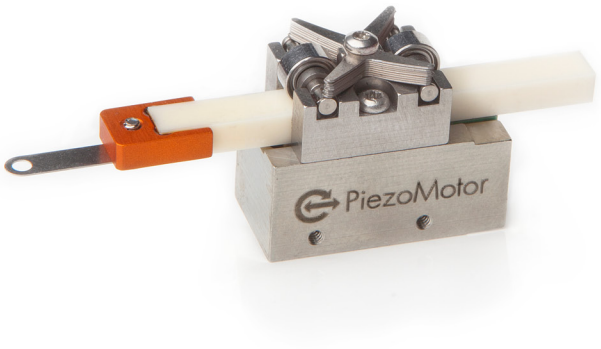
Piezo LEGS® Linear 6N



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

The Piezo LEGS 6N 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 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 the motor is 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. This means the motor has no mechanical play or backlash. The Piezo LEGS 6N linear motor is available in a standard version, a non-magnetic version, and a non-magnetic vacuum version.

Mechanical and electrical 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 101.8 mm).

Operating modes

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

Controlling the motor

PiezoMotor offers a range of drivers and controllers. The most basic one is a handheld push button driver. Another option is an analogue driver that regulates the motor speed by means of an ±7 V analogue interface. One of the more advanced alternatives is the PMD101 Microstep Driver/Controller. This product enables the user to vary the waveform as well as speed. The PMD101 is equipped with encoder signal inputs for close loop control. The microstepping feature divides full step cycle into maximum 2048 increments which results in microsteps as small as two nanometers.

PMD101

Design your own driver

Some customers prefer to design their own driver for ease of integration or for even higher waveform resolution (sub-nanometer range). In this case PiezoMotor can provide information to assist in the design.

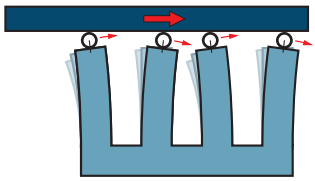
Ordering information	
Motor	
LL1011A-	Standard version, stainless steel
LL1011C-	Non-magnetic version
LL1011D-	Vacuum version, non-magnetic
Drivers and Controllers	
PMCM21-01	Handheld push button driver
PMCM31-01	Analogue driver
PMD101	Microstepping driver
Accessories	
102431-05	Motor cable 0.5 m
102431-15	Motor cable 1.5 m

Operating Principle

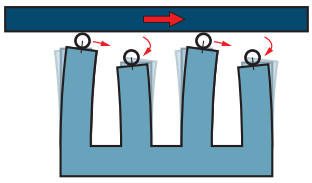
The Piezo LEGS walking principle is of the non-resonant type, i.e. the position of the drive legs is known at any given moment. This assures very good control of the motion over the whole speed range.

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 µm at no load). 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 µm x 2 kHz = 14 mm/s).

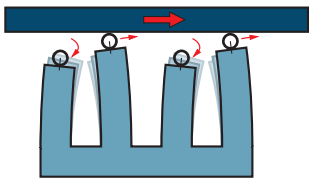
Microstepping is achieved by dividing the *wfm-step* into discrete points. The resolution will be a combination of the number of points in the waveform, and the load. Example: at 3 N load the typical wfm-step length is ~6 µm, and with 2048 discrete points in the waveform the microstep resolution will be ~3 nm. In analog bending mode or with higher resolution D/A converter it is possible to position in the sub nanometer region.



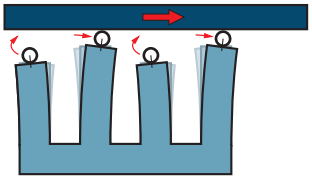
1 *When all four legs are electrically activated they are elongated and bending. As we shall see below, alternate legs move as pairs. Arrows show the direction of motion of the tip of each leg.*



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 re-positioned 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.*

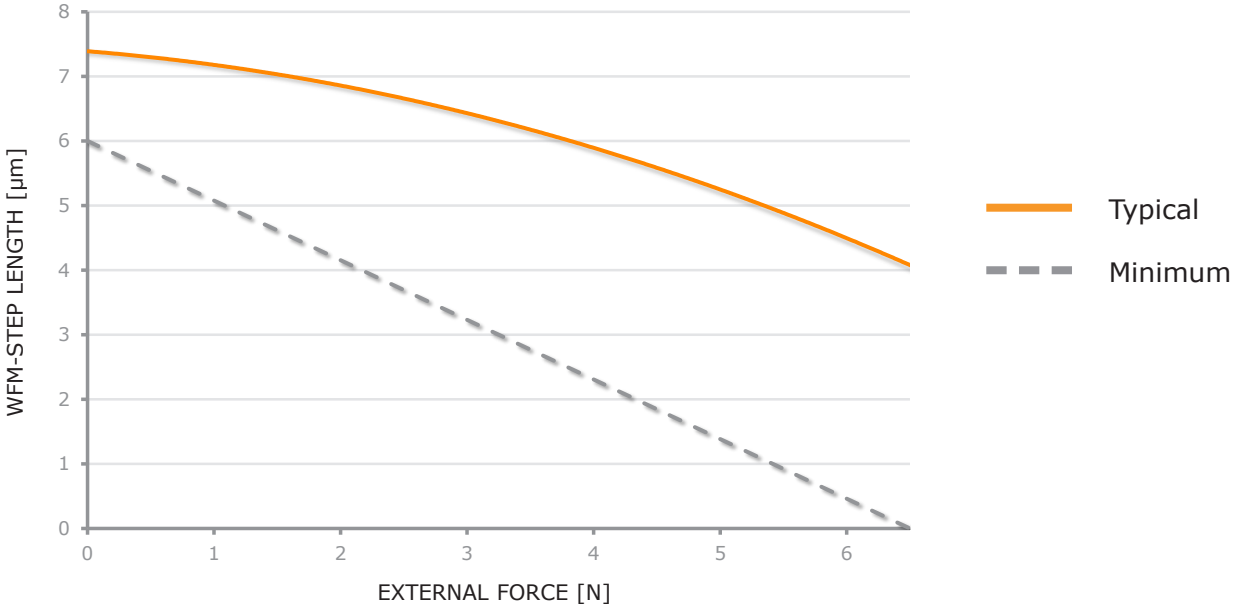
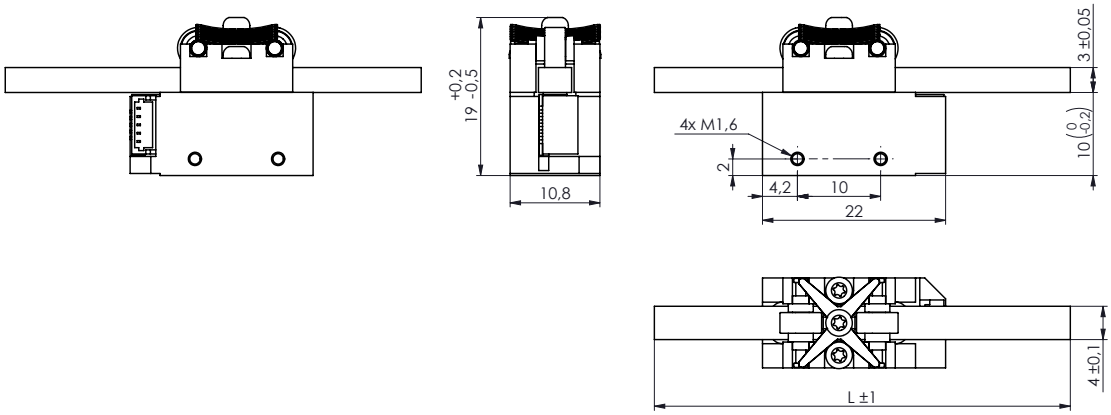


Figure 1 *Typical motor performance with rhombic waveform (Rhomb S) at 650 Hz drive frequency. Wfm-step length is the average distance the drive rod moves when the legs take one step (i.e. for one waveform cycle). Using other waveforms than rhombic will give a different curve. Dotted line is guaranteed minimum for these drive conditions.*

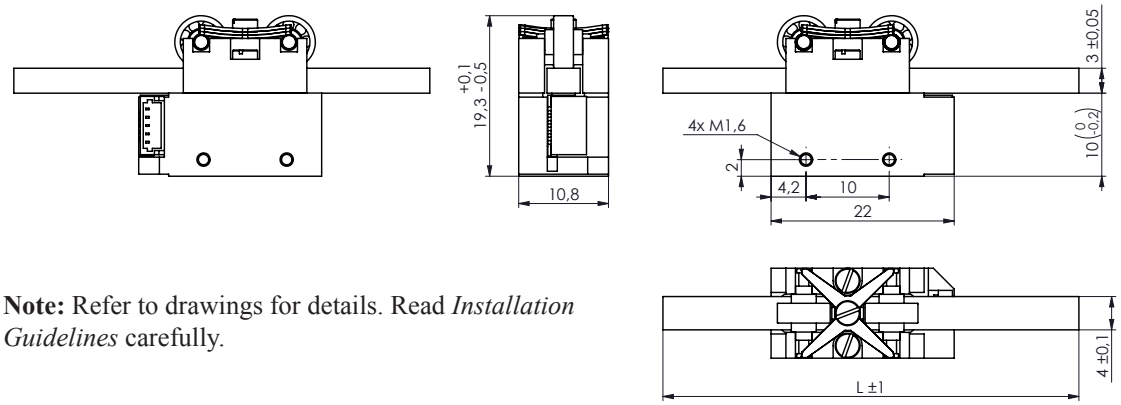
Main Dimensions LL1011A

Standard version



Main Dimensions LL1011C

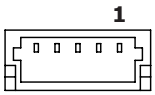
Non-magnetic version



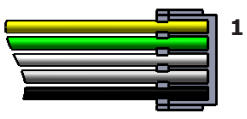
Note: Refer to drawings for details. Read *Installation Guidelines* carefully.

Electrical Connector Type

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



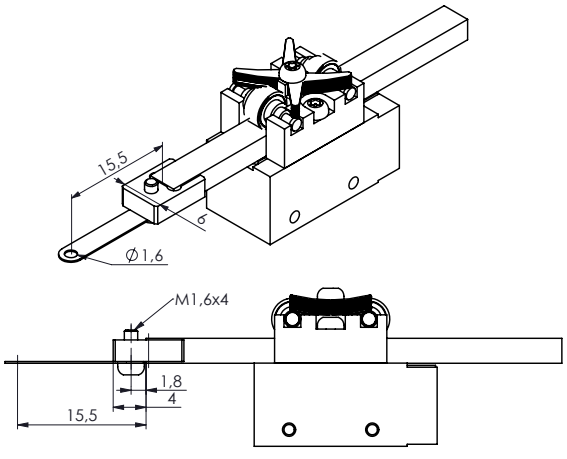
Motor type D (vacuum version) has a soldered cable with connector of type JST 05SR-3S.



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 LEGS motor. Disregarding the instructions given in the guideline document may impair both motor performance as well as life time.



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Technical Specification					
Type	**LL1011A-** **(standard)**	**LL1011C-** **(non-magnetic)**	**LL1011D-** **(vacuum)**	**Unit**	**Note**
Maximum Stroke	80 (L−20.8)	80 (L−20.8)	80 (L−20.8)	mm	100.8 mm rod, no mechanical adapter
Speed Range	0-15	0-15	0-15	mm/s	recommended, no load
Step Length	0.001[a]-6	0.001[a]-6	0.001[a]-6	µm	no load, microsteps up to full wfm-steps
Resolution [a]	< 1	< 1	< 1	nm	
Recommended Operating Range	0-3	0-3	0-3	N	for best microstepping performance and life time
Stall Force	6.5	6.5	6.5	N	
Holding Force	7	7	7	N	
Vacuum	-	-	10^{-7}	torr	
Maximum Voltage	48	48	48	V	
Connector	JST BM05B-SRSS-TB	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	22 x 19.3 x 10.8	mm	see drawing for details
Material in Motor Housing	Stainless Steel	Non-Magnetic	Non-Magnetic		
Weight	23	23	23	gram	approximate
Operating Temp.	−20 to +70	−20 to +70	−20 to +70	ºC	

a. Driver dependant

Item no. LL1011 _ - _ _ _ _ _

Stall Force
10 = 6.5 N

Version

Motor type
A = SS / Stainless Steel
C = NM / Non-Magnetic
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
A = JST connector - for motor type A and C
B = Teflon cable PTFE AWG28 with JST connector - for motor type D

Cable (standard lengths)
00 = No cable (JST connector only) - for motor type A and C
05 = 0.5 m - for motor type A and C
10 = 1.0 m - for motor type D
15 = 1.5 m - for motor type A and C

Example:
LL1011A-050D1A05: LEGS Linear, 6.5 N, version 11, Stainless Steel, 50 mm drive rod, mechanical adapter front end, JST Connector with 0.5 meter cable

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

Note: All specifications are subject to change without notice.

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

www.piezomotor.com

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