

Miniature Linear Motion Series • L12

Firgelli Technologies' unique line of Miniature Linear Actuators enables a new generation of motion-enabled product designs, with capabilities that have never before been combined in a device of this size. These small linear actuators are a superior alternative to designing with awkward gears, motors, servos and linkages.

Firgelli's L series of micro linear actuators combine the best features of our existing micro actuator families into a highly flexible, configurable and compact platform with an optional sophisticated on-board microcontroller. The first member of the L series, the L12, is an axial design with a powerful drivetrain and a rectangular cross section for increased rigidity. But by far the most attractive feature of this actuator is the broad spectrum of available configurations.



Benefits

- Compact miniature size
- Simple control using industry standard interfaces
- Low voltage
- Equal push / pull force
- Easy mounting

Applications

- Robotics
- Consumer appliances
- Toys
- Automotive
- Industrial automation

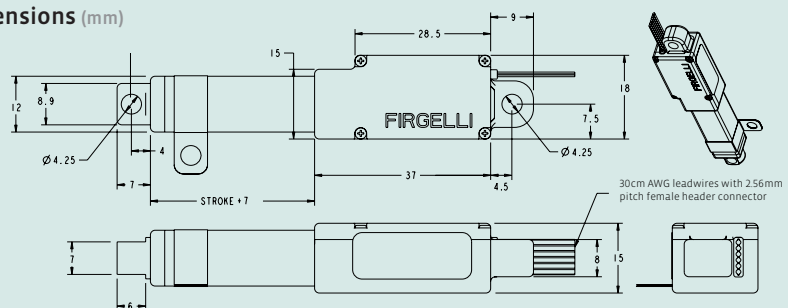
L12 Specifications

Gearing Option	50	100	210	
Peak Power Point ¹	12 N @ 11 mm/s	23 N @ 6 mm/s	45 N @ 2.5 mm/s	
Peak Efficiency Point	6 N @ 16 mm/s	12 N @ 8 mm/s	18 N @ 4 mm/s	
Max Speed (no load)	23 mm/s	12 mm/s	5 mm/s	
Backdrive Force ²	43 N	80 N	150 N	
Stroke Option	10 mm	30 mm	50 mm	100 mm
Weight	28 g	34 g	40 g	56 g
Positional Accuracy	0.1 mm	0.2 mm	0.2 mm	0.3 mm
Max Side Force (fully extended)	50 N	40 N	30 N	15 N
Mechanical Backlash	0.1 mm			
Feedback Potentiometer	2.75 kΩ/mm ± 30%, 1% linearity			
Duty Cycle	20 %			
Lifetime	1000 hours at rated duty cycle			
Operating Temperature	-10°C to +50°C			
Storage Temperature	-30°C to +70°C			
Ingress Protection Rating	IP-54			
Audible Noise	55 dB at 45 cm			
Stall Current	450 mA at 5 V & 6 V, 200 mA at 12 V			

¹ 1 N (Newton) = 0.225 lb_f (pound-force)

² a powered-off actuator will statically hold a force up to the Backdrive Force

Dimensions (mm)



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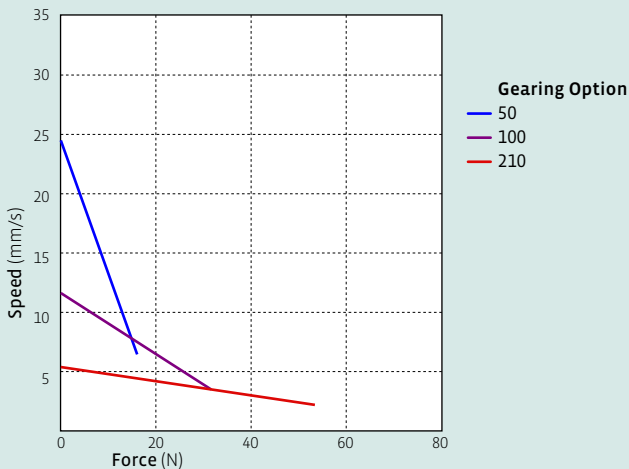
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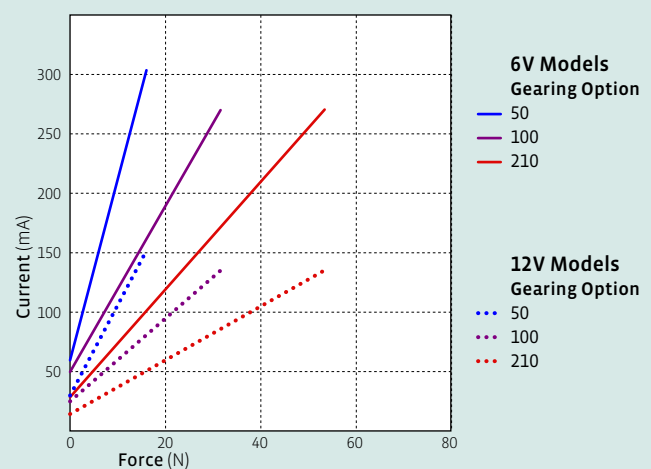
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L12 Specifications

Load Curves



Current Curves



Model Selection

The L12 has five configurable features. L12 configurations are identified according to the following scheme:

L12-SS-GG-VV-C-L

feature	options
SS: Stroke Length (in mm)	10, 30, 50, 100 Any stroke length between 10 and 100mm is available on custom orders, in 2mm increments.
GG: Gear reduction ratio (refer to force/speed plots)	50, 100, 210 Other gearing options may be possible on custom orders.
VV: Voltage	06 6V (5V power for Controller options B and P) 12 12V
C: Controller	B Basic 2-wire open-loop interface, no position feedback, control, or limit switching. Positive voltage extends, negative retracts. S 2-wire open-loop interface (like B option) with limit switching at stroke endpoints. P Simple analog position feedback signal, no on-board controller. I Integrated controller with Industrial and RC servo interfaces (see L12 Controller Options section). Not available with 10mm stroke length configurations. R RC Linear Servo. Not available with 10mm stroke or 12 volts.
L: Mechanical or electrical interface customizations	Custom option codes will be issued by Firgelli for custom builds when applicable.

Basis of Operation

The L12 actuator is designed to move push or pull loads along its full stroke length. The speed of travel is determined by the gearing of the actuator and the load or force the actuator is working against at a given point in time (see Load Curves chart on this datasheet). When power is removed, the actuator stops moving and holds its position, unless the applied load exceeds the backdrive force, in which case the actuator will backdrive. Stalling the actuator under power for short periods of time (several seconds) will not damage the actuator. Do not reverse the supply voltage polarity to actuators containing an integrated controller (I controller option).

Each L12 actuator ships with two mounting clamps, two mounting brackets and two rod end options: a clevis end and a threaded end with nut (see drawing on page 4). When changing rod ends, extend the actuator completely and hold the round shaft while unscrewing the rod end. Standard lead wires are 28 AWG, 30 cm long with 2.56 mm (0.1") pitch female header connector (Hi-Tec™ and Futaba™ compatible). Actuators are a sealed unit (IP-54 rating, resistant to dust and water ingress but not fully waterproof).

Ordering information

Sample quantities may be ordered with a credit card directly from www.firgelli.com.

Please contact Firgelli at sales@firgelli.com for volume pricing or custom configurations.

Note that not all configuration combinations are stocked as standard products. Please refer to www.firgelli.com/orders for current inventory.

L12 Controller options

Option B—Basic 2-wire interface

WIRING:

1 (red) **Motor V+** (5V or 12V)

2 (black) **Motor ground**

The –B actuators offer no control or feedback mechanisms. While voltage is applied to the motor V+ and ground leads, the actuator extends. If the polarity of this voltage is reversed, the actuator retracts. The 5V actuator is rated for 5V but can operate at 6V.

Option S—Basic 2-wire interface

WIRING:

1 (red) **Motor V+** (5V or 12V)

2 (black) **Motor ground**

When the actuator moves to a position within 0.5mm of its fully-retracted or fully-extended stroke endpoint, a limit switch will stop power to the motor. When this occurs, the actuator can only be reversed away from the stroke endpoint. Once the actuator is positioned away from its stroke endpoint, normal operation resumes. For custom orders, limit switch trigger positions can be modified at the time of manufacture, in 0.5mm increments.

Option P—Position feedback signal

WIRING:

1 (orange) **Feedback potentiometer negative reference rail**

2 (purple) **Feedback potentiometer wiper** (position signal)

3 (red) **Motor V+** (5V or 12V)

4 (black) **Motor ground**

5 (yellow) **Feedback potentiometer positive reference rail**

The –P actuators offer no built-in controller, but do provide an analog position feedback signal that can be input to an external controller. While voltage is applied to the motor V+ and ground leads, the actuator extends. If the polarity of this voltage is reversed, the actuator retracts. Actuator stroke position may be monitored by providing any stable low and high reference voltages on leads 1 and 5, and then reading the position signal on lead 2. The voltage on lead 2 will vary linearly between the two reference voltages in proportion to the position of the actuator stroke.

Option I—Integrated controller with industrial and RC servo interfaces

WIRING:

1 (green) **Current input signal** (used for 4–20 mA interface mode)

2 (blue) **Voltage input signal** (used for the 0–5V interface mode and PWM interface modes)

3 (purple) **Position Feedback signal** (0–3.3 V, linearly proportional to actuator position)

4 (white) **RC input signal** (used for RC-servo compatible interface mode)

5 (red) **Motor V+** (+6 Vdc for 6 V models, +12 Vdc for 12 V models)

6 (black) **Ground**

The –I actuator models feature an on-board software-based digital microcontroller. The microcontroller is not user-programmable.

The six lead wires are split into two connectors. Leads 4, 5 and 6 terminate at a universal RC servo three-pin connector (Hi-Tec™ and Futaba™ compatible). Leads 1, 2 and 3 terminate at a separate, similarly sized connector.

When the actuator is powered up, it will repeatedly scan leads 1, 2, 4 for an input signal that is valid under any of the four supported interface modes. When a valid signal is detected, the actuator will self-configure to the corresponding interface mode, and all other interface modes and input leads are disabled until the actuator is next powered on.

0–5 V Interface Mode: This mode allows the actuator to be controlled with just a battery, and a potentiometer to signal the desired position to the actuator – a simple interface for prototypes or home automation projects. The desired actuator position (setpoint) is input to the actuator on lead 2 as a voltage between ground and 5V. The setpoint voltage must be held on lead 2 until the desired actuator stroke position is reached. Lead 2 is a high impedance input.

4–20 mA Interface Mode: This mode is compatible with PLC devices typically used in industrial control applications. The desired actuator position (setpoint) is input to the actuator on lead 1 as a current between 4 mA and 20 mA. The setpoint current must be held on lead 1 until the desired actuator stroke position is reached.

RC Servo Interface Mode: This is a standard hobby-type remote-control digital servo interface (CMOS logic), compatible with servos and receivers from manufacturers like Futaba™ and Hi-Tec™. The desired actuator position is input to the actuator on lead 4 as a positive 5 Volt pulse width signal. A 1.0 ms pulse commands the controller to fully retract the actuator, and a 2.0 ms pulse signals full extension. If the motion of the actuator, or of other servos in your system, seems erratic, place a 1–4Ω resistor in series with the actuator's red V+ leadwire.

PWM Mode: This mode allows control of the actuator using a single digital output pin from an external microcontroller. The desired actuator position is encoded as the duty cycle of a 5 Volt 1 kHz square wave on actuator lead 2, where the % duty cycle sets the actuator position to the same % of full stroke extension. The waveform must be 0V to +5V in order to access the full stroke range of the actuator.

Option R—RC Linear Servo

WIRING:

1 (white) **RC input signal**

2 (red) **Motor V+** (6VOC)

3 (black) **Ground**

The –R actuators or 'linear servos' are a direct replacement for regular radio controlled hobby servos. Operation is as above in RC servo interface mode (option I). The –R actuators are available in 6 volt and 30, 50 and 100 mm strokes only.

Understanding the Data Sheet

Products: **All**

This note is supplied to provide further information about the data presented in Firgelli Data sheets. The intent is to provide clarification on ratings, units, and graphs.

Terms:

Peak Power Point	– Power is calculated by multiplying speed by force. The Peak Power point is the specific speed and force point that will result in the largest power output.
Peak Efficiency Point	– This indicates the motor speed where the actuator most efficiently converts electricity to mechanical power.
Max Speed (no load)	– This is the maximum speed that the actuator can achieve. This occurs when nothing is attached to the actuators piston.
Max Force (lifted)	– The maximum force that can be reliably lifted by the actuator without causing damage.
Max Side Load	– This is the maximum external force that can be applied perpendicular to the actuators shaft. If this is exceeded, the actuator may not operate correctly and life may be reduced.
Back Drive Force	– This is the amount of force that it takes to overcome friction in an actuator with the power removed, causing the shaft to move.
Stroke	– This is the distance that the actuator shaft can travel.
Input Voltage	– This is the maximum recommended supply voltage for the actuator. Using a voltage lower than this will result in reduced speed and force.
Stall Current	– This is the maximum current that the actuator will draw when it is allowed to stall against a hard limit.
Mass	– Weight of the actuator.



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Operating Temperature	– This is the ambient temperature range where the actuator will operate within its performance specs. Outside this range the actuator will continue to operate, but at different speeds, forces and currents, and with reduced life expectancy.
Positional Accuracy	– For models with potentiometer feedback this is the level of accuracy that is attainable based on the linearity of the feedback.
Lifetime	– Cycle life is based on testing of unloaded actuators with one stall condition at either end of stroke. This tests potentiometer life and mechanical life. The stall condition is the worst case load for an actuator. This applies a load well in excess of the Peak Power Point.
Audible Noise	– Maximum noise levels during normal operation measured at 45cm from the actuator.
Ingress Protection	– This rating indicates the amount of environmental protection the case provides. IP54 indicates “Protected against dust limited ingress (no harmful deposit).” And “Protection against water sprayed from all directions - limited ingress permitted.”

Units:

g – Grams,	SI Units used to indicate the weight of the actuator. Convert to ounces by multiplying by 0.035273.
N – Newtons,	SI Units used to define forces which the actuator can push or pull. Newtons can be converted to an equivalent hung Weight in pounds by dividing by 9.8 and multiplying by 2.2.
mm/s – Millimeters per Second,	SI Unit used to define actuator speed. Convert to inches per second by multiplying by 0.039370078
V,VDC - Volts Direct Current,	These are used interchangeably. No Firgelli actuators accept AC voltages. An example of AC would be the power in our houses. To get DC an AC/DC transformer can be used. An example of DC is a battery.
°C – Degrees Celsius	Convert to degrees Fahrenheit by multiplying by 1.8 and then adding 32.
dB – Decibel,	A measurement of sound level. A reading of 60-75 is comparable to a normal conversation at 3-5 feet.



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Graphs:

Load Curves

This graph shows a plot of speed versus load. As the load is increased the speed of the actuator will be reduced. The multiple lines indicate different gear options that can be specified when ordering.

Current curves

This graph shows a plot of current versus load. As the load is increased the amount of current drawn is increased. The multiple lines show different motor voltage and gear options.

Speed curves

A graph of speed versus voltage is not shown however this is also linear. Actuator speed for a fixed load can be varied by varying the motor voltage. For integrated controllers or the CIB the minimum allowed voltage is ~4V.

Schematics:

Dimensions - All dimensions are given in mm. To convert to inches multiply by 0.039370078.

Ø – Indicates a diameter.

Pitch – This is the center to center distance between two adjacent pins or pads on a connector.

Technical assistance and design support services — Disclaimer of Warranties; Release of Claims

Firgelli offers technical assistance and design support services as a convenience to Firgelli customers. Firgelli personnel strive to provide useful information regarding Firgelli products. Firgelli does not guarantee that any information or recommendation provided is accurate, complete, or correct, and Firgelli shall have no responsibility or liability whatsoever in connection with any information or recommendation provided, or the customer's reliance on such information or recommendation. The customer is solely responsible for analyzing and determining the appropriateness of any information or recommendation provided by Firgelli personnel, and any reliance on such information or recommendation is at the customer's sole risk and discretion. Accordingly, the customer shall release and hold Firgelli harmless from and against any and all loss, liability, and damage incurred by the customer or any third party as a result of any information or recommendation provided to the customer or the customer's reliance on such information or recommendation.



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