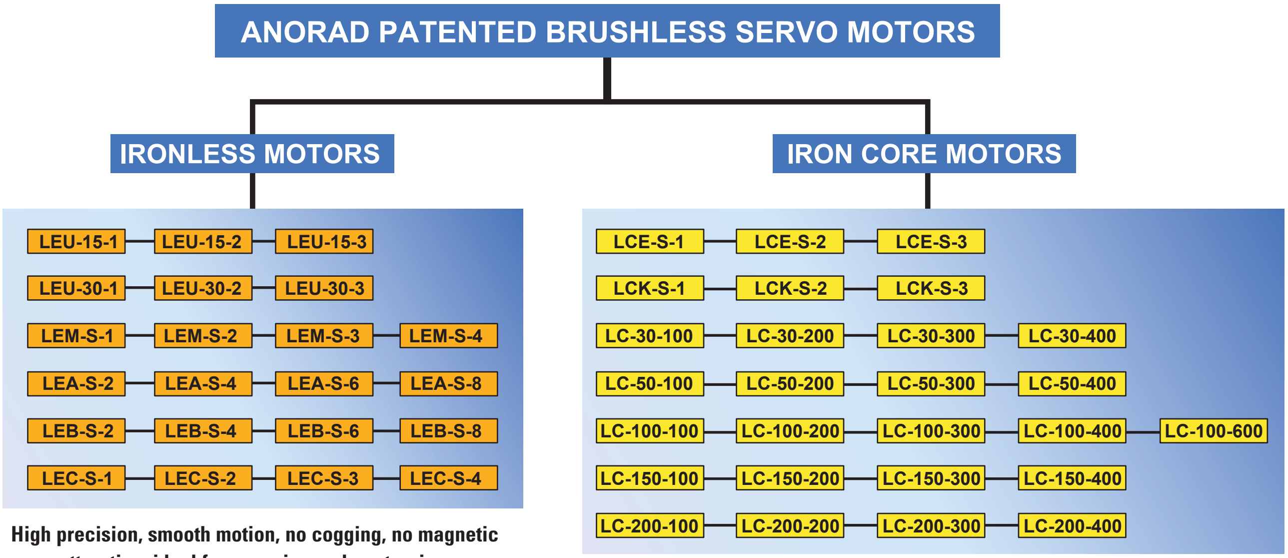
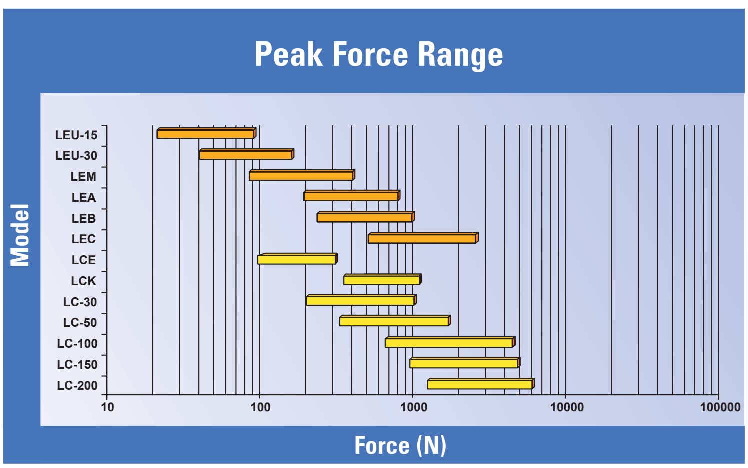
Iron Core and Ironless Linear Servo Motors

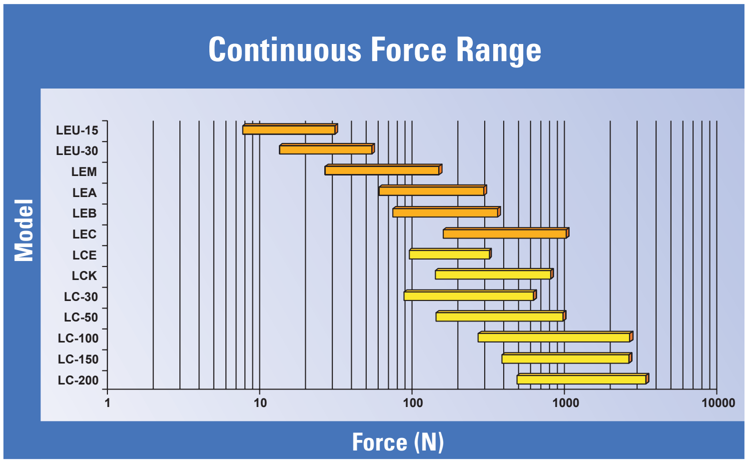
Product Overview



High precision, smooth motion, no cogging, no magnetic attraction, ideal for scanning and contouring.

High force per motor size, lower magnet assembly cost, excellent cooling, ideal for point to point applications.





Advantages of Linear Motors

Unlimited Travel

Anorad motors do not have limitations on travel displacements. Since the stationary magnet assemblies can be easily joined together to form any length of motor, travel can be made as long as necessary. Since the same moving coil assembly could be used for any travel, there is no trade-off in performance as a function of travel. Screw driven systems, on the other hand, have critical speed limitations and higher inertia with added length. Speed limitations, high inertia, and low stiffness are major performance trade-offs with larger travels with other drive techniques.

Velocity

Anorad linear servo motors can be used in both very low and very high velocity applications, all with very high precision. They can precisely operate at velocities ranging from less than 1 µm/sec (0.00004"/sec) to more than 10 m/sec (400"/sec). Ball screws and lead screws have critical speed limitations. Belt drives exhibit lower stiffness. Rack-and-pinion drives typically have backlash and poor low velocity performance.

Acceleration

Anorad linear motors have a high ratio of peak force to motor inertia (about 30:1). Therefore, almost all the motor force can be used to accelerate the moving load and perform useful work. In typical screw-driven systems, a large portion of the motor torque is lost in overcoming the rotary inertia of the motor, coupling and screw.

Smoothness Of Motion

Brushless linear servo motors can provide extremely smooth motion, since they have no contacting surfaces to cause jitter. Ultimate smooth motion is achieved with Anorad's sinusoidal-commutated non-ferrous motors. By contrast, ball screws are not as smooth due to the vibrating nature of the balls entering and exiting the ball nut raceways, which is easily observed in sub-micron systems. Belt and rack-and-pinion drives also have contacting mechanisms which are susceptible to friction and backlash caused vibrations.

Accuracy and Repeatability

With Anorad linear motors, the only limit to total system accuracy and repeatability is the sensing device and the bearings of the positioning system. In rotary driven systems there are additional factors which effect these performance variables, including backlash, hysteresis, lost motion and jitter.

Stiffness

Anorad linear servo motors have very high stiffness, typically higher than a stage's bearings and structural members. With ball screws and rack-and-pinion drives, the couplings, ball nut, and pinions are the highest contributors to low stiffness of a stage. Low stiffness reduces frequency response and increases settling times.

Maintenance and Life Expectancy

Anorad brushless linear servo motors have no contact between the two working members. Therefore, they have an extremely long, virtually maintenance-free life. The non-contact design eliminates lubrication and periodic adjustment to compensate for wear. Rotary driven mechanisms require regular lubrication and occasional replacement due to wear.

Cleanroom and Vacuum Applications

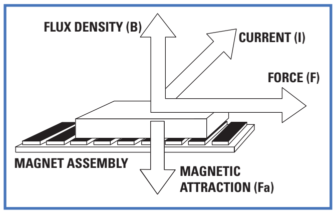
Since the coil assembly and the magnet assembly of linear servo motors do not make contact, they are ideally suited for clean room and vacuum applications. Anorad manufactures linear motors specifically for 10^{-7} torr and vacuum applications, using special material and manufacturing processes.

Linear Motor Section Contents

Common Questions

How Do They Work?

Linear servo motors essentially work the same as rotary motors, only opened up and laid out flat. Each motor is made of only two parts – a coil assembly and a magnet assembly as shown below.



The coil assembly encapsulates copper windings within a core material (e.g. epoxy, steel). The copper windings conduct current (I). The magnet assembly consists of rare earth magnets, mounted in alternating polarity on a steel plate, which generate magnetic flux density (B). When the current and the flux density interact, force (F) is generated in the direction shown above, where F = I x B.

How Critical Is Mechanical Alignment?

The coil assembly is typically attached to the moving portion of the machine. The magnet channel is usually fixed to the machine base. The air gap between the two motor elements is typically 0.6mm (0.024"). The gap can vary as much as ± 0.3 mm (± 0.012") without appreciable loss of performance.

Is There Magnetic Attraction Between The Motor Parts?

There are two basic classifications of permanent magnet servo motors: epoxy core (i.e. non-ferrous, slotless) and steel core. Variation of these classifications include an epoxy/steel core. Anorad's epoxy core motors have coils wound within epoxy support. Therefore, these motors produce extremely smooth motion and have no magnetic attraction. Anorad's steel core coil assembly motors use the steel to focus the magnetic flux, thus producing very high force density. The steel in the coils is attracted to the permanent magnets in a direction perpendicular (normal) to the operated motor force. Magnetic attraction is a constant force and is present whether or not the motor is electrically energized. Depending on the motor type, the normal force of the magnetic attraction can be up to 10 times the continuous force rating of the motor.

What Is The Cogging Level In Linear Motors?

Cogging is a form of magnetic "detenting" that occurs when a coil's steel laminations cross the alternating poles of the motor's rare-earth magnets. Cogging is negligible in non-ferrous motors (LEU, LEM, LEA, LEB, LEC). Cogging in steel core motors (LC-30/50/100/150/200, LCK) is typically +/-5% of the motor's continuous force rating.

What Is The Magnetic Flux In Linear Motors?

The magnetic flux density within the air gap of linear motors is typically several thousand gauss. The non-ferrous motors (LEU, LEM, LEA, LEB, LEC), have a closed magnetic path through the gap since two magnet plates "sandwich" the coil assembly. With these motors, very little flux exists outside the motor. Steel core motors, on the other hand, have only one magnet plate. High flux density therefore exists in the vicinity of the exposed magnets. This flux rapidly diminishes to a few gauss as the point of measure is moved a few centimeters away from the magnets. When needed, special shielding is used to further reduce the level of flux outside steel core motors.

Can A Linear Motor Be Used In A Vertical Stage?

Linear Motors are routinely used in vertical applications. To avoid motor overheating and to inhibit carriages from falling when power is removed, gravitational load offsets are typically achieved with pulleys and weights, springs, or air cylinders.

What Happens If My System Loses Power Or Feedback?

In cases of a power loss, servo control is interrupted. Stages in motion tend to stay in motion; those at rest tend to stay at rest. The stopping time and distance depend on the stage's initial velocity and the system friction. Use of the motor's back EMF for dynamic braking and positive friction brakes are often used to rapidly attenuate motion. It is also strongly advised that a system of positive stops and travel limits be built into a motion stage to prevent damage under emergency conditions (power loss, loss of feedback, and controller or servo driver failure).

Where Are The Bearings?

Anorad linear motors are frameless type motors. The motor is supplied in kit form, designed to be integrated into a customer provided structure. The motors themselves have no bearings. The machine structure in which the motors are mounted must include bearings of sufficient precision to maintain the air gap, and sufficient load rating to support the normal force of the magnetic attraction (if present).

Is Position Feedback Required?

Anorad linear motors are servo motors designed to be used in a closed loop servo positioning system. Most applications will require a linear position feedback sensor. Typical feedback sensors include linear encoders or laser interferometers. LVDT's, and linear inductosyns can also be used. The motors themselves do not have a position sensor.

Linear Motor Features and Benefits

Motor Performance

Efficiency – Anorad motors have achieved **over 100 $N/\sqrt{W}$** based on 95°C winding temperature. When comparing these values with other motor designs, care must be made to assure that the same thermal conditions are being applied.

Cogging – Non-ferrous motors have negligible cogging due to their high magnetic uniformity. Steel core motors are designed with patented anti-cogging devices, such that cogging is maintained to minimal levels **(less than 5% continuous force)**.

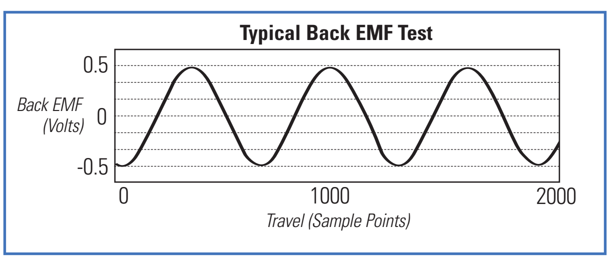
Magnetic Attraction – Steel core motors have magnetic attraction. This force, if properly used in positioning system design, can **help increase preload and stiffness** for improved performance.

Static stiffness – Anorad motors are designed for high static stiffness by a combination of rugged design and special vacuum molding manufacturing processes. Anorad's high force motor stiffness is over **900 N/micron**.

Cooling Technology – Anorad cooling design provides several advantages over common practices. 1. Epoxy core motors are cooled with internal circuits that can remove heat from the stage to an external location. 2. **Revolutionary oil cooling for high force applications** are available in epoxy core motors. 3. Steel core motors have cooling circuits very close to the coil itself, providing the maximum heat removal capacity.

Eddy currents – Anorad laminated steel core motors and reinforced aluminum core motors incorporate a **proprietary anti-eddy current design** to reduce eddy current losses to negligible levels, resulting in higher efficiency.

Magnetic Flux Density – Anorad magnets are subject to the highest quality standards to assure force uniformity at any position **better than +/-5%** (see chart below).



System Performance

Smoothness of Motion – Linear motors generally provide the smoothest linear motion. In particular, the epoxy core family of Anorad motors have been optimized to provide minimum velocity ripple. Advanced magnet designs, non-ferrous epoxy core, sinusoidal commutation, and linear servo amplifiers are just a few of the technology advantages Anorad employs to enable systems to achieve **velocity ripple of less than 0.01%**.

Settling time – Anorad's linear servo motors enable systems to achieve very high dynamic stiffness and closed loop bandwidth. The absence of mechanical windup, backlash and friction in the drive can often result in **settling time of a few milliseconds** in a carefully designed system.

Position Accuracy – Linear motors are an essential component for achieving very high positioning accuracy. Anorad motors are employed in systems achieving **sub-micron positioning performance**. Anorad motors are also cost-effective solutions in low to moderate accuracy systems requiring the advantages of direct drive technology, such as speed or reliability.

Velocity – Linear motors are capable of very high velocity in excess of **10 m/s**. Anorad's proprietary anti-eddy current design assures negligible eddy current losses at high speeds.

Acceleration – Linear motors are capable of very high acceleration **(over 10 g)**. Anorad designs its motors for minimal weight per generated force such that the ratio of force to moving weight is maximized.

Dynamic Stiffness – This is the system's ability to resist displacement under time varying forces. Dynamic stiffness **depends on the overall servo system characteristics**. With system design, the highest levels of dynamic disturbance rejection can be achieved with Anorad's motors.

Closed Loop Bandwidth – Anorad positioning systems with high force motors and third party CNC controllers have demonstrated typical linear motor closed loop position bandwidths of **100 Hz**. This is the highest known frequency to date with 9000N peak force motor.

System Configurations

To achieve the highest performance in positioning systems, the entire machine structure must be optimized to result in the highest possible natural frequency, and the entire servo system design must be optimized to achieve the highest possible closed loop bandwidth. The designer of a linear motor machine should therefore be aware of various design considerations, which are somewhat different than traditional servo system practices.

1 Very high magnetic attraction (up to 10 times drive force) can exist between the motor parts. This requires careful handling of the magnetic plates, before and during installation, proper installation tools, and design for ease of disassembly in the field.

2 Linear bearings must be selected to support both the moving load and the magnetic attraction force. Desirable bearing characteristics include high stiffness (for increased natural frequency) and low friction. Because linear motors can provide higher velocities, the speed and acceleration limitations of the bearings need to be considered.

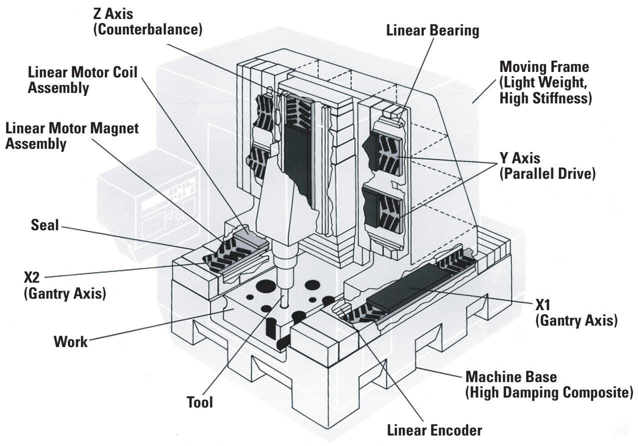
3 Machine chips must be kept outside the magnet assembly by proper sealing and bellows. This is needed to prevent machine chips from penetrating the small air gap between the motor parts.

4 The motor air gap must be maintained within specified tolerance for proper motor functioning. The machine bearings and guideway must be of sufficient precision to maintain the air gap.

5 Brushless linear motors typically have moving cables. Provision must be provided in the machine to carry the cables. Motors with cooled coils will also have moving air or liquid coolant lines.

6 If a liquid cooled motor is selected, the coolant should include a rust inhibitor additive. The motor thermistor should be connected to a safety interlock circuit in the machine control system to prevent overheating.

A typical concept of a linear motor machine.



7 When used in a vertical application, linear motors typically require a counterbalance mechanism to prevent the load from dropping in the event of a power interruption. The counter balance can also reduce the motor duty cycle by supporting the load against gravity. Typical counterbalance techniques include pneumatic cylinder, springs, or counterweight.

8 The motor should be mounted as close as possible to the center of mass of the moving load. The position feedback (e.g. linear encoder) should be mounted as close as possible to the working point of the machine. If the motor and feedback are far apart, the machine structure and bearings must be of sufficient stiffness to minimize dynamic deflections of the structure.

9 Cables should be made in a twisted pair configuration, shielded and grounded properly to the machine base, servo amplifier and motor to reduce RFI. Cables should be selected for proper flex life at the designed bend radius.

10 Brushless motors require commutation for proper operation. Anorad motors can be provided with a variety of commutation options. Select a commutation method that matches the requirements of the servo controller. Specify the commutation option when ordering the motor.

11 Take advantage of Anorad's linear motor and system design expertise. Anorad's skilled application engineers will help you scale the linear motor learning curve. Anorad provides one stop shopping for linear motors and all accessories, including servo amplifiers, digital controls and feedback devices. For over 30 years, Anorad is the world leader in linear positioning systems.

Application Support

Motor Variety – Anorad provides the largest linear motor variety, with force ranging from a few Newton's **to over 20,000N per single coil (most powerful coil in the world)**.

Manufacturing Capacity – Anorad has over **130,000 sq. ft.** of production facilities dedicated to high performance linear motion systems. We have 16,000 sq. ft. of facility dedicated exclusively to production of linear motor components. Anorad can support small users to major OEM's with products manufactured under the strictest quality standards.

Applications Engineering – Anorad has been designing high performance motion systems for over thirty years. **Our 25 years of linear motor system integration expertise** is the most extensive in the world. Anorad computer-aided system design tools enable our engineers to immediately provide customers with an optimized solution. With Anorad's engineering support, specifying a linear motor has never been easier.

Proven Reliability – An installed base of over **100,000 motors in the field** is testimony to the field proven reliability of Anorad's linear motors.

Technology Leader – Anorad has **over 40 patents** and patent pending in linear motors and motion control technology. As a major user of linear motors in our own state-of-the-art motion systems, as well as being the leading manufacturer, we have the highest level of understanding the technology of linear motors.

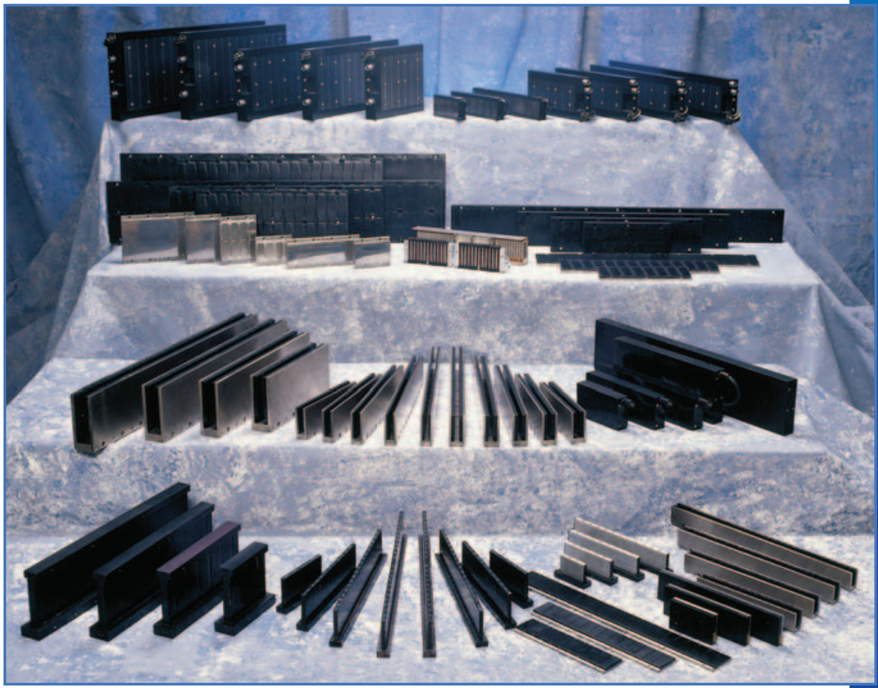
Complete Solution – Anorad provides a complete solution for positioning applications. Ranging from motion components including: **motors, encoders, amplifiers, cables, and controllers** to complete positioning systems and structural elements.

Engineering Support – From first rate applications engineering support, state-of-the-art computer aided engineering tools, to expert installation and field support, Anorad is **committed to the success of our customers**.

Anorad Offers the Most Complete Line of Linear Motors

The most complete line of patented brushless linear motors from the people who invented them. Anorad direct drive linear motors have high force density, high stiffness, enable extremely smooth velocity control and are zero maintenance.

- Zero cog ironless core balanced linear motors
- High force iron core linear motors
- Vacuum compatible linear motors
- Up to 25g's acceleration and 6 m/s velocity
- Air and water cooling options
- Wide variety of windings
- Custom designs



LEU Micro Brushless Linear Motor

Product Features

- Lowest force, epoxy core design
- 26 lbs. peak force
- No cogging, no magnetic attraction
- High acceleration
- Ideal for high precision/smooth motion

Specifications

Performance Parameter	Symbol	Units	LEU-15-1-D	LEU-15-2-D	LEU-15-3-D	LEU-30-1-D	LEU-30-2-D	LEU-30-3-D
Cooling Method			NC	NC	NC	NC	NC	NC
Continuous Force [1, 5]	F_{cTmax}	N (lb_f)	7.5 (1.7)	14.9 (3.4)	22.4 (5.0)	13.1 (2.9)	26.1 (5.9)	39.2 (8.8)
Peak Force [2]	F_p	N (lb_f)	22 (5.0)	45 (10.0)	67 (15.1)	39 (8.8)	78 (17.6)	117 (26.4)
Motor Constant [1]	K_m	$N/\sqrt{W}$ ($lb_f/\sqrt{W}$)	1.7 (0.39)	2.4 (0.55)	3.0 (0.67)	2.7 (0.61)	3.8 (0.86)	4.7 (1.06)
Thermal Resistance	R_{th}	°C/W	5.34	2.67	1.78	4.32	2.16	1.44
Max Power Dissipation	P_{cTmax}	W	19	37	56	23	46	69
Max Applied Bus Voltage	V_{DC}	Volts	160	160	160	160	160	160
Electrical Cycle Length	E_c	mm	15	15	15	15	15	15
Electrical Time Constant	τ_e	msec	0.12	0.12	0.12	0.12	0.12	0.12
Max Coil Temp	T_{max}	°C	125	125	125	125	125	125
Force Constant [1, 6]	K_F	N/A_{pk} (lb_f/A_{pk})	2.7 (0.6)	5.3 (1.2)	8.0 (1.8)	5.3 (1.2)	10.7 (2.4)	16.0 (3.6)
Back EMF Constant p-p [3, 4, 6]	K_e	V_p/m/s (V_p/in/s)	3.1 (0.08)	6.3 (0.16)	9.4 (0.24)	6.3 (0.16)	12.6 (0.32)	18.9 (0.48)
Peak Current [1, 4]	I_p	A_{pk} (A_{rms})	8.4 (5.9)	8.4 (5.9)	8.4 (5.9)	7.3 (5.2)	7.3 (5.2)	7.3 (5.2)
Continuous Current [1, 4, 5]	I_{cTmax}	A_{pk} (A_{rms})	2.8 (2.0)	2.8 (2.0)	2.8 (2.0)	2.4 (1.7)	2.4 (1.7)	2.4 (1.7)
Resistance [3, 6] **@25°C**	R_{25}	ohm	2.23	4.46	6.69	3.60	7.20	10.80
Inductance p-p [3]	L	mH	0.26	0.52	0.78	0.44	0.88	1.32
Mechanical Parameters								
Magnetic Attraction	F_a	N (lb_f)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Coil Mass	M_c	kg (lb_m)	0.022 (0.049)	0.044 (0.097)	0.066 (0.146)	0.030 (0.066)	0.060 (0.132)	0.090 (0.198)
Magnetic Track Mass	M_n	kg/m (lb/in)	2.32 (0.13)	2.32 (0.13)	2.32 (0.13)	3.87 (0.22)	3.87 (0.22)	3.87 (0.22)

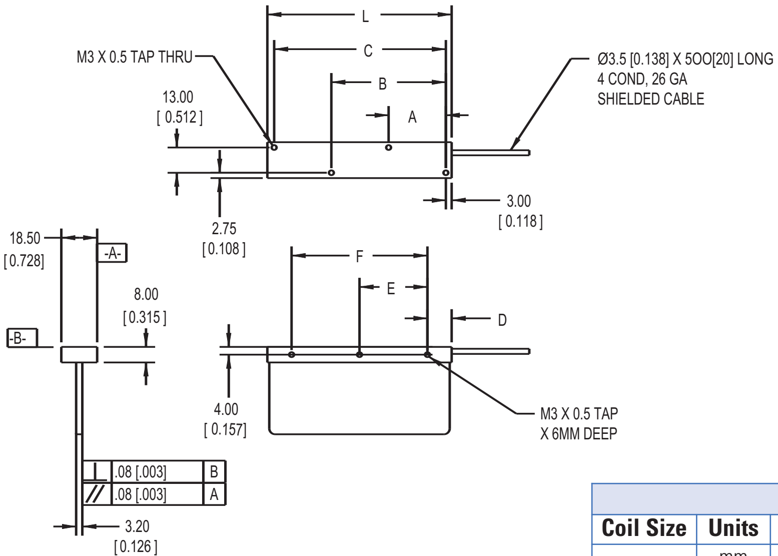
Notes: Motor performance specifications are with sinusoidal commutation.

1 Continuous forces, motor constant and currents listed are with coils at maximum temperature 125°C, mounted to a 12.7 mm (0.5") aluminum heat sink thickness whose area equals 3 times the coil area, with the heat sink at 25°C ambient.
2 Max on time 1 sec, assuming correct rms Force and Current, consult Anorad.
3 All winding parameters listed are measured line-to-line (phase-to-phase).
4 All currents and voltages listed are measured 0-peak of the sine wave unless noted rms.
5 Continuous forces and currents are based on coil moving with all phases sharing the same load in sinusoidal commutation.
6 All specifications are ±10%.

LEU Micro Brushless Linear Motor Diagram

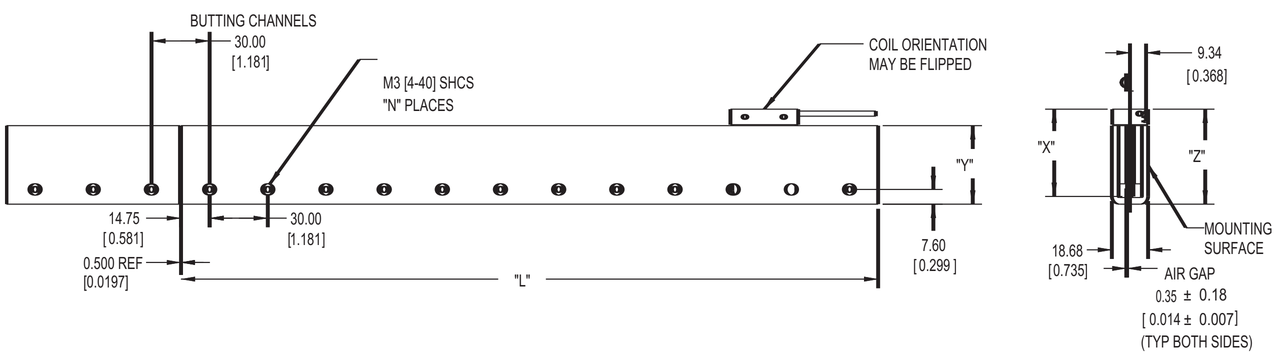
Dimensions mm [in]

Coil Assembly



Coil Dimensions									
Coil Size	**Units**	**L**	**A**	**B**	**C**	**D**	**E**	**F**
LEU-15/30-1	mm (in)	35.00 (1.378)	29.00 (1.142)			7.50 (0.295)	20.00 (0.787)	
LEU-15/30-2	mm (in)	65.00 (2.559)	29.50 (1.161)	59.00 (2.323)		12.50 (0.492)	40.00 (1.575)	
LEU-15/30-3	mm (in)	95.00 (3.740)	29.50 (1.161)	59.00 (2.323)	88.50 (3.484)	12.50 (0.492)	35.00 (1.378)	70.00 (2.756)

Magnet Channel



Magnet Channel Dimensions			
Length	**Units**	**L**	**N**
60	mm (in)	59.50 (2.343)	2
90	mm (in)	89.50 (3.523)	3
150	mm (in)	149.50 (5.886)	5
300	mm (in)	299.50 (11.791)	10

Travel Vs. Magnet Channel Length				
Magnet Channel (mm)	**Units**	**LEU-15/30-1**	**LEU-15/30-2**	**LEU-15/30-3**
		Travel (mm)		
60	mm (in)	25.00 (0.984)		
90	mm (in)	55.00 (2.165)	25.00 (0.984)	
150	mm (in)	115.00 (4.527)	85.00 (3.346)	55.00 (2.165)
300	mm (in)	265.00 (10.433)	235.00 (9.252)	205.00 (8.070)

Coil/Magnet Channel Height Dimensions				
Model	**Units**	**X**	**Y**	**Z**
LEU-15-1/2/3	mm (in)	30.00 (1.181)	25.50 (1.004)	34.00 (1.339)
LEU-30-1/2/3	mm (in)	45.00 (1.772)	40.50 (1.594)	49.00 (1.929)

LEM Brushless Linear Motor

Product Features

- Low force, epoxy core
- Integrated cooling for high duty cycle
- No cogging, no magnetic attraction
- Miniature design
- Ideal for high precision/smooth motion

Specifications

Performance Parameters	Symbol	Units	LEM-S-1			LEM-S-2-S			LEM-S-3-S			LEM-S-4-S		
Cooling Method			NC	AC	WC	NC	AC	WC	NC	AC	WC	NC	AC	WC
Continuous Force [1, 5, 6, 7]	F_{cTmax}	N (lb_f)	26 (6)	31 (7)	33 (7)	52 (12)	61 (14)	66 (15)	75 (17)	87 (20)	95 (21)	96 (22)	113 (25)	121 (27)
Peak Force [2]	F_p	N (lb_f)	83 (19)	83 (19)	83 (19)	165 (37)	165 (37)	165 (37)	238 (53)	238 (53)	238 (53)	302 (68)	302 (68)	302 (68)
Motor Constant [1]	K_M	$N/\sqrt{W}$ ($lb_f/\sqrt{W}$)	3.9 (0.9)	3.9 (0.9)	3.9 (0.9)	5.8 (1.3)	5.8 (1.3)	5.8 (1.3)	7.1 (1.6)	7.1 (1.6)	7.1 (1.6)	8.2 (1.8)	8.2 (1.8)	8.2 (1.8)
Thermal Resistance	R_{th}	°C/W	2.22	1.63	1.39	1.22	0.90	0.78	0.89	0.66	0.56	0.73	0.53	0.46
Max Power Dissipation	P_{cTmax}	W	45	62	72	82	111	129	113	152	177	136	190	217
Maximum Applied Bus Voltage	V_{DC}	Volts	325			325			325			325		
Electrical Cycle Length	E_c	mm	30			30			30			30		
Electrical Time Constant	τ_e	msec	0.5			0.5			0.5			0.5		
Maximum Coil Temperature	T_{max}	°C	125			125			125			125		
Force Constant [1, 8]	K_F	N/A_{pk} (lb_f/A_{pk})	5.3 (1.2)	5.3 (1.2)	5.3 (1.2)	11.0 (2.5)	11.0 (2.5)	11.0 (2.5)	16.7 (3.7)	16.7 (3.7)	16.7 (3.7)	22.2 (5.0)	22.2 (5.0)	22.2 (5.0)
Back EMF Constant p-p [3, 4, 8]	K_e	V_p/m/s (V_p/in/s)	6.3 (0.16)	6.3 (0.16)	6.3 (0.16)	13.0 (0.33)	13.0 (0.33)	13.0 (0.33)	19.7 (0.50)	19.7 (0.50)	19.7 (0.50)	26.3 (0.67)	26.3 (0.67)	26.3 (0.67)
Peak Current [1, 4]	I_p	A_{pk} (A_{rms})	15.6 (11.0)	15.6 (11.0)	15.6 (11.0)	15.0 (10.6)	15.0 (10.6)	15.0 (10.6)	14.3 (10.1)	14.3 (10.1)	14.3 (10.1)	13.6 (9.6)	13.6 (9.6)	13.6 (9.6)
Continuous Current [1, 4, 5, 6]	I_{cTmax}	A_{pk} (A_{rms})	4.9 (3.5)	5.8 (4.1)	6.3 (4.4)	4.8 (3.4)	5.5 (3.9)	6.0 (4.2)	4.5 (3.2)	5.2 (3.7)	5.7 (4.0)	4.3 (3.1)	5.1 (3.6)	5.4 (3.9)
Resistance p-p [3, 8] **@25°C**	R_{25}	ohm	1.8			3.5			5.3			7.1		
Inductance p-p [3]	L	mH	0.9			1.8			2.7			3.6		
Mechanical Parameters														
Magnetic Attraction	F_a	N (lb_f)	0 (0)			0 (0)			0 (0)			0 (0)		
Coil Mass [5]	M_c	kg (lb_m)	0.2 (0.3)	0.2 (0.3)	0.2 (0.3)	0.3 (0.7)	0.3 (0.7)	0.3 (0.7)	0.5 (1.0)	0.5 (1.0)	0.5 (1.0)	0.6 (1.4)	0.6 (1.4)	0.6 (1.4)
Magnetic Track Mass	M_n	kg/m (lb/in)	5.2 (0.29)			5.2 (0.29)			5.2 (0.29)			5.2 (0.29)		
Cooling Flow Rate	Q	LPM (SCFM/GPM)	n/a (n/a)	113.0 (3.9)	4.0 (1.1)	n/a (n/a)	108.0 (3.7)	4.0 (1.1)	n/a (n/a)	102.0 (3.5)	4.0 (1.1)	n/a (n/a)	93.0 (3.0)	4.0 (1.1)
Cooling Supply Pressure	P	kPa (PSIG)	n/a (n/a)	207 (30)	179 (26)	n/a (n/a)	207 (30)	193 (28)	n/a (n/a)	207 (30)	207 (30)	n/a (n/a)	207 (30)	276 (40)

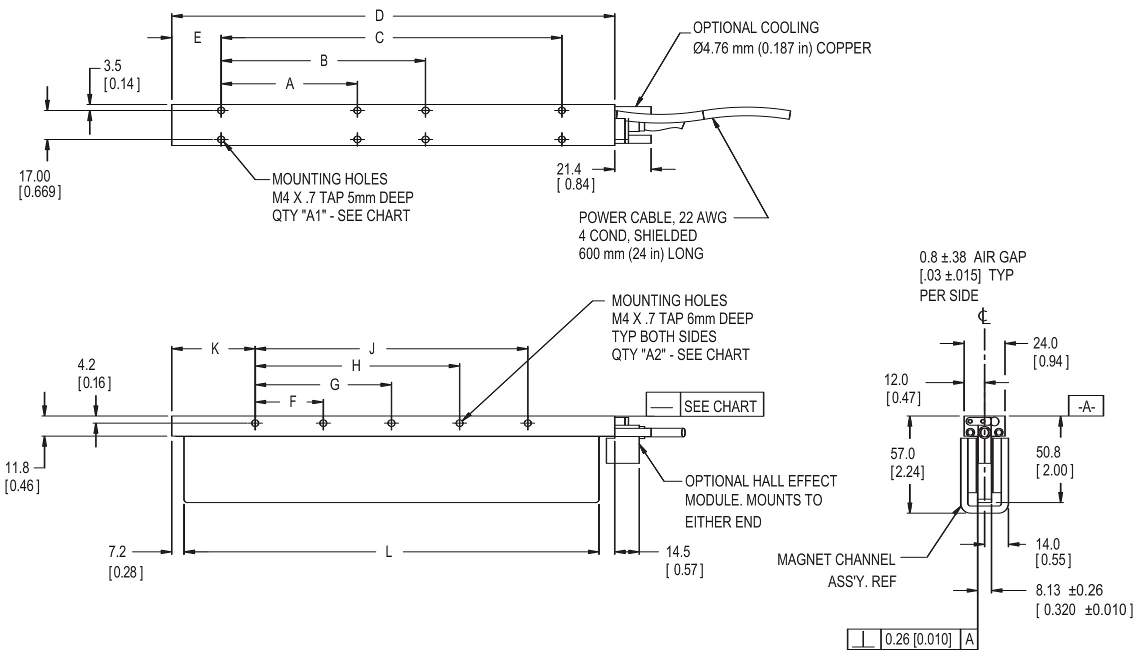
Notes: Motor performance specifications are with sinusoidal commutation.

1. Continuous forces, motor constant and currents listed are with coils at maximum temperature 125°C, mounted to a 254 x 254 x 25.4 mm (10" x 10" x 1") aluminum heat sink on top of coil, and at 25°C ambient.
2. Max on time 1 sec,. assuming correct rms Force and Current, consult Anorad.
3. All winding parameters listed are measured line-to-line (phase-to-phase).
4. All currents and voltages listed are measured 0-peak of the sine wave unless noted rms.
5. Continuous forces and currents are also based on coil moving with all phases sharing the same load in sinusoidal commutation.
6. For stand still conditions multiply continuous force and continuous current by 0.9.
7. Coil mountings on either of the two narrow sides reduces continuous force by 20%.
8. All specifications are ±10%.

LEM Brushless Linear Motor Diagram

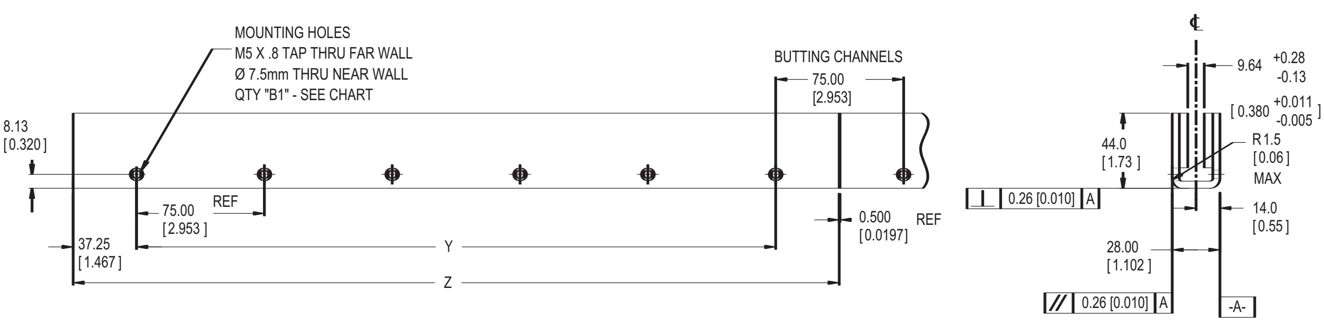
Dimensions mm [in]

Coil Assembly



Motor Coil Dimensions															
Coil Size	**Unit**	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**J**	**K**	**L**	**Straightness**	**A1**	**A2**
LEM-S-1	mm (in)	40.00 (1.575)			80.0 (3.15)	19.0 (.75)	20.00 (.787)				29.0 (1.14)	63.5 (2.5)	0.25 (.010)	4	4
LEM-S-2	mm (in)	80.00 (3.150)			140.0 (5.51)	29.0 (1.14)	40.00 (1.575)				49.0 (1.93)	123.5 (4.86)	0.25 (.010)	4	4
LEM-S-3	mm (in)	40.00 (1.575)	100.00 (3.937)	140.00 (5.512)	200.0 (7.87)	29.0 (1.14)	40.00 (1.575)	60.00 (2.362)	100.00 (3.937)		49.0 (1.93)	183.5 (7.22)	0.25 (.010)	8	8
LEM-S-4	mm (in)	80.00 (3.150)	120.00 (4.724)	200.00 (7.874)	260.0 (10.24)	29.0 (1.14)	40.00 (1.575)	80.00 (3.150)	120.00 (4.724)	160.00 (6.299)	49.0 (1.93)	243.5 (9.59)	0.50 (.020)	8	10

Magnet Channel



Magnet Channel Dimensions				
Length	**Unit**	**Y**	**Z**	**B1**
225*	mm (in)	150.00 (5.906)	224.50 (8.839)	3
300	mm (in)	225.00 (8.858)	299.50 (11.791)	4
375*	mm (in)	300.00 (11.811)	374.50 (14.744)	5
450	mm (in)	375.00 (14.764)	449.50 (17.697)	6

Magnet Channel Dimensions				
Length	**Unit**	**Y**	**Z**	**B1**
525*	mm (in)	450.00 (17.717)	524.50 (20.650)	7
600	mm (in)	525.00 (20.669)	599.50 (23.602)	8
675*	mm (in)	600.00 (23.622)	674.50 (26.555)	9
750	mm (in)	675.00 (26.575)	749.50 (29.508)	10

***** Magnet channels with an * can not be butted together since they have the same magnetic poles on each end. Additionally, magnet channels can only be butted from one side (contact factory).

LEA Brushless Linear Motor

Product Features

- Medium force, epoxy core
- Integrated cooling for high duty cycle
- No cogging, no magnetic attraction
- Mounting from all three sides
- Ideal for high precision/smooth motion

Specifications

Performance Parameters	Symbol	Units	LEA-S-2-S			LEA-S-4-S			LEA-S-6-S			LEA-S-8-SP		
Cooling Method			NC	AC	WC	NC	AC	WC	NC	AC	WC	NC	AC	WC
Continuous Force [1, 5, 6, 7]	F_{cTmax}	N (lb_f)	59 (13)	63 (14)	66 (15)	107 (24)	119 (27)	128 (29)	156 (35)	169 (38)	179 (40)	186 (42)	208 (47)	238 (53)
Peak Force [2]	F_p	N (lb_f)	187 (42)	187 (42)	187 (42)	338 (76)	338 (76)	338 (76)	489 (110)	489 (110)	489 (110)	589 (133)	589 (133)	589 (133)
Motor Constant [1]	K_M	$N/\sqrt{W}$ ($lb_f/\sqrt{W}$)	6.9 (1.5)	6.9 (1.5)	6.9 (1.5)	9.8 (2.2)	9.8 (2.2)	9.8 (2.2)	12.1 (2.7)	12.1 (2.7)	12.1 (2.7)	13.9 (3.1)	13.9 (3.1)	13.9 (3.1)
Thermal Resistance	R_{th}	°C/W	1.37	1.18	1.09	0.85	0.68	0.59	0.60	0.51	0.46	0.56	0.45	0.34
Max Power Dissipation	P_{cTmax}	W	73	85	92	117	146	169	166	196	219	179	223	292
Maximum Applied Bus Voltage	V_{DC}	Volts	325			325			325			325		
Electrical Cycle Length	E_c	mm	30			30			30			30		
Electrical Time Constant	τ_e	msec	0.5			0.5			0.5			0.5		
Maximum Coil Temperature	T_{max}	°C	125			125			125			125		
Force Constant [1, 8]	K_F	N/A_{pk} (lb_f/A_{pk})	16.0 (3.6)	16.0 (3.6)	16.0 (3.6)	32.3 (7.3)	32.3 (7.3)	32.3 (7.3)	48.7 (10.9)	48.7 (10.9)	48.7 (10.9)	32.3 (7.3)	32.3 (7.3)	32.3 (7.3)
Back EMF Constant p-p [3, 4, 8]	K_e	V_p/m/s (V_p/in/s)	18.9 (0.48)	18.9 (0.48)	18.9 (0.48)	38.2 (0.97)	38.2 (0.97)	38.2 (0.97)	57.5 (1.46)	57.5 (1.46)	57.5 (1.46)	38.2 (0.97)	38.2 (0.97)	38.2 (0.97)
Peak Current [1, 4]	I_p	A_{pk} (A_{rms})	11.6 (8.2)	11.6 (8.2)	11.6 (8.2)	10.4 (7.3)	10.4 (7.3)	10.4 (7.3)	10.0 (7.1)	10.0 (7.1)	10.0 (7.1)	18.1 (12.8)	18.1 (12.8)	18.1 (12.8)
Continuous Current [1, 4, 5, 6]	I_{cTmax}	A_{pk} (A_{rms})	3.7 (2.6)	4.0 (2.8)	4.1 (2.9)	3.3 (2.3)	3.7 (2.6)	4.0 (2.8)	3.2 (2.3)	3.5 (2.5)	3.7 (2.6)	5.8 (4.1)	6.4 (4.5)	7.4 (5.2)
Resistance p-p [3, 8] **@25°C**	R_{25}	ohm	5.2			10.4			15.6			5.2		
Inductance p-p [3]	L	mH	2.8			5.6			8.4			2.8		
Mechanical Parameters														
Magnetic Attraction	F_a	N (lb_f)	0 (0)			0 (0)			0 (0)			0 (0)		
Coil Mass [5]	M_c	kg (lb_m)	0.4 (0.9)	0.4 (0.9)	0.4 (0.9)	0.7 (1.5)	0.7 (1.5)	0.7 (1.5)	1.1 (2.4)	1.1 (2.4)	1.1 (2.4)	1.6 (3.5)	1.6 (3.5)	1.6 (3.5)
Magnetic Track Mass	M_n	kg/m (lb/in)	8.8 (0.49)			8.8 (0.49)			8.8 (0.49)			8.8 (0.49)		
Cooling Flow Rate	Q	LPM (SCFM/GPM)	n/a (n/a)	107.7 (3.7)	3.8 (1.0)	n/a (n/a)	93.1 (3.2)	3.8 (1.0)	n/a (n/a)	72.8 (2.5)	3.8 (1.0)	n/a (n/a)	66.9 (2.3)	3.8 (1.0)
Cooling Supply Pressure	P	kPa (PSIG)	n/a (n/a)	207 (30)	242 (35)	n/a (n/a)	207 (30)	276 (40)	n/a (n/a)	207 (30)	311 (45)	n/a (n/a)	207 (30)	345 (50)

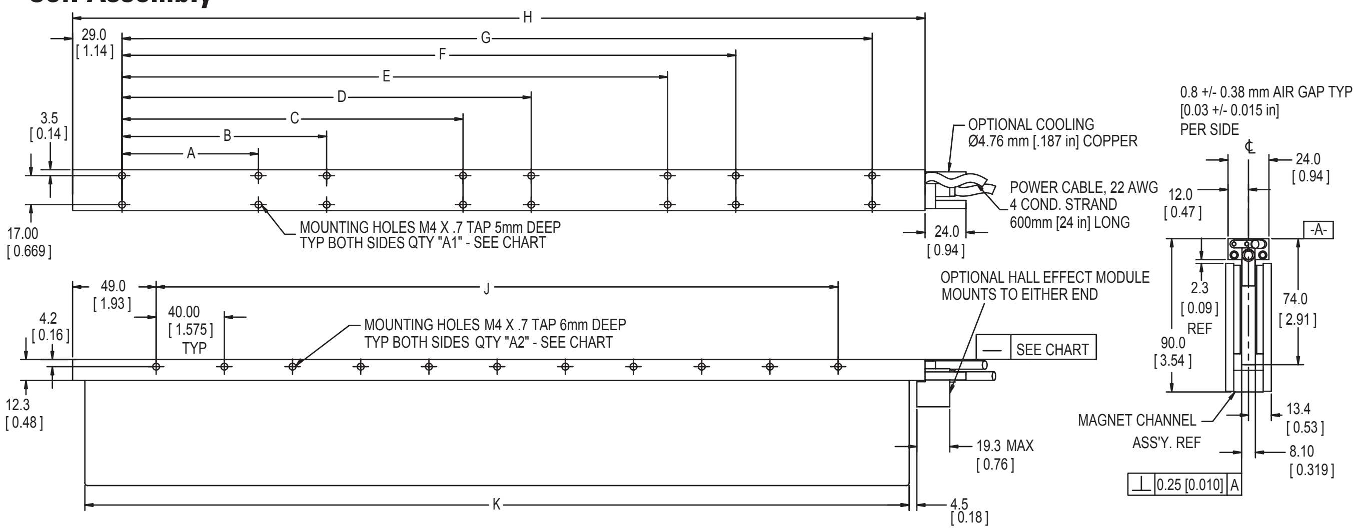
Notes: Motor performance specifications are with sinusoidal commutation.

1 Continuous forces, motor constant and currents listed are with coils at maximum temperature 125°C, mounted to a 254 x 254 x 25.4 mm (10" x 10" x 1") aluminum heat sink on top of coil, and at 25°C ambient.
2 Max on time 1 sec,. assuming correct rms Force and Current, consult Anorad.
3 All winding parameters listed are measured line-to-line (phase-to-phase).
4 All currents and voltages listed are measured 0-peak of the sine wave unless noted rms.
5 Continuous forces and currents are also based on coil moving with all phases sharing the same load in sinusoidal commutation.
6 For stand still conditions multiply continuous force and continuous current by 0.9.
7 Coil mountings on either of the two narrow sides reduces continuous force by 20%.
8 All specifications are ±10%.

LEA Brushless Linear Motor Diagram

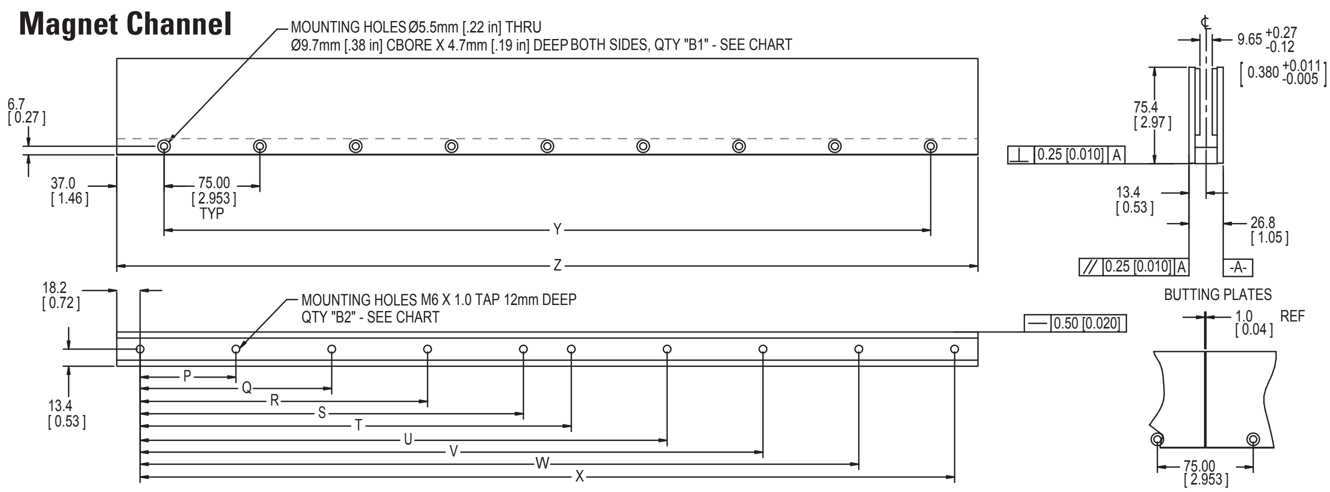
Dimensions mm [in]

Coil Assembly



Motor Coil Dimensions														
Coil Size	**Units**	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**J**	**K**	**Straightness**	**A1 Qty**	**A2 Qty**
LEA -2	mm (in)	80.00 (3.150)							140.0 (5.51)	40.00 (1.575)	123.5 (4.86)	0.25 (.010)	4	4
LEA -4	mm (in)	80.00 (3.150)	120.00 (4.724)	200.00 (7.874)					260.0 (10.24)	160.00 (6.299)	243.5 (9.59)	0.25 (.010)	8	10
LEA -6	mm (in)	80.00 (3.150)	120.00 (4.724)	200.00 (7.874)	240.00 (9.449)	320.00 (12.598)			380.0 (14.96)	280.00 (11.024)	363.5 (14.31)	0.50 (.020)	12	16
LEA -8	mm (in)	80.00 (3.150)	120.00 (4.724)	200.00 (7.874)	240.00 (9.449)	320.00 (12.598)	360.00 (14.173)	440.00 (17.323)	500.0 (19.8)	400.00 (15.748)	483.5 (19.01)	0.76 (19.030)	16	22

Magnet Channel



Magnet Channel Dimensions														
Length	**Units**	**P**	**Q**	**R**	**S**	**T**	**U**	**V**	**W**	**X**	**Y**	**Z**	**B1 Qty**	**B2 Qty**
225*	mm (in)	75.00 (2.953)	112.50 (4.429)	187.50 (7.382)							150.00 (5.906)	224.00 (8.819)	3	4
300	mm (in)	75.00 (2.953)	187.50 (7.382)	262.50 (10.335)							225.00 (8.858)	299.00 (11.772)	4	4
375*	mm (in)	75.00 (2.953)	150.00 (5.906)	187.50 (7.382)	262.50 (10.335)	337.50 (13.287)					300.00 (11.811)	374.00 (14.724)	5	6
450	mm (in))	75.00 (2.953)	150.00 (5.906)	262.50 (10.335)	337.50 (13.287)	412.50 (16.240)					375.00 (14.764)	449.00 (17.677)	6	6
525*	mm (in)	75.00 (2.953)	150.00 (5.906)	225.00 (8.858)	262.50 (10.335)	337.50 (13.287)	412.50 (16.240)	487.50 (19.193)			450.00 (17.717)	524.00 (20.630)	7	8
600	mm (in)	75.00 (2.953)	150.00 (5.906)	225.00 (8.858)	337.50 (13.287)	412.50 (16.240)	487.50 (19.193)	562.50 (22.146)			525.00 (20.669)	599.00 (23.583)	8	8
675*	mm (in)	75.00 (2.953)	150.00 (5.906)	225.00 (8.858)	300.00 (11.811)	337.50 (13.287)	412.50 (16.240)	487.50 (19.193)	562.50 (22.146)	637.50 (25.098)	600.00 (23.622)	674.00 (26.535)	9	10
750	mm (in)	75.00 (2.953)	150.00 (5.906)	225.00 (8.858)	300.00 (11.811)	412.50 (16.240)	487.50 (19.193)	562.50 (22.146)	637.50 (25.098)	712.50 (28.051)	675.00 (26.575)	749.00 (29.488)	10	10

***** Magnet channels with an * can not be butted together since they have the same magnetic poles on each end.
Additionally, magnet channels can only be butted from one side (contact factory).

LEB Brushless Linear Motor

Product Features

- High force, epoxy core
- Integrated cooling for high duty cycle
- No cogging, no magnetic attraction
- Mounting from all three sides
- Ideal for high precision/smooth motion

Specifications

Performance Parameters	Symbol	Units	LEB-S-2-S			LEB-S-4-S			LEB-S-6-S			LEB-S-8-SP		
Cooling Method			**NC**	**AC**	**WC**	**NC**	**AC**	**WC**	**NC**	**AC**	**WC**	**NC**	**AC**	**WC**
Continuous Force [1, 5, 6, 7]	F_{cTmax}	N (lb_f)	72 (16)	78 (17)	81 (18)	130 (29)	145 (33)	156 (35)	189 (42)	205 (46)	217 (49)	226 (51)	253 (57)	289 (65)
Peak Force [2]	F_p	N (lb_f)	227 (51)	227 (51)	227 (51)	410 (92)	410 (92)	410 (92)	596 (134)	596 (134)	596 (134)	716 (161)	716 (161)	716 (161)
Motor Constant [1]	K_M	$N/\sqrt{W}$ ($lb_f/\sqrt{W}$)	8.5 (1.9)	8.5 (1.9)	8.5 (1.9)	12.0 (2.7)	12.0 (2.7)	12.0 (2.7)	14.7 (3.3)	14.7 (3.3)	14.7 (3.3)	16.9 (3.8)	16.9 (3.8)	16.9 (3.8)
Thermal Resistance	R_{th}	°C/W	1.37	1.19	1.09	0.85	0.68	0.59	0.60	0.51	0.46	0.56	0.45	0.34
Max Power Dissipation	P_{cTmax}	W	73	84	92	117	146	169	166	196	219	179	223	292
Maximum Applied Bus Voltage	V_{DC}	Volts	325			325			325			325		
Electrical Cycle Length	E_c	mm	30			30			30			30		
Electrical Time Constant	τ_e	msec	0.5			0.5			0.5			0.5		
Maximum Coil Temperature	T_{max}	°C	125			125			125			125		
Force Constant [1, 8]	K_F	N/A_{pk} (lb_f/A_{pk})	19.7 (4.4)	19.7 (4.4)	19.7 (4.4)	39.3 (8.8)	39.3 (8.8)	39.3 (8.8)	59.0 (13.3)	59.0 (13.3)	59.0 (13.3)	39.3 (8.8)	39.3 (8.8)	39.3 (8.8)
Back EMF Constant p-p [3, 4, 8]	K_e	V_p/m/s (V_p/in/s)	23.2 (0.59)	23.2 (0.59)	23.2 (0.59)	46.5 (1.18)	46.5 (1.18)	46.5 (1.18)	69.7 (1.77)	69.7 (1.77)	69.7 (1.77)	46.5 (1.18)	46.5 (1.18)	46.5 (1.18)
Peak Current [1, 4]	I_p	A_{pk} (A_{rms})	11.6 (8.2)	11.6 (8.2)	11.6 (8.2)	10.5 (7.4)	10.5 (7.4)	10.5 (7.4)	10.1 (7.2)	10.1 (7.2)	10.1 (7.2)	18.3 (12.9)	18.3 (12.9)	18.3 (12.9)
Continuous Current [1, 4, 5, 6]	I_{cTmax}	A_{pk} (A_{rms})	3.7 (2.6)	3.9 (2.8)	4.1 (2.9)	3.3 (2.3)	3.7 (2.6)	4.0 (2.8)	3.2 (2.3)	3.5 (2.5)	3.7 (2.6)	5.8 (4.1)	6.4 (4.5)	7.4 (5.2)
Resistance p-p [3, 8] **@25°C**	R_{25}	ohm	5.2			10.4			15.6			5.2		
Inductance p-p [3]	L	mH	2.8			5.6			8.4			2.8		
Mechanical Parameters														
Magnetic Attraction	Fa	N (lb_f)	0 (0)			0 (0)			0 (0)			0 (0)		
Coil Mass [5]	Mc	kg (lb_m)	0.4 (0.9)	0.4 (0.9)	0.4 (0.9)	0.7 (1.5)	0.7 (1.5)	0.7 (1.5)	1.1 (2.4)	1.1 (2.4)	1.1 (2.4)	1.6 (3.5)	1.6 (3.5)	1.6 (3.5)
Magnetic Track Mass	Mn	kg/m (lb/in)	11.4 (0.64)			11.4 (0.64)			11.4 (0.64)			11.4 (0.64)		
Cooling Flow Rate	Q	LPM (SCFM/GPM)	n/a (n/a)	107.7 (3.7)	3.8 (1.0)	n/a (n/a)	93.1 (3.2)	3.8 (1.0)	n/a (n/a)	72.8 (2.5)	3.8 (1.0)	n/a (n/a)	66.9 (2.3)	3.8 (1.0)
Cooling Supply Pressure	P	kPa (PSIG)	n/a (n/a)	207 (30)	242 (35)	n/a (n/a)	207 (30)	276 (40)	n/a (n/a)	207 (30)	311 (45)	n/a (n/a)	207 (30)	345 (50)

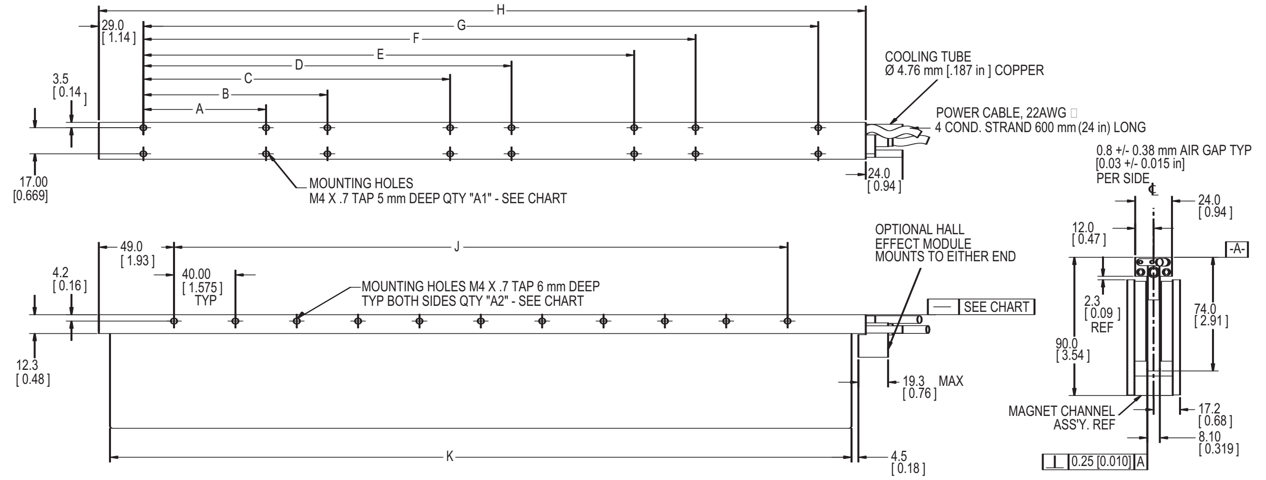
Notes: Motor performance specifications are with sinusoidal commutation.

1. Continuous forces, motor constant and currents listed are with coils at maximum temperature 125°C, mounted to a 254 x 254 x 25.4 mm (10" x 10" x 1") aluminum heat sink on top of coil, and at 25°C ambient.
2. Max on time 1 sec,. assuming correct rms Force and Current, consult Anorad.
3. All winding parameters listed are measured line-to-line (phase-to-phase).
4. All currents and voltages listed are measured 0-peak of the sine wave unless noted rms.
5. Continuous forces and currents are also based on coil moving with all phases sharing the same load in sinusoidal commutation.
6. For stand still conditions multiply continuous force and continuous current by 0.9.
7. Coil mountings on either of the two narrow sides reduces continuous force by 20%.
8. All specifications are ±10%.

LEB Brushless Linear Motor Diagram

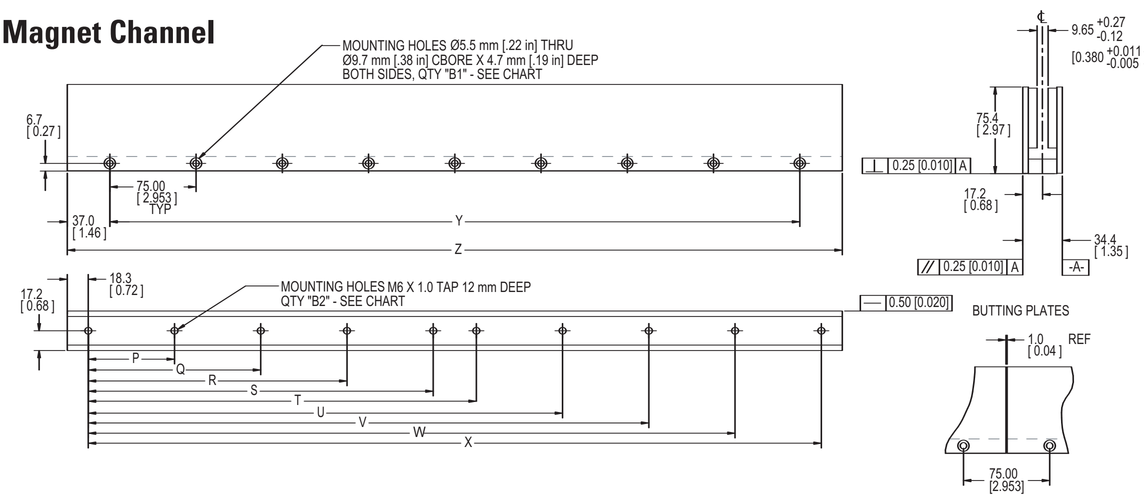
Dimensions mm [in]

Coil Assembly



Motor Coil Dimensions														
Coil Size	**Units**	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**J**	**K**	**Straightness**	**A1 Qty**	**A2 Qty**
LEB -2	mm (in)	80.00 (3.150)							140.0 (5.51)	40.00 (1.575)	123.5 (4.86)	0.25 (.010)	4	4
LEB -4	mm (in)	80.00 (3.150)	120.00 (4.724)	200.00 (7.874)					260.0 (10.24)	160.00 (6.299)	243.5 (9.59)	0.25 (.010)	8	10
LEB -6	mm (in)	80.00 (3.150)	120.00 (4.724)	200.00 (7.874)	240.00 (9.449)	320.00 (12.598)			380.0 (14.96)	280.00 (11.024)	363.5 (14.31)	0.50 (.020)	12	16
LEB -8	mm (in)	80.00 (3.150)	120.00 (4.724)	200.00 (7.874)	240.00 (9.449)	320.00 (12.598)	360.00 (14.173)	440.00 (17.323)	500.0 (19.68)	400.00 (15.748)	483.5 (19.04)	0.76 (.030)	16	22

Magnet Channel



Magnet Channel Dimensions														
Length	**Units**	**P**	**Q**	**R**	**S**	**T**	**U**	**V**	**W**	**X**	**Y**	**Z**	**B1 Qty**	**B2 Qty**
225*	mm (in)	75.00 (2.953)	112.50 (4.429)	187.50 (7.382)							150.00 (5.096)	224.00 (8.819)	3	4
300	mm (in)	75.00 (2.953)	187.50 (7.382)	262.50 (10.335)							225.00 (8.858)	299.00 (11.772)	4	4
375*	mm (in)	75.00 (2.953)	150.00 (5.906)	187.50 (7.382)	262.50 (10.335)	337.50 (13.287)					300.00 (11.811)	374.00 (14.724)	5	6
450	mm (in)	75.00 (2.953)	150.00 (5.906)	262.50 (10.335)	337.50 (13.287)	412.50 (16.240)					375.00 (14.764)	449.00 (17.677)	6	6
525*	mm (in)	75.00 (2.953)	150.00 (5.906)	225.00 (8.858)	262.50 (10.335)	337.50 (13.287)	412.50 (16.240)	487.50 (19.193)			450.00 (17.717)	524.00 (20.630)	7	8
600	mm (in)	75.00 (2.953)	150.00 (5.906)	225.00 (8.858)	337.50 (13.287)	412.50 (16.240)	487.50 (19.193)	562.50 (22.146)			525.00 (20.669)	599.00 (23.583)	8	8
675*	mm (in)	75.00 (2.953)	150.00 (5.906)	225.00 (8.858)	300.00 (11.811)	337.50 (13.287)	412.50 (16.240)	487.50 (19.193)	562.50 (22.146)	637.50 (25.098)	600.00 (23.622)	674.00 (26.535)	9	10
750	mm (in)	75.00 (2.953)	150.00 (5.906)	225.00 (8.858)	300.00 (11.811)	412.50 (16.240)	487.50 (19.193)	562.50 (22.146)	637.50 (25.098)	712.50 (28.051)	675.00 (26.575)	749.00 (29.488)	10	10

* Magnet channels with an * can not be butted together since they have the same magnetic poles on each end. Additionally, magnet channels can only be butted from one side (contact factory).

LEC Brushless Linear Motor

Product Features

- Highest force, heavy duty epoxy core
- Integrated cooling for high duty cycle
- No cogging, no magnetic attraction
- High precision/smooth motion
- Ideal for machine tool application

Specifications

Performance Parameters	Symbol	Units	LEC-S-1			LEC-S-2-P			LEC-S-3-P			LEC-S-4-P		
Cooling Method			NC	AC	WC	NC	AC	WC	NC	AC	WC	NC	AC	WC
Continuous Force [1, 5, 6, 7]	F_{cTmax}	N (lb_f)	158 (36)	178 (40)	208 (47)	317 (71)	347 (78)	416 (93)	465 (105)	525 (118)	624 (140)	624 (140)	693 (156)	832 (187)
Peak Force [2]	F_p	N (lb_f)	498 (112)	498 (112)	498 (112)	1001 (225)	1001 (225)	1001 (225)	1490 (335)	1490 (335)	1490 (335)	1979 (445)	1979 (445)	1979 (445)
Motor Constant [1]	K_M	$N/\sqrt{W}$ ($lb_f/\sqrt{W}$)	16.7 (3.7)	16.7 (3.7)	16.7 (3.7)	23.6 (5.3)	23.6 (5.3)	23.6 (5.3)	28.8 (6.5)	28.8 (6.5)	28.8 (6.5)	33.1 (7.4)	33.1 (7.4)	33.1 (7.4)
Thermal Resistance	R_{th}	°C/W	1.11	0.87	0.64	0.55	0.46	0.32	0.38	0.30	0.21	0.28	0.23	0.16
Max Power Dissipation	P_{cTmax}	W	90	114	156	181	216	312	262	333	470	355	438	630
Maximum Applied Bus Voltage	V_{DC}	Volts	325			325			325			325		
Electrical Cycle Length	E_c	mm	60			60			60			60		
Electrical Time Constant	τ_e	msec	2.3			2.3			2.3			2.3		
Maximum Coil Temperature	T_{max}	°C	125			125			125			125		
Force Constant [1, 8]	K_F	N/A_{pk} (lb_f/A_{pk})	70.0 (15.7)	70.0 (15.7)	70.0 (15.7)	70.0 (15.7)	70.0 (15.7)	70.0 (15.7)	70.0 (15.7)	70.0 (15.7)	70.0 (15.7)	70.0 (15.7)	70.0 (15.7)	70.0 (15.7)
Back EMF Constant p-p [3, 4, 8]	K_e	V_p/m/s (V_p/in/s)	82.7 (2.10)	82.7 (2.10)	82.7 (2.10)	82.7 (2.10)	82.7 (2.10)	82.7 (2.10)	82.7 (2.10)	82.7 (2.10)	82.7 (2.10)	82.7 (2.10)	82.7 (2.10)	82.7 (2.10)
Peak Current [1, 4]	I_p	A_{pk} (A_{rms})	7.1 (5.0)	7.1 (5.0)	7.1 (5.0)	14.2 (10.1)	14.2 (10.1)	14.2 (10.1)	21.2 (15.0)	21.2 (15.0)	21.2 (15.0)	28.2 (19.9)	28.2 (19.9)	28.2 (19.9)
Continuous Current [1, 4, 5, 6]	I_{cTmax}	A_{pk} (A_{rms})	2.3 (1.6)	2.5 (1.8)	3.0 (2.1)	4.5 (3.2)	4.9 (3.5)	5.9 (4.2)	6.6 (4.7)	7.5 (5.3)	8.9 (6.3)	8.9 (6.3)	9.9 (7.0)	11.9 (8.4)
Resistance p-p [3, 8] @25°C	R_{25}	ohm	17.0			8.5			5.7			4.3		
Inductance p-p [3]	L	mH	39.0			19.5			13.0			9.8		
Mechanical Parameters														
Magnetic Attraction	F_a	N (lb_f)	0 (0)			0 (0)			0 (0)			0 (0)		
Coil Mass [5]	M_c	kg (lb_m)	1.5 (3.2)	1.5 (3.2)	1.5 (3.2)	2.9 (6.4)	2.9 (6.4)	2.9 (6.4)	4.4 (9.6)	4.4 (9.6)	4.4 (9.6)	5.8 (12.8)	5.8 (12.8)	5.8 (12.8)
Magnetic Track Mass	M_n	kg/m (lb/in)	29.2 (1.64)			29.2 (1.64)			29.2 (1.64)			29.2 (1.64)		
Cooling Flow Rate	Q	LPM (SCFM/GPM)	n/a (n/a)	200.8 (6.9)	3.8 (1.0)	n/a (n/a)	192.1 (6.6)	3.8 (1.0)	n/a (n/a)	183.3 (6.3)	3.8 (1.0)	n/a (n/a)	174.6 (6.0)	3.8 (1.0)
Cooling Supply Pressure	P	kPa (PSIG)	n/a (n/a)	138 (20)	152 (22)	n/a (n/a)	138 (20)	166 (24)	n/a (n/a)	138 (20)	179 (26)	n/a (n/a)	138 (20)	193 (28)

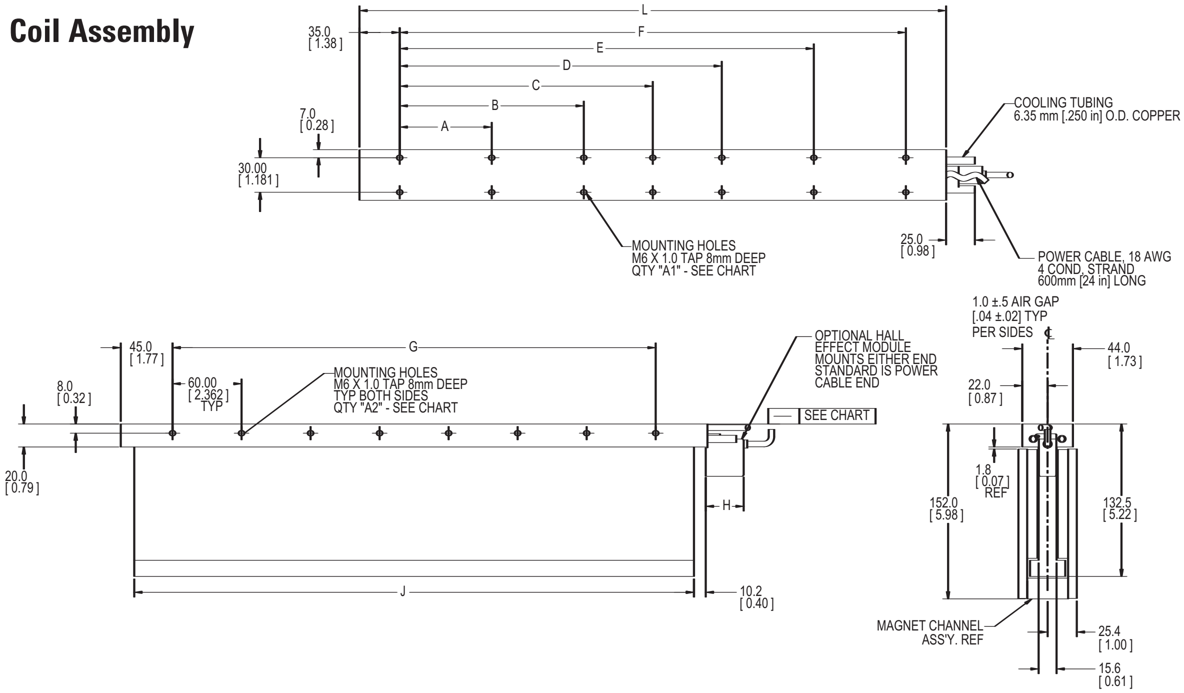
Notes: Motor performance specifications are with sinusoidal commutation.

1. Continuous forces, motor constant and currents listed are with coils at maximum temperature 125°C, mounted to a 254 x 254 x 25.4 mm (10” x 10” x 1”) aluminum heat sink on top of coil, and at 25°C ambient.
2. Max on time 1 sec,. assuming correct rms Force and Current, consult Anorad.
3. All winding parameters listed are measured line-to-line (phase-to-phase).
4. All currents and voltages listed are measured 0-peak of the sine wave unless noted rms.
5. Continuous forces and currents are also based on coil moving with all phases sharing the same load in sinusoidal commutation.
6. For stand still conditions multiply continuous force and continuous current by 0.9.
7. Coil mountings on either of the two narrow sides reduces continuous force by 20%.
8. All specifications are ±10%.

LEC Brushless Linear Motor Diagram

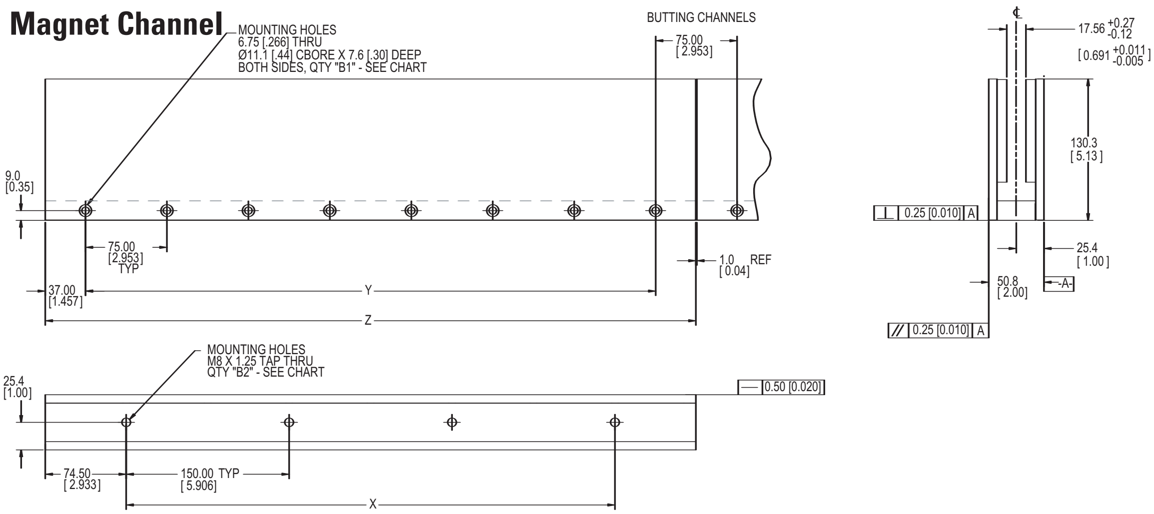
Dimensions mm [in]

Coil Assembly



Motor Coil Dimensions															
Coil Size	**Units**	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**J**	**L**	**Straightness**	**A1**	**A2**	**Hall**	
LEC -1	mm (in)	80.00 (3.150)						60.00 (2.362)	126.5 (4.98)	150.0 (5.91)	0.25 (.010)	4	4	23.5 (0.93)	34.5 (1.36)
LEC -2	mm (in)	60.00 (2.362)	140.00 (5.512)	200.00 (7.874)				180.00 (7.087)	246.63 (9.71)	270.0 (10.63)	0.25 (.010)	8	8	23.5 (0.93)	34.5 (1.36)
LEC -3	mm (in)	80.00 (3.150)	160.00 (6.299)	240.00 (9.449)	320.00 (12.598)			300.00 (11.811)	366.52 (14.43)	390.0 (15.35)	0.50 (.020)	10	12	23.5 (0.93)	34.5 (1.36)
LEC -4	mm (in)	80.00 (3.150)	160.00 (6.299)	220.00 (8.661)	280.00 (11.024)	360.00 (14.173)	440.00 (17.323)	420.00 (16.535)	486.66 (19.16)	510.0 (20.08)	0.76 (.030)	14	16	23.5 (0.93)	34.5 (1.36)

Magnet Channel

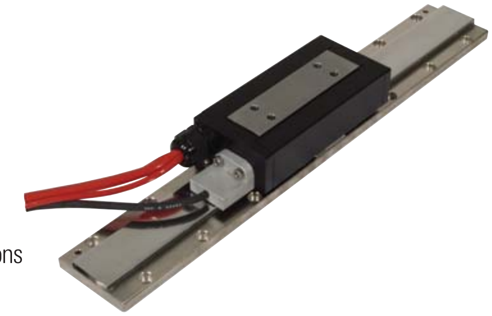


Magnet Channel Dimensions						
Length	**Units**	**X**	**Y**	**Z**	**B1**	**B2**
300	mm (in)	150.00 (5.906)	225.00 (8.858)	299.00 (11.772)	4	2
450	mm (in)	300.00 (11.811)	375.00 (14.764)	449.00 (17.677)	6	3
600	mm (in)	450.00 (17.717)	525.00 (20.669)	599.00 (23.583)	8	4
750	mm (in)	600.00 (23.622)	675.00 (26.575)	749.00 (29.488)	10	5

LC-30 Linear Motor

Product Features

- Low force, steel core design
- Sinusoidal flux density and low-cog design
- Internal thermal sensor
- IP 65 rated
- Optional UL rating
- Ideal for general automation applications



Specifications

Performance Parameters	Symbol	Units	LC-30-100			LC-30-200			LC-30-300			LC-30-400			LC-30-600			LC-30-800		
Cooling Method			NC	AC	WC	NC	AC	WC	NC	AC	WC	NC	AC	WC	NC	AC	WC	NC	AC	WC
Continuous Force [1]	F_{cTmax}	N (lb$_f$)	86 (19)	108 (24)	129 (29)	172 (39)	216 (48)	259 (58)	259 (58)	323 (73)	388 (87)	345 (78)	431 (97)	517 (116)	517 (116)	647 (145)	776 (174)	690 (155)	862 (194)	1035 (233)
Peak Force [2]	F_p	N (lb$_f$)	198 (44)	198 (44)	198 (44)	395 (89)	395 (89)	395 (89)	593 (133)	593 (133)	593 (133)	790 (178)	790 (178)	790 (178)	1185 (266)	1185 (266)	1185 (266)	1580 (355)	1580 (355)	1580 (355)
Motor Constant [1]	K_M	N/√W (lb$_f$/√W)	11.7 (2.6)	11.7 (2.6)	11.7 (2.6)	16.5 (3.7)	16.5 (3.7)	16.5 (3.7)	20.3 (4.6)	20.3 (4.6)	20.3 (4.6)	23.4 (5.3)	23.4 (5.3)	23.4 (5.3)	28.6 (6.4)	28.6 (6.4)	28.6 (6.4)	33.1 (7.4)	33.1 (7.4)	33.1 (7.4)
Thermal Resistance	R_{th}	°C/W	2.02	1.29	0.90	1.01	0.65	0.45	0.67	0.43	0.30	0.51	0.32	0.22	0.34	0.22	0.15	0.25	0.16	0.11
Max Power Dissipation	P_{cTmax}	W	54	85	122	109	170	245	163	255	367	218	340	490	326	510	734	435	680	979
Maximum Applied Bus Voltage	V_{DC}	Volts	650			650			650			650			650			650		
Electrical Cycle Length	E_c	mm	50			50			50			50			50			50		
Electrical Time Constant	τ_e	msec	10			10			10			10			10			10		
Maximum Coil Temperature	T_{max}	°C	130			130			130			130			130			130		

Performance Parameters	Symbol	Units	LC-30-100		LC-30-200		LC-30-300		LC-30-400		LC-30-600		LC-30-800	
Winding Type			D	E	D	E	D	E	D	E	D	E	D	E
Force Constant [1, 6]	K_F	N/A$_{pk}$ (lb$_f$/A$_{pk}$)	18.2 (4.1)	N/A	18.2 (4.1)	36.4 (8.2)	18.2 (4.1)	54.6 (12.3)	18.2 (4.1)	36.4 (8.2)	18.2 (4.1)	36.4 (8.2)	18.2 (4.1)	36.4 (8.2)
Back EMF Constant p-p [3, 4, 6]	K_e	V$_p$/m/s (V$_p$/in/s)	21.5 (0.55)	N/A	21.5 (0.55)	43.0 (1.09)	21.5 (0.55)	64.5 (1.64)	21.5 (0.55)	43.0 (1.09)	21.5 (0.55)	43.0 (1.09)	21.5 (0.55)	43.0 (1.09)
Peak Current [4]	I_p	A$_{pk}$ (A$_{rms}$)	12.8 (9.0)	N/A	25.5 (18.1)	12.8 (9.0)	38.3 (27.1)	12.8 (9.0)	51.1 (36.1)	25.5 (18.1)	76.6 (54.2)	38.3 (27.1)	102.1 (72.2)	51.1 (36.1)
Resistance p-p [3, 6] **@20°C**	R_{20}	ohm	2.256	N/A	1.128	4.51	0.75	6.77	0.56	2.26	0.38	1.50	0.28	1.13
Inductance p-p [3]	L	mH	21.6	N/A	10.8	43.0	7.20	65.0	5.0	22.0	4	14	3	11

			LC-30-100 D			LC-30-100 E			LC-30-200 D			LC-30-200 E			LC-30-300 D			LC-30-300 E		
Cooling Type			NC	AC	WC	NC	AC	WC	NC	AC	WC	NC	AC	WC	NC	AC	WC	NC	AC	WC
Continuous Current [1, 4]	I_{cTmax}	A$_{pk}$ (A$_{rms}$)	4.7 (3.35)	5.9 (4.2)	7.1 (5.0)	N/A	N/A	N/A	9.5 (6.7)	11.8 (8.4)	14.2 (10.1)	4.7 (3.4)	5.9 (4.2)	7.1 (5.0)	14.2 (10.1)	17.8 (12.6)	21.3 (15.1)	4.7 (3.4)	5.9 (4.2)	7.1 (5.0)

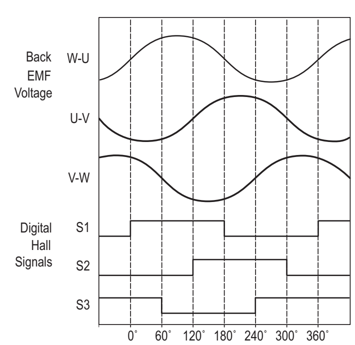
			LC-30-400 D			LC-30-400 E			LC-30-600 D			LC-30-600 E			LC-30-800 D			LC-30-800 E		
Cooling Type			NC	AC	WC	NC	AC	WC	NC	AC	WC	NC	NC	WC	NC	AC	WC	NC	AC	WC
Continuous Current [1, 4]	I_{cTmax}	A$_{pk}$ (A$_{rms}$)	19.0 (13.4)	23.7 (16.8)	28.4 (20.1)	9.5 (6.7)	11.8 (8.4)	14.2 (10.1)	28.4 (20.1)	35.5 (25.5)	42.6 (30.2)	14.2 (10.1)	17.8 (12.6)	21.3 (15.1)	37.9 (26.8)	47.4 (33.5)	56.9 (40.2)	19.0 (13.4)	23.7 (16.8)	28.4 (20.1)

Mechanical Parameters	Symbol	Units	LC-30-100			LC-30-200			LC-30-300			LC-30-400			LC-30-600			LC-30-800		
Magnetic Attraction	F_a	N (lb$_f$)	393 (88)			786 (177)			1179 (265)			1572 (353)			2358 (530)			3144 (707)		
Coil Mass	M_c	kg (lb$_m$)	1.25 (2.8)	1.40 (3.1)	1.40 (3.1)	2.22 (4.9)	2.46 (5.4)	2.46 (5.4)	3.20 (7.0)	3.54 (7.8)	3.54 (7.8)	4.17 (9.2)	4.62 (10.2)	4.62 (10.2)	6.03 (13.3)	6.66 (14.7)	6.66 (14.7)	7.94 (17.5)	8.80 (19.4)	8.80 (19.4)
Magnetic Track Mass	M_n	kg/m (lb/in)	4.712 (0.26)			4.712 (0.26)			4.712 (0.26)			4.712 (0.26)			4.712 (0.26)			4.712 (0.26)		

Notes: Motor performance specifications are with sinusoidal commutation.

1. Continuous forces, motor constant and current listed are with coils at maximum temperature 130°C, mounted to a 1" aluminum heat sink whose area equals 3x the coil mounting area, and at 20°C ambient.
2. Max on time 1 sec. In certain applications, the motor may produce significantly higher peak forces. Please contact Anorad Applications Engineering for details.
3. All winding parameters listed are measured line-to-line (phase-to-phase).
4. All currents and voltages listed are measured 0-peak of the sine wave unless noted rms.
5. AC and WC include mass of cooling plate. Consult Anorad for Flow and Pressure for air cooled and water cooled version.
6. All specifications are ±10%.

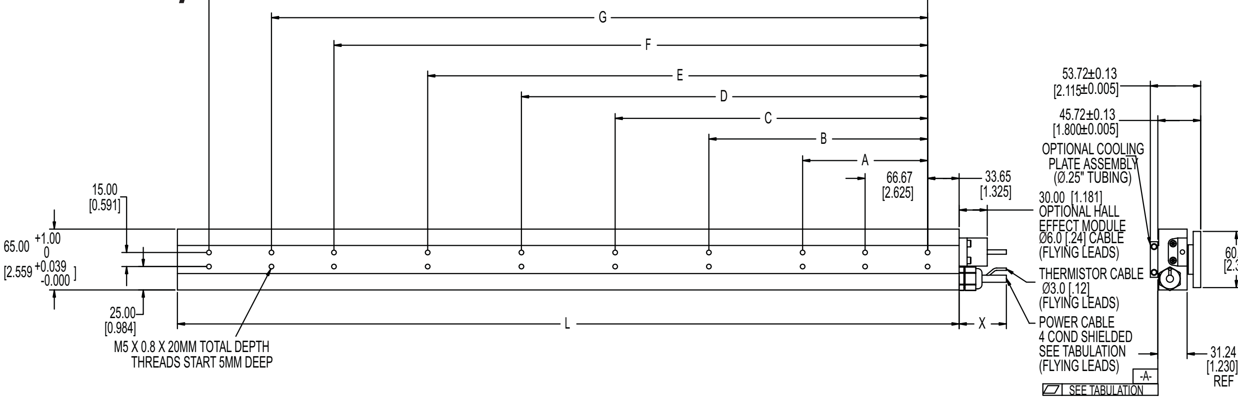
Motor Phasing Diagram



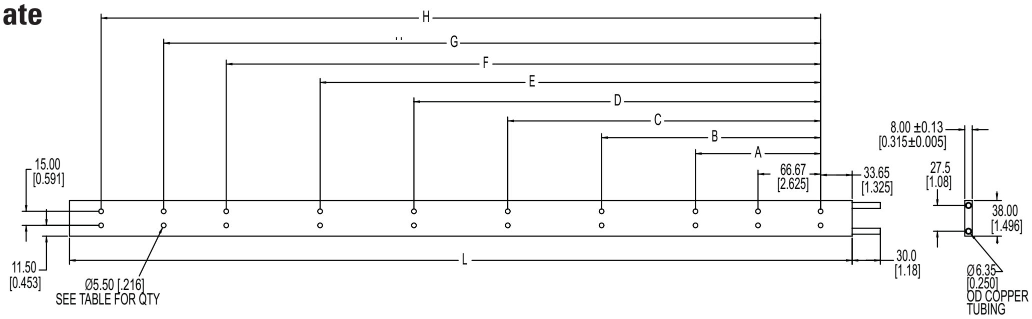
LC-30 Linear Motor Diagram

Dimensions mm [in]

Coil Assembly



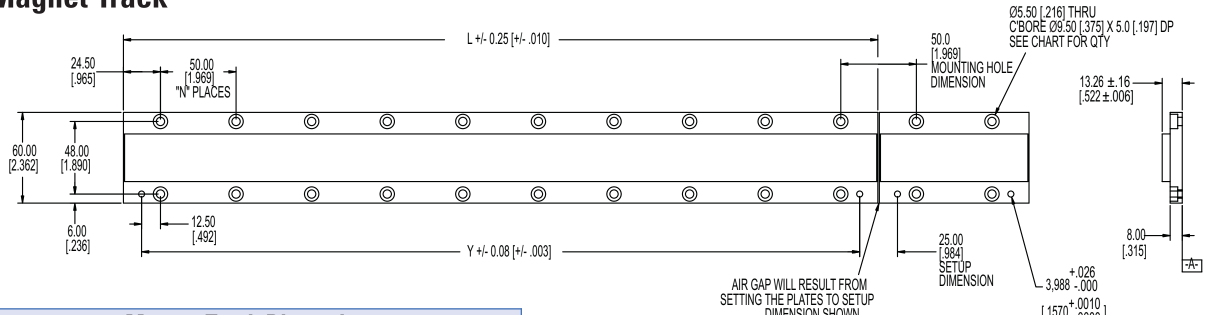
Cooling Plate



Coil and Cooling Plate Dimensions											
Coil Size	L	A	B	C	D	E	F	G	H	Hole Qty (N)	Flatness -A-
30 x 100	134.0 (5.28)									4	0.25 (0.010)
30 x 200	234.0 (9.21)	100.0 (3.937)	166.67 (6.562)							8	0.25 (0.010)
30 x 300	334.0 (13.15)	133.33 (5.249)	200 (7.874)	266.67 (10.499)						10	0.38 (0.015)
30 x 400	434.0 (17.09)	133.33 (5.249)	233.33 (9.186)	300.0 (11.811)	366.67 (14.436)					12	0.64 (0.025)
30 x 600	634.0 (24.96)	133.33 (5.249	233.33 (9.186)	333.33 (13.123)	433.33 (17.060)	500.00 (19.686)	566.66 (22.310)			16	0.89 (0.035)
30 x 800	834.0 (32.84)	133.33 (5.249)	233.33 (9.186)	333.33 (13.123)	433.33 (17.060)	533.33 (20.997)	633.33 (24.934)	700.00 (27.559)	766.66 (30.184)	20	1.16 (0.045)

Power Cable Gauge		
Coil Size	Winding Type	Wire Gauge
30 x 100	D	18 GA
30 x 200	D	18 GA
30 x 200	E	18 GA
30 x 300	D	18 GA
30 x 300	E	18 GA
30 x 400	D	18 GA
30 x 400	E	18 GA
30 x 600	D	16 GA
30 x 600	E	18 GA
30 x 800	D	14 GA
30 x 800	E	18 GA

Magnet Track

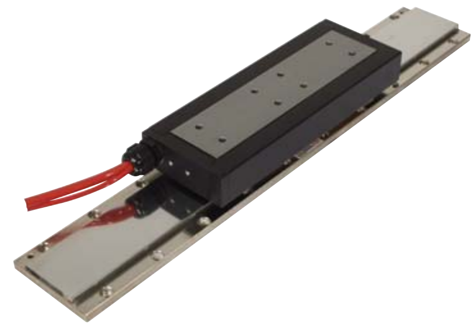


Magnet Track Dimensions					
Magnet Track Length	L	Y	Hole Qty	N	Flatness -A- TIR
100 mm	99.0 (3.90)	75.00 (2.953)	4	1	0.06 (.002)
250 mm	249.0 (9.80)	225.00 (8.853)	10	4	0.25 (.010)
400 mm	399.0 (15.71)	375.00 (14.764)	16	7	0.38 (.015)
500 mm	499.0 (19.65)	475.00 (18.750)	20	9	0.50 (.020)

LC-50 Linear Motor

Product Features

- Medium force, steel core design
- Sinusoidal flux density and low-cog design
- Internal thermal sensor
- IP 65 rated
- Optional UL rating



Specifications

	Symbol	Units	LC-50-100			LC-50-200			LC-50-300			LC-50-400			LC-50-600			LC-50-800		
Cooling Method			NC	AC	WC	NC	AC	WC	NC	AC	WC	NC	AC	WC	NC	AC	WC	NC	AC	WC
Continuous Force [1]	F_{cTmax}	N (lb_f)	139 (31)	174 (39)	208 (47)	279 (63)	348 (78)	418 (94)	422 (95)	528 (119)	633 (142)	536 (120)	670 (151)	804 (181)	821 (185)	1026 (231)	1231 (277)	1075 (242)	1343 (302)	1612 (362)
Peak Force [2]	F_p	N (lb_f)	318 (72)	318 (72)	318 (72)	632 (142)	632 (142)	632 (142)	990 (223)	990 (223)	990 (223)	1270 (285)	1270 (285)	1270 (285)	1946 (437)	1946 (437)	1946 (437)	2547 (573)	2547 (573)	2547 (573)
Motor Constant [1]	K_M	$N/\sqrt{W}$ ($lb_f/\sqrt{W}$)	15.1 (3.4)	15.1 (3.4)	15.1 (3.4)	21.3 (4.8)	21.3 (4.8)	21.3 (4.8)	26.5 (6.0)	26.5 (6.0)	26.5 (6.0)	30.7 (6.9)	30.7 (6.9)	30.7 (6.9)	37.5 (8.4)	37.5 (8.4)	37.5 (8.4)	43.3 (9.7)	43.3 (9.7)	43.3 (9.7)
Thermal Resistance	R_{th}	°C/W	1.30	0.83	0.58	0.64	0.41	0.29	0.43	0.28	0.19	0.36	0.23	0.16	0.23	0.15	0.10	0.18	0.11	0.08
Max Power Dissipation	P_{cTmax}	W	85	132	190	171	266	384	253	395	569	306	477	688	478	747	1076	615	960	1383
Maximum Applied Bus Voltage	V_{DC}	Volts	650			650			650			650			650			650		
Electrical Cycle Length	E_c	mm	50			50			50			50			50			50		
Electrical Time Constant	τ_e	msec	10			10			10			10			10			10		
Maximum Coil Temperature	T_{max}	°C	130			130			130			130			130			130		

	Symbol	Units	LC-50-100		LC-50-200		LC-50-300		LC-50-400		LC-50-600		LC-50-800	
Winding Type			D	E	D	E	D	E	D	E	D	E	D	E
Force Constant [1, 6]	K_F	N/A_{pk} (lb_f/A_{pk})	30.3 (6.8)	N/A	30.3 (6.8)	60.7 (13.6)	30.8 (6.9)	92.4 (20.8)	30.8 (6.9)	61.6 (13.8)	30.8 (6.9)	61.6 (13.8)	30.8 (6.9)	61.6 (13.8)
Back EMF Constant p-p [3, 4, 6]	K_e	V_p/m/s (V_p/in/s)	35.8 (0.91)	N/A	35.8 (0.91)	71.7 (1.82)	36.4 (0.92)	109.1 (2.77)	36.4 (0.92)	72.8 (1.85)	36.4 (0.92)	72.8 (1.85)	36.4 (0.92)	72.8 (1.85)
Peak Current [4]	I_p	A_{pk} (A_{rms})	12.3 (8.7)	N/A	24.5 (17.3)	12.2 (8.7)	37.8 (26.7)	12.6 (8.9)	48.5 (34.3)	24.2 (17.1)	74.3 (52.5)	37.2 (26.3)	97.3 (68.8)	48.6 (34.4)

	Symbol	Units	LC-50-100 D			LC-50-100 E			LC-50-200 D			LC-50-200 E			LC-50-300 D			LC-50-300 E		
Cooling Type			NC	AC	WC	NC	AC	WC	NC	AC	WC	NC	AC	WC	NC	AC	WC	NC	AC	WC
Continuous Current [1, 4]	I_{cTmax}	A_{pk} (A_{rms})	4.6 (3.2)	5.7 (4.0)	6.9 (4.9)	N/A	N/A	N/A	9.2 (6.5)	11.5 (8.1)	13.8 (9.7)	4.6 (3.2)	5.7 (4.1)	6.9 (4.9)	13.7 (9.7)	17.1 (12.1)	20.6 (14.5)	4.6 (3.2)	5.7 (4.0)	6.9 (4.8)

	Symbol	Units	LC-50-400 D			LC-50-400 E			LC-50-600 D			LC-50-600 E			LC-50-800 D			LC-50-800 E		
Cooling Type			NC	AC	WC	NC	AC	WC	NC	AC	WC	NC	AC	WC	NC	AC	WC	NC	AC	WC
Continuous Current [1, 4]	I_{cTmax}	A_{pk} (A_{rms})	17.4 (12.3)	21.7 (15.4)	26.1 (18.5)	8.7 (6.2)	10.9 (7.7)	13.0 (9.2)	26.7 (18.8)	33.3 (23.6)	40.0 (28.3)	13.3 (9.4)	16.7 (11.8)	20.0 (14.1)	34.9 (24.7)	43.6 (30.8)	52.3 (37.0)	17.4 (12.3)	21.8 (15.4)	26.2 (18.5)

	Symbol	Units	LC-50-100 D	LC-50-100 E	LC-50-200 D	LC-50-200 E	LC-50-300 D	LC-50-300 E	LC-50-400 D	LC-50-400 E	LC-50-600 D	LC-50-600 E	LC-50-800 D	LC-50-800 E
Resistance p-p [3, 6] **@20°C**	R_{20}	ohm	3.76	N/A	1.88	7.52	1.25	11.28	0.94	3.76	0.63	2.51	0.47	1.88
Inductance p-p [3]	L	mH	36	N/A	18	72	12	108	9	36	6	24	4.5	18

Mechanical Parameters	Symbol	Units	LC-50-100			LC-50-200			LC-50-300			LC-50-400			LC-50-600			LC-50-800		
Magnetic Attraction	F_a	N (lb_f)	690 (155)			1379 (310)			2069 (465)			2758 (620)			4137 (930)			5516 (1240)		
Coil Mass [5]	M_c	kg (lb_m)	1.79 (4.0)	1.97 (4.4)	1.97 (4.4)	3.13 (6.9)	3.45 (7.6)	3.45 (7.6)	4.47 (9.8)	4.92 (10.8)	4.92 (10.8)	5.80 (12.8)	6.39 (14.1)	6.39 (14.1)	8.48 (18.7)	9.34 (20.6)	9.34 (20.6)	11.15 (24.6)	12.29 (27.1)	12.29 (27.1)
Magnetic Track Mass	M_n	kg/m (lb/in)	6.62 (0.37)			6.62 (0.37)			6.62 (0.37)			6.62 (0.37)			6.62 (0.37)			6.62 (0.37)		

Notes: Motor performance specifications are with sinusoidal commutation.

1 Continuous forces, motor constant and current listed are with coils at maximum temperature 130°C, mounted to a 1" aluminum heat sink whose area equals 3x the coil mounting area, and at 20°C ambient.

2 Max on time 1 sec. In certain applications, the motor may produce significantly higher peak forces. Please contact Anorad Applications Engineering for details.

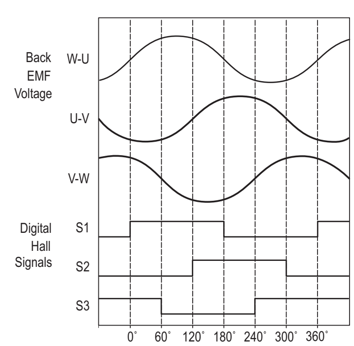
3 All winding parameters listed are measured line-to-line (phase-to-phase).

4 All currents and voltages listed are measured 0-peak of the sine wave unless noted rms.

5 AC and WC include mass of cooling plate. Consult Anorad for Flow and Pressure for air cooled and water cooled version.

6 All specifications are ±10%.

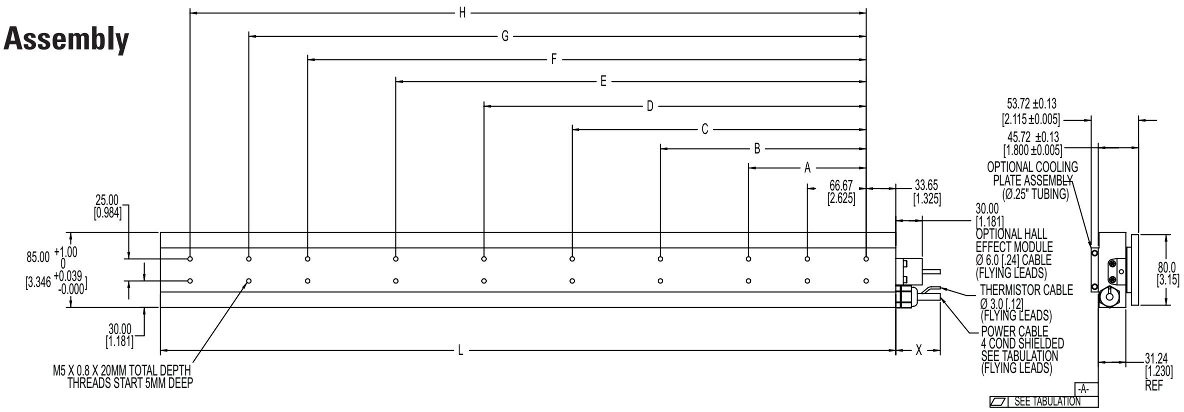
Motor Phasing Diagram



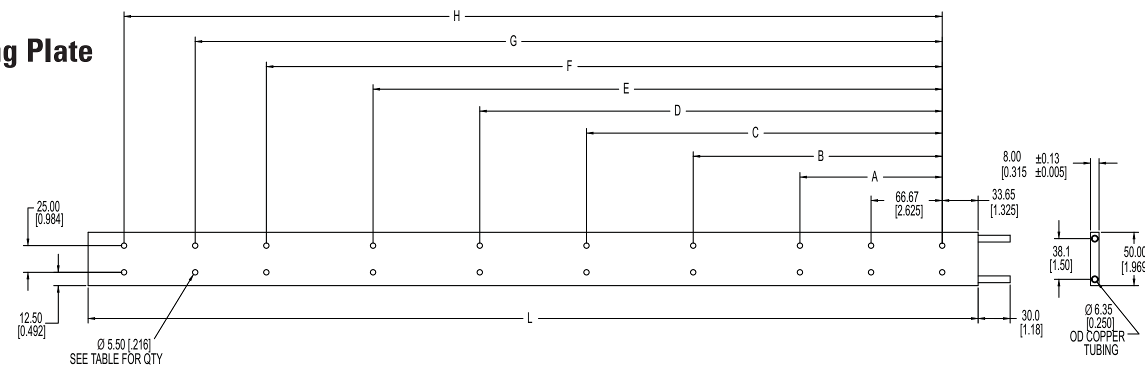
LC-50 Linear Motor Diagram

Dimensions mm [in]

Coil Assembly



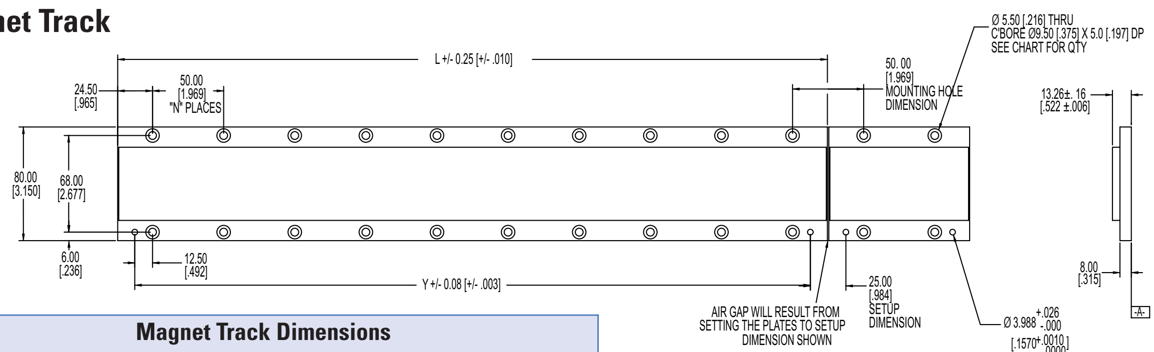
Cooling Plate



Coil and Cooling Plate Dimensions											
Coil Size	L	A	B	C	D	E	F	G	H	Hole Qty (N)	Flatness -A-
50 x 100	134.0 (5.28)									4	0.25 (0.010)
50 x 200	234.0 (9.21)	100.0 (3.937)	166.67 (6.562)							8	0.25 (0.010)
50 x 300	334.0 (13.15)	133.33 (5.249)	200 (7.874)	266.67 (10.499)						10	0.38 (0.015)
50 x 400	434.0 (17.09)	133.33 (5.249)	233.33 (9.186)	300.0 (11.811)	366.67 (14.436)					12	0.64 (0.025)
50 x 600	634.0 (24.96)	133.33 (5.249)	233.33 (9.186)	333.33 (13.123)	433.33 (17.060)	500.00 (19.686)	566.66 (22.310)			16	0.89 (0.035)
50 x 800	834.0 (32.84)	133.33 (5.249)	233.33 (9.186)	333.33 (13.123)	433.33 (17.060)	533.33 (20.997)	633.33 (24.934)	700.00 (27.559)	766.66 (30.184)	20	1.16 (0.045)

Power Cable Gauge		
Coil Size	Winding Type	Wire Gauge
50 x 100	D	18 GA
50 x 200	D	18 GA
50 x 200	E	18 GA
50 x 300	D	18 GA
50 x 300	E	18 GA
50 x 400	D	18 GA
50 x 400	E	18 GA
50 x 600	D	16 GA
50 x 600	E	18 GA
50 x 800	D	14 GA
50 x 800	E	18 GA

Magnet Track



Magnet Track Dimensions					
Magnet Track Length	L	Y	Hole Qty	N	Flatness -A- TIR
100 mm	99.0 (3.90)	75.00 (2.953)	4	1	0.06 (.002)
250 mm	249.0 (9.80)	225.00 (8.853)	10	4	0.25 (.010)
400 mm	399.0 (15.71)	375.00 (14.764)	16	7	0.38 (.015)
500 mm	499.0 (19.65)	475.00 (18.750)	20	9	0.50 (.020)

LC-100 Linear Motor

Product Features

- High force, steel core design
- Sinusoidal flux density and low-cog design
- Internal thermal sensor
- IP 65 rated
- Optional UL rating
- Ideal for heavy-duty applications

Specifications

Performance Parameters	Symbol	Units	LC-100-100			LC-100-200			LC-100-300			LC-100-400			LC-100-600			LC-100-800		
Cooling Method			NC	AC	WC	NC	AC	WC	NC	AC	WC	NC	AC	WC	NC	AC	WC	NC	AC	WC
Continuous Force [1]	F_{cTmax}	N (lb_f)	262 (59)	328 (74)	394 (89)	523 (118)	654 (147)	785 (176)	785 (176)	981 (221)	1177 (265)	1046 (235)	1308 (294)	1570 (353)	1570 (353)	1962 (441)	2354 (529)	2093 (470)	2616 (588)	3139 (706)
Peak Force [2]	F_p	N (lb_f)	622 (140)	622 (140)	622 (140)	1240 (279)	1240 (279)	1240 (279)	1860 (418)	1860 (418)	1860 (418)	2480 (558)	2480 (558)	2480 (558)	3720 (836)	3720 (836)	3720 (836)	4960 (1115)	4960 (1115)	4960 (1115)
Motor Constant [1]	K_M	N/√W (lb_f/√W)	23.7 (5.3)	23.7 (5.3)	23.7 (5.3)	33.5 (7.5)	33.5 (7.5)	33.5 (7.5)	41.0 (9.2)	41.0 (9.26)	41.0 (9.2)	47.3 (10.6)	47.3 (10.6)	47.3 (10.6)	58.0 (13.0)	58.0 (13.0)	58.0 (13.0)	66.9 (15.0)	66.9 (15.0)	66.9 (15.0)
Thermal Resistance	R_{th}	°C/W	0.89	0.57	0.40	0.45	0.29	0.20	0.30	0.19	0.13	0.23	0.14	0.10	0.15	0.10	0.07	0.11	0.072	0.050
Max Power Dissipation	P_{cTmax}	W	123	192	277	244	382	550	367	573	825	489	764	1100	733	1146	1650	978	1528	2200
Maximum Applied Bus Voltage	V_{DC}	Volts	650			650			650			650			650			650		
Electrical Cycle Length	E_c	mm	50			50			50			50			50			50		
Electrical Time Constant	τ_e	msec	10			10			10			10			10			10		
Maximum Coil Temperature	T_{max}	°C	130			130			130			130			130			130		

Performance Parameters	Symbol	Units	LC-100-100		LC-100-200		LC-100-300		LC-100-400		LC-100-600		LC-100-800	
Winding Type			D	E	D	E	D	E	D	E	D	E	D	E
Force Constant [1,6]	K_F	N/A_{pk} (lb_f/A_{pk})	60.7 (13.6)	N/A	60.7 (13.6)	121.3 (27.3)	60.7 (13.6)	182.0 (40.9)	60.7 (13.6)	121.3 (27.3)	60.7 (13.6)	121.3 (27.3)	60.7 (13.6)	121.3 (27.3)
Back EMF Constant p-p [3,4,6]	K_e	V_p/m/s (V_p/in/s)	71.7 (1.82)	N/A	71.7 (1.82)	143.3 (3.64)	71.7 (1.82)	215.0 (5.46)	71.7 (1.82)	143.3 (3.64)	71.7 (1.82)	143.3 (3.64)	71.7 (1.82)	143.3 (3.64)
Peak Current [4]	I_p	A_{pk} (A_{rms})	12.1 (8.5)	N/A	24.0 (17.0)	12.0 (8.5)	36.0 (25.5)	12.0 (8.5)	48.1 (34.0)	24.0 (17.0)	72.1 (51.0)	36.1 (25.2)	96.2 (68.0)	48.1 (34.0)
Resistance p-p [3,6] @20°C	R_{20}	ohm	6.12	N/A	3.06	12.24	2.04	18.36	1.53	6.12	1.02	4.08	0.77	3.06
Inductance p-p [3]	L	mH	61	N/A	31	122	20	184	15	61	10	41	8	31

Continuous Current [1,4], I_{cTmax}, A_{pk} (A_{rms}):

Winding Type	LC-100-100 D			LC-100-100 E			LC-100-200 D			LC-100-200 E		
Cooling Type	NC	AC	WC	NC	AC	WC	NC	AC	WC	NC	AC	WC
Continuous Current [1,4]	4.3 (3.1)	5.4 (3.8)	6.5 (4.6)	N/A	N/A	N/A	8.6 (6.1)	10.8 (7.6)	12.9 (9.1)	4.3 (3.0)	5.4 (3.8)	6.5 (4.6)

Winding Type	LC-100-300 D			LC-100-300 E			LC-100-400 D			LC-100-400 E		
Cooling Type	NC	AC	WC	NC	AC	WC	NC	AC	WC	NC	AC	WC
Continuous Current [1,4]	12.9 (9.1)	16.2 (11.4)	19.4 (13.7)	4.3 (3.0)	5.4 (3.8)	6.5 (4.6)	17.2 (12.2)	21.6 (15.2)	25.9 (18.3)	8.6 (6.1)	10.8 (7.6)	12.9 (9.1)

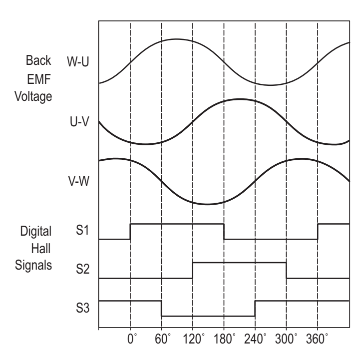
Winding Type	LC-100-600 D			LC-100-600 E			LC-100-800 D			LC-100-800 E		
Cooling Type	NC	AC	WC	NC	AC	WC	NC	AC	WC	NC	AC	WC
Continuous Current [1,4]	25.9 (18.3)	32.3 (22.9)	38.8 (27.4)	12.9 (9.1)	16.2 (11.4)	19.4 (13.7)	34.5 (24.4)	43.1 (30.5)	51.7 (36.6)	17.2 (12.2)	21.6 (15.2)	25.9 (18.3)

Mechanical Parameters	Symbol	Units	LC-100-100			LC-100-200			LC-100-300			LC-100-400			LC-100-600			LC-100-800		
Magnetic Attraction	F_a	N (lb_f)	1310 (294)			2620 (589)			3930 (883)			5240 (1178)			7860 (1767)			10480 (2356)		
Coil Mass [5]	M_c	kg (lb_m)	2.93 (6.5)	3.29 (7.3)	3.29 (7.3)	5.22 (11.5)	5.85 (12.9)	5.85 (12.9)	7.51 (16.5)	8.41 (18.5)	8.41 (18.5)	9.75 (21.5)	10.93 (24.1)	10.93 (24.1)	14.15 (31.2)	15.87 (35.0)	15.87 (35.0)	18.59 (41)	20.86 (46)	20.86 (46)
Magnetic Track Mass	M_n	kg/m (lb/in)	11.39 (0.64)			11.39 (0.64)			11.39 (0.64)			11.39 (0.64)			11.39 (0.64)			11.39 (0.64)		

Notes: Motor performance specifications are with sinusoidal commutation.

1 Continuous forces, motor constant and current listed are with coils at maximum temperature 130°C, mounted to a 1″ aluminum heat sink whose area equals 3x the coil mounting area, and at 20°C ambient.
2 Max on time 1 sec. In certain applications, the motor may produce significantly higher peak forces. Please contact Anorad Applications Engineering for details.
3 All winding parameters listed are measured line-to-line (phase-to-phase).
4 All currents and voltages listed are measured 0-peak of the sine wave unless noted rms.
5 AC and WC include mass of cooling plate. Consult Anorad for Flow and Pressure for air cooled and water cooled version.
6 All specifications are ±10%.

Motor Phasing Diagram

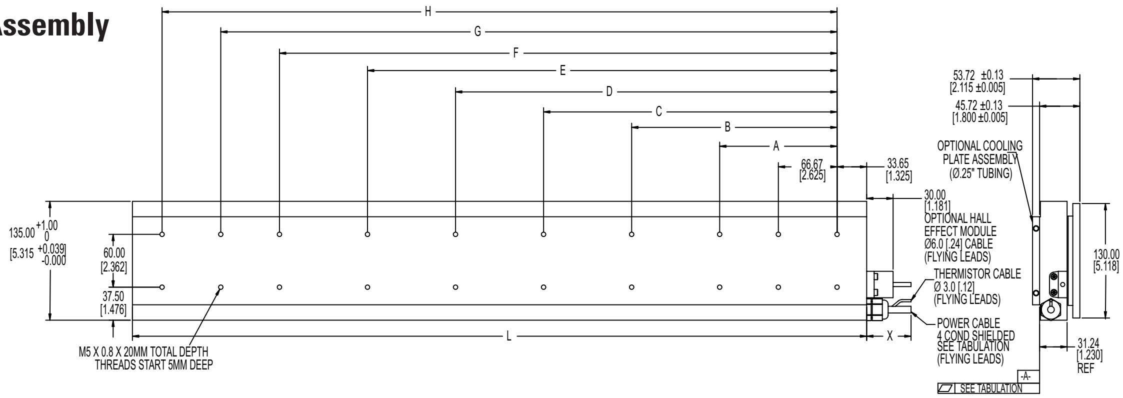


Motors

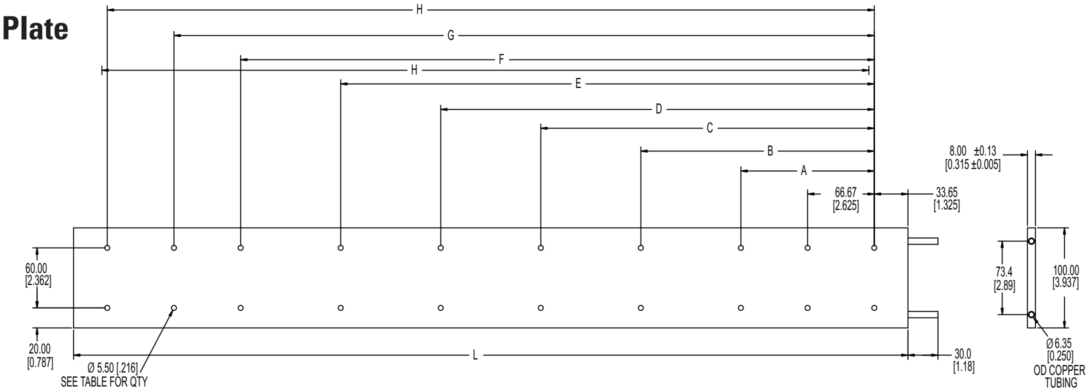
LC-100 Linear Motor Diagram

Dimensions mm [in]

Coil Assembly



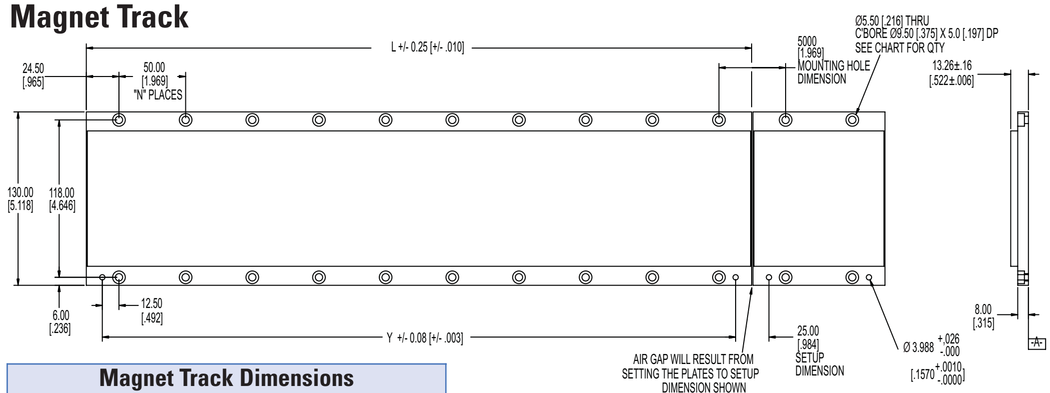
Cooling Plate



Coil and Cooling Plate Dimensions											
Coil Size	**L**	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**Hole Qty (N)**	**Flatness -A-**
100 x 100	134.0 (5.28)									4	0.25 (0.010)
100 x 200	234.0 (9.21)	100.0 (3.937)	166.67 (6.562)							8	0.25 (0.010)
100 x 300	334.0 (13.15)	133.33 (5.249)	200.0 (7.874)	266.67 (10.499)						10	0.38 (0.015)
100 x 400	434.0 (17.09)	133.33 (5.249)	233.33 (9.186)	300.0 (11.811)	366.67 (14.436)					12	0.64 (0.025)
100 x 600	634.0 (24.96)	133.33 (5.249)	233.33 (9.186)	333.33 (13.123)	433.33 (17.060)	500.0 (19.686)	566.66 (22.310)			16	0.89 (0.035)
100 x 800	834.0 (32.84)	133.33 (5.249)	233.33 (9.186)	333.33 (13.123)	433.33 (17.060)	533.33 (20.997)	633.33 (24.934)	700.0 (27.559)	766.66 (30.184)	20	1.16 (0.045)

Power Cable Gauge		
Coil Size	**Winding Type**	**Wire Gauge**
100 x 100	D	18 GA
100 x 200	D	18 GA
100 x 200	E	18 GA
100 x 300	D	18 GA
100 x 300	E	18 GA
100 x 400	D	18 GA
100 x 400	E	18 GA
100 x 600	D	16 GA
100 x 600	E	18 GA
100 x 800	D	14 GA
100 x 800	E	18 GA

Magnet Track



Magnet Track Dimensions					
Magnet Track Length	**L**	**Y**	**Hole Qty**	**N**	**Flatness -A- TIR**
100 mm	99.0 (3.90)	75.00 (2.953)	4	1	0.13 (0.005)
250 mm	249.0 (9.80)	225.00 (8.853)	10	4	0.38 (0.015)
400 mm	399.0 (15.71)	375.00 (14.764)	16	7	0.63 (0.025)
500 mm	499.0 (19.65)	475.00 (18.750)	20	9	0.90 (0.035)

LC-150 Linear Motor

Product Features

- Higher force, steel core design
- Sinusoidal flux density and low-cog design
- Internal thermal sensor
- IP 65 rated
- Optional UL rating
- Ideal for heavy-duty applications

Specifications

Performance Parameters	Symbol	Units	LC-150-100			LC-150-200			LC-150-300			LC-150-400			LC-150-600			LC-150-800		
Cooling Method			NC	AC	WC	NC	AC	WC	NC	AC	WC	NC	AC	WC	NC	AC	WC	NC	AC	WC
Continuous Force [1]	F_{cTmax}	N (lb_f)	373 (84)	467 (105)	560 (126)	746 (168)	933 (210)	1120 (252)	1118 (251)	1398 (314)	1677 (377)	1491 (335)	1863 (419)	2236 (503)	2236 (503)	2795 (628)	3354 (754)	2982 (670)	3727 (838)	4472 (1005)
Peak Force [2]	F_p	N (lb_f)	922 (207)	922 (207)	922 (207)	1843 (414)	1843 (414)	1843 (414)	2761 (621)	2761 (621)	2761 (621)	3682 (828)	3682 (828)	3682 (828)	5523 (1242)	5523 (1242)	5523 (1242)	7363 (1655)	7363 (1655)	7363 (1655)
Motor Constant [1]	K_M	$N/\sqrt{W}$ ($lb_f/\sqrt{W}$)	30.2 (6.8)	30.2 (6.8)	30.2 (6.8)	42.6 (9.6)	42.6 (9.6)	42.6 (9.6)	52.2 (11.7)	52.2 (11.7)	52.2 (11.7)	60.3 (13.6)	60.3 (13.6)	60.3 (13.6)	73.9 (16.6)	73.9 (16.6)	73.9 (16.6)	85.3 (19.2)	85.3 (19.2)	85.3 (19.2)
Thermal Resistance	R_{th}	°C/W	0.72	0.46	0.32	0.36	0.23	0.16	0.24	0.15	0.11	0.18	0.12	0.08	0.12	0.08	0.05	0.09	0.06	0.04
Max Power Dissipation	P_{cTmax}	W	153	239	345	306	479	689	458	716	1031	611	955	1375	917	1432	2063	1222	1910	2750
Maximum Applied Bus Voltage	V_{DC}	Volts	650			650			650			650			650			650		
Electrical Cycle Length	E_c	mm	50			50			50			50			50			50		
Electrical Time Constant	τ_e	msec	10			10			10			10			10			10		
Maximum Coil Temperature	T_{max}	°C	130			130			130			130			130			130		

Performance Parameters	Symbol	Units	LC-150-100		LC-150-200		LC-150-300		LC-150-400		LC-150-600		LC-150-800	
Winding Type			D	E	D	E	D	E	D	E	D	E	D	E
Force Constant [1, 6]	K_F	N/A_{pk} (lb_f/A_{pk})	91 (20.5)	N/A	91 (20.5)	182 (40.9)	91 (20.5)	273 (61.4)	91 (20.5)	182 (40.9)	91 (20.5)	182 (40.9)	91 (20.5)	182 (40.9)
Back EMF Constant p-p [3, 4, 6]	K_e	V_p/m/s (V_p/in/s)	107.5 (2.73)	N/A	107.5 (2.73)	215 (5.46)	107.5 (2.73)	322.5 (8.19)	107.5 (2.73)	215 (5.46)	107.5 (2.73)	215 (5.46)	107.5 (2.73)	215 (5.46)
Peak Current [4]	I_p	A_{pk} (A_{rms})	11.9 (8.4)	N/A	23.8 (16.8)	11.9 (8.4)	35.7 (25.2)	11.9 (8.4)	47.6 (33.6)	23.8 (16.8)	71.4 (50.5)	35.7 (25.2)	95.2 (67.3)	47.6 (33.6)

Performance Parameters	Symbol	Units	LC-150-100 D			LC-150-100 E			LC-150-200 D			LC-150-200 E			LC-150-300 D			LC-150-300 E		
Cooling Type			NC	AC	WC	NC	AC	WC	NC	AC	WC	NC	AC	WC	NC	AC	WC	NC	AC	WC
Continuous Current [1, 4]	I_{cTmax}	A_{pk} (A_{rms})	4.1 (2.9)	5.1 (3.6)	6.2 (4.3)	N/A	N/A	N/A	8.2 (5.8)	10.3 (7.3)	12.3 (8.7)	4.1 (2.9)	5.1 (3.6)	6.2 (4.3)	12.3 (8.7)	15.4 (10.9)	18.4 (13.0)	4.1 (2.9)	5.1 (3.6)	6.2 (4.3)

Performance Parameters	Symbol	Units	LC-150-400 D			LC-150-400 E			LC-150-600 D			LC-150-600 E			LC-150-800 D			LC-150-800 E		
Cooling Type			NC	AC	WC	NC	AC	WC	NC	AC	WC	NC	AC	WC	NC	AC	WC	NC	AC	WC
Continuous Current [1, 4]	I_{cTmax}	A_{pk} (A_{rms})	16.4 (11.6)	20.5 (14.5)	24.6 (17.4)	8.2 (5.8)	10.2 (7.2)	12.3 (8.7)	24.6 (17.4)	30.7 (21.7)	36.9 (26.1)	12.3 (8.7)	15.4 (10.9)	18.4 (13.0)	32.8 (23.2)	41.0 (29.0)	49.1 (34.8)	16.4 (11.6)	20.5 (14.5)	24.6 (17.4)

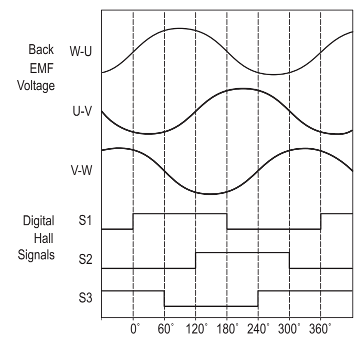
Performance Parameters	Symbol	Units	LC-150-100		LC-150-200		LC-150-300		LC-150-400		LC-150-600		LC-150-800	
Winding Type			D	E	D	E	D	E	D	E	D	E	D	E
Resistance p-p [3, 6] **@20°C**	R_{20}	ohm	8.48	N/A	4.24	16.96	2.83	25.44	2.12	8.48	1.41	5.65	1.06	4.24
Inductance p-p [3]	L	mH	86	N/A	43	173	28.80	259	22	86	14	58	11	43

Mechanical Parameters	Symbol	Units	LC-150-100			LC-150-200			LC-150-300			LC-150-400			LC-150-600			LC-150-800		
Magnetic Attraction	F_a	N (lb_f)	1965 (442)			3930 (884)			5895 (1326)			7860 (1768)			11790 (2652)			15720 (3536)		
Coil Mass [5]	M_c	kg (lb_m)	4.42 (9.8)	5.24 (11.6)	5.24 (11.6)	7.62 (16.8)	9.05 (20.0)	9.05 (20.0)	10.86 (23.9)	12.90 (28.4)	12.90 (28.4)	14.06 (31.0)	16.71 (36.8)	16.71 (36.8)	20.63 (75.5)	24.53 (54.1)	24.53 (54.1)	27.16 (59.9)	32.24 (71.1)	32.24 (71.1)
Magnetic Track Mass	M_n	kg/m (lb/in)	16.16 (0.90)			16.16 (0.90)			16.16 (0.90)			16.16 (0.90)			16.16 (0.90)			16.16 (0.90)		

Notes: Motor performance specifications are with sinusoidal commutation.

1. Continuous forces, motor constant and current listed are with coils at maximum temperature 130°C, mounted to a 1" aluminum heat sink whose area equals 3x the coil mounting area, and at 20°C ambient.
2. Max on time 1 sec. In certain applications, the motor may produce significantly higher peak forces. Please contact Anorad Applications Engineering for details.
3. All winding parameters listed are measured line-to-line (phase-to-phase).
4. All currents and voltages listed are measured 0-peak of the sine wave unless noted rms.
5. AC and WC include mass of cooling plate. Consult Anorad for Flow and Pressure for air cooled and water cooled version.
6. All specifications are ±10%.

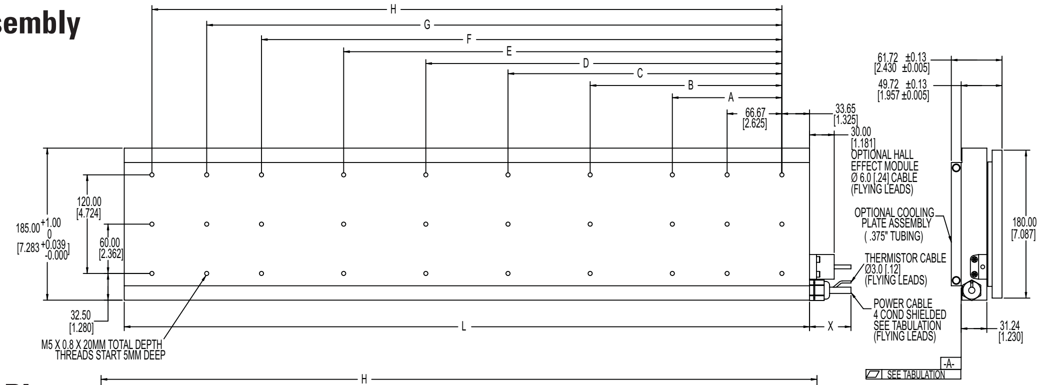
Motor Phasing Diagram



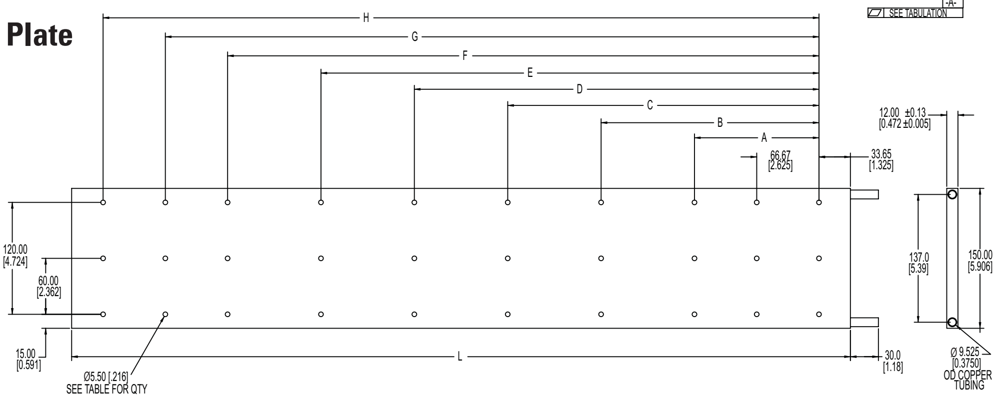
LC-150 Linear Motor Diagram

Dimensions mm [in]

Coil Assembly



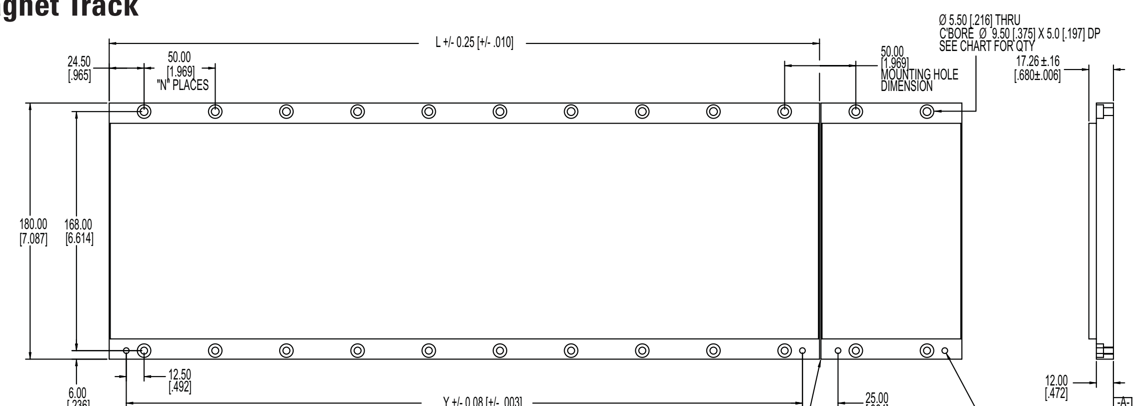
Cooling Plate



Coil and Cooling Plate Dimensions											
Coil Size	L	A	B	C	D	E	F	G	H	Hole Qty (N)	Flatness -A-
150 x 100	134.0 (5.28)									6	0.25 (0.010)
150 x 200	234.0 (9.21)	100.0 (3.937)	166.67 (6.562)							12	0.25 (0.010)
150 x 300	334.0 (13.15)	133.33 (5.249)	200.0 (7.874)	266.67 (10.499)						15	0.38 (0.015)
150 x 400	434.0 (17.09)	133.33 (5.249)	233.33 (9.186)	300.0 (11.811)	366.67 (14.436)					18	0.64 (0.025)
150 x 600	634.0 (24.96)	133.33 (5.249)	233.33 (9.186)	333.33 (13.123)	433.33 (17.060)	500.0 (19.686)	566.66 (22.310)			24	0.89 (0.035)
150 x 800	834.0 (32.84)	133.33 (5.249)	233.33 (9.186)	333.33 (13.123)	433.33 (17.060)	533.33 (20.997)	633.33 (24.934)	700.0 (27.559)	766.66 (30.184)	30	1.16 (0.045)

Power Cable Gauge		
Coil Size	Winding Type	Wire Gauge
150 x 100	D	18 GA
150 x 200	D	18 GA
150 x 200	E	18 GA
150 x 300	D	18 GA
150 x 300	E	18 GA
150 x 400	D	18 GA
150 x 400	E	18 GA
150 X 600	D	16 GA
150 X 600	E	18 GA
150 X 800	D	14 GA
150 X 800	E	18 GA

Magnet Track



6.00 [.236]

AIR GAP WILL RESULT FROM SETTING THE PLATES TO SETUP DIMENSION SHOWN

25.00 [.984] SETUP DIMENSION

Ø 3.988 +.026 -.000 [.1570 +.0010 -.0000]

Magnet Track Dimensions					
Magnet Track Length	L	Y	Hole Qty	N	Flatness -A- TIR
100 mm	99.0 (3.90)	75.00 (2.953)	4	1	0.13 (0.005)
250 mm	249.0 (9.80)	225.00 (8.853)	10	4	0.38 (0.015)
400 mm	399.0 (15.71)	375.00 (14.764)	16	7	0.63 (0.025)
500 mm	499.0 (19.65)	475.00 (18.70)	20	9	0.90 (0.035)

LC-200 Linear Motor

Product Features

- Highest force, steel core design
- Sinusoidal flux density and low-cog design
- Internal thermal sensor
- IP 65 rated
- Optional UL rating
- Ideal for heavy-duty applications

Specifications

Performance Parameters	Symbol	Units	LC-200-100			LC-200-200			LC-200-300			LC-200-400			LC-200-600			LC-200-800		
Cooling Method			NC	AC	WC	NC	AC	WC	NC	AC	WC	NC	AC	WC	NC	AC	WC	NC	AC	WC
Continuous Force [1]	F_{cTmax}	N (lb_f)	472 (106)	590 (133)	708 (159)	944 (212)	1180 (265)	1416 (318)	1416 (318)	1768 (397)	2122 (477)	1886 (424)	2357 (530)	2829 (636)	2829 (636)	3536 (795)	4243 (954)	3772 (848)	4715 (1060)	5658 (1272)
Peak Force [2]	F_p	N (lb_f)	1165 (262)	1165 (262)	1165 (262)	2331 (524)	2331 (524)	2331 (524)	3493 (785)	3493 (785)	3493 (785)	4657 (1047)	4657 (1047)	4657 (1047)	6986 (1571)	6986 (1571)	6986 (1571)	9315 (2094)	9315 (2094)	9315 (2094)
Motor Constant [1]	K_M	$N/\sqrt{W}$ ($lb_f/\sqrt{W}$)	35.6 (8.0)	35.6 (8.0)	35.6 (8.0)	50.3 (11.3)	50.3 (11.3)	50.3 (11.3)	61.5 (13.8)	61.5 (13.8)	61.5 (13.8)	71.1 (16.0)	71.1 (16.0)	71.1 (16.0)	87.0 (19.6)	87.0 (19.6)	87.0 (19.6)	100.5 (22.6)	100.5 (22.6)	100.5 (22.6)
Thermal Resistance	R_{th}	°C/W	0.62	0.40	0.28	0.31	0.20	0.14	0.21	0.13	0.09	0.16	0.10	0.07	0.10	0.07	0.05	0.08	0.05	0.035
Max Power Dissipation	P_{cTmax}	W	176	275	396	352	550	793	528	826	1189	704	1101	1585	1057	1651	2378	1409	2201	3170
Maximum Applied Bus Voltage	V_{DC}	Volts	650			650			650			650			650			650		
Electrical Cycle Length	E_c	mm	50			50			50			50			50			50		
Electrical Time Constant	τ_e	msec	10			10			10			10			10			10		
Maximum Coil Temperature	T_{max}	°C	130			130			130			130			130			130		

Performance Parameters	Symbol	Units	LC-200-100		LC-200-200		LC-200-300		LC-200-400		LC-200-600		LC-200-800	
Winding Type			D	E	D	E	D	E	D	E	D	E	D	E
Force Constant [1, 6]	K_F	N/A_{pk} (lb_f/A_{pk})	121.3 (27.3)	N/A	121.3 (27.3)	242.7 (54.6)	121.3 (27.3)	364.0 (81.8)	121.3 (27.3)	242.7 (54.6)	121.3 (27.3)	242.7 (54.6)	121.3 (27.3)	242.7 (54.6)
Back EMF Constant p-p [3, 4, 6]	K_e	V_p/m/s (V_p/in/s)	143.3 (3.64)	N/A	143.3 (3.64)	286.6 (7.28)	143.3 (3.64)	430.0 (10.92)	143.3 (3.64)	286.6 (7.28)	143.3 (3.64)	286.6 (7.28)	143.3 (3.64)	286.6 (7.28)
Peak Current [4]	I_p	A_{pk} (A_{rms})	11.3 (8.0)	N/A	22.6 (16.0)	11.3 (8.0)	33.9 (23.9)	11.3 (8.0)	45.1 (31.9)	22.6 (16.0)	67.7 (47.9)	33.9 (23.9)	90.3 (63.8)	45.1 (31.9)
Resistance p-p [3, 6] **@20°C**	R_{20}	ohm	10.84	N/A	5.42	21.68	3.62	32.58	2.72	10.86	1.81	7.24	1.36	5.43
Inductance p-p [3]	L	mH	111.6	N/A	55.8	223	37.20	335	28	112	19	74	14	56

Continuous Current [1, 4] — I_{cTmax} — A_{pk} (A_{rms})

Cooling Type	LC-200-100 D	LC-200-100 E	LC-200-200 D	LC-200-200 E	LC-200-300 D	LC-200-300 E	LC-200-400 D	LC-200-400 E	LC-200-600 D	LC-200-600 E	LC-200-800 D	LC-200-800 E
NC	3.9 (2.75)	N/A	7.8 (5.5)	3.9 (2.75)	11.7 (8.2)	3.9 (2.75)	15.5 (11.0)	7.8 (5.5)	23.3 (16.5)	11.7 (8.2)	31.1 (22.0)	15.5 (11.0)
AC	4.9 (3.4)	N/A	9.7 (6.9)	4.9 (3.4)	14.6 (10.3)	4.9 (3.4)	19.4 (13.7)	9.7 (6.9)	29.1 (20.6)	14.6 (10.3)	38.9 (27.5)	19.4 (13.7)
WC	5.8 (4.1)	N/A	11.7 (8.2)	5.8 (4.1)	17.5 (12.4)	5.8 (4.1)	23.3 (16.5)	11.7 (8.2)	35.0 (24.7)	17.5 (12.4)	46.6 (33.0)	23.3 (16.5)

Mechanical Parameters

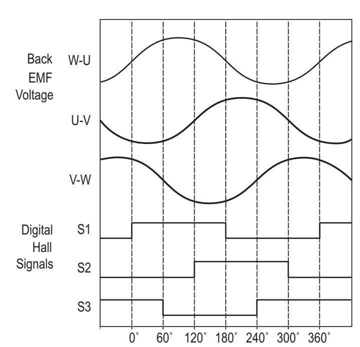
Parameter	Symbol	Units	LC-200-100	LC-200-200	LC-200-300	LC-200-400	LC-200-600	LC-200-800
Magnetic Attraction	F_a	N (lb_f)	2620 (589)	5240 (1178)	7860 (1767)	10480 (2356)	15720 (3534)	20960 (4712)
Magnetic Track Mass	M_n	kg/m (lb/in)	20.93 (1.18)	20.93 (1.18)	20.93 (1.18)	20.93 (1.18)	20.93 (1.18)	20.93 (1.18)

Parameter	Symbol	Units	LC-200-100 NC	AC	WC	LC-200-200 NC	AC	WC	LC-200-300 NC	AC	WC	LC-200-400 NC	AC	WC	LC-200-600 NC	AC	WC	LC-200-800 NC	AC	WC
Coil Mass [5]	M_c	kg (lb_m)	5.74 (12.7)	6.83 (15.1)	6.83 (15.1)	9.98 (21.8)	11.79 (26.0)	11.79 (26.0)	14.04 (30.9)	16.76 (36.9)	16.76 (36.9)	18.19 (40.1)	21.72 (47.9)	21.72 (47.9)	26.79 (59.1)	31.92 (70.4)	31.92 (70.4)	35.23 (77.7)	42.03 (92.7)	42.03 (92.7)

Notes: Motor performance specifications are with sinusoidal commutation.

1 Continuous forces, motor constant and current listed are with coils at maximum temperature 130°C, mounted to a 1" aluminum heat sink whose area equals 3x the coil mounting area, and at 20°C ambient.
2 Max on time 1 sec. In certain applications, the motor may produce significantly higher peak forces. Please contact Anorad Applications Engineering for details.
3 All winding parameters listed are measured line-to-line (phase-to-phase).
4 All currents and voltages listed are measured 0-peak of the sine wave unless noted rms.
5 AC and WC include mass of cooling plate. Consult Anorad for Flow and Pressure for air cooled and water cooled version.
6 All specifications are ±10%.

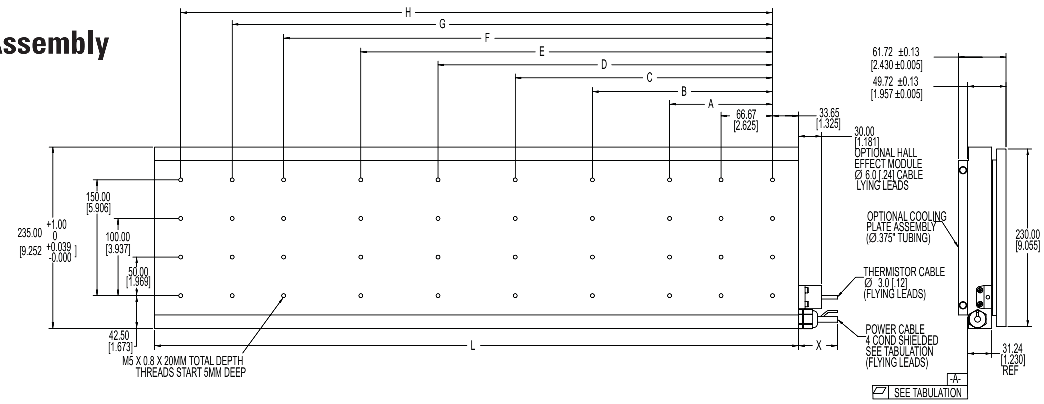
Motor Phasing Diagram



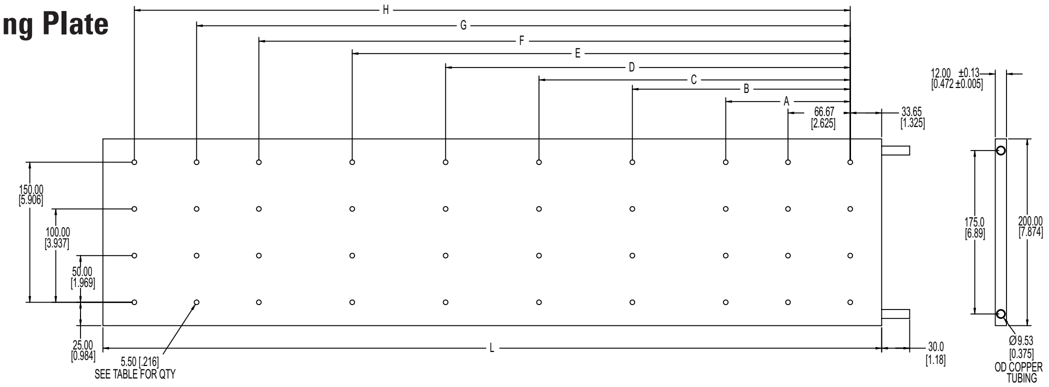
LC-200 Linear Motor Diagram

Dimensions mm [in]

Coil Assembly



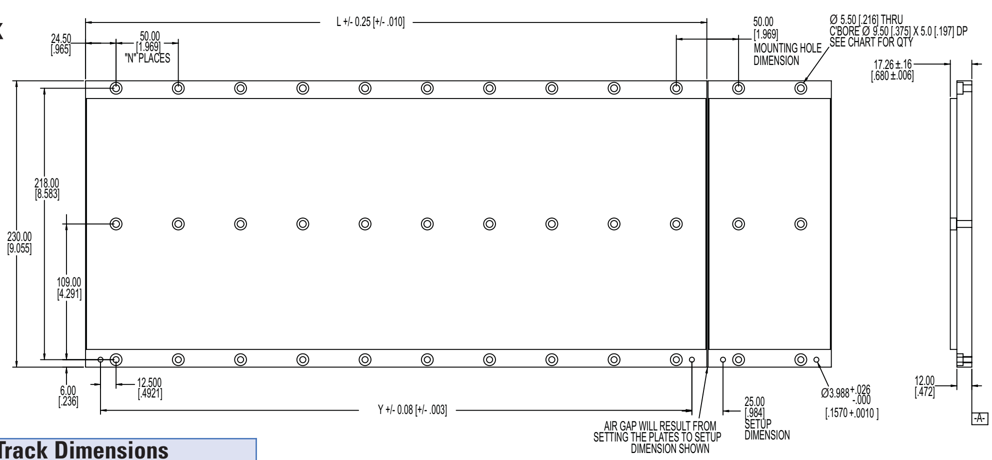
Cooling Plate



Coil and Cooling Plate Dimensions											
Coil Size	L	A	B	C	D	E	F	G	H	Hole Qty (N)	Flatness -A-
200 x 100	134.0 (5.28)									8	0.25 (0.010)
200 x 200	234.0 (9.21)	100.0 (3.937)	166.67 (6.562)							16	0.25 (0.010)
200 x 300	334.0 (13.15)	133.33 (5.249)	200.0 (7.874)	266.67 (10.499)						20	0.38 (0.015)
200 x 400	434.0 (17.09)	133.33 (5.249)	233.33 (9.186)	300.0 (11.811)	366.67 (14.436)					24	0.64 (0.025)
200 x 600	634.0 (24.96)	133.33 (5.249)	233.33 (9.186)	333.33 (13.123)	433.33 (17.060)	500.0 (19.686)	566.66 (22.310)			32	0.89 (0.035)
200 x 800	834.0 (32.84)	133.33 (5.249)	233.33 (9.186)	333.33 (13.123)	433.33 (17.060)	533.33 (20.997)	633.33 (24.934)	700.0 (27.559)	766.66 (30.184)	40	1.16 (0.045)

Power Cable Gauge		
Coil Size	Winding Type	Wire Gauge
200 x 100	D	18 GA
200 x 200	D	18 GA
200 x 200	E	18 GA
200 x 300	D	18 GA
200 x 300	E	18 GA
200 x 400	D	18 GA
200 x 400	E	18 GA
200 X 600	D	16 GA
200 X 600	E	18 GA
200 X 800	D	14 GA
200 X 800	E	18 GA

Magnet Track



Magnet Track Dimensions					
Magnet Track Length	L	Y	Hole Qty	N	Flatness -A- TIR
100 mm	99.0 (3.90)	75.00 (2.953)	6	1	0.25 (0.010)
250 mm	249.0 (9.80)	225.00 (8.853)	15	4	0.50 (0.020)
400 mm	399.0 (15.71)	375.00 (14.764)	24	7	0.76 (0.030)
500 mm	499.0 (19.65)	475.00 (18.70)	30	9	1.0 (0.040)

LCK Brushless Linear Motor

Product Features

- Medium force, steel core
- Excellent air/water cooling
- Moderate magnetic attraction preload
- Compact, sinusoidal flux density
- Ideal for general automation

Specifications

Performance Parameters	Symbol	Units	LCK-S-1			LCK-S-2-P			LCK-S-3-P		
Cooling Method			NC	AC	WC	NC	AC	WC	NC	AC	WC
Continuous Force [1, 5, 6, 7]	F_{cTmax}	N (lb_f)	139 (31)	181 (41)	208 (47)	227 (51)	352 (79)	436 (98)	304 (68)	464 (104)	641 (144)
Peak Force [2]	F_p	N (lb_f)	338 (76)	338 (76)	338 (76)	552 (124)	552 (124)	552 (124)	738 (166)	738 (166)	738 (166)
Motor Constant [1]	K_M	$N/\sqrt{W}$ ($lb_f/\sqrt{W}$)	13.5 (3.0)	13.5 (3.0)	13.5 (3.0)	19.0 (4.3)	19.0 (4.3)	19.0 (4.3)	23.3 (5.2)	23.3 (5.2)	23.3 (5.2)
Thermal Resistance	R_{th}	°C/W	0.94	0.55	0.42	0.71	0.29	0.19	0.59	0.25	0.13
Max Power Dissipation	P_{cTmax}	W	106	181	239	142	342	524	170	395	756
Maximum Applied Bus Voltage	V_{DC}	Volts	325			325			325		
Electrical Cycle Length	E_c	mm	60			60			60		
Electrical Time Constant	τ_e	msec	7.7			7.7			7.7		
Maximum Coil Temperature	T_{max}	°C	125			125			125		
Force Constant [1, 8]	K_F	N/A_{pk} (lb_f/A_{pk})	38.3 (8.6)	38.3 (8.6)	38.3 (8.6)	38.3 (8.6)	38.3 (8.6)	38.3 (8.6)	38.3 (8.6)	38.3 (8.6)	38.3 (8.6)
Back EMF Constant p-p [3, 4, 8]	K_e	$V_p/m/s$ ($V_p/in/s$)	45.3 (1.15)	45.3 (1.15)	45.3 (1.15)	45.3 (1.15)	45.3 (1.15)	45.3 (1.15)	45.3 (1.15)	45.3 (1.15)	45.3 (1.15)
Peak Current [1, 4]	I_p	A_{pk} (A_{rms})	11.5 (8.1)	11.5 (8.1)	11.5 (8.1)	18.7 (13.2)	18.7 (13.2)	18.7 (13.2)	25.0 (17.7)	25.0 (17.7)	25.0 (17.7)
Continuous Current [1, 4, 5, 6]	I_{cTmax}	A_{pk} (A_{rms})	3.6 (2.6)	4.7 (3.3)	5.4 (3.8)	5.9 (4.2)	9.2 (6.5)	11.4 (8.0)	7.9 (5.6)	12.1 (8.6)	16.7 (11.8)
Resistance p-p [3, 8] @25°C	R_{25}	ohm	7.8			3.9			2.6		
Inductance p-p [3]	L	mH	60			30			20		
Mechanical Parameters											
Magnetic Attraction	F_a	N (lb_f)	1139 (256)			2277 (512)			3416 (768)		
Coil Mass [5]	M_c	kg (lb_m)	1.3 (2.9)	1.5 (3.3)	1.5 (3.3)	2.6 (5.8)	3.0 (6.6)	3.0 (6.6)	4.0 (8.7)	4.5 (9.9)	4.5 (9.9)
Magnetic Track Mass	M_n	kg/m (lb/in)	3.4 (0.19)			3.4 (0.19)			3.4 (0.19)		
Cooling Flow Rate	Q	LPM (SCFM/GPM)	n/a (n/a)	183 (6.3)	4.0 (1.1)	n/a (n/a)	169 (5.8)	4.0 (1.1)	n/a (n/a)	151 (5.2)	4.0 (1.1)
Cooling Supply Pressure	P	kPa (PSIG)	n/a (n/a)	207 (30)	55 (8)	n/a (n/a)	207 (30)	69 (10)	n/a (n/a)	207 (30)	69 (10)

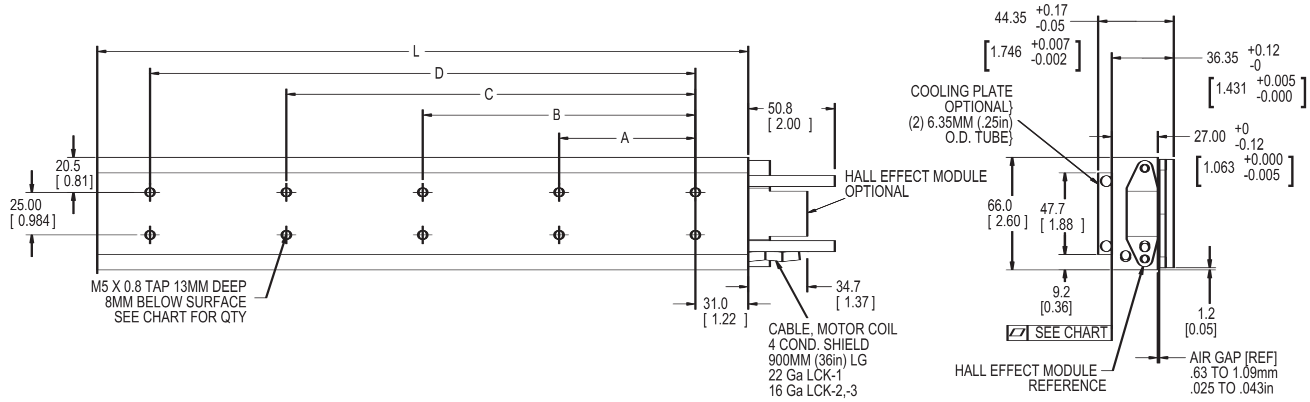
Notes: Motor performance specifications are with sinusoidal commutation.

1 Continuous forces, motor constant and currents listed are with coils at maximum temperature 125°C, mounted to a 254 x 254 x 25.4 mm (10″ x 10″ x 1″) aluminum heat sink on top of coil, and at 25°C ambient.
2 Max on time 1 sec,. assuming correct rms Force and Current, consult Anorad.
3 All winding parameters listed are measured line-to-line (phase-to-phase).
4 All currents and voltages listed are measured 0-peak of the sine wave unless noted rms.
5 Continuous forces and currents are also based on coil moving with all phases sharing the same load in sinusoidal commutation.
6 For stand still conditions multiply continuous force and continuous current by 0.9.
7 All specifications are ±10%.

LCK Brushless Linear Motor Diagram

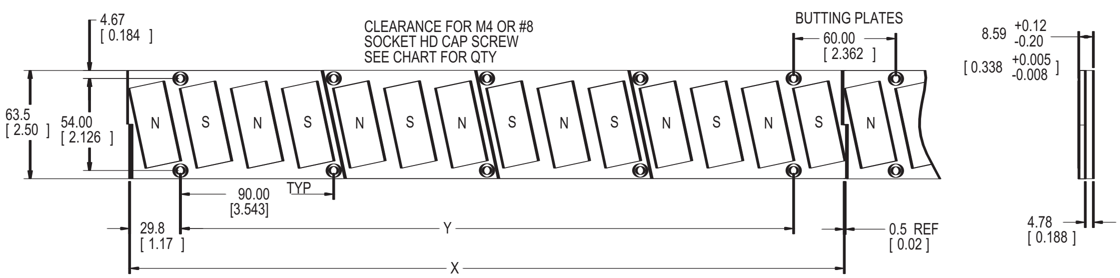
Dimensions mm [in]

Coil Assembly



Motor Coil Dimensions								
Coil Size	**Units**	**L**	**A**	**B**	**C**	**D**	**Hole Qty**	**Flatness**
LCK -1	mm (in)	142.0 (5.59)	40.00 (1.575)	80.00 (3.150)			6	0.13 (0.005)
LCK -2	mm (in)	262.0 (10.31)	80.00 (3.150)	120.00 (4.724)	200.00 (7.874)		8	0.25 (0.010)
LCK -3	mm (in)	382.0 (15.04)	80.00 (3.150)	160.00 (6.299)	240.00 (9.449)	320.00 (12.598)	10	0.38 (0.150)

Magnet Track



Magnet Track Dimensions				
Length	**Units**	**X**	**Y**	**Hole Qty**
240	mm (in)	239.50 (9.429)	180.00 (7.086)	6
420	mm (in)	419.50 (16.516)	360.00 (14.173)	10
600	mm (in)	599.50 (23.602)	540.00 (21.260)	14
780	mm (in)	779.50 (30.689)	720.00 (28.346)	18

LCE Brushless Linear Motor

Product Features

- Lowest force, epoxy/steel core
- Flat design, natural cooling
- Low cogging, low magnetic attraction
- Low profile, miniature design
- Ideal for general automation

Specifications

Performance Parameters	Symbol	Units	LCE-S-1	LCE-S-2-S	LCE-S-3-S
Cooling Method			NC	NC	NC
Continuous Force [1, 5, 6, 7]	F_{cTmax}	N (lbf)	30 (6.7)	50 (11.2)	67 (15.0)
Peak Force [2]	F_p	N (lb_f)	94 (21)	158 (36)	210 (47)
Motor Constant [1]	K_M	$N/\sqrt{W}$ ($lb_f/\sqrt{W}$)	3.7 (0.8)	5.1 (1.2)	6.2 (1.4)
Thermal Resistance	R_{th}	°C/W	1.50	1.06	0.86
Max Power Dissipation	P_{cTmax}	W	67	94	117
Maximum Applied Bus Voltage	V_{DC}	Volts	325	325	325
Electrical Cycle Length	E_c	mm	45	45	45
Electrical Time Constant	τ_e	msec	1.1	1.1	1.1
Maximum Coil Temperature	T_{max}	°C	125	125	125
Force Constant [1, 8]	K_F	N/A_{pk} (lb_f/A_{pk})	6.9 (1.5)	13.7 (3.1)	20.6 (4.6)
Back EMF Constant p-p [3, 4, 8]	K_e	V_p/m/s (V_p/in/s)	8.1 (0.21)	16.2 (0.41)	24.3 (0.62)
Peak Current [1, 4]	I_p	A_{pk} (Arms)	13.7 (9.7)	11.6 (8.2)	10.3 (7.2)
Continuous Current [1, 4, 5, 6]	I_{cTmax}	A_{pk} (Arms)	4.3 (3.1)	3.6 (2.6)	3.2 (2.3)
Resistance p-p [3, 8] @25°C	R_{25}	ohm	3.4	6.8	10.8
Inductance p-p [3]	L	mH	4	8	12
Mechanical Parameters					
Magnetic Attraction	F_a	N (lb_f)	49 (11)	99 (22)	148 (33)
Coil Mass [5]	M_c	kg (lb_m)	0.5 (1.1)	1.0 (2.2)	1.5 (3.3)
Magnetic Track Mass	M_n	kg/m (lb/in)	3.84 (0.22)	3.84 (0.22)	3.84 (0.22)
Cooling Flow Rate	Q	LPM (SCFM/GPM)	n/a (n/a)	n/a (n/a)	n/a (n/a)
Cooling Supply Pressure	P	kPa (PSIG)	n/a (n/a)	n/a (n/a)	n/a (n/a)

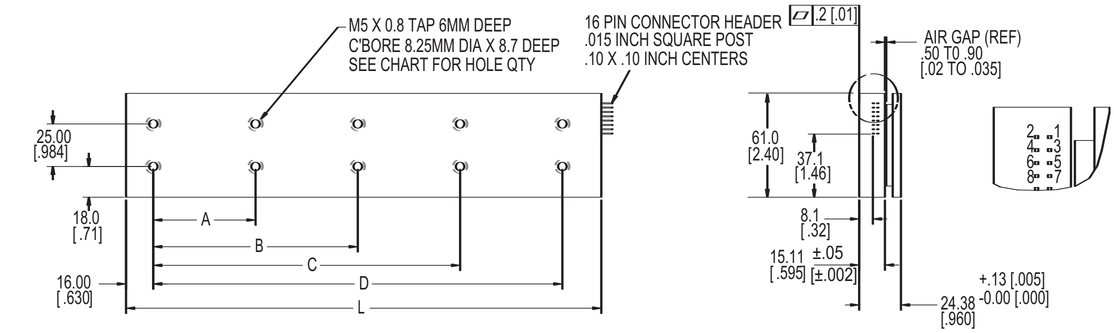
Notes: Motor performance specifications are with sinusoidal commutation.

1. Continuous forces, motor constant and currents listed are with coils at maximum temperature 125°C, mounted to a 254 x 254 x 25.4 mm (10" x 10" x 1") aluminum heat sink on top of coil, and at 25°C ambient.
2. Max on time 1 sec,. assuming correct rms Force and Current, consult Anorad.
3. All winding parameters listed are measured line-to-line (phase-to-phase).
4. All currents and voltages listed are measured 0-peak of the sine wave unless noted rms.
5. Continuous forces and currents are also based on coil moving with all phases sharing the same load in sinusoidal commutation.
6. For stand still conditions multiply continuous force and continuous current by 0.9.
7. All specifications are ±10%.

LCE Brushless Linear Motor Diagram

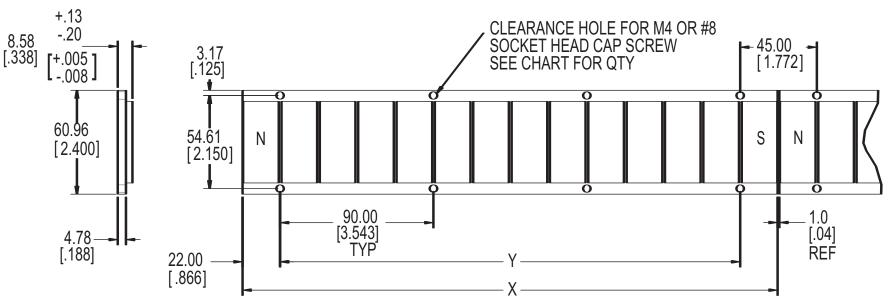
Dimensions mm [in]

Coil Assembly



Motor Coil Dimensions							
Coil Size	**Units**	**L**	**A**	**B**	**C**	**D**	**Hole Qty**
LCE -1	mm (in)	99.0 (3.90)	60.00 (2.362)				4
LCE -2	mm (in)	189.00 (7.44)	60.00 (2.362)	90.00 (3.543)	150.00 (5.906)		8
LCE -3	mm (in)	279.00 (10.98)	60.00 (2.362)	120.00 (4.724)	180.00 (7.087)	240.00 (9.449)	10

Magnet Track



Magnet Track Dimensions				
Length	**Units**	**X**	**Y**	**Hole Qty**
225	mm (in)	224.00 (8.819)	180.00 (7.086)	6
315	mm (in)	314.00 (12.362)	270.00 (10.630)	8
405	mm (in)	404.00 (15.905)	360.00 (14.173)	10
495	mm (in)	494.00 (19.449)	450.00 (17.716)	12
585	mm (in)	584.00 (22.992)	540.00 (21.260)	14
675	mm (in)	674.00 (26.535)	630.00 (24.803)	16
765	mm (in)	764.00 (30.079)	720.00 (28.346)	18
855	mm (in)	854.00 (33.622)	810.00 (31.890)	20

LEA, LEB, LEC, LEM Motor Ordering Information

Coil

Model	Number of Coil Sets	Winding Code	Cooling Option	Thermal Protection	Hall Feedback	Hall Mounting
LEA-S	1-	S-	NC-	TE-	HET-	(NS)

Model
LEA-S
LEB-S
LEC-S
LEM-S

Number of Coil Sets
1 = 1 Coil Set
2 = 2 Coil Sets
3 = 3 Coil Sets
4 = 4 Coil Sets
6 = 6 Coil Sets
8 = 8 Coil Sets
Note: See specification table for motor model coil set

Winding Code
S = Series
P = Parallel
SP = Series/Parallel
Note: See specification table for motor model winding

Cooling Option
NC = No Cooling
AC = Air Cooling
WC = Water Cooling

Thermal Protection
TE = Thermistor
NT = No Thermistor

Hall Feedback
NH = No Hall
HET = Trapezoidal Hall Effect
HES = Sinusoidal Hall Effect

Hall Mounting
(NS) = Non Standard Hall Mounting
Note: Standard hall effect mounting is on the cable side of the motor, otherwise indicate (NS)

Magnet Channel

Model	Magnet Length
LEA-S-	225

Model
LEA-S
LEB-S
LEC-S
LEM-S

Magnet Length
225 = 225mm
300 = 300mm
375 = 375mm
450 = 450mm
525 = 525mm
600 = 600mm
675 = 675mm
750 = 750mm

Cable Coding

	Color	Function		Cable Length
Motor Leads (Standard)	RED	ØA		0.3m (1 ft)
	WHT	ØB		
	BLK	ØC		
	GRN	GND		
Thermistors (Optional)	BLK	125ºC		0.3m (1 ft)
	BLK	125ºC		
Hall Effect Connector (Optional)		Trap	Sine	0.3m (1 ft)
	RED	V+	I+	
	BLU	S2	A+	
	WHT	S1	A-	
	ORN	S3	B+	
	GRN		B-	
	BLK	VRTN	I-	

Note: I+ = 5 mA Nominal; V+ = 5-24 Vdc
Motor and hall effect cables are shielded.

LEU Micro Motor Ordering Information

Coil

Model	Frame Size	Coil Length	Winding Type	Special Configuration
LEU-	15-	1-	D-	

Model
LEU

Frame Size
15
30

Coil Length
1 = 35mm
2 = 65mm
3 = 95mm

Winding Type
D = Standard

Special Configuration
Blank = Standard

Magnet Channel

Model	Frame Size	Magnet Length	Special Option
LEU-	15-	60	

Model
LEU

Frame Size
15
30

Magnet Length
60 = 60mm
90 = 90mm
150 = 150mm
300 = 300mm

Cable Coding

	Color	Function	Cable Length
Motor Leads (Standard)	RED	ØA	0.3m (1 ft)
	WHT	ØB	
	BLK	ØC	
	GRN	GND	

Note: Motor cables are shielded.

Motors

LC-30, -50, -100, -150, -200 Motor Ordering Information

Coil

Model	Frame Size	Coil Length	Winding Code	Cooling Option	Hall Feedback	Thermal Protection	Cable Length	UL Rated	Special Options
LC-	030-	100-	D-	0-	T-	TR-	0-		

Model: LC

Frame Size: 030, 050, 100, 150, 200

Coil Length:
100 = 100mm
200 = 200mm
300 = 300mm
400 = 400mm
600 = 600mm
800 = 800mm

Winding Code: D, E

Cooling Option:
0 = None (Standard)

Hall Feedback:
T = Trapezoidal Hall Effect
0 = No Feedback

Thermal Protection:
TR = PTC Thermal Sensor
TS = Thermal Switch

Cable Length:
0 = 300mm
1 = 600mm
2 = 1000mm

UL Rated:
Blank = Not UL Rated
UL = UL Rated

Special Options:
Blank = Standard

Magnet Track

Model	Frame Size	Magnet Length	Cover	Special Options
LCM-	030-	100-	C	

Model: LCM

Frame Size: 030, 050, 100, 150, 200

Magnet Length:
100 = 100mm
250 = 250mm
400 = 400mm
500 = 500mm

Cover:
C = Cover (Standard)

Special Options:
Blank = Standard

Cooling Plate

Model	Frame Size	Coil Length	Cooling
LCCP-	030-	100-	AC

Model: LCCP

Frame Size: 030, 050, 100, 150, 200

Coil Length:
100 = 100mm
200 = 200mm
300 = 300mm
400 = 400mm
600 = 600mm
800 = 800mm

Cooling:
AC = Air Cooling
WC = Water Cooling

Cable Coding		
	Color	Function
Motor Leads (Standard)	RED	ØA
	WHT	ØB
	BLK	ØC
	GRN/YEL	GND
Thermal Protection (Optional)	BLK	**TR** (130°C)
	BLK	**TR** (130°C)
	BLU	**TS** (130°C)
	BLU	**TS** (130°C)
Trapezoidal Hall Effect (Optional)	RED	V+
	WHT	S1
	BLU	S2
	ORN	S3
	BLK	VRTN

Note: V+ = 5-24 Vdc
Motor and hall effect cables are shielded.

LCK Motor Ordering Information

Coil

Model	Number of Coil Sets	Winding Code	Cooling Option	Thermal Protection	Hall Feedback
LCK-S-	1-	S-	NC-	TE-	NH

LCK-S

1 = 1 Coil Set
2 = 2 Coil Sets
3 = 3 Coil Sets

S = Series
P = Parallel

NC = No Cooling
AC = Air Cooling
WC = Water Cooling

TE = Thermistor
NT = No Thermistor

NH = No Hall
HET = Trapezoidal Hall Effect
HES = Sinusoidal Hall Effect

Magnet Track

Model	Magnet Length
LCK-S-	240

LCK-S

240 = 240mm
420 = 420mm
600 = 600mm
780 = 780mm

Cable Pinout				
	Color	Function		Cable Length
Motor Leads (Standard)	RED	ØA		0.3m (1 ft)
	WHT	ØB		
	BLK	ØC		
	GRN	GND		
Thermistors (Optional)	BLK	125ºC		0.3m (1 ft)
	BLK	125ºC		
Hall Effect Connector (Optional)		Trap	Sine	0.3m (1 ft)
	RED	V+	I+	
	BLU	S2	A+	
	WHT	S1	A-	
	ORN	S3	B+	
	GRN		B-	
	BLK	VRTN	I-	

Note: I+ = 5 mA Nominal; V+ = 5-24 Vdc
Motor and hall effect cables are shielded.

LCE Motor Ordering Information

Coil

Model	Number of Coil Sets	Winding Code	Cooling Option	Thermal Protection	Hall Feedback
LCE-S-	1-	S-	NC-	TE-	NH

LCE-S

1 = 1 Coil Set
2 = 2 Coil Sets
3 = 3 Coil Sets

S = Series

NC = No Cooling

TE = Thermistor
NT = No Thermistor

NH = No Hall
HET = Trapezoidal Hall Effect
HES = Sinusoidal Hall Effect

Magnet Track

Model	Magnet Length
LCE-S-	225

LCE-S

225 = 225mm
315 = 315mm
405 = 405mm
495 = 495mm
585 = 585mm
675 = 675mm
765 = 765mm
855 = 855mm

Cable Pinout					
	Pin	Color	Function		Cable Length
Motor Leads (Standard)	1	VIO	ØA		762mm (30 in)
	2	GRN	ØA		
	3	RED	ØB		
	4	BRN	ØB		
	5	YEL	ØC		
	6	BLU	ØC		
	7	WHT	GND		
Thermistors (Optional)	8	WHT	125ºC		762mm (30 in)
	10	BLK	125ºC		
Hall Effect Connector (Optional)			Trap	Sine	762mm (30 in)
	9	RED	V+	I+	
	11	GRN	S2	A+	
	12	BLU	S1	A-	
	13	VIO	S3	B+	
	14	BRN		B-	
	15	YEL	VRTN	I-	
	16		KEY	KEY	

Note: I+ = 5 mA Nominal; V+ = 5-24 Vdc
Motor and hall effect cables are shielded.

Motor Definitions

Continuous Force (FcTmax)
The force produced by continuous current (I_{cTmax}), all the phases sharing the load, provided the coil is secured through an adequate thermal heatsink as specified. This scenario produces a coil temperature equal to the T_{max} rating for the motor.

Peak Force (Fp)
The force produced by peak current (I_p), all the phases sharing the load, for a 1-second duration.

Motor Constant (Km)
This is a figure of merit for motor efficiency. It is the ratio of the continuous force (three phases) FcTmax to the square root of the motor power losses in the 3 phases.

Thermal Resistance (R_{th})
The equivalent thermal resistance of the motor, determined by the ratio of coil temperature rise (for example 105°C for LC series) to the total power motor losses in the three phases. We assume the motor is mounted on a heat sink of at least the size specified in this catalog, with ambient temperature below 25°C and with a stroke of at least twice the coil length.

Max Power Dissipation (PcTmax)
The continuous power losses of the motor when the RMS current in the coil is IcTmax and the ambient temperature below 25°C.

Maximum Applied Bus Voltage (V_{DC})
This is the maximum allowable Bus DC voltage that can be applied to the coil.

Electrical Cycle Length (Ec)
This is the length of the electrical cycle and corresponds to twice the magnet length (North to North).

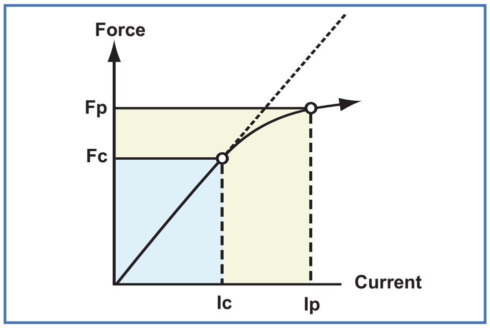
Electrical Time Constant (τ_e)
The time it takes for a step current input to the coil to reach 63% of its final value by overcoming the resistance and the inductance of the coil.

Maximum Coil Temperature (Tmax)
The temperature above which the coil failure is expected due to excessive thermal expansion or wire insulation failure. Note: insulation failure occurs between 150°C and 170°C. The recommended coil temperature for motor sizing is 60°C to 80°C.

Force Constant (Kf)
The ratio between the motor continuous force to the motor continuous current in Amp 0-peak. For zero cogging epoxy core, the force constant does not change from zero to the Peak force (see doted line). For iron core motor the force constant is non linear above the continuous force (see solid line in chart). The non linearity can be typically up to 75%.

Back EMF Constant p-p (Ke)
The ratio between the back emf voltage in volt peak to the motor speed.

Peak Current (Ip)
The peak current corresponding to the peak Force. This is a sinusoidal current which can be expressed either in Amp 0-peak or in Amp rms.



Continuous Current (IcTmax)
The continuous current corresponding to the continuous Force. This is a sinusoidal current which can be expressed either in Amp 0-peak or in Amp rms.

Resistance p-p @ 25°C (R_{25})
This is the cold coil resistance measured phase to phase (line to line) at 25°C.

Inductance p-p (L)
This is the coil inductance measured phase to phase (line to line).

Magnetic Attraction (Fa)
The magnetic attraction force exerted between the coil assembly and its magnet assembly, measured at the nominal air gap.

Coil Mass (Mc)
The mass of the coil including the standard cable length. For air cooled and water cooled motors it also includes the mass of the cooling tube or cooling plate.

Magnetic Track Mass (Mm)
The mass of the magnetic track per unit of length.

Linear Motor Engineering Notes

Useful formulas

Variable	Units		Symbol
	Metric	US custom	
Move			
Displacement	m	in	X
Velocity	m/sec	in/sec	V
Acceleration, Deceleration	m/sec^2	in/sec^2	A, D
Jerk	m/sec^3	in/sec^3	J
Moving Mass	kg	lbm	M
Duty Cycle	%	%	d/c
Move Time	sec	sec	Tm
Cycle Time	sec	sec	Tc
Acceleration Time	sec	sec	Ta
Constant Velocity Time	sec	sec	Tcv
Deceleration Time	sec	sec	Td
Dwell Time	sec	sec	Tdw
Smoothing time	sec	sec	Tj
Settling Time	sec	sec	Tst

Note: Moving mass M = Payload + structure weight + Motor weight (coil for moving coil or magnet tracks for moving magnet motor)

Variable	Metric	US custom	Symbol
Force			
Resistive Force	N	lbf	Fr
Inertial Force	N	lbf	Fi
Friction Force	N	lbf	Ff
Damping Force	N	lbf	Fd
Spring Force	N	lbf	Fs
Damping Coefficient	N/m/sec	lbf/in/sec	Kv
Friction Coefficient	–	–	μ
Total Acceleration Force	N	lbf	Fta
Total Constant Velocity Force	N	lbf	Ftcv
Total Deceleration Force	N	lbf	Ftd
Total Dwell Force	N	lbf	Ftdw

Note: Typical friction coefficient μ = 0.002 to 0.005 for linear rails with balls.

Variable	Metric	US custom	Symbol
Motor			
Force Constant	N/Apk	lbf/Apk	Kf
Back EMF Constant p-p	Vp/m/sec	Vp/in/sec	Ke
Cold Resistance p-p	ohm	ohm	R_{25}
Max. Coil Temperature	°C	°F	Tmax
Motor Peak Force	N	lbf	Fp
Motor Continuous Force	N	lbf	F_{cTmax}
Motor Rated Current	A rms	A rms	I_{cTmax}
Motor Inductance p-p	mH	mH	L
Motor Electrical Cycle Length	mm	in	Ec
Motor Thermal Resistance	°C/W	°C/W	Rth
Motor Magnetic Attraction	N	lbf	Fa

Note: p-p = Phase to phase (line to line)

Variable	Metric	US custom	Symbol
Environment			
Ambient Temperature	°C	°F	Tamb
Amplifier			
Amplifier Peak Current (0-peak value)	Amp	Amp	Ip1(0-p)
Amplifier Continuous Current (0-peak value)	Amp	Amp	Ic1(0-p)
Amplifier Max Bus Voltage	Vdc	Vdc	Vbus

Cautionary note: Rockwell Automation and some other manufacturer rate their Brushless sinusoidal amplifier by Peak current but some others do it by rms current.

Encoder	**Units Metric**	**Symbol**
Scale Pitch	μm	Sp
Interpolation	KX	Ei
Resolution	μm	Er

Note: Interpolation could be done inside the encoder reading head (Square wave output) or inside the Amplifier/Controller

Temperature Formula

T (°C) = [T (°F) – 32]*5/9
T (°F) = [T (°C)]*9/5 + 32

Encoder Formulas

Encoder Resolution	Er (μm) = Sp (μm) / (4*KX)
Square Wave Output Encoder:	
Encoder Output Frequency (per channel) (Hz)	Fenc (Hz) = V (m/sec)*10^6 /(4*Er (μm)
Sine – Cosine Encoder:	
Encoder Output Frequency (per channel)	Fenc (Hz) = V(m/sec)*10^6/Sp (μm)

Note: Ensure encoder output Frequency (Fenc) is lower than the Amplifier or Amplifier/Controller per channel Input Frequency.

Force Equations

Friction Force [1, 3]	Ff (N) = M (kg)*g*[sin(α) + μ*cos(α)]+ Fa (N)* μ +Fr(N) (g = 9.81 m/sec^2)
Inertial Force	Fi (N) = M (kg)*A (m/sec^2)
Damping Force	Fd (N) = Kv (N/m/sec)*V (m/sec)
Total Acceleration Force	Fta (N) = Fi (N) + Ff (N) + Fd (N)
Total Constant Velocity Force	Ftcv (N) = Ff (N) + Fd (N)
Total Deceleration Force	Ftd (N) = Fi (N) – Ff (N) – Fd (N)
Total Dwell Force [3]	Ftdw (N) = M (kg)*g*sin(α) (g = 9.81 m/sec^2)
RMS Force [2]	Frms (N) = $\sqrt{[\{Fta_1{}^2*Ta1+Ftr_1{}^2*Tr_1+Ftd_1{}^2*Td_1+Ftdw_1{}^2*Tdw_1+..\ Ftdw_N{}^2*Tdw_n\}/Tc]}$
Peak Force in Application	Fpa (N) = Max[Fta_1, Ftr_1, Ftd_1, $Ftdw_1$..Ft_n]

Check that Fpa < Fp/1.2 (safety factor 1.2). If not, size a larger motor or add another motor
Check that Frms < FcTmax*0.6 (safety factor 0.6 typical). If not, increase dwell time or consider cooling the motor (air or water).

Current

Rms Current in Application	Ica (rms) = Frms (N) /[Kf (N/Apk)*$\sqrt{2}$]
Peak Current (0-peak value)	Ipa (Apk) = Fpa (N) / Kf (N/Apk)

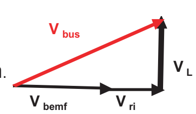
Thermal Equation

Motor Coil Temperature	Tc (°C) = Tamb + 1/[1/(1.5*R_{25}*(Ic rms)^2*Rth) – 1/259.5]
Motor Resistance Hot	Rhot = R25 * [234.5 + Tc (°C)] / (234.5 + 25)
Motor Power Losses	Pl (W) = 1.5*Rhot(ohm) * (Ic rms)^2
Motor Continuous Force vs Ambient Temperature	Fc1 = Fc*[1-0.0039*{Tamb (°C) - 25 (°C)}]

Amplifier Sizing

Voltage due to Back Emf	Vbemf = Ke (Vp/m/sec) * V(m/sec)
Voltage due to R*I	Vri = 1.225*Rhot (ohm) * Ip (A 0-peak)
Voltage due to Inductance	V_L = 7.695* V(m/sec) * L(mH)*Ip (A 0-peak)/Electrical Cycle (mm)
Minimum Bus Voltage needed in applic. [5]	Vbus = 1.15$\sqrt{(Vbemf + Vri)^2 + VL^2}$
Peak Current (0-peak value) [7]	Ip1 (Apk) = Ipa*1.2
Peak Current (rms value) [7]	Ip1 (A rms) = Ipa (rms) * 1.2
Continuous Current (0-peak value) [7]	Ic1 (Apk) = Ica (rms) * 1.2
Continuous Current (rms value) [7]	Ic1 (rms) = Ica*1.2

Notes:
1 Resistive force Fr may include linear bearings friction, spring force or any applied load force opposing motion.
2 Assuming n number of moves: calculate rms force for all moves (1 to n): Fta1 (acceleration), Ftcv2 (Const. Vel.), Ftd3 (deceleration), Ftdw4 (dwell), Fta2 (acceleration move 2) etc.
3 Angle α is load displacement versus horizontal e.g. Horizontal $\alpha = 0°$, Vertical $\alpha = 90°$
4 For US units, use above noted US units and g = 386 in/sec^2.
5 Coefficient 1.15 in Vbus is the minimum safety factor to have enough bus voltage regulation.
6 For speed V take Vmax*1.2 to allow for possible speed overshoot.
7 Amplifier peak current and Continuous current: 1.2 is a typical safety factor.

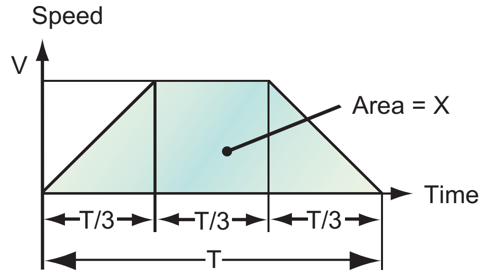


Units

1 m (meter) = 10^6μm (micron) = 10^9 nm (nanometer)
1 in = 25.4 mm = 25.4*10^{-3} m
1 lbf (pound force) = 4.4482 N (newton)
1 kg (kilogram) = 2.2046 lbm (pound mass)

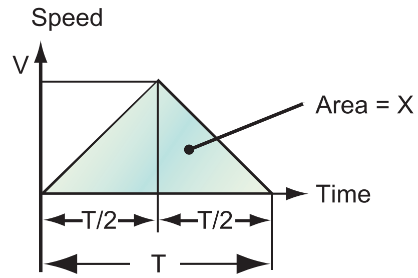
Move Formulas

Trapezoidal Profile 1/3, 1/3, 1/3



	X (m) **T** (sec)	**V** (m/sec) **T** (sec)	**A** (m/sec²) **T** (sec)	**A** (m/sec²) **V** (m/sec) **X** (m/sec)
Displacement **X** (m)		$X = \frac{2}{3} \cdot V \cdot T$	$X = \frac{1}{4.5} \cdot A \cdot T^2$	$X = 2 \cdot \frac{V^2}{A}$
Velocity **V** (m/sec)	$V = 1.5 \cdot \frac{X}{T}$		$V = \frac{A \cdot T}{3}$	$V = \sqrt{\frac{A \cdot X}{2}}$
Acceleration **A** (m/sec²)	$A = 4.5 \cdot \frac{X}{T^2}$	$A = 3 \cdot \frac{V}{T}$		$A = 2 \cdot \frac{V^2}{X}$

Triangular Profile 1/2, 1/2



	X (m) **T** (sec)	**V** (m/sec) **T** (sec)	**A** (m/sec²) **T** (sec)	**A** (m/sec²) **V** (m/sec) **X** (m/sec)
Displacement **X** (m)		$X = \frac{1}{2} \cdot V \cdot T$	$X = \frac{1}{4} \cdot A \cdot T^2$	$X = \frac{V^2}{A}$
Velocity **V** (m/sec)	$V = 2 \cdot \frac{X}{T}$		$V = \frac{A \cdot T}{2}$	$V = \sqrt{A \cdot X}$
Acceleration **A** (m/sec²)	$A = 4 \cdot \frac{X}{T^2}$	$A = 2 \cdot \frac{V}{T}$		$A = \frac{V^2}{X}$

Note: To calculate correct Velocity and Acceleration use T = Tm - (Tst +Tj)

Motor Sizing Example

Let's assume we want to move horizontally a mass of 6 kg point to point for a distance of 100 mm (X) in 205 msec including settling time (Tm) to +/- 1 micron. Total travel is 400 mm, and a dwell time of 200 msec is needed after each move.

Move profile

We will further assume an estimated settling time of 30 msec (Tst).

Now also let also assume a 25 msec smoothing time (Tj) (time for the current to go ramp up linearly from zero to the full peak current).

So the move cycle time (Tc) is 205+200 = 405 msec

Using previous move formula:

T (msec) = Tm – (Tst+Tj)

T (msec) = 205 – (30 + 25) = 150 msec

We will assume an efficient trapezoidal profile (1/3, 1/3, 1/3)

Acceleration needed here (see previous move formula):

$A = (4.5)*100*10^{-3}/(0.15)^2$

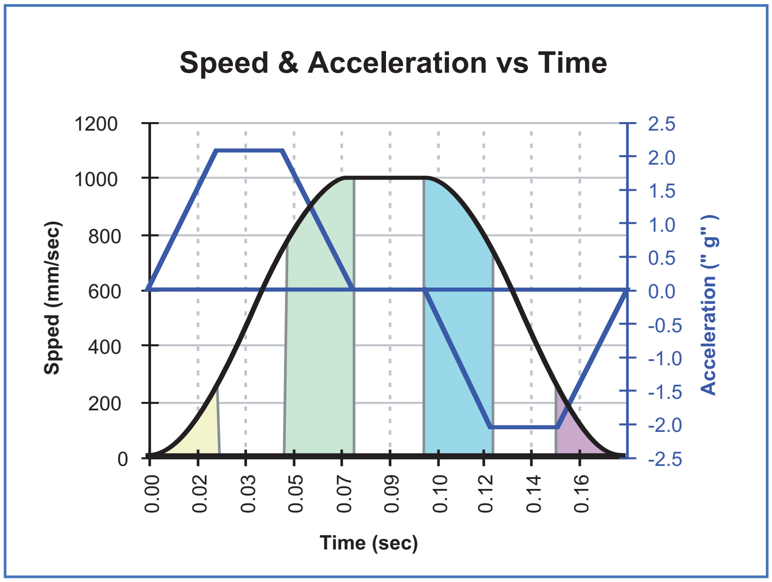
$A = 20\ m/sec^2$ (about 2 "g")

$V = (1.5)*0.1/0.15$

$V = 1.0\ m/sec$

$Jerk = 20/25*10^3$

$Jerk = 800\ m/sec^3$



The acceleration and deceleration time becomes (150/3)+25 = 75 msec

Since the smooth time is 25 msec, the time at constant acceleration is 75-(2*25) = 25 msec

The time at constant speed is now (150/3)-25 = 25 msec

continued on next page

Linear Motor Selection

We can estimate the acceleration force of the load only (see previously mentioned formula) at 2g*9.81*6 kg = 117 N.

Based on this we can select coil LC-50-100-D (peak force = 318 N, continuous force = 139 N) assuming a coil mounting plate of 1 kg.

Total moving mass: 6 kg (load) + 1 kg (plate) + 1.63 kg (coil mass) = 8.63 kg

Coil magnetic attraction Force Fa = 690 N, Coil resistance = 3.76 ohm, Coil Force constant 30.3 N/Ap, Thermal Resistance 1.3°C/W, Back Emf 35.8 Vp/m/sec, Inductance p-p 36 mH, Electrical cycle length 50 mm

We assume a good set of linear bearings with μ=0.005 and 20 N of friction.

Friction Force:	Ff (N) = 8.63*9.81*[sin(0) + 0.005*cos(0)] + 690*0.005 + 20 = 24 N
Inertial Force:	Fi (N) = 8.63*20 = 173 N
Lets neglect the damping force	Fd = 0
Total Acceleration Force	Fta (N) = 173 + 24 = 197 N
Total Constant Velocity Force	Ftcv (N) = 24 N
Total Deceleration Force	Ftd (N) = 173 – 24 = 149 N
Total Dwell Force	Ftdw (N) = 0 N
RMS Force	$Frms\ (N) = \sqrt{[\{197^2*(25*2/3+25)+24^2*25+149^2*(25*2/3+25)+(197^2+149^2)*0.25*30\}/405]}$
	Frms (N) = 86.3 N
RMS Current	Ica = 86.3/30.3 = 2.85 Amp 0-p
	$Ica = 2.7/\sqrt{2} = 2.01$ Amp rms
Peak Current	Ipa = 197/30.3 = 6.5 Amp (0-p)
	$Ipa = 6.5/\sqrt{2} = 4.6$ Amp rms
Motor Coil Temperature	$Tc\ (°C) = 25 + 1/[1/(1.5*3.76*2.01^2*1.3)-1/259.5] = 58.4°C$
Motor Resistance Hot	Rhot = 3.76*[234.5+58.4]/(234.5+25) =4.25 ohm
Motor Power Losses	$Pl\ (W) = 1.5*4.25*2.01^2 = 26$ W
Voltage due to Back Emf	Vbemf = 1.2*1 m/sec * 35.8 Vp/m/sec = 43 V
Voltage due to R*I	Vri = 1.225*4.25 (ohm) * 6.5 (Amp 0-p) = 33.8 V
Voltage due to Inductance	VL = 7.695*1.2*1 (m/sec)*36*6.5/50 = 43.2 V
Bus Voltage needed	$Vbus = 1.15*\sqrt{[(43+33.8)^2 + 43.2^2]} = 101$ Vdc

Notes:

1 Vbus is a worst case since we have assumed no phase advance and no jerk time (max speed at max acceleration).

2 An Allen Bradley Digital Servo Drives Ultra 3000 Model 2098-DSD-010 with 5 A (0-peak) continuous and 15 A (0-peak) of peak current will do the job here with either AC input 115 Vac or 230 Vac.

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