

# ABS2000 Series Stage

## User's Manual

P/N: EDS122 (Revision 1.02.00)



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## Revision History

Revision 1.02.00	March 23, 2011
Revision 1.01.00	July 9, 2007
Revision 1.00.00	January 15, 2007

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## Chapter 1: Overview

This chapter introduces standard and optional features of the ABS2000 stages, explains the model numbering system, and gives general safety precautions.

### 1.1. Standard Features

Aerotech's ABS2000 direct-drive air-bearing spindles were designed to provide superior angular positioning and velocity control for applications including disk drive testing, imaging applications, and precision wafer inspection.

Aerotech's custom designed, low-loss motor produces  $>0.25$  N-m (38 oz-in) of continuous torque, with negligible motor losses, eliminating the need for cooling fins and/or external cooling. The non-influencing motor design minimizes parasitic forces in the motor, providing the exceptionally high level of error motion performance. These motors have all the advantages of a brushless direct-drive motor — no brushes to wear, and high acceleration.

#### 1.1.1. Optional Features

The ABS2000 air bearing spindle is available with an integral rotary union for a vacuum supply. Additionally, the encoder can be configured for a variety of different resolutions (square-wave output) to meet the customers accuracy and data rate needs.

#### 1.1.2. Model Numbers

The model number indicates the optional features on a particular spindle. To determine the options on your spindle, refer to Table 1-1 for an explanation of the numbering system.

Aerotech continually improves its product offerings, and listed options may be superseded at any time. Refer to the most recent edition of the Aerotech Motion Control Product Guide for the most current product information at [www.aerotech.com](http://www.aerotech.com).

**Table 1-1: ABS2000 Model Numbering System**

<b>ABS2000 Series Direct-Drive, Air-Bearing Spindle</b>	
ABS2000	High speed air-bearing spindle
<b>Position Transducer</b>	
-256	256 lines/rev directly couple rotary encoder
-512	512 lines/rev directly couple rotary encoder
-1000	1000 lines/rev directly couple rotary encoder
-1024	1024 lines/rev directly couple rotary encoder
-2000	2000 lines/rev directly couple rotary encoder
-2048	2048 lines/rev directly couple rotary encoder
<b>Options</b>	
-Rotary Union	Integral Rotary Union for Vacuum

## 1.2. 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 damage to the equipment.

This manual and any additional instructions included with the spindle should be retained for the lifetime of the spindle.



DANGER

To minimize the possibility of electrical shock and bodily injury or death, disconnect all electrical power prior to making any electrical connections.



DANGER

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



DANGER

To minimize the possibility of bodily injury or death, disconnect all electrical power prior to making any mechanical adjustments.



DANGER

Moving parts of the spindle can cause crushing or shearing injuries. All personnel must remain clear of any moving parts.



WARNING

Improper use of the spindle can cause damage, shock, injury, or death. Read and understand this manual before operating the spindle.



WARNING

If the spindle is used in a manner not specified by the manufacturer, the protection provided by the spindle can be impaired.



WARNING

Spindle cables can pose a tripping hazard. Securely mount and position all spindle cables to avoid potential hazards.



**WARNING**

Do not expose the spindle to environments or conditions outside the specified range of operating environments. Operation in conditions other than those specified can cause damage to the equipment.

**WARNING**

The spindle must be mounted securely. Improper mounting can result in injury and damage to the equipment.

**WARNING**

Use care when moving the spindle. Manually lifting or transporting spindles can result in injury.

**WARNING**

Only trained personnel should operate, inspect, and maintain the spindle.

**WARNING**

This spindle is intended for light industrial manufacturing or laboratory use. Use of the spindle for unintended applications can result in injury and damage to the equipment.

**WARNING**

Before using this spindle, perform an operator risk assessment to determine the needed safety requirements.

### 1.3. EC Declaration of Incorporation

**Manufacturer:** Aerotech, Inc.  
101 Zeta Drive  
Pittsburgh, PA 15238  
USA



**herewith declares that the product:**

Aerotech, Inc. ABS2000 Stage

**is intended to be incorporated into machinery to constitute machinery covered by the Directive 2006/42/EC as amended;**

**does therefore not in every respect comply with the provisions of this directive;**

**and that the following harmonized European standards have been applied:**

EN ISO 12100-1,-2:2003+A1:2009

*Safety of machinery - Basic concepts, general principles for design*

ISO 14121-1:2007

*Safety of machinery - Risk assessment - Par 1: Principles*

EN 60204-1:2005

*Safety of machinery - Electrical equipment of machines - Part 1: General requirements*

**and further more declares that**

***it is not allowed to put the equipment into service until the machinery into which it is to be incorporated or of which it is to be a component has been found and declared to be in conformity with the provisions of the Directive 2006/42/EC and with national implementing legislation, i.e. as a whole, including the equipment referred to in this Declaration.***


**This is to certify that the aforementioned product is in accordance with the applicable requirements of the following Directive(s):**

2011/65/EU

RoHS 2 Directive

**Authorized Representative:** Manfred Besold  
**Address:** AEROTECH GmbH  
Süd-West-Park 90  
D-90449 Nürnberg

**Name:**

Alex Weibel /   
Engineer Verifying Compliance

**Position:**

**Location:** Pittsburgh, PA

**Date:** March 23, 2011

## Chapter 2: Installation

This chapter describes the installation procedure for the ABS2000 high speed spindle, including handling the spindle properly, preparing the spindle environment, securing the spindle to the mounting surface, attaching the payload, and making the electrical connections.



Installation must follow the instructions in this chapter. Failure to follow these instructions could result in injury and damage to the equipment.

### 2.1. Unpacking and Handling the Spindle

Carefully remove the spindle from the protective shipping container. Gently blow the spindle off with compressed nitrogen or clean, dry air. Before operating the spindle, it is important to let the spindle stabilize at room temperature for at least 24 hours. Set the spindle on a smooth, flat, and clean surface.

Each spindle 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 damage has occurred during shipping, report it immediately.



Improper stage handling could adversely affect the spindle's performance. Therefore, use care when moving the spindle.



Do not attempt to rotate the spindle table until the air supply, detailed in Section 2.5, has been installed. Moving the spindle without air supplied can cause permanent damage to the spindle.



Manually lifting or transporting the spindle can result in injury.

## 2.2. Securing the Spindle to the Mounting Surface

The published accuracy and error motion specifications apply to an undistorted spindle carrying less than its maximum load. In order to achieve these specifications, attention to detail is required when mounting the spindle's rotor and stator. The spindle is provided with the stator mounting surfaces flat to less than 0.000,100 in. The mating surface must be similarly flat in order to maintain accuracy and load capacity. If the mating surface is not flat enough, the spindle will be distorted, possibly enough to have zero load capacity or even crash.

The mating surface must be clean. Remove oily residue by wiping clean with a solvent. Remove burrs and particles with a precision ground flat stone.



The spindle must be mounted securely. Improper mounting can result in injury and damage to the equipment.

ABS2000 series spindle has 8 counter-bored mounting holes available to secure it to the mounting surface. These counter-bored holes are designed for 6mm socket head cap screws.

**NOTE:** The spindle is precision machined and verified for flatness prior to assembly at the factory. If machining is required to achieve the desired flatness, it should be performed on the mounting surface rather than the flange of the spindle. Shimming should be avoided if possible. If shimming is required, it should be minimized to improve the rigidity of the system.

## 2.3. Attaching the Payload to the Spindle

Do not disturb the 12 cap screws that hold the rotor's thrust plate to the shaft

The rotor mounting surfaces have been ground flat to 0.000,020 in. Any stiff plate that is attached to the rotor should have comparable flatness. The mating surfaces should come into total area contact with only a few pounds force. As a rule of thumb, generate 0.0001 per inch flatness of a ¼ in thick steel plate and 0.000,010 per inch for a 1 in thick plate.

When mounting to the rotor, the screws should have at least 0.20 in engagement, but not bottom out in the hole. Clean the mating surfaces and check for nicks and burrs with a precision ground flat stone prior to mounting the payload.

ABS2000 series spindle has 12, #8-32 tapped holes for securing the payload.

The ABS2000 spindle is factory balanced to a G0.4 (ISO 1940 standard) balance grade. The customer is responsible to maintain the balance grade of the spindle after the payload is mounted. Failure to maintain the balance grade will result in failure to achieve the published specifications and possibly damage to the spindle air bearing.

## 2.4. Electrical Installation

Aerotech motion control systems are adjusted at the factory for optimum performance. When the ABS2000 spindle is part of a complete Aerotech motion control system, setup usually involves connecting the spindle to the appropriate drive chassis with the cables provided. Connect the provided cables to the motor and feedback connectors on the spindle. Labels on the drive indicate the appropriate connections. Refer to your drive manuals and documentation for additional installation and operation information. In some cases, if the system is uniquely configured, a drawing showing system interconnects is supplied.

See Section 3.6. for standard wiring pintouts.



WARNING

Never connect or disconnect any electrical component or connecting cable while power is applied, or serious damage may result.



WARNING

The spindle's protective ground is located on pin A4 of the motor connector. If you are using cables other than those provided by Aerotech, you must connect pin A4 to a ground connection.

## 2.5. Air Requirements

The air supply to the air bearing is extremely important for the operation of the system. If compressed air is used, it must be filtered to 0.25 microns, dry to 0°F dew point, and oil free. If nitrogen is used, it must be 99.99% pure and filtered to 0.25 microns. The filtration requirement is to prevent particles from clogging the air bearing, which can have a minimum clearance of 2 to 5 microns. The relative humidity of the air at the bearing must be maintain at 85% or lower.

Air pressure of 120 psi, +0/-10 psi, is necessary for use. Air should be supplied via 1/8" OD standard flare-less polyurethane air hose. It is recommended that a pressure switch be installed to remove power from the air bearing if pressure drops below 50 psi because the bearing surfaces could be damaged. The operating air pressure should be capable of supporting double the greatest anticipated load (the load capacity varies directly with air pressure). While the bearing is not in use, it is recommended the air should remain on at a reduced pressure. Maintaining a flow of clean, dry air is the best protection against contamination and is the safest way to keep a bearing on standby or in storage.

Do not remove brass hex-plug and do not block, plug or restrict exhaust port of the air bearing.

The air consumption of the ABS2000 should be less than 2 SCFM.



**WARNING**

To protect the air bearing against under pressure, an in-line pressure switch tied to the motion controller is recommended.

## 2.6. Rotary Union Option

The rotary union option for the ABS2000 is for a vacuum supply only.



**WARNING**

To protect from damage due to a loss in vacuum, an in-line vacuum switch tied to the motion controller is recommended.

## Chapter 3: Operating Specifications

This chapter contains general technical information about ABS2000 spindle. Included are basic product specifications, resolution information, and motor wiring diagrams.

### 3.1. Air-Bearing Spindle Start Up

1. Purge the air line for at least 1 minute, confirm that the air-line humidity is below 85%
2. Install the inlet line
3. Turn the air on and adjust the pressure to 120 psi. Measure the air pressure as close to the spindle as possible to take into account the pressure drop of the supply line.
4. Remove the rotor lock. The rotor should turn freely with a touch of a finger. If the spindle shows any sign of stickiness, let stand at max pressure for 24 hours before further diagnosis (with the rotary union option there is friction which will require more than a touch to spin).
5. Reattach the rotor lock whenever the bearing is not in use, being stored or shipped without pressure. The air bearing will be damaged if rotated without sufficient air pressure.

### 3.2. Air-Bearing Spindle Shutdown Procedure

1. Install the rotor lock
2. Dry the air bearing surface. Use an absorbent swab in the corner of where the rotor and stator meet and wipe away from the gap (do not push debris into the corner). Do not use an air blast to dry the bearing
3. Clean the bearing with acetone or isopropanol. Clean all accessible surfaces including the rotor bore and any unfilled tapped holes.
4. Let the bearing stand for 24 hours at a reduced pressure (50 psi)
5. Turn off the air supply and remove the air line
6. Place the bearing in a plastic bag with a fresh pack of desiccant.

### 3.3. Storing the Air-Bearing Spindle

The ABS2000 spindle can be safely stored without air if it is cleaned and dried. However the best insurance against liquid penetration is to keep at least 10 psi pressure on the air bearing at all times. If the outer surfaces are to be protected by a rust-preventative oil, care must be taken not to let the oil accumulate near the rotor's exhaust regions. Put a drop of oil on a clean lint free cloth and wipe off the spindle. Do not force the cloth down into the corner where the outer diameter of the rotor meet the stator. It is better to leave the corner dry than to over oil the bearing.

### 3.4. Environmental Specifications

The environmental specifications for the ABS2000 are listed in the following table.

**Table 3-1: Environmental Specifications**

<b>Ambient Temperature</b>	Operating: 16° to 25° C (61° to 77° F) The optimal operating temperature is 20° C ±2° C (68° F ±4° F). If at any time the operating temperature deviates from 20° C degradation in performance could occur. Contact Aerotech for information regarding your specific application and environment.
	Storage: 0° to 40° C (32° to 104° F) in original shipping packaging
<b>Humidity</b>	Operating: 40 percent to 60 percent RH The optimal operating humidity is 50 percent RH.
	Storage: 30 percent to 60 percent RH, non-condensing in original packaging
<b>Altitude</b>	Operating: 0 to 2,000 m (0 to 6,562 ft) above sea level Contact Aerotech if your specific application involves use above 2,000 m or below sea level.
<b>Vibration</b>	Use the system in a low vibration environment. Excessive floor or acoustical vibration can affect spindle and system performance. Contact Aerotech for information regarding your specific application.
<b>Dust Exposure</b>	The ABS2000 spindles are not suited for dusty or wet environments. This equates to an ingress protection rating of IP00.
<b>Use</b>	Indoor use only



**WARNING**

Do not expose the spindle to environments or conditions outside the specified range of operating environments. Operation in conditions other than those specified can cause damage to the equipment.



### 3.5. Specifications

The ABS2000 series spindle specifications are shown in Table 3-2. Motor specifications are shown in Table 3-3.

**Table 3-2: ABS2000 Series Specifications**

Basic Model		ABS2000 Spindle
Motor		SF75-21-2X
Continuous Current, Stall	A <sub>pk</sub>	3 A
	A <sub>rms</sub>	2.1 A
Feedback		Directly-Couple Rotary Encoder
Resolution		256 – 2048 lines/rev (other line counts available)
Rated Speed <sup>(1)</sup>		6000 rpm
Maximum Load	Radial	66 N (15 lb)
	Axial	178 N (40 lb)
Inertia (unloaded)		0.0015 kg-m <sup>2</sup>
Synchronous Error Motions <sup>(2)</sup> <sup>(3)</sup>	Radial	< 100 nm
	Axial	< 100 nm
Asynchronous Error Motions <sup>(3)</sup>	Radial	20 nm
	Axial	20 nm
Velocity Ripple		< 0.1% at 6000 rpm
Balance Grade <sup>(4)</sup>		ISO 1940 G 0.4
Bearing Rigidity	Radial	50 N/um
	Axial	140 N/um
Mass		6.0 kg (13.2 lbs)
Operating Pressure <sup>(5)</sup>		120 psi
Air Consumption <sup>(6)</sup>		<2 scfm
Material	Shaft	Steel
	Housing	Aluminum (Steel Available)
Finish		Electroless Nickel or Black Hardcoat
<p>(1) Maximum speed based on stage capability; maximum application velocity may be limited by system data rate and system resolution</p> <p>(2) Per ANSI B89.3.4M, "Axes of rotation methods for specifying and testing"</p> <p>(3) Consult Aerotech regarding error motions for the ABS2000 with rotary union option</p> <p>(4) Per ISO 1940, "Mechanical vibration - balancing quality requirements of rigid rotors"</p> <p>(5) An in-line pressure switch tied to the motion controller is recommended to protect the air bearing against under-pressure</p> <p>(6) Air supply must be clean, dry to 0°F dew point, and filtered to 0.25 μm or better (nitrogen at 99.9% purity recommended)</p>		

**Table 3-3: ABS2000 Motor Specifications**

Model	SF-75-21-2X	
<b>Performance Specifications (1,5)</b>		
Stall Torque, Continuous (2)	N-m	0.27
	oz-in	38.4
Peak Torque (3)	N-m	1.08
	oz-in	153.6
Rated Speed	rpm	4,000
Rated Power Output, Continuous	watts	113.6
<b>Electrical Specifications (5)</b>		
BEMF Constant (line to line, max)	Volts pk / krpm	10.9
Continuous Current, Stall (2)	Amp pk	3.00
	Amp rms	2.12
Peak Current, Stall (3)	Amp pk	12.00
	Amp rms	8.49
Torque Constant (4,9)	N-m / Amp pk	0.09
	oz-in / Amp pk	12.8
	N-m / Amp rms	0.13
	oz-in / Amp rms	18.1
Motor Constant (2,4)	N-m / $\sqrt{W}$	0.042
	oz-in / $\sqrt{W}$	5.92
Resistance, 25 °C (line to line)	ohms	4.8
Inductance (line to line)	mH	0.45
Maximum Bus Voltage	VDC	160
Thermal Resistance	°C / W	1.78
Number of Poles	P	8
<p>(1) Performance is dependent upon heat sink configuration, system cooling conditions, and ambient temperature                  (2) Values shown @ 68 °C rise above a 25 °C ambient temperature, with housed motor mounted to a 250 mm x 250 mm x 6 mm aluminum heat sink                  (3) Peak torque assumes correct rms current, consult Aerotech                  (4) Torque Constant and Motor Constant specified at stall                  (5) All performance and electrical specifications +/- 10%                  (6) Losses due to bearings and aerodynamics considered negligible                  (7) Maximum winding temperature is 93 °C                  (8) Ambient operating temperature range: 0 °C - 25 °C, consult Aerotech for performance in elevated ambient temperatures                  (9) All Aerotech amplifiers are rated Apk; use torque constant in N-m / Apk when sizing</p>		

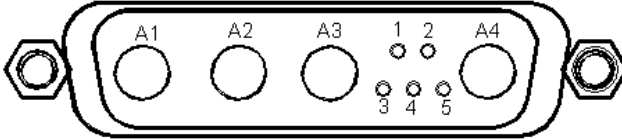
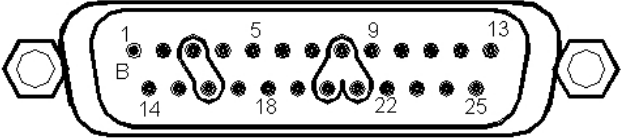
### 3.6. Standard Motor Wiring

Spindles come from the factory completely wired and assembled. For reference, connector pin outputs (pin-outs) and general wiring information are given in the following figures. Pinouts are defined in Table 3-5.

**NOTE:** Refer to the other documentation accompanying your Aerotech equipment. Call your Aerotech representative if there are any questions on system configuration.

**NOTE:** If you are using your own cables to connect the stage, ensure that motor and ground wires can handle current higher than the continuous current listed in Table 3-3. The voltage rating of the wire insulation must be greater than the maximum bus voltage listed in Table 3-3.

**Table 3-4: Standard Wiring Connectors for ABS2000**

			
Pin	Description	Pin	Description
A1	MTR ØA	3	RESERVED
A2	MTR ØB	4	RESERVED
A3	MTR ØC	5	RESERVED
1	MTR SHLD	A4	FRM GND
2	RESERVED		
			
Pin	Description	Pin	Description
1	SIG SHLD	14	COS
2		15	COS-N
3	ENC +5V	16	
4		17	SIN
5	HALL B	18	SIN-N
6	MKR-N	19	
7	MKR	20	
8		21	ENC COM
9		22	
10	HALL A	23	
11	HALL C	24	
12		25	
13			

**Table 3-5: Motor Wiring Pinout Descriptions**

Pin Output	Description
COS	Cosine. Incremental encoder output; either TTL line driven or amplified sine wave type signal.
COS-N	Incremental encoder output. Complement of cos.
ENC COM	+ 5 V return for optical encoders (ground).
ENC +5V	+5 V supply input for optical encoders. Typical requirement is 250 mA.
HALL A	Hall Effect A. Brushless motor commutation track output. TTL line driven signal with rotary motor.
HALL B	Hall Effect B. Brushless motor commutation track output. TTL line driven signal with rotary motor.
HALL C	Hall Effect C. Brushless motor commutation track output. TTL line driven signal with rotary motor.
LMT +5v	+ 5 V supply input for optical limit switch boards. Typical requirement is 50 mA.
LMT COM	Common ground for limit switch
MKR	Marker. Incremental encoder output pulse given once per revolution. Typically used for home reference cycle.
MKR-N	Incremental encoder output; either the compliment of Marker with a line driven, TTL type encoder or 2.5 V DC bias level with amplified sine wave type encoder.
SIN	Sine. Incremental encoder output; either TTL line driven or amplified sign wave type signal.
SIN-N	Incremental encoder output. Complement of sin.
TH+	Positive lead for motor thermistor (to motion controller)
TH-	Negative lead for motor thermistor (tied to ground via feedback connector).
MTR ØA	Motor Phase A.
MTR ØB	Motor Phase B.
MTR ØC	Motor Phase C.
FRM GND	Ground to stage base
SIG SHLD	Shield for feedback connector
MTR SHLD	Shield for motor wiring connector

### **3.7. Vacuum Operation**

The ABS2000 is an air-bearing spindle and is not compatible with operation in a vacuum environment. Contact the factory for alternate solutions.



## Chapter 4: Maintenance

Although the it is a non-contact air bearing design, the ABS2000 spindle does require periodic inspections and cleaning of the external surfaces. Included in this chapter are recommended cleaning solvents.

**NOTE:** The stage must be kept free of foreign matter and moisture; otherwise, the performance and life expectancy of the spindle will be reduced.



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

### 4.1. Service and Inspection Schedule

It is recommended that the ABS2000 stage be inspected once per month until a trend develops for the specific application and environment. Routine checks and general usage guidelines should be followed including:

1. Monitor the humidity of the air to ensure that it is less than 85%
2. Use a rotor lock any time the spindle is not at maximum pressure. Never disconnect the air line or reduce the air pressure without the rotor lock on. Never rotate the spindle without 50 psi.
3. Be sure that the air pressure can adequately support the load. Never exceed 50% of the ultimate load capacity.
4. Observe safety precautions. Use guards for high-rotational-energy applications

#### 4.1.1. Field Service

In general, repair and/or replacement of damaged or malfunctioning components of the ABS2000 spindle by Aerotech field service personnel is not possible. Spindle repair typically requires that the unit be returned to the factory. Please contact Aerotech Technical Support for more information.

### 4.2. Recommended Cleaning Solvents

It is recommended that any metal surface may be cleaned with isopropyl alcohol on a lint-free cloth. Avoid getting excess cleaning solvent on the surfaces, as it could damage the delicate electronics inside. A rust-preventative oil may be used on the air bearing, wiped carefully on using a lint-free cloth. Rust-Lick 606 is the recommended.



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





## Appendix A: 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.

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## Appendix B: Technical Changes

**Table B-1: Current Changes (1.02.00)**

<b>Section(s) Affected</b>	<b>General Information</b>
Section 1.3.	Section added
Section 3.4.	Section added
Chapter 2: Installation, Section 2.1. , Section 2.2. , Section 2.4. , and Section 1.2.	Safety information and warnings added
Section 3.6.	Note about motor wire current and ground requirements added
Table 3-3	Motor specification table added

**Table B-2: Archived Changes**

<b>Revision</b>	<b>Section(s) Affected</b>	<b>General Information</b>
1.00.00	--	New Manual
1.01.00	Section 2.5.	Air Bearing under pressure warning added
1.01.00	Section 2.6.	Rotary Union Option section added
1.01.00	Table 3-2	Specification table added

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