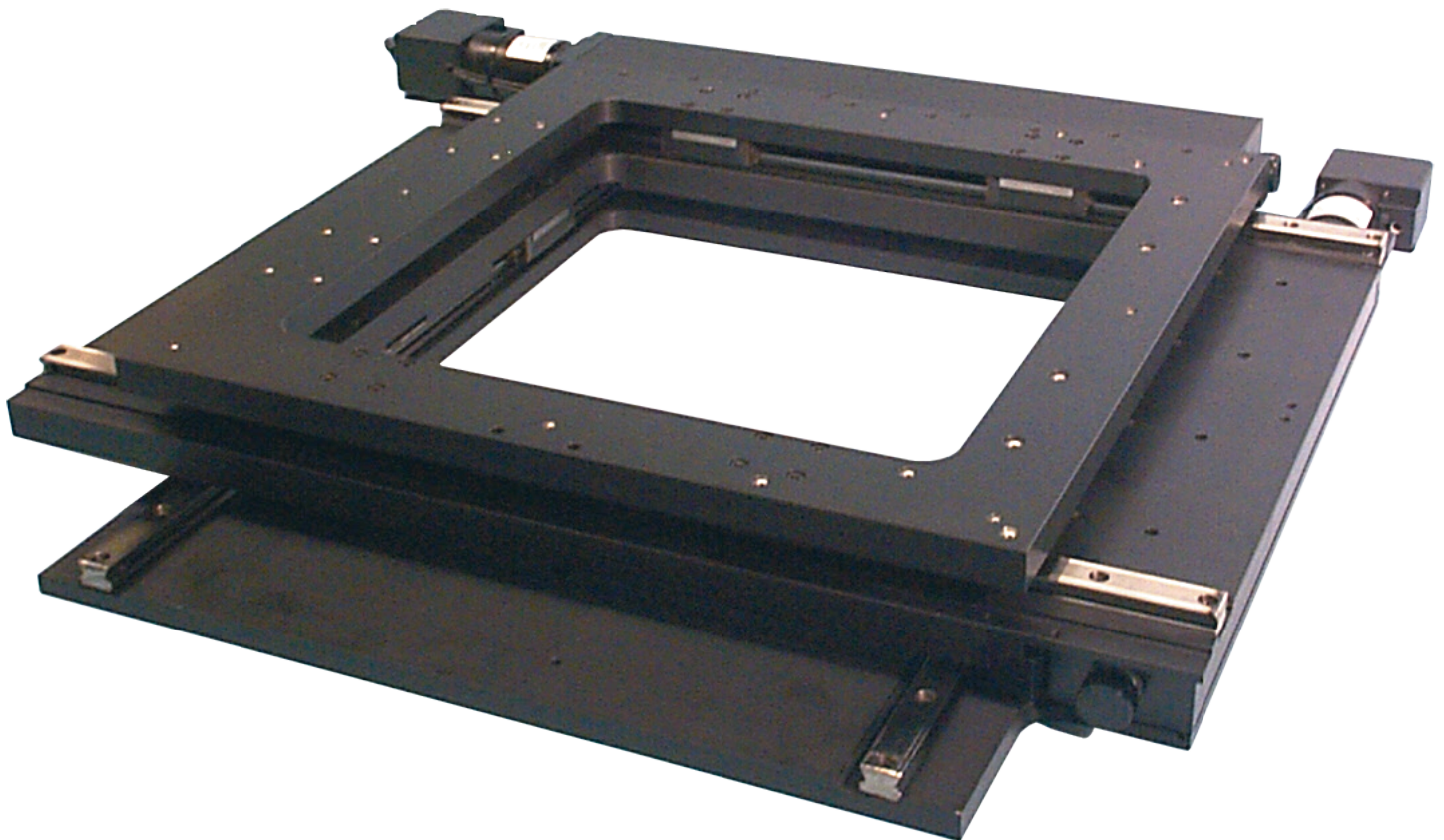




# ATS3600 Hardware Manual

Revision: 1.00.00



## Global Technical Support

Go to [www.aerotech.com/global-technical-support](http://www.aerotech.com/global-technical-support) for information and support about your Aerotech, Inc. products. The website supplies software, product manuals, Help files, training schedules, and PC-to-PC remote technical support. If necessary, you can complete Product Return (RMA) forms and get information about repairs and spare or replacement parts. To get help immediately, contact a service office or your sales representative. Include your customer order number in your email or have it available before you call.

United States (World Headquarters)	
Email: Support@aerotech.com Phone: +1-412-967-6440 Fax: +1-412-967-6870	101 Zeta Drive Pittsburgh, PA 15238-2811 www.aerotech.com
United Kingdom	China
Email: Support@aerotech.com Phone: +44 (0)1256 855055 Fax: +44 (0)1256 855649	Email: Support@aerotech.com Phone: +86 (21) 5508 6731
Germany	Taiwan
Email: Support@aerotech.com Phone: +49 (0)911 967 9370 Fax: +49 (0)911 967 93720	Email: Support@aerotech.com Phone: +886 (0)2 8751 6690
France	
Email: Support@aerotech.com Phone: +33 2 37 21 87 65	

This manual contains proprietary information and may not be reproduced, disclosed, or used in whole or in part without the express written permission of Aerotech, Inc. Product names mentioned herein are used for identification purposes only and may be trademarks of their respective companies.

Copyright © 2010-2020, Aerotech, Inc., All rights reserved.

Aerotech Worldwide

United States ■ France ■ Germany ■ United Kingdom  
China ■ Taiwan



## Table of Contents

<b>ATS3600 Hardware Manual</b> .....	<b>1</b>
Table of Contents .....	3
List of Figures .....	4
List of Tables .....	5
Safety Procedures and Warnings .....	6
EU Declaration of Incorporation .....	7
<b>Chapter 1: Overview</b> .....	<b>9</b>
1.1. Environmental Specifications .....	10
1.2. Accuracy and Temperature Effects .....	10
1.3. Basic Specifications .....	11
1.4. Vacuum Operation .....	12
<b>Chapter 2: Mechanical Specifications and Installation</b> .....	<b>13</b>
2.1. Unpacking and Handling the Stage .....	13
2.2. Dimensions .....	14
2.3. Securing the Stage to the Mounting Surface .....	15
2.4. Attaching the Payload to the Stage .....	16
<b>Chapter 3: Electrical Specifications and Installation</b> .....	<b>17</b>
3.1. Motor and Feedback Connectors .....	18
3.2. Motor and Feedback Wiring .....	24
3.3. Motor and Feedback Specifications .....	26
3.4. Limits, Marker, and Machine Direction .....	29
3.5. Motor and Feedback Phasing .....	30
<b>Chapter 4: Maintenance</b> .....	<b>31</b>
4.1. Service and Inspection Schedule .....	31
4.2. Cleaning and Lubrication .....	32
4.3. Troubleshooting .....	34
<b>Appendix A: Warranty and Field Service</b> .....	<b>35</b>
<b>Appendix B: Revision History</b> .....	<b>37</b>
<b>Index</b> .....	<b>39</b>

## List of Figures

Figure 2-1: ATS3600 Dimensions .....	14
Figure 3-1: Brushless Motor and Feedback Wiring [-M1 and -M2] .....	24
Figure 3-2: Stepper Motor and Feedback Wiring [-M3] .....	25
Figure 3-3: Machine Direction .....	29
Figure 3-4: Hall Phasing .....	30
Figure 3-5: Analog Encoder Phasing Reference Diagram .....	30
Figure 3-6: TTL Encoder Phasing Reference Diagram .....	30

## List of Tables

Table 1-1:	ATS3600 Model Numbering System .....	9
Table 1-2:	Environmental Specifications .....	10
Table 1-3:	ATS3600 Series Specifications .....	11
Table 2-1:	Stage to Mounting Surface Hardware .....	15
Table 3-1:	Brushless Motor Connector Pinout [-M1 and -M2] .....	19
Table 3-2:	Stepper Motor Connector Pinout [-M3] .....	19
Table 3-3:	Brushless Motor Feedback Connector Pinout [-M1 and -M2] .....	20
Table 3-4:	Stepper Motor Feedback Connector Pinout [-M3] .....	21
Table 3-5:	Limits with 9-Pin D-Connector (-LI1 or -LI3) .....	22
Table 3-6:	Limits with Flying Leads (-LI2 or -LI4 Option) .....	22
Table 3-7:	15-Pin Linear Encoder Connector (-E1) .....	23
Table 3-8:	15-Pin Linear Encoder Connector (-E2) .....	23
Table 3-9:	Feedback Specifications .....	26
Table 3-10:	Motor Specifications [BMS60] .....	27
Table 3-11:	Motor Specifications [SM60] .....	28
Table 3-12:	Motor Rotary Encoder Option Specifications .....	28
Table 3-13:	Stage Linear Encoder Option Specifications .....	28

## Safety Procedures and Warnings

Read this manual in its entirety before installing, operating, or servicing this product. If you do not understand the information contained herein, contact an Aerotech representative before proceeding. Strictly adhere to the statements given in this section and other handling, use, and operational information given throughout the manual to avoid injury to you and damage to the equipment.

The following statements apply wherever the Warning or Danger symbol appears within this manual. Failure to observe these precautions could result in serious injury to those individuals performing the procedures and/or damage to the equipment. Operators should be trained before operating this equipment.



**DANGER:** This product contains potentially lethal voltages. To reduce the possibility of electrical shock, bodily injury, or death the following precautions must be followed.

1. Access to the ATS3600 and component parts must be restricted while connected to a power source.
2. Do not connect or disconnect any electrical components or connecting cables while connected to a power source.
3. Disconnect electrical power before servicing equipment.
4. All components must be properly grounded in accordance with local electrical safety requirements.
5. Operator safeguarding requirements must be addressed during final integration of the product.



**WARNING:** To minimize the possibility of electrical shock, bodily injury or death the following precautions must be followed.

1. Moving parts can cause crushing or shearing injuries. Access to all stage and motor parts must be restricted while connected to a power source.
2. Cables can pose a tripping hazard. Securely mount and position all system cables to avoid potential hazards.
3. Do not expose this product to environments or conditions outside of the listed specifications. Exceeding environmental or operating specifications can cause damage to the equipment.
4. The ATS3600 stage must be mounted securely. Improper mounting can result in injury and damage to the equipment.
5. Use care when moving the ATS3600 stage. Lifting or transporting the ATS3600 stage improperly can result in injury or damage to the ATS3600.
6. This product is intended for light industrial manufacturing or laboratory use. Use of this product for unintended applications can result in injury and damage to the equipment.
7. If the product is used in a manner not specified by the manufacturer, the protection provided by the product can be impaired and result in damage, shock, injury, or death.
8. Operators must be trained before operating this equipment.
9. All service and maintenance must be performed by qualified personnel.



**DANGER: PINCH POINT!** Keep Hands Clear while the stage is in motion.

## EU Declaration of Incorporation

**Manufacturer:** Aerotech, Inc.  
101 Zeta Drive  
Pittsburgh, PA 15238-2811  
USA

**herewith declares that the product:**  
ATS3600 Stage

*is intended to be incorporated into machinery to constitute machinery covered by the Directive 2006/42/EC as amended; and that the following harmonized European standards have been applied:*

EN ISO 12100:2010

Safety of machinery - Basic concepts, general principles for design

EN 60204-1:2010

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, for example, 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):*

EU 2015/863

RoHS 3 Directive

**Authorized Representative:** Simon Smith, European Director  
**Address:** Aerotech Ltd  
The Old Brick Kiln, Ramsdell, Tadley  
Hampshire RG26 5PR  
UK

**Name**  / Alex Weibel  
**Position** Engineer Verifying Compliance  
**Location** Pittsburgh, PA  
**Date** 2/19/2020



*This page intentionally left blank.*



## Chapter 1: Overview

**NOTE:** Aerotech continually improves its product offerings; listed options may be superseded at any time. All drawings and illustrations are for reference only and were complete and accurate as of this manual's release. Refer to [www.aerotech.com](http://www.aerotech.com) for the most up-to-date information.

**Table 1-1: ATS3600 Model Numbering System**

ATS3600 Series Mechanical-Bearing Screw-Driven Linear Stage with Aperture	
-100XY	100 x 100 mm travel
-200XY	200 x 200 mm travel
-300XY	300 x 300 mm travel
-400XY	400 x 400 mm travel
Motor (Optional)	
-M1	BMS60 brushless servomotor with 2500-line TTL encoder
-M2	BMS60 brushless servomotor with 1000-line 1 Vpp encoder
-M3	SM60 stepper motor
Limits (Required)	
-LI1	Normally-closed limit switches, 9-pin D connector
-LI2	Normally-closed limit switches, flying leads
-LI3	Normally-open limit switches, 9-pin D connector
-LI4	Normally-open limit switches, flying leads
Direct Linear Feedback (Optional)	
-E1	Incremental linear encoder, 1 Vpp
-E2	Incremental linear encoder, 0.1 $\mu$ m digital TTL output
Coupling (Optional)	
-CP1	Coupling for 0.250 in diameter shaft
-CP2	Coupling for 0.375 in diameter shaft
Metrology (Required)	
-PL1	Metrology, uncalibrated with performance plots
-PL2	Metrology, calibrated (HALAR) with performance plots

## 1.1. Environmental Specifications



**WARNING:** Do not expose this product to environments or conditions outside of the listed specifications. Exceeding environmental or operating specifications can cause damage to the equipment.

**Table 1-2: Environmental Specifications**

<b>Ambient Temperature</b>	Operating: 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.
	Storage: 0° to 40° C (32° to 104° F) in original shipping packaging
<b>Humidity</b>	Operating: 20% to 60% RH
	Storage: 10% to 70% RH, non-condensing in original packaging.
<b>Altitude</b>	Operating: 0 m to 2,000 m (0 ft 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 system performance. Contact Aerotech for information regarding your specific application.
<b>Use</b>	Indoor use only

## 1.2. Accuracy and Temperature Effects

Aerotech products are designed for and built in a 20°C (68°F) environment. Extreme temperature changes could cause a decrease in performance or permanent damage to the ATS3600. At a minimum, the environmental temperature must be controlled to within 0.25°C per 24 hours to ensure the ATS3600 specifications are repeatable over an extended period of time. The severity of temperature effects on all specifications depends on many different environmental conditions, including how the ATS3600 is mounted. Contact the factory for more details.

If the stage is not equipped with an optional linear encoder, the accuracy of the screw is a key element in the overall positioning accuracy. A scale error can be expected if temperature of the screw differs from 20 °C (68 °F). The greater the temperature difference, the greater the error. The temperature of the screw depends on the speed and duty cycle of the stage. The faster the movement and higher the duty cycle, the more the stage accuracy will be affected by heat. The thermal expansion coefficient of the screw is 11.7 ppm/°C.

The temperature error,  $t\epsilon$ , can be calculated with the formula that follows:

$$t\epsilon = \alpha \times L \times \Delta t$$

where

- $\alpha$  = 11.7 x 10<sup>-6</sup> m/mm per ° C (6.67 x 10<sup>-6</sup> in/in per °F)
- $L$  = Length of ball screw between base and table top
- $\Delta t$  = temperature difference between ambient and 20° C (68° F)

Likewise, if the stage is equipped with an optional linear encoder, travel of the stage will expand at a rate of the encoder scale (7.5 ppm/°C).

### 1.3. Basic Specifications

**NOTE:** Aerotech continually improves its product offerings; listed options may be superseded at any time. All drawings and illustrations are for reference only and were complete and accurate as of this manual's release. Refer to [www.aerotech.com](http://www.aerotech.com) for the most up-to-date information.

**Table 1-3: ATS3600 Series Specifications**

			ATS3600-100XY	ATS3600-200XY	ATS3600-300XY	ATS3600-400XY
Travel			100 mm	200 mm	300 mm	400 mm
Bus Voltage			Up to 160 VDC			
Maximum Travel Speed <sup>(1)</sup>			200 mm/s			
Maximum Load <sup>(2)</sup>			90.0 kg			
Accuracy	High-Precision Ball Screw Only		±2.0 µm/25 mm			
	Direct Linear Feedback	Calibrated <sup>(3)</sup>	±2.0 µm			
		Standard	±4.0 µm	±8.0 µm	±12.0 µm	±16.0 µm
Repeatability (Bidirectional)	High-Precision Ball Screw Only		±2.0 µm			
	Direct Linear Feedback		±1.0 µm			
Straightness and Flatness	Differential		1.0 µm/25mm			
	Maximum Deviation		±2.0 µm	±4.0 µm	±6.0 µm	±8.0 µm
Pitch and Yaw			10 arc sec	15 arc sec	18 arc sec	20 arc sec
Nominal Stage Weight	Less Motor		22.8 kg	34.2 kg	44.4 kg	60.3 kg
	With Motor		26.4 kg	37.8 kg	48.0 kg	63.9 kg
Construction			Aluminum Body; Black Anodize Finish			
1. Excessive duty cycle may impact stage accuracy.						
2. Payload specifications are based on ball screw and bearing life of 2500 km (100 million inches) of travel.						
3. Available with Aerotech controllers.						
<b>NOTE:</b> Specifications are for single-axis systems, measured 25 mm above the tabletop. Performance of multi-axis systems is payload and workpoint dependent. Consult factory for multi-axis or non-standard applications.						

## 1.4. Vacuum Operation

Aerotech can specially prepare the ATS3600 for operation in vacuum environments. Aerotech offers two vacuum preparation options; one for low vacuum (for use in atmospheric pressures to  $10^{-3}$  Torr) and one for high vacuum (preparation for environments from  $10^{-3}$  to  $10^{-6}$  Torr). As part of this preparation, attention to detail during modification, cleaning, and assembly results in products with optimal performance in vacuum applications.

To make sure that the ATS3600 will continue to perform well in the vacuum environment, use the guidelines that follow (in addition to standard handling, installation, and lubrication guidelines outlined in this manual).

- Do not remove the ATS3600 from its sealed bag until it is ready to use.
- Always handle the ATS3600 in a clean environment and use powder-free polyethylene gloves to prevent any contaminants from adhering to the surface of the ATS3600.
- During installation, use cleaned, vented, stainless steel fasteners when securing the ATS3600.
- Reduced air pressure eliminates significant convective heat transfer. This, coupled with the viscous vacuum-compatible lubricants, could result in excessive motor operating temperatures. Because of this, consider all continuous torque ratings to be 40 to 60% lower than the value specified for operation in normal atmospheric environment. Reduce motor usage accordingly.
- For vacuum applications, the recommended lubricant is a small quantity of **Braycote® 602EF** grease or a compatible substitute of equal quality.
- Baking vacuum components significantly reduces outgassing at initial pump-down to vacuum pressure and evaporates water vapor that impregnates porous surfaces on the aluminum and Teflon cables. Aerotech recommends that customers bake out vacuum systems when first installing them in the vacuum chamber. Contact Aerotech for bakeout temperatures and times for your application.

## Chapter 2: Mechanical Specifications and Installation



**WARNING:** ATS3600 installation must be in accordance to instructions provided by this manual and any accompanying documentation. Failure to follow these instructions could result in injury or damage to the equipment.

### 2.1. Unpacking and Handling the Stage



**DANGER/HEAVY:** Manually lifting and moving the stage requires a minimum of two people on either side of the stage. Refer to [Section 1.3](#) for stage mass specifications.

- Do not attempt to lift heavy loads single handed.
- Follow the lifting instructions and only manually lift from the specified surfaces (if lifting hardware hasn't been supplied).
- Do not use any of the cables as lifting points.



**WARNING:** It is the customer's responsibility to safely and carefully lift the stage.

- Make sure that all moving parts are secure before moving the ATS3600. Unsecured moving parts may shift and cause bodily injury.
- Improper handling could adversely affect the performance of the ATS3600. Use care when moving the ATS3600.

**NOTE:** If any damage has occurred during shipping, report it immediately.

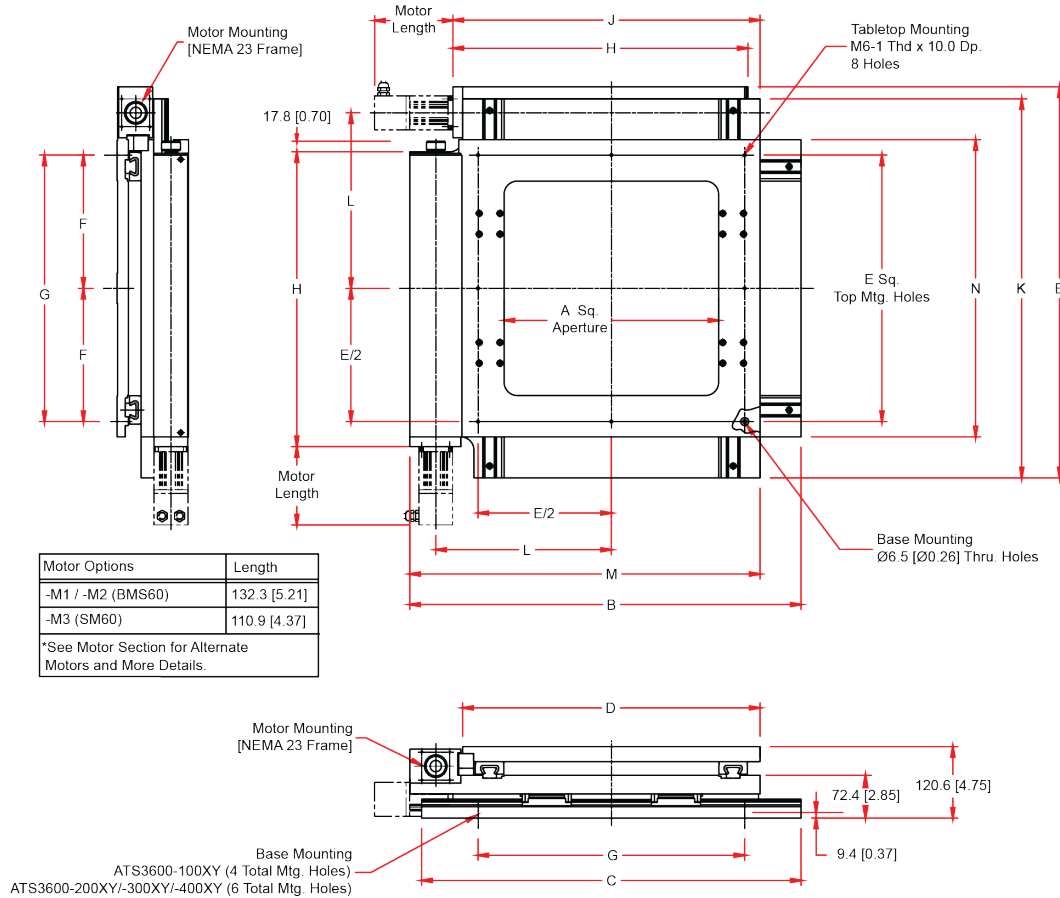
Carefully remove the ATS3600 from its protective shipping container. Gently set the ATS3600 on a smooth, flat, and clean surface.

Before operating the ATS3600, it is important to let it stabilize at room temperature for at least 12 hours. Allowing it to stabilize to room temperature will ensure that all of the alignments, preloads, and tolerances are the same as they were when tested at Aerotech. Use compressed nitrogen or clean, dry, oil-free air to remove any dust or debris that has collected during shipping.

Each ATS3600 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.

## 2.2. Dimensions

**NOTE:** Aerotech continually improves its product offerings; listed options may be superseded at any time. All drawings and illustrations are for reference only and were complete and accurate as of this manual's release. Refer to [www.aerotech.com](http://www.aerotech.com) for the most up-to-date information.



Basic Model	Total Travel	Dimensions - Millimeters [Inches]					
		A	B	C	D	E	F
ATS3600-100XY	100.0 [4.00]	158.8 [6.25]	416.4 [16.40]	355.6 [14.00]	298.5 [11.75]	250.0 [9.84]	-
ATS3600-200XY	200.0 [8.00]	260.4 [10.25]	547.6 [21.56]	516.4 [20.33]	400.0 [15.75]	350.0 [13.78]	175.0 [6.89]
ATS3600-300XY	300.0 [12.00]	362.0 [14.25]	660.2 [26.00]	640.0 [25.20]	501.7 [19.75]	450.0 [17.72]	225.0 [8.86]
ATS3600-400XY	400.0 [16.00]	463.6 [18.25]	800.1 [31.50]	800.0 [31.50]	603.3 [23.75]	550.0 [21.65]	275.0 [10.83]
	G	H	J	K	L	M	N
ATS3600-100XY	250.0 [9.84]	294.0 [11.60]	314.9 [12.40]	355.60 [14.00]	194.7 [7.67]	387.9 [15.27]	301.0 [11.85]
ATS3600-200XY	350.0 [13.78]	396.2 [15.60]	416.5 [16.40]	516.4 [20.33]	245.5 [9.67]	489.5 [19.27]	400.0 [15.75]
ATS3600-300XY	450.0 [17.72]	497.8 [19.60]	518.1 [20.40]	640.0 [25.20]	296.3 [11.67]	591.1 [23.27]	501.7 [19.75]
ATS3600-400XY	550.0 [21.65]	599.4 [23.60]	619.7 [24.40]	800.0 [31.50]	347.1 [13.67]	692.7 [27.27]	603.3 [23.75]

Figure 2-1: ATS3600 Dimensions

## 2.3. Securing the Stage to the Mounting Surface



**WARNING:** Make sure that all moving parts are secure before moving the ATS3600. Unsecured moving parts may shift and cause bodily injury.



**WARNING:** The ATS3600 must be mounted securely. Improper mounting can result in injury and damage to the equipment.

The mounting surface must be flat and have adequate stiffness to achieve the maximum performance from the ATS3600 stage. When it is mounted to a non-flat surface, the stage can be distorted while the mounting screws are tightened. This distortion will decrease overall accuracy. Adjustments to the mounting surface must be done before the stage is secured.

Inspect the mounting surface for dirt or unwanted residue and clean if necessary. Use precision flatstones on the mounting surface to remove any burrs or high spots. Clean the mounting surface with a lint-free cloth and acetone or isopropyl alcohol and allow the cleaning solvent to completely dry. Gently place the stage on the mounting surface.

**NOTE:** To maintain accuracy, the mounting surface must be flat to within 7.5  $\mu\text{m}$  over the entire footprint of the stage.

**NOTE:** The ATS3600 is precision machined and verified for flatness prior to product assembly at the factory. If machining is required to achieve the desired flatness, it should be performed on the mounting surface rather than the ATS3600. Shimming should be avoided if possible. If shimming is required, it should be minimized to retain maximum rigidity of the system.

**NOTE:** 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.



**WARNING:** Do not attempt to manually move the ATS3600 if it is connected to a power source.

Tightening torque values for the mounting hardware are dependent on the properties of the surface to which the stage is being mounted. Values provided in [Table 2-1](#) are typical values and may not be accurate for your mounting surface. Refer to [Section 2.2](#) for specific model mounting locations and dimensions.

**Table 2-1: Stage to Mounting Surface Hardware**

Mounting Hardware	Typical Screw Torque
M6 x 20 mm SHCS M6 washer, hardened steel	7.0 N·m [5 ft·lb]

## 2.4. Attaching the Payload to the Stage

Inspect the mounting surface for dirt or unwanted residue and clean if necessary. Clean the mounting surface with a lint-free cloth and acetone or isopropyl alcohol and allow the cleaning solvent to completely dry.

Aerotech recommends that customers use a representative payload during start-up to prevent accidental damage to the stage and the payload. Proceed with the electrical installation and test the motion control system in accordance with the system documentation. Document all results for future reference. For information on electrical installation refer to [Chapter 3](#) and the documentation delivered with the stage.

The payload must be flat, rigid, and comparable to the stage in quality to maintain optimum performance.

**NOTE:** For valid system performance, the mounting interface should be flat within 7.5  $\mu\text{m}$ .

Applied loads should be symmetrically distributed whenever possible (i.e., the payload should be centered on the stage table and the entire stage should be centered on the support structure).



## Chapter 3: Electrical Specifications and Installation



**WARNING:** Electrical installation must be performed by properly qualified personnel.

Aerotech motion control systems are adjusted at the factory for optimum performance. When the ATS3600 is part of a complete Aerotech motion control system, setup usually involves connecting the ATS3600 to the appropriate drive chassis with the cables provided. Labels on the system components usually indicate the appropriate connections.

If system level integration was purchased, an electrical drawing showing system interconnects has been supplied with the system (separate from this documentation).

The electrical wiring from the motor and encoder are integrated at the factory. Refer to the sections that follow for standard motor wiring and connector pinouts.



**WARNING:** Applications requiring access to the stage while it is energized will require additional grounding and safeguards. The System Integrator or qualified installer is responsible for determining and meeting all safety and compliance requirements necessary for the integration of this stage into the final application.



**DANGER:** Remove power before connecting or disconnecting electrical components or cables. Failure to do so may cause electric shock or damage to the equipment.



**WARNING:** Operator access to the base and tabletop must be restricted while connected to a power source. Failure to do so may expose the operator to electric shock and mechanical hazards.

**NOTE:** If the ATS3600 was not purchased as part of an integrated system, refer to the controller documentation to adjust servo gains for optimum velocity and position stability.

### 3.1. Motor and Feedback Connectors

Stages equipped with standard motors and encoders come from the factory completely wired and assembled.

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

The protective ground connection of the ATS3600 provides motor frame ground protection only. Additional grounding and safety precautions are required for applications requiring access to the stage while it is energized. The System Integrator or qualified installer is responsible for determining and meeting all safety and compliance requirements necessary for the integration of this stage into the final application.



**DANGER:** Remove power before connecting or disconnecting electrical components or cables. Failure to do so may cause electric shock or damage to the equipment.

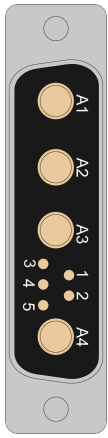


**WARNING:** The protective ground connection must be properly installed to minimize the possibility of electric shock.



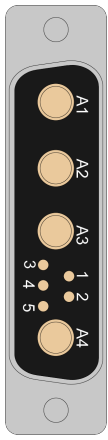
**CAUTION:** The stage controller must provide over-current and over-speed protection. Failure to do so may result in permanent damage to the motor and stage components.

**Table 3-1: Brushless Motor Connector Pinout [-M1 and -M2]**

Pin	Description	Connector
Case	Shield Connection	
A1	Motor Phase A	
A2	Motor Phase B	
A3	Motor Phase C	
1	Reserved	
2	Reserved	
3	Reserved	
4	Reserved	
5	Reserved	
A4	Frame Ground (motor protective ground)	

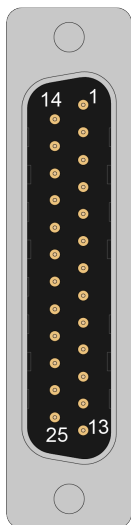
Mating Connector	Aerotech P/N	Third Party P/N
Backshell	ECK00656	Amphenol #17E-1726-2
Sockets [QTY. 4]	ECK00659	ITT Cannon #DM53744-6
Connector	ECK00657	ITT Cannon #DBM9W4SA197

**Table 3-2: Stepper Motor Connector Pinout [-M3]**

Pin	Description	Connector
Case	Shield Connection	
A1	Motor Phase A	
A2	Motor Phase B	
A3	Motor Phase A Return	
A4	Motor Phase B Return	
3	Reserved	
4	Frame	
5	Frame	

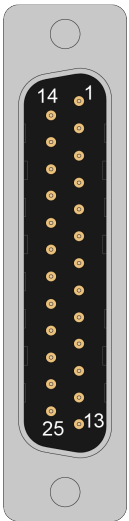
Mating Connector	Aerotech P/N	Third Party P/N
Backshell	ECK00656	Amphenol #17E-1726-2
Sockets [QTY. 4]	ECK00659	ITT Cannon #DM53744-6
Connector	ECK00657	ITT Cannon #DBM9W4SA197

**Table 3-3: Brushless Motor Feedback Connector Pinout [-M1 and -M2]**

Pin	Description	Connector
Case	Shield Connection	
1	Reserved	
2	Over-Temperature Thermistor sensor <sup>(1)</sup>	
3	+5 V power supply	
4	Reserved	
5	Hall Effect sensor, phase B	
6	Marker-N	
7	Marker	
8	Reserved	
9	Reserved	
10	Hall Effect sensor, phase A	
11	Hall Effect sensor, phase C	
12	Reserved	
13	Brake - <sup>(2)</sup>	
14	Cosine	
15	Cosine-N	
16	Reserved	
17	Sine	
18	Sine-N	
19	Reserved	
20	Common ground	
21	Common ground	
22	Reserved	
23	Reserved	
24	Reserved	
25	Brake + <sup>(2)</sup>	
1. BMS motors only (otherwise Reserved)		
2. with brake option only		

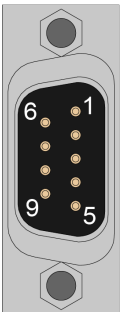
Mating Connector	Aerotech P/N	Third Party P/N
Backshell	ECK00656	Amphenol #17E-1726-2
Connector	ECK00300	FCI DB25S064TLF

**Table 3-4: Stepper Motor Feedback Connector Pinout [-M3]**

Pin	Description	Connector
1	Reserved	
2	Reserved	
3	+5 V power supply	
4	Reserved	
5	Reserved	
6	Marker-N	
7	Marker	
8	Reserved	
9	Reserved	
10	Reserved	
11	Reserved	
12	Reserved	
13	Reserved	
14	Cosine	
15	Cosine-N	
16	+5 V power supply	
17	Sine	
18	Sine-N	
19	Reserved	
20	Common ground	
21	Common ground	
22	Reserved	
23	Reserved	
24	Reserved	
25	Reserved	

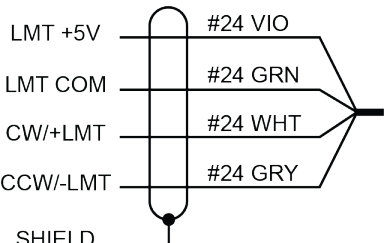
Mating Connector	Aerotech P/N	Third Party P/N
Backshell	ECK00656	Amphenol #17E-1726-2
Connector	ECK00300	FCI DB25S064TLF

**Table 3-5: Limits with 9-Pin D-Connector (-LI1 or -LI3)**

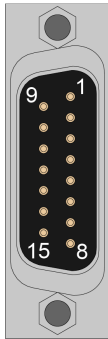
Pin #	Description	Connector
Case	Signal shield connection	
1	+5V supply input for optical limit switch boards	
2	Common ground to limit switch	
3	Signal indicating maximum travel produced by positive/CW stage direction	
4	Reserved	
5	Signal indicating stage maximum travel produced by negative/CCW stage direction	
6	Reserved	
7	Reserved	
8	Reserved	
9	Reserved	

Mating Connector	Aerotech P/N	3rd Party P/N
Connector	ECK00340	DE09S064TLF
Backshell	ECK01021	Amphenol #17E-1724-2

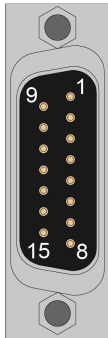
**Table 3-6: Limits with Flying Leads (-LI2 or -LI4 Option)**

Typical	Description	Flying Leads
Violet	+5V supply input for optical limit switch boards	 <p>(typical configuration shown)</p>
Green	Common ground to limit switch	
Gray <sup>(1)</sup>	Signal indicating stage maximum travel produced by negative/CCW stage direction	
White <sup>(1)</sup>	Signal indicating maximum travel produced by positive/CW stage direction	
Case	Signal shield connection	

**Table 3-7: 15-Pin Linear Encoder Connector (-E1)**

Pin	-E1 Option	Connector
1	Sine	
2	Cosine	
3	Marker	
4	+5 V power supply	
5	Reserved	
6	Reserved	
7	Reserved	
8	Reserved	
9	Sine-N	
10	Cosine-N	
11	Marker-N	
12	Common ground	
13	Setup	
14	Reserved	
15	Reserved	

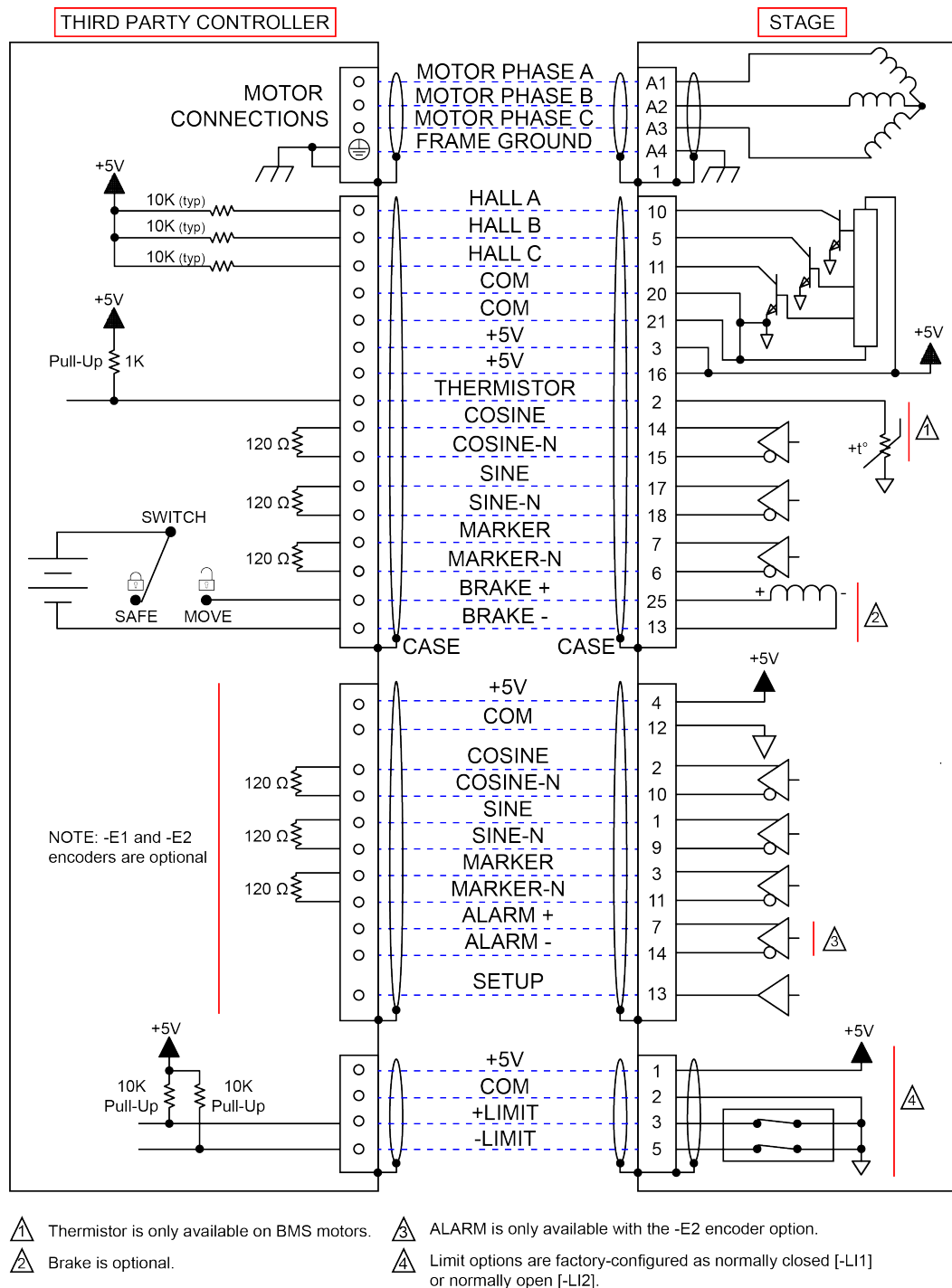
**Table 3-8: 15-Pin Linear Encoder Connector (-E2)**

Pin	-E2 Option	Connector
1	Sine	
2	Cosine	
3	Marker	
4	+5 V power supply	
5	Reserved	
6	Reserved	
7	Alarm+	
8	Reserved	
9	Sine-N	
10	Cosine-N	
11	Marker-N	
12	Common ground	
13	Setup	
14	Alarm-	
15	Reserved	

Mating Connector	Aerotech P/N	Third Party P/N
15-Pin D-Connector	ECK00326	DA15S064TLF
Backshell	ECK01022	Amphenol 17-1725-2

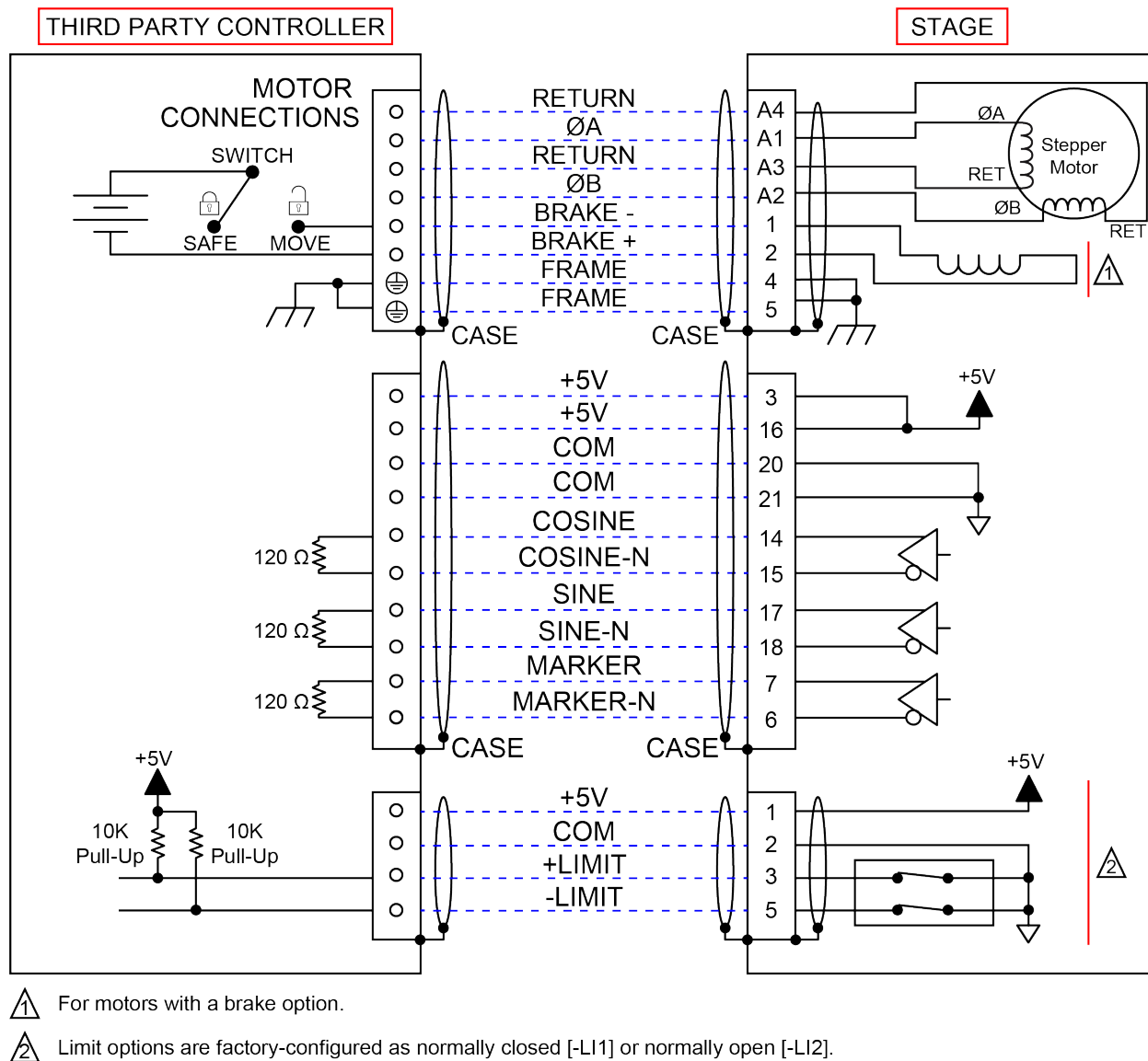
### 3.2. Motor and Feedback Wiring

All motor and controller manufacturers have their own designations for motor phases A/B/C and Hall signals A/B/C (refer to [Section 3.5.](#) for motor phasing). Shielded cables are required for the motor and feedback connections.



**Figure 3-1: Brushless Motor and Feedback Wiring [-M1 and -M2]**





### Figure 3-2: Stepper Motor and Feedback Wiring [-M3]

### 3.3. Motor and Feedback Specifications

**Table 3-9: Feedback Specifications**

Hall-Effect Sensors Specifications [BM and BMS motors options only]	
Supply Voltage	5 V $\pm 5\%$ <sup>(1)</sup>
Supply Current	50 mA
Output Type	Open Collector
Output Voltage	24 V max (pull up)
Output Current	5 mA (sinking)
1. For brushless motors, the Hall-Effect sensors and encoder are connected to the same 5V supply pin in the feedback connector. See 3.1.	
Thermistor Specifications [BMS motors options only]	
Polarity	Logic "0" (no fault)
	Logic "1" (over-temperature fault)
Cold Resistance	~ 100 $\Omega$
Hot Resistance	~ 10 K
<b>Note:</b> 1K pull-up to +5V recommended.	
Encoder Specifications	
Supply Voltage	5 V $\pm 5\%$ <sup>(1)</sup>
Supply Current	250 mA (typical)
Output Signals	<b>Sinusoidal Type (Incremental Encoder):</b> 1 V <sub>pk-pk</sub> into 120 $\Omega$ Load (differential signals SIN+, SIN-, COS+, COS- are .5 V <sub>pk-pk</sub> relative to ground.)
	<b>Digital Output (Incremental Encoder):</b> RS422/485 compatible
1. For brushless motors, the Hall-Effect sensors and encoder are connected to the same 5V supply pin in the feedback connector. See 3.1.	
Limit Switch Specifications	
Supply Voltage	5 V $\pm 5\%$
Supply Current	25 mA
Output Type	Open Collector
Output Voltage	5 V
Output Current	10 mA (sinking)
Output Polarity	Normally Closed (NC) <ul style="list-style-type: none"> <li>Sinks current to ground (Logic "0") when not in limit</li> <li>High impedance (Logic "1") when in limit</li> <li>Requires external pull-up to +5 V (10 k<math>\Omega</math> recommended)</li> </ul>
	Normally Open (NO) <ul style="list-style-type: none"> <li>Sinks current to ground (Logic "0") when in limit</li> <li>High impedance (Logic "1") when not in limit</li> <li>Requires external pull-up to +5 V (10 k<math>\Omega</math> recommended)</li> </ul>
<b>Note:</b> If the ATS3600 is driven beyond the electrical limit, it will encounter a mechanical stop. Impacting the mechanical stop could cause damage to the stage even at low speeds.	

**Table 3-10: Motor Specifications [BMS60]**

		BMS60
<b>Performance Specifications <sup>(1, 5)</sup></b>		
Stall Torque, Continuous <sup>(2)</sup>	N·m (oz·in)	0.33 (46.2)
Peak Torque <sup>(3)</sup>	N·m (oz·in)	1.31 (184.9)
Rated Power Output, Continuous	W	116
<b>Electrical Specifications <sup>(5)</sup></b>		
Winding Designation		-A
BEMF Constant (Line-Line, Max)	$V_{pk}/k_{rpm}$	19.0
Continuous Current, Stall <sup>(2)</sup>	$A_{pk} (A_{rms})$	2.3 (1.6)
Peak Current, Stall <sup>(3)</sup>	$A_{pk} (A_{rms})$	9.2 (6.5)
Torque Constant <sup>(4, 8)</sup>	$N·m/A_{pk}$ (oz·in/ $A_{pk}$ )	0.140 (20.10)
	$N·m/A_{rms}$ (oz·in/ $A_{rms}$ )	0.200 (28.40)
Motor Constant <sup>(2, 4)</sup>	$N·m/\sqrt{W}$ (oz·in/ $\sqrt{W}$ )	0.050 (7.02)
Resistance, 25°C (Line-Line)	$\Omega$	13.4
Inductance (Line-Line)	mH	44.9
Maximum Bus Voltage	$V_{DC}$	340
Thermal Resistance	°C/W	1.73
Number of Poles	--	8
1. Performance is dependent upon heat sink configuration, system cooling conditions, and ambient temperature 2. Values shown @ 75°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. Force constant and motor constant specified at stall 5. All performance and electrical specifications $\pm 10\%$ 6. Maximum winding temperature is 100 °C (thermistor trips at 100 °C) 7. Ambient operating temperature range 0 °C - 25 °C; consult Aerotech for performance in elevated ambient temperatures 8. All Aerotech amplifiers are rated $A_{pk}$ ; use torque constant in $N·m/A_{pk}$ when sizing		

**Table 3-11: Motor Specifications [SM60]**

	SM60-VT2
NEMA Motor Frame Size	NEMA 23
Stall Torque	1.41 N·m (200 oz·in)
Rated Amps Per Phase	0.84 A
Maximum Voltage Across the Motor	160 V
Rotor Inertia	3.00E-05 kg·m <sup>2</sup> (0.0042 oz·in·s <sup>2</sup> )
Full Step Angle	1.8°
Accuracy	±0.09°
Maximum Radial Load	7.7 kg (17 lb)
Maximum Thrust Load	1.5 kg (3.4 lb)
Weight	0.70 kg (1.54 lb)

**Table 3-12: Motor Rotary Encoder Option Specifications**

Encoder Option	Fundamental Signal Period	Digital Resolution
-M1 (2500 line, RS422 line-driver)	2 µm	0.5 µm
-M2 (1000 line, 1 V <sub>p-p</sub> amplified sinewave)	5 µm	-
-M2 (1000 line, 1 V <sub>p-p</sub> amplified sinewave) With 1000x interpolation <sup>(1)</sup>	5 µm	5 nm
-M2 (1000 line, 1 V <sub>p-p</sub> amplified sinewave) With 4000x interpolation <sup>(1)</sup>	5 µm	1.25 nm

1. Quadrature decoding included in interpolated resolution calculations

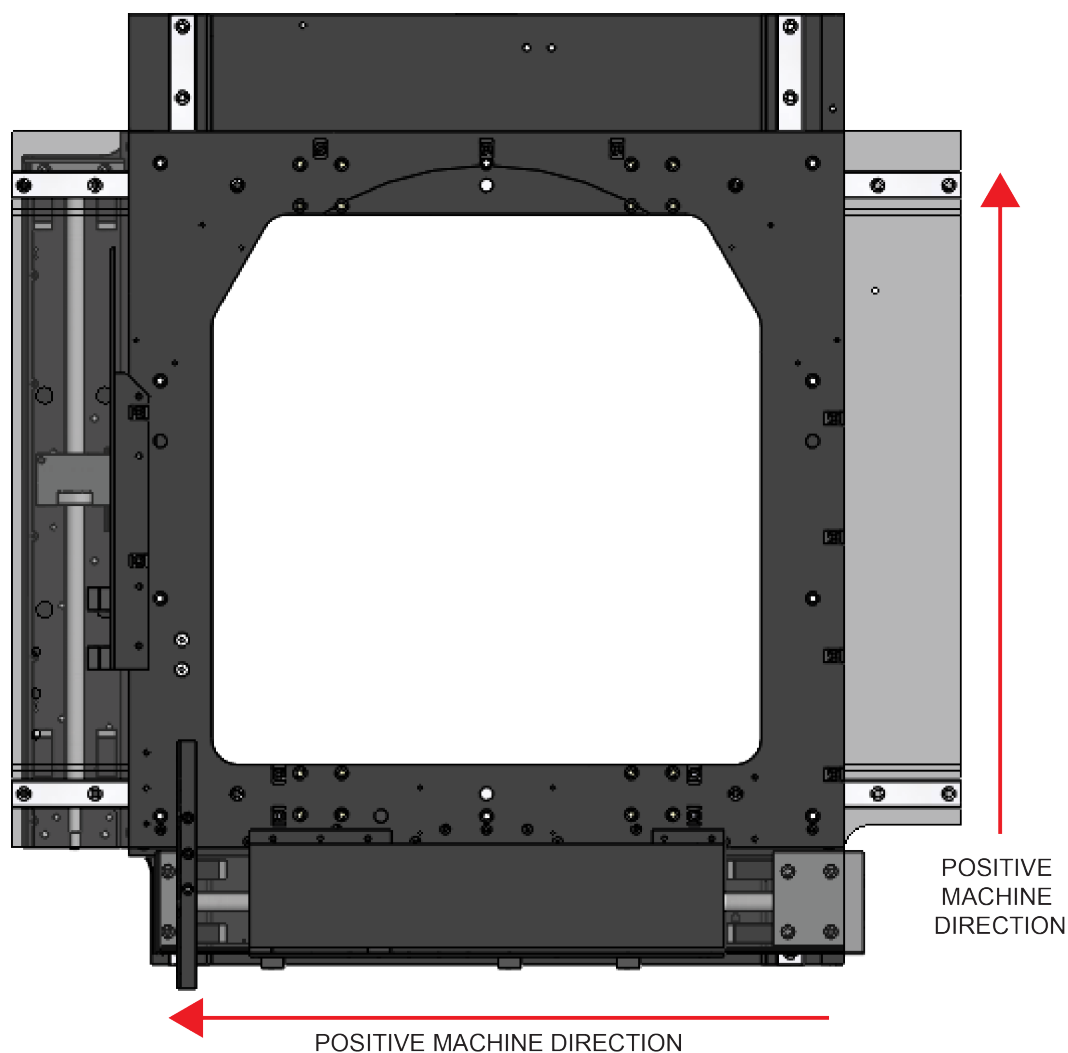
**Table 3-13: Stage Linear Encoder Option Specifications**

Encoder Option	Fundamental Signal Period	Digital Resolution
-E1 incremental linear sinewave	20 µm	-
-E1 incremental linear sinewave With x4000 interpolation <sup>(1)</sup>	20 µm	5 nm
-E1 incremental linear sinewave With x16000 interpolation <sup>(1)</sup>	20 µm	1.25 nm
-E2 Incremental linear 0.1 µm digital (RS422 line-driver)	20 µm	0.1 µm

1. Quadrature decoding included in interpolated resolution calculations

### 3.4. Limits, Marker, and Machine Direction

Aerotech stages are configured to have positive and negative "machine" directions. The machine direction defines the phasing of the feedback and motor signals and is dictated by the stage wiring (refer to [Section 3.5](#) for Motor and Feedback phasing information). Programming direction of a stage is set by the controller that is used to move the stage. Programming direction is typically selectable in the controller, while machine direction is hardwired in the stage. [Figure 3-3](#) shows the machine direction of ATS3600 stages.

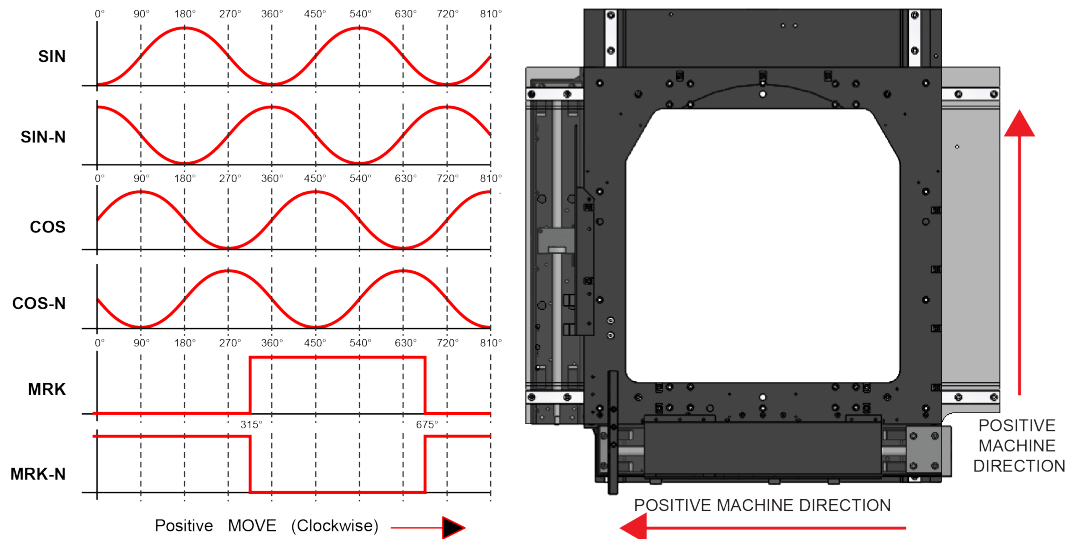


**Figure 3-3: Machine Direction**

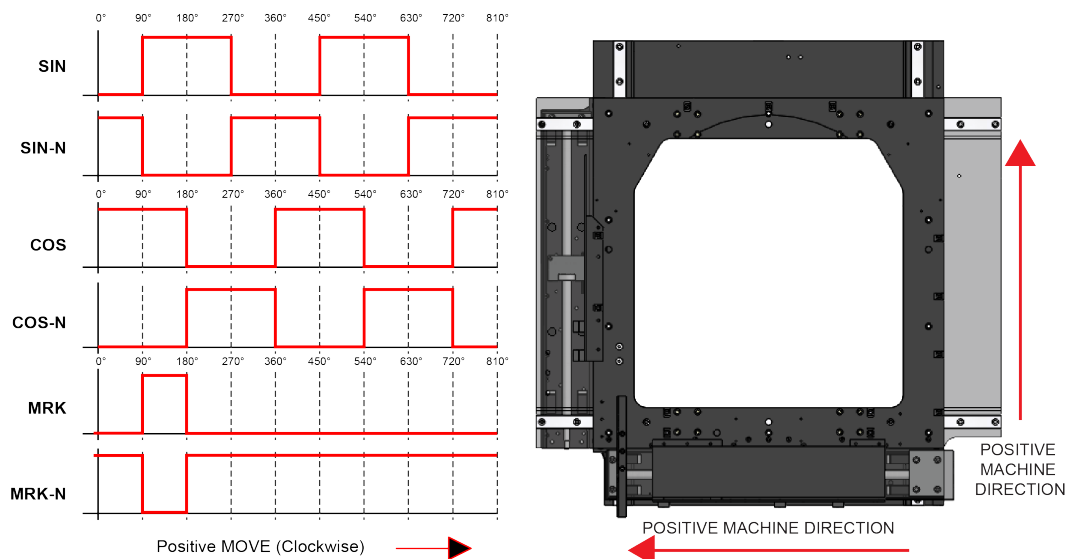
### 3.5. Motor and Feedback Phasing

Motor phase voltage is measured relative to the virtual wye common point.

**Figure 3-4: Hall Phasing**



**Figure 3-5: Analog Encoder Phasing Reference Diagram**



**Figure 3-6: TTL Encoder Phasing Reference Diagram**

## Chapter 4: Maintenance

**NOTE:** If the bearing area is not kept free of foreign matter and moisture, the performance and life expectancy of the stage will be reduced.



**DANGER:** To minimize the possibility of bodily injury or death, disconnect all electrical power prior to performing any maintenance or making adjustments to the equipment.

### 4.1. Service and Inspection Schedule

Inspect the ATS3600 at least once per month. A longer or shorter inspection interval may be required depending on the application and conditions, such as the duty cycle, speed, and environment.

In general, stages operating in a clean environment should be cleaned and lubricated annually or every 500 km (whichever comes first). For stages operating under conditions involving excessive debris, the stage should be cleaned every six months. For high-speed applications (those near max speed at a duty cycle of 50%), frequent maintenance with standard lubricants is required.

Monthly inspections should include but not be limited to:

- Visually inspect the stage and cables.
- Re-tighten loose connectors.
- Replace or repair damaged cables.
- Clean the ATS3600 and any components and cables as needed.
- Repair any damage before operating the ATS3600.
- Inspect and perform an operational check on all safeguards and protective devices.

## 4.2. Cleaning and Lubrication

When cleaning and/or lubricating components of the ATS3600 series stages:

1. Be sure to use a clean, dry, soft, lint-free cloth for cleaning.
2. Before using a cleaning solvent on any part of the ATS3600, blow away small particles and dust with clean, dry, compressed air.
3. Take the opportunity during the lubrication procedure to inspect the motion guides or bearings for any damage or signs of wear.
4. In applications that have multiple stages bolted together to form multi-axis systems, the orthogonality may be lost if the stage tables of the support stages are loosened. Precision aligned stages should not be loosened or disassembled.
5. Further disassembly of the stage is not recommended because proper assembly and calibration can only be done at the factory. In addition, an autocollimator is required for post assembly verification to maintain warranties. Contact Aerotech for more information.



**DANGER:** To minimize the possibility of bodily injury or death, disconnect all electrical power prior to performing any maintenance or making adjustments to the equipment.

### Cleaning

If a solvent is necessary for cleaning the stage, Aerotech recommends using isopropyl alcohol. Harsher solvents, such as acetone, may damage the plastic and rubber seals on the ball screw and LMG trucks. If acetone is required, avoid contact the ball screw and bearing seals.



**WARNING:** Make sure that all solvent has completely evaporated before attempting to move the stage.

### Lubrication

For standard ball screw, linear guides, and gearset assemblies, lubricate per grease label located next to the motor flange on the base. If no label is present, contact Aerotech for grease type.

For high-speed applications (i.e., near maximum speed at a duty cycle of 50%), frequent maintenance with standard lubricants is required.

If the application process uses only a small portion of travel for most of the duty cycle, periodically drive the stage through full travel to redistribute the lubrication in the bearings.

**NOTE:** During the lubrication procedure, inspect the linear motion guides for any damage or signs of wear.

For the ATS3600, do the steps that follow to lubricate each axis.

1. Drive the stage table to one end of travel and remove power to the stage.
2. Remove the screws on the edges of the hardcover and slide it out from the side opposite of the motor. This can be done without removing the table.
3. Remove any accumulated dust or debris from the inside of the assembly.



4. Remove any dirty or dried lubricant from the ball screw. Use a clean, lint-free cloth with a side-to-side motion. Manually turn the ball screw to clean its entire circumference. A swab soaked in isopropyl alcohol may be used to remove stubborn debris.
5. Clean the end of the ball-screw nut and wiper with a clean, lint-free cloth or swab.
6. Clean the linear bearing guides using a similar technique.
7. Apply a thin, continuous film of lubricant to the ball-screw threads and linear bearing guides. A natural bristle brush is an excellent applicator.
8. For stages without an optional brake, manually move the stage to the opposite end of travel. This will work the grease into the ball screw and linear bearing guides. If the stage has an optional brake, the stage cannot be moved by hand. In this case, restore power to the stage, drive it to the desired position, then remove power and continue to Step 9. Be sure to use extreme caution while operating the stage temporarily without the hardcover installed.
9. Repeat steps 3 through 7 for any areas covered by the original table position.
10. Refasten the hardcover. Torque the hardcover screws to 36 - 42 in-lbs to ensure proper support.
11. Restore power to the stage, and drive the stage table back to its original position to redistribute lubricants.

### 4.3. Troubleshooting

Symptom	Possible Cause and Solution
Stage will not move	Brake not released (if equipped with brake; refer to stage documentation). In Limit condition. Check limits (refer to <a href="#">Chapter 3</a> ) and refer to the Controller documentation for polarity and compatibility requirements (Example: voltage requirements). Controller trap or fault (refer to the Controller documentation).
Stage moves uncontrollably	Encoder (sine and cosine) signal connections (refer to <a href="#">Chapter 3</a> and Controller documentation). Motor Connections (refer to <a href="#">Chapter 3</a> and the Controller documentation).
Stage oscillates or squeals	Gains misadjusted (refer to the Controller documentation). Encoder signals (refer to the Controller documentation).

## Appendix A: Warranty and Field Service

Aerotech, Inc. warrants its products to be free from harmful 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, whether 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 on 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.

THE EXPRESS WARRANTY SET FORTH HEREIN IS IN LIEU OF AND EXCLUDES ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED, BY OPERATION OF LAW OR OTHERWISE. IN NO EVENT SHALL AEROTECH BE LIABLE FOR CONSEQUENTIAL OR SPECIAL DAMAGES.

### Return Products Procedure

Claims for shipment damage (evident or concealed) must be filed with the carrier by the buyer. Aerotech must be notified within thirty (30) days of shipment of incorrect material. 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. A "Return Materials Authorization (RMA)" number must accompany any returned product(s). The RMA number may be obtained by calling an Aerotech service center or by submitting the appropriate request available on our website ([www.aerotech.com](http://www.aerotech.com)). 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 thirty (30) days after the issuance of a return authorization number will be subject to review.

Visit <https://www.aerotech.com/global-technical-support.aspx> for the location of your nearest Aerotech Service center.

### Returned Product Warranty Determination

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 expedited method of return, the product(s) will be shipped collect. Warranty repairs do not extend the original warranty period.

**Fixed Fee Repairs** - Products having fixed-fee pricing will require a valid purchase order or credit card particulars before any service work can begin.

**All Other Repairs** - After Aerotech's evaluation, 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 thirty (30) days of notification will result in the product(s) being returned as is, at the buyer's expense.

Repair work is warranted for ninety (90) days from date of shipment. Replacement components are warranted for one year from date of shipment.

### Rush Service

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.

### 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 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.

### Service Locations

<http://www.aerotech.com/contact-sales.aspx?mapState=showMap>

USA, CANADA, MEXICO	CHINA	GERMANY
Aerotech, Inc. Global Headquarters Phone: +1-412-967-6440 Fax: +1-412-967-6870	Aerotech China Full-Service Subsidiary Phone: +86 (21) 5508 6731	Aerotech Germany Full-Service Subsidiary Phone: +49 (0)911 967 9370 Fax: +49 (0)911 967 93720
TAIWAN	UNITED KINGDOM	
Aerotech Taiwan Full-Service Subsidiary Phone: +886 (0)2 8751 6690	Aerotech United Kingdom Full-Service Subsidiary Phone: +44 (0)1256 855055 Fax: +44 (0)1256 855649	

Have your customer order number ready before calling.

## Appendix B: Revision History

Revision	Description
1.00.00	New Manual

*This page intentionally left blank.*

# Index

			<b>L</b>	
	<b>2</b>	label		13
2006/42/EC	7	Limit Switch Specifications		26
	<b>A</b>	linear motion guide		
acetone (caution)	32	lubrication		33
Altitude	10	lubricants		
Ambient Temperature	10	vacuum operation		12
	<b>B</b>	Lubrication		32
BMS60	27		<b>M</b>	
Braycote® 602EF	12	mounting surface		
	<b>C</b>	cleaning		15
cleaning		securing stage		15
mounting surface	15	multiaxis combinations		32
Cleaning	32		<b>P</b>	
cleaning solvent	32	part number		13
	<b>D</b>	Possible Cause		34
Directive 2006/42/EC	7	protective ground connection		18
	<b>E</b>		<b>S</b>	
EN 60204-1 2010	7	serial number		13
EN ISO 12100 2010	7	shimming		15
Encoder Specifications	26	SM60-VT2		28
EU 2015/863	7	Solution		34
	<b>G</b>	stabilizing stage		13
Global Technical Support	2	stage		
grease	12	distortion		15
	<b>H</b>	stabilizing		13
Hall-Effect Sensors Specifications	26	Support		2
Humidity	10	Symptom		34
	<b>I</b>		<b>T</b>	
Inspection Schedule	31	Technical Support		2
isopropyl alcohol	32	thermal expansion coefficient		10
		Thermistor Specifications		26

**V**

vacuum	12
vacuum guidelines	12
Vibration	10

**W**

Warranty and Field Service	35
----------------------------	----