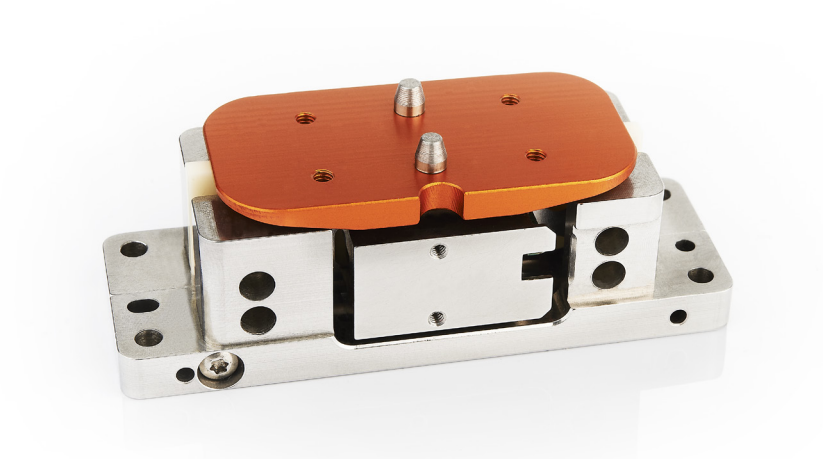


- **For stage integration**
- **Direct drive - backlash free**
- **Nanometer resolution**
- **Simple drive electronics**
- **Quick response and high speed**

The Piezo LEGS Caliper 20N motor is intended for motorizing linear stages or goniometer stages. It is miniaturized to such a degree it will fit within the stage block. Manufacturers can with the Caliper motor reach new degrees of miniaturization in stage motorization. The very high speed dynamics and nanometer resolution makes it ideal for motorized stages.

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.

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.

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.

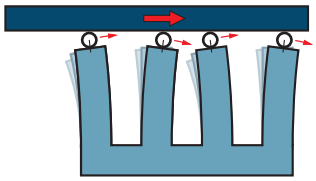
Ordering information	
Motor	
LC2010	Motor for goniometer stage
LC2020	Motor for linear stage
Drivers and Controllers	
PMCM21-01	Handheld Push Button Driver
PMCM31-01	Analogue Driver
PMD101	Microstepping Driver
Accessories	
LEGS-LT CONNECT	Twin Connect Board

Operating Principle

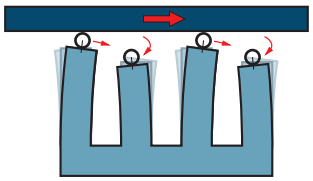
The Piezo LEGS walking principle is of the non-resonant type, i.e. the position of the drive legs is known at any given moment. This assures very good control of the motion over the whole speed range.

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* (~5 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 (5 µm x 2 kHz = 10 mm/s).

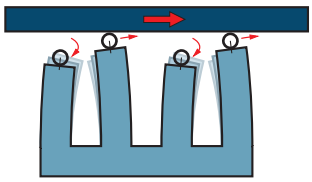
Microstepping is achieved by dividing the *wfm-step* into discrete points. The resolution will be a combination of the number of points in the waveform, and the load. Example: at 9 N load the typical wfm-step length is ~4 µm, and with 2048 discrete points in the waveform the microstep resolution will be ~2 nm. In analog bending mode or with higher resolution D/A converter it is possible to position in the sub nanometer region.



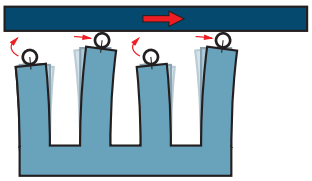
1 *When all four legs are electrically activated they are elongated and bending. As we shall see below, alternate legs move as pairs. Arrows show the direction of motion of the tip of each leg.*



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.*

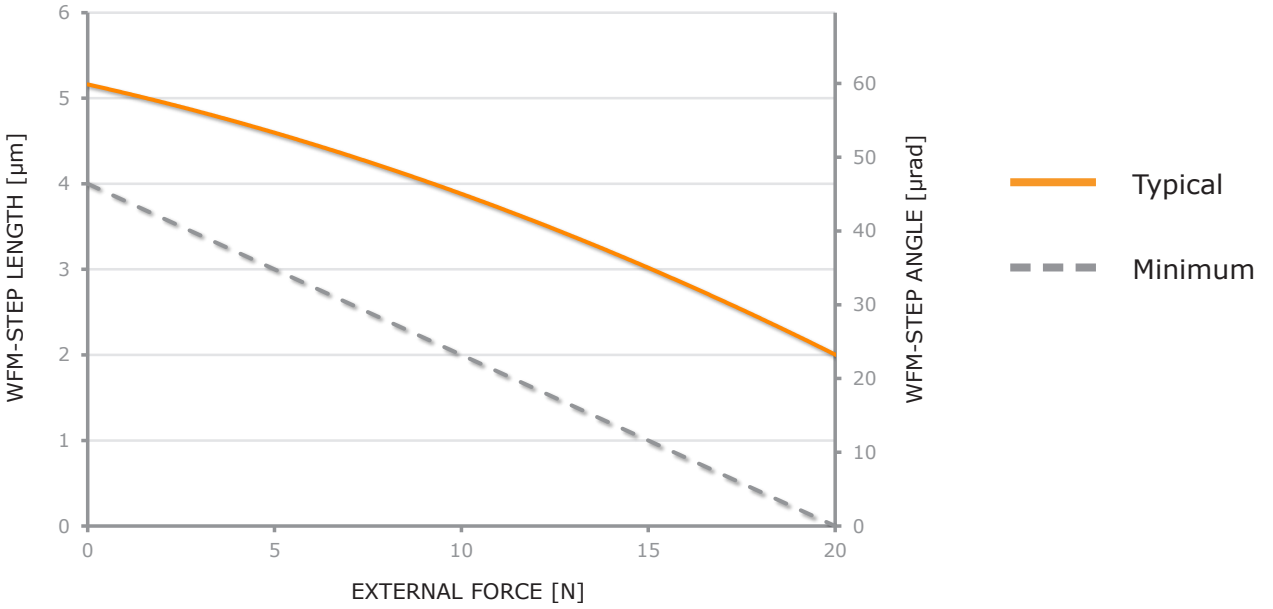
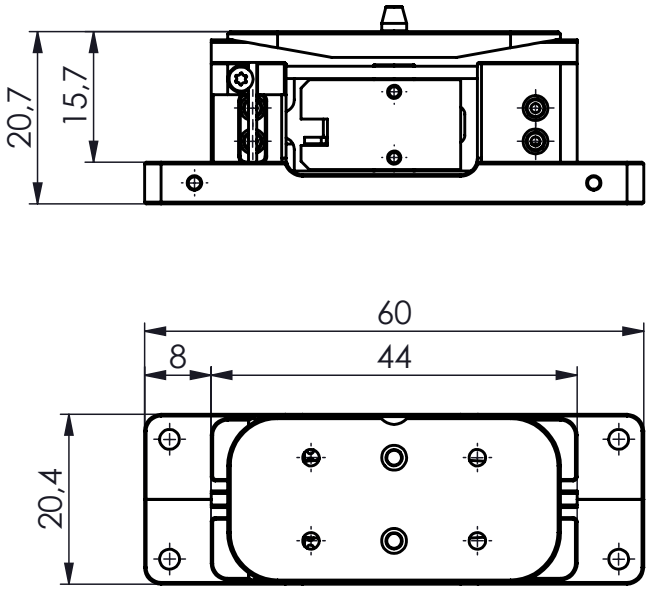


Figure 1 *Typical motor performance with rhombic waveform (Rhomb S) at 650 Hz drive frequency. Wfm-step length/angle is the average distance/angle the drive rod moves when the legs take one step (i.e. for one waveform cycle). Using other waveforms than rhombic will give a different curve. Dotted line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

Main Dimensions LC20



Note: All specifications are subject to change without notice. Detailed drawings can be found in the document *Installation Guidelines for the Piezo LEGS Caliper.*

Installation

The Piezo LEGS Caliper is designed for stage integration. It is miniaturized to a degree where it will fit inside a linear stage or a goniometer stage (figure 2). The motor is easily mounted in the stage blocks using eight screws. No further adjustments have to be made. Please look at the document *Installation Guidelines for the Piezo LEGS Caliper* for information on how to design the stage blocks and how to correctly mount the motor. The guideline document also has more detailed drawings of the motor.

The PiezoMotor staff will be happy to assist you with details on system integration and can provide mechanical engineering expertise. On our webpage you can find CAD files for download (motor units and mock-up stages).

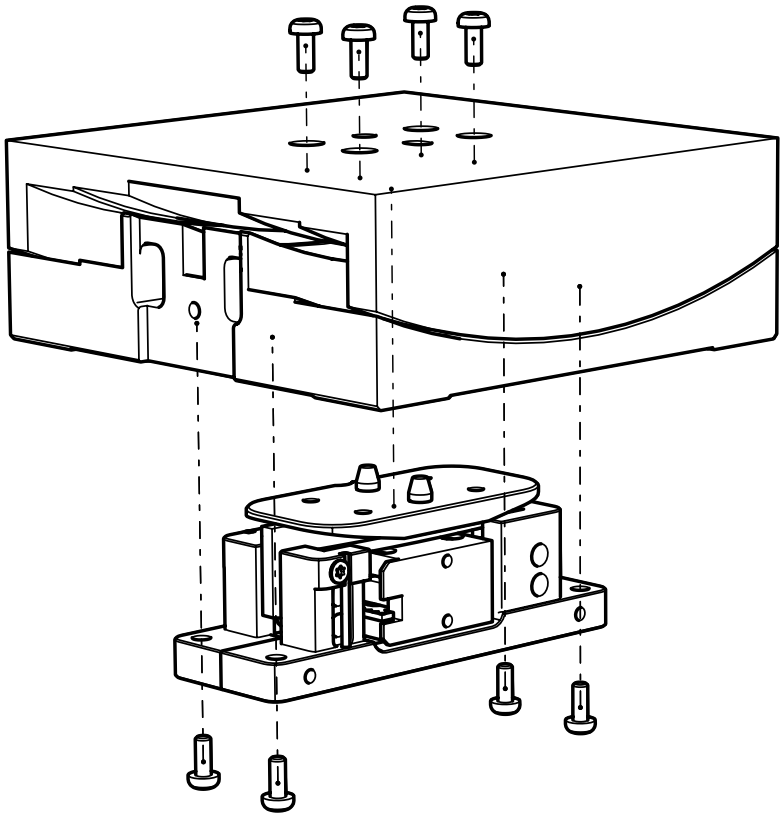


Figure 2 Example of Caliper motor integration in a 70x70 mm goniometer stage.

150052-03

Technical Specification			
Type	**LC2010 (for gonio stage)**	**LC2020 (for linear stage)**	**Note**
Stroke	±10º [a]	29 mm	
Minimum Radius	86 mm	-	see installation guidelines
Speed Range	0-7 º/s [a]	0-10 mm/s	recommended, no load
Step Angle/Length	0.01[b]-45 µrad [a]	0.001[b]-4 µm	no load, microsteps up to full wfm-steps
Resolution [b]	< 10 nrad [a]	< 1 nm	
Recommended Operating Range	0-10 N	0-10 N	for best microstepping performance and life time
Stall Force	20 N	20 N	
Holding Force	22 N	22 N	
Maximum Voltage	48 V	48 V	
Connector	2 x soldered cable with JST 05SR-3S	2 x soldered cable with JST 05SR-3S	
Mechanical Size	60 x 20.7 x 20.4 mm	60 x 20.7 x 20.4 mm	see drawing for details
Material in Motor Housing	Stainless Steel, Aluminum	Stainless Steel, Aluminum	
Weight	110 grams	110 grams	
Operating Temp.	0 to +50 ºC	0 to +50 ºC	

a. At the minimum radius 86 mm b. Driver dependant

Note: All specifications are subject to change without notice.

Item no.

LC20 A-044A10

Stall Force
20 = 20 N

Version
10 = for goniometer stage mount
20 = for linear stage mount

Motor type
A = SS / Stainless Steel

Drive rod (standard lengths)
044 = 44 mm (will give stroke according to specifications)

Connector
A = Soldered cable with JST connector

Cable Options
10 = 2 x 1.0 m

Twin connect board is sold separately, see accessory list on page 1.

Electrical Connector Type

The motor is fitted with two cables that both need to be connected in parallell to the driver. Use *Twin connect board* to have the two motor cables connected in parallel.

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

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

www.piezomotor.com

PiezoMotor

PiezoMotor Uppsala AB
Stålgatan 14
SE-754 50 Uppsala, Sweden

Telephone: +46 18 489 5000
Fax: +46 18 489 5001

info@piezomotor.com
www.piezomotor.com