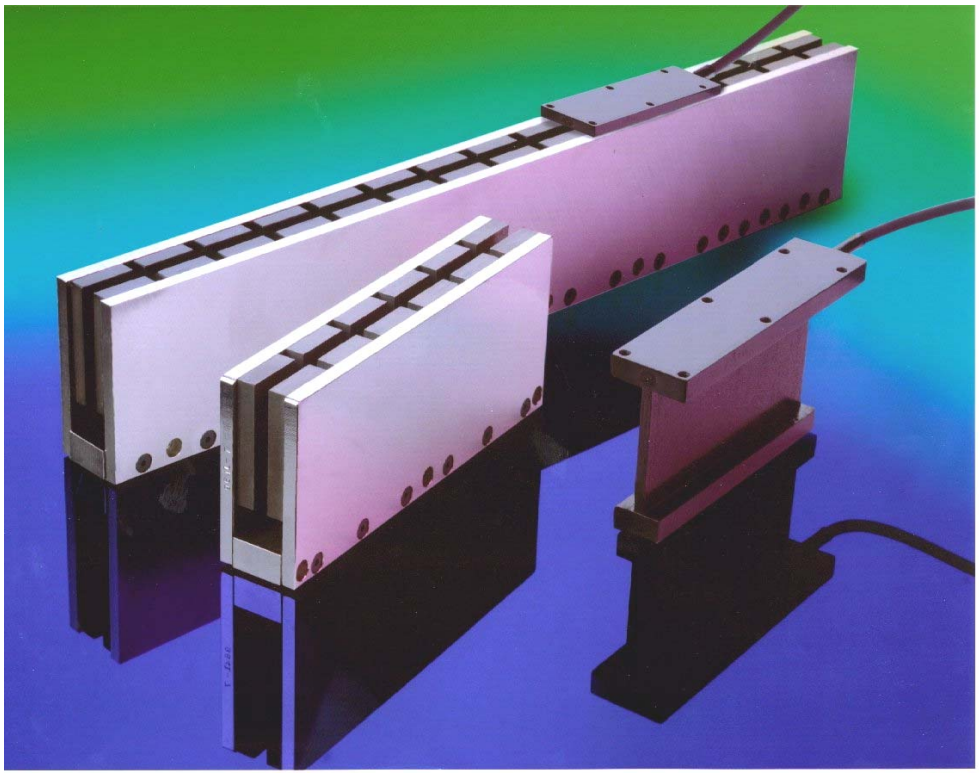
AIREX CORPORATION

LINEAR MOTOR
Application Catalog



QUALITY
PERFORMANCE
FLEXIBILITY

Setting a New Standard

Solution Series™ Linear Motors

www.airex.com

ISO 9001:2000 CERTIFIED

Purpose

This catalog is provided to familiarize you with Airex ***Solution Series***™ linear motors. It covers basic specifications and some key application concerns. Additional information is available on specification drawings and/or on our web site at www.airex.com.

Linear motors have tremendous capacity for high velocities, accelerations and very accurate, repeatable movement. The major limiting factors to linear motor performance are normally application issues external to the motor. These factors include bearing performance, system bandwidth, mechanical stiffness, heat sink capacity and control characteristics. These issues will often affect motor sizing and performance and should be taken into consideration when selecting or specifying the linear motor.

Please contact the factory or any of our factory representatives with questions for developing linear applications,. We will do whatever we can to assist you in your selection of products and the use of those products.

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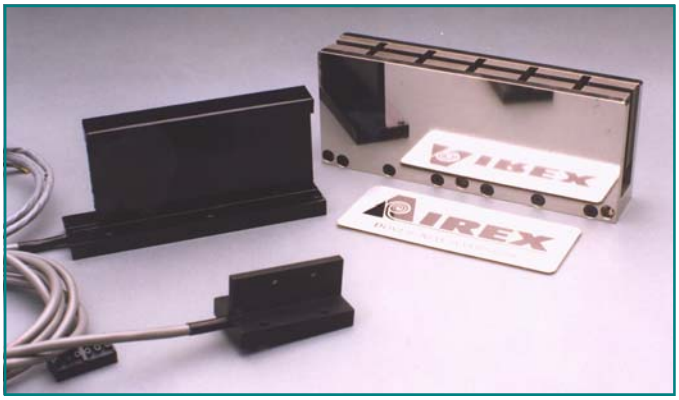
ISO 9001:2000 CERTIFIED

Designed for today's most advanced applications, Airex Brushless Linear Servo Motors offer the absolute best in linear motion technology.

Airex patented manufacturing technology produces unmatched unit-to-unit repeatability in linear motors that feature exceptional performance and smoothness with high accuracy, acceleration and stiffness. Used in high precision processing equipment, these motors meet and exceed the rigorous demands required in today's mfg, assembly, test and inspection environments.

Applications include precision stages, semiconductor mfg, inspection systems, micro-machining equipment, optical scanning devices, laser machining, and electrical component testing.

This catalog is intended to provide general guidance for selecting and implementing standard designs in the ***Solution Series***™ ironless linear motor family. Please refer to data sheets and engineering drawings for information on specific designs.



Solution Series™ Features

- ***Continuous Force up to 80 lbs.***
- ***Peak Force up to 250 lbs.***
- ***Highest Force to Coil Mass Ratio***
- ***High Accuracy/Repeatability***
- ***Efficient Thermal Performance***
- ***Velocities > 5 M/sec Accelerations > 10 G***
- ***Zero Magnetic Preload***
- ***Sinusoidal or Hall Effect Commutation***
- ***Positive or Negative Coefficient Thermistors***
- ***High Performance Rare Earth Magnets***
- ***Low inductance Coil for Fast Response***
- ***Non-Contacting Assemblies***
- ***Continuous Track to 48 inches***
- ***Configurable Connections/Cable Options***
- ***Fully Customizable Design***

Performance and Craftsmanship

Airex has been a key player in high performance magnetic components for over 50 years. We manufacture for space, aerospace, medical and high reliability commercial applications, and are key suppliers to both our international partners and world class technology companies. Our linear motors exhibit a level of performance and craftsmanship that is consistent with the most demanding customer requirements. We are uniquely qualified to develop, manufacture and test components that deliver precise, repeatable performance over a wide range of conditions at the highest level of quality.

ISO 9001 Certified Quality Control

Full process documentation and a stringent quality assurance program are provided through out the manufacturing cycle. Detailed in-process inspections provide the highest standards of mechanical and electrical performance. We have developed and built engineering prototypes and flight units to the most critical requirements on Navy, Air Force and NASA contracts, and have achieved UL approval for several commercial projects. ISO 9000 quality standards have been instituted and maintained at the request of our customers.

State-of-the-Art Manufacturing

Airex has designed automation machinery for key projects and specialty applications for over 30 years. These projects range from simple tooling modifications to custom, microprocessor-based, robotic automation equipment. We have unique capabilities in control technology used for automated machinery in the manufacture of high reliability magnetic components, and hold numerous patents in manufacturing technologies. As developers of manufacturing systems for high reliability applications, we have an exceptional understanding of the requirements for uniformity of product which we insure by state-of-the-art manufacturing methods.

Design and Manufacturing

Airex designs and manufactures high reliability linear motors, rotary motors, integrated magnetic bearings and custom components to design specifications. We have in-house engineering and design capability well suited to specialized projects. Design steps include computer aided design, prototype development, manufacturing engineering, and performance verification testing. Our design strategy assures consistent repeatability and low cost over repeated production runs through the use of our own CNC manufacturing equipment.

Background

Airex is uniquely qualified to manufacture components that deliver precise, repeatable performance. As developers of manufacturing systems for spacecraft and aerospace applications, we have an exceptional understanding of high reliability manufacturing and its impact on end users.

Airex has defined the path to the next generation of linear motor technology. Patented processes capable of producing complete coil assemblies hold inherent magnetic and mechanical advantages over labor intensive methods that must produce a series of sub-assemblies. Automated systems replace tedious, costly and uncertain dependence on operator skill, and provide a path to low cost, high quality motors of the future.

Today's advanced applications continue to push technology's limits. When it comes to specifying a linear motor, the best answer may be an Airex high performance linear motor. Custom and standard models are available. Contact your representative or the factory directly for additional information.

Theory of Operation

Airex ***Solution Series***™ linear motors are capable of producing varying force in a linear direction, while maintaining smoothness and reliability. These brushless motors contain rare earth permanent magnets. The motor itself has no moving parts, and is built to attach to the customers' bearing system. It can be custom configured to meet the most demanding industrial applications.

Brush type motors have existed for many years. The brushes act as switches to direct current into the appropriate phases. The motors are inherently unreliable and produce sparking that can cause unwanted EMI (electromagnetic interference). Iron core motors use iron in the coil to focus the flux (increase the permeability of the magnetic circuit). Although this increases the available force, it greatly increases motor cogging, thus reducing motor smoothness. The addition of iron also increases the inductance of the coil and the mass of the moving coil member, limiting bandwidth and acceleration in linear applications.

Most people would categorize the ***Solution Series***™ linear motor as a brushless DC motor; however it is actually under the broad category of AC synchronous motors. This motor series consist of wire coils connected as three phases that interact with an alternating magnetic field to produce force in either direction. The very strong magnetic field (10k Gauss) is created using high temperature rare earth magnets attached to highly permeable magnetic flux return iron. The magnet structure is designed to maintain high mechanical stiffness while allowing flexibility in mounting.

The coil assembly is available in incrementing segments to meet a wide range of force requirements. Each segment contains a single three phase coil. Our ***Solution Series***™ P20-4, for example, contains four complete segments. The magnet track is also available in varying lengths to determine the travel of the motor. Total travel is determined by the length of the track less the coil assembly length less any commutation devices.

Closed Loop Servo Control/Drive

Airex linear motors are normally used as part of a 'closed loop' servo system. A typical system consists of the following:

Servo controller / amplifier
Airex Linear Motor
Encoder or other position feedback device

Requirements for force, smoothness, acceleration, duty cycle and many other factors provide data necessary for the ideal servo loop setup. The Airex Linear Motor is optimized to provide high acceleration while retaining mechanical stiffness.

Commutation

With current applied to the appropriate phase, the motor produces a magnetic field which interacts with the permanent magnet field to produce force. This force is in proportion to the current applied to the individual phase within the motor. The continuous production of force while in motion relies on the phases being sequentially energized to push or pull against each magnet in turn. This process is known as commutation (selection of phases).

The motor commutation points and the phase relationship of the driver (amplifier) output current are directly related. Two types of commutation are common. The first and the preferred method commutate the motor based on a calculation of magnet position using the system encoder. The second uses Hall Effect transistors to sense the magnet position.

Ironless vs. Iron Core Linear Motors

Ironless motors have several advantages over iron core motors. Heavy coils associated with the presence of back iron add to the moving mass and require more power for operation. Iron core motors typically have very high inductance, which causes slow motor response to changes requested by the servo controller. The acceleration, deceleration and maximum speed of the motor are affected by the high inertia coil assembly coupled with the high inductance. The heavy coil weight appears as a lower mass-to-force ratio which leaves less force to move the load due to the force needed to move the coil. Finally, the higher I^2R drop which leaves less voltage for velocity for a given amplifier. The following additional issues apply generally to toothed (or toothless) moving iron core motors when compared to the Solution Series™ toothless, ironless motor design.

Magnetic Attraction

Iron core motor coil assemblies are strongly attracted to the magnet track in linear designs. This attractive force can approach 600 pounds in small motors and several thousand pounds in large motor designs. The bearing system and the mechanical structure must bear this force. This characteristic greatly increases the moving mass needed in long travel systems while also requiring more expensive bearing components.

Cogging

The magnetic attraction in iron core motors contributes to large cogging forces. Discontinuities in the iron, the lamination pole faces or the iron poles (teeth) themselves attract flux unevenly from passing magnets of varying strengths. Saliencies occur where the moving member has preferred positions or detents created by magnetic attraction to the iron. These saliencies can be felt in rotary or linear designs when moving an un-powered coil by hand, and inherently limit motor performance. Cogging is also produced as the magnetic path reluctance changes with position. This cogging will limit the smoothness of the motor when the motor is run in the velocity control mode, and cause the motor inductance to vary with position. This can cause amplifier current loop tuning to be compromised at varying positions in the move profile. The Back EMF waveform will be distorted by the same factors resulting in motor cogging at higher speeds.

Stray Magnetic Fields

Open magnet tracks used with iron core motors have exposed magnet surfaces resulting in flux leakage thousands of times higher than (ironless) closed tracks. Stray magnetic fields create an attractive force with ferrous objects such as mounting bolts, structural steel or mounting brackets. These stray fields also generate electrical currents (eddy currents) in non-ferrous objects such as aluminum plates that show up as electrical noise in the system. Small parts and environmental debris are especially attracted to these open magnet surfaces. Contact between the coil and magnet via a foreign object or particle can destroy the motor and/or amplifier.

Heat

Heat is generated in the moving coil via two mechanisms. "I^2R" loss produces heat in the motor winding as the current overcomes the resistance of the winding. Additionally, core losses in iron core motors are generated in the coil structure via losses in the iron, and include eddy currents and hysteresis losses. This heat must be removed from the system by conduction, and to a lesser degree from convection or radiation. The laminated iron in an iron core motor is a poor conductor of heat relative to the copper windings. A layer of insulation between the windings and the iron structure further reduces the transfer of heat. As such, iron core motors often have trouble relative to heat removal. Excessive heat can cause degradation to system performance, and if unchecked, can result in burned-up motors and amplifiers.

Custom Motor Options

Airex ***Solution Series***™ Linear Motors solve your motion control requirements through a level of performance and craftsmanship that is consistent with the most stringent customer requirements. Custom configurations can vary from a simple custom winding to complete specification analysis and design for the most demanding application. Design steps may include FEA, Lumped Parameter Models, 3-D modeling, prototype development, manufacturing engineering, and performance verification testing.

Through patented machine winding technology, we are able to produce standard or custom motors with exceptional electromagnetic characteristics, including the industry's highest copper density and thermal performance. Airex ***Solution Series***™ Linear Motors set the standard for versatility and performance. Automated manufacturing methods assure exceptional part-to-part consistency.

Custom machine wound coils are available with alternative force and/or thermal characteristics. Airex recommends sinusoidal commutation for smoothest operation and highest performance. When Hall Effects must be used, our external HED module will provide accurate commutation without the external noise or thermal drift found in embedded units.

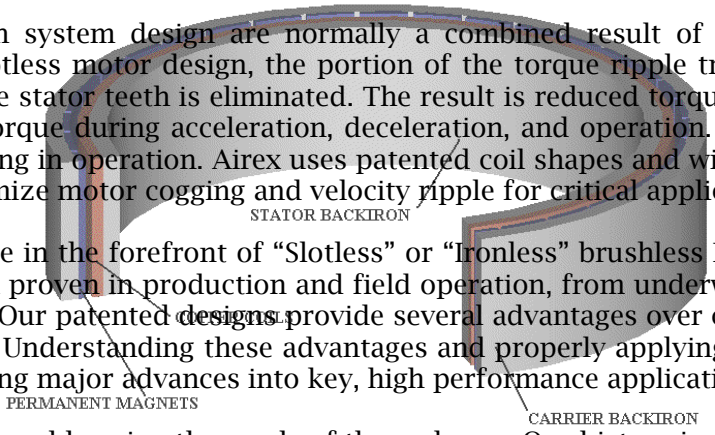
Low Cogging Brushless DC Motors

Airex designed Low Cogging D.C. Motors are available in rotary or linear configuration, and offer fine position and rate control over a wide dynamic range. These motors eliminate magnetically induced cogging torque, permitting low noise performance in multi-pole, brushless designs. Virtually vibration-free, these motors eliminate the need for lengthy, expensive noise reduction programs involving the isolation of noise frequencies and resonances. Their inherently "quiet" design makes them ideal for applications requiring minimum structural noise and maximum dynamic range. Current examples include undersea projects, space platforms, high end machine tools and antenna positioning applications.

Slotless Motor Advantages

In conventional permanent magnet motors, the magnets force a preferred angular position with respect to the teeth or iron. Even when no power is applied to the motor the magnetic positioning effect can be felt. The force required to move the motor from this position is known as cogging torque. As motor designs have changed to high energy magnets cogging torque has become more of a problem. Airex designed slotless motors can dramatically reduce this problem at any speed.

Torque variations in system design are normally a combined result of the motor and controller dynamics. In the slotless motor design, the portion of the torque ripple traceable to the reaction of the magnets with the stator teeth is eliminated. The result is reduced torque ripple in a motor design providing smooth torque during acceleration, deceleration, and operation. Motor winding placement can also cause cogging in operation. Airex uses patented coil shapes and winding techniques on all of our designs to minimize motor cogging and velocity ripple for critical applications.



Airex continues to be in the forefront of "Slotless" or "Ironless" brushless DC motor technology. Our technology has been proven in production and field operation, from underwater vehicles to precision inspection systems. Our patented designs provide several advantages over conventional brushless DC motor construction. Understanding these advantages and properly applying them has resulted in the slotless design making major advances into key, high performance applications.

Airex is committed to addressing the needs of the end user. Our history in program development and manufacturing as well as our military and space certification provide us with a unique insight into the world of precision manufacturing and personalized customer service.

Heat Management

One of the most important aspects of sizing a linear motor is the calculation of the heat sink needed to dissipate the power induced into the coil. Heat sinks come in many forms, including the mounting structure of the stage or machine (typically aluminum blocks) that acts as the heat sink for the motor. The design and usage of the heat sink varies with application, but appropriate engineering methods must be employed to calculate the heat sink size. Proper application will allow good short-term heat dissipation until the block heats to thermal equilibrium, at which point its thermal capacity is reduced to the point that little additional heat can be transferred from the coil. This may take a long time, but could eventually be reached if the system is run continuously. The motor should be sized to accommodate the worst case application conditions.

The explanation for this is relatively simple. All motor coils contain resistance. As current is driven through this resistance, heat is produced. The power lost (heat) is equal to the current squared times the resistance ($\mathbf{P = I^2 R}$). The Airex linear motor has been optimized such that resistance is minimized and the thermal path to remove heat from the motor is as effective as possible. Heat management is the principle design criteria when applying this style of motor. Failure to observe and control heat can result in motor failure.

The Airex motor contains a thermistor or an optional thermostat-type switch to measure motor temperature and allow the user to shut the system down if the motor temperature rating is exceeded. Together these devices can provide complete thermal protection, insuring a long life for both the motor and the system.

Heat dissipation will be the principle limiting factor when applications of the Airex linear motor approach performance extremes. Heat is removed from the motor by conduction into the attached mass (motor load), convection, and radiation into the surrounding environment. Of these, conduction is the primary contributor. The motor load (stage, work-piece, table...) must act as a heat sink to conduct heat away from the motor. Heat must be conducted away fast enough to maintain a temperature below the maximum rating during motor "STALL" conditions. The motor temperature must never be allowed to go higher than the maximum 125° C rating. The power (**P**) into the motor during static conditions is determined by the equation

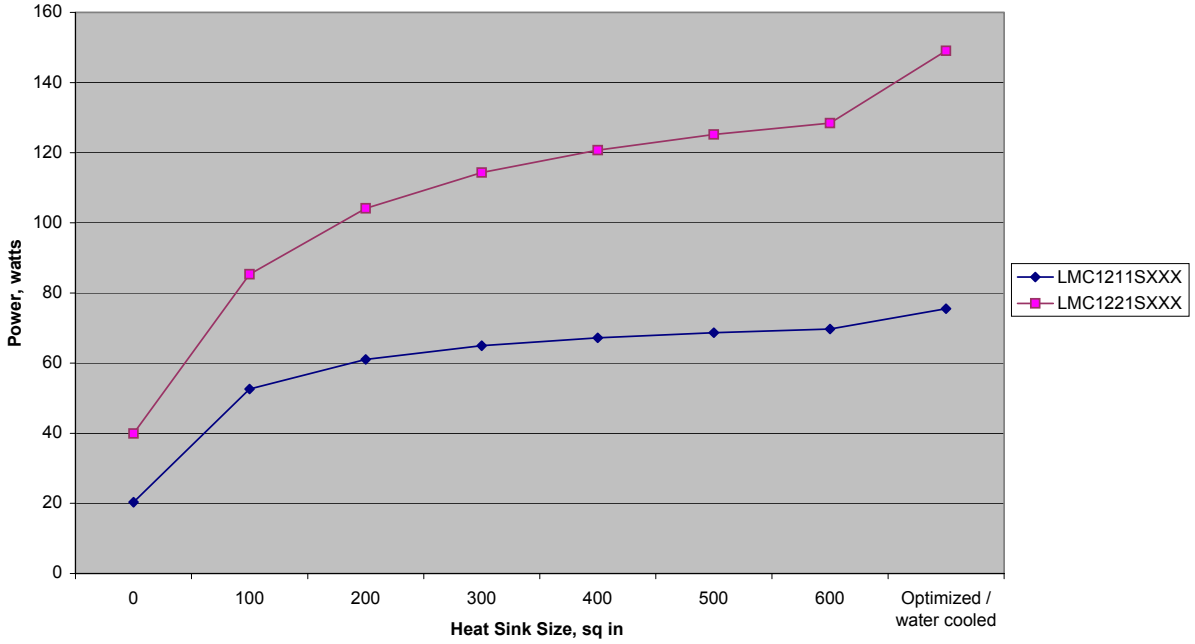
$$\mathbf{P = I^2 R}$$

where **I** is the current being supplied to the motor and **R** is the resistance of the motor coils. A current of 4 amps through a resistance of 8 ohms will cause the motor to draw 128 watts. A rated motor resistance of 8 ohms at room temperature will become 11.3 ohms at 125 degrees C. At this resistance the power draw becomes 180 watts. Heat must be withdrawn fast enough such that the motor does not exceed its maximum rated temperature.

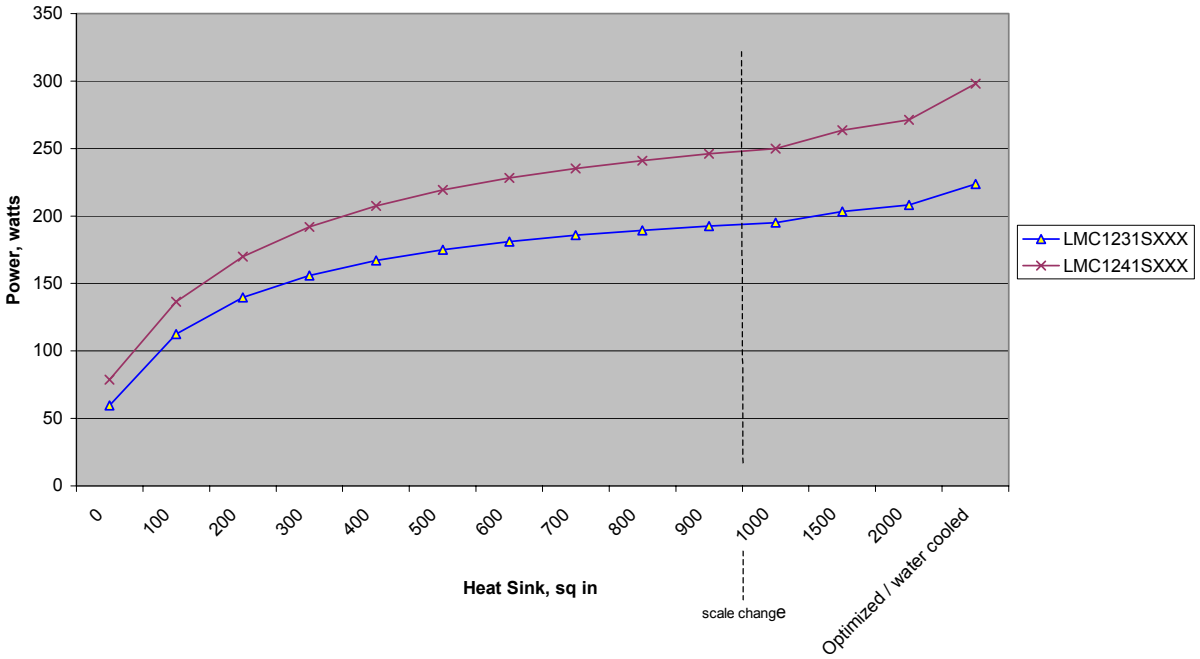
The thermistor or optional thermostat-type switch should be used to monitor temperature and to shut the system down if the motor temperature rating is exceeded. Thermistors can be provided in a normally-open or normally-closed configuration. The thermistor should be monitored and the system shut-down if the resistance falls below a threshold equated to 120 degrees C, the rated internal temperature for the coils.

The charts below show the maximum power vs. heat sink size for a 100° C. rise in each of the P12, P15 and P20 Series. The user must be aware of the system thermal dynamics, the heat removal process, and the requirement to design with one or more thermal protection circuits to insure safety and prevent failure. Contact the factory for more information about the use of these devices in your system, or additional cooling options to extend the operating range of the motor.

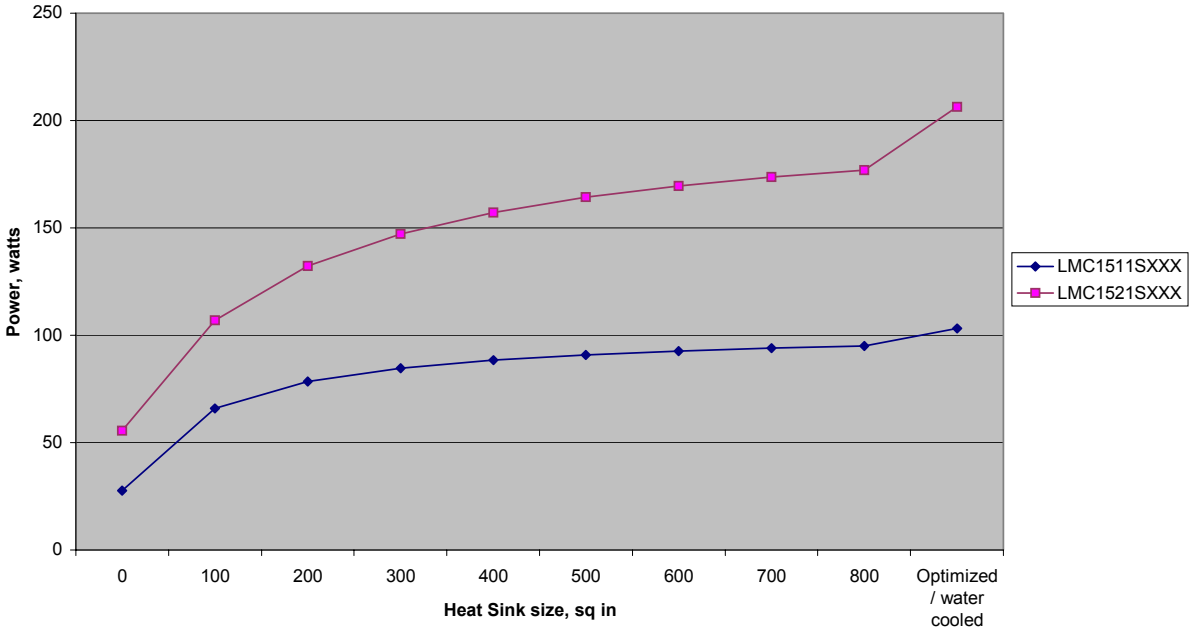
1200 Series LM Max Power vs Heat Sink Size
for a 100*C temperature rise
(maimum operating temperature is 125*C)



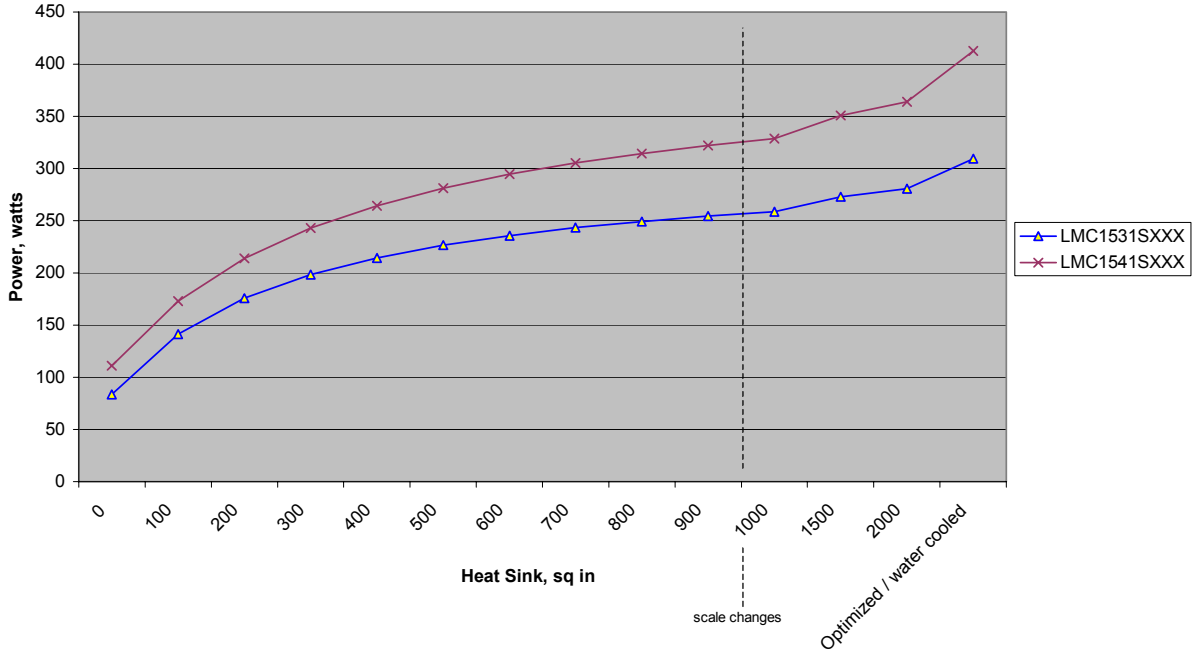
1200 Series LM Max Power vs Heat Sink Size
For a 100*C Temperature Rise
(maximum operating temperature is 125*C)

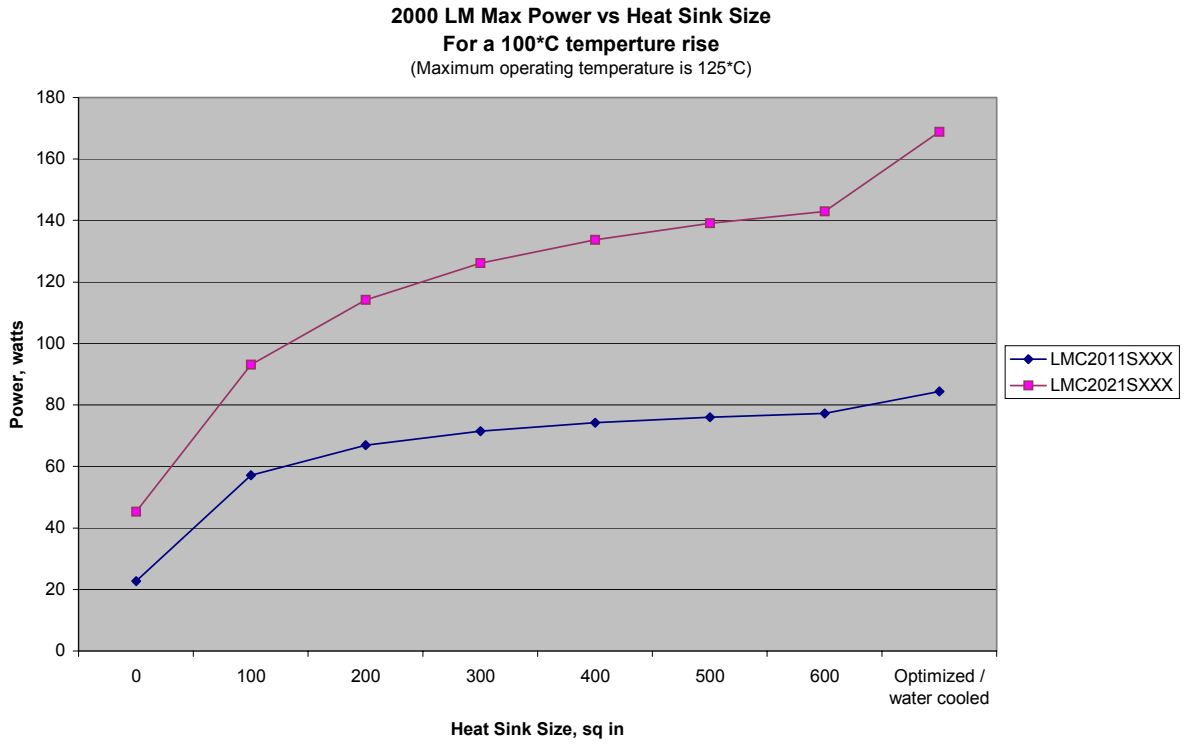


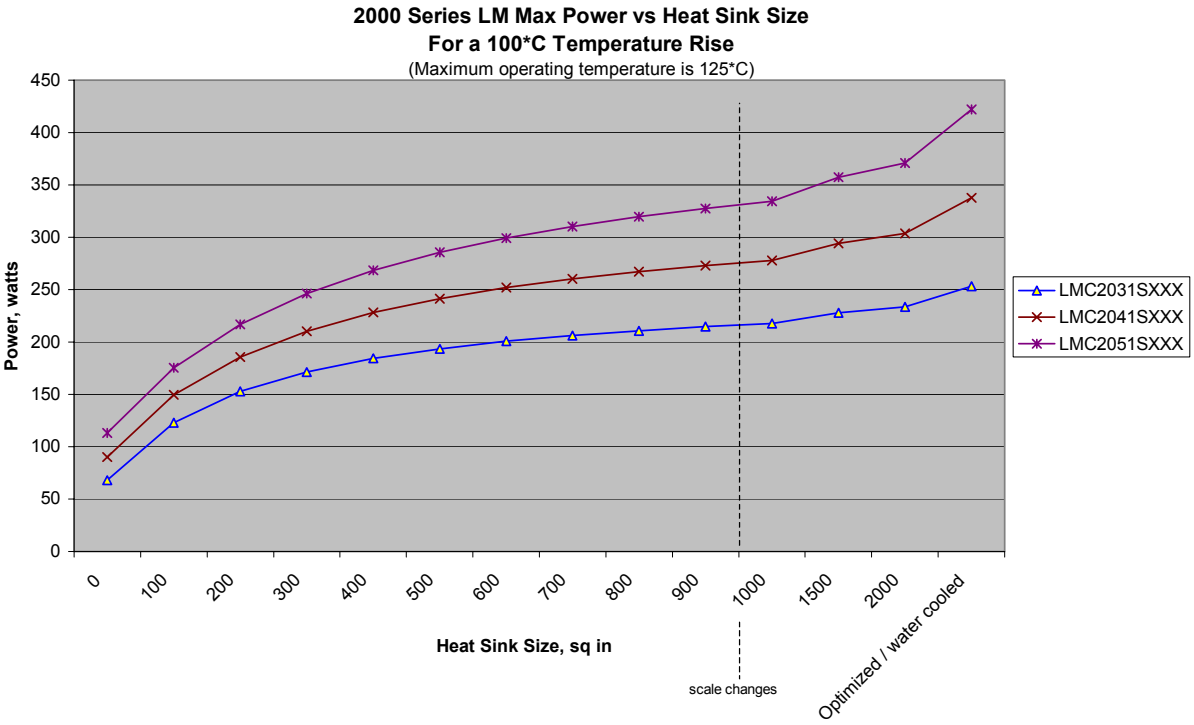
1500 Series LM Max Power vs Heat Sink Size
for a 100*C temperature rise
(maximum operating temperature is 125*C)



1500 Series LM Max Power vs Heat Sink size
For a 100*C Temperature Rise
(maximum operating temperature is 125*C)




2000 LM Max Power vs Heat Sink Size
For a 100*C temperture rise
(Maximum operating temperature is 125*C)
Power, watts
180
160
140
120
100
80
60
40
20
0
0
100
200
300
400
500
600
Optimized / water cooled
Heat Sink Size, sq in
LMC2011SXXX
LMC2021SXXX


2000 Series LM Max Power vs Heat Sink Size
For a 100*C Temperature Rise
(Maximum operating temperature is 125*C)
Power, watts
450
400
350
300
250
200
150
100
50
0
0
100
200
300
400
500
600
700
800
900
1000
1500
2000
Optimized / water cooled
Heat Sink Size, sq in
scale changes
LMC2031SXXX
LMC2041SXXX
LMC2051SXXX

Hall Effect Commutation

Airex can provide Hall Effect commutation for linear motor systems in non-sinusoidal drive applications. This module is specified with the linear motor order. Assembly drawings for mounting come with the installation package, or are available from Airex upon request.

Hall Effect Commutation Module . . . . 120º or optional 60º

The Airex modular design provides very accurate commutation by sensing flux between magnet pairs deep in the magnet track, where the flux change is very large and the Hall switching is very sharp and predictable. Sensing the flux from within the magnet track where the changes in flux are sharp greatly decreases susceptibility to disturbances that cause inaccurate or drifting switching points.

The Airex HED commutation module has been designed to maximize performance in application by minimizing the following effects.

Heat

The switching point of the Hall device can change with temperature. The Airex HED is positioned away from the coil assembly to minimize temperature variation in the device and to stabilize switching points.

Magnet Variations

All magnets vary in strength after magnetization. Commercial magnet flux typically varies by 5% magnet to magnet, but can be much larger in the fringe fields. Airex can provide a magnet selection service for critical magnet tracks.

Hall Effect Device Variations

Sensitivity variations in each Hall device are well documented. This will greatly affect the phase-to-phase commutation point when sensing small amounts of flux. The Airex device is mounted deep in the magnet track to minimize this effect.

Air Gap Variations

As the motor coil slides with a bearing set, the motor to magnet track position can vary by as much as .030 inches. Variations to Airex HED modules buried deep within the track are minimized, whereas conventional HED's can sense large variations in the fringe flux due to their mounting location. Always maintain the clearance gap as uniformly as possible along the full range of travel to minimize variations in commutation points.

Stray Fields

Stray electric or magnetic fields from motor coils, motor leads or connecting coils can be interpreted by the electronics and cause false switching. The Airex HED module is mounted deep in the magnet track to eliminate the effect of stray fields. The Airex HED module is external to the motor coils and thus will not be directly heated. The cable from the module is shielded, and is separate from the motor current carrying cable, providing the user with specific alternatives for dealing with noise immunity.

Frequently Asked Questions

What are the longest and shortest magnet track lengths available?

Airex can produce magnet tracks from 1.2 to 72 inches in length. Standard tracks run typically to 48 inches. Multiple tracks can be placed end-to-end to produce any length, and dowel pin alignment holes are provided to maintain precise magnet to magnet location between tracks. Increments of 2.4" are preferred for best performance.

Is the coil assembly cable susceptible to breakage and/or wear?

The cable is specifically designed for robotic movements and abrasion resistance. Never place direct force on the cable at the attachment point and/or at the junction with the motor itself. The cable should not be exposed to a radius of less than 1.5". Under normal conditions and with proper installation the cable will provide years of worry free use. Airex provides three (3) feet of cable standard on all motors. Contact Airex for specific questions regarding wiring configuration, cable installation or custom length cable.

What feedback method is desired for best commutation?

The Airex linear motor is capable of producing force using either Hall Effect or sinusoidal commutation. The preferred feedback for Airex motors is sinusoidal commutation. The Airex magnet track magnets are placed with such precision that the system encoder can be used to locate the commutation points. See your controller and amplifier supplier for details regarding this use. Airex also offers an external Hall Effect module for use in Hall commutated systems.

What is 120 Degree Hall Effect commutation?

The standard HED module uses 120º commutation, where sensors are placed 120 electrical degrees apart or 0.8 inches. Some controllers use only 120 degree commutation. The 60º or .4 inch spacing is available on some models and results in a shorter module. The Hall module must be specified at the time of the order.

How is the motor connected electrically?

The standard Airex linear motor is internally connected in a 3ϕ delta configuration with internal coils in series. Optional connections are available, including parallel coil connections for the reduction of BEMF and electrical time constant. Contact Airex Corporation for other customized winding and/or connection options.

Does the motor need shielded wire?

The Airex linear motor cable is shielded. Follow the directions in your controller and amplifier manual for the appropriate use of this shield. Airex also provides a ground wire within the cable that can be used to ground the motor bracket.

Can the coil assembly run outside the magnet track at the end of travel?

Yes! Long coil assemblies can extend beyond the track with a proportional loss of force. The Hall Effects (if used) and the last two coil assemblies must stay within the magnet track to allow the motor to reverse direction.

Can the magnet track be disassembled?

NO! Do not attempt to disassemble the magnet track under ***any*** circumstances. Magnet tracks that require disassembly should be returned to Airex for evaluation and disassembly.

Will the magnets ever fall off or weaken?

In normal use the magnets will never come loose or lose strength. Extreme heat within the magnet track can cause damage to the magnets. Accidental damage such as mechanical shock can also crack or break the magnets. Airex can evaluate, repair or clean magnet tracks at the customer's request. Contact the factory for additional information on this service. Never run the motor if there are magnet chips, broken magnets or foreign materials in the path of the coil assembly.

What chemicals can the motor be exposed to?

Prolonged exposure of the motor coil to solvents, petroleum based products, or liquids of any kind should be avoided. The Airex motor coil is designed to withstand moderate chemical and mechanical stress. Please contact the factory for testing information on specific requirements or wash downs.

Can I drill mounting holes in the motor bracket or magnet track?

You should have the factory drill an required holes in the magnet track or bracket. Chips from drilling the magnet track can get sucked into the magnets where they could damage the coil. The end turns of the motor coils extend up into the bracket, so drilling holes in the wrong places will cut the conductors and ruin the motor.

What happens to the linear system in power failures?

Linear motors have no inherent drag or friction like lead screws. While this provides a significant advantage under most conditions, the mechanical system must provide for a stop under failure conditions. A system crash could occur if the system design does not provide a back-up safety mechanism, particularly in vertical applications.

What special considerations are required in vertical applications?

As discussed above, linear motors have no inherent drag or friction. Vertical applications must be designed to avoid the effects of gravity causing a system crash in power outages or system failure conditions. Safe design requires that this be accounted for in the mechanical system. A counter balance is recommended to reduce system power requirements and to minimize the potential for system failure.

What performance is to be expected from the specification?

The specifications describe both minimum and maximum performance attributes available from the motor using sinusoidal commutation. Examples include force constant (minimum) and power dissipation (maximum) respectively. Applications using Hall Effect commutation can expect slightly lower performance. Review the **Interpreting Motor Specifications** section in this catalog for complete detail on motor performance parameters. **Never** exceed the specified ratings.

Standard Motor Specifications – P12

P12 Series	UNITS	P12-1	P12-2	P12-3	P12-4
Coil Length	inches [mm]	2.4 [61.0]	4.8 [122.0]	7.2 [182.9]	9.6 [243.8]
Bracket Length *	inches [mm]	3.6 [91.4]	6.0 [152.4]	8.4 [213.4]	10.8 [274.3]
Coil Weight	lbs [Kg]	0.19 [.09]	0.38 [.17]	0.58 [.26]	0.77 [.35]
Magnet Track Weight	lbs/Ft [N/cm]	2.0 [0.3]	2.0 [0.3]	2.0 [0.3]	2.0 [0.3]
Max. Winding Temperature	°C	125	125	125	125
Series Connected Coils					
Force Constant	lbs [N]/Amp	1.9 [8.4]	3.8 [16.8]	5.7 [25.2]	7.5 [33.5]
Coil Resistance ** (6 Lead @25° C)	Ohms	8.70	17.40	26.10	34.80
Phase Resistance ** (@25° C in delta)	Ohms	5.80	11.60	17.40	23.20
Coil Resistance ** (6 Lead @125° C)	Ohms	12.05	24.10	36.16	48.21
Phase Resistance ** (@125° C in delta)	Ohms	8.04	16.07	24.11	32.14
Inductance (6 Lead [Delta] @ 1kHz)	mH	1.9 [1.3]	3.8 [2.5]	5.6 [3.8]	7.5 [5.0]
Continuous Force	lbs [N]	6.0 [26.7]	12.0 [53.3]	18.0 [80.0]	24.0 [106.7]
Continuous Current ***	Amps	3.18	3.18	3.18	3.18
Continuous Power (@125° C)	Watts	81	163	244	325
Peak Force	lbs [N]	19 [84]	38 [169]	57 [253]	76 [337]
Peak Current ***	Amps	10.06	10.06	10.06	10.06
Peak Power (@125° C; 10% Duty Cycle)	Watts	813	1625	2438	3251
Back EMF Constant	V/ips [V /mps]	0.2 [8.4]	0.4 [16.8]	0.6 [25.2]	0.9 [33.5]
Electrical Time Constant **	msec	0.22	0.22	0.22	0.22
Thermal Resistance	°C/Watt	1.60	0.80	0.53	0.40
Motor Constant	lbs [N]/√W	0.7 [2.96]	0.9 [4.18]	1.2 [5.12]	1.3 [5.92]
Parallel Connected Coils					
Force Constant	lbs [N]/Amp	0.9 [4.2]	1.9 [8.4]	2.8 [12.6]	3.8 [16.8]
Coil Resistance ** (6 Lead @125° C)	Ohms	2.13	4.27	6.40	8.53
Phase Resistance ** (@25° C. in delta)	Ohms	1.42	2.84	4.27	5.69
Coil Resistance ** (6 Lead @125° C)	Ohms	3.31	6.61	9.92	13.23
Phase Resistance ** (@125° C. in delta)	Ohms	2.20	4.41	6.61	8.82
Inductance @ (6 Lead [Delta] @ 1kHz)	mH	0.5 [0.3]	0.9 [0.6]	1.4 [0.9]	1.9 [1.3]
Continuous Force	lbs [N]	6.0 [26.7]	12.0 [53.3]	18.0 [80.0]	24 [106.7]
Continuous Current ***	Amps	6.36	6.36	6.36	6.36
Continuous Power (@125° C)	Watts	89	178	268	357
Peak Force	lbs [N]	19 [84]	38 [169]	57 [253]	76 [337]
Peak Current ***	Amps	20.11	20.11	20.11	20.11
Peak Power (@125° C; 10% Duty Cycle)	Watts	892	1783	2675	3567
Back EMF Constant	V/ips [V /mps]	0.1 [4.2]	0.2 [8.4]	0.3 [12.6]	0.4 [16.8]
Electrical Time Constant **	msec	.22	.22	.22	.22
Thermal Resistance	°C/Watt	1.46	0.73	0.49	0.36
Motor Constant	lbs [N]/√W	0.6 [2.82]	0.9 [3.99]	1.1 [4.89]	1.3 [5.65]

* Length is specified without Hall device
** These specifications reflect a 6 lead or delta connected coil with 1 foot of cable. A 6-lead motor has Start/Finish leads available at the cable end for control of each individual phase. Additional cable will increase resistance values.
*** An appropriate heat sink is required to dissipate the continuous power generated by the motor coil and maintain the coil assembly at or below the maximum specified operating temperature.

Standard Motor Specifications – P15

P15 Series	Units	P15-1	P15-2	P15-3	P15-4
Coil Length	inches [mm]	2.4 [61.0]	4.8 [122.0]	7.2 [182.9]	9.6 [243.8]
Bracket Length *	inches [mm]	3.6 [91.4]	6.0 [152.4]	8.4 [213.4]	10.8 [274.3]
Coil Weight	lbs [Kg]	0.2 0 [.09]	0.50 [.23]	0.80 [.36]	1.10 [.50]
Magnet Track Weight	lbs/Ft [N/cm]	3.7 [0.5]	3.7 [0.5]	3.7 [0.5]	3.7 [0.5]
Max. Coil Temperature	^{0}C	125	125	125	125
Series Connected Coils					
Force Constant	lbs [N]/Amp	2.7 [12.1]	5.4 [24.2]	8.2 [36.3]	10.9 [48.4]
Coil Resistance ** (6 lead @25° C)	Ohms	9.98	19.97	29.95	39.94
Phase Resistance ** (@25° C. in delta)	Ohms	6.66	13.31	19.97	26.63
Coil Resistance ** (6 lead @125° C)	Ohms	13.83	27.67	41.50	55.33
Phase Resistance ** (@125° C. in delta)	Ohms	9.22	18.44	27.67	36.89
Inductance (6 Lead [Delta]) @ 1kHz)	mH	2.1 [1.4]	4.2 [2.8]	6.3 [4.2]	8.4 [5.6]
Continuous Force	lbs [N]	7.9 [35.1]	15.8 [70.2]	23.7 [105.3]	31.6 [140.4]
Continuous Current ***	Amps	2.90	2.90	2.90	2.90
Continuous Power (@125° C)	Watts	78	155	233	310
Peak Force	lbs [N]	25 [111]	50 [222]	75 [333]	100 [444]
Peak Current ***	Amps	9.17	9.17	9.17	9.17
Peak Power (@125° C; 10% Duty Cycle)	Watts	775	1550	2325	3100
Back EMF Constant	V/ips [V /mps]	0.3 [12.1]	0.6 [24.2]	0.9 [36.3]	1.2 [48.4]
Electrical Time Constant **	msec	.21	.21	.21	.21
Thermal Resistance	0C/Watt	1.68	0.84	0.56	0.42
Motor Constant	lbs [N]/√W	0.9 [3.99]	1.3 [5.64]	1.6 [6.90]	1.8 [7.97]
Parallel Connected Coils					
Force Constant	lbs [N]/Amp	1.4 [6.1]	2.7 [12.1]	4.1 [18.2]	5.4 [24.2]
Coil Resistance ** (6 lead @25° C)	Ohms	2.45	4.90	7.34	9.79
Phase Resistance ** (@25° C. in delta)	Ohms	1.63	3.26	4.90	6.53
Coil Resistance ** (6 lead @125° C)	Ohms	3.70	7.40	11.10	14.80
Phase Resistance ** (@125° C. in delta)	Ohms	2.47	4.93	7.40	9.86
Inductance (6 Lead [Delta]) @ 1kHz	mH	0.5 [0.3]	1.0 [0.7]	1.6 [1.0]	2.1 [1.4]
Continuous Force	lbs [N]	7.9 [35.0]	15.7 [70.0]	23.6 [105.0]	31.5 [139.9]
Continuous Current ***	Amps	5.78	5.78	5.78	5.78
Continuous Power (@125° C)	Watts	82	165	247	330
Peak Force	lbs [N]	25 [111]	50 [221]	75 [332]	99 [443]
Peak Current ***	Amps	18.28	18.28	18.28	18.28
Peak Power (@125° C; 10% Duty Cycle)	Watts	824	1648	2472	3295
Back EMF Constant	V/ips [V /mps]	0.2 [6.1]	0.3 [12.1]	0.5 [18.2]	0.6 [24.2]
Electrical Time Constant **	msec	.21	.21	.21	.21
Thermal Resistance	0C/Watt	1.58	0.79	0.53	0.39
Motor Constant	lbs [N]/√W	0.9 [3.85]	1.2 [5.45]	1.5 [6.68]	1.7 [7.71]

* Length is specified without Hall device
** These specifications reflect a 6 lead or delta connected coil with 1 foot of cable. A 6-lead motor has Start/Finish leads available at the cable end for control of each individual phase. Additional cable will increase resistance values.
*** An appropriate heat sink is required to dissipate the continuous power generated by the motor coil and maintain the coil assembly at or below the maximum specified operating temperature.

Standard Motor Specifications – P20

P20 Series	UNITS	P20-1	P20-2	P20-3	P20-4	P20-5
Coil Length *	inches [mm]	2.4 [61.0]	4.8 [122.0]	7.2 [182.9]	9.6 [243.8]	12.0 [305.0]
Bracket Length *	inches [mm]	3.2 [81.3]	5.6 [142.2]	8.0 [203.2]	10.4 [264.2]	12.8 [325.1]
Coil Weight	lbs [Kg]	0.5 [.23]	1.10 [.50]	1.70 [0.77]	2.20 [1.00]	2.80 [1.27]
Magnet Track Weight	lbs/Ft [N/cm]	11 [1.6]	11 [1.6]	11 [1.6]	11 [1.6]	11 [1.6]
Max. Coil Temperature	°C	125	125	125	125	125
Series Connected Coils						
Force Constant	lbs [N]/Amp	3.9 [17.3]	7.8 [34.6]	11.7 [52.0]	15.6 [69.3]	19.5 [86.6]
Coil Resistance ** (6 lead @25° C)	Ohms	5.01	10.03	15.04	20.05	25.07
Phase Resistance ** (@25° C. in delta)	Ohms	3.34	6.68	10.03	13.37	16.71
Coil Resistance ** (6 lead @125° C)	Ohms	6.95	13.89	20.84	27.78	34.73
Phase Resistance ** (@125° C in delta)	Ohms	4.63	9.26	13.89	18.52	23.15
Inductance (6 Lead [Delta]) @ 1kHz)	mH	1.8 [1.2]	3.7 [2.4]	5.5 [3.7]	7.3 [4.9]	9.1 [6.1]
Continuous Force	lbs [N]	16.3 [72.7]	32.7 [145.4]	49.0 [218.1]	65.4 [290.9]	81.7 [363.6]
Continuous Current ***	Amps	4.2	4.2	4.2	4.2	4.2
Continuous Power (@125° C)	Watts	82	163	245	327	408
Peak Force	lbs [N]	52 [230]	103 [460]	155 [690]	207 [920]	258 [1150]
Peak Current ***	Amps	13.28	13.28	13.28	13.28	13.28
Peak Power (@125° C; 10% Duty Cycle)	Watts	816	1633	2449	3265	4082
Back EMF Constant	V/ips [V /mps]	0.4 [17.3]	0.9 [34.6]	1.3 [52.0]	1.8 [69.3]	2.2 [86.6]
Electrical Time Constant **	msec	.36	.36	.36	.36	.36
Thermal Resistance	°C/Watt	1.59	0.80	0.53	0.40	0.32
Motor Constant	lbs [N]/√W	1.8 [8.05]	2.6 [11.38]	3.1 [13.94]	3.6 [16.10]	4.0 [18.00]
Parallel Connected Coils						
Force Constant	lbs [N]/Amp	2.0 [9.1]	4.1 [18.1]	6.1 [27.2]	8.2 [36.3]	10.2 [45.3]
Coil Resistance ** (6 lead @25° C)	Ohms	1.43	2.86	4.28	5.71	7.14
Phase Resistance ** (@25° C in delta)	Ohms	0.95	1.90	2.86	3.81	4.76
Coil Resistance ** (6 lead @125° C)	Ohms	2.19	4.37	6.56	8.74	10.93
Phase Resistance ** (@125° C. in delta)	Ohms	1.46	2.91	4.37	5.83	7.28
Inductance (6 Lead [Delta]) @ 1kHz)	mH	0.5 [0.3]	1.0 [0.7]	1.5 [1.0]	2.0 [1.3]	2.5 [1.7]
Continuous Force	lbs [N]	15.9 [70.6]	31.8 [141.3]	47.7 [211.9]	63.5 [282.6]	79.4 [353.2]
Continuous Current ***	Amps	7.79	7.79	7.79	7.79	7.79
Continuous Power (@125° C)	Watts	88	177	265	354	442
Peak Force	lbs [N]	50 [223]	100 [447]	151 [670]	201 [894]	251 [1117]
Peak Current ***	Amps	24.64	24.64	24.64	24.64	24.64
Peak Power (@125° C; 10% Duty Cycle)	Watts	884	1769	2653	3538	4422
Back EMF Constant	V/ips [V /mps]	0.2 [9.1]	0.5 [18.1]	0.7 [27.2]	0.9 [36.3]	1.2 [45.3]
Electrical Time Constant **	msec	.35	.35	.35	.35	.35
Thermal Resistance	°C/Watt	1.47	0.73	0.49	0.37	0.29
Motor Constant	lbs [N]/√W	1.7 [7.51]	2.4 [10.62]	2.9 [13.01]	3.4 [15.02]	3.8 [16.80]

* Length is specified without Hall device
** These specifications reflect a 6 lead or delta connected coil with 1 foot of cable. A 6-lead motor has Start/Finish leads available at the cable end for control of each individual phase. Additional cable will increase resistance values.
*** An appropriate heat sink is required to dissipate the continuous power generated by the motor coil and maintain the coil assembly at or below the maximum specified operating temperature.

Interpreting Motor Specifications

Coil Length

The coil length is actually the length of the coil, excluding the mounting bracket. It does not include the bend radius of cable attached to the end of the motor bracket. The length of travel is normally described as the magnet track length minus the coil length. Remember to account for the length of the HED module when required.

Coil Weight

The specified weight of the coil assembly includes approximately three feet of cable. This weight should be added to the stage and load weights to calculate the total moving mass.

Magnet Track Weight

The magnet track weight is expressed in pounds/foot. In addition to the standard track, Airex can provide a lighter weight track for custom applications.

Force Constant

This is the relationship between the force produced by the motor and how much current is applied. Airex specifies the force constant in both pounds per amp (lb/Amp) and Newtons per amp.

Resistance

The resistance is measured with the motor coils connected in delta. Understanding the motor resistance is important to proper motor application. Motor resistance increases with temperature by 0.393% per degree C. Motor power is defined by the equation:

$$\mathbf{P} = \mathbf{I}^2 * \mathbf{R}$$

where: **I** = Current
P = Power
R = Resistance

As the motor warms up (keeping the current a constant) the power dissipated by the motor increases. This increase causes the motor to warm up even faster. The temperature reached by the winding is above the ambient temperature as a result of the power being dissipated by the motor.

Inductance

The inductance of the winding and the resistance of the winding determine the electrical time constant of the motor. Lower inductance is desired for faster motor response but the amplifier may require a minimum inductance to drive the motor successfully. The option of coil connections in parallel reduces inductance, back EMF and resistance, but requires approximately double the current to produce an equivalent force.

Continuous Force

Continuous Force is the largest force that the motor can exert on the system for an extended period of time. To use the motor at this power level, a suitable heat sink must be provided to dissipate the heat generated by the motor (See Heat Management).

Continuous Current

This is the current that is needed to produce the continuous force. This level of current should only be used when the motor bracket is securely bolted to the load and the load can dissipate all the heat generated by the coil to remain at a constant temperature. This current level should not be exceeded without a suitable heat-sink for the power dissipated by the motor, as the motor could burn-up.

Continuous Power
This is the power resulting from the current that is needed to produce the continuous force. To use the motor at this power level, a suitable heat sink must be provided to manage the power dissipated by the motor (See Heat Management).

Peak Force
Peak Force is the largest force that the motor can exert on the system for a short period of time. It is specified for a 10% or shorter duty cycle. To use the motor at peak force, a suitable heat-sink must be provided to manage the power dissipated by the motor (See Heat Management).

Peak Current
This is the current that is needed to produce the peak force. This level of power should be allowed only when the motor bracket is securely bolted to the load and the load provides a suitable heat-sink for all the power dissipated by the motor.

Peak Power
This is the power resulting from the current that is needed to produce the peak force. This level of power should be allowed only when a suitable heat-sink is provided to manage the power dissipated by the motor (See Heat Management).

BEMF Constant
The BEMF constant is multiplied by the maximum motor speed to determine how much voltage is generated by the motor. The amplifier must be able to produce more voltage than the generated voltage to cause current to flow in the motor. The following formula is a good rule of thumb to determine the needed amplifier voltage:

Bus Voltage = 1.25 * ((BEMF * Max Speed) + (DC Resistance (hot) * Current))

Remember to express speed in inches per second.

Electrical Time Constant
The electrical time constant is the motor inductance divided by the motor resistance. It is a measure of how quickly the motor current can be changed; in fact it is the time for the current to change by 63%. The Airex Linear Motor has inherently low inductance due to its ironless design, thereby allowing fast response.

Motor Sizing

Motor Sizing can be approached in many different ways. One approach is illustrated in the following example. Please contact our factory or sales representatives for assistance with sizing questions.

Problem

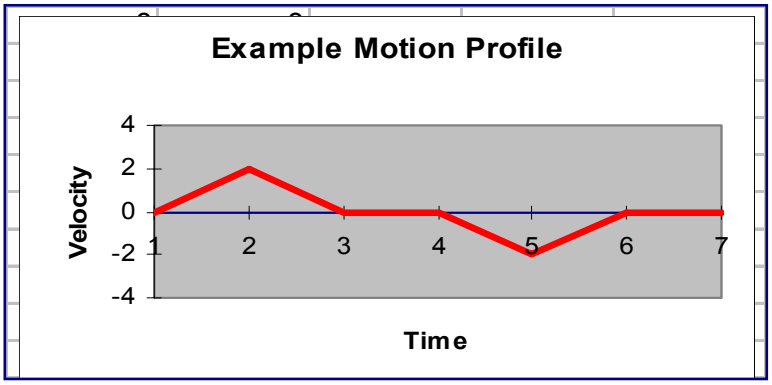
A linear motor driven machine is required to cycle 4800 times per hour. The cycle is defined as the total move including a dwell at either end of the move. The stage and tool (load) is 30 lb. and needs to move 10 inches. A dwell at either end of the stroke of 0.125 seconds is required. The bearing friction is anticipated to be 1 lb.

Solution

Step One: Calculate Duty Cycle

One hour contains 3600 seconds (sec). 3600 sec/4800 moves = .75 sec/cycle. Of this cycle, .25 sec is the dwell at either end of the stroke. In the cycle, .5 sec is motion (.25 in each direction). The duty cycle is defined as the amount of time energy is being expended divided by the total cycle time. The duty cycle is calculated as follows:

.5 sec/.75 sec = **67% Duty Cycle**



Step Two: Analyze the Motion Profile

Analyze the motion profile and calculate the time sequence of motion as follows.

T 1 = **0 sec** >> Velocity is 0, motion is starting.
T 2 = 0.25 sec/2 = **.125 sec** >> Velocity is max. halfway through move, begin decel.
T 3 = **.25 sec** >> Velocity is 0, begin dwell at end of move.
T 4 = 25 + .125 = **.375 sec** >> Begin return to home
T 5 = .375 +.125 = **.5 sec** >> Velocity is max. in reverse direction
T 6 = .5 + .125 = **.625 sec** >> End of second motion
T 7 = **.75 sec** >> Total cycle time - Ready for second cycle

Step Three: Calculate the Maximum Velocity

Using common motion formulas, calculate velocity at maximum points on the motion profile graph.

X = (Vo + V) t/2 where:

X	=	Position
Vo	=	Initial Velocity
V	=	Current Velocity
t	=	Time

This can be rearranged and reduced to:

V = 2X/t when **Vo = 0** **∴V = 2 (10 in.) / .25s = 80 in./sec.**

VELOCITY CALCULATION TABLE			
	Time	Position	Velocity
A	0	0 (home)	0
B	.125 sec	5 in.	80 in/sec
C	.25 sec	10 in.	0
D	.375 sec	10 in.	0
E	.5 sec	5 in. (reverse direction)	80 in/sec
F	.625 sec	0 (home)	0
G	.75 sec	0	0

Step 4: Calculate Acceleration

We can calculate the acceleration (a) from:

$V = Vo + a\,t$ or $a = V/t$ with $Vo = 0$

So, a = 80 in sec/.125 sec = 640 in/sec^2;

Dividing by 12 to convert inches to feet:

a = (640 in/sec^2) / 12 = 53.33 ft/sec^2

For convenience we convert acceleration to g's, dividing 53.33 ft/sec^2 acceleration by that of gravity (32 ft/sec^2):

(53.33 ft/sec^2) / (32 ft/sec^2) = **1.66 g's**

Step 5: Calculate Motor Force

We can calculate the required force (remembering to add the motor weight and bearing resistance) from the equation:

F = MA where: **F** = Force, **M** = Mass, **A** = Acceleration

We estimate a ***Solution Series***™ P20-4 motor is required, since

F = (30 lb. {load} + 2 lb. {motor} + 1 lb. {bearing friction}) (1.66 g's) = **54.78 lb.**

From the motor data specification sheet, we see that 55 pounds of force is able to be handled by a -4 motor continuously. We can now work backward from the continuous rating requirement to calculate the peak power and peak force needed at a given duty cycle. Start with the target motor size as follows:

Question: Will a *Solution Series*™ P20-3 work at the 67% duty cycle?

From the motor specification table, a -3 motor at a maximum continuous rating of 4 amps provides a force of 48 lb. Applying $\mathbf{P = I^2R}$ to calculate total power,

>> **P** = 4^2 * 10.8 ohms = **172.8 watts** total power dissipation

For our load, we need 55 lb./(12.3 lb./amp) = **4.47 amps,** which required

>> **P** = 4.47^2 (10.8 ohms) = **219.5 watts**

172.8 watts/215.9 watts = **.800 or 80%**

So the -3 could be used for a duty cycle of up to 80% (with an infinite heat sink).

Step 6: BEMF Allowance

Next we will look at the resulting BEMF. For the -3 motor the BEMF constant is 1.2 v/in/sec. So at the peak velocity of 80 in/sec the BEMF or generated voltage is:

80 (1.25 v/in/s) = **100 volts**

To drive the 4.5 Amps into the -3 motor Ohms Law dictates: *The voltage at the coil (without BEMF included) is:*

V = IR = 4.5 (14 {adjusted for temperature rise}**) = 63 volts**

The amplifier must be capable of driving the motor with 4.5 amps utilizing a minimum of **163 volts** (100 + 63). To allow for losses in the amplifier and leads, we should use a factor of 1.25 as margin or ≈203 volts. So, a **200 volt** DC Bus for the amplifier would work well.

Technical Drawings

Technical Drawings may be attached as appropriate. Additional drawings are avaible on our web site or directly from Airex in conventional engineering formats including 3d models.

Ordering Information

Order your ***Solution Series***™ linear motor with the appropriate part number as described below.

LINEAR MOTOR COIL	MOTOR SERIES	# OF POLES	COMMUTATION	INTERNAL CONNECTION	CABLE LENGTH	THERMAL DEVICE
L M C -	**P 1 2** -	**1**	**3**	**S**	**7 2**	**N**
LMC	P12	1	1 = coil only	S = series	36 = 36 inches	X = none
	P15	2	3 = coil with 120° Hall Effect Device	P = parallel	180 = 180 inches	L = normally closed thermostat (P15 & P20)
	P20	3				F = normally open thermostat (P15 & P20)
		4				N = negative temp. coeff. thermistor
		5 (P20 only)				P = positive temp. coef. thermistor
						C = temperature to current thermistor

Motor Series

Select from the standard series available or contact Airex for custom motors.

Number of Poles

Complete the motor sizing worksheet or contact your Airex representative to determine the appropriate number of poles required by your design. Multiple motors may be used in a single track to meet customer requirements.

Commutation

Specify a Hall Effect Modules when Hall commutation is required. Remember to incorporate the additional length requirement into the magnet track length to achieve full travel in HED commutated systems.

Internal Connections

Specify series or parallel connections as required by the application and associated electronics. Airex motors are configured with all 6 phase-leads brought out in the power cable. Delta or Wye connections are made externally. Schematics and mechanical drawings are provided in this catalog or on our Web Site.

Cable Length

Specify cable length required in inches.

Thermal Device

Thermal options are available as shown.

LINEAR MOTOR TRACK	MOTOR SERIES	TRACK LENGTH	MAGNET	PROFILE
L M D T - P 1 2 - 1 2 . 0			**F**	**S**
LMDT	P12	25.2 = 25.2" [640.1mm]	F = standard for P12 & P15	S = standard
	P15	P12 & P15 available in 1.20 [30.5mm] increments	B = standard for P20 series	
	P20	P20 available in 2.40 [61.0mm] increments		

Motor Series
Select from the standard series available or contact Airex for custom motors.

Track Length
Select a magnet track length to meet travel plus the coil and HED module requirements. Magnet track increments of 1.2 inches are available in P12 &" P15 series. P20 Series are available in 2.4 inch increments.

Track Profile
Alternate track profiles may be available for your application. Please contact your representative or the factory for additional profile options.

Order Acceptance
Orders are only accepted by written confirmation from the factory located in Somersworth, NH, USA. Published and quoted prices exclude shipping unless otherwise indicated and are subject to change without notice. Quotations and order confirmations including transportation charges will gladly be provided upon request.

Written quotations are valid for acceptance within 30 days unless specifically extended by us. State and local taxes at destination, if applicable, are additional and for the buyer's account. Credit arrangements are subject to approval by our credit manager. A current Credit Application including specific project information is required.

Airex Corporation specifications were current at the time of publication. However, we do have a policy of continuous product improvement and reserve the right to make modifications to standard products without advance notice. On orders for custom or standard products, *AIREX* will provide drawings prior to fabrication for review and approval by the owner's representative. Once "*approved*", these drawings shall constitute the final specifications and bill of materials for the order.

Motor Mounting & Activation

Airex motors are designed for use in high performance linear applications. It should be noted that the motor will slide freely when power is not being applied. Proper safety mechanisms should be in place at all times in both horizontal and *vertical* mounting configurations. Particular attention should be paid to safety in vertical applications, where power loss can cause injury and/or machine damage.

Refer to Customer Prints provided by Airex for mechanical and electrical motor configurations. The following guidelines should be reviewed prior to motor installation.

Unplug (and discharge) the amplifier and power supply from the line voltage *before* making motor connections. Avoid bending the cable to a radius smaller than 10x the cable radius to prevent damage to the cable. Secure cables appropriately to avoid scraping and entanglement. Shorting the motor leads during motor movement may cause severe damage to motor and/or control components.

Use extreme caution when working around a motor in use or immediately following usage. The motor can operate at *extremely* high speeds and temperatures.

The user protects the motor from internal over-temperature conditions via a factory installed thermistor or thermostat. To insure long life and continued operation, the motor should not be operated at internal temperatures exceeding 125° C, and motor or HED module cable temperatures should not exceed 90°C. Always follow standard engineering guidelines for heat dissipation, and never operate the motor at high current without an appropriate heat sink.

Do not underestimate the strength of the magnetic flux in the magnet track. Personnel involved in the use of this track should use extreme caution when handling tools, fasteners and other mechanical devices around the magnet track. Do not disassemble the track under any circumstances without factory authorization.

A clearance gap must be maintained at all times between the windings and the magnet track. Severe damage to the motor may occur if foreign objects are allowed to enter the magnet track or if the motor is allowed to scrape along the magnets. Stop use immediately if contact occurs.

Component specifications and setup procedures must be followed when fine tuning your closed loop servo application. Remember to review your system motion requirements and duty cycle to prevent exceeding the ratings of system components.

Exposure to high levels of shock (such as dropping) can damage mechanical components and reduce the integrity of the motor or magnet track.

Direct any questions regarding motor operation or installation to:

Airex Corporation
15 Lilac Lane, Somersworth, NH 03878 USA
Phone: 603-841-2040 Fax: 603-692-4317
email: INFO@AIREX.com

Safety recommendations must be strictly followed.
Please speak directly with a factory representative if any abnormal condition or improper operation is observed

Coil Assembly Mounting

The coil mounting bracket must always be connected to the stage or load before high power operation. The stage is the heat sink for the motor coil and without a proper heat sink the motor can overheat. A thermal compound should be used to improve thermal conductivity.

The clearance gap between the motor coils and the magnets must be maintained. The motor coil must never be allowed to rub against the magnets in operation. Use shim material to establish the position of the motor in the magnet track while tightening the fasteners. Use the ***correct length*** bolts when fastening the bracket, as long bolts could protrude down and jam or rub against the magnet track.

Always monitor at least one thermal device in the motor coil and shut down the power amplifier when an over temperature condition occurs. Set the current limit of the amplifier such as to not exceed the published specifications of the motor.

DO NOT let the coil contact any end-of-travel stops. A mechanical impact could damage the windings causing an electrical shock or system failure. Do not use the motor if chips or other objects have entered the magnet track. Always use a cable carrier for the motor and Hall Effect cables to insure long flex life. A minimum bend radius of 10x the cable diameter is recommended.

HED Module Mounting

The HED module must never be allowed to rub against the magnets in operation.

DO NOT let the device contact end-of-travel stops. Mechanical impacts can damage components causing system failure.

Do not energize the motor if chips or other foreign materials have entered the magnet track. Use a suitable cable carrier for cables to insure long flex life. A minimum bend radius of 10x the cable diameter is recommended.

Magnet Track Mounting and Installation

A clean, flat and secure mounting surface must be provided for the magnet track. The track experiences forces in the opposite direction of the motor coil.

CAUTION: The magnet track contains extremely strong, rare earth magnets that will attract fasteners, tools, and metal chips. **DO NOT LET TOOLS OR SCREWS FALL INTO MOTOR TRACK.** Stray iron chips found on tools, work areas, and even on clothing can cause serious malfunctions if conveyed to the track. A contaminated magnet track should be returned to Airex for cleaning. Always keep the track sealed in its shipping container until it is ready to be installed.

The magnet track can be mounted laying down or standing on its back. Multiple tracks can be placed end-to-end to achieve any length of travel. Contact the factory for specific details.

General Guidelines for track mounting include:
Use a flat surface for track mounting
DO NOT bend the magnet track

⚠ CAUTION

DO NOT DISMANTLE THE MAGNET TRACK
Use sufficient quality and quantity of fasteners to insure mounting rigidity.

Warranty Information

Airex Corporation warrants that all products will be free from defects in material and workmanship under normal use, and are manufactured in accordance with the latest specifications in effect at the time of manufacture and/or in accordance with any drawing approved by the buyer and by Airex. This warranty is valid for a period of 90 days from the date of purchase, but is void if payment is not made in accordance with the terms of purchase.

A return must receive prior authorization from Airex. Returned products must be received in the same condition as originally shipped with transportation charges prepaid. Airex will, at our option, either repair or replace defective hardware upon receipt in accordance with the terms outlined above. This warranty is limited to motor repair or replacement only and shall not cover any other damages whatsoever including, without limitation, damages to other system components, loss of business, profits, business interruption, personal injury or other pecuniary losses arising out of the use of or inability to use this product, even if Airex has been advised of the possibility of such.

THERE ARE NO WARRANTIES WHICH EXTEND BEYOND THE DESCRIPTION CONTAINED HEREIN. ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTY OF MERCHANTABILITY AND THE IMPLIED WARRANTY OF FITNESS ARE HEREBY EXCLUDED.

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LINEAR MOTOR
Technical Drawings

QUALITY
PERFORMANCE
FLEXIBILITY

Setting a New Standard in Linear Motion

Solution Series™ Linear Motors

www.airex.com

ISO 9001:2000 CERTIFIED

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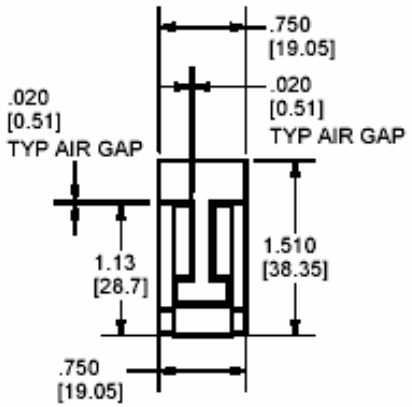
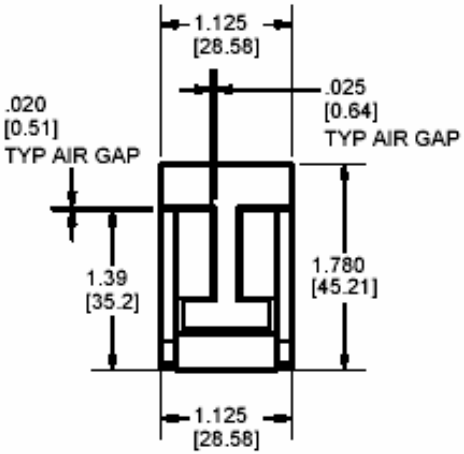
Tel: 603.841.2040 Fax: 603.692.4317 15 Lilac Lane, Somersworth, NH 03878
www.airex.com

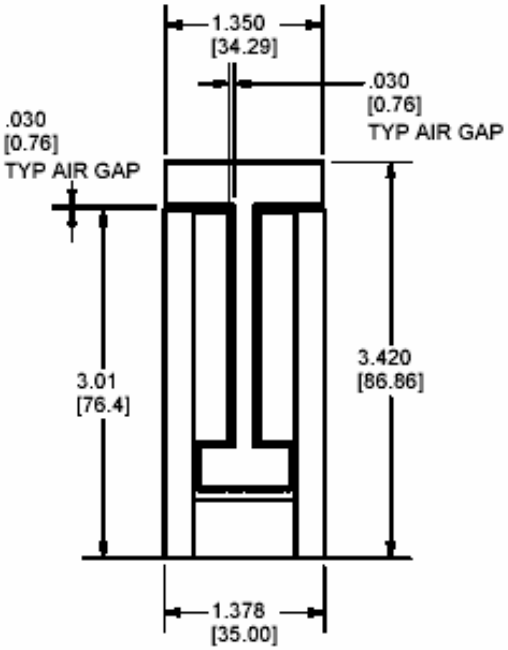
REVISION HISTORY						
REV	ECO#	ZONE	DESCRIPTION	BY	DATE	APPROVED
A	-	-	INITIAL RELEASE	PMJ	12/16/2005	JAW



P12
COIL AND MAGNET TRACK ASSEMBLY



P15
COIL AND MAGNET TRACK ASSEMBLY



P20
COIL AND MAGNET TRACK ASSEMBLY

UNLESS OTHERWISE SPECIFIED:
- DIMENSIONS ARE IN INCHES [mm]
- TOLERANCES ON:
X.XX ±0.01 [± 0.25 mm]
X.XXX ±0.005 [± 0.125 mm]
X/X ± 1/32
ANGLES ± 0°30'
125
DRAWING CONFORMS TO ANSI Y14.5

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DRAWN	PMJ	DATE 12/16/2005
CHECKED	PMJ	DATE 12/19/2005
APPROVED	JAW	DATE 12/19/2005
RELEASED	PMJ	DATE 12/19/2005
SCALE	NTS	SHEET 1 OF 1
MATERIAL	N/A	
FINISH	N/A	

AIREX CORPORATION
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www.airex.com

TITLE: P-SERIES COIL AND MAGNET TRACK ASSEMBLY PROFILES

SIZE	PART NO	REV
A	11625	A

NEXT LEVEL ASSEMBLY

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15 Lilac Lane, Somersworth, NH 03878
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REVISION HISTORY						
REV	ECO#	ZONE	DESCRIPTION	BY	DATE	APPROVED
A	-	-	INITIAL RELEASE	JAW	4/8/2004	DJC
B	159	-	CHANGES PER ECO 159	JAW	5/27/2004	DJC
C	188	-	CHANGES PER ECO#188	PMJ	12/16/2005	PMJ

COIL PART NUMBERING FORMAT

LINEAR MOTOR COIL	MOTOR SERIES	# OF POLES	COIL TYPE	INTERNAL WIRING	CABLE LENGTH	THERMAL DEVICE
LMC	- P12	- 1	3	S	36	N
LMC	P12	1	1 = COIL ONLY	S = SERIES	36 = 36 INCHES [914.4mm]	X = NONE
	P15	2	3 = COIL WITH HED COMMUTATION MODULE	P = PARALLEL	180 = 180 INCHES [4572mm]	L = NORMALLY CLOSED THERMOSTAT (P15 & P20)
	P20	3			(STANDARD LENGTH = 36 INCHES)	F = NORMALLY OPEN THERMOSTAT (P15 & P20)
		4				N = NEGATIVE TEMP. COEF. THERMISTOR
		5 (P20 ONLY)				P = POSITIVE TEMP. COEF. THERMISTOR
						C = TEMP TO CURRENT SENSOR

EXAMPLE: LMC-P12-13S36N

MAGNET TRACK PART NUMBERING FORMAT

LINEAR MOTOR TRACK	MOTOR SERIES	TRACK LENGTH	MAGNET	PROFILE
LMDT	- P12	- 12.0	F	S
LMDT	P12	25.2 = 25.2 INCHES [640.1mm]	F = STANDARD FOR P12 & P15	S = STANARD
	P15	P12 & P15 AVAILABLE IN 1.20 INCH [30.5mm] INCREMENTS	B = STANDARD FOR P20	
	P20	P20 AVAILABLE IN 2.40 INCH [61.0mm] INCREMENTS		

EXAMPLE: LMDT-P12-12.0FS

NOTES:

1. THESE TABLES ARE INTENDED TO BE USED AS A GUIDE FOR DETERMINING APPROPRIATE PART NUMBERS. PLEASE CONSULT THE AIREX APPLICATION MANUAL AND/OR SALES TEAM WITH ANY QUESTIONS.

2. MAGNET TRACK SECTIONS CAN BE CASCADED TO FORM ANY LENGTH TRACK. 1.20" [30.5] HOLE SPACING AND MOUNTING SURFACES MUST BE MAINTAINED.

UNLESS OTHERWISE SPECIFIED:
- DIMENSIONS ARE IN mm [INCHES]
- TOLERANCES ON:
X.XX ± 0.25mm [± 0.01inches]
X.XXX ± 0.125mm [± 0.005inches]
X/X ± N/A [± 1/32inches]
ANGLES ± 0°30'
DRAWING CONFORMS TO ANSI Y14.5

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DRAWN John W	DATE 4/8/2004	
CHECKED PMJ	DATE 12/16/2005	
APPROVED JAW	DATE 12/16/2005	
RELEASED PMJ	DATE 12/16/2005	
SCALE NTS	SHEET 1 OF 1	
MATERIAL N/A	SIZE A	PART NO 11046 / REV C
FINISH N/A	NEXT LEVEL ASSEMBLY	

AIREX CORPORATION
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TITLE: LINEAR MOTOR PART NUMBERING CONVENTION

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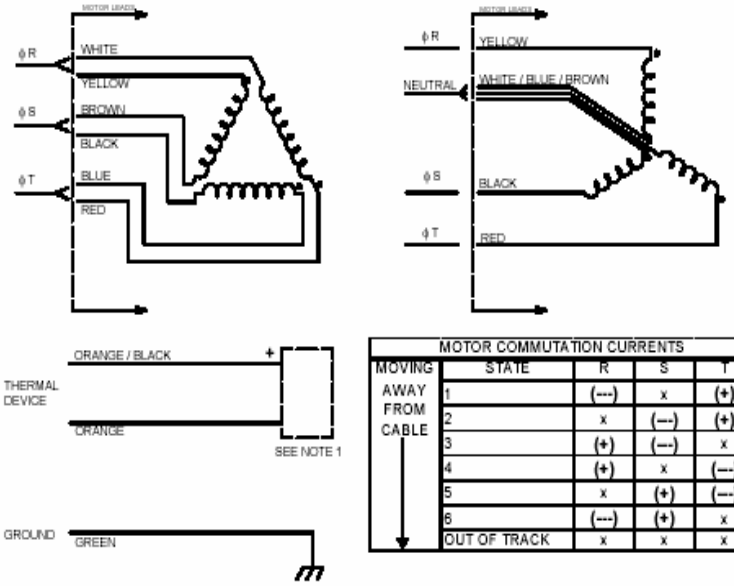
MOTOR SCHEMATICS



MOTOR COMMUTATION CURRENTS

MOVING AWAY FROM CABLE	STATE	R	S	T
	1	(---)	x	(+)
	2	x	(---)	(+)
	3	(+)	(---)	x
	4	(+)	x	(---)
	5	x	(+)	(---)
	6	(---)	(+)	x
	OUT OF TRACK	x	x	x

COMMUTATION CHART FOR OPTIONAL COMMUTATION MODULE

MOVING AWAY FROM CABLE	STATE	LMC-P20 SERIES HED CABLE BLUE S1	WHITE S2	GREEN S3	DELTA CONNECTED MOTOR CURRENTS R	S	T	LMC-P12 and LMC-P15 SERIES HED CABLE BLUE S1	WHITE S2	GREEN S3
	1	0	1	1	(---)	x	(+)	0	0	1
	2	0	0	1	x	(---)	(+)	1	0	1
	3	1	0	1	(+)	(---)	x	1	0	0
	4	1	0	0	(+)	x	(---)	1	1	0
	5	1	1	0	x	(+)	(---)	0	1	0
	6	0	1	0	(---)	(+)	x	0	1	1
	OUT OF TRACK	1	1	1	x	x	x	1	1	1

NOTES:

1. REFER TO APPLICATION MANUAL AND/OR DRAWING 11046 FOR THERMAL DEVICE OPTIONS.
2. GROUND (GREEN) LEAD IS ATTACHED TO THE MOUNTING BRACKET AND MUST BE PROPERLY GROUNDED. CABLE SHIELD (NOT SHOWN) TO BE GROUNDED AT CONTROLS.
3. PLEASE CONSULT THE FACTORY BEFORE USING THE OPTIONAL COMMUTATION MODULE WITH A WYE CONNECTED MOTOR.

REVISION HISTORY

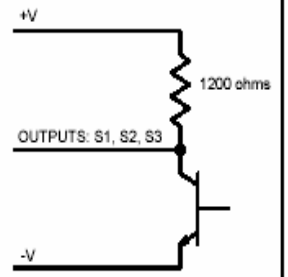
REV	ECO#	ZONE	DESCRIPTION	BY	DATE	APPROVED
A	-	ALL	INITIAL RELEASE	JAW	4/1/2004	DJC
B	156	-	ADDED HED SCHEMATIC & TABLES. MODIFIED LAYOUT.	JAW	5/5/2004	DJC
C	159	B1	CHANGES PER ECO 159	JAW	5/27/2004	DJC
D	189	ALL	CHANGES PER ECO 189	JS	1/6/2006	DJC

DATA FOR OPTIONAL HED COMMUTATION MODULE

CABLE COLOR CODE

HED CABLE	DESCRIPTION
RED	+V
BLACK	-V (GND)
BLUE	HALL OUTPUT S1
WHITE	HALL OUTPUT S2
GREEN	HALL OUTPUT S3

SCHEMATIC OF HED OUTPUT DRIVERS



HED SPECIFICATION

PARAMETER	CONDITIONS	VALUE
+V		+4.5 VDC TO +24 VDC
+V CURRENT	HED OUT OF TRACK	30 ma MAX
OUTPUT SINK CURRENT	Vsat = 0.8, +V = 24	0.5 ma
	Vsat = 0.8, +V = 4.5	19.5 ma
OUTPUT SOURCE CURRENT	Vsource = +V - 2	1.7 ma

NOTE: ALL TEST CONDITIONS ARE REFERENCED TO -V.

Log Code: 50000 Publish Date: 01-06-2006

UNLESS OTHERWISE SPECIFIED:
- DIMENSIONS ARE IN INCHES [mm]
- TOLERANCES ON:
X.XX ±0.01 [± 0.25 mm]
X.XXX ±0.005 [± 0.125 mm]
X/X ± 1/32
ANGLES ± 0°30'
DRAWING CONFORMS TO ANSI Y14.5

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DRAWN	John W	DATE 4/1/2004
CHECKED	SKN	DATE 5/27/2004
APPROVED	DJC	DATE 5/27/2004
RELEASED	JAW	DATE 5/27/2004
SCALE	NTS	SHEET 1 OF 1
MATERIAL		
FINISH		

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TITLE: CONNECTION SCHEMATIC WITH COMMUTATION CHART

SIZE	PART NO	REV
B	11022	D

NEXT LEVEL ASSEMBLY

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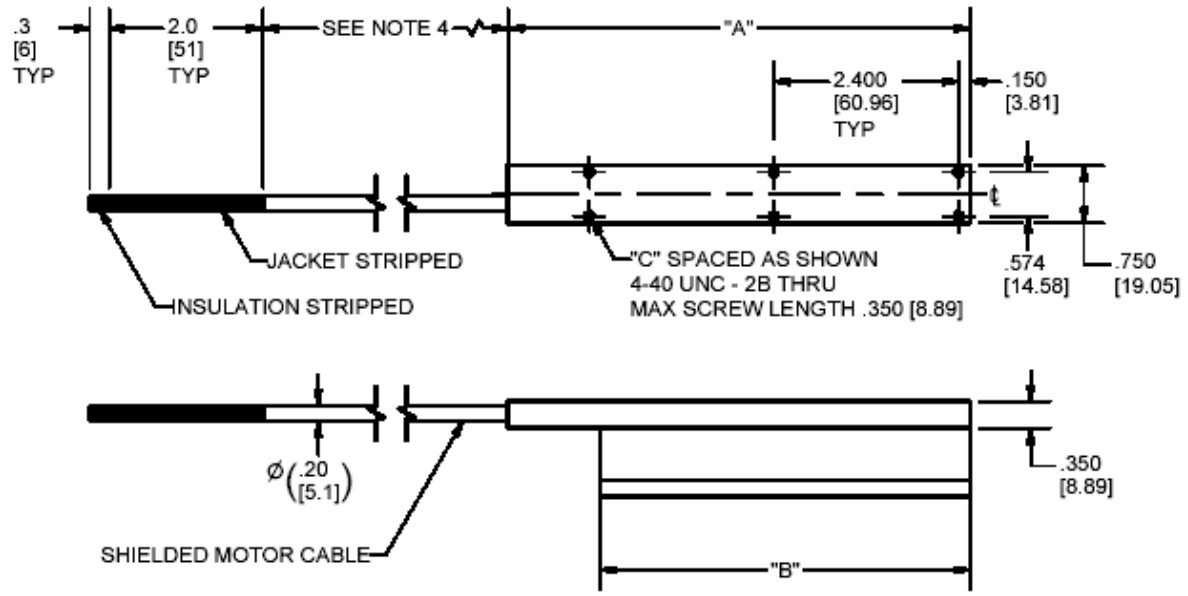
PART NUMBER	"A"	"B"	"C": # OF HOLES
LMC-P12-11XXXX	3.61 [91.7]	2.41 [61.2]	4
LMC-P12-21XXXX	6.01 [152.7]	4.81 [122.2]	6
LMC-P12-31XXXX	8.41 [213.6]	7.21 [183.1]	8
LMC-P12-41XXXX	10.81 [274.6]	9.61 [244.1]	10

REVISION HISTORY

REV	ECO#	ZONE	DESCRIPTION	BY	DATE	APPROVED
A	-	ALL	INITIAL RELEASE	JAW	4/1/2004	DJC
B	159	-	CHANGES PER ECO# 159	JAW	1/7/2005	DJC
C	188	-	CHANGES PER ECO#188	PMJ	11/3/2005	JAW



NOTES:

1. INCHES [MILLIMETERS].
2. LMC-P12-21XXXX MOTOR SHOWN.
3. REFER TO DRAWING 11022 FOR CONNECTION AND COMMUTATION DATA.
4. PRODUCT PART NUMBER SPECIFIES INTERNAL CONNECTION TYPE, CABLE LENGTH, AND THERMAL MANAGEMENT DEVICE. REFER TO DRAWING 11046 FOR PART NUMBERING CONVENTION.
4. SEE SHEET 2 FOR HED-COMMUTATED COIL DIMENSIONS.

UNLESS OTHERWISE SPECIFIED:
- DIMENSIONS ARE IN INCHES [mm]
- TOLERANCES ON:
X.XX ± 0.01 [± 0.25 mm]
X.XXX ± 0.005 [± 0.125 mm]
X/X ± 1/32
ANGLES ± 0°30'
125
DRAWING CONFORMS TO ANSI Y14.5

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DRAWN	John W	DATE 3/22/2004
CHECKED	PMJ	DATE 12/16/2005
APPROVED	JAW	DATE 12/16/2005
RELEASED	PMJ	DATE 12/16/2005
SCALE	NTS	SHEET 1 OF 3
MATERIAL	N/A	
FINISH	N/A	

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TITLE
P12 SERIES TABULATED SPECIFICATION DRAWING - COIL

SIZE	PART NO	REV
A	11021	C

NEXT LEVEL ASSEMBLY

AIREX CORPORATION
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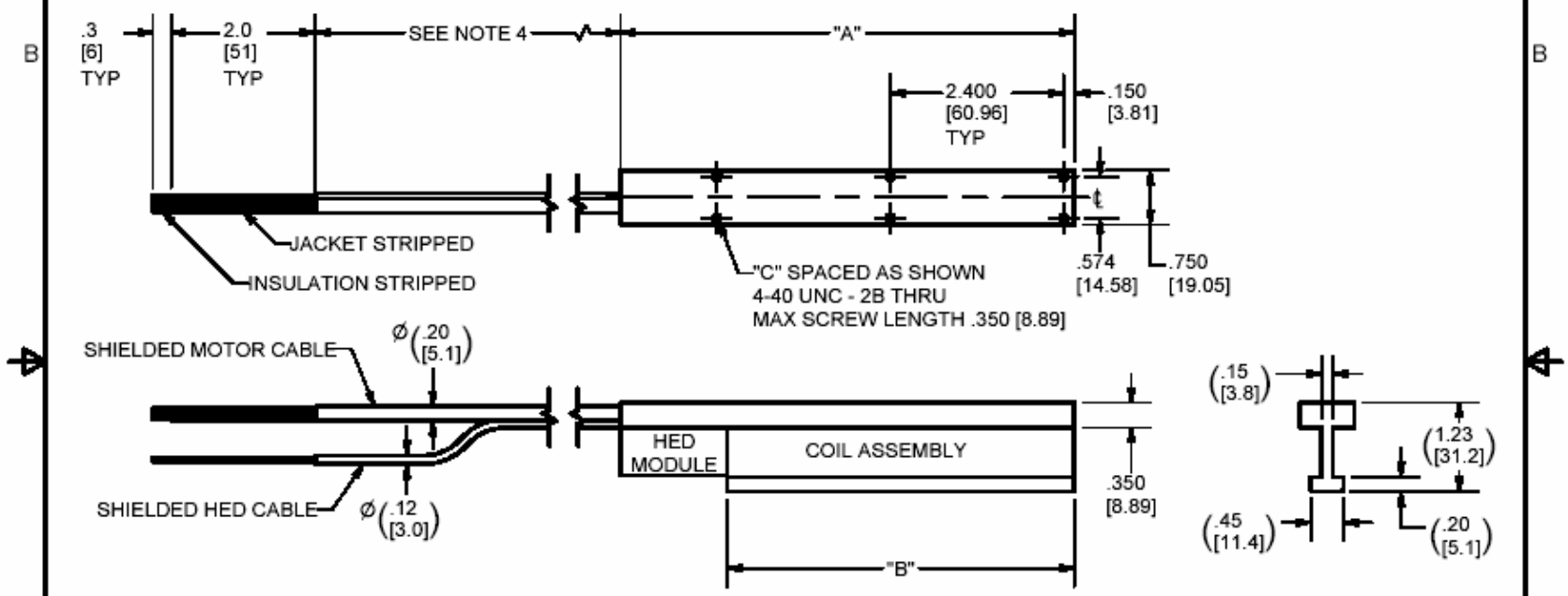
PART NUMBER	"A"	"B"	"C": # OF HOLES
LMC-P12-13XXXX	3.89 [98.8]	2.41 [61.2]	4
LMC-P12-23XXXX	6.29 [159.8]	4.81 [122.2]	6
LMC-P12-33XXXX	8.69 [220.7]	7.21 [183.1]	8
LMC-P12-43XXXX	11.09 [281.7]	9.61 [244.1]	10

REVISION HISTORY

REV	ECO#	ZONE	DESCRIPTION	BY	DATE	APPROVED
A	-	ALL	INITIAL RELEASE	JAW	4/1/2004	DJC
B	159	-	CHANGES PER ECO# 159	JAW	1/7/2005	DJC
C	188	-	CHANGES PER ECO#188	PMJ	11/3/2005	JAW



NOTES:

1. INCHES [MILLIMETERS].
2. LMC-P12-23XXXX MOTOR SHOWN.
3. REFER TO DRAWING 11022 FOR CONNECTION AND COMMUTATION DATA.
4. PRODUCT PART NUMBER SPECIFIES INTERNAL CONNECTION TYPE, CABLE LENGTH, AND THERMAL MANAGMENT DEVICE. REFER TO DRAWING 11046 FOR PART NUMBERING CONVENTION.
5. SEE SHEET 1 FOR NON-HED COMMUTATED COIL DIMENSIONS.

UNLESS OTHERWISE SPECIFIED:
- DIMENSIONS ARE IN INCHES [mm]
- TOLERANCES ON:
X.XX ± 0.01 [± 0.25 mm]
X.XXX ± 0.005 [± 0.125 mm]
X/X ± 1/32
ANGLES ± 0°30'
125
DRAWING CONFORMS TO ANSI Y14.5

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DRAWN John W	DATE 3/22/2004	
CHECKED PMJ	DATE 12/16/2005	
APPROVED JAW	DATE 12/16/2005	
RELEASED PMJ	DATE 12/16/2005	
SCALE NTS	SHEET 2 OF 3	

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TITLE: P12 SERIES TABULATED SPECIFICATION DRAWING - COIL WITH HED

MATERIAL	SIZE	PART NO	REV
N/A	A	11021	C

FINISH N/A

NEXT LEVEL ASSEMBLY

AIREX CORPORATION
15 Lilac Lane, Somersworth, NH 03878
Tel: 603.841.2040 Fax: 603.692.4317
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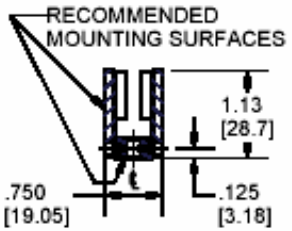
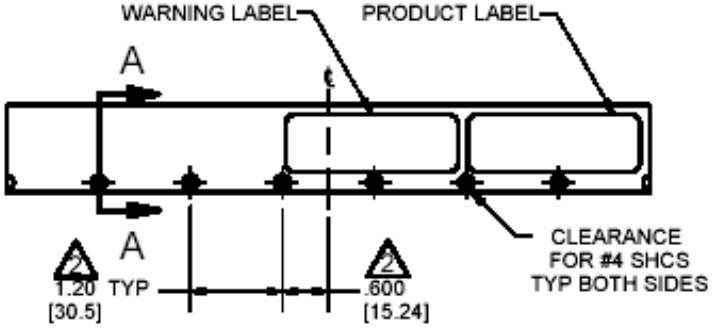
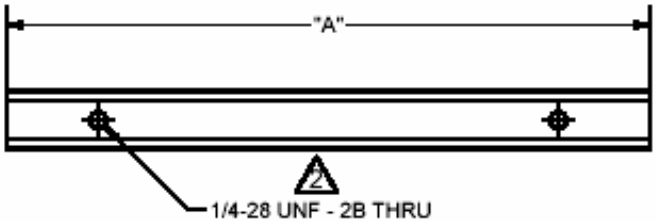
PART NUMBER	"A"
LMDT-P12-7.2FS	7.19 [182.6]
LMDT-P12-8.4FS	8.39 [213.1]
LMDT-P12-9.6FS	9.59 [243.6]
LMDT-P12-10.8FS	10.79 [274.1]
LMDT-P12-12.0FS	11.99 [304.5]
LMDT-P12-13.2FS	13.19 [335.0]
LMDT-P12-14.4FS	14.39 [365.5]
LMDT-P12-15.6FS	15.59 [396.0]
LMDT-P12-16.8FS	16.79 [426.5]
LMDT-P12-18.0FS	17.99 [456.9]
LMDT-P12-19.2FS	19.19 [487.4]
LMDT-P12-20.4FS	20.39 [517.9]
LMDT-P12-21.6FS	21.59 [548.4]
LMDT-P12-22.8FS	22.79 [578.9]
LMDT-P12-24.0FS	23.99 [609.3]

REVISION HISTORY						
REV	ECO#	ZONE	DESCRIPTION	BY	DATE	APPROVED
A	-	ALL	INITIAL RELEASE	JAW	4/1/2004	DJC
B	159	-	CHANGES PER ECO# 159	JAW	1/7/2005	DJC
C	188	-	CHANGES PER ECO#188	PMJ	11/3/2005	JAW



SECTION A-A





NOTES:
1. INCHES [MILLIMETERS].
2. CONSULT FACTORY FOR DETAILED DRAWINGS OF BOTTOM AND SIDE MOUNT OPTIONS. CENTERLINE MAY HAVE A FASTENER OR MOUNTING HOLE DEPENDING ON TRACK LENGTH.
3. REFER TO DRAWING 11046 FOR PART NUMBERING CONVENTION.
4. TRACK SECTIONS CAN BE CASCADED TO FORM ANY LENGTH. 1.20 [30.5] HOLE SPACING AND MOUNTING SURFACES MUST BE MAINTAINED.
5. LMDT-P12-8.4FS TRACK SHOWN.
6. CONSULT FACTORY FOR TRACK LENGTHS GREATED THAN 24" [609.6].

UNLESS OTHERWISE SPECIFIED:
- DIMENSIONS ARE IN INCHES [mm]
- TOLERANCES ON:
X.XX ± 0.01 [± 0.25 mm]
X.XXX ± 0.005 [± 0.125 mm]
X/X ± 1/32
ANGLES ± 0°30'
DRAWING CONFORMS TO ANSI Y14.5

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DRAWN	John W	DATE 3/22/2004
CHECKED	PMJ	DATE 12/16/2005
APPROVED	JAW	DATE 12/16/2005
RELEASED	PMJ	DATE 12/16/2005
SCALE	NTS	SHEET 3 OF 3
MATERIAL	N/A	
FINISH	N/A	

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TITLE: P12 SERIES TABULATED SPECIFICATION DRAWING - MAGNET TRACK

SIZE	PART NO	REV
A	11021	C

NEXT LEVEL ASSEMBLY: -

AIREX CORPORATION
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Tel: 603.841.2040 Fax: 603.692.4317
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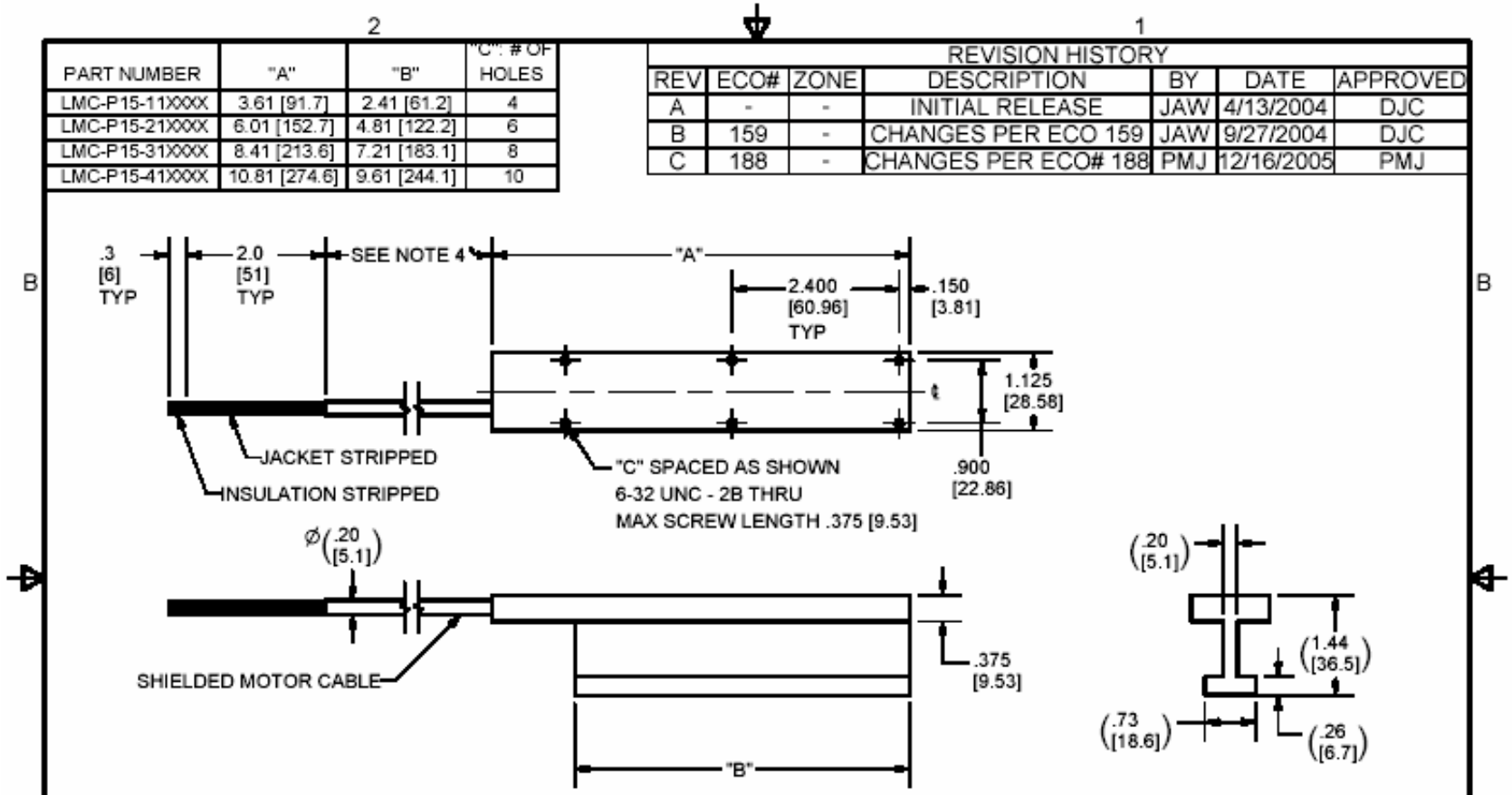
PART NUMBER	"A"	"B"	"C": # OF HOLES
LMC-P15-11XXXX	3.61 [91.7]	2.41 [61.2]	4
LMC-P15-21XXXX	6.01 [152.7]	4.81 [122.2]	6
LMC-P15-31XXXX	8.41 [213.6]	7.21 [183.1]	8
LMC-P15-41XXXX	10.81 [274.6]	9.61 [244.1]	10

REVISION HISTORY

REV	ECO#	ZONE	DESCRIPTION	BY	DATE	APPROVED
A	-	-	INITIAL RELEASE	JAW	4/13/2004	DJC
B	159	-	CHANGES PER ECO 159	JAW	9/27/2004	DJC
C	188	-	CHANGES PER ECO# 188	PMJ	12/16/2005	PMJ



NOTES:

1. INCHES [MILLIMETERS].
2. LMC-P15-21XXXX MOTOR SHOWN.
3. REFER TO DRAWING 11022 FOR CONNECTION & COMMUTATION DATA.
4. PRODUCT PART NUMBER SPECIFIES INTERNAL CONNECTION TYPE, CABLE LENGTH, AND THERMAL MANAGEMENT DEVICE. REFER TO DRAWING 11046 FOR PART NUMBERING CONVENTION.
5. SEE SHEET 2 FOR HED-COMMUTATED COIL DIMENSIONS.

UNLESS OTHERWISE SPECIFIED:
- DIMENSIONS ARE IN INCHES [mm]
- TOLERANCES ON:
X.XX ± 0.01 [± 0.25 mm]
X.XXX ± 0.005 [± 0.125 mm]
X/X ± 1/32
ANGLES ± 0°30'
DRAWING CONFORMS TO ANSI Y14.5

THESE DRAWINGS AND SPECIFICATIONS ARE THE PROPERTY OF AIREX CORP. ARE PROPRIETARY, ISSUED IN STRICT CONFIDENCE, AND SHALL NOT BE REPRODUCED, CONVEYED OR USED WITHOUT PRIOR WRITTEN PERMISSION.

DRAWN	John W	DATE 4/12/2004
CHECKED	PMJ	DATE 12/16/2005
APPROVED	JAW	DATE 12/16/2005
RELEASED	PMJ	DATE 12/16/2005
SCALE	NTS	SHEET 1 OF 3
MATERIAL	N/A	
FINISH	N/A	

AIREX CORPORATION
Precision Electromagnetic Component Design and Manufacturing
www.airex.com

TITLE: P15 SERIES TABULATED SPECIFICATION DRAWING - COIL

SIZE	PART NO	REV
A	11052	C

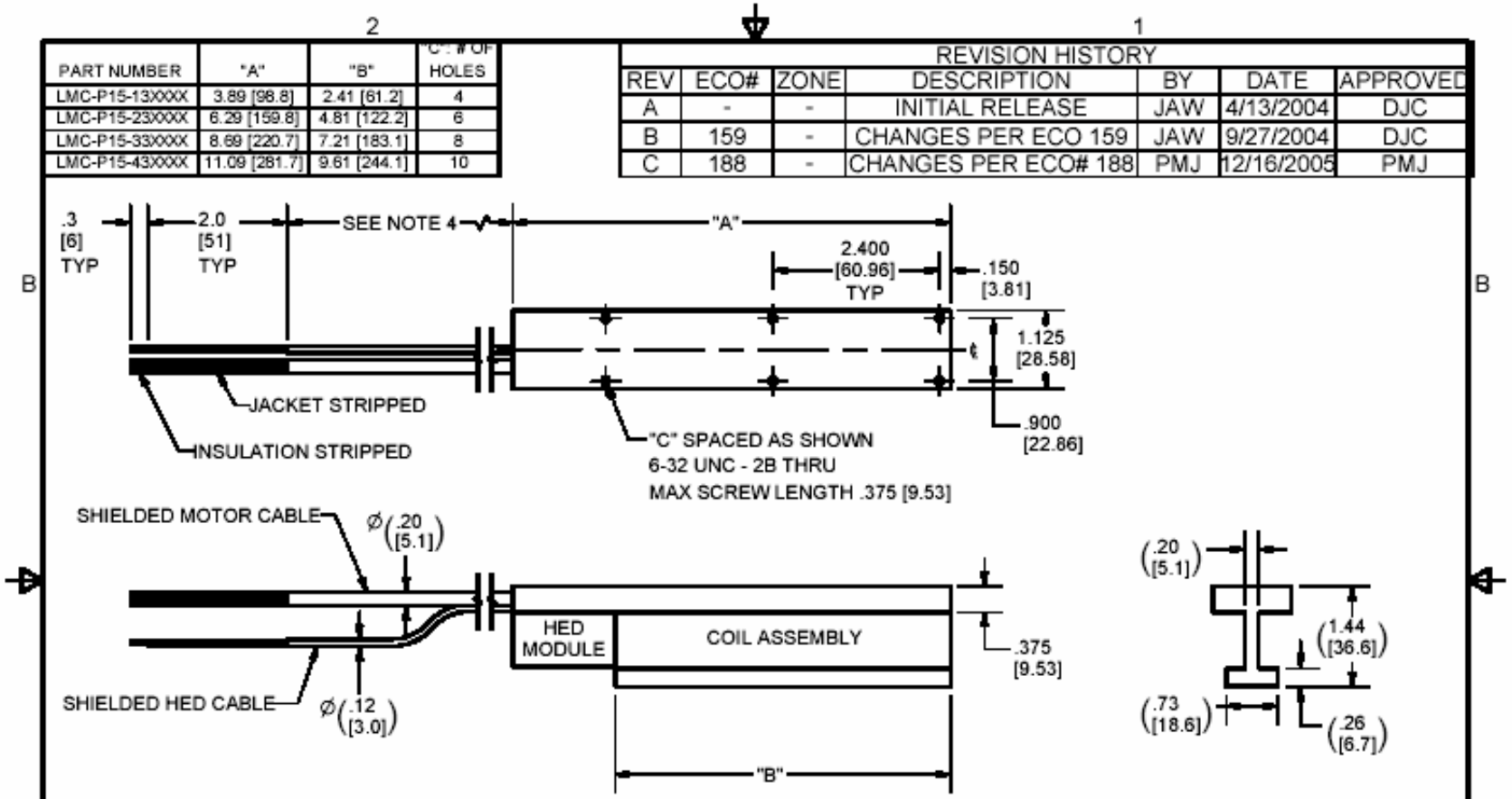
NEXT LEVEL ASSEMBLY

AIREX CORPORATION
15 Lilac Lane, Somersworth, NH 03878
Tel: 603.841.2040 Fax: 603.692.4317
www.airex.com

PART NUMBER	"A"	"B"	"C": # OF HOLES
LMC-P15-13XXXX	3.89 [98.8]	2.41 [61.2]	4
LMC-P15-23XXXX	6.29 [159.8]	4.81 [122.2]	6
LMC-P15-33XXXX	8.69 [220.7]	7.21 [183.1]	8
LMC-P15-43XXXX	11.09 [281.7]	9.61 [244.1]	10

REVISION HISTORY

REV	ECO#	ZONE	DESCRIPTION	BY	DATE	APPROVED
A	-	-	INITIAL RELEASE	JAW	4/13/2004	DJC
B	159	-	CHANGES PER ECO 159	JAW	9/27/2004	DJC
C	188	-	CHANGES PER ECO# 188	PMJ	12/16/2005	PMJ



NOTES:

1. INCHES [MILLIMETERS]
2. LMC-P15-23XXXX MOTOR SHOWN.
3. REFER TO DRAWING 11022 FOR CONNECTION AND COMMUTATION DATA.
4. PRODUCT PART NUMBER SPECIFIES INTERNAL CONNECTION TYPE, CABLE LENGTH, AND THERMAL MANAGEMENT DEVICE. REFER TO DRAWING 11046 FOR PART NUMBERING CONVENTION.
5. SEE SHEET 1 FOR NON-HED COMMUTATED COIL DIMENSIONS.

UNLESS OTHERWISE SPECIFIED:
- DIMENSIONS ARE IN INCHES [mm]
- TOLERANCES ON:
X.XX ± 0.01 [± 0.25 mm]
X.XXX ± 0.005 [± 0.125 mm]
X/X ± 1/32
ANGLES ± 0°30'
DRAWING CONFORMS TO ANSI Y14.5

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DRAWN	John W	DATE 4/12/2004
CHECKED	PMJ	DATE 12/16/2005
APPROVED	JAW	DATE 12/16/2005
RELEASED	PMJ	DATE 12/16/2005
SCALE	NTS	SHEET 2 OF 3
MATERIAL	N/A	
FINISH	N/A	

AIREX CORPORATION
Precision Electromagnetic Component Design and Manufacturing
www.airex.com

TITLE: P15 SERIES TABULATED SPECIFICATION DRAWING - COIL WITH HED

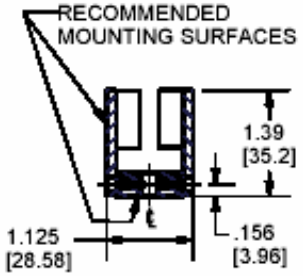
SIZE	PART NO	REV
A	11052	C

NEXT LEVEL ASSEMBLY

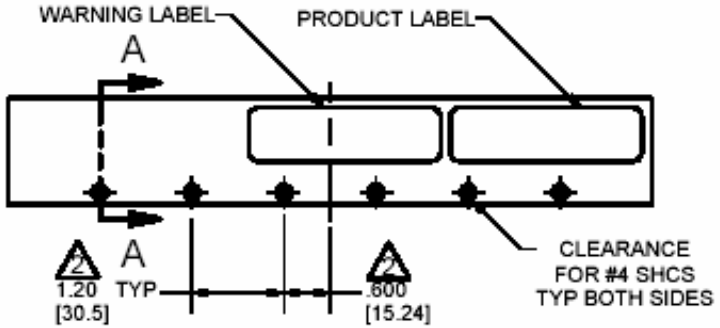
AIREX CORPORATION
15 Lilac Lane, Somersworth, NH 03878
Tel: 603.841.2040 Fax: 603.692.4317
www.airex.com

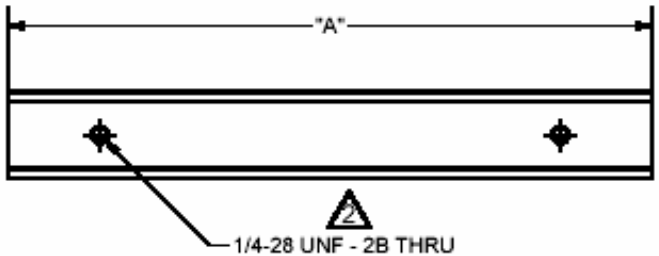
PART NUMBER	A
LMDT-P15-7.2FS	7.19 [182.6]
LMDT-P15-8.4FS	8.39 [213.1]
LMDT-P15-9.6FS	9.59 [243.6]
LMDT-P15-10.8FS	10.79 [274.1]
LMDT-P15-12.0FS	11.99 [304.5]
LMDT-P15-13.2FS	13.19 [335.0]
LMDT-P15-14.4FS	14.39 [365.5]
LMDT-P15-15.6FS	15.59 [396.0]
LMDT-P15-16.8FS	16.79 [426.5]
LMDT-P15-18.0FS	17.99 [456.9]
LMDT-P15-19.2FS	19.19 [487.4]
LMDT-P15-20.4FS	20.39 [517.9]
LMDT-P15-21.6FS	21.59 [548.4]
LMDT-P15-22.8FS	22.79 [578.9]
LMDT-P15-24.0FS	23.99 [609.3]

REVISION HISTORY						
REV	ECO#	ZONE	DESCRIPTION	BY	DATE	APPROVED
A	-	-	INITIAL RELEASE	JAW	4/13/2004	DJC
B	159	-	CHANGES PER ECO 159	JAW	9/27/2004	DJC
C	188	-	CHANGES PER ECO# 188	PMJ	12/16/2005	PMJ



SECTION A-A





NOTES:
1. INCHES [MILLIMETERS].
2. CONSULT FACTORY FOR DETAILED DRAWINGS OF BOTTOM AND SIDE MOUNT OPTIONS. CENTERLINE MAY HAVE A FASTENER OR MOUNTING HOLE DEPENDING ON THE TRACK LENGTH.
3. REFER TO DRAWING 11046 FOR PART NUMBERING CONVENTION.
4. TRACK SECTIONS CAN BE CASCADED TO FORM ANY LENGTH. 1.20 [30.5] HOLE SPACING AND MOUNTING SURFACES MUST BE MAINTAINED.
5. LMDT-P15-8.4FS TRACK SHOWN.
6. CONSULT FACTORY FOR TRACK LENGHTS GREATER THAN 24" [609.6].

UNLESS OTHERWISE SPECIFIED:
- DIMENSIONS ARE IN INCHES [mm]
- TOLERANCES ON:
X.XX ±0.01 [± 0.25 mm]
X.XXX ±0.005 [± 0.125 mm]
X/X ± 1/32
ANGLES ± 0°30'
DRAWING CONFORMS TO ANSI Y14.5

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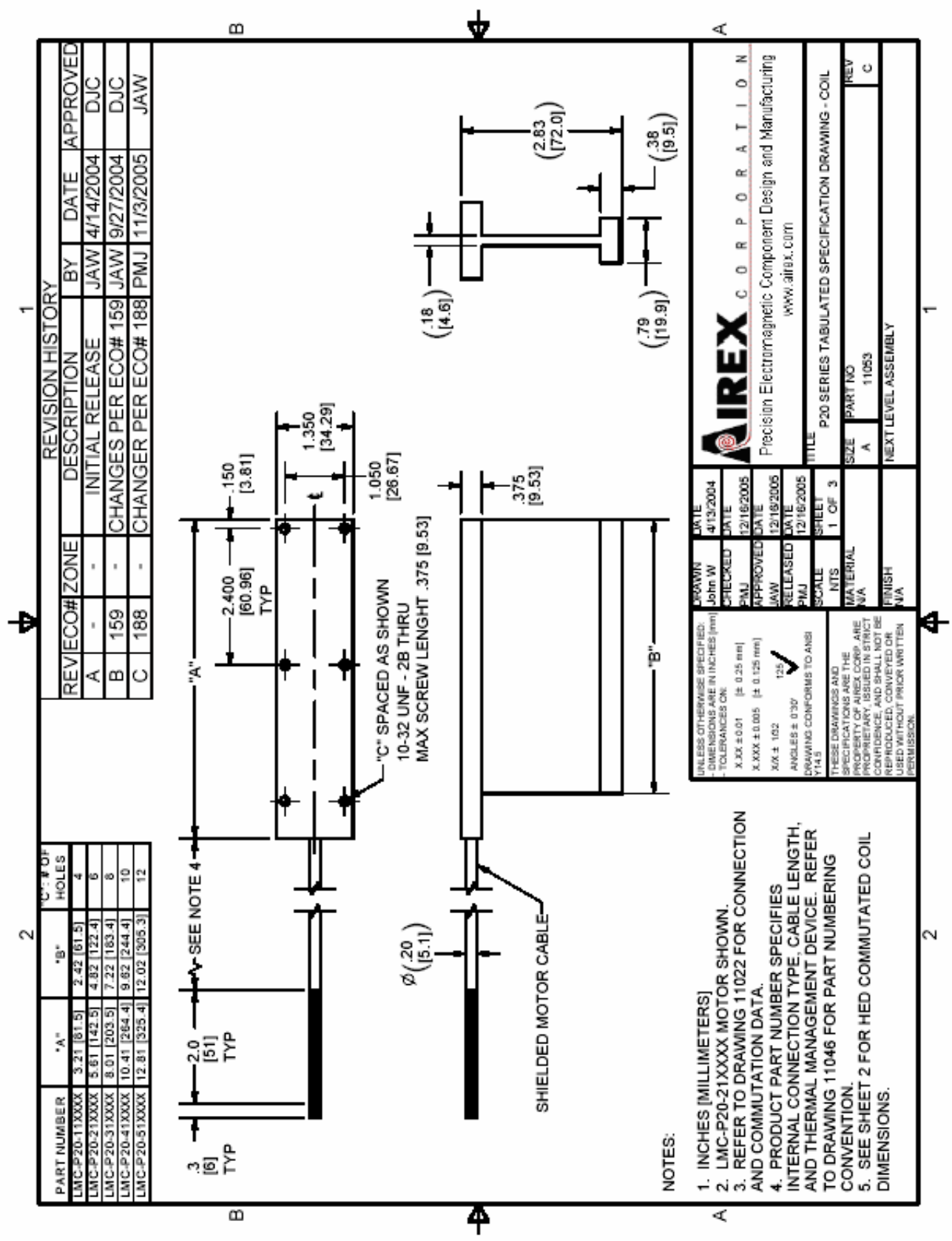
DRAWN	John W	DATE 4/12/2004
CHECKED	PMJ	DATE 12/16/2005
APPROVED	JAW	DATE 12/16/2005
RELEASED	PMJ	DATE 12/16/2005
SCALE	NTS	SHEET 3 OF 3
MATERIAL	N/A	
FINISH	N/A	

AIREX CORPORATION
Precision Electromagnetic Component Design and Manufacturing
www.airex.com

TITLE: P15 SERIES TABULATED SPECIFICATION DRAWING - MAGNET TRACK

SIZE	PART NO	REV
A	11052	C

NEXT LEVEL ASSEMBLY


REVISION HISTORY
REV | ECO# | ZONE | DESCRIPTION | BY | DATE | APPROVED
A | - | - | INITIAL RELEASE | JAW | 4/14/2004 | DJC
B | 159 | - | CHANGES PER ECO# 159 | JAW | 9/27/2004 | DJC
C | 188 | - | CHANGER PER ECO# 188 | PMJ | 11/3/2005 | JAW
PART NUMBER | "A" | "B" | "C" # OF HOLES
LMC-P20-11XXXX | 3.21 [81.5] | 2.42 [61.5] | 4
LMC-P20-21XXXX | 5.61 [142.5] | 4.82 [122.4] | 6
LMC-P20-31XXXX | 8.01 [203.5] | 7.22 [183.4] | 8
LMC-P20-41XXXX | 10.41 [264.4] | 9.62 [244.4] | 10
LMC-P20-51XXXX | 12.81 [325.4] | 12.02 [305.3] | 12
.3 [6] TYP
2.0 [51] TYP
SEE NOTE 4
"A"
2.400 [60.96] TYP
.150 [3.81]
1.350 [34.29]
1.050 [26.67]
"C" SPACED AS SHOWN
10-32 UNF - 2B THRU
MAX SCREW LENGHT .375 [9.53]
.375 [9.53]
"B"
Ø(.20 [5.1])
SHIELDED MOTOR CABLE
(.18 [4.6])
(2.83 [72.0])
(.38 [9.5])
(.79 [19.9])
NOTES:
1. INCHES [MILLIMETERS]
2. LMC-P20-21XXXX MOTOR SHOWN.
3. REFER TO DRAWING 11022 FOR CONNECTION AND COMMUTATION DATA.
4. PRODUCT PART NUMBER SPECIFIES INTERNAL CONNECTION TYPE, CABLE LENGTH, AND THERMAL MANAGEMENT DEVICE. REFER TO DRAWING 11046 FOR PART NUMBERING CONVENTION.
5. SEE SHEET 2 FOR HED COMMUTATED COIL DIMENSIONS.
UNLESS OTHERWISE SPECIFIED: - DIMENSIONS ARE IN INCHES [mm] - TOLERANCES ON: X.XX ± 0.01 [± 0.25 mm] X.XXX ± 0.005 [± 0.125 mm] X/X ± 1/32 ANGLES ± 0.30' 125 DRAWING CONFORMS TO ANSI Y14.5
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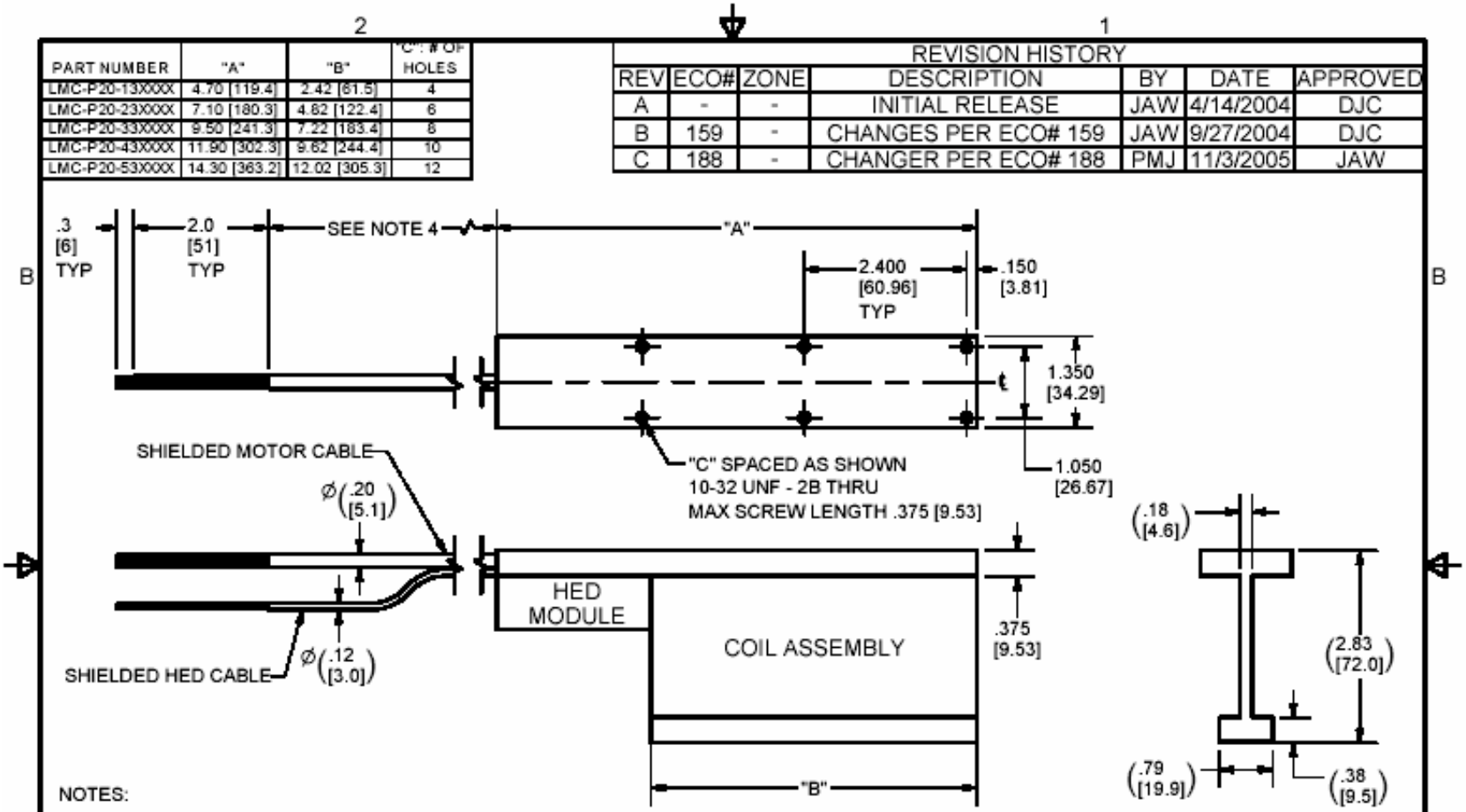
DRAWN John W DATE 4/13/2004
CHECKED PMJ DATE 12/16/2005
APPROVED JAW DATE 12/16/2005
RELEASED PMJ DATE 12/16/2005
SCALE NTS SHEET 1 OF 3
MATERIAL N/A
FINISH N/A
AIREX CORPORATION
Precision Electromagnetic Component Design and Manufacturing
www.airex.com
TITLE P20 SERIES TABULATED SPECIFICATION DRAWING - COIL
SIZE A PART NO 11053 REV C
NEXT LEVEL ASSEMBLY

AIREX CORPORATION
15 Lilac Lane, Somersworth, NH 03878
Tel: 603.841.2040 Fax: 603.692.4317
www.airex.com

PART NUMBER	"A"	"B"	"C": # OF HOLES
LMC-P20-13XXXX	4.70 [119.4]	2.42 [61.5]	4
LMC-P20-23XXXX	7.10 [180.3]	4.82 [122.4]	6
LMC-P20-33XXXX	9.50 [241.3]	7.22 [183.4]	8
LMC-P20-43XXXX	11.90 [302.3]	9.62 [244.4]	10
LMC-P20-53XXXX	14.30 [363.2]	12.02 [305.3]	12

REVISION HISTORY

REV	ECO#	ZONE	DESCRIPTION	BY	DATE	APPROVED
A	-	-	INITIAL RELEASE	JAW	4/14/2004	DJC
B	159	-	CHANGES PER ECO# 159	JAW	9/27/2004	DJC
C	188	-	CHANGER PER ECO# 188	PMJ	11/3/2005	JAW



NOTES:

1. INCHES [MILLIMETERS].
2. LMC-P20-23XXXX MOTOR SHOWN.
3. REFER TO DRAWING 11022 FOR CONNECTION AND COMMUTATION DATA.
4. PRODUCT PART NUMBER SPECIFIES INTERNAL CONNECTION TYPE, CABLE LENGTH, AND THERMAL MANAGEMENT DEVICE. REFER TO DRAWING 110046 FOR PART NUMBERING CONVENTION.
5. SEE SHEET 1 FOR NON-HED COMMUTATED COIL DIMENSIONS.

UNLESS OTHERWISE SPECIFIED:
- DIMENSIONS ARE IN INCHES [mm]
- TOLERANCES ON:
X.XX ± 0.01 [± 0.25 mm]
X.XXX ± 0.005 [± 0.125 mm]
X/X ± 1/32
ANGLES ± 0°30'
DRAWING CONFORMS TO ANSI Y14.5

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DRAWN	John W	DATE 4/13/2004
CHECKED	PMJ	DATE 12/16/2005
APPROVED	JAW	DATE 12/16/2005
RELEASED	PMJ	DATE 12/16/2005
SCALE	NTS	SHEET 2 OF 3
MATERIAL	N/A	
FINISH	N/A	

AIREX CORPORATION
Precision Electromagnetic Component Design and Manufacturing
www.airex.com

TITLE: P20 SERIES TABULATED SPECIFICATION DRAWING - COIL WITH HED

SIZE	PART NO	REV
A	11053	C

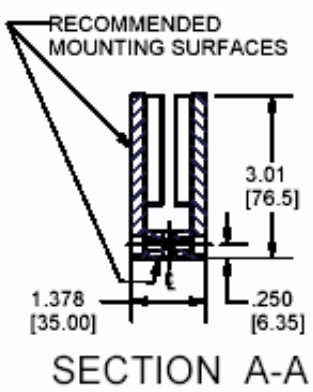
NEXT LEVEL ASSEMBLY

AIREX CORPORATION
15 Lilac Lane, Somersworth, NH 03878
Tel: 603.841.2040 Fax: 603.692.4317
www.airex.com

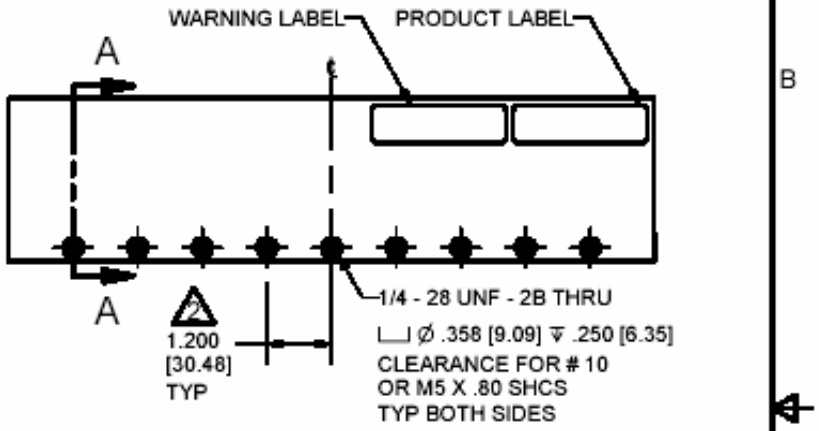
PART NUMBER	A
LMDT-P20-7.2BS	7.19 [182.6]
LMDT-P20-9.6BS	9.59 [243.6]
LMDT-P20-12.0BS	11.99 [304.5]
LMDT-P20-14.4BS	14.39 [365.5]
LMDT-P20-16.8BS	16.79 [426.5]
LMDT-P20-19.2BS	19.19 [487.4]
LMDT-P20-21.6BS	21.59 [548.4]
LMDT-P20-24.0BS	23.99 [609.3]
LMDT-P20-26.4BS	26.39 [670.3]
LMDT-P20-28.8BS	28.79 [731.3]
LMDT-P20-31.2BS	31.19 [792.2]
LMDT-P20-33.6BS	33.59 [853.2]
LMDT-P20-36.0BS	35.99 [914.1]
LMDT-P20-38.4BS	38.39 [975.1]
LMDT-P20-40.8BS	40.79 [1036.1]
LMDT-P20-45.6BS	45.59 [1158.0]
LMDT-P20-48.0BS	47.99 [1218.9]

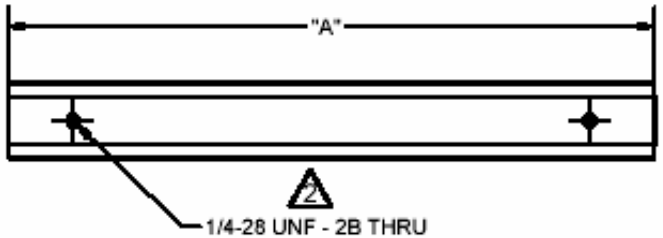
REVISION HISTORY

REV	ECO#	ZONE	DESCRIPTION	BY	DATE	APPROVED
A	-	-	INITIAL RELEASE	JAW	4/14/2004	DJC
B	159	-	CHANGES PER ECO# 159	JAW	9/27/2004	DJC
C	188	-	CHANGER PER ECO# 188	PMJ	11/3/2005	JAW



SECTION A-A





NOTES:

1. INCHES [MILLIMETERS].
2. CONSULT FACTORY FOR DETAILED DRAWINGS OF BOTTOM AND SIDE MOUNT OPTIONS. CENTERLINE MAY HAVE A FASTENER OR MOUNTING HOLE DEPENDING ON TRACK LENGTH.
3. REFER TO DRAWING 11046 FOR PART NUMBERING CONVENTION.
4. TRACK SECTIONS CAN BE CASCADED TO FORM ANY LENGTH. 1.20 [30.5] HOLE SPACING AND MOUNTING SURFACES MUST BE MAINTAINED.
5. LMDT-P20-12.0BS TRACK SHOWN.

UNLESS OTHERWISE SPECIFIED:
- DIMENSIONS ARE IN INCHES [mm]
- TOLERANCES ON:
X.XX ± 0.01 [± 0.25 mm]
X.XXX ± 0.005 [± 0.125 mm]
X/X ± 1/32
ANGLES ± 0°30'
DRAWING CONFORMS TO ANSI Y14.5

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DRAWN	John W	DATE 4/13/2004
CHECKED	PMJ	DATE 12/16/2005
APPROVED	JAW	DATE 12/16/2005
RELEASED	PMJ	DATE 12/16/2005
SCALE	NTS	SHEET 3 OF 3
MATERIAL	N/A	
FINISH	N/A	

AIREX CORPORATION
Precision Electromagnetic Component Design and Manufacturing
www.airex.com

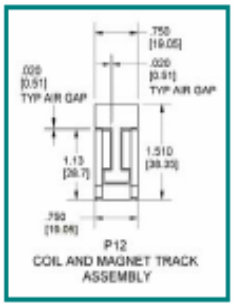
TITLE
P20 SERIES TABULATED SPECIFICATION DRAWING - MAGNET TRACK

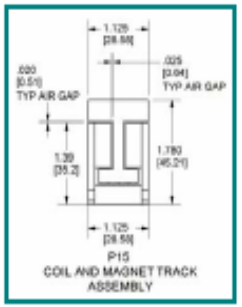
SIZE	PART NO	REV
A	11053	C

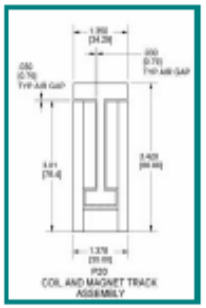
NEXT LEVEL ASSEMBLY

AIREX CORPORATION
15 Lilac Lane, Somersworth, NH 03878
Tel: 603.841.2040 Fax: 603.692.4317
www.airex.com

P-Series Linear Motor Summary







Coil Configurations	*-1 to -4 Coil Options*	*-1 to -4 Coil Options*	*-1 to -6 Coil Options*
Continuous Force	*to 24 Pounds*	*to 32 Pounds*	*to 80 Pounds*
	to 100 Newtons	*to 140 Newtons*	*to 360 Newtons*
Continuous Power	*to 320 Watts*	*to 330 Watts*	*to 420 Watts*
Peak Force	*to 76 Pounds*	*to 100 Pounds*	*to 400 Pounds*
	to 337 Newtons	*to 444 Newtons*	*to 1150 Newtons*
Peak Power	*to 3250 Watts*	*to 3295 Watts*	*to 4200 Watts*
Motor Constant	*to 1.3 lbs/√watt*	*to 1.7 lbs/√watt*	*to 3.8 lbs/√watt*
	to 5.65 N/√watt	*to 7.71 N/√watt*	*to 16.80 N/√watt*
Velocities	*to 3 Meters/second*	*to 3 Meters/second*	*to 5 Meters/second*
Accelerations	*to 5 G's*	*to 5 G's*	*to 10 G's*
Electrical Time Constant	*.22*	*.21*	*.35*
Additional Features	*Sinusoidal or Hall Commutation* *Thermistor & Thermostat options* *Continuous Tracks to 24 inches* *Vacuum Compatible Designs* *High Performance Rare Earth Magnets* *Low Inductance Coil for Fast Response* *Non-Contacting Assemblies* *Configurable Coil Connections* *Fully Customizable Design*	*Sinusoidal or Hall Commutation* *Thermistor & Thermostat options* *Continuous Tracks to 24 inches* *Vacuum Compatible Designs* *High Performance Rare Earth Magnets* *Low Inductance Coil for Fast Response* *Non-Contacting Assemblies* *Configurable Coil Connections* *Fully Customizable Design*	*Sinusoidal or Hall Commutation* *Thermistor & Thermostat options* *Continuous Tracks to 40 inches* *Vacuum Compatible Designs* *High Performance Rare Earth Magnets* *Low Inductance Coil for Fast Response* *Non-Contacting Assemblies* *Configurable Coil Connections* *Fully Customizable Design*

Solution Series® Linear Motors

www.airex.com

ISO 9001:2000 certified

January 2006 Release