

# AVS/AVSI Series Stage Hardware Manual

Revision: 1.00.00



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*Dedicated to the Science of Motion*

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## Table of Contents

Table of Contents .....	iii
List of Figures .....	iv
List of Tables .....	v
Safety Procedures and Warnings .....	vii
EC Declaration of Incorporation .....	ix
<b>Chapter 1: Overview .....</b>	<b>1</b>
1.1. Environmental Specifications .....	2
1.2. Accuracy and Temperature Effects .....	2
1.3. Basic Specifications .....	3
1.4. Vacuum Operation .....	4
<b>Chapter 2: Mechanical Specifications and Installation .....</b>	<b>5</b>
2.1. Unpacking and Handling the Stage .....	5
2.2. Dimensions .....	6
2.3. Securing the Stage to the Mounting Surface .....	12
2.4. Attaching the Payload to the Stage .....	14
2.4.1. Load Capability .....	15
<b>Chapter 3: Electrical Specifications and Installation .....</b>	<b>17</b>
3.1. Motor and Feedback Connectors .....	20
3.2. Motor and Feedback Wiring .....	25
3.3. Motor and Feedback Specifications .....	26
3.4. Motor and Feedback Phasing .....	29
<b>Chapter 4: Maintenance .....</b>	<b>31</b>
4.1. Cleaning and Lubrication .....	32
4.2. Belt Adjustment (AVS Only) .....	34
4.3. Troubleshooting .....	36
<b>Appendix A: Warranty and Field Service .....</b>	<b>37</b>
<b>Appendix B: Revision History .....</b>	<b>39</b>
<b>Index .....</b>	<b>41</b>

**List of Figures**

Figure 2-1: AVS106 Dimensions ..... 6

Figure 2-2: AVS113 Dimensions ..... 7

Figure 2-3: AVS125 Dimensions ..... 8

Figure 2-4: AVSI106 Dimensions ..... 9

Figure 2-5: AVSI113 Dimensions ..... 10

Figure 2-6: AVSI125 Dimensions ..... 11

Figure 2-7: AVS Stage Mounting Orientation ..... 13

Figure 2-8: Surface Mounting Hole Location (AVSI106 Shown) ..... 13

Figure 2-9: AVS106 Cantilevered Load Capabilities ..... 15

Figure 2-10: AVS113 Cantilevered Load Capabilities ..... 15

Figure 2-11: AVS125 Cantilevered Load Capabilities ..... 16

Figure 3-1: Electrical Connections (AVS) ..... 18

Figure 3-2: Electrical Connections (AVSI) ..... 19

Figure 3-3: Motor and Feedback Wiring ..... 25

Figure 3-4: Hall Phasing ..... 29

Figure 3-5: Analog Encoder Phasing Reference Diagram ..... 30

Figure 3-6: Encoder Phasing Reference Diagram (Standard) ..... 30

Figure 4-1: Foldback Motor Option Example ..... 34

Figure 4-2: Belt Access and Adjustment on Foldback Models (Mounting Screws) ..... 35

Figure 4-3: Belt Access and Adjustment on Foldback Models (Pulley Set Screws) ..... 35

## List of Tables

Table 1-1: AVS Series Vertical Translation Stage .....	1
Table 1-2: Options (AVS only) .....	1
Table 1-3: Accessories (AVS only) .....	1
Table 1-4: Cable Orientation (AVSI only) .....	1
Table 1-5: Environmental Specifications .....	2
Table 1-6: AVS Series Specifications .....	3
Table 3-1: Motor Wiring Connector (BMS60) .....	20
Table 3-2: Feedback Connector (BMS60 / AVS) .....	21
Table 3-3: Feedback Mating Connector (BMS60 / AVS) .....	21
Table 3-4: Feedback Connector (BMS60 / AVSI) .....	22
Table 3-5: Feedback Mating Connector (BMS60 / AVSI) .....	22
Table 3-6: Limits Connector (AVS) .....	23
Table 3-7: 23-Pin Motor and Feedback Stepper Motor Connector (AVS) .....	24
Table 3-8: Feedback Specifications .....	26
Table 3-9: BMS60 Motor Specifications .....	27
Table 3-10: Stepper Motor Specifications .....	28

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## Safety Procedures and Warnings

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.

**NOTE:** 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.

**NOTE:** Aerotech continually improves its product offerings; listed options may be superseded at any time. Refer to [www.aerotech.com](http://www.aerotech.com) for the most up-to-date information.

**NOTE:** All drawings and illustrations are for reference only and were complete and accurate as of this manual's release. The most recent system drawings and schematics can be found on your software DVD or on [www.aerotech.com](http://www.aerotech.com).

**NOTE:** This product is intended for light industrial manufacturing or laboratory use.



**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 all AVS 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 making any mechanical adjustments or performing maintenance.
4. Make sure the AVS and all components are 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 the AVS stage to environments or conditions outside of the listed specifications. Exceeding environmental or operating specifications can cause damage to the equipment.
4. The AVS must be mounted securely. Improper mounting can result in injury and damage to the equipment.
5. Use care when moving the AVS. Lifting or transporting the AVS improperly can result in injury or damage to the AVS.
6. The AVS is intended for light industrial manufacturing or laboratory use. Use of the AVS for unintended applications can result in injury and damage to the equipment.
7. If the AVS is used in a manner not specified by the manufacturer, the protection provided by the AVS can be impaired and result in damage, shock, injury, or death.
8. The motor case temperature may exceed 75°C.
9. Operators must be trained before operating this equipment.
10. All service and maintenance must be performed by qualified personnel.



## EC Declaration of Incorporation

**Manufacturer:** Aerotech, Inc.  
101 Zeta Drive  
Pittsburgh, PA 15238-2897  
USA

**herewith declares that the product:**  
AVS 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:**

ISO 12100  
Safety of machinery - Basic concepts, general principles for design  
EN 60204-1  
Safety of machinery - Electrical equipment of machines - Part 1: General requirements

**and further more declares that**

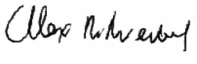
**it is not allowed to put the equipment into service until the machinery into which it is to be incorporated or of which it is to be a component has been found and declared to be in conformity with the provisions of the Directive 2006/42/EC and with national implementing legislation, i.e. as a whole, 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:** Simon Smith, European Director  
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**Position** Engineer Verifying Compliance  
**Location** Pittsburgh, PA  
**Date** November 21, 2014

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## Chapter 1: Overview

**NOTE:** Aerotech continually improves its product offerings; listed options may be superseded at any time. Refer to [www.aerotech.com](http://www.aerotech.com) for the most up-to-date information.

**Table 1-1: AVS Series Vertical Translation Stage**

Option	Description
AVS106 / AVSI106	6 mm travel stage with limits
AVS113 / AVSI113	13 mm travel stage with limits
AVS125 / AVSI125	25 mm travel stage with limits
<b>Mounting and Grid Pattern</b>	
-M	Metric dimension mounting pattern and holes
<b>AVS Motor Option</b>	
-BMS	Brushless servomotor with connectors and 1000-line line driver output encoder (BMS60-A-D25-E1000H)
-NM	No motor or encoder
-SM	50SMB2-HM NEMA 23 stepper motor with home marker
<b>AVSI Motor Option</b>	
-IM2500H	Integral motor based on BMS60 with 2500 line driver encoder
-IM1000AS	Integral motor based on BMS60 with 1000 amplified sine encoder
-IM2500H-BRK	Integral motor based on BMS60 with 2500 line driver encoder and 24 VDC holding brake
-IM1000AS-BRK	Integral motor based on BMS60 with 1000 amplified sine encoder and 24 VDC holding brake
<b>Limit Options</b>	
-NC	Normally-closed end-of-travel and home limit switches (standard)
-NO	Normally-open end-of-travel and home limit switches
-9DU*	9-pin D limit connector (use with -BMS motor options)
-FLY*	Flying lead limit wiring (use with -NM or -SM motor options)
* option not available on the AVSI	

**Table 1-2: Options (AVS only)**

Option	Description
-FB	Foldback motor kit
-BRK23	24 VDC spring-set motor brake for NEMA23 motor

**Table 1-3: Accessories (AVS only)**

Option	Description
HALAR	High-accuracy system – linear error correction for accuracy and repeatability

**Table 1-4: Cable Orientation (AVSI only)**

Option	Description
-3	Left cable exit
-5	Right cable exit

## 1.1. Environmental Specifications

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

**Table 1-5: 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. 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: 20% to 60% RH
	Storage: 10% to 70% RH, non-condensing in original packaging. The stage should be packaged with desiccant if it is to be stored for an extended time.
<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>Ingress Protection</b>	The AVS stages have limited protection against debris, but not water. This equates to an ingress protection rating of IP30.
<b>Use</b>	Indoor use only



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

## 1.2. Accuracy and Temperature Effects

The accuracy specification of AVS series stages is measured at the center of travel mm above the table with the stage in a horizontal position. The stage is assumed to be fully supported by a mounting surface meeting or exceeding the specification in [Section 2.3](#).

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. With a 23° wedge angle, this translates to 5.0 ppm/°C in the direction of travel.

In addition, overall stage temperature has a similar effect on accuracy of motion. The stage is primarily constructed of aluminum and expands or contracts at roughly 23.6 ppm/°C. Deviations in stage temperature from 20°C will result in thermal growth or contraction in the direction of travel at that rate.

### 1.3. Basic Specifications

Resolution is dependent on ball-screw pitch, encoder resolution, and controller interpolation.

**NOTE:** Aerotech continually improves its product offerings; listed options may be superseded at any time. Refer to [www.aerotech.com](http://www.aerotech.com) for the most up-to-date information.

**Table 1-6: AVS Series Specifications**

		106	113	125
Total Travel		6 mm	13 mm	25 mm
Drive System		Precision Ball Screw/Brushless Servomotor [BMS60]		
Bus Voltage		Up to 160 VDC		
Continuous Current	A <sub>PK</sub>	2.3 A		
	A <sub>RMS</sub>	1.6 A		
Resolution	1000-line line driver output encoder (AVS)	0.53 μm @ 4000 steps/rev motor resolution		
	1000-line amplified sine output encoder (AVSI)	5.3 nm - 0.106 μm		
	2500-line line driver output encoder (AVSI)	0.2 μm @ 10,000 steps/rev motor resolution		
Maximum Travel Speed		50 mm/s		
Effective Lead		2.12 mm/rev		
Maximum Load <sup>(1)</sup>		25.0 kg		
Accuracy	Standard	±1.5 μm	±3.0 μm	±5.0 μm
	HALAR <sup>(2)</sup>	±1.0 μm		
Bidirectional Repeatability	Standard	±1.0 μm		
	HALAR <sup>(2)</sup>	±0.75 μm		
Straightness and Flatness (Maximum Deviation)		±1.5 μm	±3.0 μm	±5.0 μm
Pitch and Roll		±5 arc sec	±7.5 arc sec	±10 arc sec
Nominal Stage Weight (with Motor)		4.1 kg	6.1 kg	10.5 kg
Construction		Black Anodized Aluminum Body with Hard-Coated Tabletop		
<p>(1) Higher load possible with larger motor on the AVS series stage.                      (2) With Aerotech controllers.                      (3) Specifications are for single-axis systems, measured 50 mm above the tabletop. Performance of multi-axis system is payload and workpoint dependent. Consult factory for multi-axis or non-standard applications.                      (4) For inverted operation, consult factory.</p>				

## 1.4. Vacuum Operation

Aerotech can specially prepare the AVS 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.

### Special Guidelines

To ensure that the AVS will continue to perform well in the vacuum environment, follow the guidelines listed below (in addition to standard handling, installation, and lubrication guidelines outlined in this manual).

1. Do not remove the AVS from the sealed bag until it is ready for use.
2. Always handle the AVS in a clean environment and use powder-free polyethylene gloves to prevent any contaminants from adhering to the surface of the AVS.
3. During installation, use cleaned, vented, stainless steel fasteners when securing the AVS.
4. 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.
5. For vacuum applications, the recommended lubricant is a small quantity of **Braycote® 602EF** grease or a compatible substitute of equal quality.
6. Baking vacuum components between 100 and 125 °C for 24 to 48 hours significantly reduces outgassing at initial pump-down to vacuum pressure and evaporates water vapor that impregnates porous surfaces on the aluminum surfaces and Teflon cables. Aerotech recommends that customers bake out vacuum systems when first installing them in the vacuum chamber.

## Chapter 2: Mechanical Specifications and Installation



**WARNING:** AVS 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

Carefully remove the AVS from its protective shipping container. Before operating the AVS, 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-less air to remove any dust or debris that has collected during shipping. Set the AVS on a smooth, flat, and clean surface.

Each AVS 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.



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



**WARNING:** Lift the AVS only by the base. Improper handling could adversely affect the AVS's performance.

## 2.2. Dimensions

**NOTE:** All drawings and illustrations are for reference only and were complete and accurate as of this manual's release. The most recent system drawings and schematics can be found on your software DVD or on [www.aerotech.com](http://www.aerotech.com).

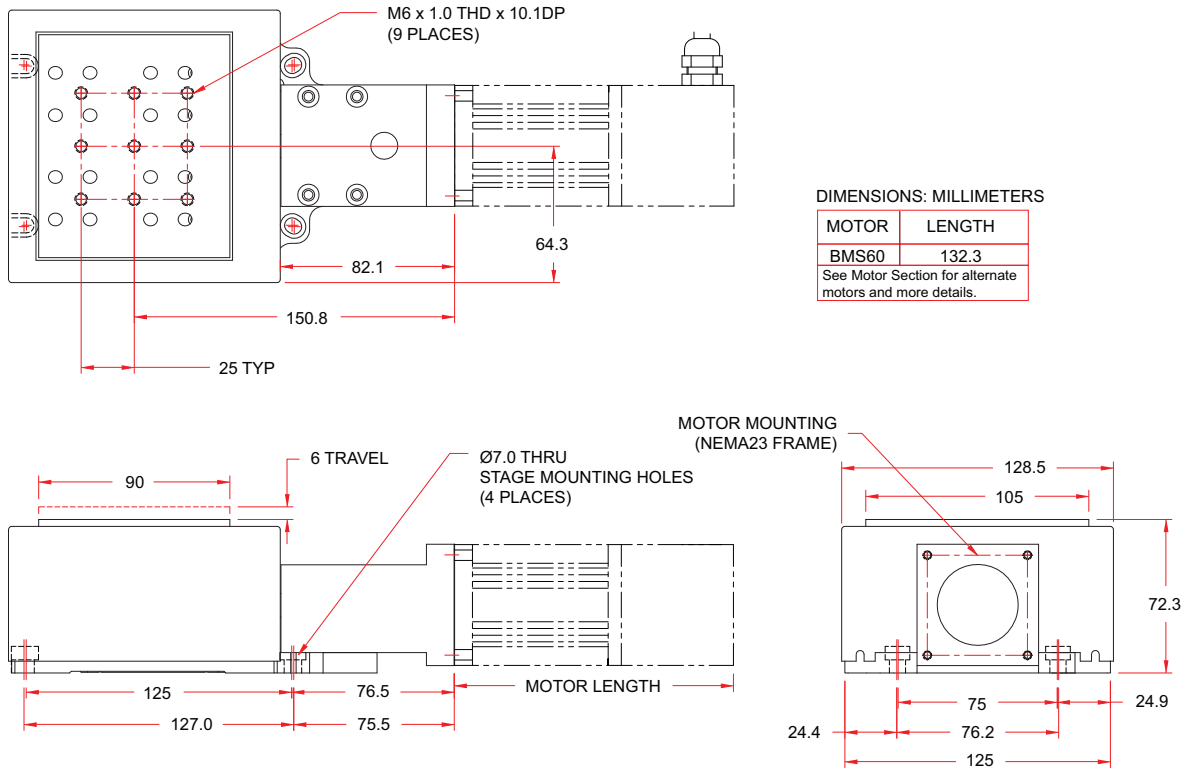
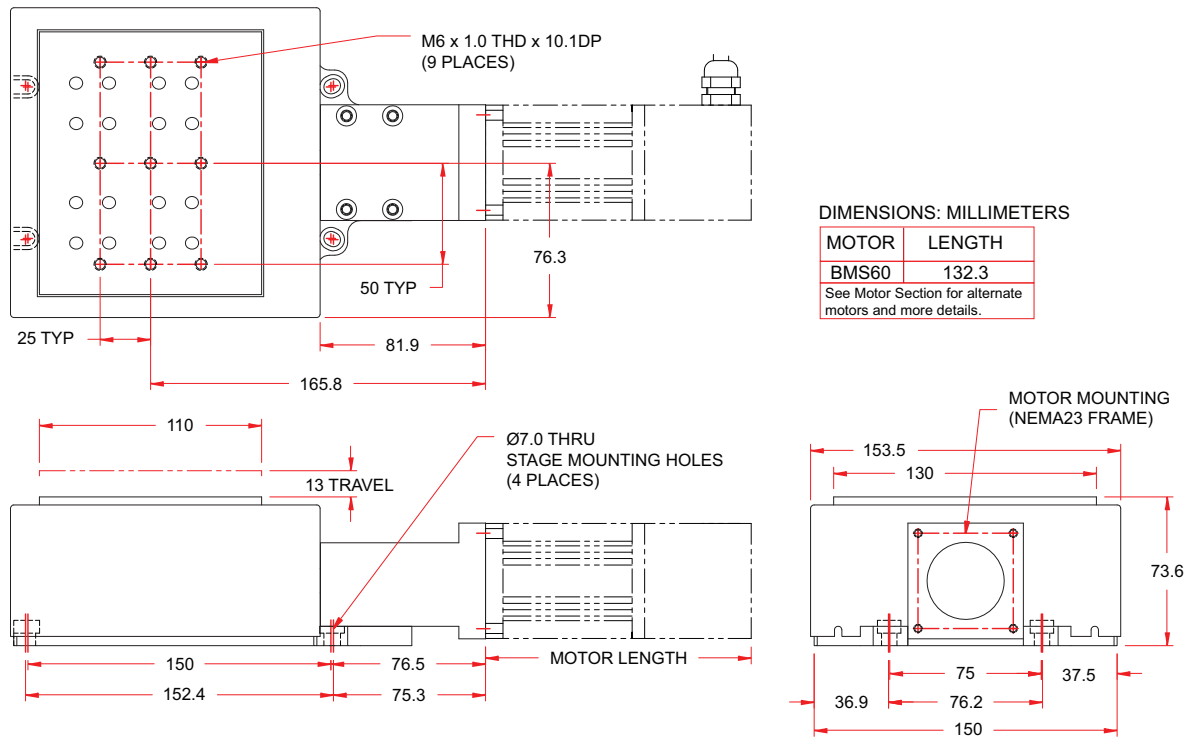


Figure 2-1: AVS106 Dimensions





**Figure 2-2: AVS113 Dimensions**

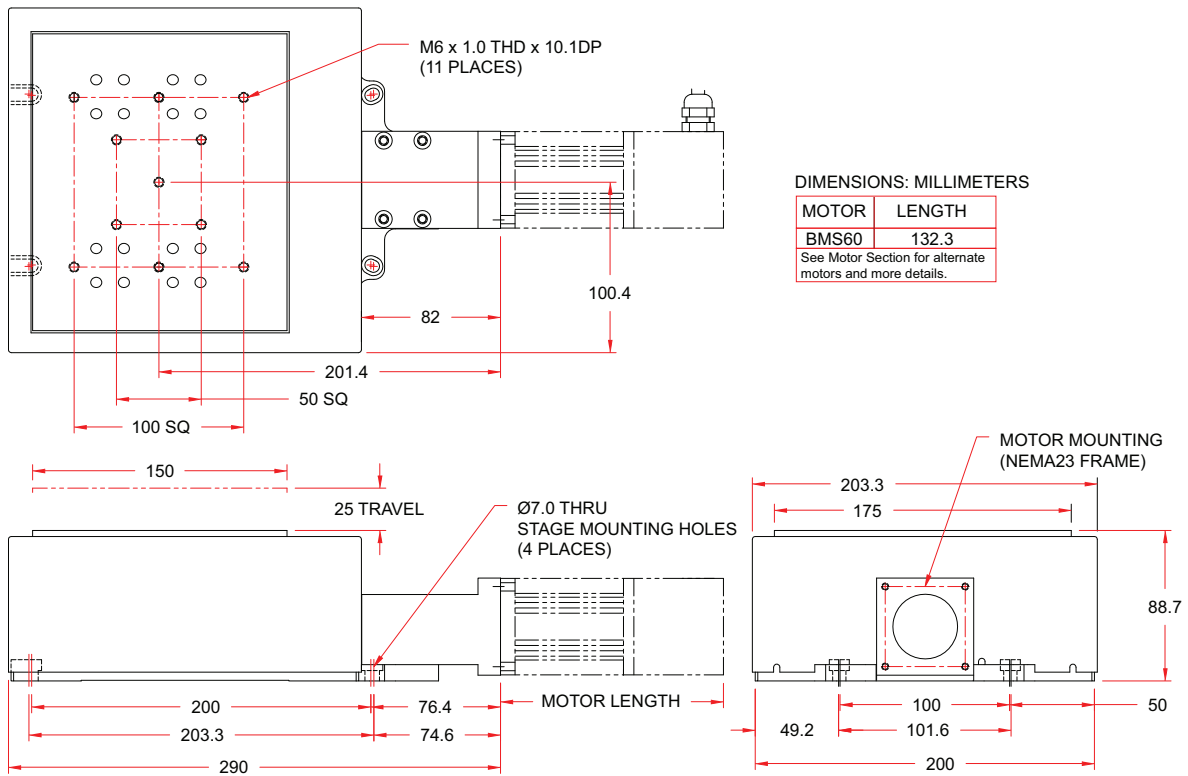


Figure 2-3: AVS125 Dimensions

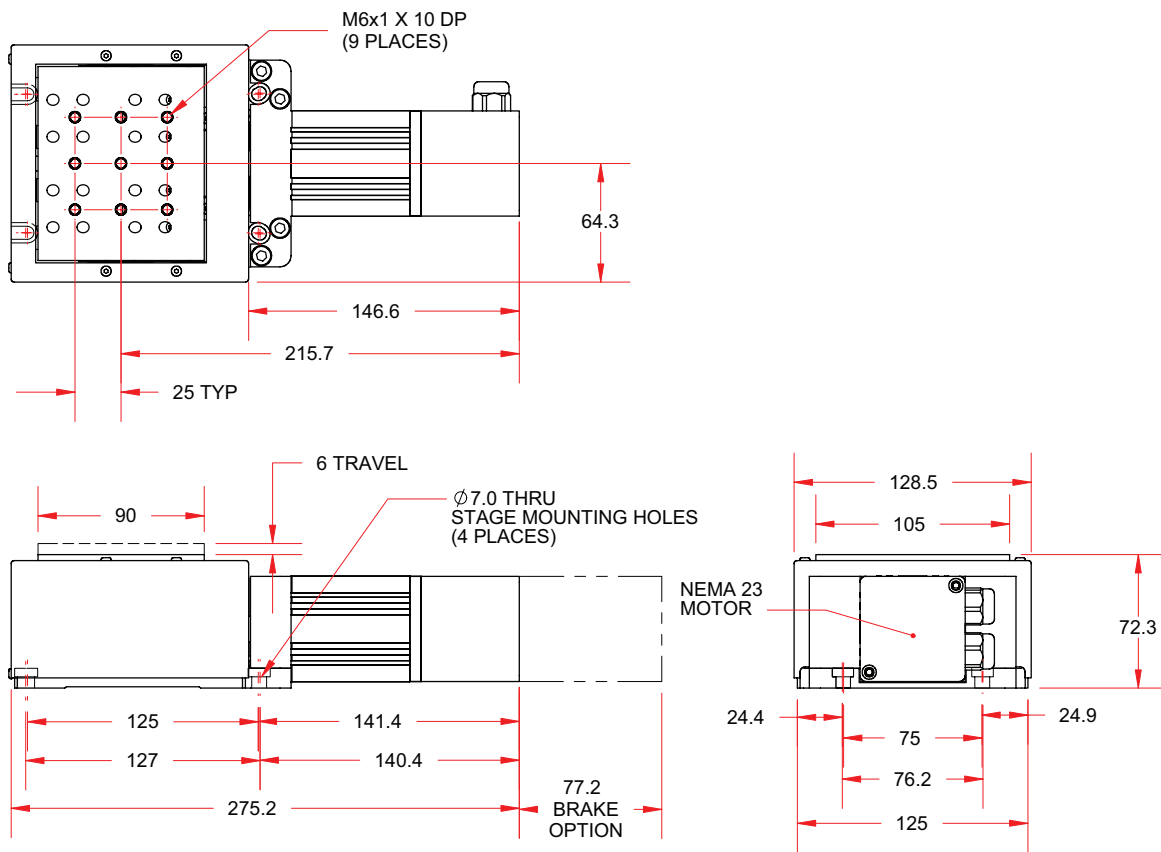


Figure 2-4: AVS106 Dimensions

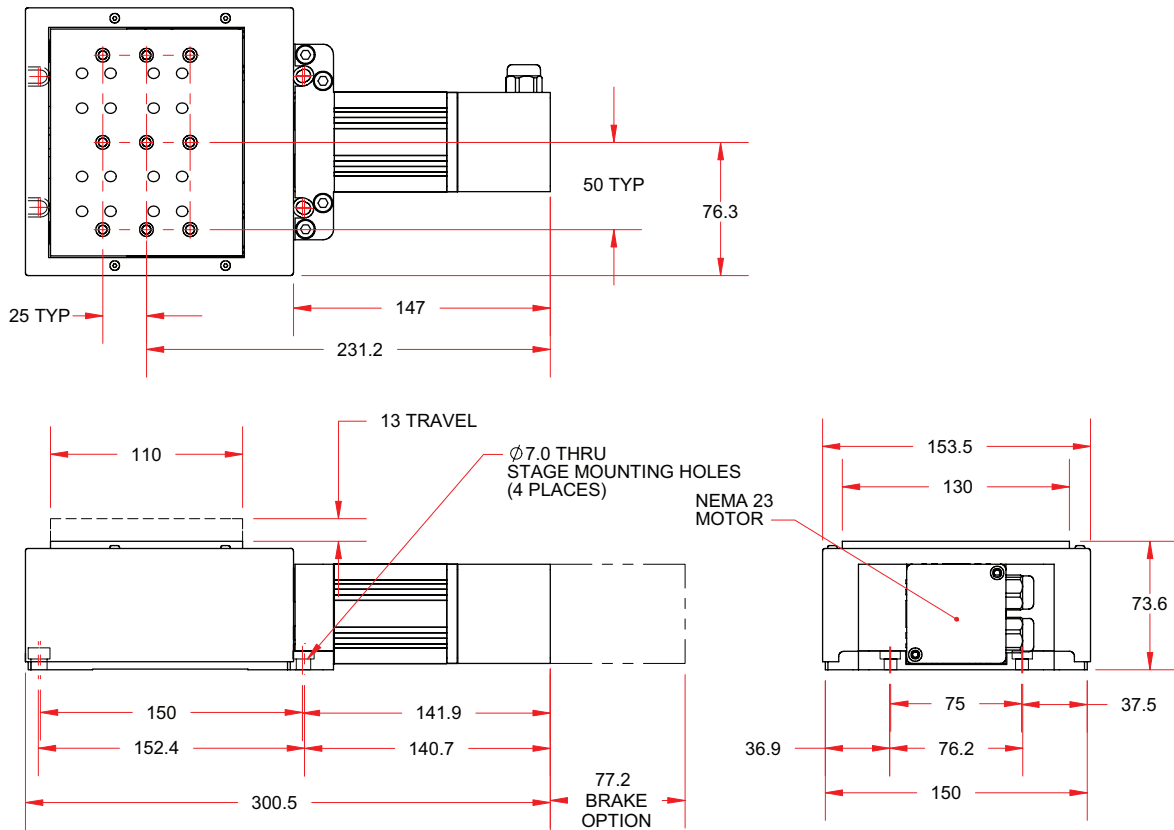


Figure 2-5: AVSI113 Dimensions

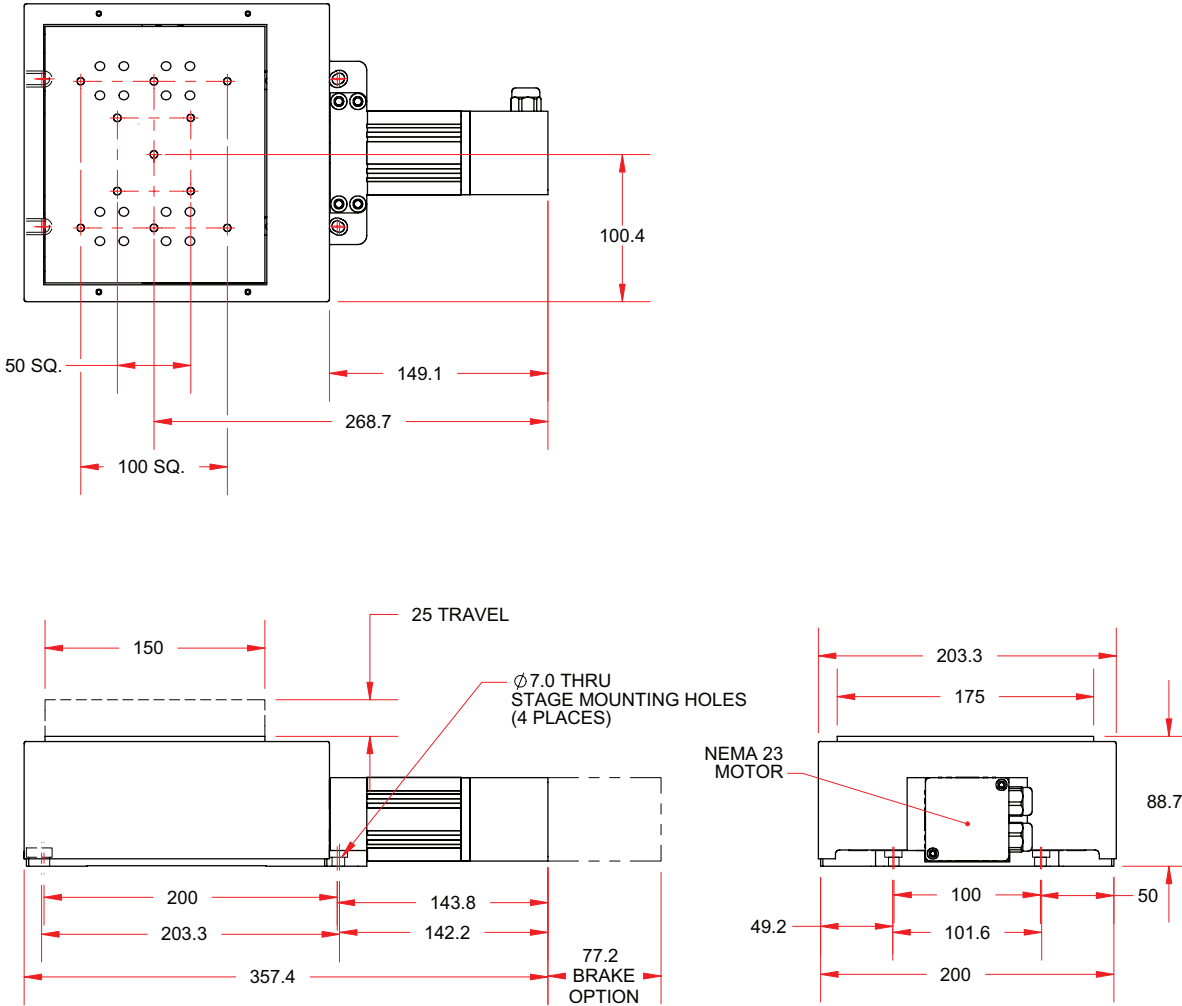


Figure 2-6: AVSI125 Dimensions

## 2.3. Securing the Stage to the Mounting Surface



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

**NOTE:** The AVS 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 AVS. Shimming should be avoided if possible. If shimming is required, it should be minimized to improve the rigidity of the system.

The mounting surface must be flat and have adequate stiffness in order to achieve the maximum performance from the AVS stage. When it is mounted to a non-flat surface, the stage can be distorted as 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:** For valid system performance, the mounting interface should be flat within 7.5  $\mu\text{m}$ .

AVS stages are intended to be mounted to a flat, horizontal surface with gravity acting down on the stage as shown in [Figure 2-7](#). Inverted or side mounted orientations are not allowable without special consideration and stage customization. Contact the factory for details.

To secure the stage to the mounting surface:

1. Remove the front cover with the stage logo to expose the front mounting slots.
2. Use M6 socket head cap screws to mount the stage in the location shown. Typical tightening torque for M6 socket head cap screws is 7.0 N·m.
3. Reinstall the front cover, being sure to maintain a gap between the cover and the upper wedge.

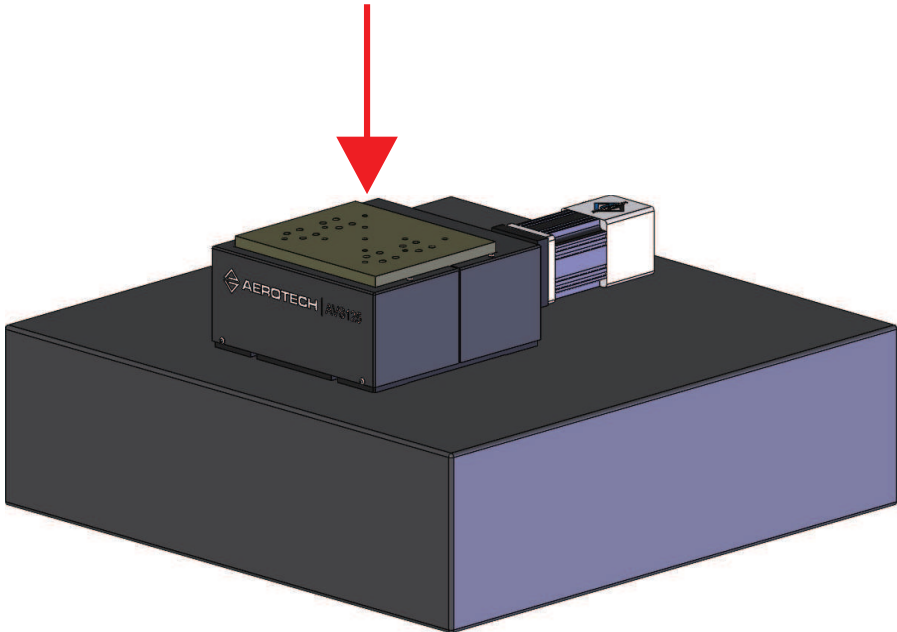


Figure 2-7: AVS Stage Mounting Orientation

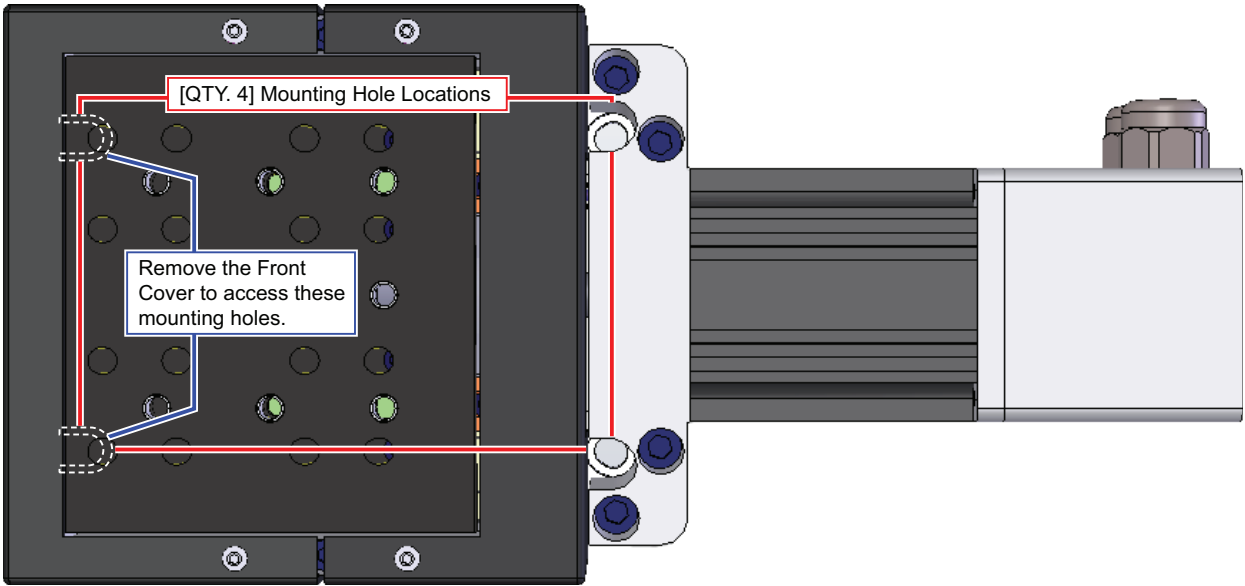


Figure 2-8: Surface Mounting Hole Location (AVSI106 Shown)

## 2.4. Attaching the Payload to the Stage



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

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.

To prevent damage to the payload or stage, test the operation of the stage before the payload is attached to the stage table. 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.

**NOTE:** Stages that ship with Aerotech controls are often tuned with a representative payload based on the information provided at the time of order. If the stage is started up without a payload, the servo gains provided by Aerotech with the shipment may not be appropriate and servo instability can occur. Refer to the controller help file for tuning assistance.

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  $\mu\text{m}$ .

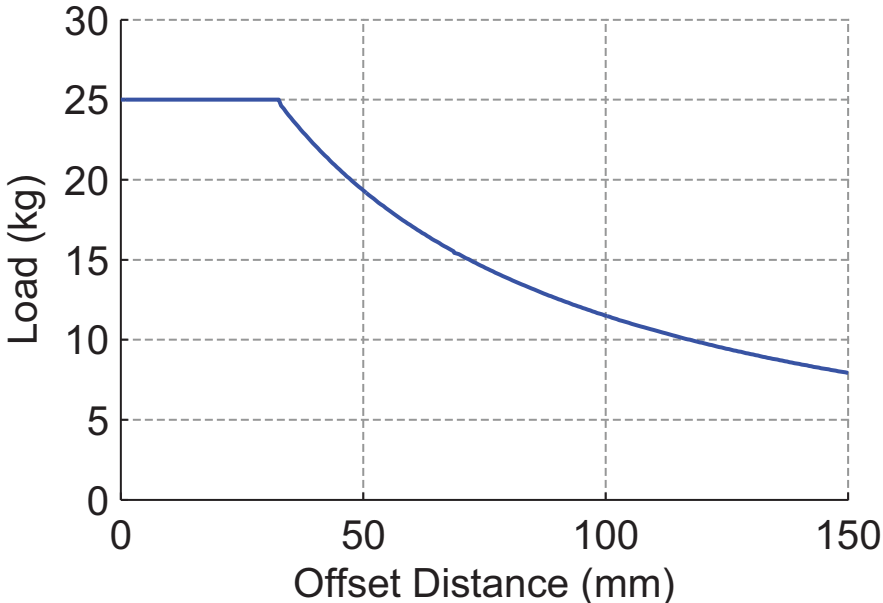
Refer to [Section 2.4.1](#) for information on cantilevered loads and load positioning.



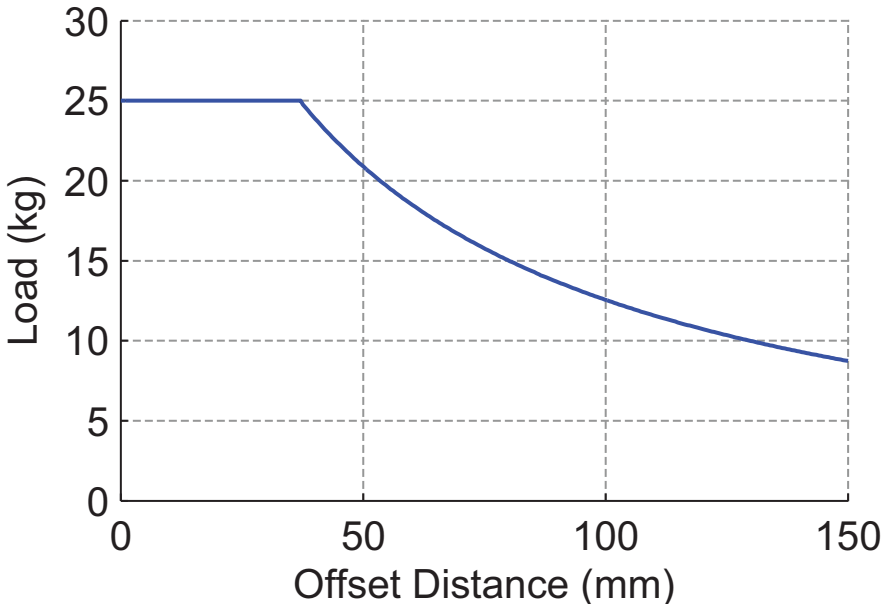
**2.4.1. Load Capability**

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).

Refer to [Section 1.3](#) for maximum load carrying capacity specifications. If cantilevered loads are applied, refer to [2.4.1](#) through [Figure 2-11](#) to find the maximum allowable load.



**Figure 2-9: AVS106 Cantilevered Load Capabilities**



**Figure 2-10: AVS113 Cantilevered Load Capabilities**

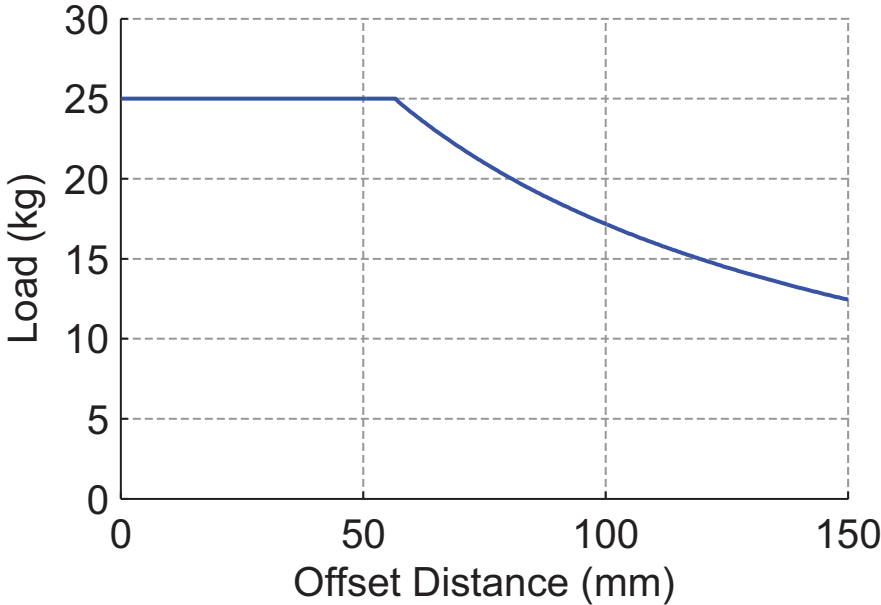


Figure 2-11: AVS125 Cantilevered Load Capabilities

## Chapter 3: Electrical Specifications and Installation



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

Electrical installation requirements will vary depending on stage options. Installation instructions in this section are for stages equipped with standard Aerotech motors intended for use with an Aerotech motion control system. Contact Aerotech for further information regarding stages that are otherwise configured.

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

Refer to the appropriate system manuals and documentation included on the software DVD for additional installation and operation information. If the system is uniquely configured, a drawing showing system interconnects is supplied.

The AVS/AVSI is equipped with optical limit switches (refer to [Section 3.3](#)). The limit signals are included in the feedback connector for the AVSI. For the AVS, the limit cable exits the stage on the same side as the motor and is bundled with the motor cables (refer to [Figure 3-1](#)).

The electrical wiring from the motor and encoder are integrated at the factory. Refer to [Section 3.1](#) for standard motor wiring and connector pin outputs.



**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.



**WARNING:** Operator access to the base and table top must be restricted while connected to a power source. Failure to do so may cause electric shock.

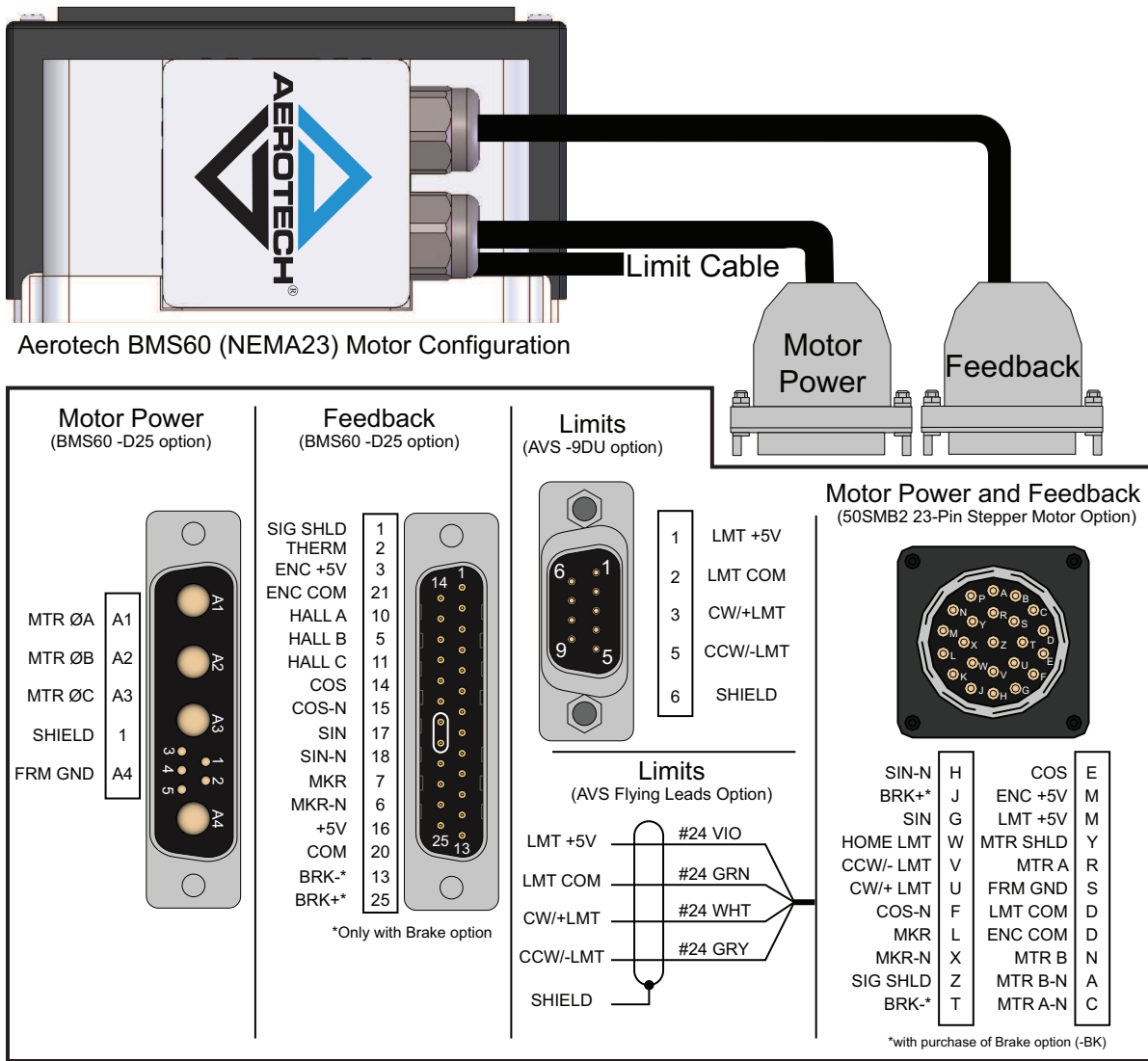


Figure 3-1: Electrical Connections (AVS)

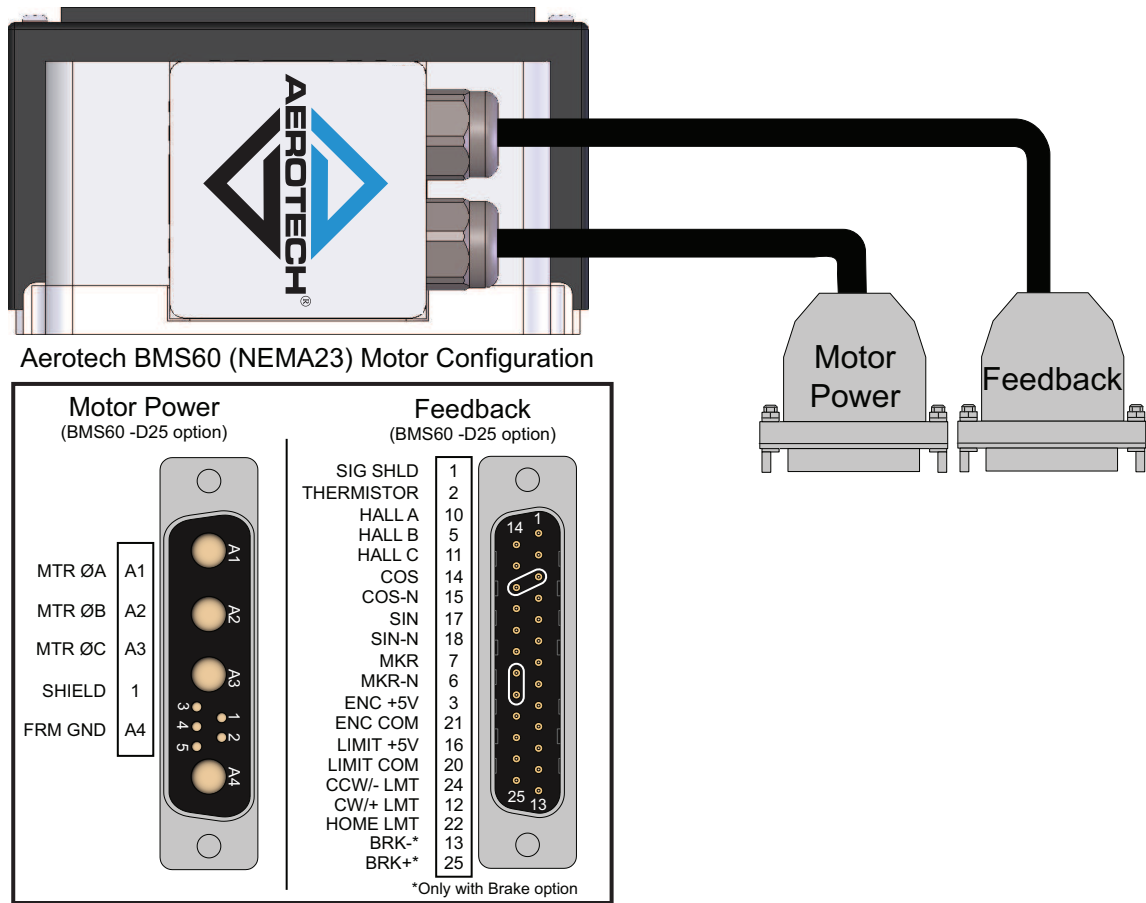


Figure 3-2: Electrical Connections (AVSI)

### 3.1. Motor and Feedback Connectors

Stages fitted 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 AVS's protective ground connection provides motor frame ground protection only. Additional grounding and safety safeguards 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.



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



**WARNING:** Operator access to the base and table top must be restricted while connected to a power source. Failure to do so may cause 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: Motor Wiring Connector (BMS60)**

Pin	Description	Connector
A1	MTR ØA (Motor Phase A)	
A2	MTR ØB (Motor Phase B)	
A3	MTR ØC (Motor Phase C)	
1	Motor Shield (EMI shield)	
2	Reserved: Not Used	
3	Reserved: Not Used	
4	Reserved: Not Used	
5	Reserved: Not Used	
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 #DBMM9W4SA197

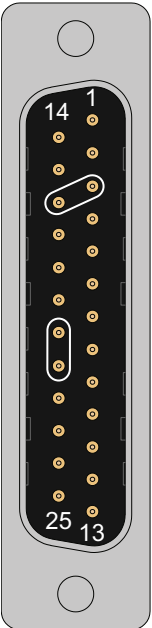
**Table 3-2: Feedback Connector (BMS60 / AVS)**

Pin	Description	Connector
1	Signal shield connection	
2	Over-Temperature Thermistor sensor	
3	+5 V power supply input (the typical requirement is 250 mA).	
5	Hall Effect sensor, phase B	
6	Marker-N	
7	Marker	
10	Hall Effect sensor, phase A	
11	Hall Effect sensor, phase C	
14	Cosine	
15	Cosine-N	
16	+5 V power supply input	
17	Sine	
18	Sine-N	
20	Common ground	
21	Common ground	

**Table 3-3: Feedback Mating Connector (BMS60 / AVS)**

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

**Table 3-4: Feedback Connector (BMS60 / AVSI)**

Pin	Description	Connector
1	Signal shield connection	
2	Over-Temperature Thermistor sensor	
3	+5 V supply input for optical encoders (the typical requirement is 250 mA).	
5	Hall Effect sensor, phase B	
6	Marker-N	
7	Marker	
10	Hall Effect sensor, phase A	
11	Hall Effect sensor, phase C	
12	Signal indicating maximum travel produced by positive/CW stage direction.	
13	Brake -	
14	Cosine	
15	Cosine-N	
16	+5V supply input for optical limit switch boards (the typical requirement is 50 mA).	
17	Sine	
18	Sine-N	
20	Common ground to limit switch.	
21	Common ground to encoder power	
22	Home limit output	
24	Active high signal indicating stage maximum travel produced by negative/CCW stage direction.	
25	Brake +	

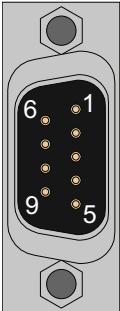
(1) BMS motors only. Reserved on all other motors.  
(2) With Brake option only

**Table 3-5: Feedback Mating Connector (BMS60 / AVSI)**

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

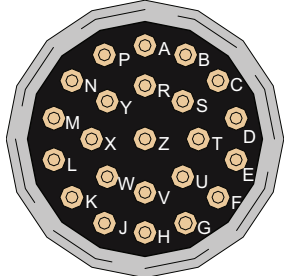


**Table 3-6: Limits Connector (AVS)**

Pin #	Description	Connector
1	+5V supply input for optical limit switch boards (the typical requirement is 50 mA).	
2	Common ground to limit switch.	
3	Signal indicating maximum travel produced by positive/CW stage direction.	
4	Home reference limit output	
5	Active high signal indicating stage maximum travel produced by negative/CCW stage direction.	
6	Signal shield connection	
NOTE: Pins not shown are reserved.		

Mating Connector	Aerotech P/N	3rd Party P/N
Backshell	ECK01021	Amphenol DE24657
Connector	ECK00340	Cinch DE-9S

**Table 3-7: 23-Pin Motor and Feedback Stepper Motor Connector (AVS)**

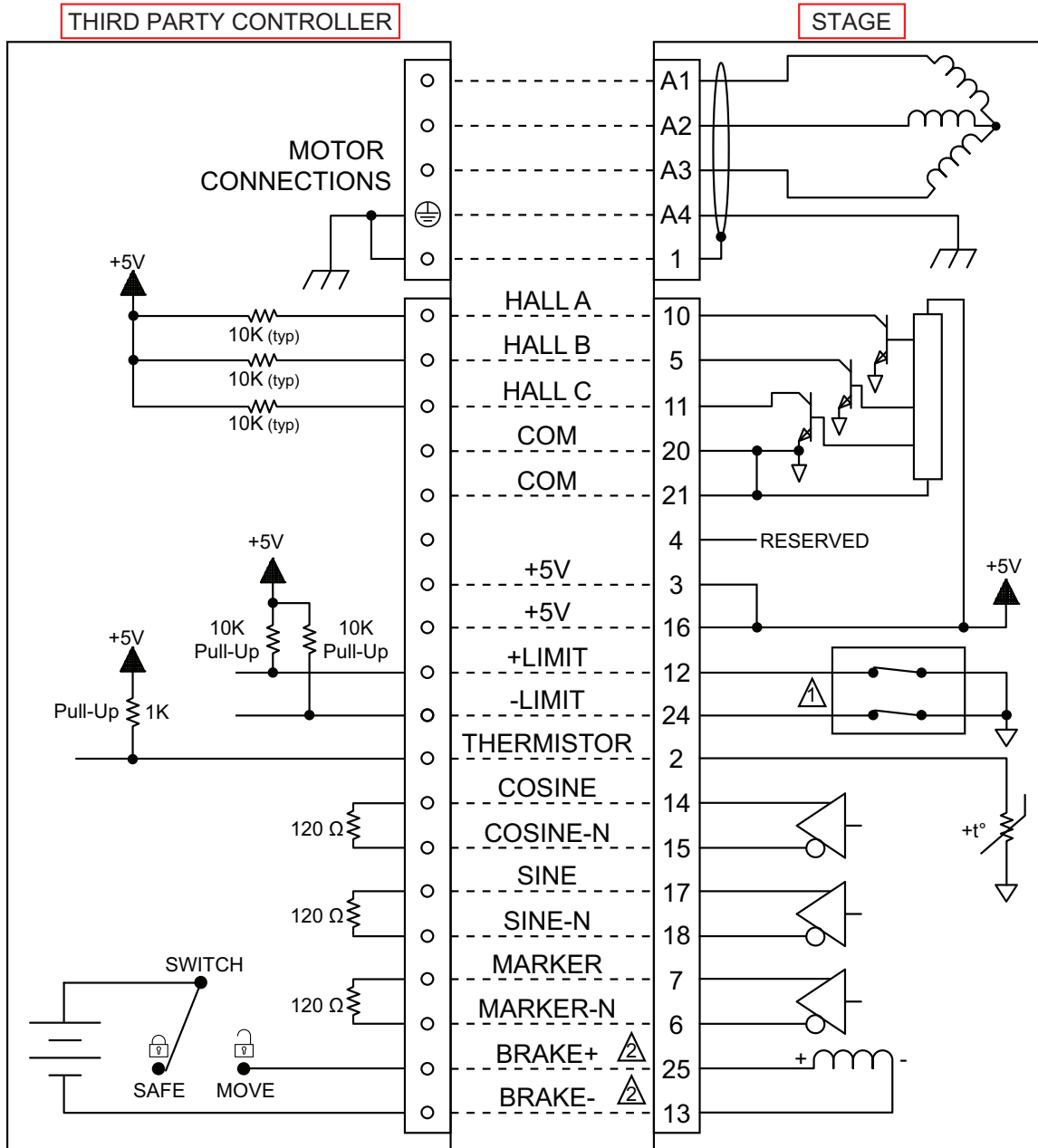
Pin	Label	Description	Connector
A	MTR BCT	Phase B Center Tap	
B	MTR A	Phase A+	
C	MTR A'	Phase A- (Return)	
N	MTR B	Phase B+	
P	MTR B'	Phase B- (Return)	
R	MTR ACT	Phase A Center Tap	
Y	MTR SHLD	Shield	
J	BRK+( <sup>1</sup> )	Brake +	
T	BRK- ( <sup>1</sup> )	Brake -	
U	CW/+LMT	Signal indicating maximum travel produced by positive/CW stage direction.	
V	CCW/-LMT	Active high signal indicating stage maximum travel produced by negative/CCW stage direction.	
W	HM LMT	Home reference limit output	
M	LMT +5V	+5V supply input for optical limit switch boards (the typical requirement is 50 mA).	
D	LMT COM	Common ground to limit switch.	
G	SIN	Sine	
E	COS	Cosine	
F	COS-N	Cosine-N	
L	MKR	Marker	
X	MKR-N	Marker-N	
S	FRM GND	Frame ground	

(1) With Brake option only

Mating Connector	Aerotech P/N	3rd Party P/N
Plug	ECK00135	Burndy UTG618-23SN
Clamp	ECK00617	Burndy UTG18C
Sockets (#24-#22)	ECK00402	Burndy SC24M-1TK6
Sockets (#20-#16)	ECK00403	Burndy SC16M-1TK6

### 3.2. Motor and Feedback Wiring

All motor and controller manufacturers have their own designations for motor ØA/ØB/ØC and Hall signals A/B/C, refer to Section 3.4. for motor phasing. Shielded cables are required for the motor and feedback connections.



- ⚠ Stage limit options are factory-configured as Normally Closed (NC) or Normally Open (NO).
- ⚠ Brake is optional.
- ⚠ Stages equipped with the Foldback Motor Option (AVS only): CW/+ and CCW/- limits swap, as does the + Machine Direction.

**Figure 3-3: Motor and Feedback Wiring**

### 3.3. Motor and Feedback Specifications

**Table 3-8: Feedback Specifications**

<b>Hall-Effect Sensors Specifications</b>	
Supply Voltage	5 V
Supply Current	50 mA
Output Type	Open Collector
Output Voltage	24 V max (pull up)
Output Current	5 mA (sinking)
<b>Thermistor Specifications</b>	
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	
<b>Encoder Specifications</b>	
Supply Voltage	5 V $\pm$ 10%
Supply Current	300 mA
Output Voltage	<b>Sinusoidal Type:</b> 1V <sub>pk-pk</sub> into 120 $\Omega$ Load (differential signals SIN+, SIN-, COS+, COS- are .5V <sub>pk-pk</sub> relative to ground.)
	<b>Digital Output:</b> RS422/485 compatible
<b>Limit Switch Specifications (1,2)</b>	
Supply Voltage	5 V
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>
<p>1. If the AVS 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.</p> <p>2. Stage limit options are factory-configured as NC (standard) or NO.</p>	
<b>Brake Specifications</b>	
Supply Voltage	24 V
Supply Current (typical)	500 mA (current required to release the brake and allow motion)

Table 3-9: BMS60 Motor Specifications

Motor Model	Units	BMS60
<b>Winding Designation</b>		-A
<b>Performance Specifications (1, 5)</b>		
Stall Torque, Continuous (2)	N·m (oz·in)	0.33 (46.2)
Peak Torque (3)	N·m (oz·in)	1.31 (184.9)
Rated Speed	rpm	4,000
Rated Power Output, Continuous	W	112
<b>Electrical Specifications (5)</b>		
BEMF Constant (Line-Line, Max)	$V_{pk}/k_{rpm}$	19
Continuous Current, Stall (2)	$A_{pk} (A_{rms})$	2.3 (1.6)
Peak Current, Stall (3)	$A_{pk} (A_{rms})$	9.2 (6.5)
Torque Constant (4, 8)	$N·m/A_{pk}$ (oz·in/ $A_{pk}$ )	0.14 (20.1)
	$N·m/A_{rms}$ (oz·in/ $A_{rms}$ )	0.20 (28.4)
Motor Constant (2, 4)	$N·m/\sqrt{W}$ (oz·in/ $\sqrt{W}$ )	0.050 (7.02)
Resistance, 25°C (Line-Line)	$\Omega$	8.4
Inductance (Line-Line)	mH	1.30
Maximum Bus Voltage	$V_{DC}$	340
Thermal Resistance	°C/W	1.73
Number of Poles	--	8
<b>Mechanical Specifications</b>		
Motor Weight	kg (lb)	1.1 (2.4)
Rotor Moment of Inertia	$kg·m^2$ (oz·in·s <sup>2</sup> )	$1.96 \times 10^{-5}$ (0.0028)
Max Radial Load	N (lb)	89 (20)
Max Axial Load	N (lb)	89 (20)
Frame Size	NEMA	23
<p>1. Performance is dependent upon heat sink configuration, system cooling conditions, and ambient temperature.</p> <p>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</p> <p>3. Peak torque assumes correct rms current; consult Aerotech.</p> <p>4. Force constant and motor constant specified at stall.</p> <p>5. All performance and electrical specifications +/- 10%</p> <p>6. Maximum winding temperature is 100 °C (thermistor trips at 100 °C)</p> <p>7. Ambient operating temperature range 0°C - 25°C; consult Aerotech for performance in elevated ambient temperatures.</p> <p>8. All Aerotech amplifiers are rated Apk; use torque constant in N·m/ Apk when sizing.</p>		



**WARNING:** The motor case temperature may exceed 75°C.

**Table 3-10: Stepper Motor Specifications**

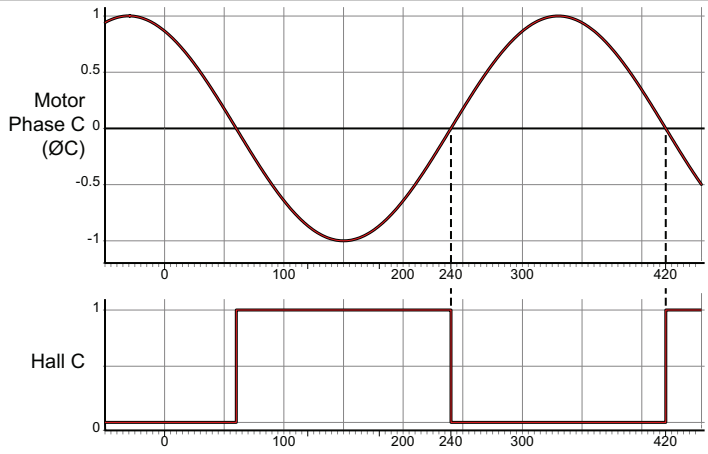
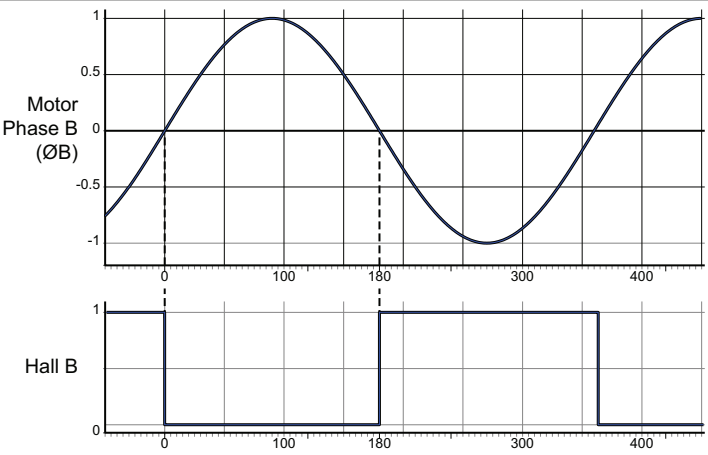
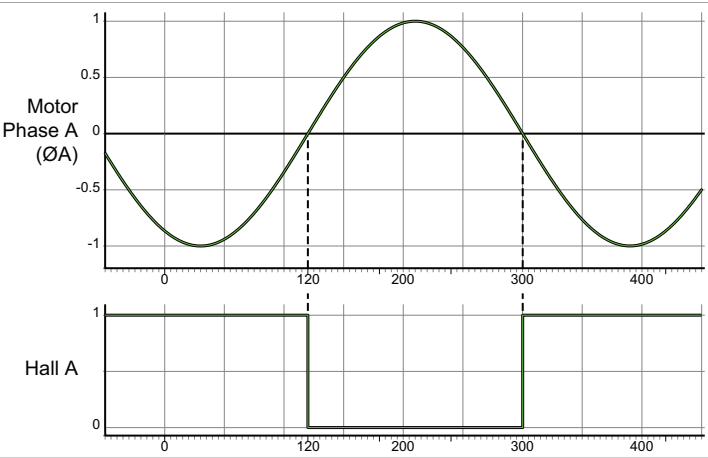
Model	Units	50SM
NEMA Motor Frame Size		23
Stall Torque	N·m (oz·in)	0.3 (38)
Rated Phase Current	A	1
Recommended Driver Bus Voltage	V	40
Rotor Inertia	kg·m <sup>2</sup> (oz·in·s <sup>2</sup> )	12 x 10 <sup>-6</sup> ( 1.66 x 10 <sup>-3</sup> )
Full Step Angle	°	1.8
Accuracy	°	±0.054° (Non-Cumulative)
Maximum Radial Load	N (lb)	67 (15)
Maximum Thrust Load	N (lb)	111 (25)
Weight	kg (lb)	0.6 (1.4)



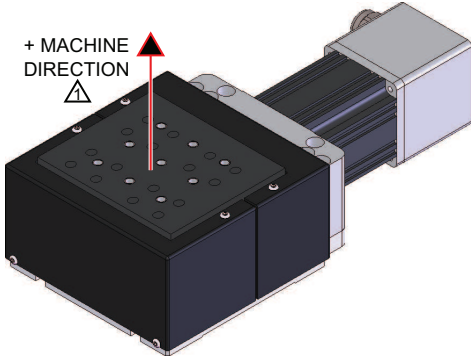
**WARNING:** The motor case temperature may exceed 75°C.

### 3.4. Motor and Feedback Phasing

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

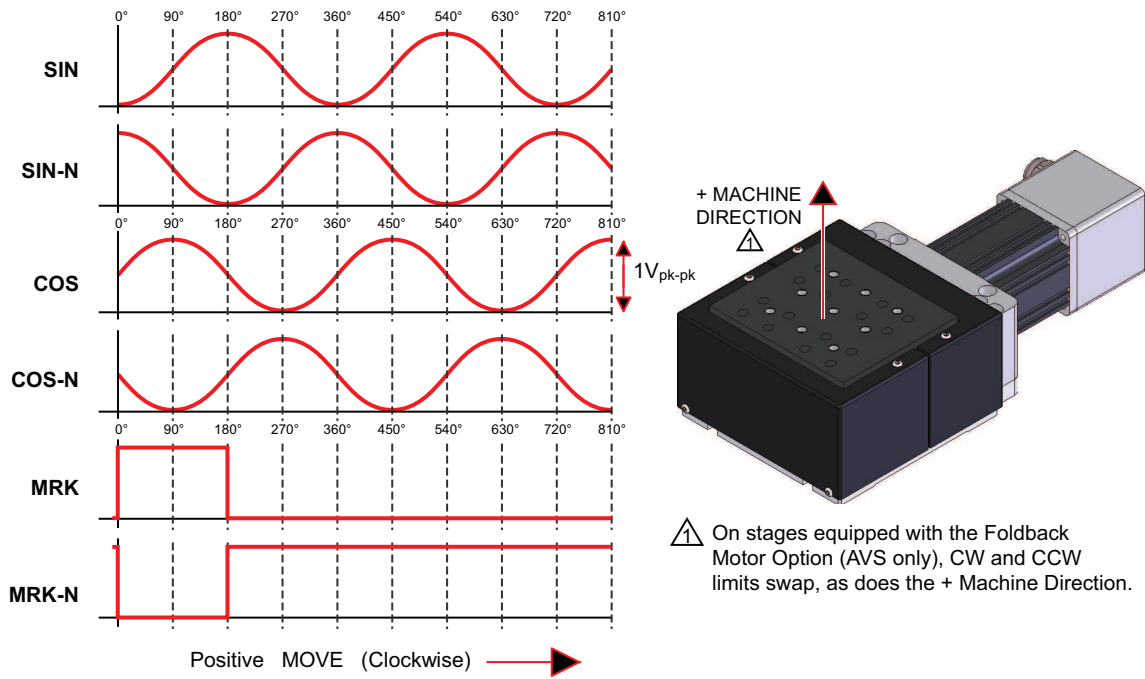


Positive MOVE (Clockwise) →

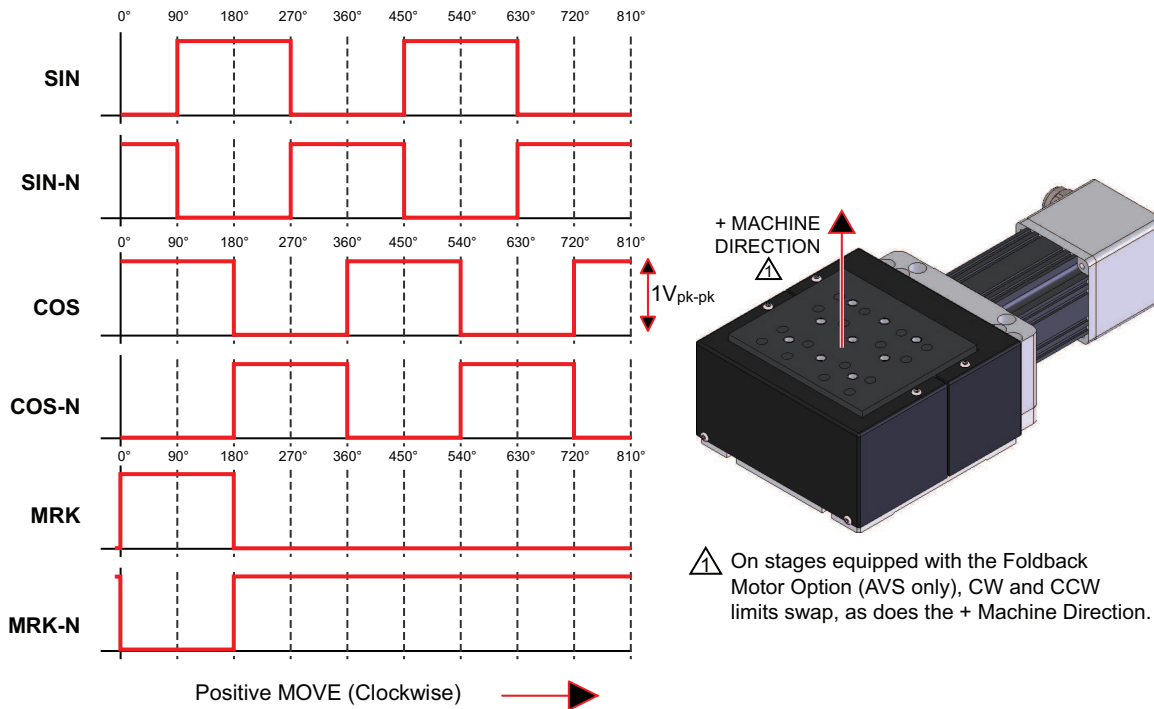


⚠ On stages equipped with the Foldback Motor Option (AVS only), CW and CCW limits swap, as does the + Machine Direction.

Figure 3-4: Hall Phasing



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



**Figure 3-6: Encoder Phasing Reference Diagram (Standard)**



## Chapter 4: Maintenance

**NOTE:** The bearing area must be kept free of foreign matter and moisture; otherwise, 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.

Inspect the AVS once per month until a trend develops for the specific application and environment. Longer or shorter intervals may be required to maintain the cleanliness of the stage. The cleaning interval depends on conditions such as duty cycle, speed, and the environment.

In general, stages operating in a clean environment should be cleaned annually. For stages operating under conditions involving excessive debris, stages should be cleaned every six months. With proper cleanliness of the stage, the bearing will not require lubrication or maintenance for the life of the stage.

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.

Visually inspect the stage, motor, and cables once per month to:

- Re-tighten loose connectors.
- Replace or repair damaged cables.
- Clean the AVS and any components and cables if needed.
- Repair any damage before operating the AVS.

## 4.1. Cleaning and Lubrication

When cleaning and/or lubricating components of the AVS 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 AVS, 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.

### 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.

### Lubrication

Aerotech recommends using NSK-LGU grease in standard non-vacuum prepared AVS stages.

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

The lubrication and cleaning process is outlined in the steps that follow.

1. Drive the stage table to the top of travel and remove power to the stage.



**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.

2. Remove the screws from the stage covers and remove the covers.
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 exposed lower linear bearing guides using a similar technique.
7. Apply a thin, continuous film of lubricant to the ball-screw threads and exposed linear bearing guides. A good quality, natural bristle artist's brush makes 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,

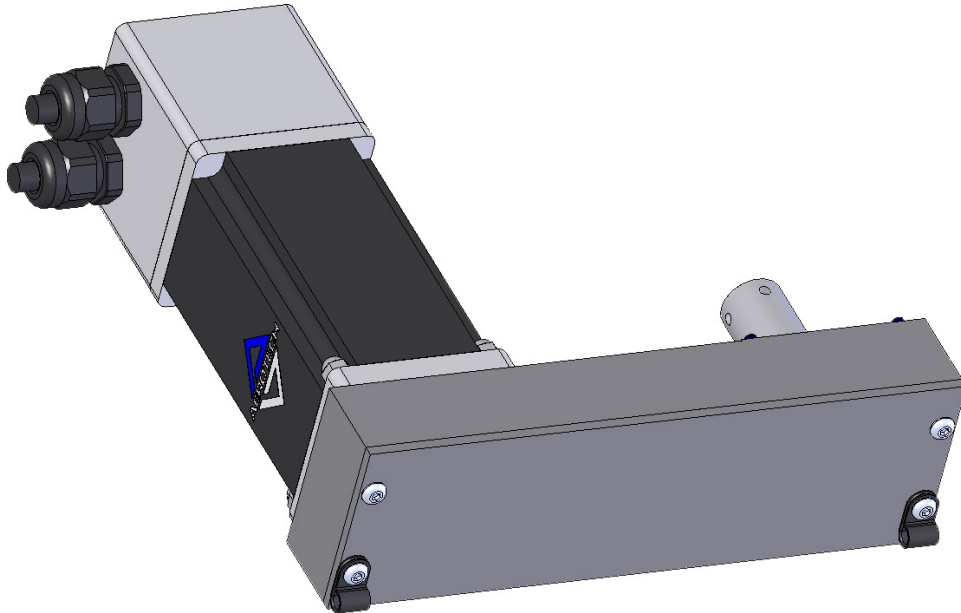
then remove power and continue to Step 9. Be sure to use extreme caution while operating the stage temporarily without the hardcover installed.

9. Refasten the covers.
10. Restore power to the stage; drive the stage table back to its original position to redistribute lubricants.

**NOTE:** The upper bearings are inaccessible for relubrication in the field. In dirty environments, it may be necessary to send the AVS stage to the Aerotech factory for lubrication or replacement of the upper linear bearings.

## 4.2. Belt Adjustment (AVS Only)

This section applies to stages equipped with foldback motor options. On foldback stages, the motor torque is transferred to the ball screw via a timing belt. Belt tension is critical to stage performance and accuracy.



**Figure 4-1: Foldback Motor Option Example**

Check the belt tension when lubricating and cleaning the stage. Deflection in the belt should be less than 5 mm when applying a downward force directly between the pulleys (Figure 4-2) of approximately 5 N. If deflection exceeds this range, the belt tension should be adjusted. The method of adjustment is outlined below.

1. Remove power to the stage.
2. Remove the four mounting screws for the foldback cover (Figure 4-2).
3. Check the tension in the belt to determine if adjustment is necessary.
4. If adjustment is required, loosen (but do not remove) the four motor mounting screws (Figure 4-2).
5. The motor mounting holes are slotted to allow for belt adjustment (Figure 4-3). With all four screws loose, pull the motor away from the stage by hand until achieving the necessary belt tension.
6. Tighten motor mounting screws and re-check the tension in the belt. Belt tension may change after the mounting screws are tightened, so if necessary repeat step 5 until desired tension is reached.
7. While adjusting tension, it is advisable to verify that the pulleys are tight on their respective shafts. Each pulley is held in position with two set screws (Figure 4-3). If a pulley is loose, it may be necessary to tighten one or both of these screws.
8. Once tension adjustment is complete, replace the foldback cover and mounting screws. Restore power to the stage.

**NOTE:** If the stage has been calibrated (HALAR), note the orientation of the two pulleys with regard to each other or recalibration might be required.

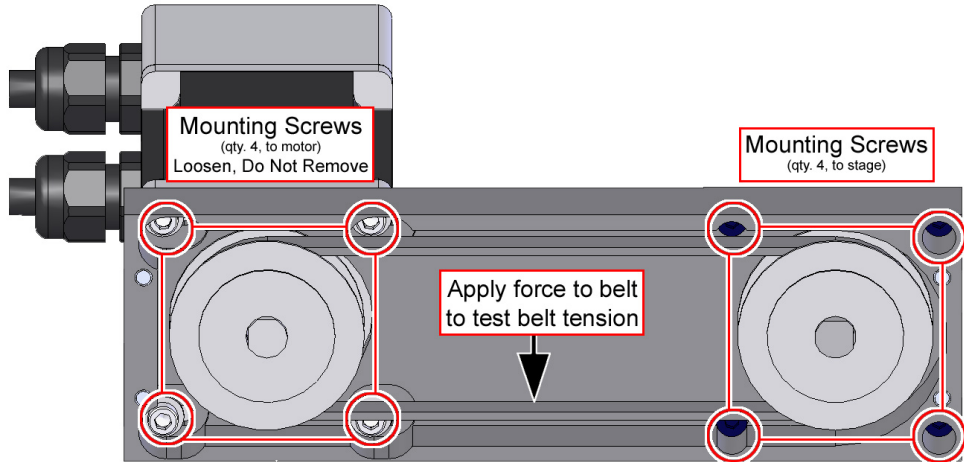


Figure 4-2: Belt Access and Adjustment on Foldback Models (Mounting Screws)

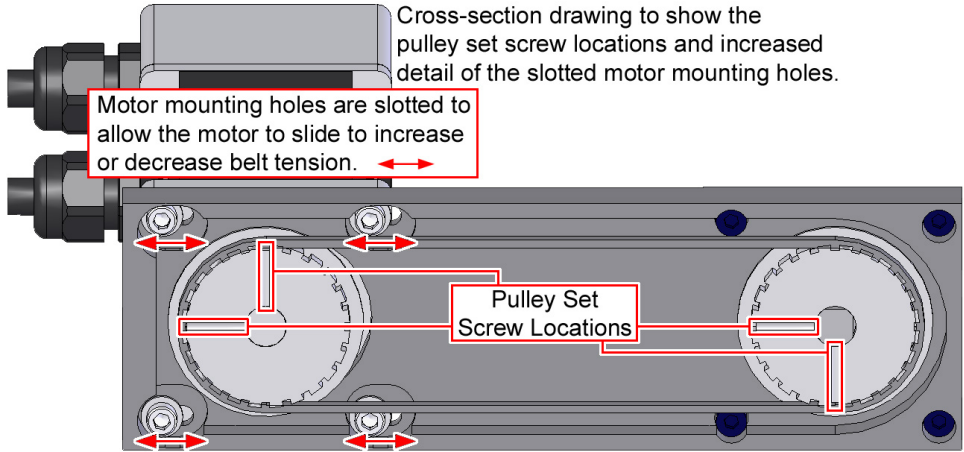


Figure 4-3: Belt Access and Adjustment on Foldback Models (Pulley Set Screws)

### 4.3. Troubleshooting

Symptom	Possible Cause and Solution
Stage will not move.	<ul style="list-style-type: none"><li>• Brake not released (If equipped with brake). See stage documentation.</li><li>• In Limit condition. Check limits. Refer to <a href="#">Section 3.2.</a> and your controller documentation for polarity and compatibility requirements (Example: voltage requirements).</li><li>• Controller trap or fault. Refer to your controller documentation.</li></ul>
Stage moves uncontrollably	<ul style="list-style-type: none"><li>• Encoder (sine and cosine) signals connections. Refer to <a href="#">Section 3.2.</a> and your controller documentation.</li><li>• Motor Connections. Refer to <a href="#">Section 3.2.</a> and your controller documentation.</li></ul>
Stage oscillates or squeals	<ul style="list-style-type: none"><li>• Gains misadjusted. Refer to your controller documentation.</li><li>• Encoder signals. Refer to your controller documentation.</li></ul>

## 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 <http://www.aerotech.com/service-and-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>

<b>USA, CANADA, MEXICO</b>	<b>CHINA</b>	<b>GERMANY</b>
Aerotech, Inc. Global Headquarters Phone: +1-412-967-6440 Fax: +1-412-967-6870	Aerotech China Full-Service Subsidiary Phone: +86 (21) 3319 7715	Aerotech Germany Full-Service Subsidiary Phone: +49 (0)911 967 9370 Fax: +49 (0)911 967 93720
<b>JAPAN</b>	<b>TAIWAN</b>	<b>UNITED KINGDOM</b>
Aerotech Japan Full-Service Subsidiary Phone: +81 (0)47 489 1741 Fax: +81 (0)47 489 1743	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



## Appendix B: Revision History

Revision	Date	Description
1.00.00	November 21, 2014	New manual

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# Index

		<b>C</b>	
	-	Cable Orientation	1
-3	1	cleaning solvent	32
-5	1	Construction	3
-BMS	1	Continuous Current	3
-BRK23	1	<b>D</b>	
-FB	1	Drive System	3
-IM1000AS	1	<b>E</b>	
-IM1000AS-BRK	1	Effective Lead	3
-IM2500H	1	Encoder Specifications	26
-IM2500H-BRK	1	encoders	20
-M	1	<b>F</b>	
-NM	1	Feedback Connector (BMS60 / AVS)	21
-SM	1	Feedback Connector (BMS60 / AVSI)	22
<b>2</b>		Feedback Mating Connector (BMS60 / AVS)	21
23-Pin Motor and Feedback Stepper Motor Connector (AVS)	24	Feedback Mating Connector (BMS60 / AVSI)	22
<b>5</b>		foldback	34
50SM	28	Foldback Motor Option Example	34
<b>A</b>		<b>G</b>	
Accuracy	3	grease	4,32
acetone (caution)	32	<b>H</b>	
Altitude	2	HALAR	1
Ambient Temperature	2	Hall-Effect Sensors Specifications	26
Attaching the Payload to the Stage	14	Handling the Stage	5
<b>B</b>		Humidity	2
belt tension	34	<b>I</b>	
Bidirectional Repeatability	3	inspect	31
BMS60 Motor Specifications	27	isopropyl alcohol	32
Brake Specifications	26	<b>L</b>	
Braycote® 602EF	4	label	5
Bus Voltage	3	Limit Switch Specifications	26
		limit switches	17

