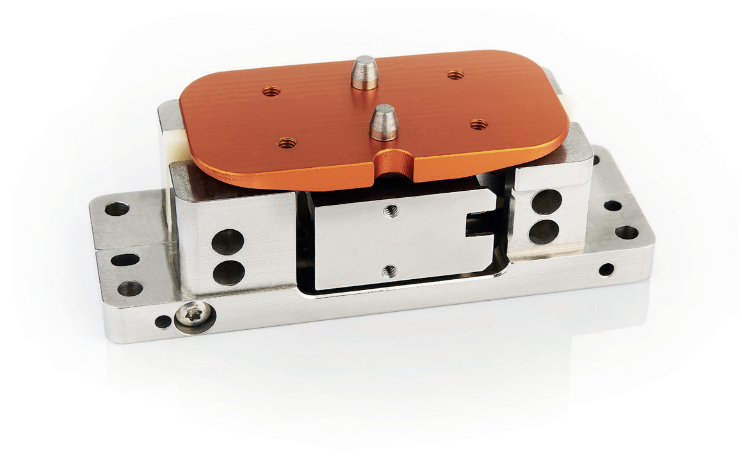
Piezo LEGS® Caliper 20N



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

The LC20 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 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.

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. The motor has no mechanical play or backlash.

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

PiezoMotor offers a range of drivers and controllers. The most basic one is a hand-held push button driver. Another option is an analogue driver that regulates the motor speed by means of an ±10 V analogue interface. More advanced alternatives are micro-step drivers/controllers in the 100- and 200-series. These products allow for 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 nanometer range. The PMD units are straight forward to use, supports quadrature and serial sensors, and have multiple I/O ports.

PMD101

PMD206

Design your own driver

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

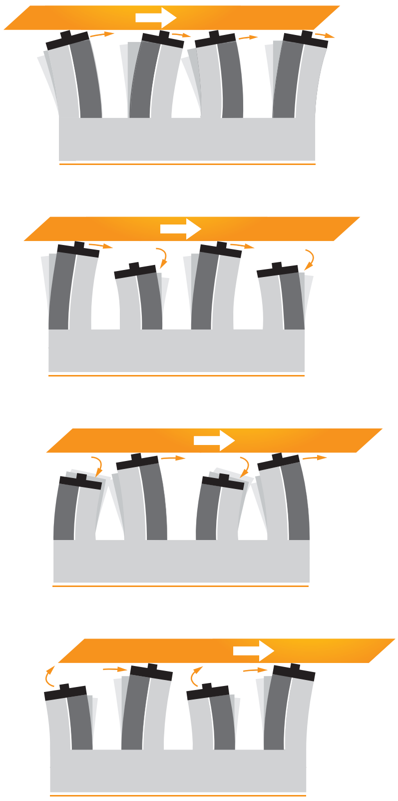
Ordering information	
Motors	
LC2010	Motor for goniometer stage
LC2020	Motor for linear stage
Drivers and Controllers	
PMCM21	Hand-held push button driver
PMD101	1-axis micro-stepping driver
PMD206	6-axis micro-stepping driver
DMC-30019	Controller
Linear Encoders	
See separate data sheet	

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* (~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 (5 µm x 2 kHz = 10 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 10 N load the typical wfm-step length with waveform *Delta* is ~2.5 µm, and with 8192 discrete points in the waveform the micro-step resolution will be ~0.3 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.

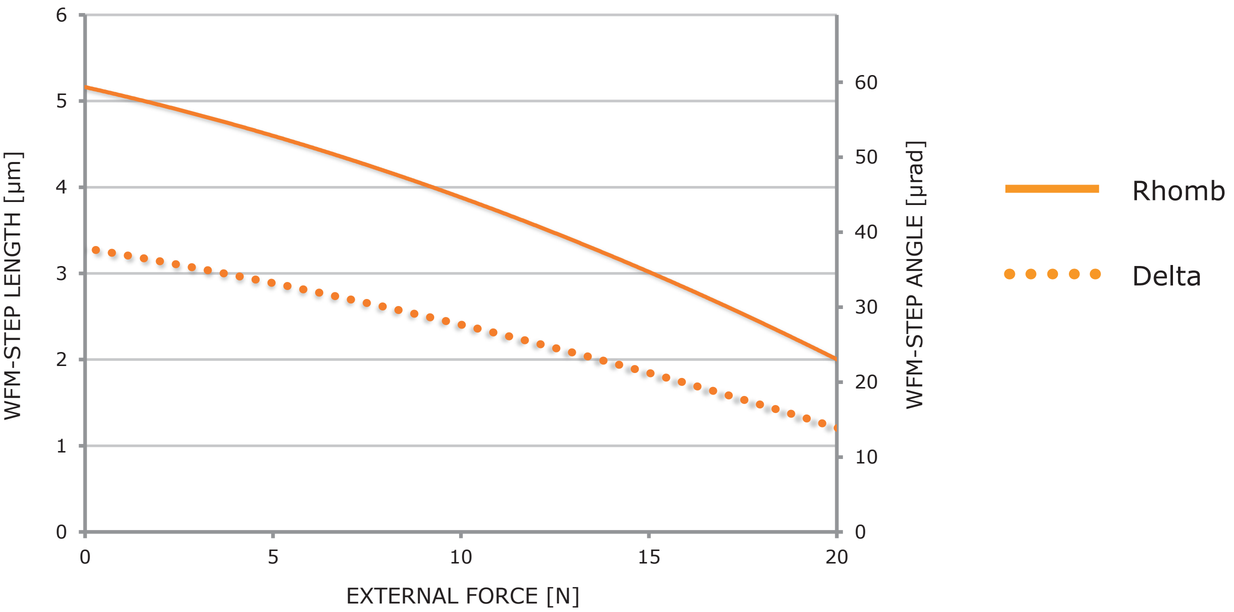
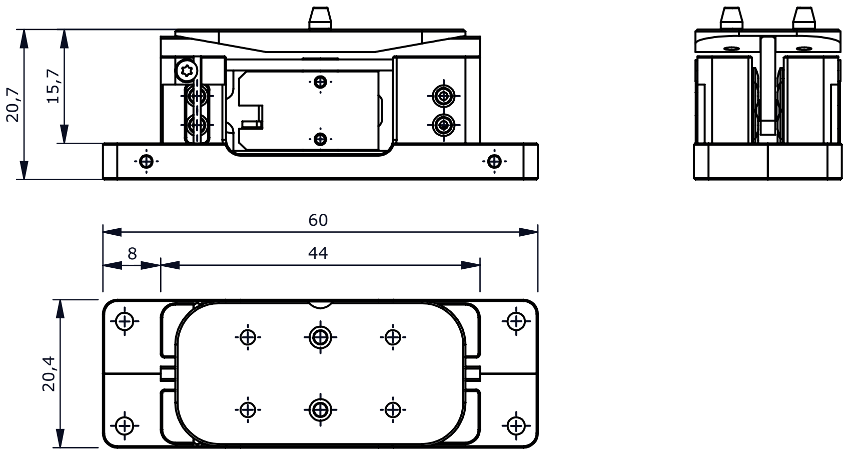


Figure 1 *Motor performance with waveform Rhomb (filled) and waveform Delta (dotted). Wfm-step length/angle is the average distance the drive rod moves when the legs take one wfm-step (i.e. for one waveform cycle). Note: Standard deviation σ of 0.5 µm should be taken into account. Typical values are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

Main Dimensions LC20

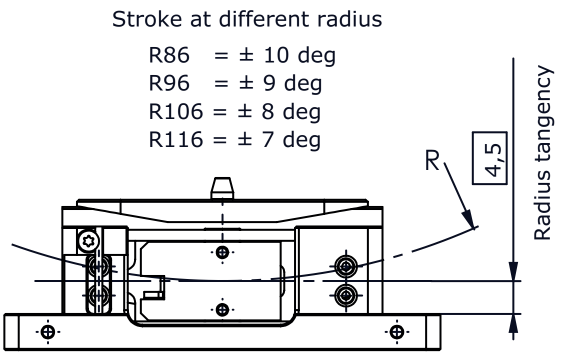


Note: All specifications are subject to change without notice. Detailed drawings can be found in the document *Installation Guidelines for the Piezo LEGS Caliper.*

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).



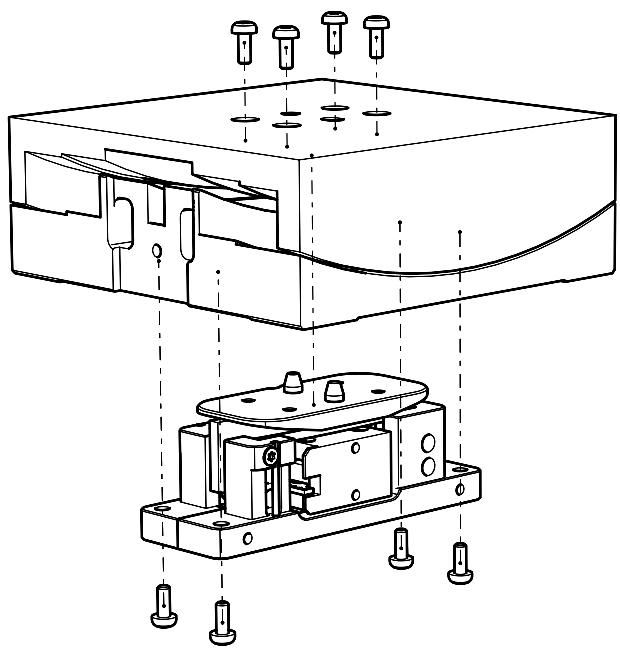


Figure 2 Example of Caliper motor integration in a 70x70 mm goniometer stage.

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Technical Specification

Type	LC2010 (for gonio stage)	LC2020 (for linear stage)	Note
Stroke	±10° [a]	29 mm	
Minimum Radius	86 mm	-	see installation guidelines
Speed Range [b]	0-7 °/s [a]	0-10 mm/s	recommended, no load
Step Angle/Length [c]	30 µrad [a]	2.5 µm	one wfm-step
	0.004 µrad [a d]	0.0003 µm [d]	one micro-step [d]
Resolution	< 10 nrad [a]	< 1 nm	driver dependent
Recommended Operating Range	0-10 N	0-10 N	for best micro-stepping performance and life time
Stall Force	20 N	20 N	
Holding Force	22 N	22 N	
Maximum Voltage	48 V	48 V	
Power Consumption [e]	10 mW/Hz	10 mW/Hz	=1 W at 100 Hz wfm-step frequency
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, Aluminium	Stainless Steel, Aluminium	
Weight	110 grams	110 grams	
Operating Temp.	0 to +50 °C	0 to +50 °C	

a. Value is valid for minimum radius 86 mm.
b. Max value is typical for waveform *Rhomb* at 2 kHz, no load, temperature 20°C.
c. Typical values for waveform *Delta*, 10 N load, temperature 20°C.
d. Driver dependent; 8192 micro-steps per wfm-step for driver in the PMD200-series.
e. At temperature 20°C, intermittent runs.

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

Item no. LC20 A-044

Family name
LEGS Caliper

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/Cable
A15 = 1.5 m cables - does not connect directly to either PM driver
K15 = 1.5 m cable-kit for driver PMD101 and PMCM31
L15 = 1.5 m cable-kit for driver PMD206 and PMD236

Electrical Connector Type

The motor is fitted with two cables with JST 05SR-3S connectors on the end. The cables need to be connected in parallel to the driver.

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

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