Linear Positioning Stage

Hardware Manual

P/N: EDA130 (Revision 1.01.00)

Dedicated to the Science of Motion
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Revision History

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Table of Contents

List of Figures

List of Tables

Chapter 1: Overview

This manual provides general information on the installation and care of many Aerotech linear positioning stages. Chapter 2: Installation provides tips on unpacking the stage, preparing the mounting surface and installing the stage. Chapter 3: Maintenance gives instructions for cleaning and lubricating the stage.

1.1. Safety Procedures and Warnings

The following statements apply throughout this manual. Failure to observe these precautions could result in serious injury to those performing the procedures and/or damage to the equipment.

To minimize the possibility of electrical shock and bodily injury, confirm that all electrical power is disconnected prior to making any electrical connections.

To minimize the possibility of electrical shock and bodily injury when any electrical circuit is in use, ensure that no person comes in contact with the circuitry when the stage is connected to a power source.

Care must be exercised that all personnel remain clear of any moving parts.

To minimize the possibility of bodily injury, confirm that all electrical power is disconnected prior to making any mechanical adjustments.

Chapter 2: Installation

This chapter covers the mechanical aspects of setting up Aerotech linear positioning stages, including handling the stage properly, preparing the mounting surface to accept the stage, securing the stage to the mounting surface, and attaching the payload.

2.1. Unpacking and Handling the Stage

Carefully remove the stage from the protective shipping container. Set the stage on a smooth, flat, and clean surface. This is a simple, yet very important step in maintaining the integrity of the stage. Each stage has a label listing the system part number and serial number. These numbers contain information necessary for maintaining or updating system hardware and software. Locate this label and record the information for later reference. If any concealed damage has occurred during shipping, report it immediately.

Improper stage handling could adversely affect the stage's performance. Therefore, use care when moving the stage. Do not allow the stage to drop onto the mounting surface.

2.2. Preparing the Mounting Surface

To obtain the full benefit from these precision products, the mounting surface must be comparable in quality, flat, and rigid. For a linear positioning stage to maintain accuracy, the mounting surface should be coplanar within 50 * 10^{-6} in/in (cm/cm)for low accuracy stages and 10 * 10^{-6} in/in for high accuracy stages. For example, if the longest distance between the rectangular base hole pattern on a high accuracy stage is 8 in (20 cm), then the mounting surface should be coplanar within 0.000080 in (0.00020 cm). Adjustments to the mounting surface must be done before the stage is secured. The effects of coplanar versus noncoplanar mounting are illustrated in Figure 2-1.

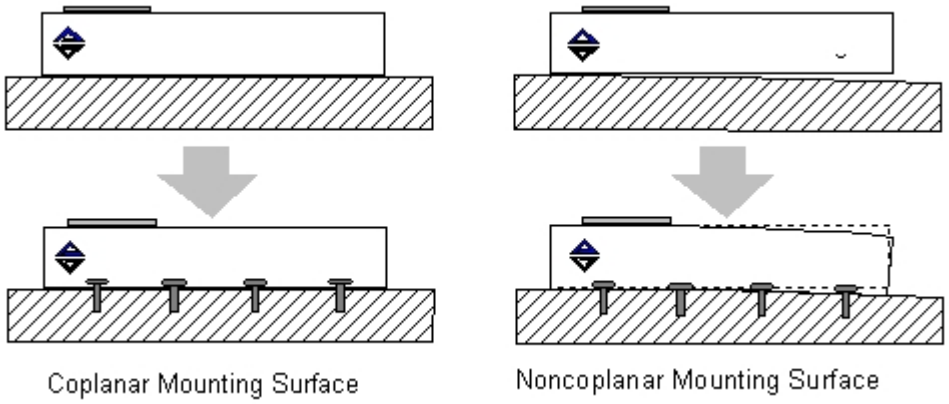

Figure 2-1: Results of Coplanar versus Noncoplanar Mounting

When a stage is mounted to a noncoplanar surface (see Figure 2-1), the stage can be distorted as the mounting screws are tightened. This distortion will decrease the overall accuracy of the stage.

NOTE

The pads of the stage have been "flatness calibrated" on a grade–AA laboratory granite base at the factory. Any scraping must be done to the mounting surface, not to the stage. Any shimming must be done prior to securing the stage to the surface.

2.3. Securing the Stage to the Mounting Surface

Most stages have external mounting holes on the base. Some stages (ATS100 series) have internal mounting holes. On some stages with internal mounting holes, the stage table will have corresponding holes that allow access to the mounting holes. On others, the way cover must be removed. Remove the way cover or manually move the stage table so that access holes on the stage table are aligned with any two of the mounting holes on the under side of the stage. Install the appropriately sized mounting screws though the access holes and secure the stage to the mounting surface. Repeat this process for each set of mounting holes.

The stage table may offer a considerable amount of resistance when it is moved manually. This is especially true if the stage is fitted with a motor assembly. If the stage is not connected to a power source, it should be possible, with a steady, even pressure, to move the stage table by hand. Do not attempt to move the stage if it is connected to a power source.

2.4. Attaching the Payload to the Stage

To prevent damage to delicate payloads, test the operation of the stage before the payload is attached to the stage table. Proceed with the electrical installation and test the motion control system in accordance with the system documentation. Document all results for future reference.

It is recommended that application loads be symmetrically distributed (i.e. the payload should be centered on the stage table and the entire stage should be centered on the support structure). Refer to the Aerotech Motion Control Product guide for information on loading capacity and cantilevered loading. To maintain valid accuracy, the payload should be of comparable to the stage in quality, rigidity, and flatness. When attaching a payload to the stage table, the mounting interface should generally be coplanar within

$50 * 10^{-6}$ to $10 * 10^{-6}$ in/in (cm/cm) for low and high accuracy stages, respectively. This can be achieved by scraping or shimming the mounting surface of the payload. It is recommended that feet or pads be used on the payload surface to minimize the amount of surface area that needs to be coplanar.

Chapter 3: Maintenance

It is necessary to keep the bearing surfaces properly lubricated. Otherwise, failure and deformation may occur at the contact areas. This can seriously affect the performance and life of the bearings.

The bearing area must be kept free of foreign matter and moisture, otherwise, the performance and life expectancy of the stage will be reduced. Always operate the stage with the way cover in place to help keep dirt out.

3.1. Lubrication Schedule

Lubricant inspection and replenishment depend on conditions such as duty cycle, speed, and the environment. An inspection interval of once per week is recommended until a trend develops for the application. Longer or shorter intervals may be required to maintain the film of lubricant on the raceway and bearings of the stage.

Between lubrications, periodically running the stage from limit to limit will help redistribute the lubricant and extend the life of the stage.

Ball screws, lead screws, linear bearings, linear motion guides (LMG), and end bearings are the components that may require lubrication. In general, ball screws and linear bearings require lubricant after 500,000 m (20 million in) of travel, while lead screws and gear sets require more frequent lubrication. A LMG may require lubrication after 100,000 m (4 million in) of travel. Some lead screw/ball screw end bearings and motor bearings are shielded, and should not need to be relubricated under normal use.

3.2. Lubrication and Cleaning Process

The lubrication and cleaning process is outlined in the steps that follow. Some steps may not be applicable to your stage.

1. Drive the stage table to either end of travel and turn the power off.
2. Remove or disconnect the way covers.
3. Remove any accumulated dust or debris from the inside of the assembly.
4. Remove any dirty or dried lubricant from the lead screw/ball screw. Use a clean cloth with a side-to-side motion to clean the thread roots. Manually turn the lead screw/ball screw to clean its entire circumference. A cotton swab soaked in solvent may be used to remove stubborn debris.
5. Clean the end of the lead screw/ball screw nut and wiper with a clean cloth or cotton swab. These areas can be accessed from the underside of the stage if necessary.
6. Clean the linear bearing guides using a similar technique.
7. After the solvent has evaporated (if solvent is used), apply a thin, continuous film of lubricant to the lead screw/ball screw threads and linear bearing guides. A good quality, natural bristle artist's brush makes an excellent applicator.
8. If they are unshielded, inspect ball screw/lead screw end bearings. If dirty or contaminated, the bearing should be replaced by Aerotech. If dry, then apply grease to races with a hypodermic needle.
9. If the stage has LMG bearing trucks with grease nipples, lubricate the LMG bearing trucks on each corner of the table carriage. Use a grease gun with a grease nipple (type UU or SS).
10. Refasten the way covers and screws to the stage table.
11. Restore power to the stage, drive the stage table to the opposite (far) end of travel, and remove power.
12. Repeat steps 2 through 9.

3.3. Imporant Notes on Lubrication

When cleaning and/or lubricating stage components:

1. Be sure to use a clean dry, soft, lint–free cloth for cleaning.
2. Take the opportunity during the lubrication procedure to inspect the linear motion guides for any damage or signs of wear.
3. In applications that have multiple stages bolted together to form multiaxis systems, the orthogonality may be lost if the stage tables of the support stages are loosened. A master square must be used to realign the XY or YZ orthogonality.
4. Further disassembly of the stage is not recommended, since proper assembly and calibration can only be done at the factory.

3.4. Recommended Lubricants

For lead screw assemblies, the recommended lubricant is an extreme pressure lubricant (#3 or equivalent) available at:

Chicago Manufacturing and Distribution Division
Evans Product Company
2980 Switzer Street
Columbus, Ohio 43219

For standard ball screw and gearset assemblies, use Dow Corning's BR 2 lithium soap grease.

For high−speed applications (i.e., near maximum speed at a duty cycle of 50%), frequent ball screw maintenance with standard lubricants or an auto-lubrication design is required.

For linear bearings, Dow Corning's Molykote 44 is recommended.

Appendix A: Glossary

Abbe Error	The positioning error resulting from angular motion and an offset between the measuring device and the point of interest.
Abbe Offset	The value of the offset between the measuring device and the point of interest.
Absolute Move	A move referenced to a known point or datum.
Absolute Programming	A positioning coordinate reference where all positions are specified relative to a reference or “home” position.
AC Brushless Servo	A servomotor with stationary windings in the stator assembly and permanent magnet rotor. AC brushless generally refers to a sinusoidally wound motor (such as BM series) to be commutated via sinusoidal current waveform. (see DC brushless servo)
Acceleration	The change in velocity as a function of time.
Accuracy	An absolute measurement defining the difference between actual and commanded position.
Accuracy Grade	In reference to an encoder grating, accuracy grade is the tolerance of the placement of the graduations on the encoder scale.
ASCII	American Standard Code for Information Interchange. This code assigns a number to each numeral and letter of the alphabet. Information can then be transmitted between machines as a series of binary numbers.
Axial Runout	Positioning error of the rotary stage in the vertical direction when the tabletop is oriented in the horizontal plane. Axial runout is defined as the total indicator reading on a spherical ball positioned 50 mm above the tabletop and centered on the axis of rotation.
Axis of Rotation	A centerline about which rotation occurs.
Back emf, Kemf	The voltage generated when a permanent magnet motor is rotated. This voltage is proportional to motor speed and is present whether or not the motor windings are energized.
Backlash	A component of bidirectional repeatability, it is the non-responsiveness of the system load to reversal of input command.
Ball Screw	A precision device for translating rotary motion into linear motion. A lead screw is a low-cost lower performance device performing the same function. Unit consists of an externally threaded screw and an internally threaded ball nut.
Ball Screw Lead	The linear distance a carriage will travel for one revolution of the ball screw (lead screw).
Bandwidth	A measurement, expressed in frequency (hertz), of the range which an amplifier or motor can respond to an input command from DC to -3dB on a frequency sweep.
Baud Rate	The number of bits transmitted per second on a serial communication channel such as RS-232 or modem.
BCD	Binary Coded Decimal - A number system using four bits to represent 0-F (15).
Bearing	A support mechanism allowing relative motion between two surfaces loaded against each other. This can be a rotary ball bearing, linear slide bearing, or air bearing (zero friction).
Bidirectional Repeatability	See Repeatability.
CAM Profile	A technique used to perform nonlinear motion that is electronically similar to the motion achieved with mechanical cams.

Cantilevered Load	A load not symmetrically mounted on a stage.
Closed Loop	A broad term relating to any system where the output is measured and compared to the input. Output is adjusted to reach the desired condition.
CNC	Computer Numerical Control. A computer-based motion control device programmable in numerical word address format.
Coefficient of Friction	Defined as the ratio of the force required to move a given load to the magnitude of that load.
Cogging	Nonuniform angular/linear velocity. Cogging appears as a jerkiness, especially at low speeds, and is due to magnetic poles attracting to steel laminations.
Commutation	The action of steering currents to the proper motor phases to produce optimum motor torque/force. In brush-type motors, commutation is done electromechanically via the brushes and commutator. A brushless motor is electronically commutated using a position feedback device such as an encoder or Hall effect devices. Stepping motors are electronically commutated without feedback in an open-loop fashion.
Commutation, 6-Step	Also referred to as trapezoidal commutation. The process of switching motor phase current based on three Hall effect signals spaced 120 electrical degrees beginning 30 degrees into the electrical cycle. This method is the easiest for commutation of brushless motors.
Commutation, Modified 6-Step	Also referred to as modified sine commutation. The process of switching motor phase current based on three Hall effect signals spaced 120 electrical degrees beginning at 0 electrical degrees. This method is slightly more difficult to implement than standard 6-step, but more closely approximates the motor's back emf. The result is smoother control and less ripple. Aerotech's BA series self-commutate using this method.
Commutation, Sinusoidal	The process of switching motor phase current based on motor position information, usually from an encoder. In this method, the three phase currents are switched in very small increments that closely resemble the motor's back emf. Sinusoidal commutation requires digital signal processing to convert position information into three-phase current values and, consequently, is most expensive to implement. The result, however, is the best possible control. All Aerotech controllers, as well as the BAS series amplifiers, commutate using this method.
Connectorized Ports	Machined features in the back of the motor which support connector hardware.
Coordinated Motion	Multi-axis motion where the position of each axis is dependent on the other axis, such that the path and velocity of a move can be accurately controlled. Drawing a circle requires coordinated motion.
Critical Speed	A term used in the specification of a lead screw or ball screw indicating the maximum rotation speed before resonance occurs. This speed limit is a function of the screw diameter, distance between support bearings, and bearing rigidity.
Current Command	Motor driver or amplifier configuration where the input signal is commanding motor current directly, which translates to motor torque/force at the motor output. Brushless motors can be commutated directly from a controller that can output current phase A and B commands.
Current, Peak	An allowable current to run a motor above its rated load, usually during starting conditions. Peak current listed on a data sheet is usually the highest current safely allowed to the motor.
Current, rms	Root Mean Square. Average of effective currents over an amount of time. This current is calculated based on the load and duty cycle of the application.
Cycle	When motion is repeated (move and dwell) such as repetitive back-and-forth motion.
DC Brushless Servo	A servomotor with stationary windings in the stator assembly and permanent magnet rotor. (See AC Brushless Servo)
Deceleration	The change in velocity as a function of time.

Duty Cycle	For a repetitive cycle, the ratio of "on" time to total cycle time used to determine a motor's rms current and torque/force.
Dwell Time	Time in a cycle at which no motion occurs. Used in the calculation of rms power.
Efficiency	Ratio of input power vs. output power.
Electronic Gearing	Technique used to electrically simulate mechanical gearing. Causes one closed loop axis to be slaved to another open or closed loop axis with a variable ratio.
Encoder Marker	Once-per-revolution signal provided by some incremental encoders to accurately specify a reference point within that revolution. Also known as Zero Reference Signal or Index Pulse.
Encoder Resolution	Measure of the smallest positional change which can be detected by the encoder. A 1000-line encoder with a quadrature output will produce 4000 counts per revolution.
Encoder, Incremental	Position encoding device in which the output is a series of pulses relative to the amount of movement.
Feedback	Signal that provides process or loop information such as speed, torque, and position back to the controller to produce a "closed loop" system.
Flatness (of travel)	Measure of the vertical deviation of a stage as it travels in a horizontal plane.
Force, Continuous	The value of force that a particular motor can produce in a continuous stall or running (as calculated by the rms values) condition.
Force, Peak	The maximum value of force that a particular motor can produce. When sizing for a specific application, the peak force is usually that required during acceleration and deceleration of the move profile. The peak force is used in conjunction with the continuous force and duty cycle to calculate the rms force required by the application.
Friction	The resistance to motion between two surfaces in contact with each other.
G.P.I.B.	A standard protocol, analogous to RS-232, for transmitting digital information. The G.P.I.B. interface (IEEE-488) transmits data in parallel instead of serial format. (See IEEE-488)
Gain	Comparison or ratio of the output signal and the input signal. In general, the higher the system gain, the higher the response.
Grating Period	Actual distance between graduations on an encoder.
Hall Effect Sensors	Feedback device (HED) used in a brushless servo system to provide information for the amplifier to electronically commutate the motor.
HED	Hall Effect Device. (See Hall Effect Sensors)
Home	Reference position for all absolute positioning movements. Usually defined by a home limit switch and/or encoder marker.
Home Switch	A sensor used to determine an accurate starting position for the home cycle.
Hysteresis	A component of bidirectional repeatability. Hysteresis is the deviation between actual and commanded position and is created by the elastic forces in the drive systems.
I/O	Input / Output. The reception and transmission of information between control devices using discrete connection points.
IEEE-488	A set of codes and formats to be used by devices connected via a parallel bus system. This standard also defines communication protocols that are necessary for message exchanges, and further defines common commands and characteristics. (See G.P.I.B.)
Incremental	A move referenced from its starting point (relative move).

Move	
Inertia	The physical property of an object to resist changes in velocity when acted upon by an outside force. Inertia is dependent upon the mass and shape of an object.
Lead Error	The deviation of a lead screw or ball screw from its nominal pitch.
Lead Screw	A device for translating rotary motion into linear motion. Unit consists of an externally threaded screw and an internally threaded carriage (nut). (See Ball Screw)
Life	The minimum rated lifetime of a stage at maximum payload while maintaining positioning specifications.
Limit Switch	A sensor used to determine the end of travel on a linear motion assembly.
Limits	Sensors called limits that alert the control electronics that the physical end of travel is being approached and motion should stop.
Linear Motor	A motor consisting of 2 parts, typically a moving coil and stationary magnet track. When driven with a standard servo amplifier, it creates a thrust force along the longitudinal axis of the magnet track.
Load Carrying Capability	The maximum recommended payload that does not degrade the listed specifications for a mechanical stage.
Master-Slave	Type of coordinated motion control where the master axis position is used to generate one or more slave axis position commands.
Motion Profile	A method of describing a process in terms of velocity, time, and position.
Motor Brush	The conductive element in a DC brush-type motor used to transfer current to the internal windings.
Motor, Brushless	Type of direct current motor that utilizes electronic commutation rather than brushes to transfer current.
Motor, Stepping	Specialized motor that allows discrete positioning without feedback. Used for noncritical, low power applications, since positional information is easily lost if acceleration or velocity limits are exceeded.
NC	Numerical Control. Automated equipment or process used for contouring or positioning. (See CNC)
NEMA	National Electrical Manufacturer's Association. Sets standards for motors and other industrial electrical equipment.
Non-Volatile Memory	Memory in a system that maintains information when power is removed.
Open Collector	A signal output that is performed with a transistor. Open collector output acts like a switch closure with one end of the switch at circuit common potential and the other end of the switch accessible.
Open Loop	Control circuit that has an input signal only, and thus cannot make any corrections based on external influences.
Operator Interface	Device that allows the operator to communicate with a machine. A keyboard or thumbwheel is used to enter instructions into a machine. (See HMI or MMI)
Optical Encoder	A linear or angular position feedback device using light fringes to develop position information.
Opto-isolated	System or circuit that transmits signal with no direct electrical connections, using photoelectric coupling between elements.
Orthogonality	The condition of a surface or axis perpendicular (offset 90°) to a second surface or axis. Orthogonality specification refers to the error from 90° from which two surfaces of axes are aligned.
Overshoot	In a servo system, referred to the amount of velocity and/or position overrun from the input command. Overshoot is a result of many factors including mechanical structure, tuning gains, servo controller capability, and inertial mis-

	match.
PID	A group of gain terms in classical control theory (Proportional Integral Derivative) used in compensation of a closed-loop system. The terms are optimally adjusted to have the output response equal the input command. Aerotech controllers utilize the more sophisticated PID FVFA loop which incorporates additional terms for greater system performance.
Pitch (of travel)	Angular motion of a carriage around an axis perpendicular to the motion direction and perpendicular to the yaw axis.
Pitch Error	Positioning error resulting from a pitching motion.
PLC	Programmable Logic Controller. A programmable device that utilizes “ladder logic” to control a number of input and output discrete devices.
PWM	Pulse Width Modulation. Switch-mode technique used in amplifiers and drivers to control motor current. The output voltage is constant and switched at the bus value (160 VDC with a 115 VAC input line).
Quadrature	Refers to the property of position transducers that allows them to detect direction of motion using the phase relationship of two signal channels. A 1000-line encoder will yield 4000 counts via quadrature.
Radial Runout	Positioning error of the rotary stage in the horizontal direction when the tabletop is oriented in the horizontal plane. Radial runout is defined as the total indicator reading on a spherical ball positioned 50 mm above the tabletop and centered on the axis of rotation.
Ramp Time	Time it takes to accelerate from one velocity to another.
Range	The maximum allowable travel of a positioning stage.
RDC	Resolver to Digital Converter. Electronic component that converts the analog signals from a resolver (transmitter type) into a digital word representing angular position.
Repeatability	The maximum deviation from the mean (each side) when repeatedly approaching a position. Unidirectional repeatability refers to the value established by moving toward a position in the same direction. Bidirectional repeatability refers to the value established by moving toward a position in the same or opposite direction.
Resolution	The smallest change in distance that a device can measure.
Retroreflector	An optical element with the property that an input light beam is reflected and returns along the same angle as the input beam. Used with laser interferometers.
Roll (of travel)	Angular motion of a carriage around an axis parallel to the motion direction and perpendicular to the yaw axis.
Roll Error	Positioning error resulting from a roll motion.
Rotor	The rotating part of a magnetic structure. In a motor, the rotor is connected to the motor shaft.
RS-232C	Industry standard for sending signals utilizing a single-ended driver/receiver circuit. As such, the maximum distance is limited based on the baud rate setting but is typically 50-100 feet. This standard defines pin assignments, handshaking, and signal levels for receiving and sending devices.
RS-274	Industry standard programming language. Also referred to as G-code machine programming. A command set specific for the machine tool industry that defines geometric moves.
RS-422	Industry communication standard for sending signals over distances up to 4000 feet. Standard line driver encoder interfaces utilize RS-422 because of the noise immunity.
Runout	The deviation from the desired form of a surface during full rotation (360 degrees) about an axis. Runout is measured as total indicated reading (TIR). For a rotary stage, axis runout refers to the deviation of the axis of rotation from the theoretical axis of rotation.
Servo System	Refers to a closed loop control system where a command is issued for a change in position and the change is then verified via a feedback system.

Settling Time	Time required for a motion system to cease motion once the command for motion has ended.
Shaft Radial Load	Maximum radial load that can be applied to the end of the motor shaft at maximum motor speed.
Shaft Runout	Deviation from straight line travel.
Slotless	Describes the type of laminations used in a motor that eliminates cogging torque due to magnetic attraction of the rotor to the stator slots.
Stator	Non-rotating part of a magnetic structure. In a motor, the stator usually contains the mounting surface, bearings, and non-rotating windings.
Stiction	Friction encountered when accelerating an object from a stationary position. Static friction is always greater than moving friction, and limits the smallest possible increment of movement.
Straightness of Travel	Measure of the side-to-side deviation of a stage as it travels in a horizontal plane.
Torque	Rotary equivalent to force. Equal to the product of the force perpendicular to the radius of motion and distance from the center of rotation to the point where the force is applied.
TIR (Total Indicated Reading)	The full indicator reading observed when a dial indicator is in contact with the part surface during one full revolution of the part about its axis of rotation.
TIR (Total Indicator Runout)	The smallest perpendicular distance between two planes, both parallel with the reference plane, that enclose all points on the surface.
Torque, Continuous	Torque needed to drive a load over a continuous time.
Torque, Peak	Maximum amount of torque a motor can deliver when the highest allowable peak currents are applied.
Torque, rms	Root Mean Square is a mathematical method to determine a steadfast or average torque for a motor.
Torque, Stall	The maximum torque without burning out the motor.
Tuning	In a servo system, the process of optimizing loop gains (usually PID terms) to achieve the desired response from a stage or mechanism from an input command.
Unidirectional Repeatability	See Repeatability
Velocity Command	Motor driver or amplifier configuration where the input signal is commanding motor velocity. Motors with analog tachometers are normally driven by this driver configuration.
Wobble	An irregular, non-repeatable rocking or staggering motion of the table top of a rotary stage. Wobble is defined as an angular error between the actual axis of rotation and the theoretical axis of rotation.
Yaw (of travel)	Rotation about the vertical axis, perpendicular to the axis of travel. Angular movement (error) that affects straightness and positioning accuracy.
Yaw Error	Positioning error resulting from a yaw motion.

Appendix B: Warranty and Field Service

Aerotech, Inc. warrants its products to be free from defects caused by faulty materials or poor workmanship for a minimum period of one year from date of shipment from Aerotech. Aerotech's liability is limited to replacing, repairing or issuing credit, at its option, for any products that are returned by the original purchaser during the warranty period. Aerotech makes no warranty that its products are fit for the use or purpose to which they may be put by the buyer, where or not such use or purpose has been disclosed to Aerotech in specifications or drawings previously or subsequently provided, or whether or not Aerotech's products are specifically designed and/or manufactured for buyer's use or purpose. Aerotech's liability or any claim for loss or damage arising out of the sale, resale or use of any of its products shall in no event exceed the selling price of the unit.	
Aerotech, Inc. warrants its laser products to the original purchaser for a minimum period of one year from date of shipment. This warranty covers defects in workmanship and material and is voided for all laser power supplies, plasma tubes and laser systems subject to electrical or physical abuse, tampering (such as opening the housing or removal of the serial tag) or improper operation as determined by Aerotech. This warranty is also voided for failure to comply with Aerotech's return procedures.	***Laser Products***
Claims for shipment damage (evident or concealed) must be filed with the carrier by the buyer. Aerotech must be notified within (30) days of shipment of incorrect materials. No product may be returned, whether in warranty or out of warranty, without first obtaining approval from Aerotech. No credit will be given nor repairs made for products returned without such approval. Any returned product(s) must be accompanied by a return authorization number. The return authorization number may be obtained by calling an Aerotech service center. Products must be returned, prepaid, to an Aerotech service center (no C.O.D. or Collect Freight accepted). The status of any product returned later than (30) days after the issuance of a return authorization number will be subject to review.	***Return Procedure***
After Aerotech's examination, warranty or out-of-warranty status will be determined. If upon Aerotech's examination a warranted defect exists, then the product(s) will be repaired at no charge and shipped, prepaid, back to the buyer. If the buyer desires an airfreight return, the product(s) will be shipped collect. Warranty repairs do not extend the original warranty period.	***Returned Product Warranty Determination***
After Aerotech's examination, the buyer shall be notified of the repair cost. At such time, the buyer must issue a valid purchase order to cover the cost of the repair and freight, or authorize the product(s) to be shipped back as is, at the buyer's expense. Failure to obtain a purchase order number or approval within (30) days of notification will result in the product(s) being returned as is, at the buyer's expense. Repair work is warranted for (90) days from date of shipment. Replacement components are warranted for one year from date of shipment.	***Returned Product Non-warranty Determination***
At times, the buyer may desire to expedite a repair. Regardless of warranty or out-of-warranty status, the buyer must issue a valid purchase order to cover the added rush service cost. Rush service is subject to Aerotech's approval.	***Rush Service***

On-site Warranty Repair	If an Aerotech product cannot be made functional by telephone assistance or by sending and having the customer install replacement parts, and cannot be returned to the Aerotech service center for repair, and if Aerotech determines the problem could be warranty-related, then the following policy applies: Aerotech will provide an on-site field service representative in a reasonable amount of time, provided that the customer issues a valid purchase order to Aerotech covering all transportation and subsistence costs. For warranty field repairs, the customer will not be charged for the cost of labor and material. If service is rendered at times other than normal work periods, then special service rates apply. If during the on-site repair it is determined the problem is not warranty related, then the terms and conditions stated in the following "On-Site Non-Warranty Repair" section apply.
On-site Non-warranty Repair	If any Aerotech product cannot be made functional by telephone assistance or purchased replacement parts, and cannot be returned to the Aerotech service center for repair, then the following field service policy applies: Aerotech will provide an on-site field service representative in a reasonable amount of time, provided that the customer issues a valid purchase order to Aerotech covering all transportation and subsistence costs and the prevailing labor cost, including travel time, necessary to complete the repair.
Company Address	Aerotech, Inc. 101 Zeta Drive Pittsburgh, PA 15238-2897 Phone: (412) 963-7470 Fax: (412) 963-7459

Appendix C: Technical Changes

Table C-1: Current Changes (1.01.00)

Section(s) Affected	General Information
--	Updated manual to new manual style
Appendix A: Glossary	Added Appendix A: Glossary
Appendix C: Technical Changes	Added Appendix C: Technical Changes
Index	Added Index

Table C-2: Archived Changes

Revision	Section(s) Affected	General Information
1.00.00	--	New Manual

Index

Reader's Comments

Linear Positioning Stage Series Stage Manual **P/N: EDA130, December 29, 2008** **Revision 1.01.00** Please answer the questions below and add any suggestions for improving this document.	

Is the manual:	Yes	No
Adequate to the subject		
Well organized		
Clearly presented		
Well illustrated		

How do you use this document in your job? Does it meet your needs? What improvements, if any, would you like to see? Please be specific or cite examples.

	Stage/Product Details		Name	
Model #			**Title**	
Serial #			**Company Name**	
Date Shipped			**Address**	
Customer Order #				
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