ATX165SL/SLE Hardware Manual

Revision: 1.01.00

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Safety Procedures and Warnings

This manual tells you how to carefully and correctly use and operate the ATX165SL/SLE. Read all parts of this manual before you install or operate the ATX165SL/SLE or before you do maintenance to your system. To prevent injury to you and damage to the equipment, obey the precautions in this manual. The precautions that follow apply when you see a Danger or Warning symbol in this manual. If you do not obey these precautions, injury to you or damage to the equipment can occur. If you do not understand the information in this manual, contact Aerotech Global Technical Support.

This product has been designed for light industrial manufacturing or laboratory environments. The protection provided by the equipment could be impaired if the product is used in a manner not specified by the manufacturer.

NOTE: Aerotech continually improves its product offerings; listed options may be superseded at any time.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 for the most up-to-date information.

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 ATX165SL/SLE 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 ATX165SL/SLE stage must be mounted securely. Improper mounting can result in injury and damage to the equipment.
5. Use care when moving the ATX165SL/SLE stage. Lifting or transporting the ATX165SL/SLE stage improperly can result in injury or damage to the ATX165SL/SLE.
6. 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.
7. The motor case temperature may exceed 75°C.
8. Operators must be trained before operating this equipment.
9. All service and maintenance must be performed by qualified personnel.

EU Declaration of Incorporation

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

herewith declares that the product:

ATX165SL/SLE Linear 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, 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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The Old Brick Kiln, Ramsdell, Tadley
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Name / Alex Weibel
Position Engineer Verifying Compliance
Location Pittsburgh, PA
Date 7/16/2019

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Chapter 1: Overview

Table 1-1: Model Numbers and Ordering Options

ATX165SL/SLE Mechanical-Bearing Screw-Driven Linear Stage	
Direct Linear Feedback (Required)	
SL	No direct linear feedback
SLE-E1	Incremental linear encoder, 1 Vpp
SLE-E2	Incremental linear encoder, 0.05 µm digital TTL output
SLE-E3	Absolute linear encoder
Travel (Required)	
-150	150 mm travel stage
-200	200 mm travel stage
-250	250 mm travel stage
Motor (Optional)	
-M1	BMS60 brushless servomotor and 10,000-line TTL encoder
-M2	BMS60 brushless servomotor, 10,000-line TTL encoder, and brake
-M3	BMS60 brushless servomotor and 1,000-line 1 Vpp encoder
-M4	BMS60 brushless servomotor, 1,000-line 1 Vpp encoder, and brake
-M5	BM75 brushless servomotor and 10,000-line TTL encoder
-M6	BM75 brushless servomotor, 10,000-line TTL encoder, and brake
-M7	BM75 brushless servomotor and 1,000-line 1 Vpp encoder
-M8	BM75 brushless servomotor, 1,000-line 1 Vpp encoder, and brake
-M9	SM60 stepper motor, high voltage
Foldback Kit (Optional, not available with the Lifting Hardware options)	
-FB1	Foldback kit for a .250 inch diameter shaft NEMA 23 motor (standard)
-FB2	Foldback kit for a .375 inch diameter shaft NEMA 23 motor
Motor Orientation (Optional)	
-2	Bottom cable exit (optional orientation)
-3	Left side cable exit (standard orientation)
-5	Right side cable exit (optional orientation)
-8	Right side foldback (standard orientation)
-9	Right-side foldback with bottom cable exit, optional orientation
-12	Left side foldback (optional orientation)
-13	Left-side foldback with bottom cable exit, optional orientation
Coupling (Optional)	
-CP1	Coupling for 0.250 inch diameter shaft
-CP2	Coupling for 0.375 inch diameter shaft, required for BMS100/BM130 motor
Lifting Hardware (Optional, not available with the Foldback Kit option)	
-LF1	Lifting handles
-LF2	Hoist rings
ThermoComp® (Optional)	
-TCMP	ThermoComp® integrated thermal compensation
Metrology (Required)	
-PL1	Uncalibrated with performance plots
-PL2	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

Ambient Temperature	Operating: 10° to 35° C (50° to 95° F) The optimal operating temperature is 20° C ±2° C (68° F ±4° F). If at any time the operating temperature deviates from 20° C degradation in performance could occur.
	Storage: 0° to 40° C (32° to 104° F) in original shipping packaging
Humidity	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.
Altitude	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.
Vibration	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.
Protection Rating	The ATX165SL/SLE stages have an ingress protection rating of IP10.
Use	Indoor use only

1.2. Accuracy and Temperature Effects

The accuracy specification of ATX165SL/SLE series stages is measured 25 mm above the table with the stage in an unloaded condition. 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 of the SL stage. 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.

SLE stages contain a linear encoder for direct feedback of the carriage position. The stage travel as seen by the linear encoder will expand at the rate of 3.25 ppm/°C as the temperature of the encoder scale deviates from 20°C.

The ThermoComp™ option is a hardware and software solution that uses the functionality of the A3200 controller to mitigate the effects of changing temperature by detecting and compensating for thermal changes. ThermoComp™ is effective at compensating for both self-heating and environmental temperature changes.

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 for the most up-to-date information.

Table 1-3: ATX165SL/SLE Series Specifications (-050 to -250)

			-150	-200	-250
Travel			150 mm	200 mm	250 mm
Accuracy(1)	SL	Uncalibrated	±8 µm	±8 µm	±9 µm
		Calibrated(2)	±1 µm	±1 µm	±1 µm
	SLE	Uncalibrated	±4 µm	±5 µm	±6 µm
		Calibrated(2)	±0.4 µm	±0.5 µm	±0.5 µm
Resolution (Minimum Incremental Motion)(8)	SL		0.05 µm(3) 0.1 µm(4)		
	SLE	-E1(6)	0.025 µm		
		-E2	0.1 µm		
		-E3	0.2 µm		
Bidirectional Repeatability(1)	SL		±0.5 µm		
	SLE		±0.15 µm	±0.2 µm	±0.25 µm
Horizontal Straightness(1)			±1.75 µm	±2.0 µm	±2.25 µm
Vertical Straightness(1)			±1.75 µm	±2.0 µm	±2.25 µm
Pitch			80 µrad (16 arc·sec)	85 µrad (17 arc·sec)	90 µrad (18 arc·sec)
Yaw			80 µrad (16 arc·sec)	85 µrad (17 arc·sec)	90 µrad (18 arc·sec)
Maximum Speed (5)	DC Motor (-M1, -M2, -M5, -M6)		100 mm/s		
	DC Motor (-M3, -M4, -M7, -M8)		130 mm/s		
	Stepper Motor (-M9)		25 mm/s		
Load Capacity	Horizontal		40 kg		
	Side		25 kg		
	Vertical (Axial)		20 kg		
Moving Mass			3.4 kg	3.8 kg	4.1 kg
Stage Mass			12.3 kg	13.7 kg	15.0 kg
Material			Anodized Aluminum		

1. Certified with each stage.
2. Available with Aerotech controllers
3. Achieved with Aerotech rotary motor with amplified sine encoder. Specification is unidirectional.
4. Achieved with Aerotech rotary motor with 10,000 lines/rev digital encoder. Specification is unidirectional.
5. Requires the selection of an appropriate amplifier with sufficient voltage and current.
6. Requires motor with 1 Vpp amplified sine encoder (-M3, -M4, -M7, -M8 Motor Options) and linear amplifier.
7. Specifications listed are non-foldback kit options. Contact factory for specifications when a foldback kit (-FBx) is used.
8. Resolution is dependent on ball-screw pitch, encoder resolution, and controller interpolation.

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Chapter 2: Installation

WARNING: ATX165SL/SLE 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

WARNING: It is the customer's responsibility to safely and carefully lift and move the ATX165SL/SLE.

- Lift only by the base, lifting handles, or hoist rings.
- Do not use the carriage, drive screw, motor, or cables as lifting points.
- For multi-axis assemblies, always lift the system by the lower axis.
- Secure all moving parts before lifting or moving the ATX165SL/SLE to a new location. Unsecured moving parts could shift and cause bodily injury.
- Improper handling could adversely affect the performance of the ATX165SL/SLE. Use care when moving the ATX165SL/SLE.

Carefully remove the ATX165SL/SLE stage from its protective shipping container. Gently set the ATX165SL/SLE stage on a smooth, flat, and clean surface.

Before operating the ATX165SL/SLE stage, 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.

Each ATX165SL/SLE 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.

Lifting Features

The ATX165SL/SLE has two lifting options: lifting handles (-LF1) and hoist rings (-LF2). The lifting hardware must be removed before the stage can be operated. These options are not available with the foldback version of the stage.

NOTE: Retain the lifting features for future use. Do not transport or ship the ATX165SL/SLE without the lifting features attached.

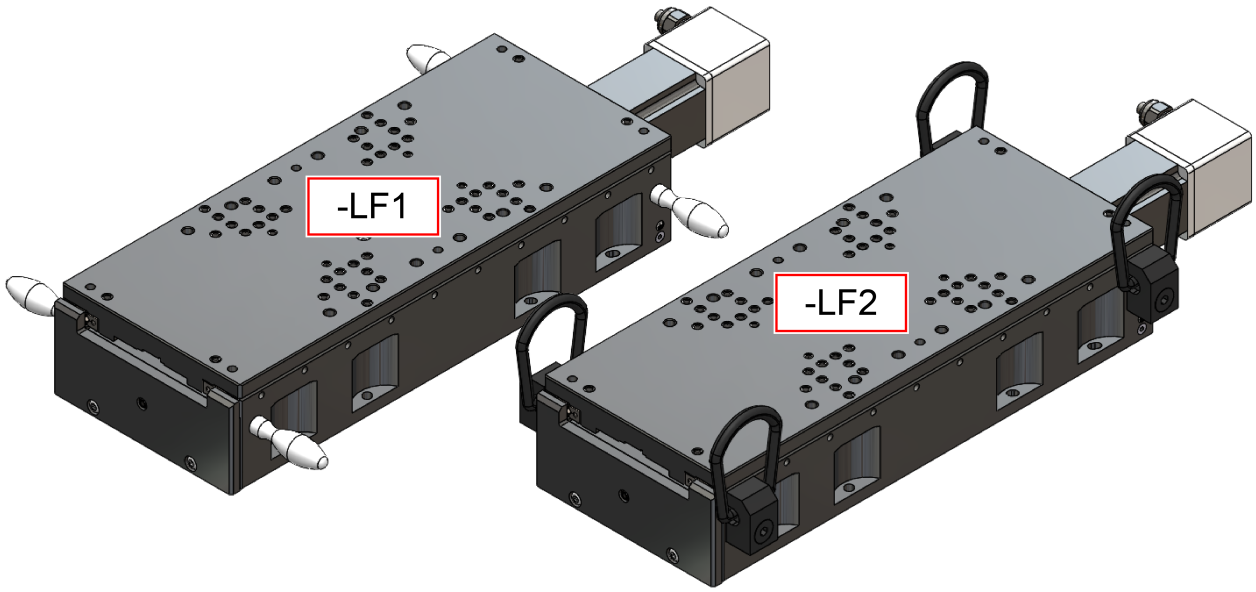
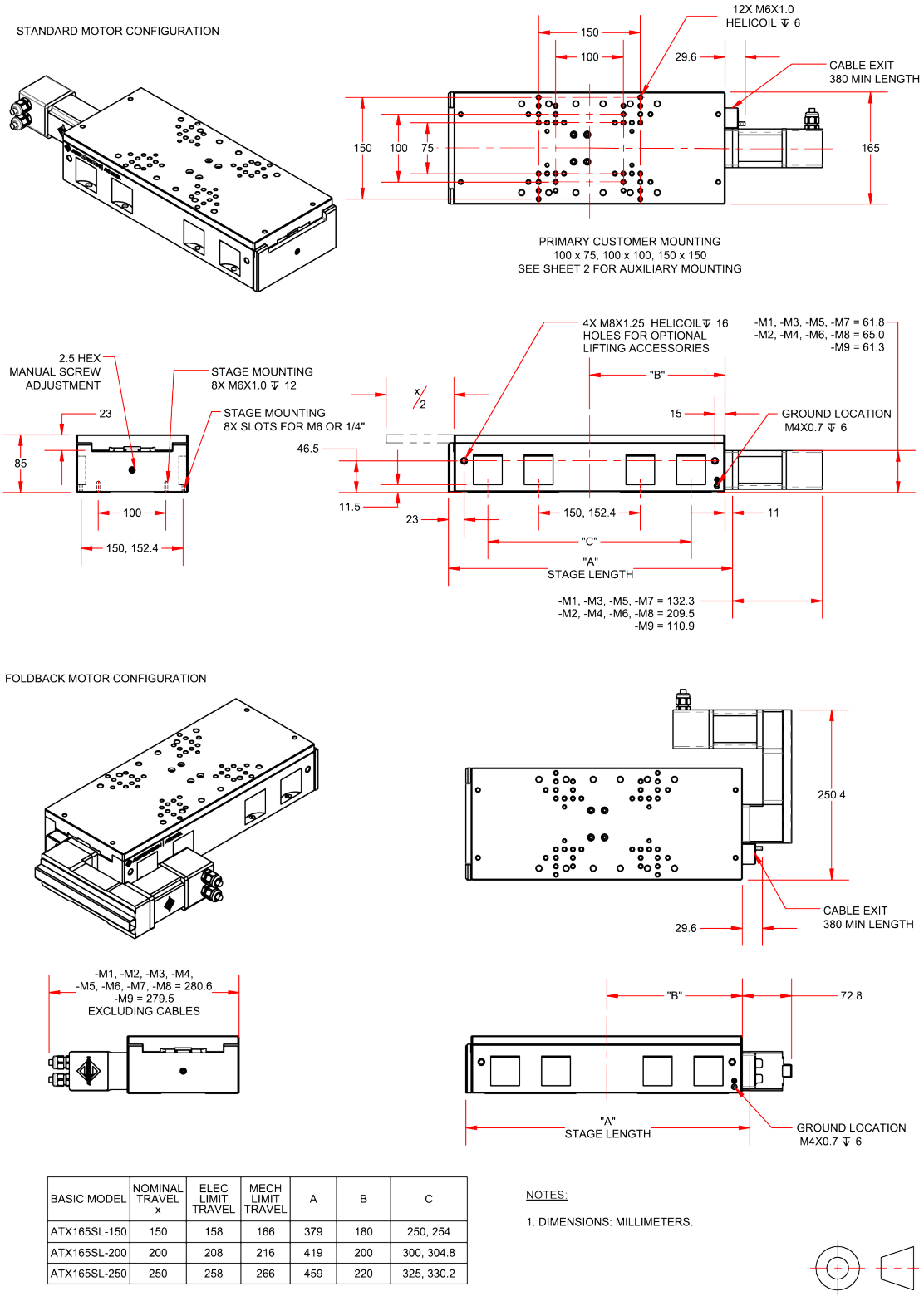


Figure 2-1: Lifting Features

2.2. Dimensions



BASIC MODEL	NOMINAL TRAVEL x	ELEC LIMIT TRAVEL	MECH LIMIT TRAVEL	A	B	C
ATX165SL-150	150	158	166	379	180	250, 254
ATX165SL-200	200	208	216	419	200	300, 304.8
ATX165SL-250	250	258	266	459	220	325, 330.2

NOTES:

1. DIMENSIONS: MILLIMETERS.

Figure 2-2: ATX165SL/SLE Dimensions

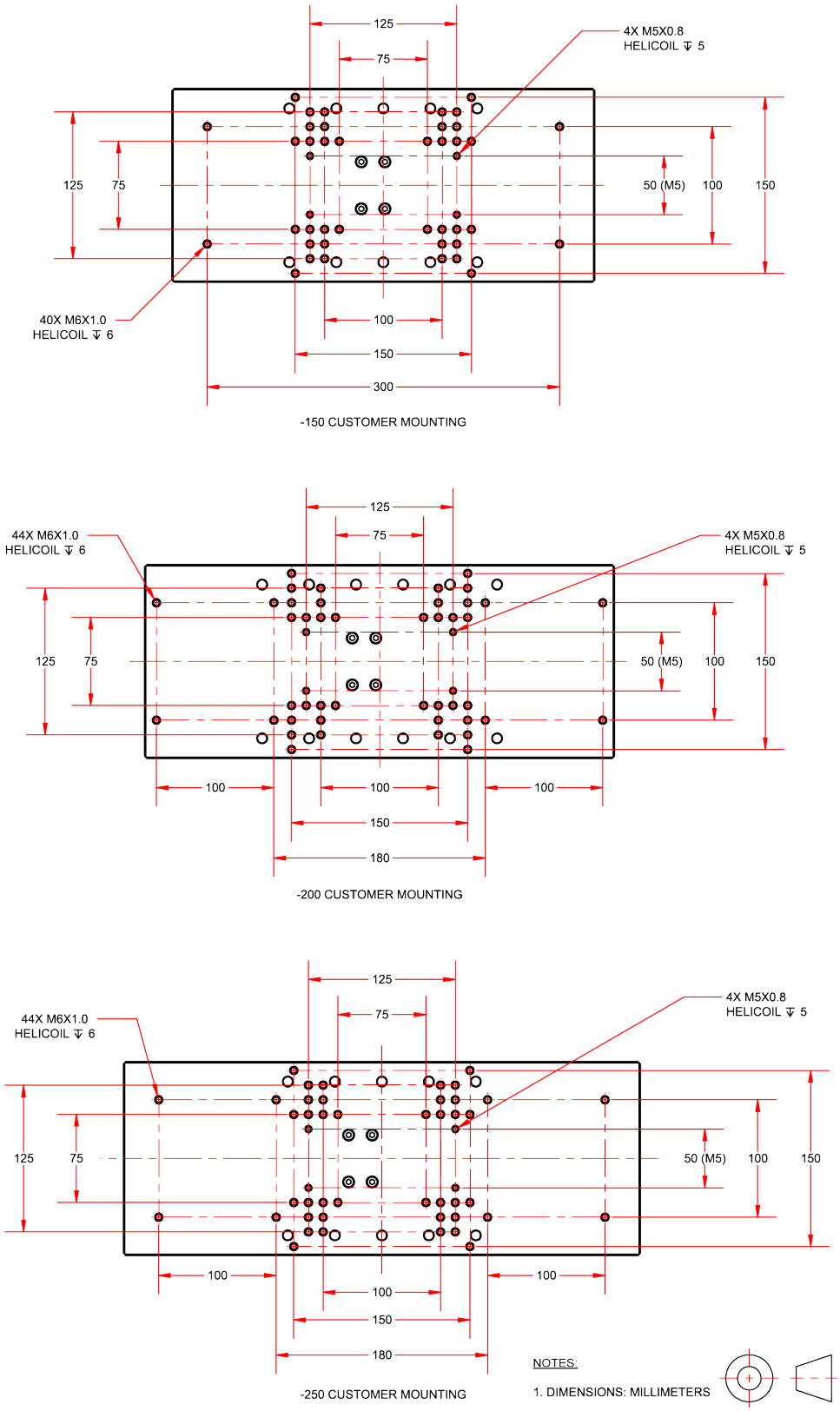


Figure 2-3: ATX165SL/SLE Mounting Dimensions

2.3. Securing the Stage to the Mounting Surface

WARNING: The ATX165SL/SLE must be mounted securely. Improper mounting can result in injury and damage to the equipment.

WARNING: Make sure that all moving parts are secure before moving the ATX165SL/SLE. Unsecured moving parts may shift and cause bodily injury.

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

The mounting surface must be flat and have adequate stiffness to achieve the maximum performance from the ATX165SL/SLE 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: The ATX165SL/SLE 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 ATX165SL/SLE. Shimming should be avoided if possible. If shimming is required, it should be minimized to retain maximum rigidity of the system.

Table 2-1: Stage Mounting Surface Flatness Requirement

Stage Travel	Flatness Requirement
All Travels	7.5 µm

This stage is designed to use socket head cap screws (SHCS) to secure the base to the mounting surface.

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 2-2 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 2-2: Stage to Mounting Surface Hardware

Mounting Hardware	Typical Screw Torque
M6 x 22 mm (or 1/4" x 7/8") SHCS with flat washers	7 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 Electrical Installation 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 µm.

WARNING: Refer to the dimensions in Section 2.2. for maximum allowable thread engagement. Screws that are too long or too short could result in an inadequately secured payload.

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

For a cantilevered load, first determine if it is a Vertical, Horizontal, or a Side cantilever system. Measure the cantilever length, then find the corresponding load value from Figure 2-4.

The **Vertical** curve is for situations where the stage is mounted in a vertical orientation and the payload is mounted to the carriage with its center of gravity extended outward in a direction normal to the carriage surface. Refer to Figure 2-8 or Figure 2-9 for torque requirements on a vertical orientation.

The **Horizontal** curve assumes a horizontal stage orientation with the payload offset extending outwards along the surface of the carriage.

The **Side** curve is for situations where the stage is mounted on its side and the offset load extends outwards in a direction normal to the carriage surface.

Refer to Figure 2-7 for clarification on Vertical, Horizontal, or a Side orientations.

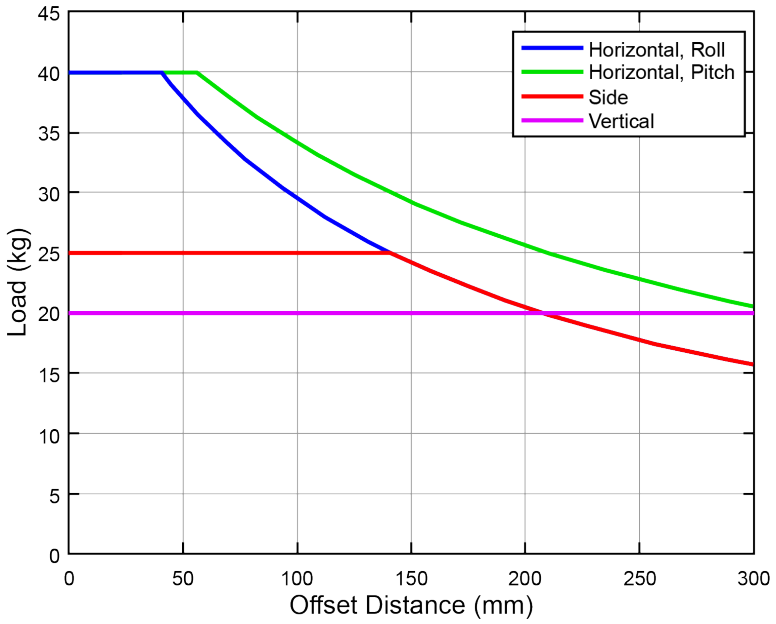


Figure 2-4: ATX165SL/SLE-150 Cantilevered Load Capability

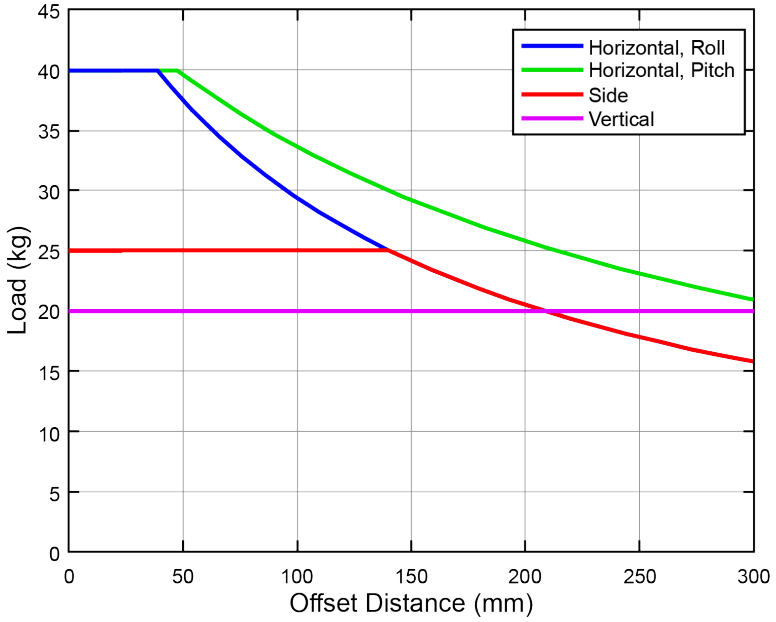


Figure 2-5: ATX165SL/SLE-200 Cantilevered Load Capability

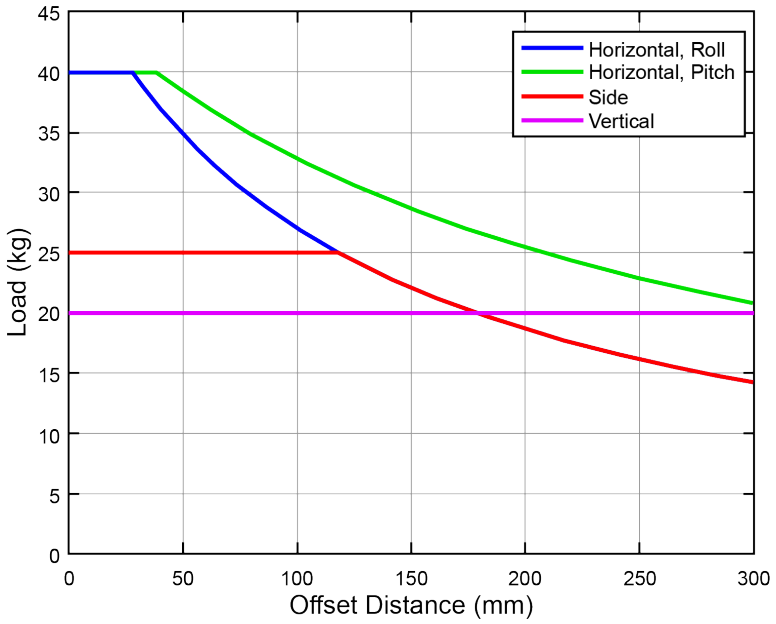


Figure 2-6: ATX165SL/SLE-250 Cantilevered Load Capability

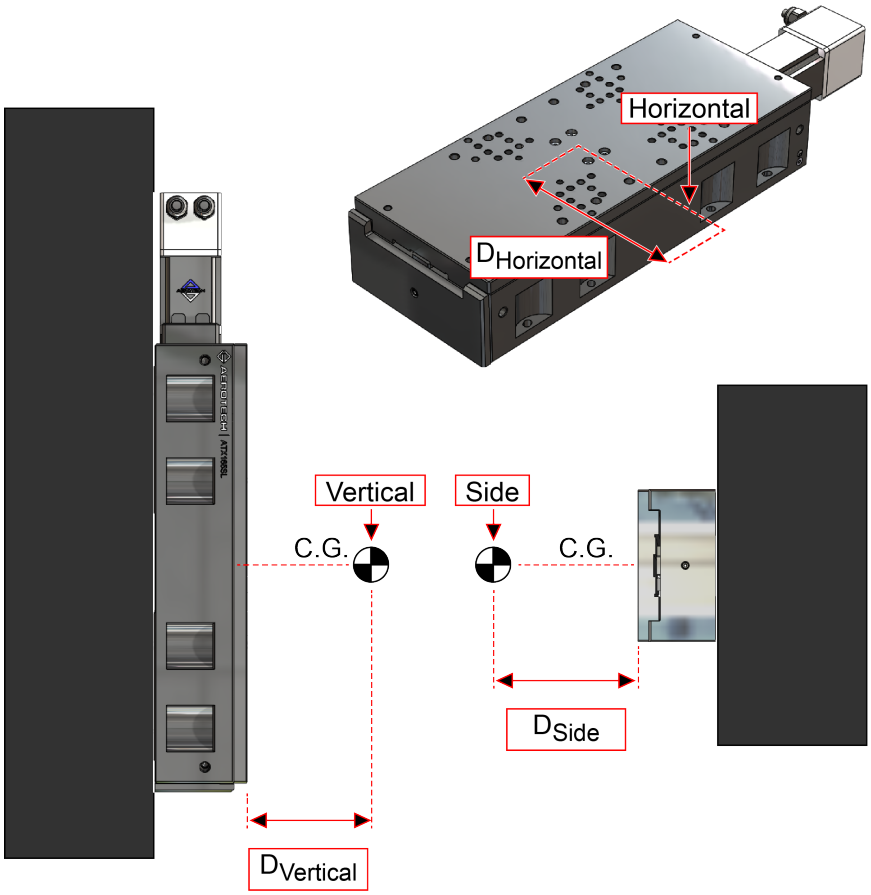


Figure 2-7: Stage Orientations

The approximate amount of torque required to turn the ball screw of ATX165SL/SLE series stages can be found from Figure 2-9 or the following equation:

$$Torque_{REQ} = \frac{(AxialLoad)\ x\ (LeadofScrew)}{2\ x\ \pi\ x\ (Efficiency)}$$

Figure 2-8: Load Torque Equation

For ATX165SL/SLE series stages, the ball screw efficiency is rated at 90% (0.90).

The maximum axial load carrying capacity of ATX165SL/SLE stages is 20 kg in the vertical direction.

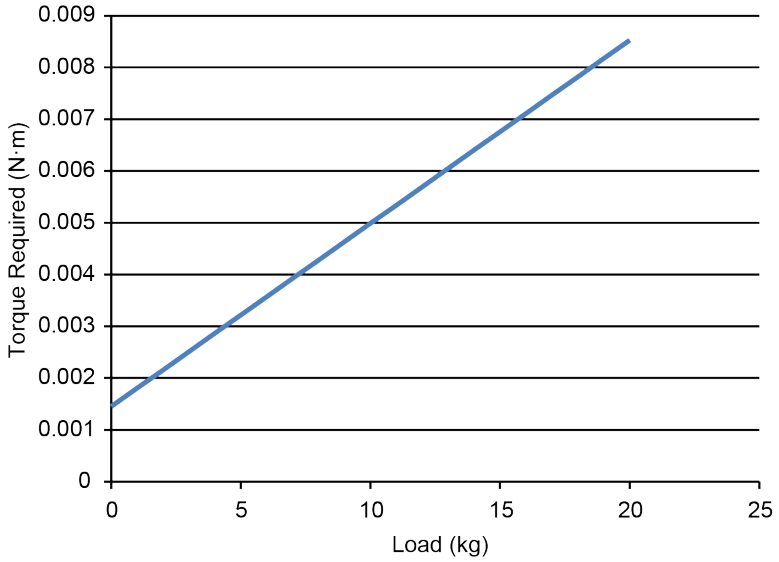


Figure 2-9: Torque Required to Turn Ball Screw in Vertical Orientation

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Chapter 3: Electrical Installation

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

Electrical installation requirements will vary depending on product options. Installation instructions in this section are for ATX165SL/SLE stages equipped with standard Aerotech motors intended for use with an Aerotech motion control system. Contact Aerotech for further information regarding products that are otherwise configured.

Aerotech motion control systems are adjusted at the factory for optimum performance. When the ATX165SL/SLE is part of a complete Aerotech motion control system, setup usually involves connecting the ATX165SL/SLE 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.

DANGER: You must limit access to all motor and stage parts while your system is connected to a power source.

- The voltage from this product can kill you.
- Moving parts can cause crushing or shearing injuries.

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.

NOTE: If using standard Aerotech motors and cables, motor and encoder connection adjustments are not required.

NOTE: The ATX165SL/SLE requires two encoder feedback channels. When used with the Lab controller, the second encoder channel will require a second axis and an adapter cable. The motor output of the second axis will not be available to drive a motor.

The protective ground connection of the ATX165SL/SLE 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: You must limit access to all motor and stage parts while your system is connected to a power source.

- The voltage from this product can kill you.
- Moving parts can cause crushing or shearing injuries.

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: 4-Pin Motor Connector Pinout for the -M1 through -M8 Options

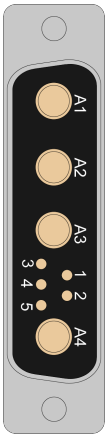
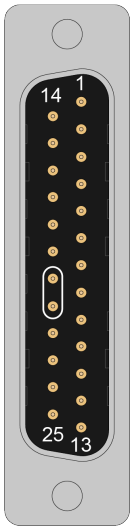
Pin	Description	Connector
Case	Shield connection	
A1	Motor Phase A	
A2	Motor Phase B	
A3	Motor Phase C	
1	Reserved	
2	Reserved	
3	Reserved	
4	Reserved	
5	Reserved	
A4	Frame ground (motor protective ground)	

Table 3-2: 4-Pin Motor Mating Connector Part Numbers

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: 25-Pin Feedback Connector Pinout for the -M1 through -M8 Options

Pin	Description	Connector
Case	Shield connection	
1	Reserved	
2	Over-Temperature Thermistor sensor (1)	
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 - (2)	
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 + (2)	

1. BMS motors only (otherwise Reserved)
2. With Brake option only

Table 3-4: 25-Pin Feedback Mating Connector Part Numbers

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

Table 3-5: 4-Pin Motor Connector Pinout for the -M9 Option

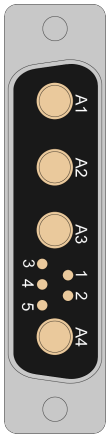
Pin	Description	Connector
A1	Motor Phase A	
A2	Motor Phase B	
A3	Motor Phase A Return	
A4	Motor Phase B Return	
1	Brake - (with -BK option)	
2	Brake + (with -BK option)	
3	Reserved	
4	Frame	
5	Frame	
CASE	Shield	

Table 3-6: 4-Pin Motor Mating Connector Part Numbers

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 3-7: 25-Pin Feedback Connector Pinout for the -M9 Option

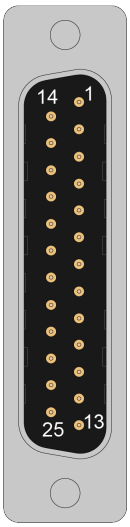
Pin	Description	Connector
1	Reserved	
2	Reserved	
3	Encoder +5 V	
4	Reserved	
5	Reserved	
6	Marker-N	
7	Marker	
8	Reserved	
9	Reserved	
10	Reserved	
11	Reserved	
12	Reserved	
13	Reserved	
14	Cosine	
15	Cosine-N	
16	Limit +5 V	
17	Sine	
18	Sine-N	
19	Reserved	
20	Limit Common	
21	Encoder Common	
22	Reserved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

Table 3-8: 25-Pin Feedback Mating Connector Part Numbers

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

Table 3-9: 9-Pin Limit Connector Pinout

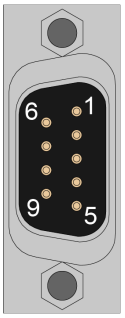
Pin #	Description	Connector
Case	Shield connection	
1	+5V supply input for optical limit switch boards	
2	Common ground to limit switch	
3	Signal indicating maximum travel produced by positive/CW stage direction	
4	Reserved	
5	Signal indicating stage maximum travel produced by negative/CCW stage direction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

Table 3-10: 9-Pin Mating Connector Part Numbers

Mating Connector	Aerotech P/N	3rd Party P/N
Backshell	ECK01021	Amphenol #17E-1724-2
Connector	ECK00340	Cinch DE-9S

Table 3-11: 15-Pin Linear Encoder Connector Pinout for the -SLE-E1 and -SLE-E2 Option

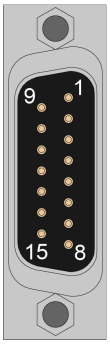
Pin	Description	Connector
1	Reserved	
2	Signal Common	
3	Reserved	
4	Marker-N	
5	Cosine-N	
6	Sine-N	
7	+5 V power supply	
8	+5 V power supply	
9	Signal Common	
10	Reserved	
11	Reserved	
12	Marker	
13	Cosine	
14	Sine	
15	Reserved	
Case	Signal shield connection (to case)	

Table 3-12: 15-Pin Mating Connector Part Numbers

Mating Connector	Aerotech P/N	3rd Party P/N
Backshell	ECK01022	Amphenol 17E-1725-2
Connector	ECK00326	Amphenol DA15S064TLF

Table 3-13: 15-Pin Linear Encoder Connector Pinout for the -SLE-E3 Option

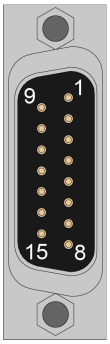
Pin	Description	Connector
1	Reserved	
2	Signal Common	
3	Reserved	
4	Clock -	
5	Data +	
6	Reserved	
7	+5 V power supply	
8	+5 V power supply	
9	Signal Common	
10	Reserved	
11	Reserved	
12	Clock +	
13	Data -	
14	Reserved	
15	Reserved	
Case	Signal shield connection (to case)	

Table 3-14: 15-Pin Mating Connector Part Numbers

Mating Connector	Aerotech P/N	3rd Party P/N
Backshell	ECK01022	Amphenol 17E-1725-2
Connector	ECK00326	Amphenol DA15S064TLF

Table 3-15: 15-Pin Connector Pinout for the -TCMP Option

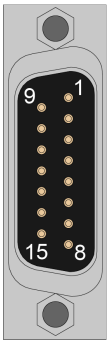
Pin	Description	Connector
1	+5 V power supply	
2	Reserved	
3	TCMP	
4	Common	
5	Reserved	
6	Reserved	
7	Reserved	
8	Reserved	
9	Reserved	
10	Reserved	
11	Reserved	
12	Reserved	
13	Reserved	
14	Reserved	
15	Reserved	
Case	Signal shield connection (to case)	

Table 3-16: 15-Pin Mating Connector Part Numbers

Mating Connector	Aerotech P/N	3rd Party P/N
Backshell	ECK01022	Amphenol 17E-1725-2
Connector	ECK00326	Amphenol DA15S064TLF

3.2. Motor and Feedback Wiring

Shielded cables are required for the motor and feedback connections.

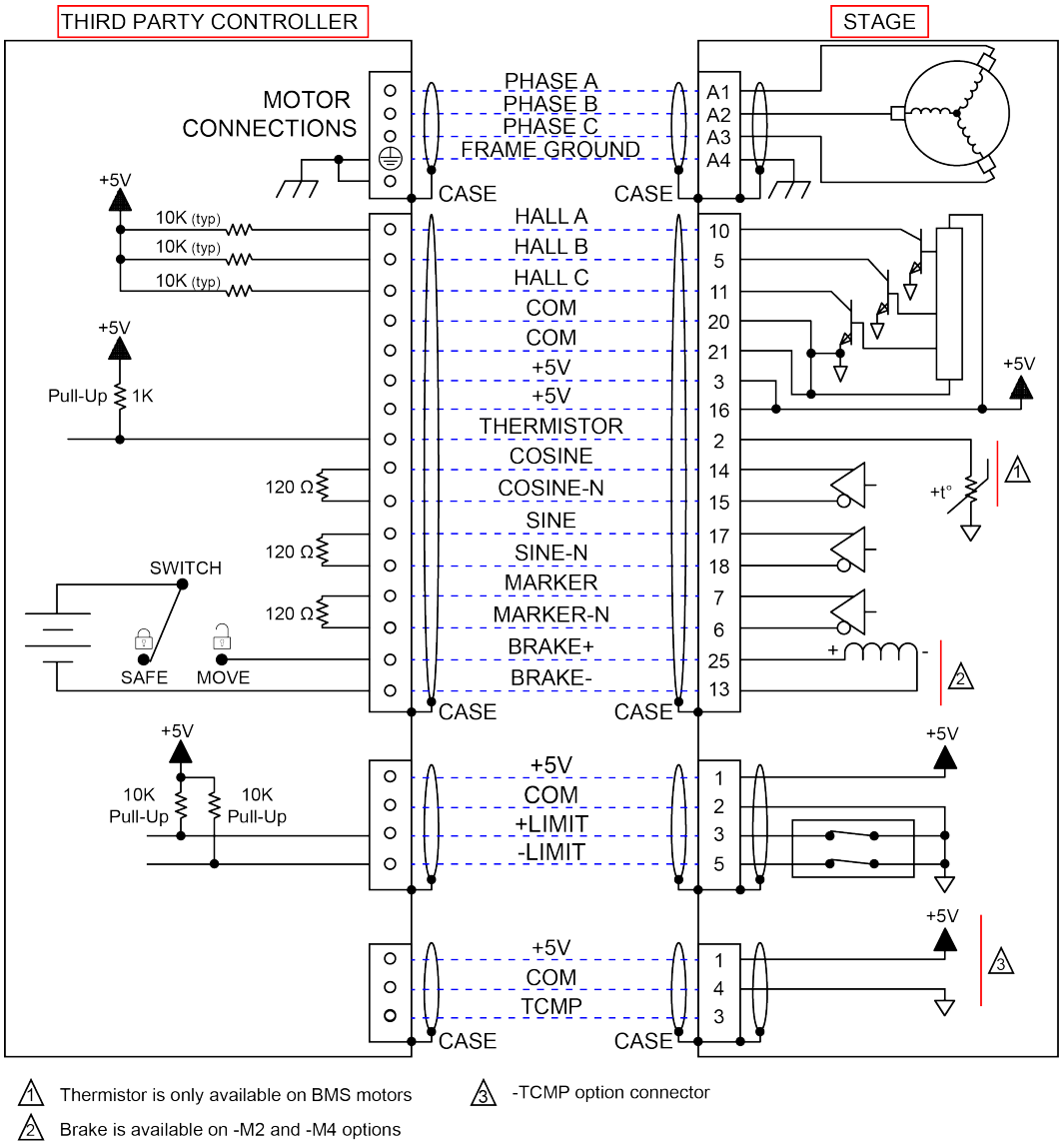
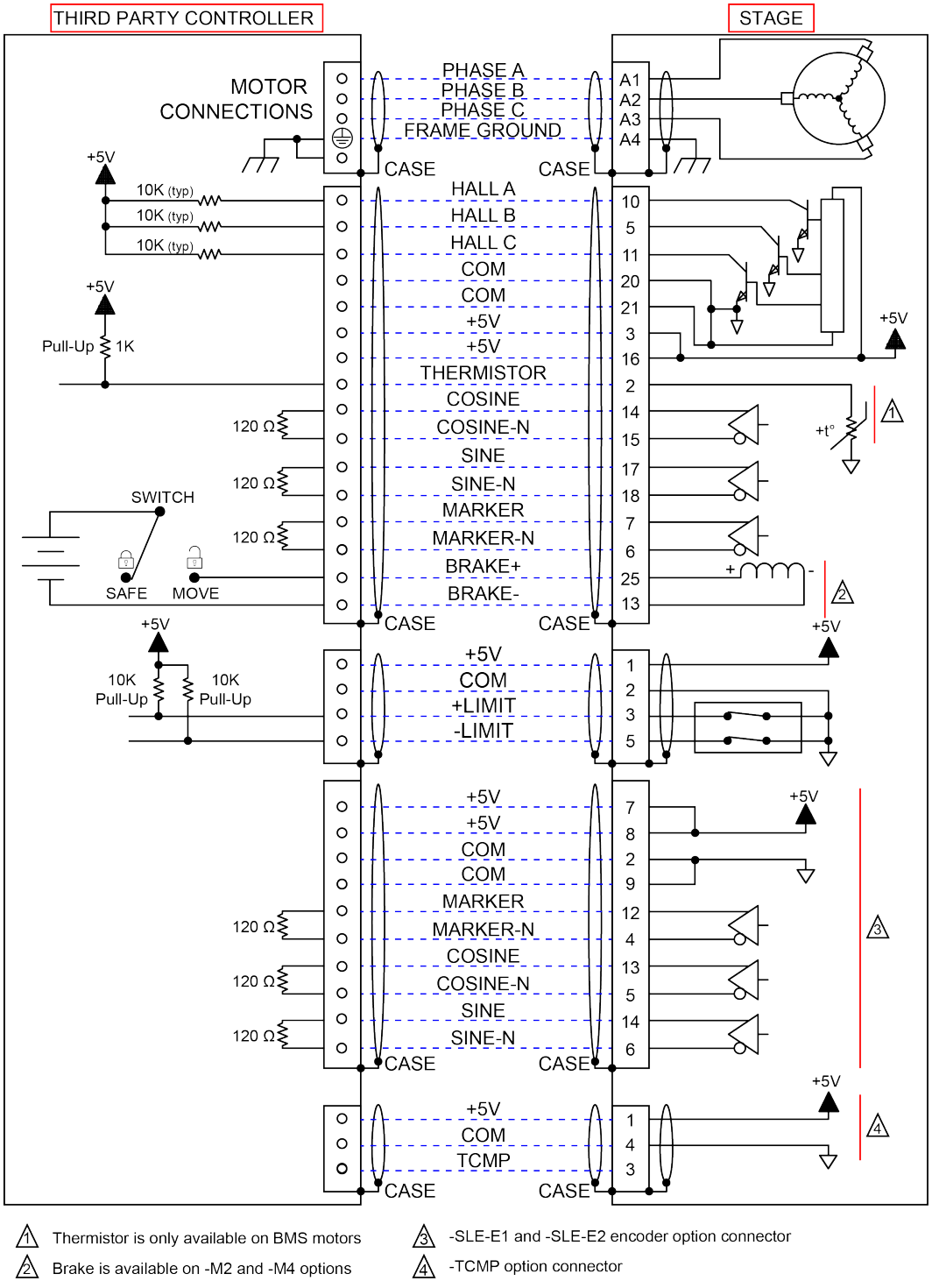


Figure 3-1: ATX165SL BM/BMS Motor and Feedback Wiring



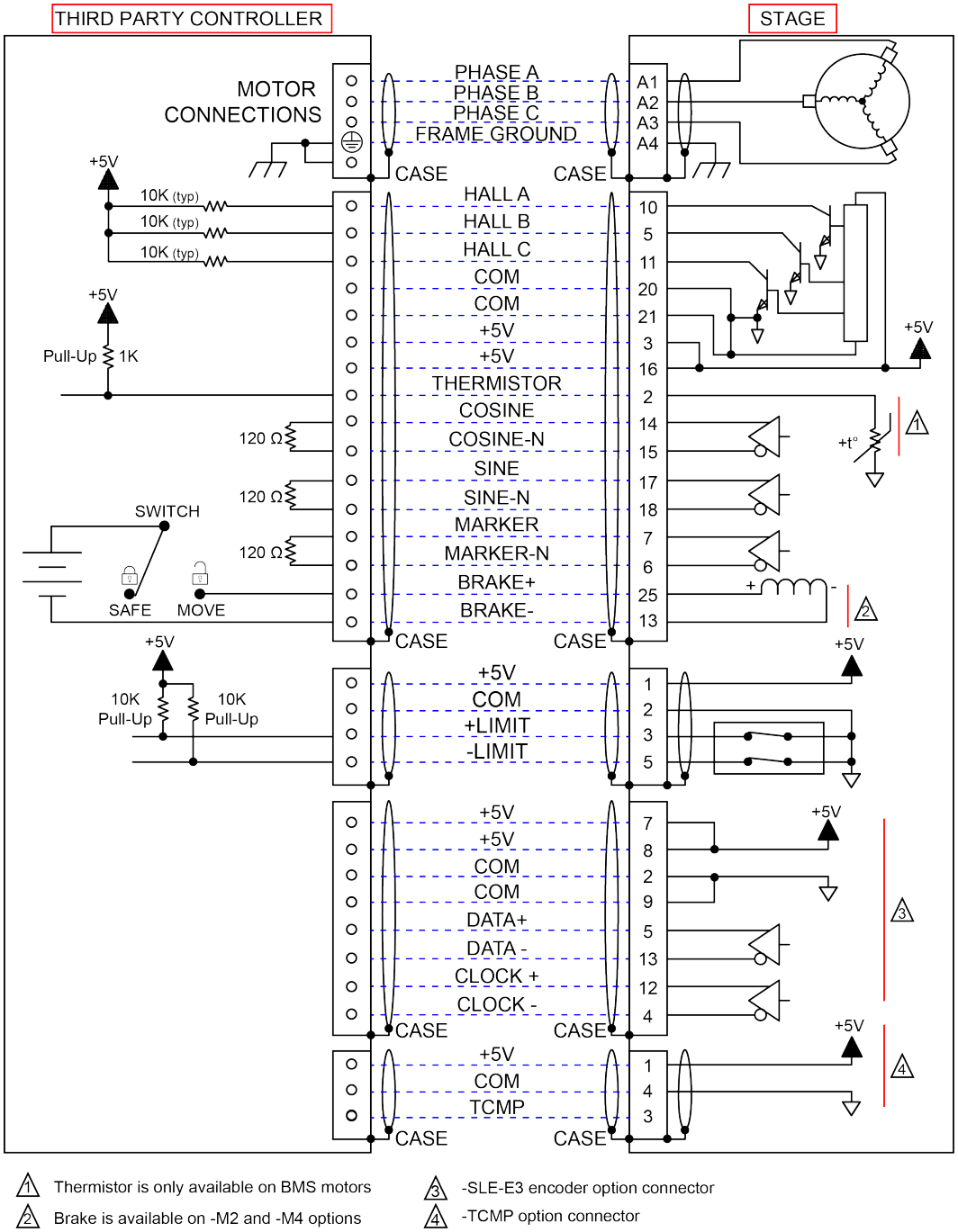
1 Thermistor is only available on BMS motors

2 Brake is available on -M2 and -M4 options

3 -SLE-E1 and -SLE-E2 encoder option connector

4 -TCMP option connector

Figure 3-2: ATX165SLE-E1 and -E2 BM/BMS Motor and Feedback Wiring



1 Thermistor is only available on BMS motors

2 Brake is available on -M2 and -M4 options

3 -SLE-E3 encoder option connector

4 -TCMP option connector

Figure 3-3: ATX165SLE-E3 BM/BMS Motor and Feedback Wiring

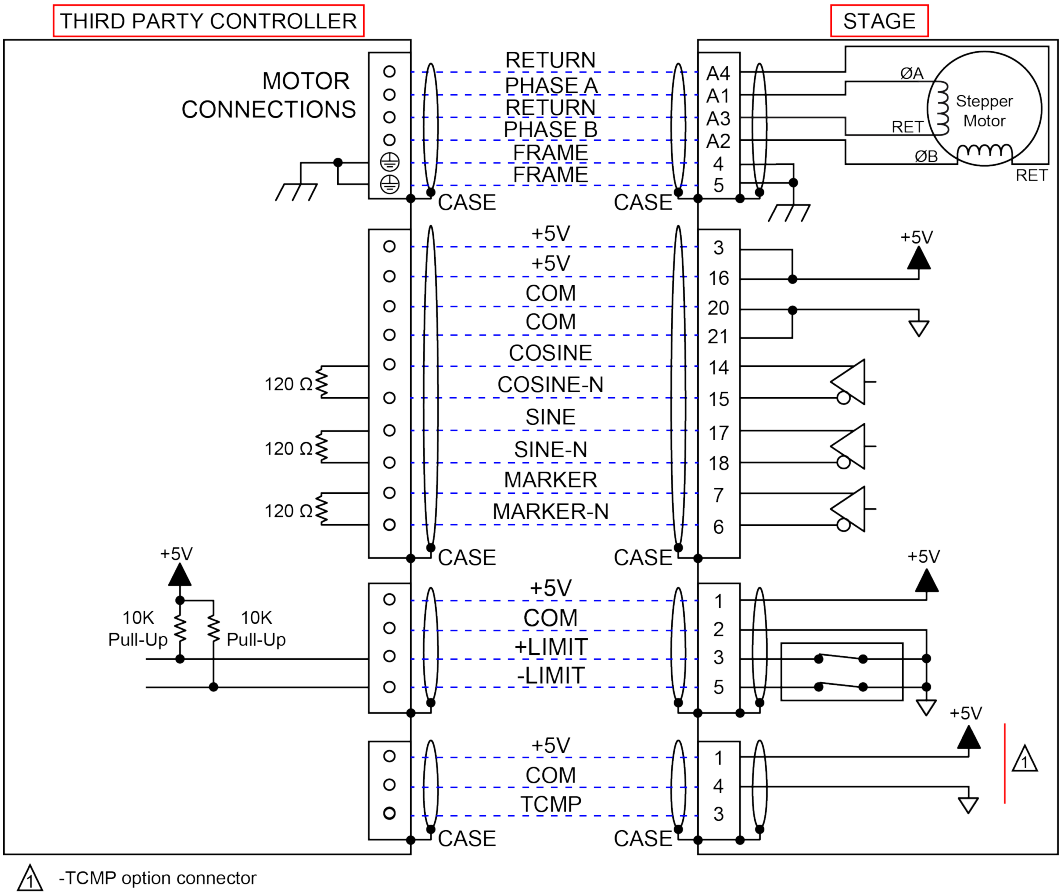


Figure 3-4: ATX165SL Stepper Motor and Feedback Wiring

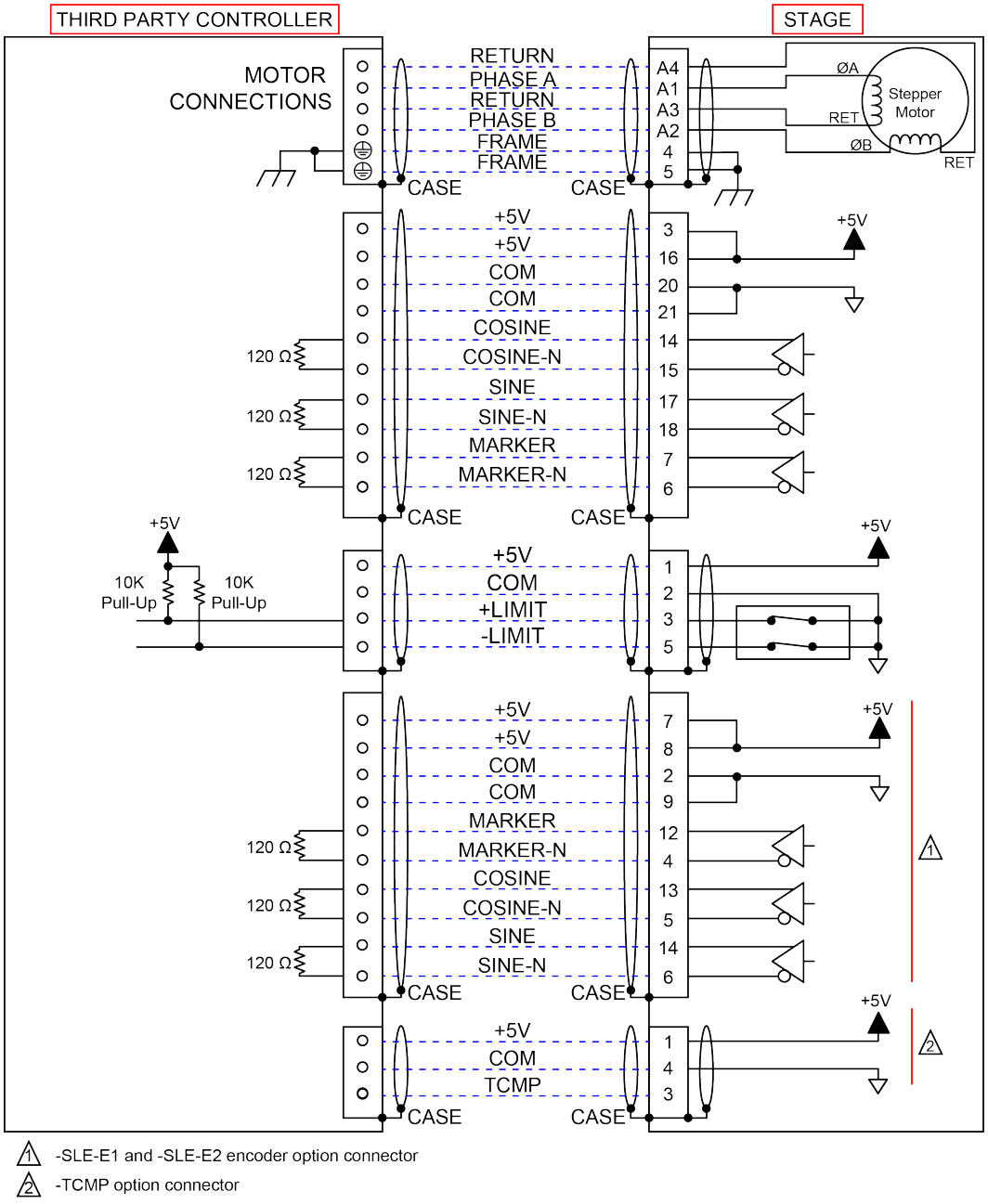


Figure 3-5: ATX165SLE-E1 and -E2 Stepper Motor and Feedback Wiring

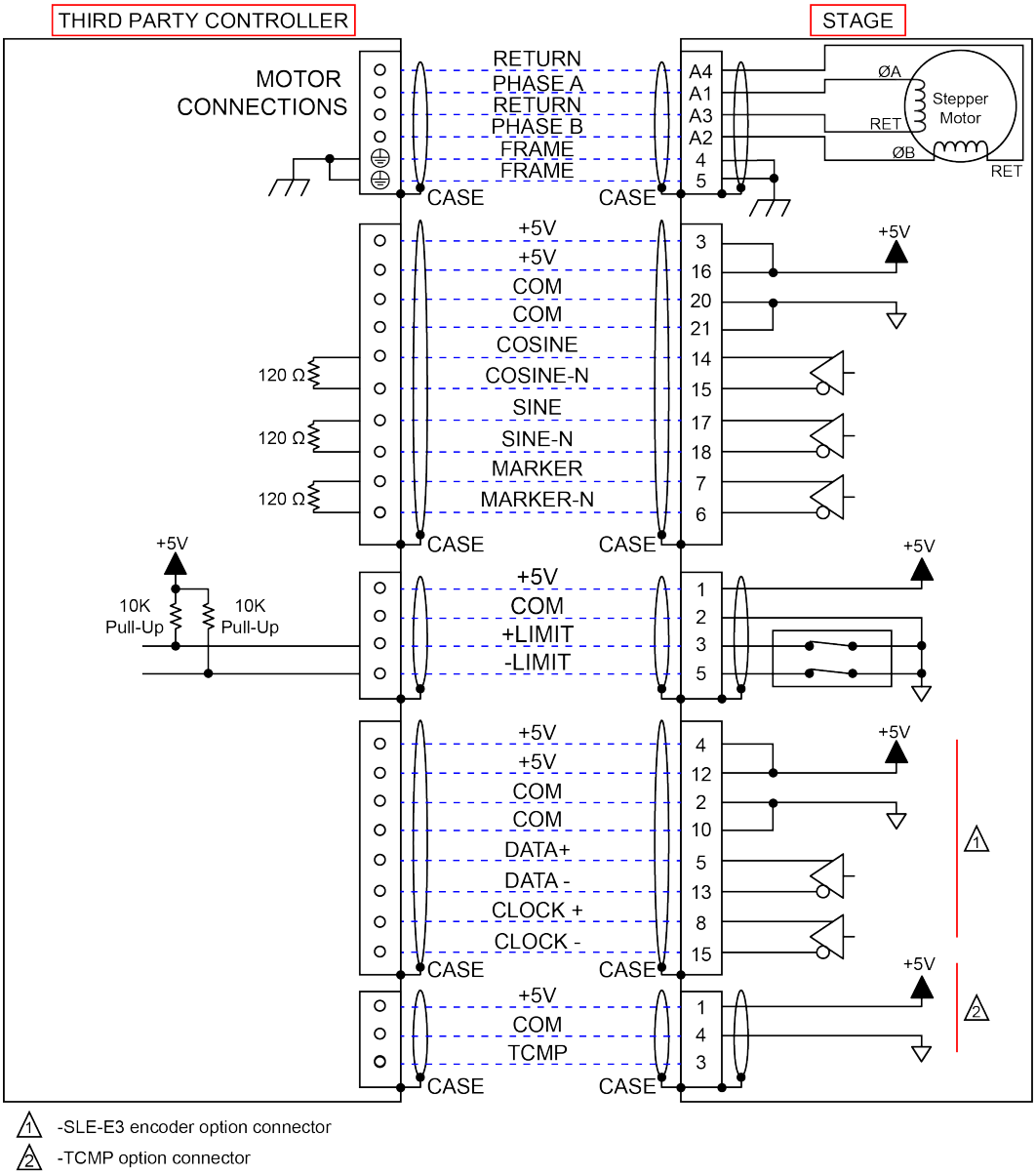


Figure 3-6: ATX165SLE-E3 Stepper Motor and Feedback Wiring

3.3. Motor and Feedback 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 for the most up-to-date information.

Table 3-17: Feedback Specifications

Hall-Effect Sensors Specifications [BM and BMS motors options only]	
Supply Voltage	5 V ±5%
Supply Current	50 mA
Output Type	Open Collector
Output Voltage	24 V max (pull up)
Output Current	5 mA (sinking)

Thermistor Specifications [BMS motors options only]	
Polarity	Logic "0" (no fault)
	Logic "1" (over-temperature fault)
Cold Resistance	~100 Ω
Hot Resistance	~10 K
Note: 1K pull-up to +5V recommended.	

Encoder Specifications	
Supply Voltage	5 V ±5%
Supply Current	250 mA Typical
Output Signals	**Sinusoidal Type (Incremental Encoder)**: 1 V_{pk-pk} into 120 Ω Load (differential signals SIN+, SIN-, COS+, COS- are .5 V_{pk-pk} relative to ground.)
	Digital Output (Incremental Encoder): RS422/485 compatible
	Serial Output (Absolute Encoder): EnDat 2.2 with 36 bit word

Brake Specifications	
Supply Voltage	24 VDC
Supply Current (typical)	250 mA (Current required to release the brake and allow motion.)

Table 3-18: ATX165SL/SLE Motor Specifications (BMS60)

		BMS60
Performance Specifications (1, 5)		
Stall Torque, Continuous (2)	N·m (oz·in)	0.33 (46.2)
Peak Torque (3)	N·m (oz·in)	1.31 (184.9)
Rated Power Output, Continuous	W	116
Electrical Specifications (5)		
Winding Designation		-A
BEMF Constant (Line-Line, Max)	V_{pk}/k_{rpm}	19.0
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})	0.140 (20.10)
	N·m/A_{rms} (oz·in/A_{rms})	0.200 (28.40)
Motor Constant (2, 4)	N·m/√W (oz·in/√W)	0.050 (7.02)
Resistance, 25°C (Line-Line)	Ω	8.40
Inductance (Line-Line)	mH	1.30
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 ±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

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

Table 3-19: ATX165SL/SLE Motor Specifications (BM75)

		BM75
Performance Specifications (1,2)		
Stall Torque, Continuous (3)	N·m (oz·in)	0.51 (72.0)
Peak Torque(4)	N·m (oz·in)	1.30 (181.0)
Rated Power Output, Continuous	W	192
Electrical Specifications (2)		
BEMF Constant (Line-Line, Max)	V_{pk}/k_{rpm}	9.0
Continuous Current, Stall (3)	A_{pk} (A_{rms})	9.0 (6.4)
Peak Current, Stall (4)	A_{pk} (A_{rms})	22.5 (15.9)
Torque Constant (5)	N·m/A_{pk} (oz·in/A_{pk})	0.060 (8.00)
	N·m/A_{rms} (oz·in/A_{rms})	0.080 (11.40)
Motor Constant (3,5)	N·m/√W (oz·in/√W)	0.055 (7.84)
Resistance, 25°C (Line-Line)	Ω	1.00
Inductance (Line-Line)	mH	1.42
Maximum Bus Voltage	V_{DC}	340
Thermal Resistance	°C/W	1.18
Number of Poles	--	8

1. Performance is dependent upon heat sink configuration, system cooling conditions, and ambient temperature
2. All performance and electrical specifications ±10%
3. Values shown @ 105°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
4. Peak torque assumes correct rms current; consult Aerotech
5. Torque constant and motor constant specified at stall
6. Maximum winding temperature is 130 °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

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

Table 3-20: ATX165SL/SLE Motor Specifications (SM60-VT2)

	SM60-VT2
NEMA Motor Frame Size	NEMA 23
Stall Torque	1.41 N·m (200 oz·in)
Rated Amps Per Phase	0.84 A
Phase Inductance	40.74 mH
Phase Resistance	13.25 Ω
Maximum Voltage Across the Motor	160 V
Rotor Inertia	3.00E-05 kg·m^2 (0.0042 oz·in·s^2)
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)

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

Table 3-21: Rotary Encoder Specifications

Encoder Option	Fundamental Signal Period	Digital Resolution
-M1, -M2, -M5, -M6 (10,000 line TTL signal)	200 nm	50 nm
-M3, -M4, -M7, -M8 (1,000 line 1 Vpp Amplified Sine signal)	2000 nm	500 nm
-M3, -M4, -M7, -M8 with 1000x Interpolation (1) (1000 line 1 Vpp Amplified Sine signal)	2 nm	0.5 nm
-M3, -M4, -M7, -M8 with 4000x Interpolation (1) (1000 line 1 Vpp Amplified Sine signal)	0.5 nm	0.125 nm
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 3-7 shows the machine direction of ATX165SL/SLE stages.

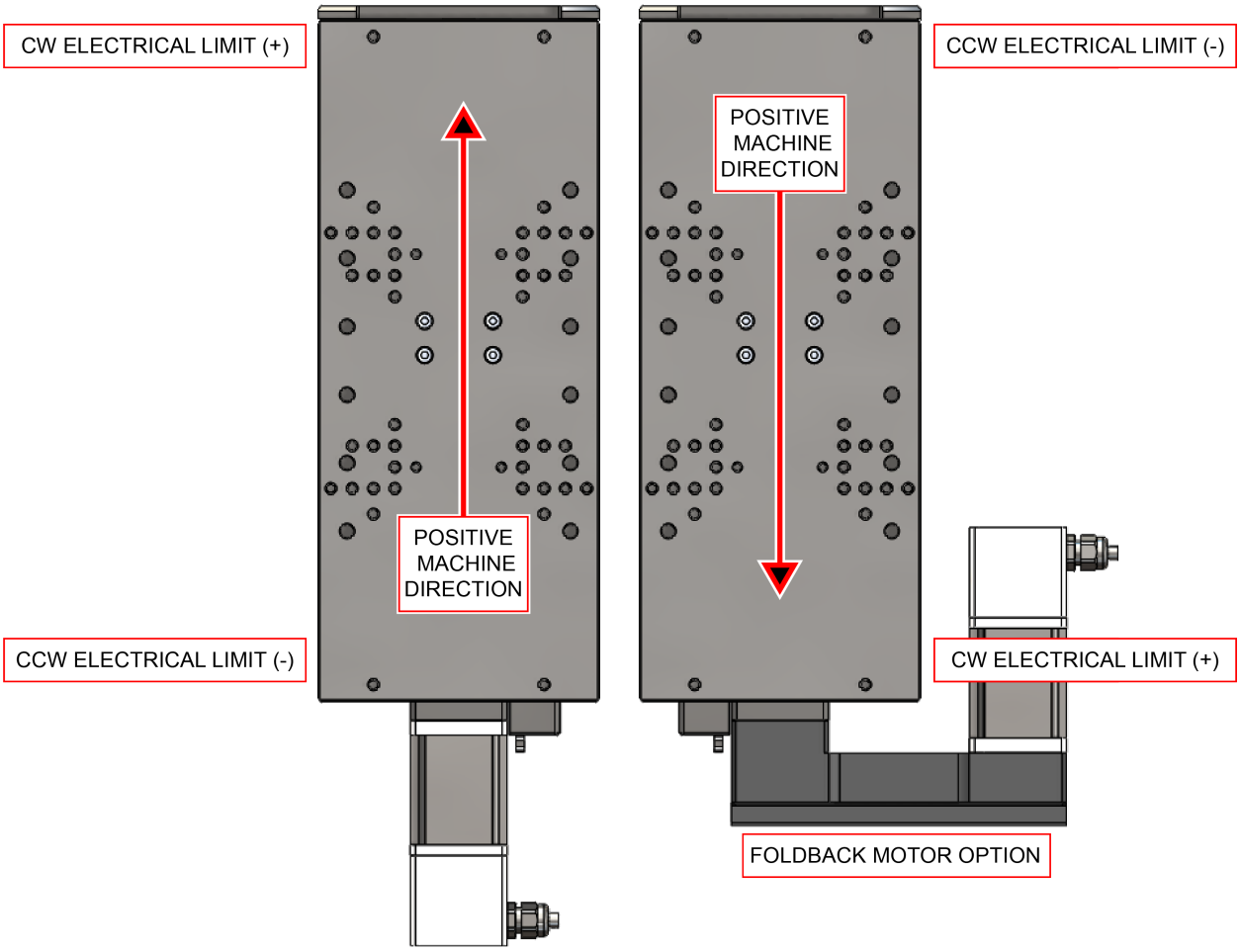


Figure 3-7: Machine Direction

3.5. Motor and Feedback Phasing

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

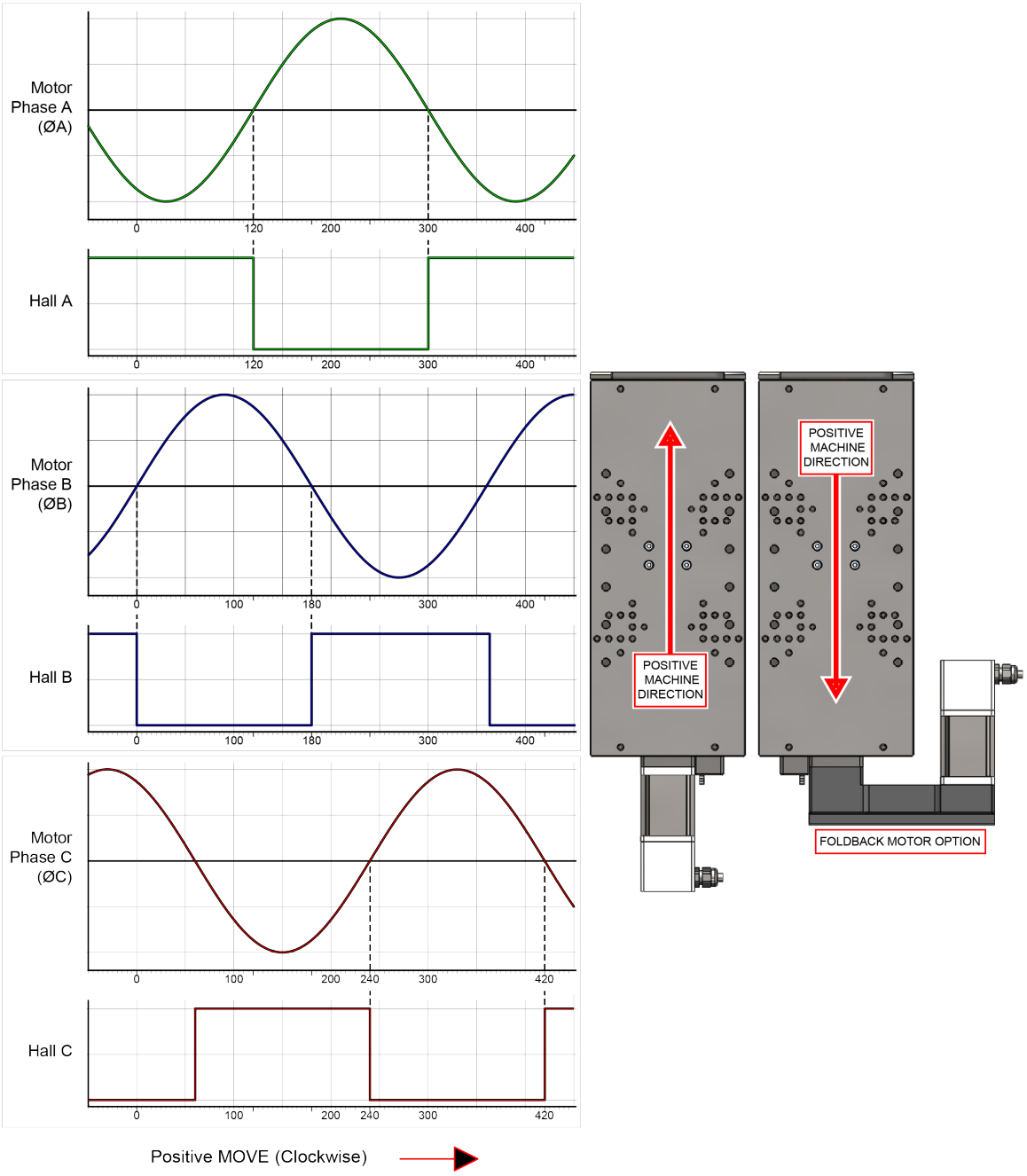


Figure 3-8: Hall Phasing

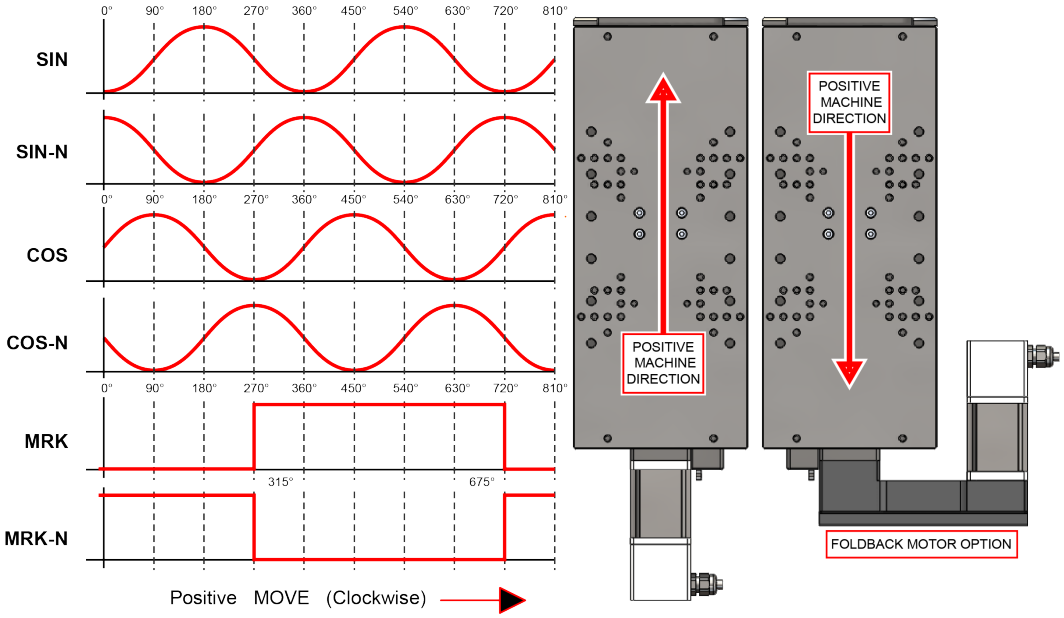


Figure 3-9: Analog Encoder Phasing Reference Diagram

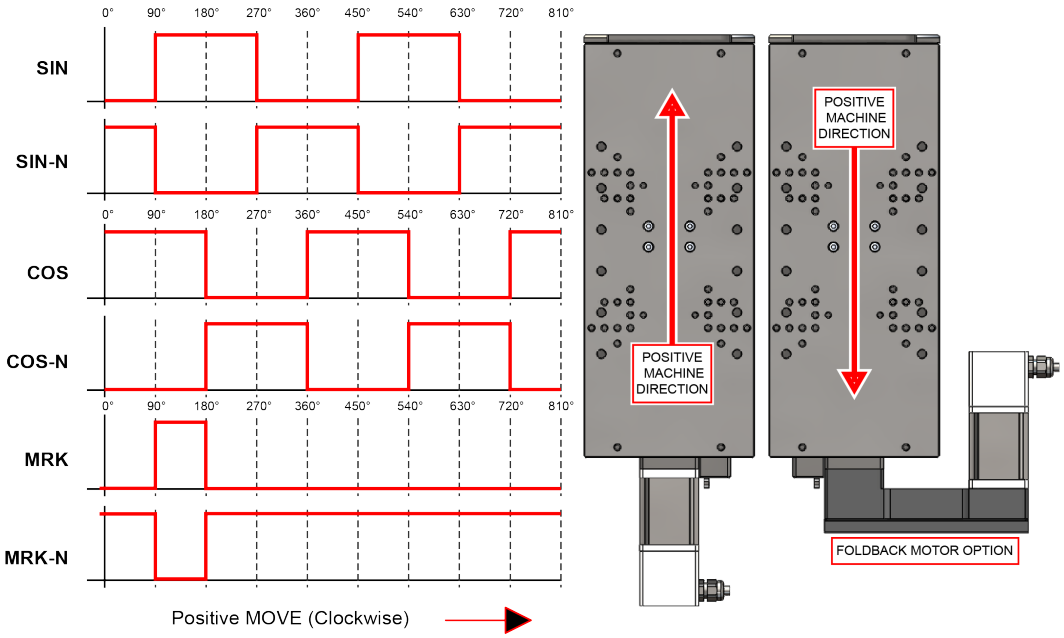


Figure 3-10: Encoder Phasing Reference Diagram (Standard)

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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 ATX165SL/SLE 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.

NOTE: The stage carriage 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.

NOTE: If the stage is not connected to a power source, the stage should move freely by hand. Do not attempt to manually move the stage if it is connected to a power source.

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 ATX165SL/SLE and any components and cables as needed.
- Repair any damage before operating the ATX165SL/SLE.
- 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 ATX165SL/SLE 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 ATX165SL/SLE, 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 bolts 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 bearing trucks.

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

WARNING: Isopropyl alcohol should only be used on metal surfaces.

Lubrication

Aerotech recommends that you use only Kluberplex BEM 34-132 as the standard lubricant for ATX165SL/SLE stages.

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 bearings and ball screw for any damage or signs of wear.

DANGER: You must limit access to all motor and stage parts while your system is connected to a power source.

- The voltage from this product can kill you.
- Moving parts can cause crushing or shearing injuries.

DANGER: Use extreme caution when you operate the stage with the hardcovers removed.

1. Drive the stage to the end of travel closest to the motor. Remove the four flat head screws and then slide the exposed hardcover out from under the carriage.

NOTE: The 250 mm travel version of the ATX165SL/SLE has a two-piece hardcover on this side of the stage.

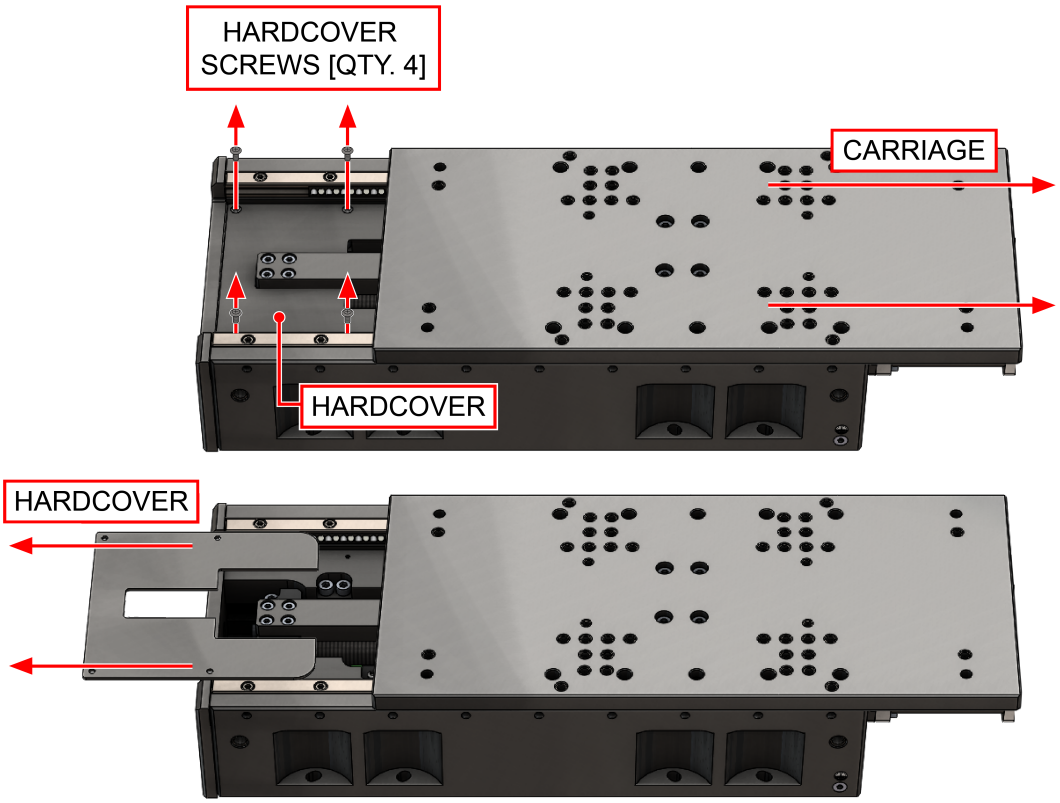

Figure 4-1: Hardcover Removal (Left)

2. Drive the stage to the other end of travel. Remove the four flat head screws and then slide the exposed hardcover out from under the carriage.

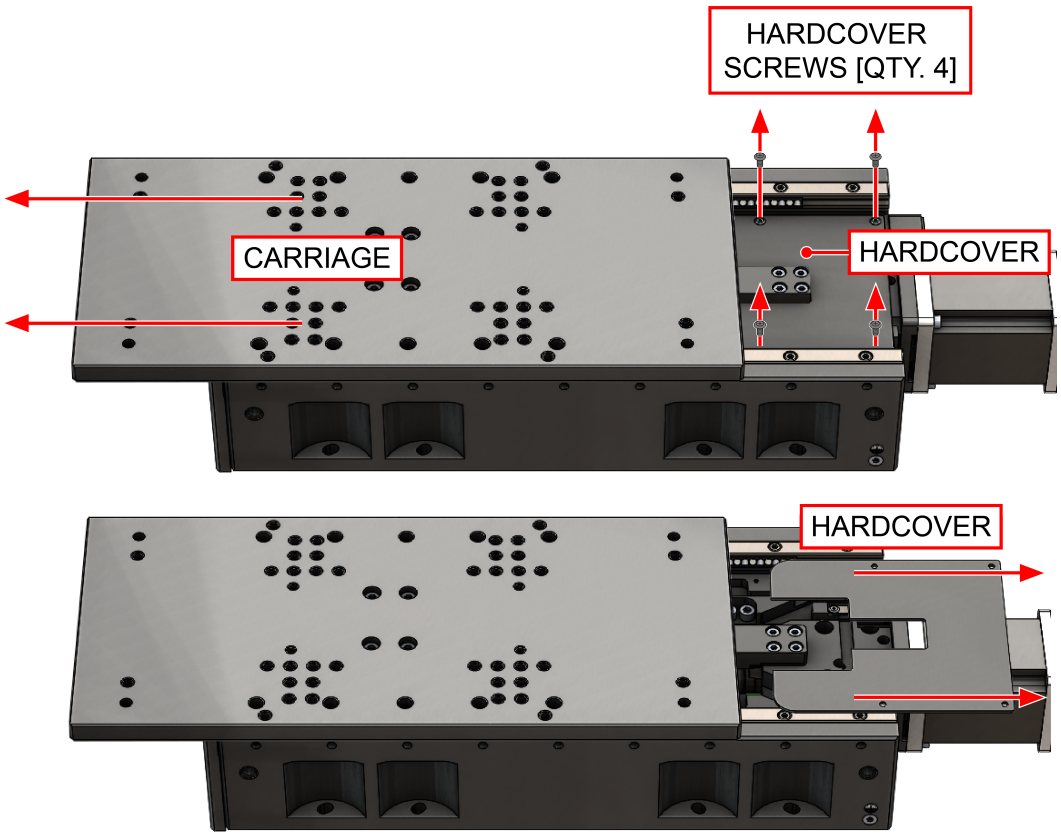

Figure 4-2: Hardcover Removal (Right)

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. A swab soaked in Isopropyl Alcohol may be used to remove stubborn debris.
   A. Without a Brake: Manually move the stage to the opposite end of travel to access to clean the ball screw's entire circumference
   B. With a Brake: The stage cannot be moved by hand. You must restore power to the stage, drive it to the desired position, and then remove power to continue cleaning the ball screw.
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 with a clean, lint-free cloth or swab.
7. Apply a thin, continuous film of lubricant to the ball-screw threads and linear bearing guides. A good quality, natural bristle artist's brush makes an excellent applicator.
8. Work the grease into the ball screw and linear bearing guides:
   A. Without a Brake: Manually move the stage to the opposite end of travel
   B. With a Brake: The stage cannot be moved by hand. You must restore power to the stage, drive it to the desired position, and then remove power.
9. Repeat steps 3 through 9 for any areas covered by the original carriage position.
10. Refasten the front and rear hardcovers.
11. Restore power to the stage and drive the stage carriage back to its original position to redistribute lubricants.

4.3. Belt Adjustment

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.

Check the belt tension when lubricating and cleaning the stage. Deflection in the belt should be within ±10% of 1.5 mm when applying a 5 N downward force directly between the pulleys. If the deflection exceeds this value, the belt tension needs to be adjusted.

You will also need to apply lubricant to the inside flanges of the pulleys if the flanges are dry. The flanges should have a thin film of lubricant to reduce belt wear as the belt contacts the flanges. Parker Super O-Lube (silicone-based) is the approved lubricant for standard polyurethane belts.

Belt Tension Adjustment Procedure

1. Remove power to the stage.
2. Remove the four mounting screws for the foldback cover and remove the foldback cover. Keep the cable guide and cable cover together (Figure 4-3).
3. Check that the pulleys are tight on their respective shafts (Figure 4-4).
    a. Each pulley is held in position with two set screws.
    b. Ensure that the set screws are tight and centered over the shaft flats.
4. Check the tension in the belt to determine if adjustment is necessary (Figure 4-4).
5. If adjustment is required, loosen (but do not remove) the mounting screws for the idler pulley mounting bracket (Figure 4-4).
    a. If the belt tension is too low: Remove the M4 set screw below the idler pulley mounting bracket to gain access to the tapped hole.
    b. If the belt tension is too high: Remove the M4 set screw above the idler pulley mounting bracket.
6. Insert an M4 screw or threaded stud long enough to contact the idler pulley mounting bracket (Figure 4-4).
7. Use the threaded stud to drive the idler pulley mounting bracket upward to increase belt tension, or downward to decrease belt tension.
8. Tighten the mounting screws for the idler pulley mounting bracket.
9. Measure the belt deflection again and repeat the previous steps until the belt tension adjustment is complete.
10. Check the pulley flanges for lubrication.
11. Add small amounts of Parker Super O-Lube lubricant around the circumference of both pulley flanges (Figure 4-5).
12. Replace the foldback cover and mounting screws. Remove the M4 threaded stud and replace it with the M4 set screw.
13. Restore power to the stage and resume normal use.

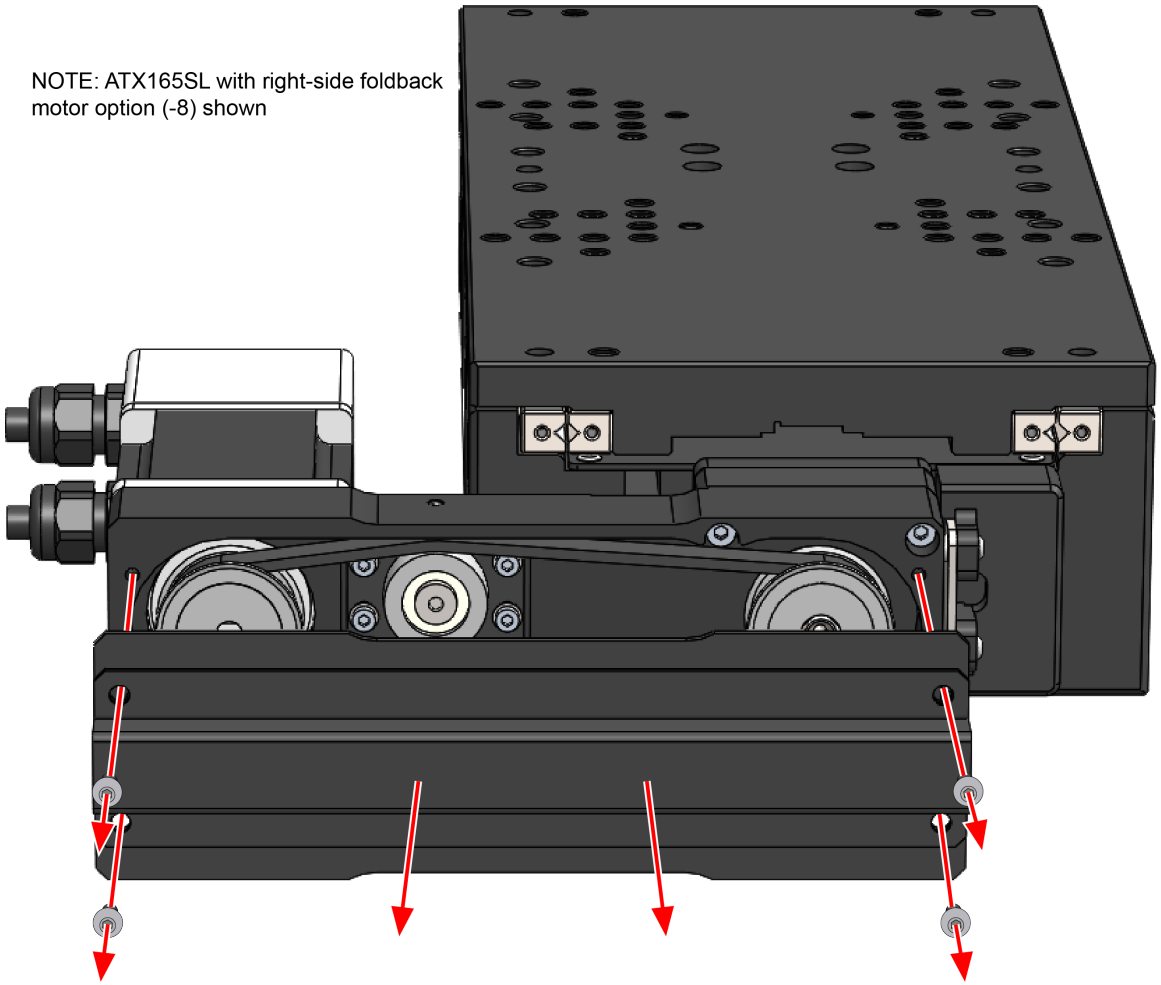

Figure 4-3: Foldback Motor Cover Removal

NOTE: If the stage has been calibrated (-PL2 option), note the orientation of the two pulleys with regard to each other or recalibration might be required.

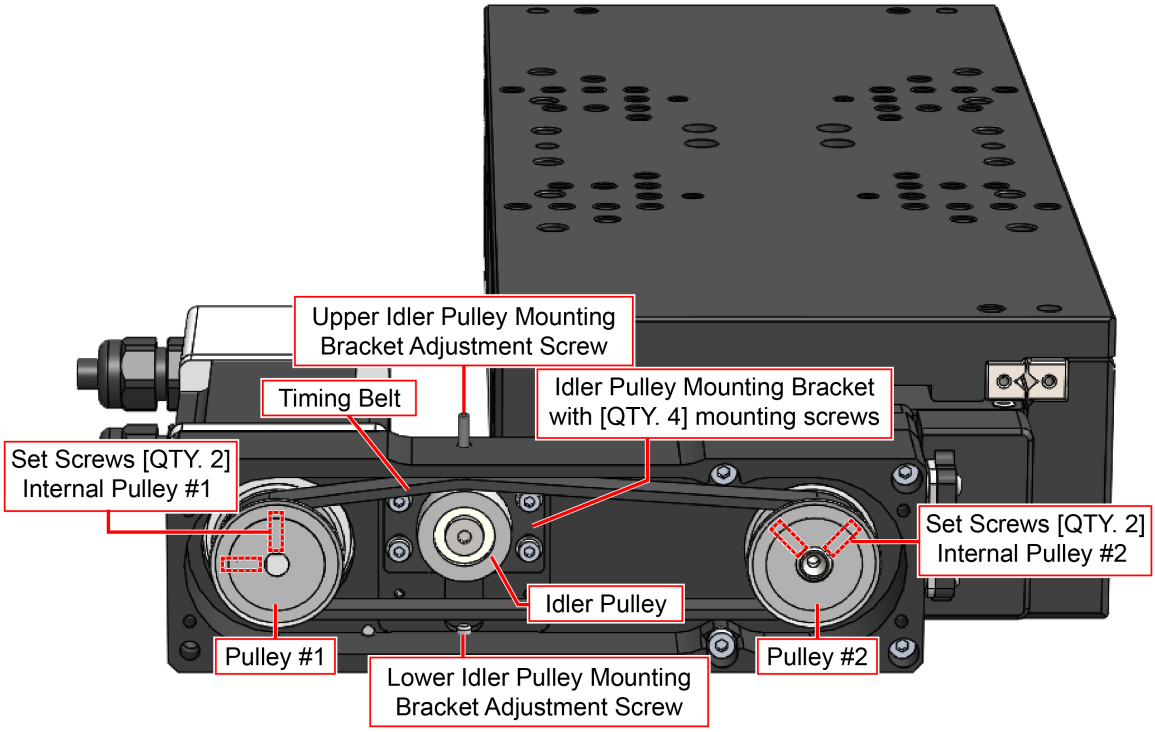

Figure 4-4: Foldback Motor Part Callouts

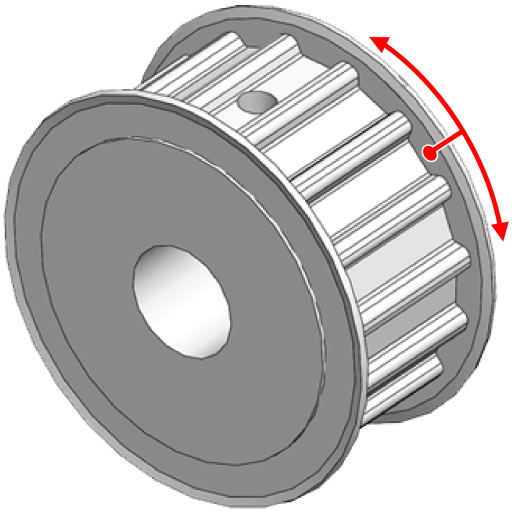

Figure 4-5: Lubricate the Pulley Flanges

4.4. 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 Chapter 3) 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 Chapter 3 and Controller documentation). Motor Connections (refer to Chapter 3 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). 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
1.01.00	Added maximum speed for all motor options: Section 1.3.
1.00.00	New Manual

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