mechanical Connector Type

The drive rod can be fastened using a mechanical adapter with sheet metal extender. Please read *Installation Guidelines* carefully for notes on how to properly connect the Piezo LEGS motor. Disregarding the instructions given in the guideline document may impair both motor performance as well as life time.



Technical Specification				
Type	**LL1011A-** **stainless steel**	**LL1011D-** **n-m vacuum**	**Unit**	**Note**
Maximum Stroke	80 (L−20.8)	80 (L−20.8)	mm	100.8 mm rod, no mechanical adapter
Speed Range [a]	0-15	0-15	mm/s	recommended, no load
Step Length [b]	4	4	µm	one wfm-step
	0.0005 [c]	0.0005 [c]	µm	one micro-step [c]
Resolution	< 1	< 1	nm	driver dependent
Recommended Operating Range	0-3	0-3	N	for best micro-stepping performance and life time
Stall Force	6.5	6.5	N	
Holding Force	7	7	N	
Vacuum	-	10^{-7}	torr	
Maximum Voltage	48	48	V	
Power Consumption [d]	5	5	mW/Hz	=0.5 W at 100 Hz wfm-step frequency
Connector	JST BM05B-SRSS-TB	soldered cable w. JST 05SR-3S		
Mechanical Size	22 x 19 x 10.8	22 x 19.3 x 10.8	mm	see drawing for details
Material in Motor Housing	Stainless Steel	Non-Magnetic		
Weight	23	23	gram	approximate
Operating Temp.	−20 to +70	−20 to +70	ºC	

150010-06

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; 8192 micro-steps per wfm-step for driver in the PMD200-series.
d. At temperature 20ºC, intermittent runs.

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

Item no. **LL1011 _ -** _ _ _ _ _

Family name
LEGS Linear

Stall force
10 = 6.5 N

Version

Motor type
A = SS / Stainless Steel
D = NMV / Non-Magnetic Vacuum

Drive rod (standard lengths)
030 = 30 mm
040 = 40 mm
050 = 50 mm
060 = 60 mm
070 = 70 mm
101 = 100.8 mm

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

Connector/Cable

Motor type A

A00 = JST connector, no cable
K05 = 0.5 m cable for driver PMD101 and PMCM31
K15 = 1.5 m cable for driver PMD101 and PMCM31
L05 = 0.5 m cable-kit for driver PMD206 and PMD236
L15 = 1.5 m cable-kit for driver PMD206 and PMD236

Motor type D

B10 = 1.0 m Teflon flying wires PTFE AWG28 for connection to driver PMD101 and PMCM31

For connection to driver PMD206 or PMD236 you need a D-sub adapter, p/n CK6280.

Note: All combinations are **not** available!

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

www.piezomotor.com

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