Product catalogue

2018–2019

PiezoMotor

INNOVATION IN MOTION

Content

About PiezoMotor

PiezoMotor is a world-leading developer and producer of groundbreaking micromotors based on piezoelectric materials. The technology enables compact motors with high precision and true direct drive. The objective is to move and hold position.

At our headquarters in Sweden, we have our own development and production facility. We have a solid patent portfolio with more than 60 patents. The PiezoMotor share is traded at Nasdaq First North in Stockholm.

PiezoMotor solutions

World-leading engineering

- Adjust our solution to fit your design
- Close contact during your implementation

Supporting software

- Easy interface
- Download free software

Partners of excellence

- System integrators
- Technology consultants
- Sales partners / Distributors

Tailor-made controllers

- Stand-alone
- Packaged
- License of design

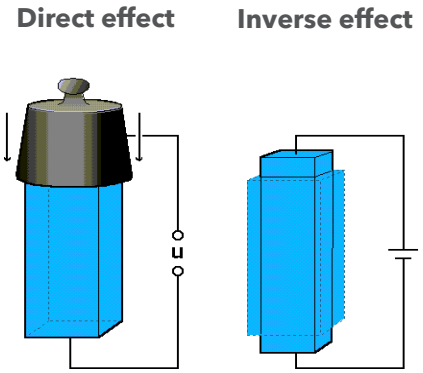
When you buy from PiezoMotor you get more than just a motor. Our expert engineers are ready to help you get started. We offer standard motors in various sizes and strokes. We are happy to help you select suitable position sensors as well as provide guidance to, or customization of, the mechanical interface of the motor. Our experienced mechanical and electronic designers will help you throughout the process. If standard is not enough, we have a broad network of system integrators and technical consultants who can help you integrate the motor in your motion system.

With our free software that can be downloaded from our website, it is easy to get started testing the motor. We offer drive electronics and the possibility to buy the design of schematics so that you can create your own circuit board with customized connectors and form factor.

About the technology

The piezoelectric effect

The word piezo is derived from the Greek word for pressure. In 1880 Jacques and Pierre Curie discovered that pressure generates electrical charges in several crystals such as quartz and tourmaline; they called this phenomenon the piezoelectric effect. Later they noticed that electrical fields can deform piezoelectric materials. This effect is called the inverse piezoelectric effect.



Advantages of the piezo technology

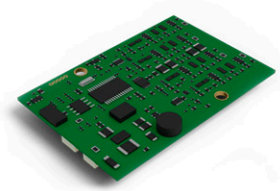
PiezoMotor technology enables:

- Piezo LEGS® can easily position on a sub-micron level, or even down to sub-nanometers. The resolution depends on the electronics; the limiting factor is not the motor itself. With the possibility to microstep down to sub-nanometer, you can achieve a truly smooth motion.
- A controlled linear motion without backlash is accomplished without the need of gearboxes or ball screws – the motor responds instantly. The true direct drive enables a combination of high precision and a dynamic speed range. Piezo LEGS® is self-locking and will hold load even when powered off.
- The drive unit in the Piezo LEGS is non-magnetic. This enables motor designs suitable for high-magnetic environments or where magnetic disturbance is an issue.
- The motor has a compact design which fits perfectly in OEM applications.

How it works

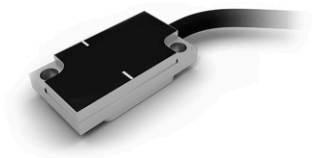
The system

To run a piezo motor you need electronics, as in all modern motion control. The core of the motor is a multi-layer piezo ceramic, a component with high performance at low voltage. By applying controlled electrical voltage to the ceramic, a linear or rotary motion is created. To keep control of the position, an encoder is required. The resolution of the system depends on both the encoder resolution and the electronics resolution.



Controller

Motor with drive rod



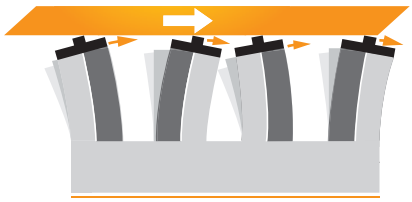
Encoder

One of the greatest advantages of piezo-based systems is the combination of high precision and quick response time without increasing cost of the system.

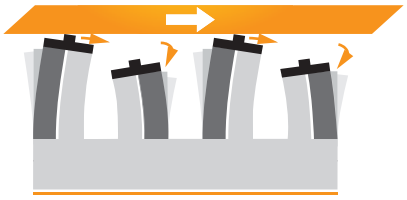
A piezo motor-based system has a true direct drive, meaning that the object to be moved is directly connected to the piezoceramic actuator legs in the motor via the drive rod of the motor. This has the important advantage of giving no backlash, quick response time, and high resolution. This enables short cycle times in repeated move-and-settle applications reducing overall processing time.

The motor

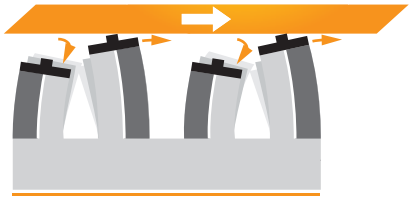
Piezo LEGS® work with friction drive, where force is created by the internal preload of the piezoceramic actuator legs in direct friction contact with the rotor or drive rod. When the legs start walking, they are always in mechanical contact with the drive rod.



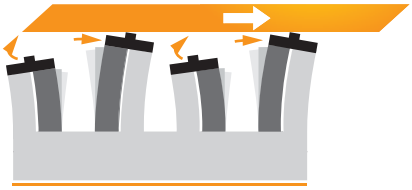
1 All four legs are electrically activated.



2 The first pair of legs maintains contact with the rod and moves right. The second pair retracts. Their tips bend left.



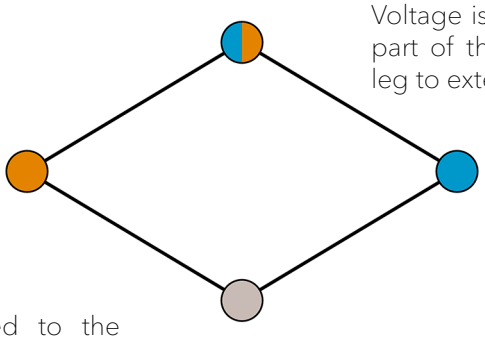
3 The second pair now extends and repositions on the rod. Their tips move right. The first pair retracts and their tips bend left.

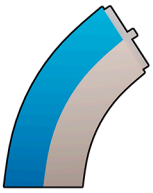


4 The second pair of legs moves right. The first pair begins to extend and move up towards the rod.

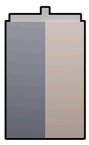
Voltage is applied to both left and right, causing the leg to extend to its fullest length

Voltage is applied to the left part of the leg, causing the leg to extend to the right





Voltage is applied to the right part of the leg, causing the leg to extend to the left



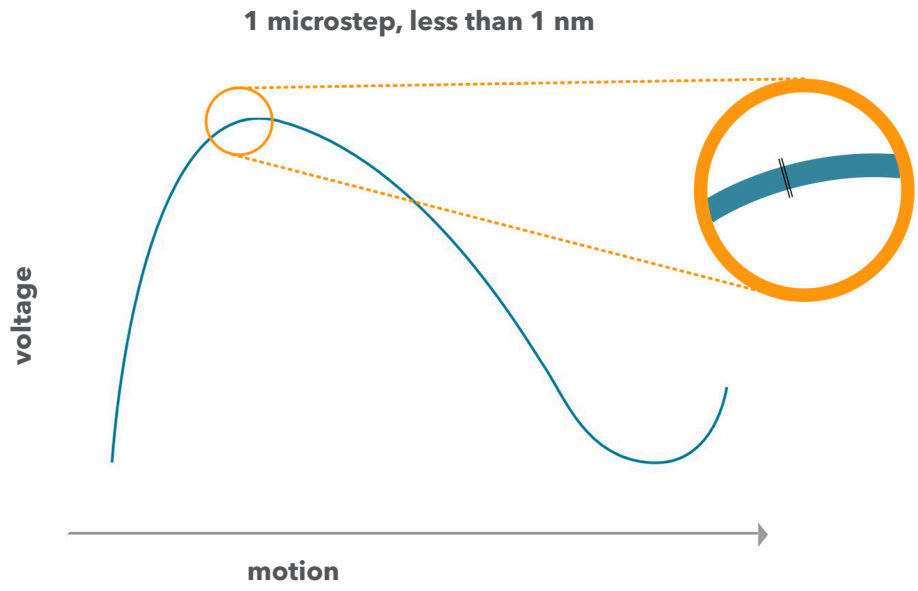
No voltage applied to the leg

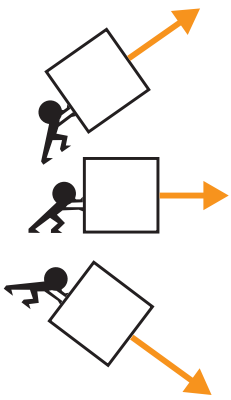
The electronics

A controlled motion is created by applying voltage signals to the ceramics. The step length depends on the load as shown in the figure below. One full step can be divided into several thousands of microsteps. The length of a microstep reaches down to sub-nanometer level.

Waveform optimized for high microstep resolution

A microstep = a fraction of the waveform (full step); e.g. 8192 microsteps per waveform.

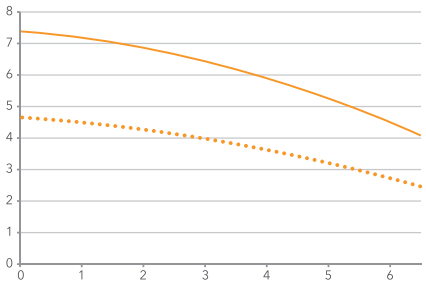




FULL STEPS PER SECOND	SPEED
1	3 µm/s
1000	3 mm/s
1	5 µm/s
1000	5 mm/s
1	7 µm/s
1000	7 mm/s

Motion is load-dependent. The step length will vary with the load, impacting both speed and resolution.

Motor characteristics



Full step versus external load for an LL06 motor. The filled line shows a typical curve for waveform Rhomb, and the dotted line shows waveform Delta. Values are typical for room temperature, and mean values for the motor type. Statistical spread is not shown.

In this catalogue you will find detailed information about the standard products from PiezoMotor. Piezo LEGS® are non-resonant walking motors; in several aspects quite different from DC or stepper motors. A Piezo LEGS® motor is friction based, meaning the motion is transferred through contact friction between the drive leg and the drive rod/disc. You cannot rely on each step being equal to the next. This is especially true if the motor is operated under varying loads. For each waveform cycle of the drive signal, the motor will take one full step, sometimes referred to as a waveform step (wfm-step). There is dependence between the external load on the motor and the full step length. At zero external load, the typical full step length is ~5 µm, but as the load is increased, the full step length is shortened by one or a few microns. In opposite, the full step length will be increased in the direction of the external force. The full step length will also depend on the internal piezo temperature and on the type of waveform.

The full step length can be used to calculate the approximate motor speed. Full step length at a given load is multiplied with the frequency of the drive signal waveform.

Example 1

Waveform type	LL06 motor, no load, 2000 full steps per second
Rhomb	~7 µm x 2 kHz = ~14 mm/s
Delta	~4.5 µm x 2 kHz = ~9 mm/s

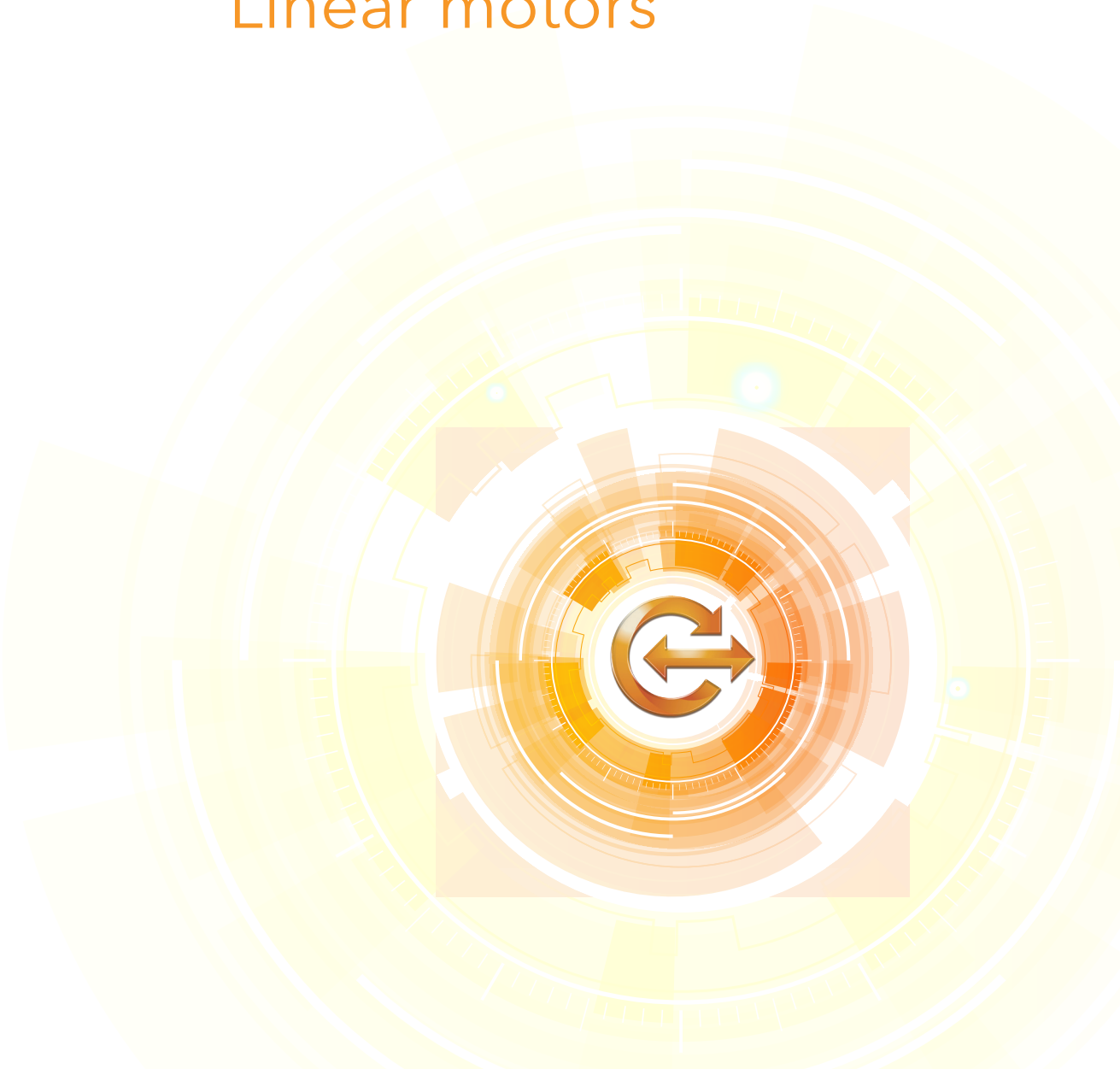
Example 2

Waveform type	LL06 motor, 10 N load, 2000 full steps per second
Rhomb	~6.5 µm x 2 kHz = ~13 mm/s
Delta	~4 µm x 2 kHz = ~8 mm/s

Fine positioning is achieved by dividing the full step into discrete points; so called microsteps. The resolution will be a combination of the number of points in the waveform and the external load. For example, a full step of 4 µm can be divided into 8192 microsteps that are only ~0.5 nm. The resolution of the motor depends entirely on the controller and how well it can manage the discrete voltage levels of the waveform.


Piezo LEGS®
by PiezoMotor
10174-019

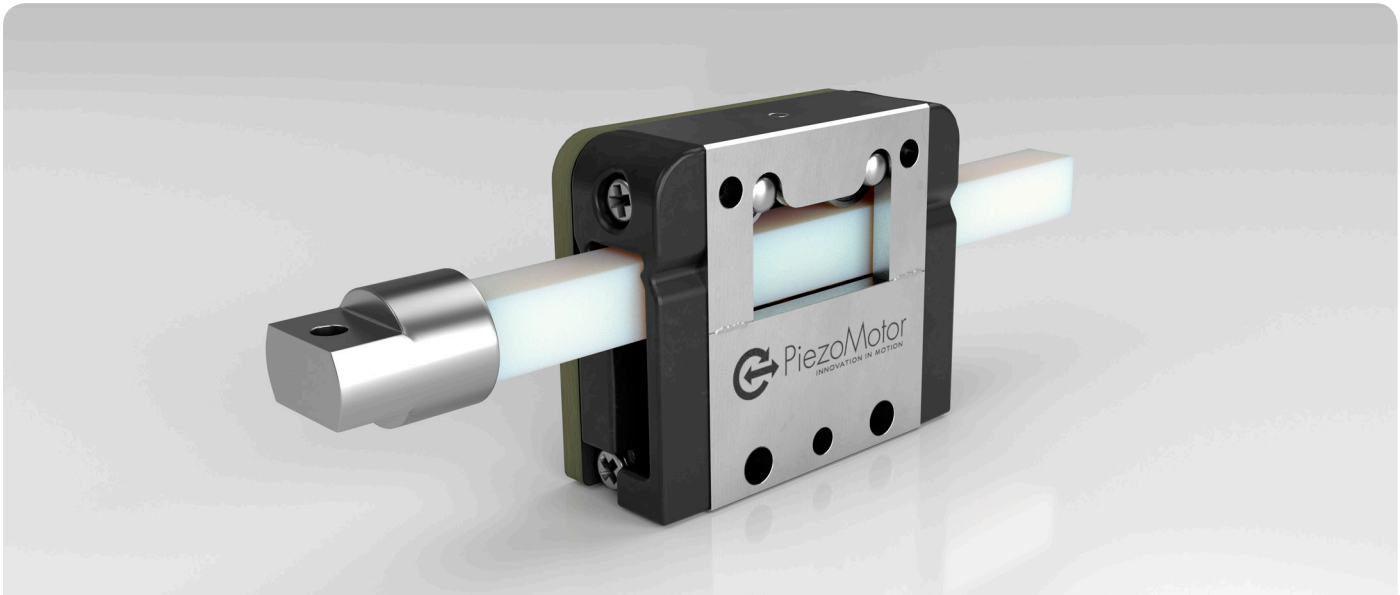
Linear motors



		Stall force (N)	Recommended working force (N)	Speed range (mm/s)[a]	Max stroke (mm)	Built-in encoder versions	Vacuum compatible versions (10^{-7} Torr)	Non-magnetic versions
Motor	LL06 (A)	6.5	0–3	0–24	74.1	Optional	No	No
	LT20 (A/C/D)	20	0–10	0–24	74	No	Yes	Yes
	LT40 (A/C/D)	40	0–20	0–12	67	No	Yes	Yes
	LS15 (B/D)	15	0–8	0–12	130	No	Yes	Yes
	LTC40 (A)	40	0–20	0–12	13	No	No	No
	LTC300 (B)	300	0–150	0–0.3	20	No	Yes	No
	LTC450 (B)	450	0–225	0–0.3	20	No	Yes	No

a. Rhomb, no load, 20°C

		Description
Type	A	Standard, stainless steel
	B	Vacuum, soldered cable
	C	Non-magnetic
	D	Non-magnetic vacuum

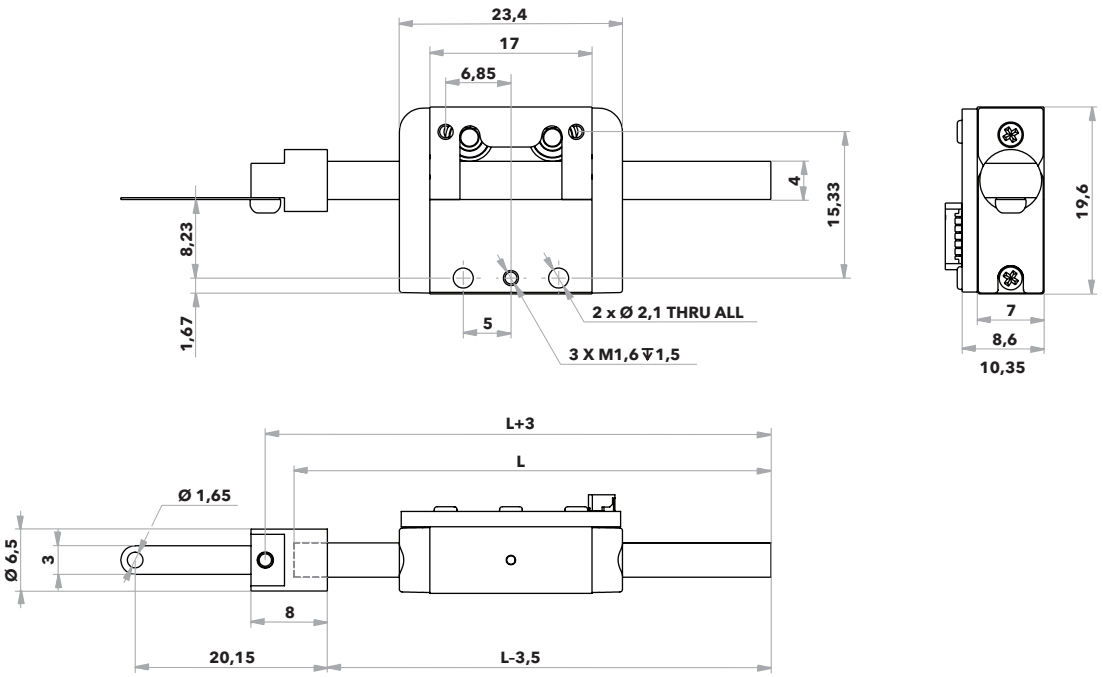


Technical specification LL06	
Type	**Standard (A)**
Stroke (mm) For more information, see table on opposite page.	0–74.1
Speed range (mm/s) @ Rhomb, no load, 20°C	0–24
Step length, full step (µm) @ Delta, no load, 20°C	4.5
Motor resolution, microstep (nm) 14 bits, 8192 microsteps	<1
Built-in encoder	Yes
Encoder resolution (µm)	1.25 (encoder E1)), reflective optical type with quadrature output (ABZ)
Encoder accuracy (µm)	±3
Encoder repeatability (µm)	1.25
Stall force (N)	6.5
Holding force (N)	>6.5
Recommended operating range (N)	0–3
Maximum voltage (V)	48
Power consumption (mW/Hz)	5
Mechanical size (mm) with guides and encoder	23.4 x 19.6 x 10.35
Mechanical size (mm) without guides and encoder	17 x 19.6 x 7
Weight (g)	16
Operating temperature (°C)	-20 to +70
Connector	Motor Hirose DF52-5S-0.8H
	Encoder Hirose DF52-6S-0.8H
Material in motor housing	Stainless steel

Note: All specifications are subject to change without notice. For more information, see www.piezomotor.com.

Main dimensions

Standard



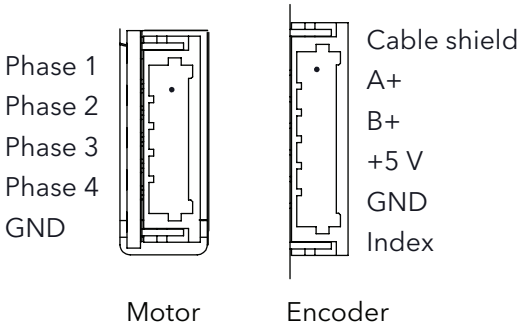
Stroke range

Stroke (with one adapter, 26.9 mm)	Drive rod length (mm)
0–3.1 mm	30 mm (not available with encoder)
0–13.1 mm	40
0–23.1 mm	50
0–33.1 mm	60
0–74.1 mm	100.8

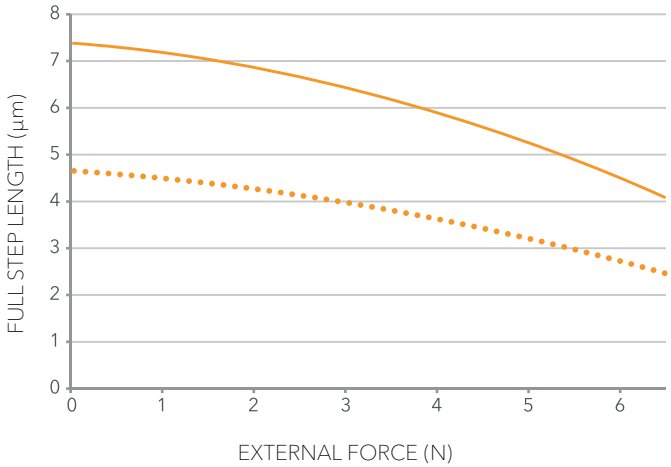
Motor speed at 20°C, no load

Waveform	Max freq. (Hz)	Speed range (mm/s)
Delta	3000	0–15
Rhomb		0–24

Connection

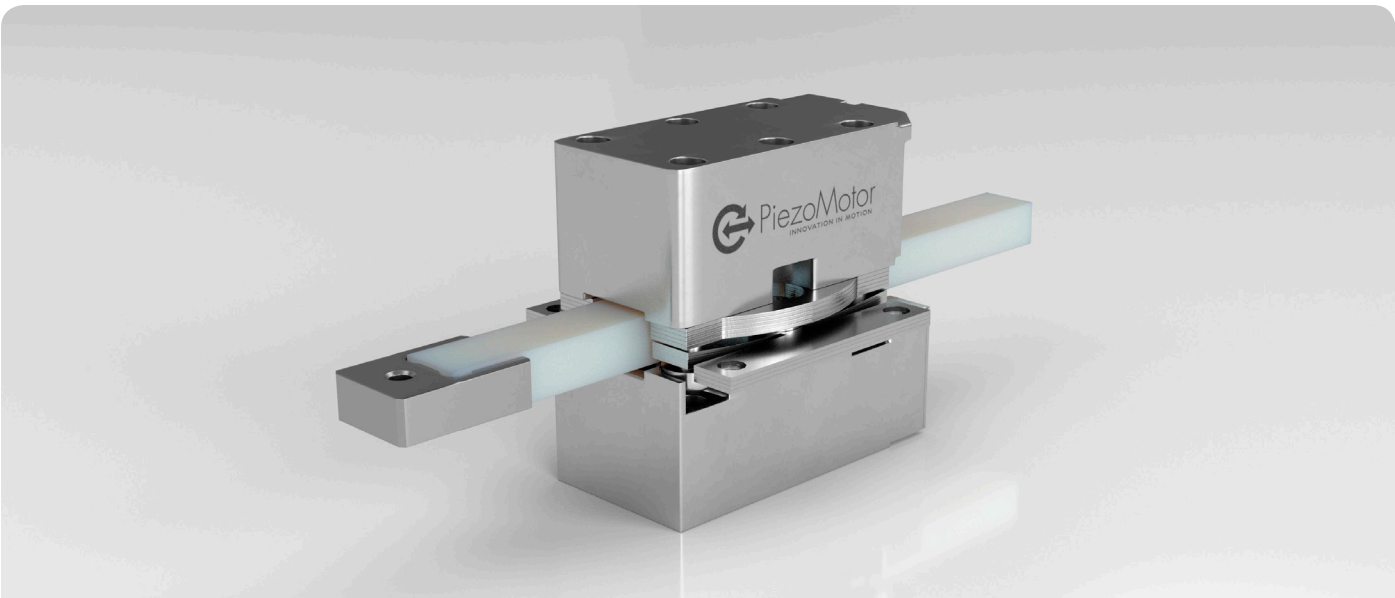


Motor performance



Motor performance with waveform Rhomb (filled) and waveform Delta (dotted). The full step length is the average distance the drive rod moves when the legs take one full step (i.e. for one waveform cycle).

Note: A standard deviation σ of 0.5 µm should be taken into account. Typical values are given for 20°C.

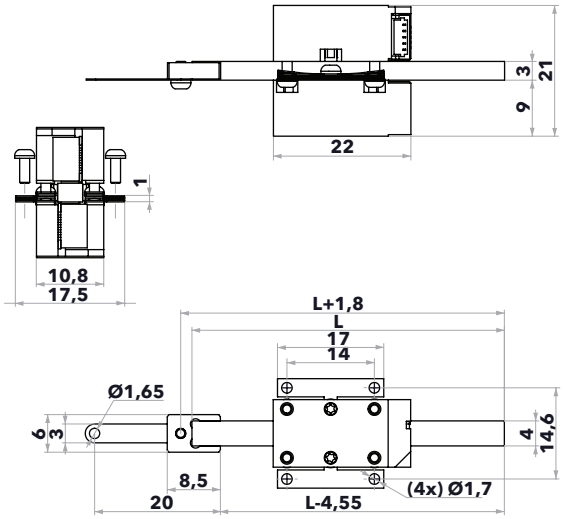


Technical specification LT20			
Type	**Standard (A)**	**Non-magnetic (C)**	**Non-magnetic vacuum (D)**
Stroke (mm) For more information, see table on opposite page.	0–74.5		
Speed range (mm/s) @ Rhomb, no load, 20°C	0–24		
Step length, full step (µm) @ Delta, no load, 20°C	4.5		
Motor resolution, microstep (nm) 14 bits, 8192 microsteps	<1		
Built-in encoder	No		
Encoder resolution (µm)	N/A		
Stall force (N)	20		
Holding force (N)	>20		
Recommended operating range (N)	0–10		
Maximum voltage (V)	48		
Power consumption (mW/Hz)	10		
Operating temperature (°C)	−20 to +70		
Mechanical size (mm)	21.8 x 21 x 17.5 mm (drive rod excluded)		
Weight (g)	29		
Vacuum (torr)	N/A	N/A	10^{-7}
Connector	2 x JST BM05B-SRSS-TB	2 x JST BM05B-SRSS-TB	Soldered cable w. 2 x JST 05SR-3S
Material in motor housing	Stainless steel	Non-magnetic	Non-magnetic

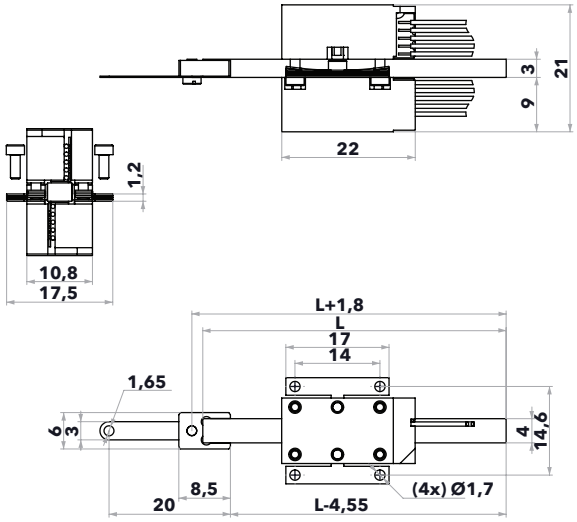
Note: All specifications are subject to change without notice. For more information, see www.piezomotor.com.

Main dimensions

LT2020A – Standard / C – Non-magnetic



LT2020D – Non-magnetic vacuum



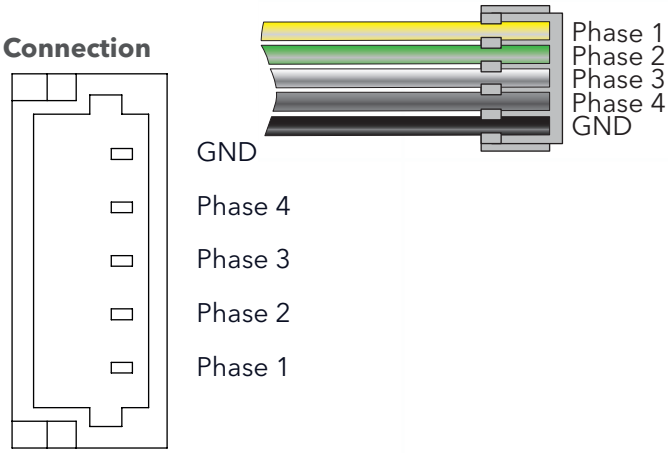
Stroke range

Stroke (with one adapter, 26.5 mm)	Drive rod length (mm)
0–3.5 mm	30
0–13.5 mm	40
0–23.5 mm	50
0–33.5 mm	60
0–74.5 mm	100.8

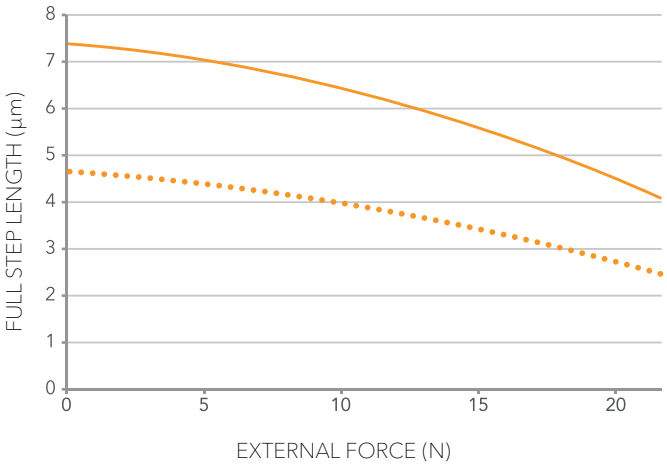
Motor speed at 20°C, no load

Waveform	Max freq. (Hz)	Speed range (mm/s)
Delta	3000	0–15
Rhomb		0–24

Connection



Motor performance



RHOMB
DELTA

Motor performance with waveform Rhomb (filled) and waveform Delta (dotted). The full step length is the average distance the drive rod moves when the legs take one full step (i.e. for one waveform cycle).

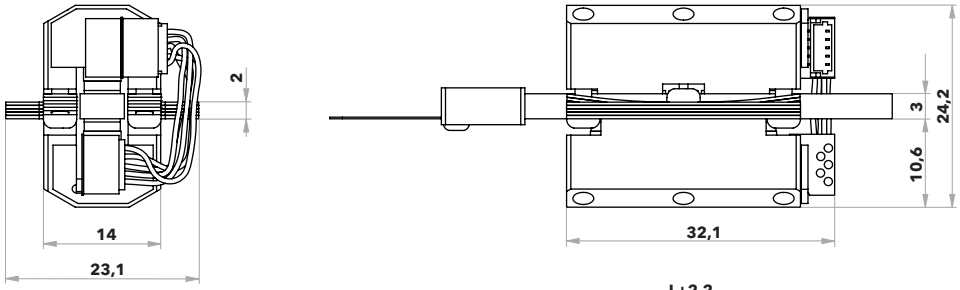
Note: A standard deviation σ of 0.5 µm should be taken into account. Typical values are given for 20°C.

Technical specification LT40			
Type	**Standard (A)**	**Non-magnetic (C)**	**Non-magnetic vacuum (D)**
Stroke (mm) For more information, see table on opposite page.	0–67		
Speed range (mm/s) @ Rhomb, no load, 20°C	0–12		
Step length, full step (µm) @ Delta, no load, 20°C	5		
Motor resolution, microstep (nm) 14 bits, 8192 microsteps	<1		
Built-in encoder	No		
Encoder resolution (µm)	N/A		
Stall force (N)	40		
Holding force (N)	>40		
Recommended operating range (N)	0–20		
Maximum voltage (V)	48		
Power consumption (mW/Hz)	20		
Operating temperature (°C)	−20 to +70		
Mechanical size (mm)	32.1x 24.2 x 23.1 mm (drive rod excluded)		
Weight (g)	61		
Vacuum (torr)	N/A	N/A	10^{-7}
Connector	JST BM05B-SRSS-TB	JST BM05B-SRSS-TB	Soldered cable w. 2 x JST 05SR-3S
Material in motor housing	Stainless steel	Non-magnetic	Non-magnetic

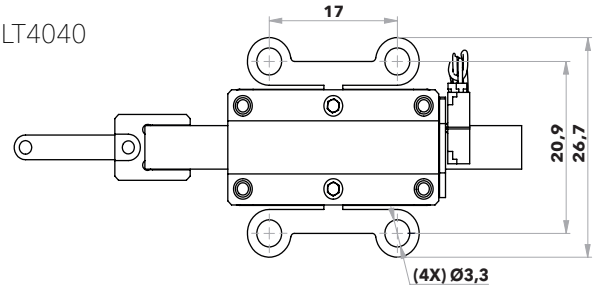
Note: All specifications are subject to change without notice. For more information, see www.piezomotor.com.

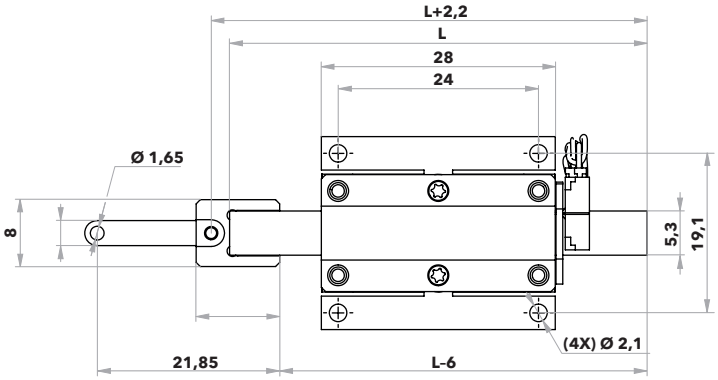
Main dimensions

LT4050A / LT4050C – Standard and non-magnetic



LT4040





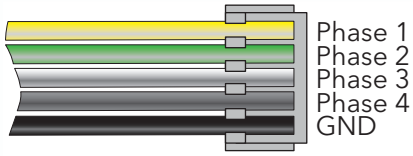
Stroke range

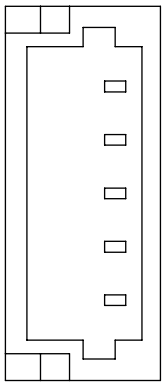
Stroke (one adapter, 34 mm)	Drive rod length
0–6 mm	40 mm
0–16 mm	50 mm
0–26 mm	60 mm
0–67 mm	100.8 mm

Motor speed at 20°C, no load

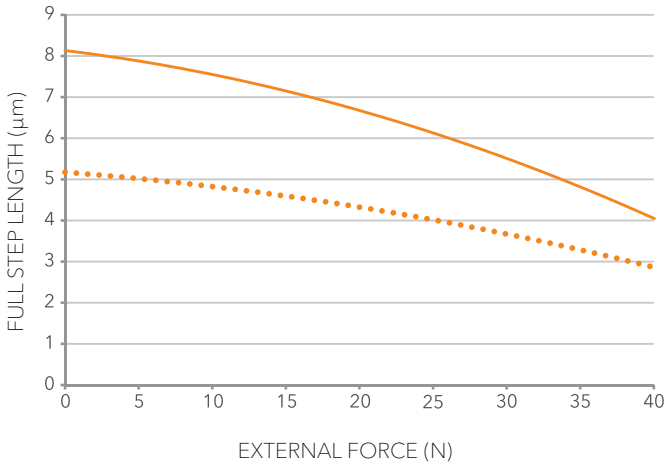
Waveform	Max freq. (Hz)	Speed range (mm/s)
Delta	1500	0–8
Rhomb		0–12

Connection





Motor performance



Motor performance with waveform Rhomb (filled) and waveform Delta (dotted). The full step length is the average distance the drive rod moves when the legs take one full step (i.e. for one waveform cycle).

Note: A standard deviation σ of 0.5 µm should be taken into account. Typical values are given for 20°C.

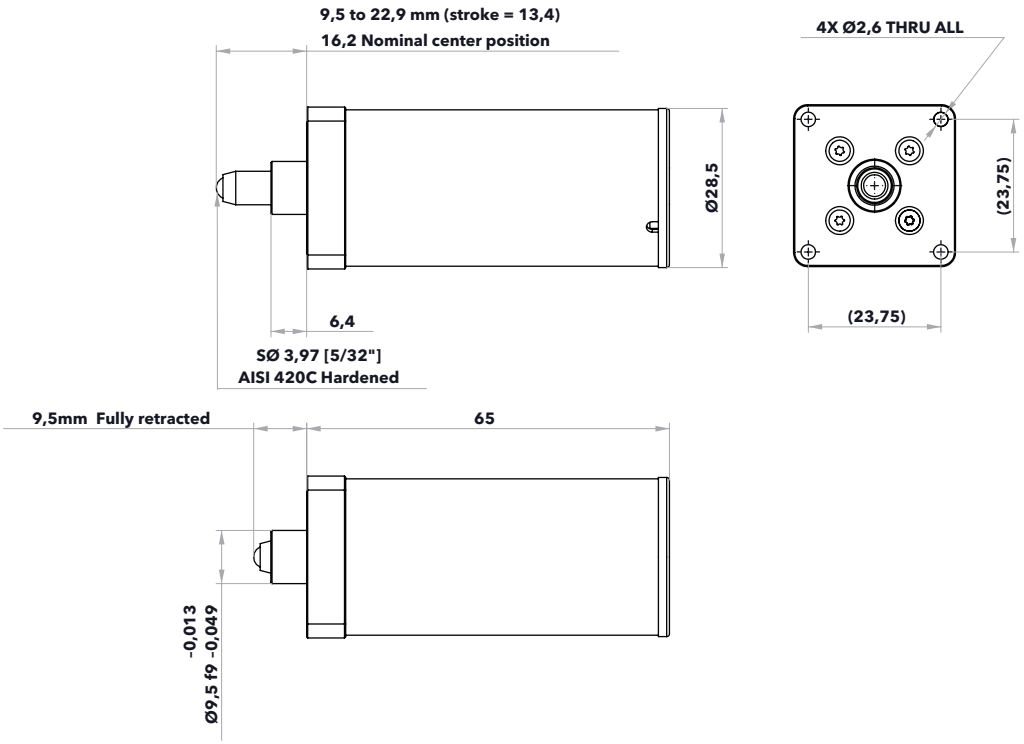
LTC40

Technical specification LTC40	
Type	**Standard (A)**
Stroke (mm) For more information, see table on opposite page.	0–13
Speed range (mm/s) @ Rhomb, no load, 20°C	0–12
Step length, full step (µm) @ Delta, no load, 20°C	5
Motor resolution, microstep (nm) 14 bits, 8192 microsteps, 20°C	<1
Built-in encoder	No
Encoder resolution (µm)	N/A
Stall force (N)	40
Holding force (N)	>40
Recommended operating range (N)	0–20
Maximum voltage (V)	48
Power consumption (mW/Hz)	20
Operating temperature (°C)	-20 to +70
Mechanical size (mm)	74.5 x 23.75 x 23.75
Weight (g)	175
Vacuum (torr)	N/A
Connector	Cable w. JST 05SR-3S
Material in motor housing	Stainless steel

Note: All specifications are subject to change without notice. For more information, see www.piezomotor.com.

Main dimensions

LTC40



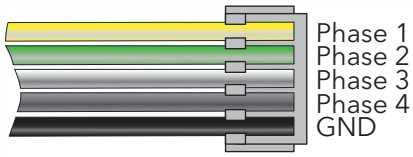
Stroke range

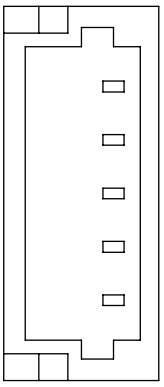
Stroke (mm)	Drive rod length
0–13	Fixed

Motor speed at 20°C, no load

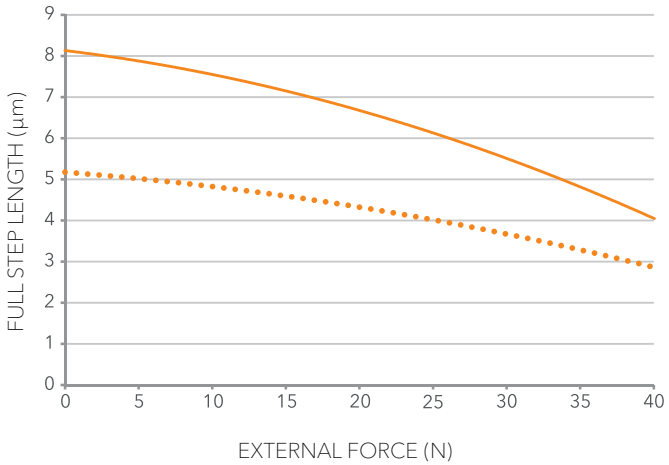
Waveform	Max freq. (Hz)	Speed range (mm/s)
Delta	1500	0–8
Rhomb		0–12

Connection





Motor performance



RHOMB

DELTA

Motor performance with waveform Rhomb (filled) and waveform Delta (dotted). The full step length is the average distance the drive rod moves when the legs take one full step (i.e. for one waveform cycle).

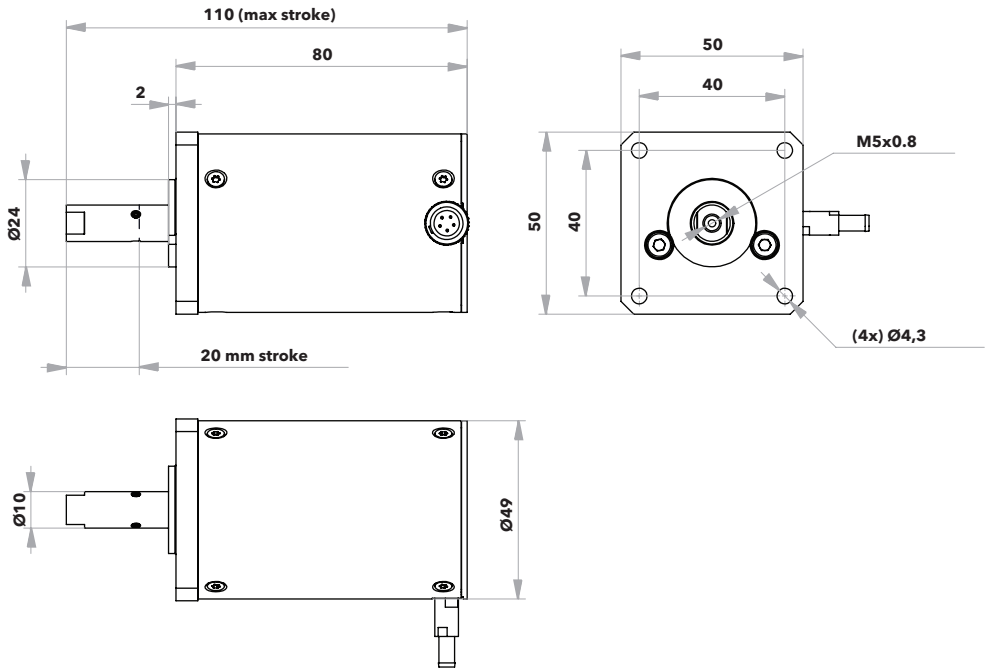
Note: A standard deviation σ of 0.5 µm should be taken into account. Typical values are given for 20°C.

Technical specification LTC300	
Type	**Vacuum (B)**
Stroke (mm) For more information, see table on opposite page.	0–20
Speed range (mm/s) @ Rhomb, no load, 20°C	0–0.3
Step length, full step (µm) @ Delta, no load, 20°C	4
Motor resolution, microstep (nm) 14 bits, 8192 microsteps	<1
Built-in encoder	No
Encoder resolution (µm)	N/A
Stall force (N)	300
Holding force (N)	>300
Recommended operating range (N)	0–150
Maximum voltage (V)	48
Power consumption (mW/Hz)	200
Mechanical size (mm)	80 x 50 x 50
Weight (g)	955
Operating temperature (°C)	+10 to +70
Vacuum (torr)	10^{-7}
Connector	Cable w. JST 05SR-3S
Material in motor housing	Stainless steel

Note: All specifications are subject to change without notice. For more information, see www.piezomotor.com.

Main dimensions

LTC300 – Vacuum



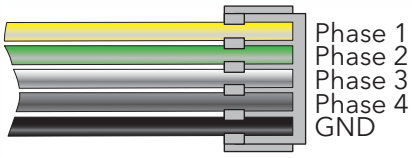
Stroke range

Stroke (mm)	Drive rod length
0–20	Fixed

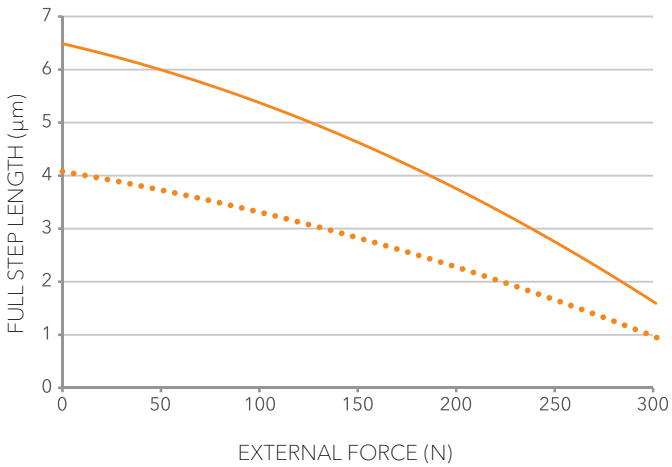
Motor speed at 20°C, no load

Waveform	Max freq. (Hz)	Speed range (mm/s)
Delta	50	0–0.2
Rhomb		0–0.3

Connection



Motor performance



RHOMB

DELTA

Motor performance with waveform Rhomb (filled) and waveform Delta (dotted). The full step length is the average distance the drive rod moves when the legs take one full step (i.e. for one waveform cycle).

Note: A standard deviation σ of 0.5 µm should be taken into account. Typical values are given for 20°C.

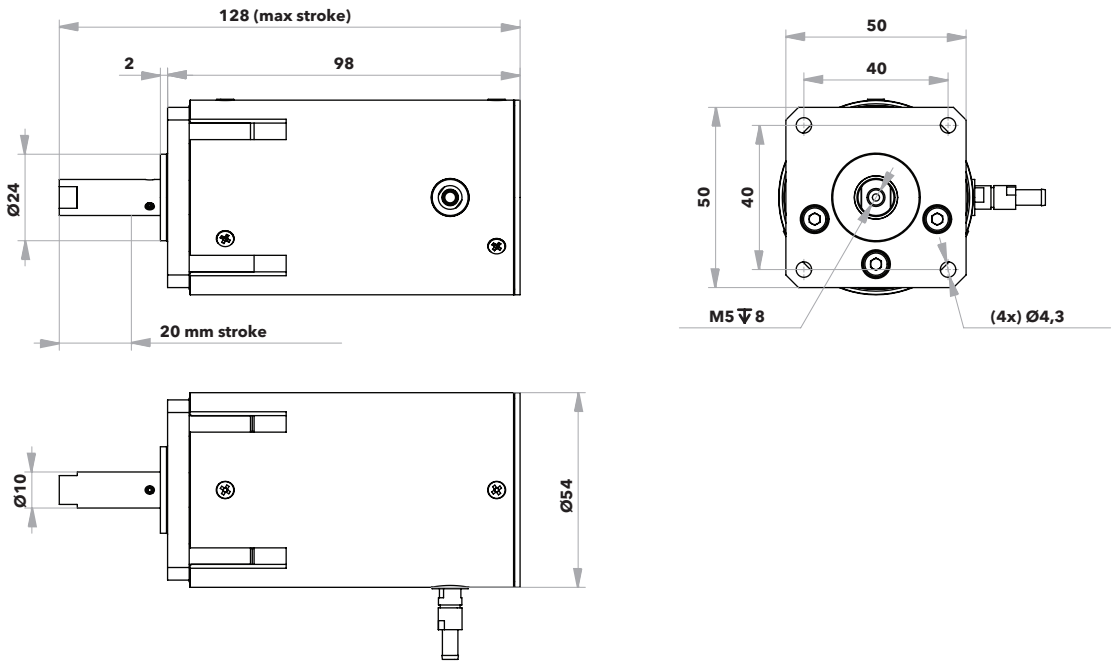
LTC450

Technical specification LTC450	
Type	**Vacuum (B)**
Stroke (mm) For more information, see table on opposite page.	0–20
Speed range (mm/s) @ Rhomb, no load, 20°C	0–0.3
Step length, full step (µm) @ Delta, no load, 20°C	4
Motor resolution, microstep (nm) 14 bits, 8192 microsteps	<1
Built-in encoder	No
Encoder resolution (µm)	N/A
Stall force (N)	450
Holding force (N)	>450
Recommended operating range (N)	0–225
Maximum voltage (V)	48
Power consumption (mW/Hz)	300
Mechanical size (mm)	98 x 50 x 50
Weight (g)	1060
Operating temperature (°C)	+10 to +70
Vacuum (torr)	10^{-7}
Connector	Cable w. JST 05SR-3S
Material in motor housing	Stainless steel

Note: All specifications are subject to change without notice. For more information, see www.piezomotor.com.

Main dimensions

LTC450 – Vacuum



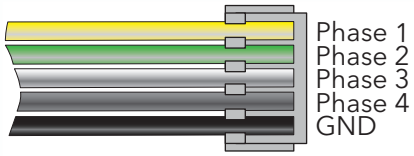
Stroke range

Stroke (mm)	Drive rod length
0–20	Fixed

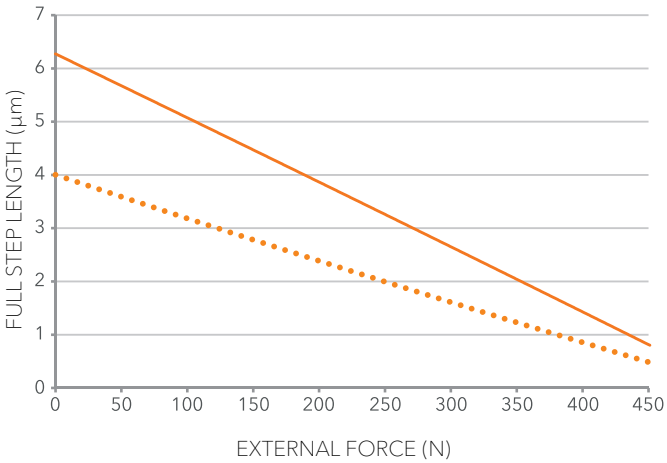
Motor speed at 20°C, no load

Waveform	Max freq. (Hz)	Speed range (mm/s)
Delta	50	0–0.2
Rhomb		0–0.3

Connection



Motor performance



RHOMB

DELTA

Motor performance with waveform Rhomb (filled) and waveform Delta (dotted). The full step length is the average distance the drive rod moves when the legs take one full step (i.e. for one waveform cycle).

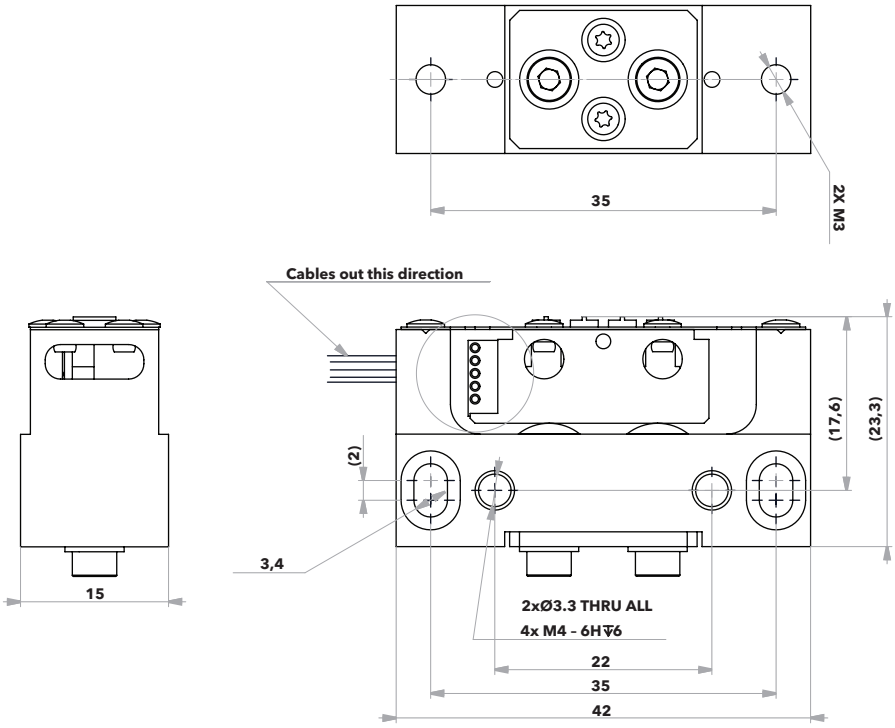
Note: A standard deviation σ of 0.5 µm should be taken into account. Typical values are given for 20°C.

Technical specification LS15		
Type	**Vacuum (B)**	**Non-magnetic vacuum (D)**
Stroke (mm) For more information, see table on opposite page.	0–130	
Speed range (mm/s) @ Rhomb, no load, 20°C	0–12	
Step length, full step (µm) @ Delta, no load, 20°C	4.5	
Motor resolution, microstep (nm)	<1	
Built-in encoder	No	
Encoder resolution (µm)	N/A	
Stall force (N)	15	
Holding force (N)	>15	
Recommended operating range (N)	0–8	
Maximum voltage (V)	48	
Power consumption (mW/Hz)	7	
Mechanical size (mm)	42 x 23.3 x 15	
Weight (g)	70	
Operating temperature (°C)	-20 to +70	
Vacuum (torr)	10^{-7}	
Connector	Soldered PTFE wires w. JST 05SR-3S	
Material in motor housing	Stainless steel	Non-magnetic

Note: All specifications are subject to change without notice. For more information, see www.piezomotor.com.

Main dimensions

LS15 – Vacuum



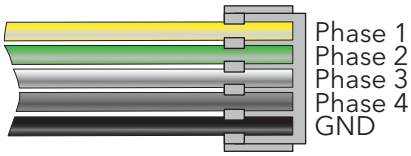
Stroke range

Stroke (mm)	Drive rod length (mm)
0–20	40
0–30	50
0–40	60
0–80.8	100.8
0–130	150

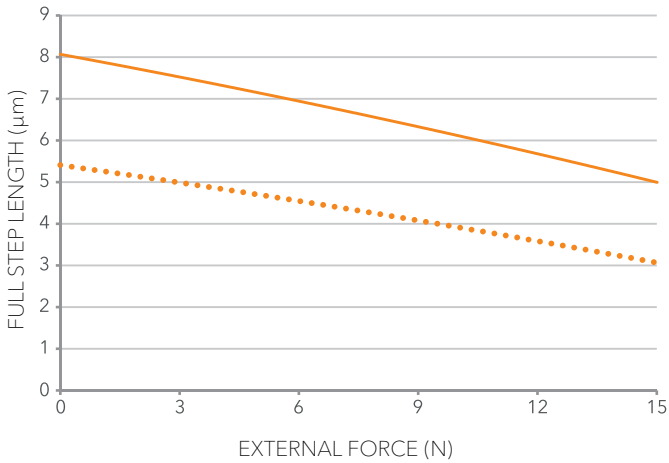
Motor speed at 20°C, no load

Waveform	Max freq. (Hz)	Speed range (mm/s)
Delta	1500	0–8
Rhomb		0–12

Connection



Motor performance



Motor performance with waveform Rhomb (filled) and waveform Delta (dotted). The full step length is the average distance the drive rod moves when the legs take one full step (i.e. for one waveform cycle).

Note: A standard deviation σ of 0.5 µm should be taken into account. Typical values are given for 20°C.


OLYMPUS
QUICK STOP

Rotary motors

		Max. torque (mNm)	Recommended working torque (mNm)	Speed range (°/s)	Built-in encoder versions	Vacuum compatible versions (10^{-7} Torr)	Non-magnetic versions
Motor	**LR17 (A)**	30	0–15	0–265 (0–44 rpm)	Yes	No	No
	LR23-50 (C/D)	50	0–25	0–160 (0–27 rpm)	Optional (C)	Yes	Yes
	LR23-80 (A)	80	0–40	0–160 (0–27 rpm)	Optional	No	No

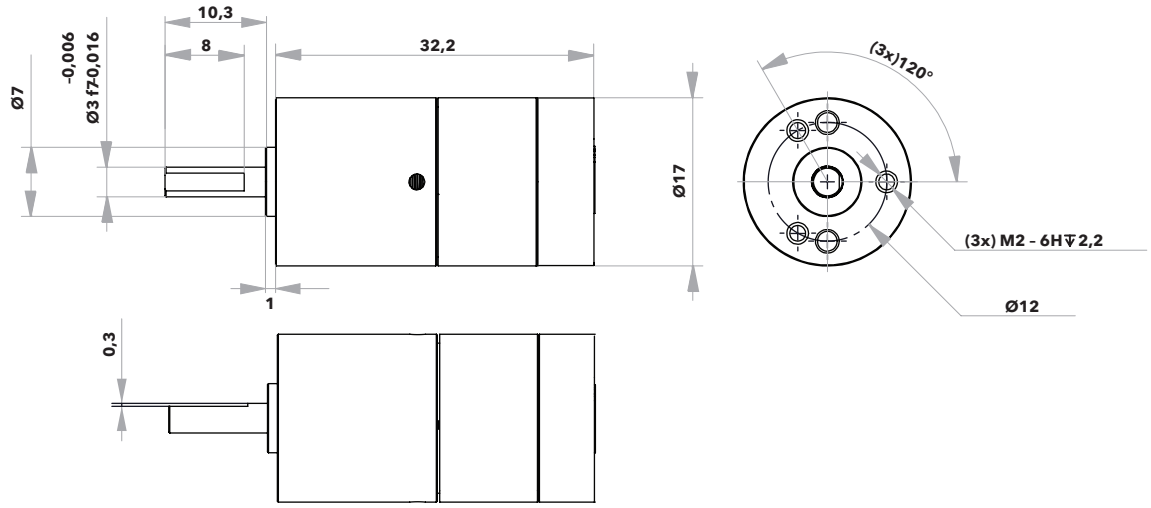
		Description
Type	**A**	Standard
	C	Non-magnetic
	D	Non-magnetic vacuum, soldered cables

Technical specification LR17	
Type	**Standard (A)**
Diameter (mm)	17
Angular range (°)	360
Speed range (°/s) @ Rhomb, no load, 20°C	0–265 (0–44 rpm)
Step angle, full step (µrad) @ Delta, no load, 20°C	1000
Motor resolution, microstep (µrad) 14 bits, 8192 microsteps	<0.1
Built-in encoder	Yes
Encoder type	Magnetic, absolute
Encoder accuracy (mrad)	2.0
Encoder resolution (mrad)	0.2
Stall torque (mNm)	30
Holding Torque (mNm)	>30
Recommended operating range (mNm)	0–15
Maximum voltage (V)	48
Power consumption (mW/Hz)	3.5
Shaft load, max. (N) radial, 6.5 mm from mounting face	1
Shaft load, max. (N) axial	2
Shaft press fit force, max. (N)	5
Weight (g)	30
Operating temperature (°C)	-20 to +70
Connector	CviLux CI1116M-2VD0
Material in motor housing	Aluminium, stainless steel

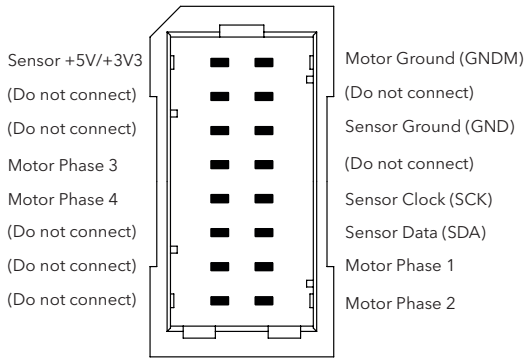
Note: All specifications are subject to change without notice. For more information, see www.piezomotor.com.

Main dimensions

LR17 – Standard

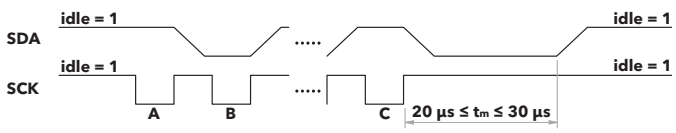


Connection



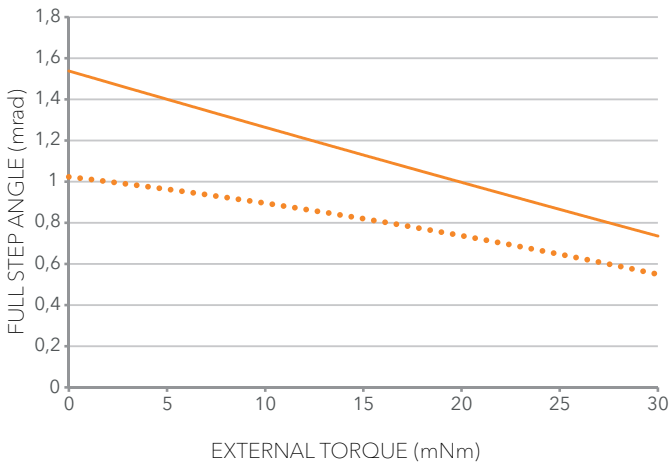
Encoder information

The LR17 has an integrated magnetic absolute encoder. It gives 15-bit SSI data. SCK (Sensor Clock) and SDA (Sensor Data) are normally at high level (idle). When receiving a clock pulse from the controller, the LR17 will respond with position data. The SCK frequency should be 70–180 kHz. Data should be read shortly before the positive flank. The time-out between positive flanks is 20–30 µs. The output data is 15 bits (msb first), followed by a stop bit. If SCK continues beyond the stop bit, there will be a second stop bit followed by repeated 15-bit data and a stop bit. A minimum of 120 µs is needed after position readout to make sure that position data is refreshed. Reading position every 0.5 ms is the maximum recommended rate for continuous operation.



a. 1st clock pulse, SDA stays idle until positive flank.
b. 2nd clock pulse, SDA output is bit1 (msb).
c. 16th clock pulse, SDA output is bit15 (lsb).

Motor performance



RHOMB
DELTA

Motor performance with waveform Rhomb (filled) and waveform Delta (dotted). The full step angle is the average distance the drive disc rotates when the legs take one full step (i.e. for one waveform cycle).

Note: A standard deviation σ of 0.1 mrad should be taken into account. Typical values are given for 20°C.

Motor speed at 20°C, no load

Waveform	Max freq. (Hz)	Speed range
Delta	3000	0–28 rpm (0–170°/s)
Rhomb		0–44 rpm (0–265°/s)

LR23-50

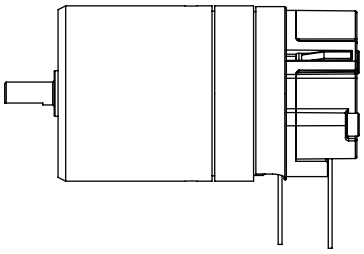
Technical specification LR23-50				
Type	**Non-magnetic (C)**	**Non-magnetic (C), extended shaft**	**Non-magnetic (C), encoder**	**Non-magnetic vacuum (D)**
Diameter (mm)	23			
Angular range (°)	360			
Speed range (°/s) @ Rhomb, no load, 20°C	0–160 (0–27 rpm)			
Step angle, full step (µrad) @ Delta, no load, 20°C	550			
Motor resolution, microstep (µrad) 14 bits, 8192 microsteps	<0.1			
Built-in encoder	No	No	Yes	No
Encoder type	N/A	N/A	TBA	N/A
Encoder accuracy (mrad)	N/A	N/A	TBA	N/A
Encoder resolution (mrad)	N/A	N/A	TBA	N/A
Stall torque (mNm)	50			
Holding Torque (mNm)	>50			
Recommended operating range (mNm)	0–25			
Maximum voltage (V)	48			
Power consumption (mW/Hz)	7			
Shaft load, max. (N)	TBA			
Shaft load, max. (N) axial	TBA			
Shaft press fit force, max. (N)	TBA			
Weight (g)	TBA			
Operating temperature (°C)	-20 to +70			
Connector	JST BM05B-SRSS-TB	JST BM05B-SRSS-TB	Cable attached, driver-dependent	Soldered cable w. JST 05SR-3S
Material in motor housing	Non-magnetic			

Note: All specifications are subject to change without notice. For more information, see www.piezomotor.com.

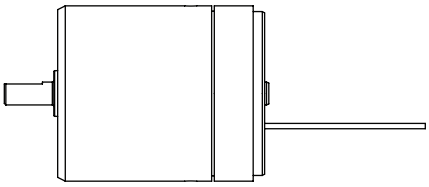
Main dimensions

LR23-50

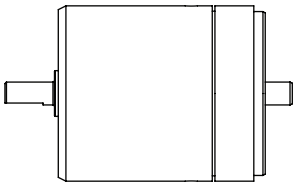
Note: LR23 50 mNm will be available in Q1 2019. The drawings and technical specifications are preliminary. The next version of the product catalogue will contain all necessary data for these motors. Until then, please check www.piezomotor.com for updates.



With encoder



Without encoder (cable attached for vacuum version only)



Without encoder, with extended shaft

Summary of the LR23-50 mNm product portfolio

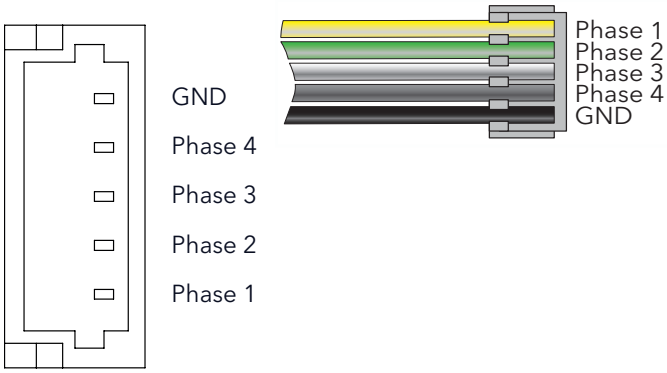
LR23-50 will come in 3 physically different versions:

- with encoder
- without encoder
- without encoder and with extended shaft.

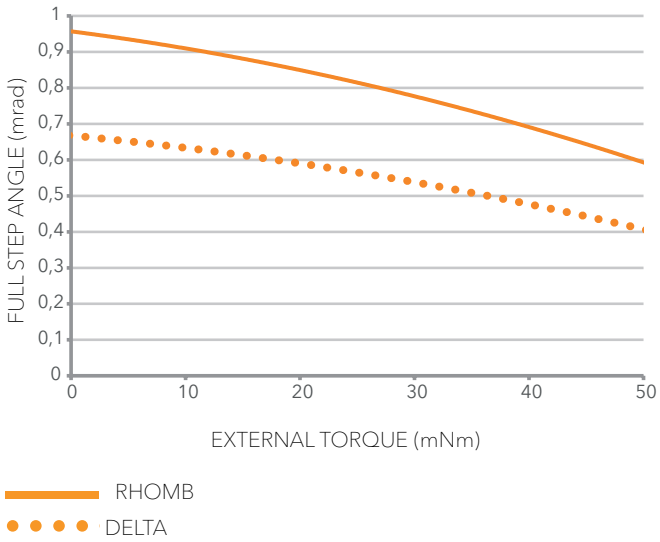
The LR23-50 replaces the previous model LR50.

Motor speed at 20°C, no load

Waveform	Max freq. (Hz)	Speed range
Delta	3000	0–19 rpm (0–114°/s)
Rhomb		0–27 rpm (0–160°/s)



Motor performance



Motor performance with waveform Rhomb (filled) and waveform Delta (dotted). The full step angle is the average distance the drive disc rotates when the legs take one full step (i.e. for one waveform cycle).

Note: A standard deviation σ of 0.1 mrad should be taken into account. Typical values are given for 20°C.

LR23-80

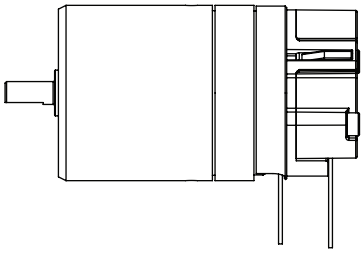
Technical specification LR23-80			
Type	**Standard (A)**	**Standard (A), extended shaft**	**Standard (A), encoder**
Diameter (mm)	23		
Angular range (°)	360		
Speed range (°/s) @ Rhomb, no load, 20°C	0–160 (0–27 rpm)		
Step angle, full step (µrad) @ Delta, no load, 20°C	550		
Motor resolution, microstep (µrad) 14 bits, 8192 microsteps	<0.1		
Built-in encoder	No	No	Yes
Encoder type	N/A	N/A	TBA
Encoder accuracy (mrad)	N/A	N/A	TBA
Encoder resolution (mrad)	N/A	N/A	TBA
Stall torque (mNm)	80		
Holding Torque (mNm)	>80		
Recommended operating range (mNm)	0–40		
Maximum voltage (V)	48		
Power consumption (mW/Hz)	7		
Shaft load, max. (N)	TBA		
Shaft load, max. (N) axial	TBA		
Shaft press fit force, max. (N)	TBA		
Weight (g)	TBA		
Operating temperature (°C)	-20 to +70		
Connector	JST BM05B-SRSS-TB	JST BM05B-SRSS-TB	Cable attached, driver-dependent
Material in motor housing	Stainless steel		

Note: All specifications are subject to change without notice. For more information, see www.piezomotor.com.

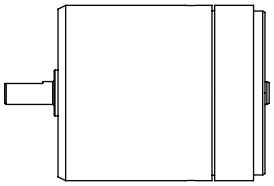
Main dimensions

LR23-80

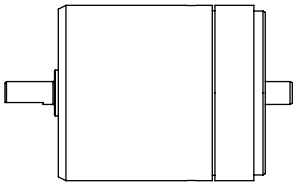
Note: LR23 80 mNm will be available in Q1 2019. The drawings and technical specifications are preliminary. The next version of the product catalogue will contain all necessary data for these motors. Until then, please check www.piezomotor.com for updates



With encoder



Without encoder



Without encoder, with extended shaft

Summary of the LR23-80 mNm product portfolio

LR23-80 will come in 3 physically different versions:

- with encoder
- without encoder
- without encoder and with extended shaft.

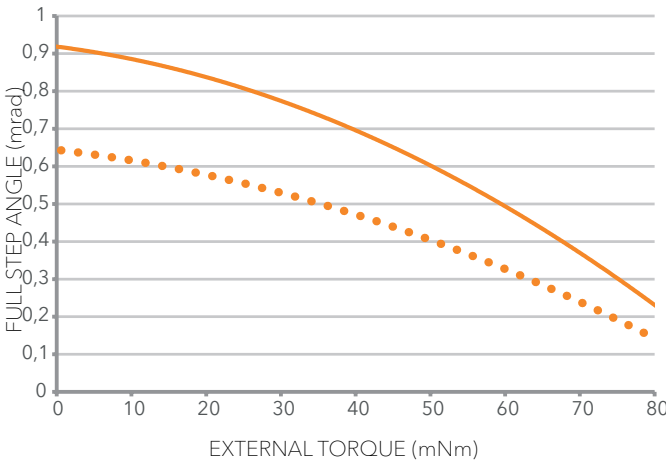
The 80 mNm version is made in stainless steel.

The LR23-80 replaces the previous model LR80.

Motor speed at 20°C, no load

Waveform	Max freq. (Hz)	Speed range
Delta	3000	0–19 rpm (0–114°/s)
Rhomb		0–27 rpm (0–160°/s)

Motor performance



Motor performance with waveform Rhomb (filled) and waveform Delta (dotted). The full step angle is the average distance the drive disc rotates when the legs take one full step (i.e. for one waveform cycle).

Note: A standard deviation σ of 0.1 mrad should be taken into account. Typical values are given for 20°C.

Controllers

PiezoMotor offers different controllers to customers, and a license agreement for customers who want to incorporate the electronics into their own system. The controller range includes a fully enclosed standalone controller, a smaller controller board and a more complex motion controller. All controllers can function in both open and closed loop. With the motion controller, you can set not only speed and position but also time from A to B.

For detailed information for each controller, see separate datasheet. Note that the speed capacity for each combination of controller and motor differs, so make sure to check the performance matrix below.

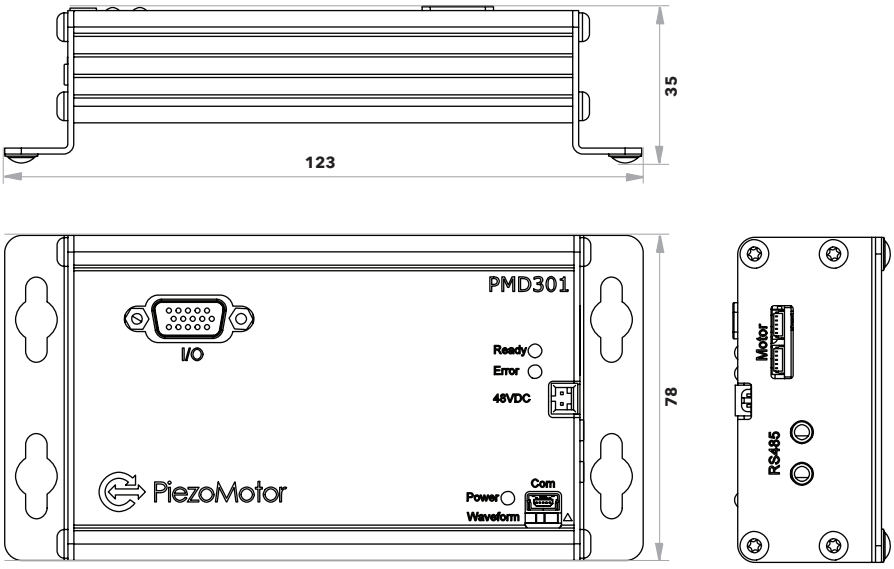
Performance matrix

Motor		Controller					
		PMD301		PMD401		DMC-30019	
		Delta	Rhomb	Delta	Rhomb	Delta	Rhomb
LL06	Hz	2500		1500		2500	
	(mm/s)	12.5	20	7.5	12	12.5	20
LT20	Hz	2500		750		2500	
	(mm/s)	12.5	20	3.8	6	12.5	20
LT40	Hz	1500		350		1500	
	(mm/s)	8	12	2	3	8	12
LTC40	Hz	1500		350		1500	
	(mm/s)	8	12	2	3	8	12
LTC300	Hz	50		N/A		50	
	(mm/s)	0.2	0.3			0.2	0.3
LTC450	Hz	50		N/A		50	
	(mm/s)	0.2	0.3			0.2	0.3
LS15	Hz	1500		1000		1000	
	(mm/s)	8	12	5.3	8	5	7.5
LR17	Hz	2500		1000		2500	
	Rpm	24	36	10	15	24	36
LR23	Hz	2500		1000		2500	
	Rpm	24	36	10	15	24	36

Technical specification PMD301		
Type	**Value**	**Note**
Number of axes	1	
Multi-axis support	Yes	Units can be RS485-chained for multi-axis
True speed control	No	Only stepping rate controlled
Resolution	8192 microsteps	Each full step of about 5 µm is divided into 8192 steps
Maximum stepping rate (Full step frequency - Hz)	2500	Depends on motor
Supported encoders	Quadrature	ABZ differential, 20 MHz counting
	SSI	8–30 bits, 750 or 130 kbps
	BiSS	18/26/32 bits, 750 kbps
	Analog	Analog ±10 V (12 bits)
Host communication	Two-wire RS485	Commands are sent in ASCII format, 115.2 kbps (n81)
	USB (virtual COM port)	
Servo interface	SPI	16 bits (signed), max 20 Mbps
	Analog	Analog interface ±10 V (12 bits, 5 kHz)
General I/O	4 in	Depending on encoder type and use of limit switches
	2 out	
Stacking connector	N/A	
Motor connector	5-pole, JST SM05B-SRSS-TB	Two connectors, parallel connection
Encoder/servo connector	15-pin HD female D-sub	Input for sensors or servo interface
Limit switch	Yes	Input for external limit switches
Communication connector	3.5 mm audio jack x 2	RS485, daisy chain
	USB mini type B	Input for USB virtual COM port
Power connector	2-pole header, 2.54 mm, Molex 70543-0001	Input for 48 V supply
Power supply	48 V DC, 20 W	48 V DC ±5%
Dimensions (mm)	123 x 78 x 35	

Note: All specifications are subject to change without notice. For more information, see www.piezomotor.com.

Main dimensions



Product description

The PMD301 is a 1-axis controller for use with Piezo LEGS® motors from PiezoMotor. Units can be chained to form multi-axis systems.

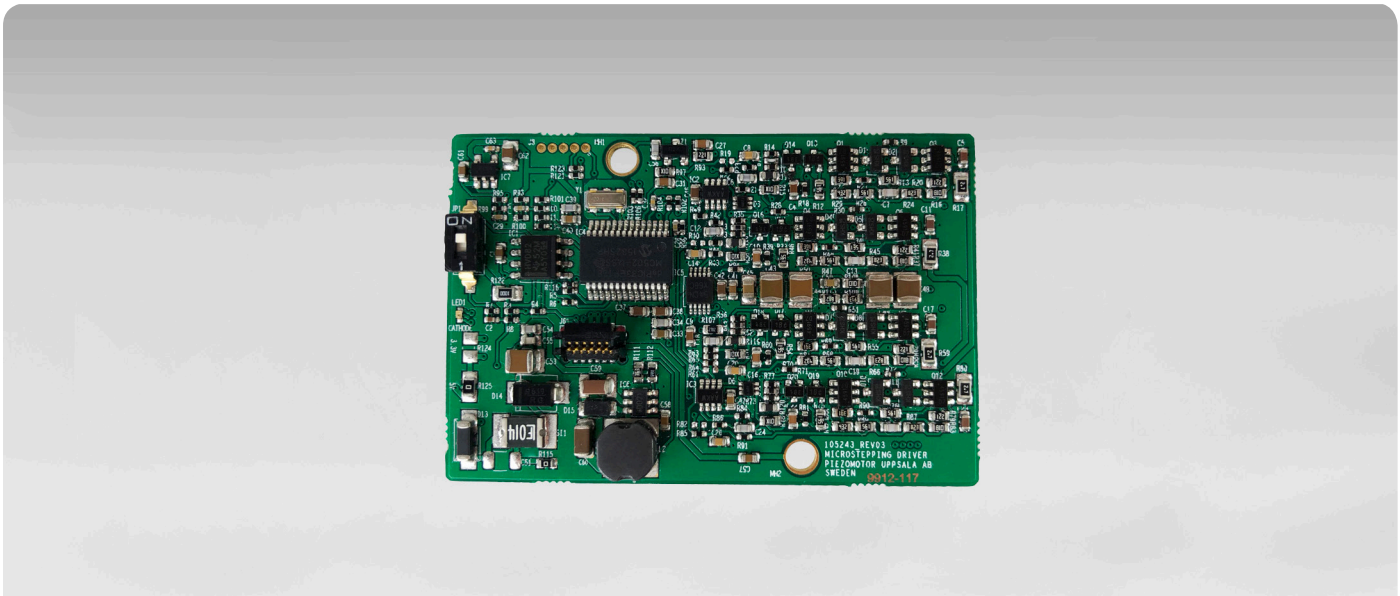
It provides sub-nanometer resolution and speed in the mm/s range. PMD301 is the ideal choice for system designs where one or several Piezo LEGS® motors are used. Multiple units can be easily chained to form multi-axis systems.

Host communication is either via a 2-wire RS485 or USB virtual COM port through ASCII commands. A 15-pole D-Sub port can be configured for general I/O, sensor input and as a servo interface. An external motion controller may control the speed via SPI or analog voltage interface.

Features

- Nanometer resolution
- Closed loop control
- Open loop mode
- Servo mode
- Chained RS485 for multi-axis
- Closed loop controller taking commands from host via RS485 or USB
- Slave amplifier to external motion controller – analog or SPI interface
- Sub-nanometer resolution to the Piezo LEGS® motor
- Chain units to form multi-axis system
- General-purpose inputs/outputs – maximum 4 in and 2 out

PMD401

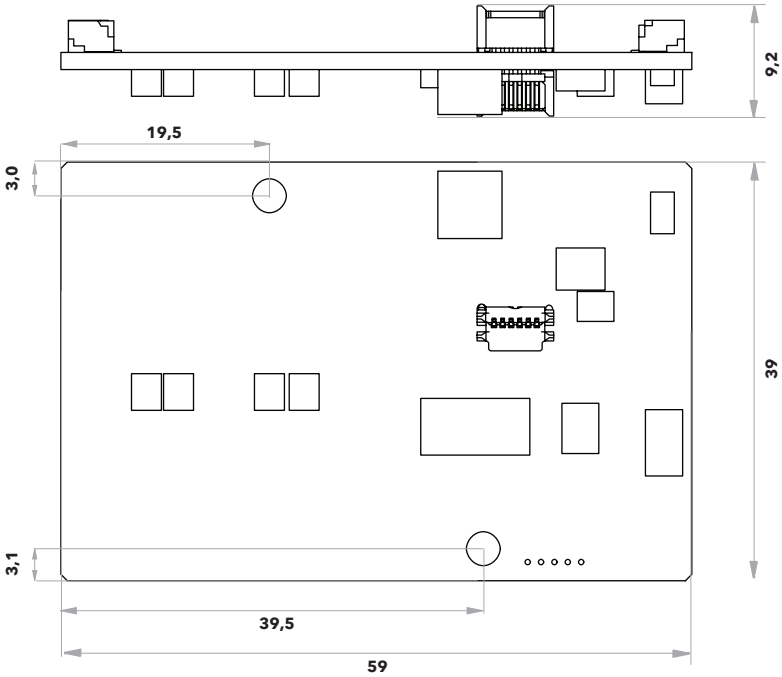


Technical specification PMD401		
Type	**Value**	**Note**
Number of axes	1	
Multi-axis support	Yes	Units can be RS485-chained for multi-axis
True speed control	No	Only stepping rate controlled
Resolution	8192 microsteps	Each full step of about 5 µm is divided into 8192 steps
Maximum stepping rate (Full step frequency – Hz)	1500	Depends on motor
Supported encoders	Quadrature	ABZ differential, 20 MHz counting
	SSI	8–30 bits, 330 or 130 kbps
	BiSS	18/26/32 bits, 330 kbps
Host communication	Two-wire RS485	Commands are sent in ASCII format, 115.2 kbps (n81)
Servo interface	SPI	16 bits (signed), max 15 Mbps
General I/O	4 in	Depending on encoder type and use of limit switches
	3 out	
Stacking connector	6-pole, ERNI MicroStac 114711	GND, 48 V, RS485
Motor connector	5-pole, JST SM05B-SRSS-TB	Two connectors, parallel connection
Encoder/servo connector	6-pole, JST SM06B-SRSS-TB	Input for sensors or SPI servo interface
Limit switch	Yes	Input for external limit switches
Communication connector	3-pole, JST SM03B-SRSS-TB	Input for RS485, or use stacking connector
Power connector	2-pole, JST SM02B-SRSS-TB	Input for 48 V supply, or use stacking connector
Power supply	48 V DC, 5 W	48 V DC ±5%
Dimensions (mm)	59 x 39 x 9.2	

a. Power and communication can be provided through either a stacking connector or through power/communication connectors.

Note: All specifications are subject to change without notice. For more information, see www.piezomotor.com.

Main dimensions



Note: The connector board used for stacking has the dimensions 59 x 62,6 x 18,5 mm (the same with one attached PMD401 controller card).

Product description

The PMD401 is a fully featured miniature controller for open loop and closed loop operation that can be easily stacked to form a multi-axis controller system.

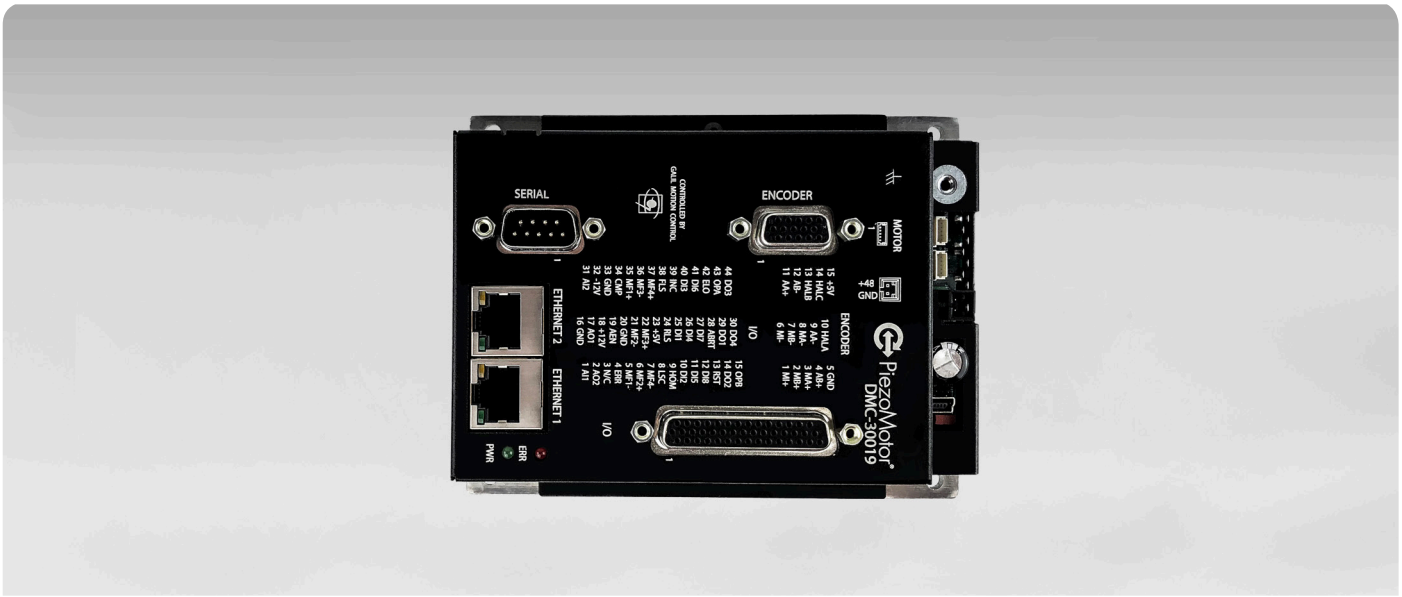
It can be connected to the customer's mainboard for integration in OEM applications. Host communication is done via 2-wire RS485 through ASCII commands. The PMD401 can also be used as a servo amplifier where the external controller regulates the speed via an SPI interface.

A breakout board with terminal blocks for easy access to power and communication is offered optionally for customers who want to get application development started straight away. It provides sub-nanometer resolution and speed in the mm/s range.

Features

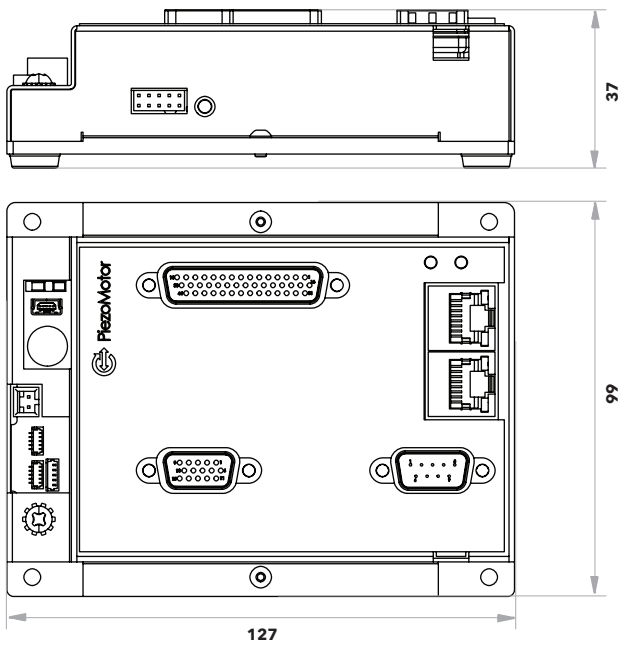
- Nanometer resolution
- Closed loop control
- Open loop mode
- Servo mode
- Stackable boards for multi-axis
- Small form factor
- Slave amplifier to external motion controller via SPI interface
- Sub-nanometer resolution to the Piezo LEGS® motor
- General-purpose inputs/outputs – maximum 4 in and 3 out
- General-purpose inputs/outputs – maximum 4 in and 3 out

DMC-30019



Technical specification DMC-30019		
Type	**Value**	**Note**
Number of axes	1	
Multi-axis support	No	
True speed control	Yes	By encoder feedback
Resolution	8192 microsteps	Each full step of about 5 µm is divided into 8192 steps
Maximum stepping rate (Full step frequency – Hz)	2500	Depends on motor
Supported encoders	Quadrature	ABZ differential, 15 MHz counting
	SSI	0–31 bits, 370–2000 kbps
	BiSS	0–38 bits, 370–2000 kbps
	Analog	Analog ±10 V (12 bits)
Host communication	Two Ethernet 10/100 ports	Commands are sent in ASCII or binary format, up to 115 kbps
	One RS232 port	Daisy-chain Ethernet – no external hub required
Servo interface	N/A	
General I/O	8 isolated inputs	
	4 isolated outputs	
	2 analog inputs	0–5 V, 12-bit ADC
	1 uncommitted analog output	±10 V, 16-bit DAC
Stacking connector	N/A	
Motor connector	2 separate 5-pole JST and 1 Molex	
Encoder/servo connector	15-pole D-sub HD Female (Sensor)	3 connectors, parallel connections
	44-pole D-sub HD Female (I/O)	
Limit switch	Yes	Input for external limit switches
Communication connector	9-pole D-sub	RS232
	RJ45 (2x)	Ethernet
Power connector	2-pole header, 2.54 mm, Molex 70543-0001	Input for 48 V supply
Power supply	48 V DC, 20 W	48 V DC ±5%
Dimensions (mm)	99 x 127 x 37	

Main dimensions



Note: All specifications are subject to change without notice. For more information, see www.piezomotor.com.

Product description

The DMC-30019 is a single-axis motion controller with a motor amplifier for use with Piezo LEGS® motors from PiezoMotor. The unit is built on the DMC-30000 Pocket Motion Controller Series, which is the latest generation single-axis motion controllers from Galil Motion Control, Inc. The controller is assembled by PiezoMotor.

The motion controller operates stand-alone or can be networked to a PC via Ethernet. Like all Galil motion controllers, these controllers use a simple, English-like command language which makes them very easy to program. PiezoTools software further simplifies the system set-up with real-time display of position and velocity information.

Features

- Compact enclosure.
- Ethernet supports multiple masters and slaves. TCP/IP, UDP and Modbus TCP master protocol for communication with I/O devices.
- PID compensation with velocity and acceleration feed forward, integration limits, notch filter and low-pass filter, offset adjustments, and velocity smoothing to minimize jerks.
- Non-volatile memory for programs, variables and arrays. Concurrent execution of four programs.

Modes of motion

- Jogging
- Position tracking
- Point-to-point positioning
- Contouring
- PVT
- Electronic gearing
- Electronic cam
- Teach and playback

Uncommitted inputs / outputs

- 8 isolated inputs
- 4 isolated outputs
- 2 analog inputs; 0–5 V, 12-bit ADC
- 1 uncommitted analog output ±10 V, 16-bit DAC

Dedicated inputs

- Main encoder inputs: channel A, A-, B, B-, I, I- (±12 V or TTL)
- Forward and reverse limit inputs – isolated
- Home input – isolated

Accessories

Cable matrix

		Controller					
		PMD301		PMD401		DMC-30019	
		Motor cable	Encoder cable	Motor cable	Encoder cable	Motor cable	Encoder cable
Motor	LL06	CK6292	CK6295	CK6292	CK6293	CK6292	CK6296
	LT20 (A/C)	CK6272, CK6274	N/A	CK6272, CK6274	N/A	CK6272, CK6274	N/A
	LT20 (D)	Cable attached	N/A	Cable attached	N/A	Cable attached	N/A
	LT40 (A/C)	CK6261	N/A	CK6261	N/A	CK6261	N/A
	LT40 (D)	Cable attached	N/A	Cable attached	N/A	Cable attached	N/A
	LTC40	Cable attached	N/A	Cable attached	N/A	Cable attached	N/A
	LTC300	Cable attached	N/A	N/A	N/A	Cable attached	N/A
	LTC450	Cable attached	N/A	N/A	N/A	Cable attached	N/A
	LS15 (B/D)	Cable attached	N/A	Cable attached	N/A	Cable attached	N/A
	LR17 (A)	CK6256		CK6254		CK6257	
	LR23 (A/C)	CK6261	N/A	CK6261	N/A	CK6261	N/A
	LR23 (A/C) encoder	Cable attached		Cable attached		Cable attached	
	LR23 (D)	Cable attached	N/A	Cable attached	N/A	Cable attached	N/A

Cables	
Art. no	**Description**
CK6254	Motor and encoder cable for PMD401
CK6256	Motor and encoder cable for PMD301
CK6257	Motor and encoder cable for DMC30019
CK6261	Motor cable, black jacket, 0.5 m, JST end
CK6272	Motor cables, black jacket, 2 x 0.5 m
CK6274	Motor cable, Y-cable for LT20
CK6292	Motor cable, black jacket, 0.5 m, JST end
CK6293	Encoder cable, black jacket, 0.5 m, JST end
CK6295	Encoder cable, black jacket, 0.5 m, D15HD end
CK6296	Encoder cable, black jacket, 0.5 m, D15HD end (Galil)

Note: All specifications are subject to change without notice. For more information, see www.piezomotor.com.

Starter kit

PiezoMotor Starter kit

With the Starter kit you can easily get started with Piezo LEGS®. With the free PiezoMotor DriveLab application, you can run the motor in closed loop and with controlled position from a built-in encoder.

The Starter kit is delivered with a PMD401 controller and a linear or rotary motor (LL06 or LR17). It's a fully featured miniature connector board for open loop and closed loop operation that can be easily stacked to form a multi-axis controller system. It can be connected to the customer's mainboard for integration in OEM applications. The PMD401 provides a resolution of up to 8192 microsteps, which means a positioning resolution in the sub-nanometer range. Host communication is done via 2-wire RS485 through ASCII commands.

For customers interested in a Starter kit with a rotary motor, we offer the same setup but with an LR17 motor with a built-in encoder. The encoder has a resolution of 0,2 mrad.

The Starter kit is delivered with power supply for all regions and a USB (RS85) connection to a Windows computer running DriveLab. Download Piezo DriveLab from the PiezoMotor official website.

Starter kit linear version LL06

Content	Art. no
LL06 motor with position encoder	LL06A0-050M1G1E1
PMD401 controller	PMD401-01B
Connector board	CB-PMD401
Power supply 48 V (with 4 regional adapters)	105787-HK-ALL
USB-to-RS485 converter	107401
Motor cable (5-pole)	CK6292-05
Encoder cable (6-pole)	CK6293-05

Starter kit rotary version LR17

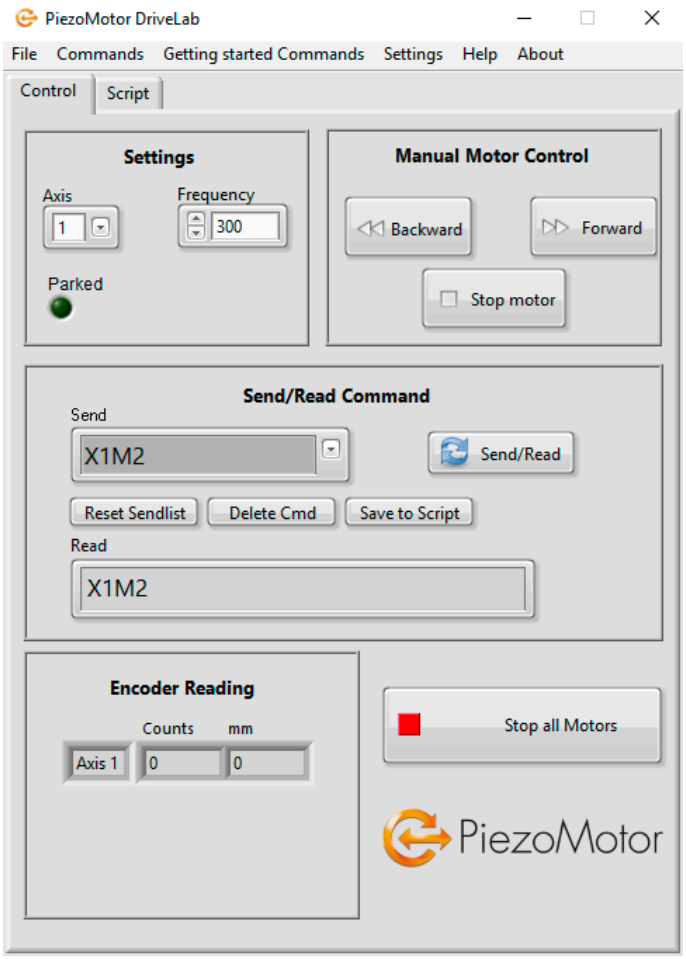
Content	Art. no
LR17 motor with position encoder	LR17-030A21E1A00
PMD401 controller	PMD401-01B
Connector board	CB-PMD401
Power supply 48 V (with 4 regional adapters)	105787-HK-ALL
USB-to-RS485 converter	107401
Motor cable (5-pole)	CK6292-05
Encoder cable (6-pole)	CK6293-05

PiezoMotor DriveLab

PiezoMotor DriveLab is a LabVIEW application designed to help you get started with our Piezo LEGS® motors. It is easy to get started with this software.

DriveLab lets you:

- Run the motor in jog mode or closed loop mode.
- Read out the position from the encoder and set encoder limits.
- Run the motor in various speeds and change the waveform via the controller to optimize speed or precision.
- Import and export scripts from the software.



Nomenclature

LL06

LL 06 A 0 - 000 Mx Gx Ex

Family name
LEGS Linear

Series
06

Motor Type
A = Standard

Version
0

Drive Rod (standard length)
030 = 30 mm* **060** = 60 mm
040 = 40 mm **101** = 100.8 mm
050 = 50 mm
Other lengths are made on request at an extra charge (up to 100.8 mm)

Mechanical Adapter
M1 = One Adapter - Front

Guides
G0 = Without Guides
G1 = With Guides

Encoder (position sensor)* - only available together with guides
E0 = Without Position Sensor
E1 = 1.25 µm incremental optical encoder with index

* Sensor not available with 30 mm rod

LT20

LT 20 XX X - 000 X0 X00

Family name
LEGS Linear Twin

Series
20

Version
20 = M1.6 screw mount

Motor Type
A = SS / Standard
C = NM / Non-Magnetic
D = NMV / Non-Magnetic Vacuum

Drive Rod (standard length)
030 = 30 mm **060** = 60 mm
040 = 40 mm **070** = 70 mm
050 = 50 mm **101** = 100.8 mm
Other lengths are made on request at an extra charge (up to 100.8 mm)

Mechanical Adapter
A0 = no adapter
D1 = One adapter - Front
D2 = One adapter - Back
E1 = Two adapters - Front and Back *Extra charge for two adapters*

Connector / Cable
Motor type A and C
A00 = 2 x JST connector, no cable

Motor type D
B10 = 1.0 m Teflon flying wires PTFE AWG28

LT40

LT 40 XX X - 000 X0 X00

Family name
LEGS Linear Twin

Series
40

Version
40 = M3 screw mount
50 = M2 screw mount

Motor Type
A = SS / Standard
C = NM / Non-Magnetic
D = NMV / Non-Magnetic Vacuum

Drive Rod (standard length)
040 = 40 mm **060** = 60 mm
050 = 50 mm **101** = 100.8 mm
Other lengths are made on request at an extra charge (up to 100.8 mm)

Mechanical Adapter
A0 = no adapter
D1 = One adapter - Front
D2 = One adapter - Back
E1 = Two adapters - Front and Back *Extra charge for two adapters*

Connector / Cable
Motor type A and C
A00 = JST connector, no cable

Motor type D
B10 = 1.0 m Teflon flying wires PTFE AWG28

LR17

LR 17 - 000 A 00 X0 X00

Family name
LEGS Rotary

Diameter
17 = 17 mm diam.

Stall Torque
030 = 30 mNm

Motor Type
A = SS / Standard

Version

Encoder
E1 = Magnetic 15 bit SSI encoder

Connector / Cable
A00 = Connector, no cable

LR23

LR 23 - 000 X 0X X0 X00

Family name
LEGS Rotary

Diameter
23 = 23 mm diam.

Stall Torque
050 = 50 mNm
080 = 80 mNm

Motor Type
A = SS / Standard
C = NM /Non-Magnetic
D = NMV /Non-Magnetic Vacuum

Version
1A Standard shaft
2A Extended shaft (mandatory for E1)

Encoder

E0 = No encoder (mandatory for D-versions)
E1 = Encoder (Extended shaft mandatory)

Connector / Cable
A00 = No cable (Not an option for motors with encoder)
B10 = 1.0 m Teflon flying wires PTFE AWG28 with JST connector (included in D-versions)

Mandatory for motors with encoder (E1)
Exx = Cabel connector for PMD301
Fxx = Cabel connector for PMD401
Gxx = Cabel connector for DMC-30019 Galil
xx is cable length, standard is 05 which is 0,5m

Glossary

Accuracy

The closeness of a measured value to its true value. An example would be how close an arrow gets to the bullseye center.

Full step

Sometimes also referred to as waveform step. The step taken for one full waveform period. The step size depends on the load and the temperature. A typical load dependence curve is given for each motor.

Holding force / Holding torque

The force / torque that the motor can hold without slippage.

Microstep

An incremental step within the full wfm-step. The size of the microstep will give the resolution of the motor. For a linear motor, the microstep can be on a sub-nanometer scale.

Precision

The closeness of two or more measurement values to each other. Also known as repeatability.

Recommended operating range

The range of external load recommended for best microstepping performance and life time. The motor can handle higher loads, but the microstep linearity is impaired.

Resolution

The piezo actuator legs are analog components which bend to move the drive rod or to rotate the drive disc. The resolution depends on the number of microsteps per waveform cycle.

Self-locking

Full holding force at power off/power loss.

Stall force / Stall torque

The load at which the motor no loner gives linear motion or rotates.

Step angle

Rotary motion, angular displacement for full step in a load dependence curve. In the technical specification tables, the value is also given for a single microstep.

Step length

Linear travel specified for full steps in a load dependence curve. In the technical specification tables, the value is also given for a single microstep.

Waveform

The shape and form of the electrical signal which controls the Piezo LEGS®. Waveform Rhomb and Delta are commonly used, and will give different behavior in terms of speed, microstepping performance etc.

www.piezomotor.com

www.facebook.com/piezomotor

www.youtube.com/user/PiezoMotorUppsalaAB

www.linkedin.com/company/piezomotor-ab

www.instagram.com/piezomotor

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

Phone: +46 (0)18 489 50 00
E-mail: info@piezomotor.se