



PR0165SL and SLE Mechanical Bearing, Ball-Screw Stage

HARDWARE MANUAL

Revision 2.03



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EU Declaration of Incorporation

Manufacturer: Aerotech, Inc.
Address: 101 Zeta Drive
 Pittsburgh, PA 15238-2811
 USA
Product: PRO165SL/SLE - linear positioning stage
Models: All

This is to certify that the aforementioned product is in accordance with the applicable requirements of the following directive.

- 2006/42/EC
 Machinery Directive (partially completed machinery)
- 1.1 General Remarks
 - 1.1.2 Principles of safety integration
 - 1.1.5 Design of machinery to facilitate handling
 - 1.2 Control Systems
 - 1.2.1 Safety and reliability of control systems
 - 1.3 Protection against mechanical hazards
 - 1.3.1 Risk of loss of stability
 - 1.3.2 Risk of breakup during operation
 - 1.3.3 Risks due to falling or ejected objects
 - 1.3.4 Risks due to surfaces, edges, or angles
 - 1.5 Risks due to other hazards
 - 1.5.4 Error of fitting
 - 1.5.9 Vibrations
 - 1.6 Maintenance
 - 1.6.5 Cleaning of internal parts
 - 1.7 Instructions
 - 1.7.4.1 Instructions

and that the following harmonized European standards have been applied:

- EN ISO 12100
 Safety of machinery – Basic concepts, general principles for design
- EN 60204-1:2018
 Safety of machinery – Electrical equipment of machines – Part 1: General requirements

and furthermore declares that

the equipment shall not be put into service until the machinery into which it is to be incorporated or of which it is to be a component has been found and declared to be in conformity with the provisions of the Directive 2006/42/EC and with national implementing legislation, for example, as a whole, including the equipment referred to in this Declaration. Technical documentation showing compliance with this declaration in accordance with Annex VII part B will be provided in digital format upon request.

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Alex Weibel

Date: 3/20/2025


AEROTECH UKCA Declaration of Incorporation

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

herewith declares that the following Aerotech stage series:

PRO165SL/SLE

To which this declaration relates, meets the essential health and safety requirements and is in conformity with the relevant UK legislation listed below:

Supply of Machinery (Safety) Regulations 2008

Hazardous Substances in Electrical and Electronic Equipment Regulations 2012
 Restricted Substances Directive

Using the relevant section of the following UK designated standards and other normative documents when installed in accordance with the installation instructions supplied by the manufacturer:

EN ISO 12100

Safety of machinery – Basic concepts, general principles for design

EN 60204-1:2018

Safety of machinery – Electrical equipment of machines – Part 1: General requirements

and furthermore declares that

it is not allowed to put the product 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 Supply of Machinery (Safety) Regulations 2008 UK Legislation and with national implementing legislation, for example, as a whole, including the equipment referred to in this Declaration.

Authorized Representative:

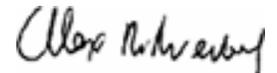
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Safety Procedures and Warnings



IMPORTANT: This manual tells you how to carefully and correctly use and operate the stage.

- Read all parts of this manual before you install or operate the stage or before you do maintenance to your system.
- To prevent injury to you and damage to the equipment, obey the precautions in this manual.
- All specifications and illustrations are for reference only and were complete and accurate as of the release of this manual. To find the newest information about this product, refer to www.aerotech.com.

If you do not understand the information in this manual, contact Aerotech Global Technical Support.



IMPORTANT: This product has been designed for light industrial manufacturing or laboratory environments. If the product is used in a manner not specified by the manufacturer:

- The protection provided by the equipment could be impaired.
- The life expectancy of the product could be decreased.

Safety notes and symbols are placed throughout this manual to warn you of the potential risks at the moment of the safety note or if you fail to obey the safety note.



Shock/Electrocution Hazard



Pinch, Shear, or Crush Hazard



General/Conditional Awareness



Rotational Machinery Hazard



Hot Surface Hazard



Pinch/Entanglement Hazard



Magnetic Field Hazard



Trip Hazard



Heavy, Bulky Lifting Hazard



Appropriate Equipment Required



Pressure/Explosive Atmosphere Hazard



Electrostatic Discharge Hazard

A blue circle symbol is an action or tip that you should obey. Some examples include:



General tip



Read the manual/section



Wear personal protective equipment (PPE): Safety Glasses



If applicable, do not lift unassisted



Wear personal protective equipment (PPE): Gloves



Wear personal protective equipment (PPE): Hearing Protection

Installation and Operation

To decrease the risk of damage to the equipment, you must obey the precautions that follow.



DANGER: General Hazard Warning!

This product can produce high forces and move at velocities that could cause injury. The user is responsible for its safe operation. The following general equation is provided to assist with risk assessments in regards to contact and pinch points:

$$Pressure_{Max} \left[\frac{N}{mm^2} \right] = \frac{Force_{Peak} [N]}{Area_{Contact} [mm^2]}$$



WARNING: General Hazard Warning!

- Only trained operators should operate this equipment.
- All service and maintenance must be done by approved personnel.
- Use this product only in environments and operating conditions that are approved in this manual.
- Never install or operate equipment that appears to be damaged.
- On stages with BMS motors: the motor over-temperature sensor must be monitored by the drive. Use it to shut down the drive if the motor overheats.
- Make sure that the product is securely mounted before you operate it.
- Make sure that all pneumatic lines are securely connected.
- Use care when you move the stage or you could negatively affect the performance of it.



WARNING: Trip Hazard!

Route, house, and secure all cables, duct work, air, or water lines. Failure to do so could introduce trip hazards around the system that could result in physical injury or could damage the equipment.

Electrical Warnings

To decrease the risk of electrical shock, injury, death, and damage to the equipment, obey the precautions that follow.



DANGER: Electrical Shock Hazard!

- Stage motor phase voltage levels could be hazardous live.
- Personnel are protected from hazardous voltages unless electrical interconnections, protective bonding (safety ground), or motor/stage enclosures are compromised.
- Do not connect or disconnect stage/motor interconnections while connected to a live electrical power source.
- Before you set up or do maintenance, disconnect electrical power.
- It is the responsibility of the End User/System Integrator to make sure that stages are properly connected and grounded per Engineering Standards and applicable safety requirements.
- It is the responsibility of the End User/System Integrator to configure the system drive or controller within the Aerotech motor/stage electrical and mechanical specifications.

Motor-Related Warnings

Aerotech motors are capable of producing high forces and velocities. Obey all warnings and all applicable codes and standards when you operate a system that incorporates Aerotech motors.



DANGER: Mechanical Hazard!

Personnel must be made aware of the mechanical hazards during set up or when you do service to the stage.



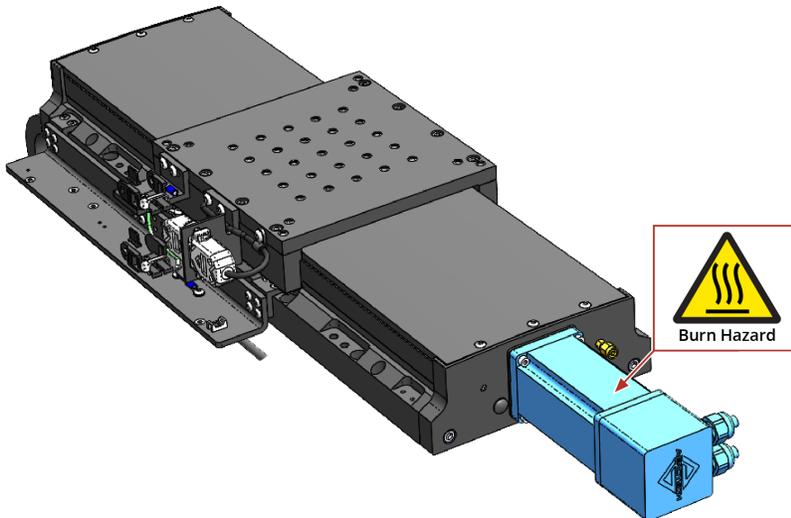
- Unintentional manual movement into the stage "end-of-travel" stops, could damage the stage or undo precision alignments.
- Stage movement could create pinch points, entanglement hazards, or rotational mechanical hazards.



DANGER: Hot Surface Hazard!

- The stage/motor frame temperature could exceed 70°C in some applications.
- Do not touch the stage/motor frame while it is in operation.
- Wait until the stage/motor has cooled before you touch it.

Figure 1: Motor Location



DANGER: Risk in Explosive Atmosphere!

- Standard Aerotech stage/motors are not rated for applications with explosive atmospheres such as airborne dust or combustible vapors.
- Do not operate stage/motors outside of Aerotech environmental specifications.



DANGER: Magnetic Field Hazard!

Aerotech stage/motors contain magnets which can present a Magnetic Field Hazard.

- Do not disassemble a stage motor under any circumstances.
- Strong magnetic fields could interfere with external/internal medical devices.
- Strong magnetic fields could present mechanical hazards such as pinch points.

Pinch Points

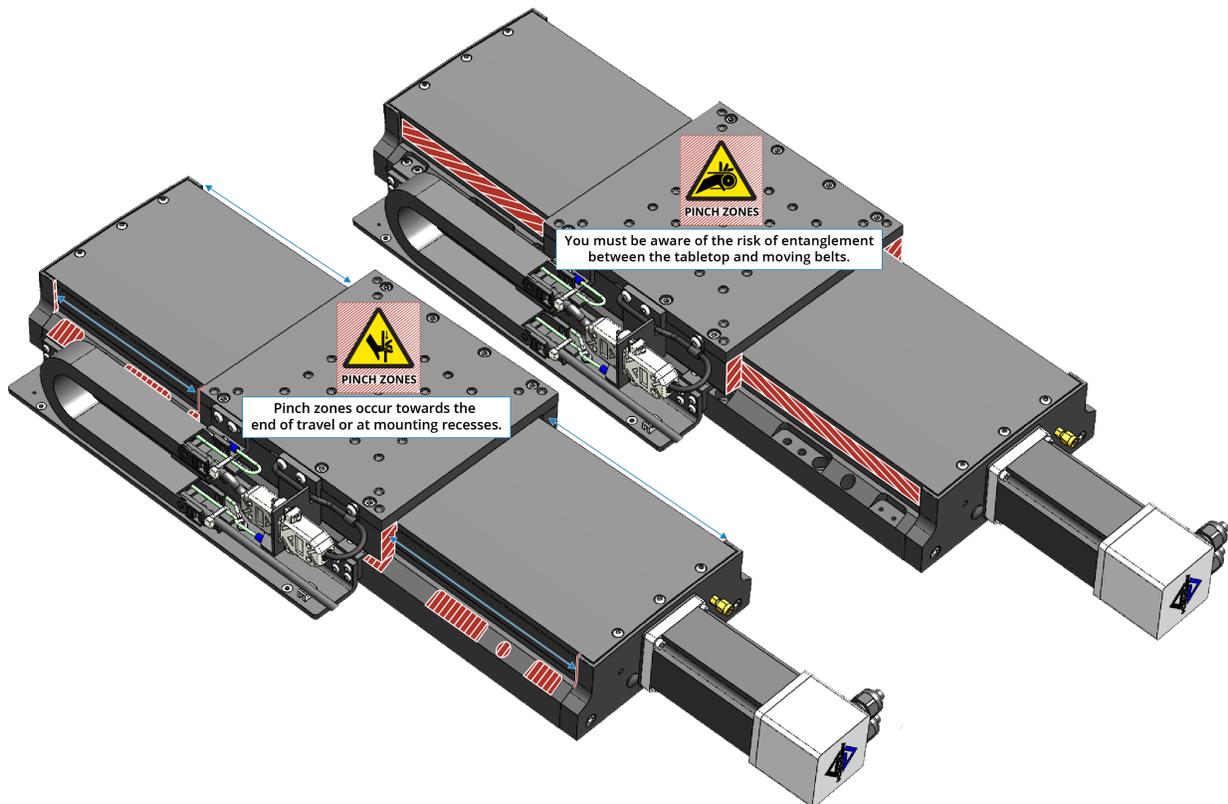
A pinch point is a mechanical hazard that can occur when there are exposed parts of the stage or system that can move. For example, the travel of a stage tabletop could expose the user to a pinch point between the tabletop and the stage housing. The images that follow will show you typical external and internal pinch point locations.

DANGER: Mechanical Hazard!



- System travel can cause crush, shear, or pinch injuries.
- Only trained operators should operate this equipment.
- Do not put yourself in the travel path of machinery.
- Restrict access to all motor and stage parts
 - when the system moves under power (during normal operation, for example).
 - when the system is moved manually (during the installation process or when you do maintenance, for example).
- Motors are capable of very high speeds and acceleration rates.

Figure 2: Typical Pinch Point Locations



Handling and Storage



IMPORTANT: It is the responsibility of the customer to safely and carefully lift and move the stage.

- Be careful when you move or transport the stage.
- Retain the shipping materials for future use.
- Transport or store the stage in its protective packaging.



WARNING: Electrostatic Discharge (ESD) Sensitive Components!

Wear an ESD wrist strap when you handle, install, or do service to the system assembly.

Failure to observe the correct ESD practices could cause ESD damage to stage electronics, system drives, and/or power supplies.

Inspect the shipping container for any evidence of shipping damage. If any damage exists, notify the shipping carrier immediately.

Remove the packing list from the shipping container. Make sure that all the items specified on the packing list are contained within the package.

The documentation for the stage is on the included installation device. The documents include manuals, interconnection drawings, and other documentation pertaining to the system. Save this information for future reference.

Each stage has a label listing the system part number and serial number. These numbers contain information necessary for maintenance or system hardware and software updates. Locate this label and record the information for later reference.

Unpacking and Handling

It is the responsibility of the customer to safely and carefully lift and move the stage.



IMPORTANT: All electronic equipment and instrumentation is wrapped in antistatic material and packaged with desiccant. Ensure that the antistatic material is not damaged during unpacking.



DANGER: Lifting Hazard! Use care when you move the stage or you could negatively affect the performance of it.

- Use the correct lifting techniques, mechanical assistance, or additional help to lift or move this product.
- Do not use the cables or the connectors to lift or move this product.
- Make sure that all moving parts are secure before you move the stage. Unsecured moving parts could shift and cause injury or damage to the equipment.
- If the stage is heavy, a single person lift could cause injury. Use assistance when you lift or move it.
 - Refer to [Section 2.1. Dimensions](#) for dimensions
 - Refer to [Section 1.3. Basic Specifications](#) for weight specifications.

Carefully remove the stage from its protective shipping container.

- Lift this product only by the base.
- Use lifting hardware if it has been provided (refer to [Figure 3](#)).
- For multi-axis assemblies, always lift the system by the lower axis.
- Use a cart, dolly, or similar device to move the stage to a new location.

Gently set the stage on a smooth, flat, and clean surface. Use compressed nitrogen or clean, dry, oil-free air to remove any dust or debris that has collected during shipping.

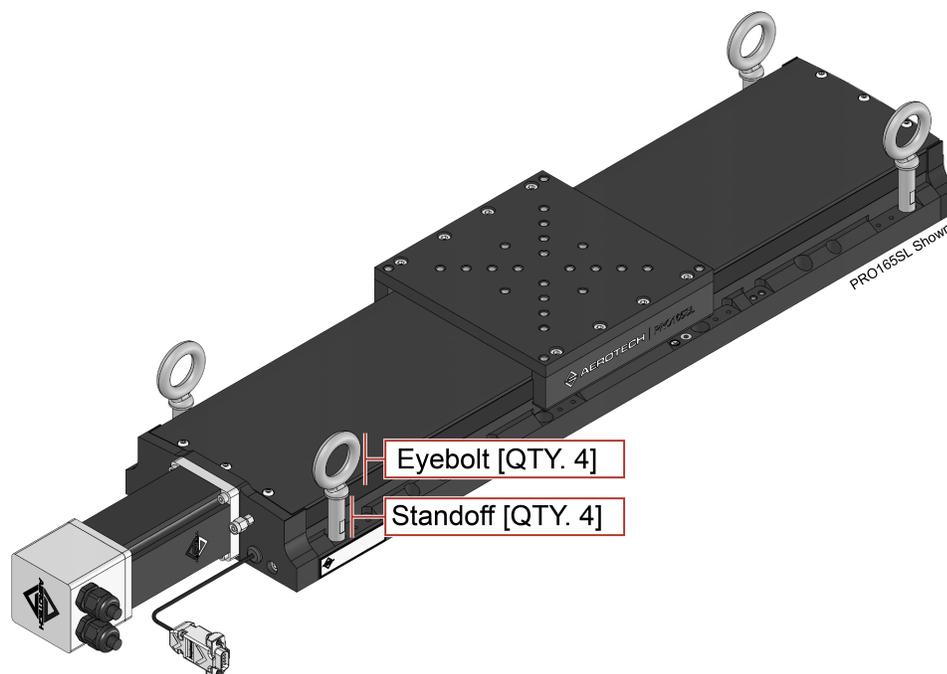
Before you operate the stage, let it stabilize at room temperature for at least 12 hours. This will ensure that all of the alignments, preloads, and tolerances are the same as they were when they were tested at Aerotech.

Each stage has a label listing the system part number and serial number. These numbers contain information necessary for maintenance or system hardware and software updates. Locate this label and record the information for later reference.

Lifting Features

The lifting kit includes four eyebolts and four standoffs. Thread the eyebolts onto the standoffs and thread the standoffs into the stage base. Remove the lifting hardware by turning a wrench on the flats of the standoffs (see [Figure 3](#)). If the stage is part of a multi-axis system, the lifting hardware should be attached to the lower axis. The lifting hardware must be removed before the stage can be operated.

Figure 3: Lifting Features



Storage

Store the stage in the original shipping container. If the original packaging included ESD protective packaging, make sure to store the stage in it. The storage location must be dry, free of dust, free of vibrations, and flat.

Refer to [Section 1.1. Environmental Specifications](#)

Chapter 1: Overview

The specifications in this manual pertain to the second generation of PRO SL/SLE stages. Second generation stages can be distinguished from their first generation counterparts by the curved hardcover on the second generation. Contact Aerotech if you need a first generation manual.

Table 1-1: Model Numbers and Ordering Options

PRO165SL and PRO165SLE Series Linear Ball-Screw Stage	
Direct Linear Feedback (-SLE only)	
-E1	Incremental linear encoder; 1 Vpp
-E2	Incremental linear encoder; 0.1 μ m digital RS422 output
-E3	Absolute linear encoder; EnDat 2.2
-E4	Incremental linear encoder; 0.5 μ m digital RS422 output
Travel (Required)	
-050	50 mm travel stage
-100	100 mm travel stage
-150	150 mm travel stage
-200	200 mm travel stage
-250	250 mm travel stage
-300	300 mm travel stage
-400	400 mm travel stage
-500	500 mm travel stage
-600	600 mm travel stage
Tabletop (Optional for SL Stages; Required for SLE Stages)	
-TT1	Tabletop with metric dimension mounting
-TT2	Tabletop with English dimension mounting
-TT3	Accessory tabletop with mounting for select rotary stages
-TT4	Tabletop with metric dimension mounting and wiper brushes
-TT5	Tabletop with English dimension mounting and wiper brushes
-TT6	Accessory tabletop with mounting pattern for select rotary stages and wipers
Motor (Optional)	
-M1	BMS100 brushless servomotor and 2500-Line Digital RS422 encoder
-M2	BMS100 brushless servomotor, 2500-Line Digital RS422 encoder, and brake
-M3	BMS100 brushless servomotor and 1000-Line 1 Vpp encoder
-M4	BMS100 brushless servomotor, 1000-Line 1 Vpp encoder, and brake
-M5	BM130 brushless servomotor, 2500-Line 1 Digital RS422 encoder, and brake
-M6	BM130 brushless servomotor, 2500-Line Digital RS422 encoder, and brake
-M7	BM130 brushless servomotor and 1000-Line 1 Vpp encoder
-M8	BM130 brushless servomotor, 1000-Line 1 Vpp encoder, and brake

PRO165SL and PRO165SLE Series Linear Ball-Screw Stage (continued)	
Foldback (Optional)	
-FB1	Foldback kit for 1/4" diameter shaft NEMA 23 motor
-FB2	Foldback kit with brake for 1/4" diameter shaft NEMA 23 motor
-FB3	Foldback kit for 3/8" diameter shaft NEMA 23 motor
-FB4	Foldback kit with brake for 3/8" diameter shaft NEMA 23 motor
NOTE: -TT1 option required for lower axis of XY when a foldback kit is used	
Motor Orientation (Optional)	
-2	Bottom cable exit, optional orientation
-3	Left-side cable exit, standard orientation
-4	Top cable exit, optional orientation
-5	Right-side cable exit, optional orientation
-8	Right-side foldback, standard orientation
-12	Left-side foldback, optional orientation
Limits (Required)	
-LI1	Normally-closed limit switches; 5 VDC with 9-pin D connector
-LI2	Normally-open limit switches; 5 VDC with 9-pin D connector
-LI3	Normally-closed limit switches; 24 VDC with 9-pin D connector
Coupling (Optional)	
-CP1	Coupling for 1/4" diameter shaft
-CP2	Coupling for 3/8" diameter shaft
Lifting Hardware (Optional)	
-LF	Lifting hardware
NOTE: Lifting option only available on travels 400 mm and greater. Lifting should never be ordered on the upper-axis of an XY set (only order on lower-axis).	
ThermoComp™ (Optional)	
-TCMP	ThermoComp™ integrated thermal compensation unit
NOTE: You must use an Automation1 or A3200 controller with the -TCMP option.	
Metrology (Required)	
-PL0	No metrology performance plots
-PL1	Uncalibrated with performance plots
-PL2	Calibrated with performance plots
Accessories (To be Ordered as a Separate Line Item)	
ALIGN-NPA	Non-precision XY assembly
ALIGN-NPAZ	Non-precision XZ or YZ assembly
ALIGN-PA10	XY assembly; 10 arc sec orthogonality; alignment to within 7 µm orthogonality for short travel stages
ALIGN-PA10Z	XZ or YZ assembly with L-bracket; 10 arc second orthogonality; alignment to within 10 µm orthogonality for short travel stages
ALIGN-PA5	XY assembly; 5 arc sec orthogonality; alignment to within 3 µm orthogonality for short travel stages
ALIGN-PA5Z	XZ or YZ assembly with L-bracket; 5 arc second orthogonality; alignment to within 5 µm orthogonality for short travel stages
HDZ165	Right angle L-bracket for 50 mm, 100 mm, and 150 mm travels only
NOTE: HDZ bracket requires a tabletop when mounting to a PRO series stage	

1.1. Environmental Specifications



WARNING: General Hazard Warning! Do not expose this product to environments or conditions outside of the listed specifications. You could damage the equipment if you exceed the environmental or operating specifications.



DANGER: Risk in Explosive Atmosphere!

- Standard Aerotech stage/motors are not rated for applications with explosive atmospheres such as airborne dust or combustible vapors.
- Do not operate stage/motors outside of Aerotech environmental specifications.

Table 1-2: Environmental Specifications

Ambient Temperature	Operating: 10 °C to 35 °C (50 °F to 95 °F)
	The optimal operating temperature is 20 °C \pm 2 °C (68 °F \pm 4 °F). If at any time the operating temperature deviates from 20 °C degradation in performance could occur.
	Storage: 0 °C to 40 °C (32 °F 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. Floor or acoustical vibration can affect system performance. Contact Aerotech for information regarding your specific application.
Protection Rating	These stages have limited protection against dust, but not water. This equates to an ingress protection rating of IP50.
Use	Indoor use only

1.2. Accuracy and Temperature Effects

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

The accuracy specification of stage 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 2.2](#).

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 Automation1 or 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

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

Table 1-3: PRO165SL/SLE Series Specifications (-050 to -250)

		-050	-100	-150	-200	-250	
Travel		50 mm	100 mm	150 mm	200 mm	250 mm	
Accuracy ⁽¹⁾	SL	Standard	±6 μm	±6 μm	±8 μm	±8 μm	±9 μm
		Calibrated	±1 μm	±1.25 μm	±1.5 μm	±1.75 μm	±2 μm
	SLE	Standard	±3 μm	±4 μm	±6 μm	±8 μm	±9 μm
		Calibrated	±1 μm	±1 μm	±1 μm	±1.5 μm	±1.5 μm
Resolution (Minimum Incremental Motion)	SL	0.1 μm ⁽²⁾ , 1.0 μm ⁽³⁾					
	SLE	0.05 μm (-E1/-E3 encoder), 0.2 μm (-E2 encoder), 1.0 μm (-E4 encoder)					
Bidirectional Repeatability ⁽¹⁾	SL	±1 μm					
	SLE	±0.5 μm					
Horizontal Straightness ⁽¹⁾		±1.5 μm	±2.5 μm	±3 μm	±4 μm	±5 μm	
Vertical Straightness ⁽¹⁾		±1.5 μm	±2.5 μm	±3 μm	±4 μm	±5 μm	
Pitch		19 μrad (3.9 arc-sec)	29 μrad (6 arc-sec)	29 μrad (6 arc-sec)	39 μrad (8 arc-sec)	49 μrad (10.1 arc-sec)	
Roll		19 μrad (3.9 arc-sec)	29 μrad (6 arc-sec)	29 μrad (6 arc-sec)	39 μrad (8 arc-sec)	49 μrad (10.1 arc-sec)	
Yaw		19 μrad (3.9 arc-sec)	29 μrad (6 arc-sec)	29 μrad (6 arc-sec)	39 μrad (8 arc-sec)	49 μrad (10.1 arc-sec)	
Ball Screw Lead		5 mm/rev					
Maximum Speed ⁽⁴⁾		300 mm/s					
Maximum Acceleration ⁽⁴⁾		Function of motor, amplifier, payload, and maximum axial load					
Load Capacity ⁽⁵⁾	Horizontal	45 kg					
	Vertical (Axial)	25 kg					
	Side	45 kg					
Moving Mass (with tabletop)	SL	2.3 kg					
	SLE	2.4 kg					
Stage Mass (no motor)	SL	5.6 kg	6.1 kg	6.6 kg	7.1 kg	7.6 kg	
	SLE	6.2 kg	6.7 kg	7.3 kg	7.8 kg	8.3 kg	
Material		Anodized Aluminum					
Mean Time Before Failure (MTBF)		20,000 Hours					
<p>1. Certified with -PL1 and -PL2 option.</p> <p>2. Achieved with Aerotech rotary motor with amplified sine encoder.</p> <p>3. Achieved with Aerotech rotary motor with 2500 counts/rev digital encoder.</p> <p>4. Requires the selection of an applicable amplifier with sufficient voltage and current.</p> <p>5. Axis orientation for on-axis loading is listed.</p> <p>6. Specifications are for single-axis systems measured 25 mm above the tabletop; performance of multi-axis system depend upon the payload and workpoint. Consult the Aerotech factory for multi-axis or non-standard applications.</p> <p>7. Specifications listed are non-foldback kit options. Contact the factory for specifications when a foldback kit (-FBx) is used.</p>							

Table 1-4: PRO165SL/SLE Series Specifications (-300 to -600)

			-300	-400	-500	-600
Travel			300 mm	400 mm	500 mm	600 mm
Accuracy ⁽¹⁾	SL	Standard	±10 µm	±12 µm	±14 µm	±16 µm
		Calibrated	±2.5 µm	±3 µm	±3.5 µm	±4 µm
	SLE	Standard	±10 µm	±12 µm	±14 µm	±15.5 µm
		Calibrated	±1.5 µm	±1.5 µm	±2 µm	±2 µm
Resolution (Minimum Incremental Motion)	SL	0.1 µm ⁽²⁾ , 1.0 µm ⁽³⁾				
	SLE	0.05 µm (-E1/-E3 encoder), 0.2 µm (-E2 encoder), 1.0 µm (-E4 encoder)				
Bidirectional Repeatability ⁽¹⁾	SL	±1 µm				
	SLE	±0.5 µm	±0.5 µm	±0.75 µm	±0.75 µm	
Horizontal Straightness ⁽¹⁾			±6 µm	±8 µm	±9 µm	±10 µm
Vertical Straightness ⁽¹⁾			±6 µm	±8 µm	±9 µm	±10 µm
Pitch			58 µrad (12 arc-sec)	70 µrad (14.4 arc-sec)	80 µrad (16.5 arc-sec)	90 µrad (18.6 arc-sec)
Roll			58 µrad (12 arc-sec)	70 µrad (14.4 arc-sec)	80 µrad (16.5 arc-sec)	90 µrad (18.6 arc-sec)
Yaw			58 µrad (12 arc-sec)	70 µrad (14.4 arc-sec)	80 µrad (16.5 arc-sec)	90 µrad (18.6 arc-sec)
Ball Screw Lead			5 mm/rev			
Maximum Speed ⁽⁴⁾			300 mm/s			
Maximum Acceleration ⁽⁴⁾			Function of motor, amplifier, payload, and maximum axial load			
Load Capacity ⁽⁵⁾	Horizontal		45 kg			
	Vertical (Axial)		25 kg			
	Side		45 kg			
Moving Mass (with tabletop)	SL		2.3 kg			
	SLE		2.4 kg			
Stage Mass (no motor)	SL		8.1 kg	9.1 kg	10.1 kg	11.1 kg
	SLE		8.9 kg	9.9 kg	11.0 kg	12.0 kg
Material			Anodized Aluminum			
Mean Time Before Failure (MTBF)			20,000 Hours			
<p>1. Certified with -PL1 and -PL2 option.</p> <p>2. Achieved with Aerotech rotary motor with amplified sine encoder.</p> <p>3. Achieved with Aerotech rotary motor with 2500 counts/rev digital encoder.</p> <p>4. Requires the selection of an applicable amplifier with sufficient voltage and current.</p> <p>5. Axis orientation for on-axis loading is listed.</p> <p>6. Specifications are for single-axis systems measured 25 mm above the tabletop; performance of multi-axis system depend upon the payload and workpoint. Consult the Aerotech factory for multi-axis or non-standard applications.</p> <p>7. Specifications listed are non-foldback kit options. Contact the factory for specifications when a foldback kit (-FBx) is used.</p>						

1.4. Vacuum Operation

There are two vacuum preparation options:

- Low Vacuum (for use in environments from atmospheric pressure, down to 10^{-3} Torr)
- High Vacuum (for use in environments from 10^{-3} Torr, down to 10^{-6} Torr)

Special preparations include:

- Parts are lubricated with vacuum-compatible lubricants.
- Materials, fasteners, and coatings are selected to be compatible with the specified level of vacuum.
- High-vacuum systems are designed to eliminate trapped volumes.
- Prior to assembly, stage parts are thoroughly cleaned in a clean environment.
- The stage is packaged in a special polyethylene bag.

Vacuum Guidelines

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

1. Do not remove the stage from its sealed bag until it is ready to use.
2. Always handle the stage in a clean environment and use powder-free polyethylene gloves to prevent any contaminants from adhering to the surface of the stage.
3. During installation, use cleaned, vented, stainless steel fasteners to secure the stage.
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. We recommend that you use a small quantity of **Braycote® 602EF** grease or a compatible substitute of equal quality lubricant in vacuum applications.
6. To reduce outgassing during the initial pump-down to vacuum pressure, Aerotech recommends that you bake out vacuum systems when you first install them into the vacuum chamber. Bake the vacuum components at 60 °C for 24 to 48 hours to desorb water vapor from surfaces and degas polymers (such as cable insulation).

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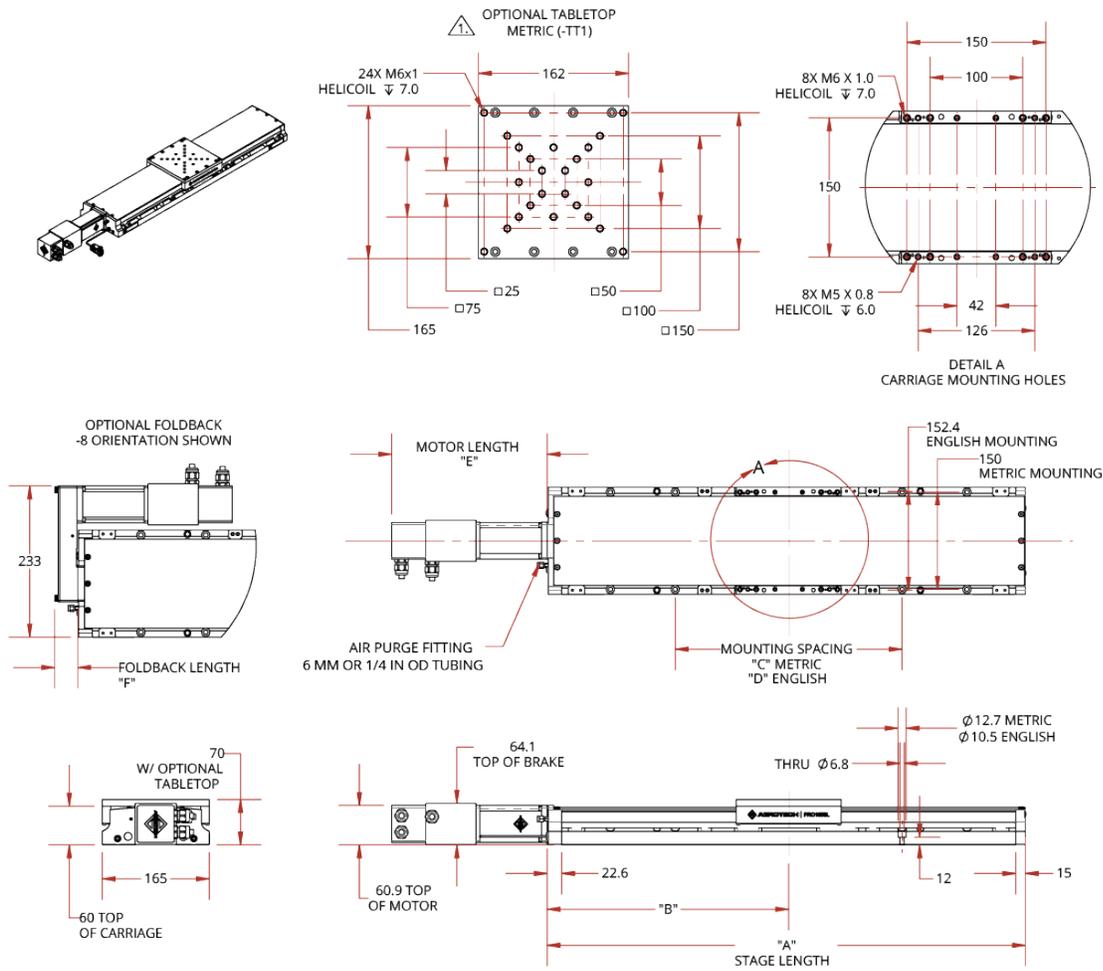
Chapter 2: Installation



IMPORTANT: The stage installation must be in accordance with the 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. Dimensions

Figure 2-1: PRO165SL Dimensions



OPTION	DIMENSION E
-M5, -M7	162.3
-M6, -M8	239.5
-M1, -M3	162.3
-M2, -M4	239.5
	F
-FB1, -FB3	35.4
-FB2, -FB4	73.5

BASIC MODEL	NOMINAL TRAVEL	ELEC LIMIT TRAVEL	MECH LIMIT TRAVEL	A	B	C	D
PRO165SL-050	50	58.4-63.2	75.3	287.6	147.6	150	152.4
PRO165SL-100	100	109.2-114	125.3	337.6	172.6	150	152.4
PRO165SL-150	150	160-164.8	175.3	387.6	197.6	150	152.4
PRO165SL-200	200	210.8-215.6	225.3	437.6	222.6	150, 350	152.4
PRO165SL-250	250	261.6-266.4	275.3	487.6	247.6	150, 350	152.4, 406.4
PRO165SL-300	300	312.4-317.2	325.3	537.6	272.6	150, 350	152.4, 406.4
PRO165SL-400	400	414-418.8	425.3	637.6	322.6	150, 350, 550	152.4, 406.4
PRO165SL-500	500	515.6-519	525.3	737.6	372.6	150, 350, 550	152.4, 406.4
PRO165SL-600	600	617.2-619	625.3	837.6	422.6	150, 350, 550, 750	152.4, 406.4, 660.4

NOTES:

1. -TT1 TABLETOP OPTION REQUIRED FOR LOWER AXIS OF XY ASSEMBLIES WHEN FOLDBACK OPTION IS CHOSEN.
2. DIMENSIONS: MILLIMETERS.



Figure 2-2: PRO165SL Tabletop Dimensions (-TT2/-TT3 Option)

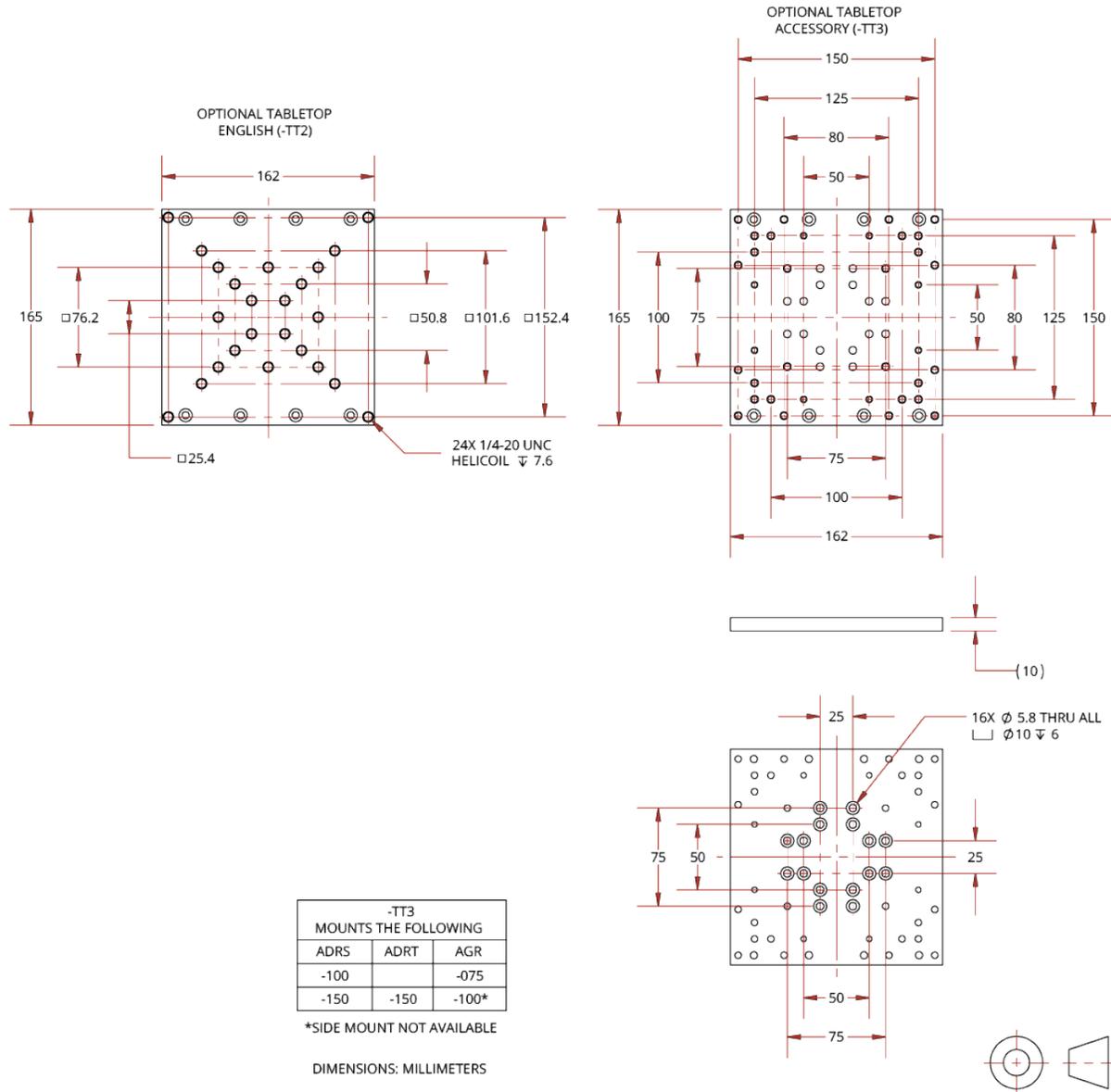
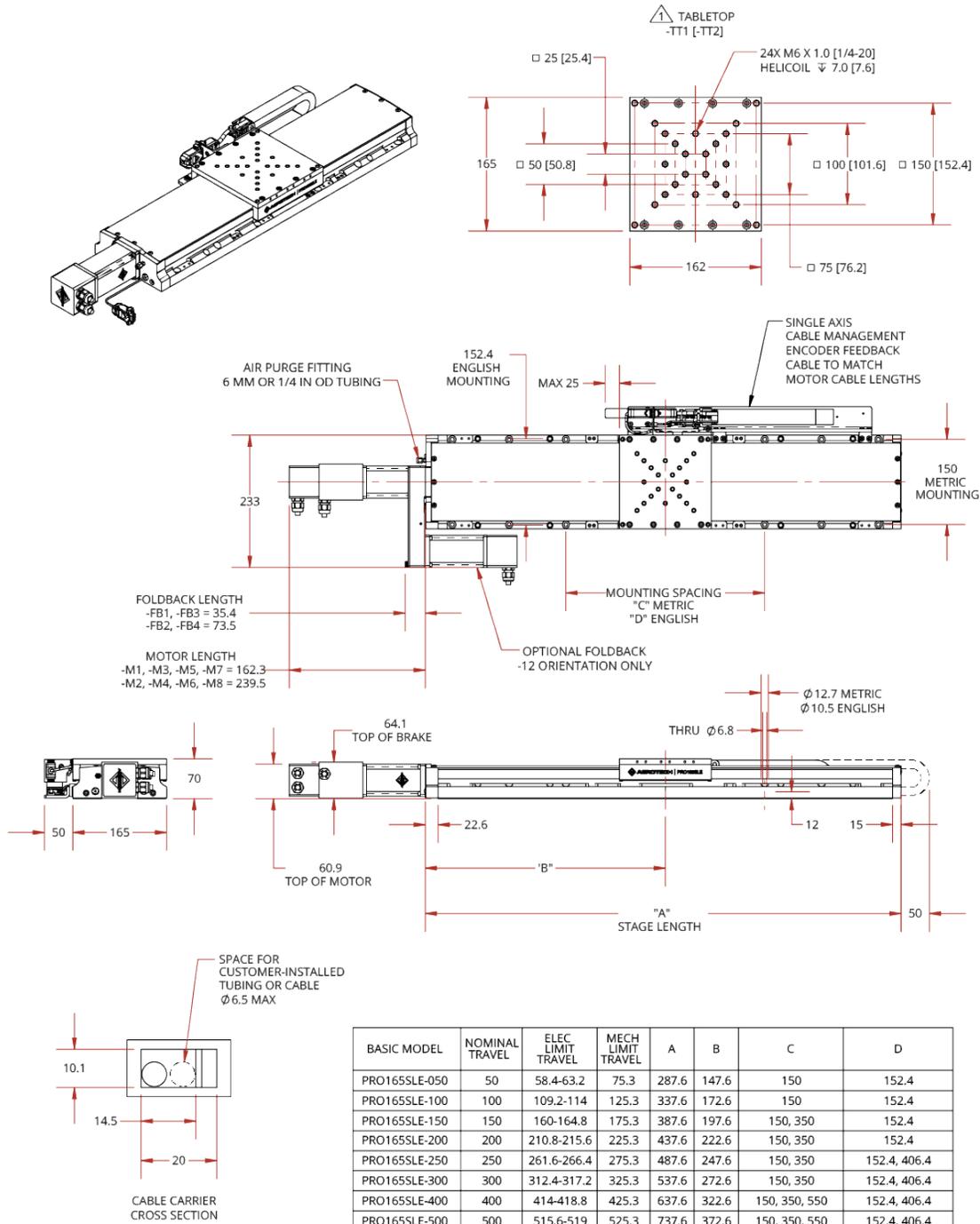


Figure 2-3: PRO165SLE Dimensions



NOTES:

△ -TT1 TABLETOP OPTION REQUIRED FOR LOWER AXIS OF XY ASSEMBLIES WHEN FOLDBACK OPTION IS CHOSEN.

2. DIMENSIONS: MILLIMETERS.

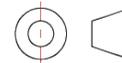


Figure 2-4: PRO165SLE Tabletop Dimensions (-TT3 Option)

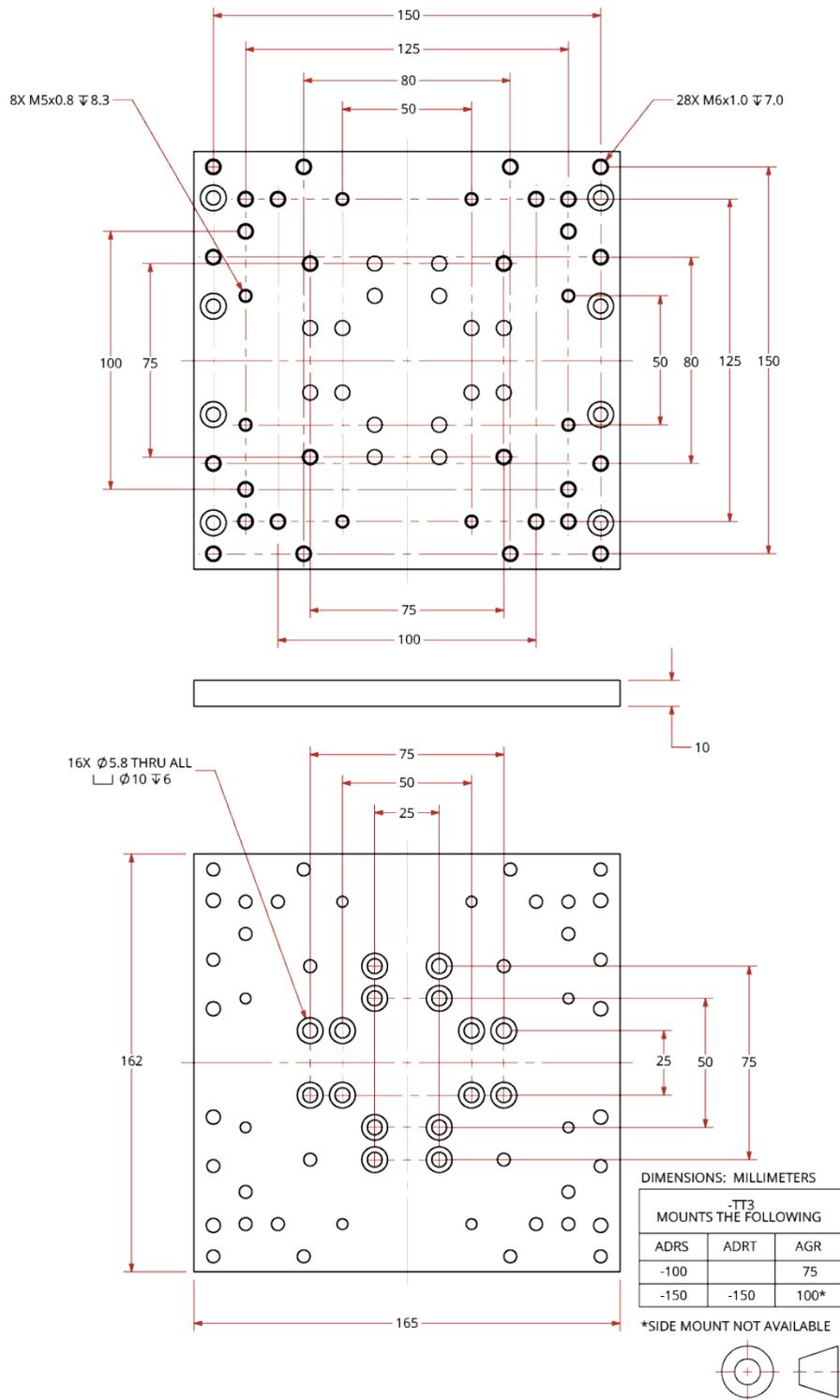
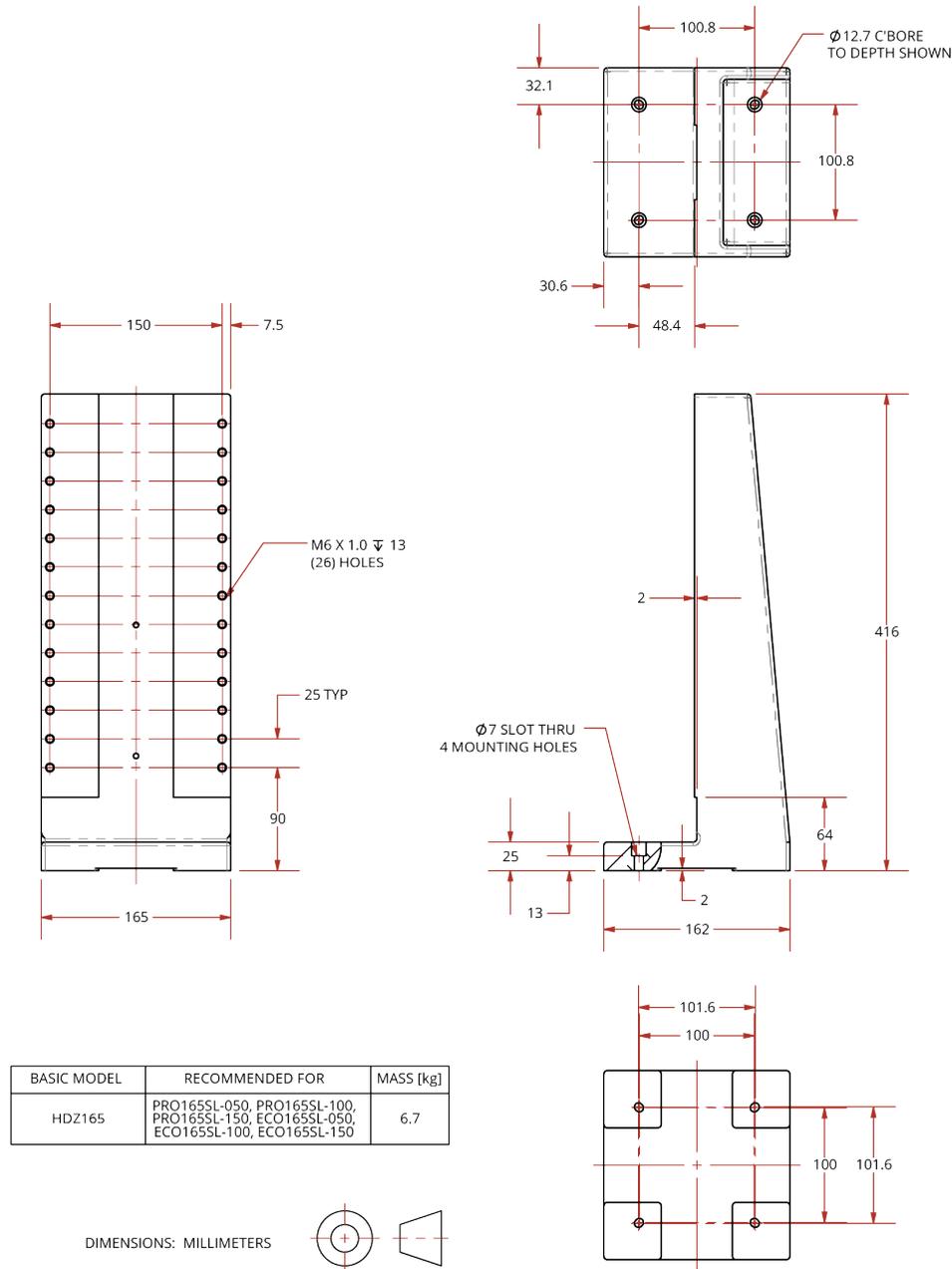


Figure 2-5: Z-Axis Bracket Dimensions



BASIC MODEL	RECOMMENDED FOR	MASS [kg]
HDZ165	PRO165SL-050, PRO165SL-100, PRO165SL-150, ECO165SL-050, ECO165SL-100, ECO165SL-150	6.7



2.2. Securing the Stage to the Mounting Surface



DANGER: Mechanical Hazard!

Personnel must be made aware of the mechanical hazards during set up or when you do service to the stage.

- Do not manually move the stage if it is connected to a power source.
- The stage must be mounted securely. Improper mounting can result in injury and damage to the equipment.
- When you move the tabletop manually to do maintenance, this could expose the operator to pinch points. Refer to [Pinch Points](#) on [Page 12](#).

The mounting surface must be flat and have adequate stiffness to achieve the maximum performance from the 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.



IMPORTANT: The stage 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 stage. 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 μ m

If necessary, manually move the stage table to access the mounting holes along the edges of the stage. This stage is designed to use socket head cap screws (SHCS) to secure the base to the mounting surface.



IMPORTANT: The stage table may offer a considerable amount of resistance when it is moved manually.

- Do not attempt to manually move the stage if it is connected to a power source or includes an integrated brake.

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 2.1](#) for 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]

2.3. Attaching the Payload to the Table Top or Carriage

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. Gently place the stage on the mounting surface.

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: Electrical Installation](#) and the documentation delivered with the stage.



IMPORTANT: If your PRO165SL/SLE was purchased with Aerotech controls, it could have been tuned with a representative payload based on the information provided at the time of order. If you start the PRO165SL/SLE 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.

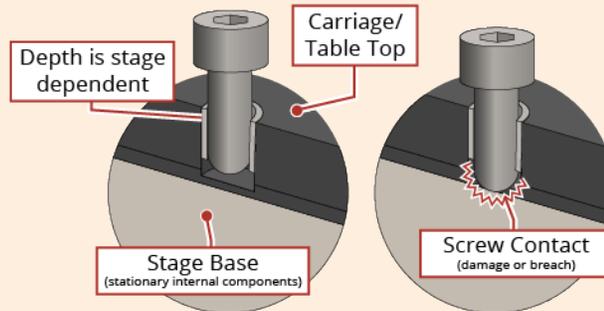
Table 2-3: Payload Mounting Surface Flatness Requirement

Stage Travel	Flatness Requirement
All Travels	12 μ m

WARNING: General Hazard Warning!

Be careful when you attach the payload to stage table top or carriage mounting surfaces.

- If a mounting screw extends through the table top/carriage, it can affect travel and damage the stage.
- Refer to the dimensions in [Section 2.1](#) for maximum allowable thread engagement.
- **Mounting Hole Cutaway:**



Applied loads should be symmetrically distributed whenever possible. The payload should be centered on the stage mounting surface 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 (refer to Figure 2-6).

The **Vertical** curve is for situations where the stage is mounted in a vertical orientation and the payload is mounted to the table top with its center of gravity extended outward in a direction normal to the tabletop 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 tabletop.

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 tabletop surface.

Measure the cantilever length, then find the corresponding load value from Figure 2-7.

Figure 2-6: Stage Orientations

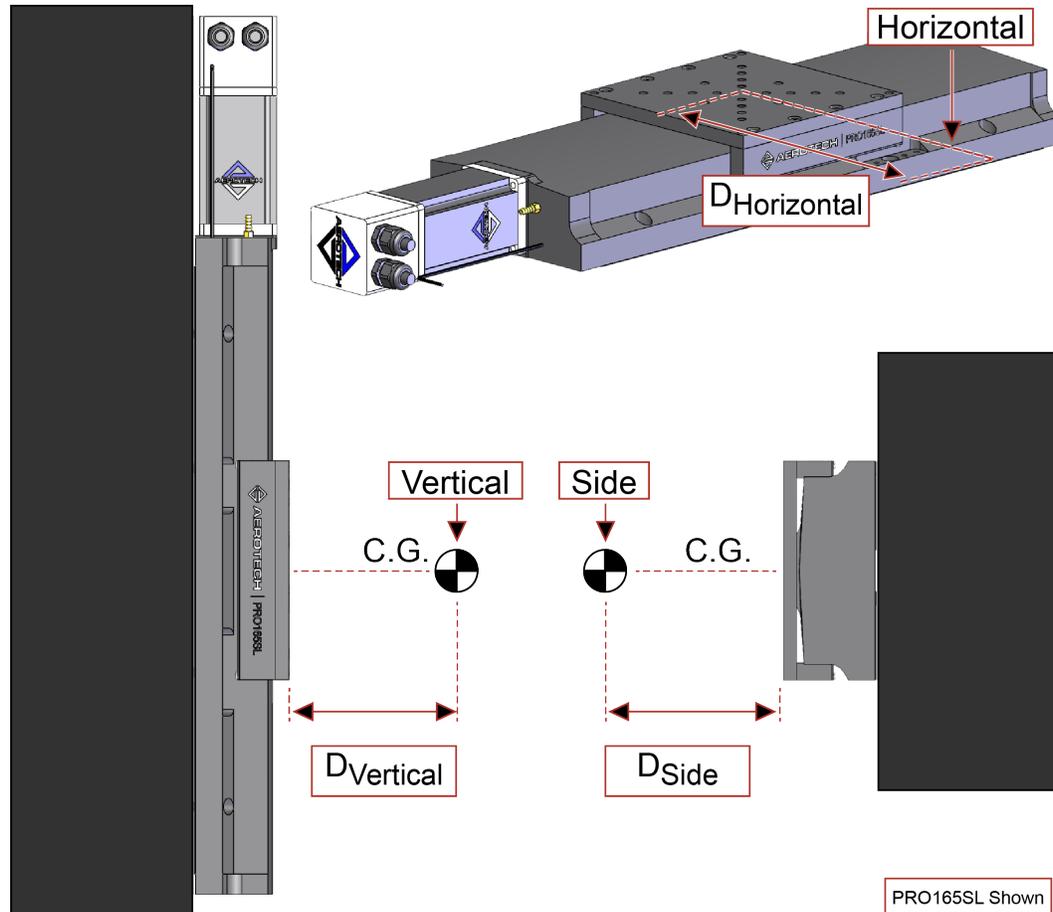
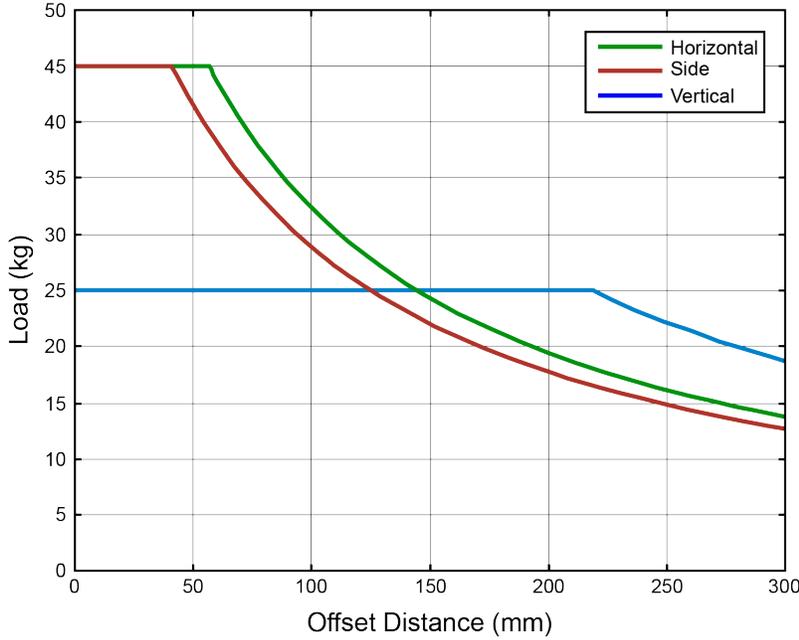


Figure 2-7: Cantilevered Load Capability



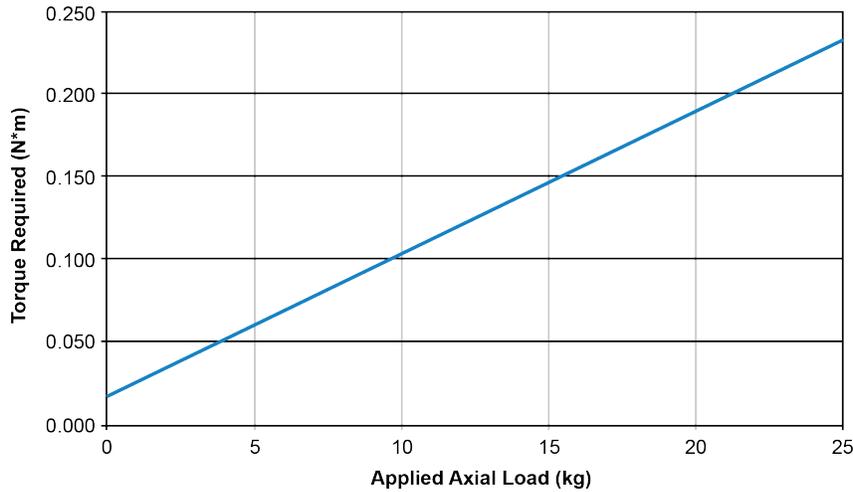
The approximate amount of torque required to turn the ball screw of PRO165SL/SLE series stages can be found from [Figure 2-9](#) or the following equation:

Figure 2-8: Load Torque Equation

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

For PRO165SL/SLE series stages, the ball screw efficiency is rated at 90% (0.90).

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



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Chapter 3: Electrical Installation

DANGER: Electrical Shock Hazard!



- Stage motor phase voltage levels could be hazardous live.
- Personnel are protected from hazardous voltages unless electrical interconnections, protective bonding (safety ground), or motor/stage enclosures are compromised.
- Do not connect or disconnect stage/motor interconnections while connected to a live electrical power source.
- Before you set up or do maintenance, disconnect electrical power.
- It is the responsibility of the End User/System Integrator to make sure that stages are properly connected and grounded per Engineering Standards and applicable safety requirements.
- It is the responsibility of the End User/System Integrator to configure the system drive or controller within the Aerotech motor/stage electrical and mechanical specifications.

WARNING: General Hazard Warning!



Applications that require access to the PRO165SL/SLE must be restricted to qualified and trained personnel. The system integrator or qualified installer is responsible for determining and meeting all safety and compliance requirements when they integrate the PRO165SL/SLE into a completed system. Failure to do so could expose the operator to electrical or mechanical hazards.

Electrical installation requirements will depend on the ordered product options. Installation instructions in this section are for Aerotech products equipped with standard Aerotech motors intended for use with an Aerotech motion control system. Contact Aerotech for further information on products that are otherwise configured.

Aerotech motion control systems are adjusted at the factory for optimum performance. When the PRO165SL/SLE is part of a complete Aerotech motion control system, setup should only require that you connect the stage to the appropriate drive chassis with the cables provided. Labels on the system components should indicate the appropriate connections.

If system level integration was purchased, an electrical drawing that shows the 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.



IMPORTANT: Refer to the controller documentation to adjust servo gains for optimum velocity and position stability.

3.1. Motor and Feedback Connectors

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



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



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

The protective ground connection of the PRO165SL/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: Electrical Shock Hazard!

- The protective ground connection must be properly installed to minimize the possibility of electric shock.
- The stage controller must provide over-current and over-speed protection. Failure to do so could cause electric shock or damage to the equipment.

Table 3-1: Brushless Motor Connector Pinout

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: Mating Connector Part Numbers for the Brushless Motor Connector

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

Table 3-3: Brushless Motor Feedback Connector Pinout

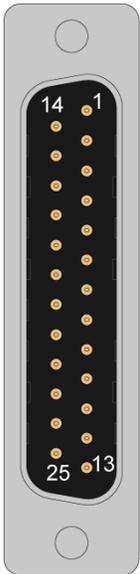
Pin	Description	Connector
Case	Shield Connection	
1	Reserved	
2	BMS Motors: Over-Temperature Thermistor Sensor	
	BM Motors: Reserved	
3	5V Power Supply Input	
4	Reserved	
5	Hall Effect Sensor (Phase B)	
6	MRK- (Encoder Marker-)	
7	MRK+ (Encoder Marker+)	
8	Reserved	
9	Reserved	
10	Hall Effect Sensor (Phase A)	
11	Hall Effect Sensor (Phase C)	
12	Reserved	
13	Reserved	
	Brake - (with Brake Option)	
14	COS+ (Encoder Cosine+)	
15	COS- (Encoder Cosine-)	
16	Reserved	
17	SIN+ (Encoder Sine+)	
18	SIN- (Encoder Sine-)	
19	Reserved	
20	Common ground (PIN 20 is internally connected to PIN 21)	
21	Common ground (PIN 21 is internally connected to PIN 20)	
22	Reserved	
23	Reserved	
24	Reserved	
25	Reserved	
	Brake + (with Brake Option)	

Table 3-4: Mating Connector Part Numbers for the Brushless Motor Feedback Connector

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

Table 3-5: Linear Encoder Connector Pinout (-SLE only)

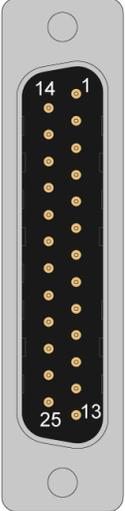
Pin	-E1, -E2, and -E4 Encoder Option	-E3 Encoder Option	Connector
Case	Shield Connection	Shield Connection	
1	Reserved	Reserved	
2	Reserved	Reserved	
3	+5 V power supply	+5 V power supply	
4	Reserved	Reserved	
5	Reserved	Reserved	
6	Marker-N	Clock -	
7	Marker	Clock +	
8	Reserved	Data -	
9	Reserved	Reserved	
10	Reserved	Reserved	
11	Reserved	Reserved	
12	Reserved	Reserved	
13	Reserved	Reserved	
14	Cosine	Reserved	
15	Cosine-N	Reserved	
16	+5 V power supply	+5 V power supply	
17	Sine	Reserved	
18	Sine-N	Reserved	
19	Reserved	Data +	
20	Common ground	Common ground	
21	Common ground	Common ground	
22	Reserved	Reserved	
23	Reserved	Reserved	
24	Reserved	Reserved	
25	Reserved	Reserved	

Table 3-6: Mating Connector Part Numbers for the Encoder Connector

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

Table 3-7: Limit Connector Wiring

Pin	Description	Limits Connector
Case	Shield Connection	
1	-LI1/-LI2 Option: 5V Power Supply Limit Input -LI3 Option: 24V Power Supply Limit Input	
2	Limit Common	
3	+Limit/CW (Positive/Clockwise Travel Limit)	
4	Home Limit	
5	-Limit/CCW (Negative/Counterclockwise Limit)	
6	Reserved	
7	Common ground	
8	Reserved	
9	Reserved	

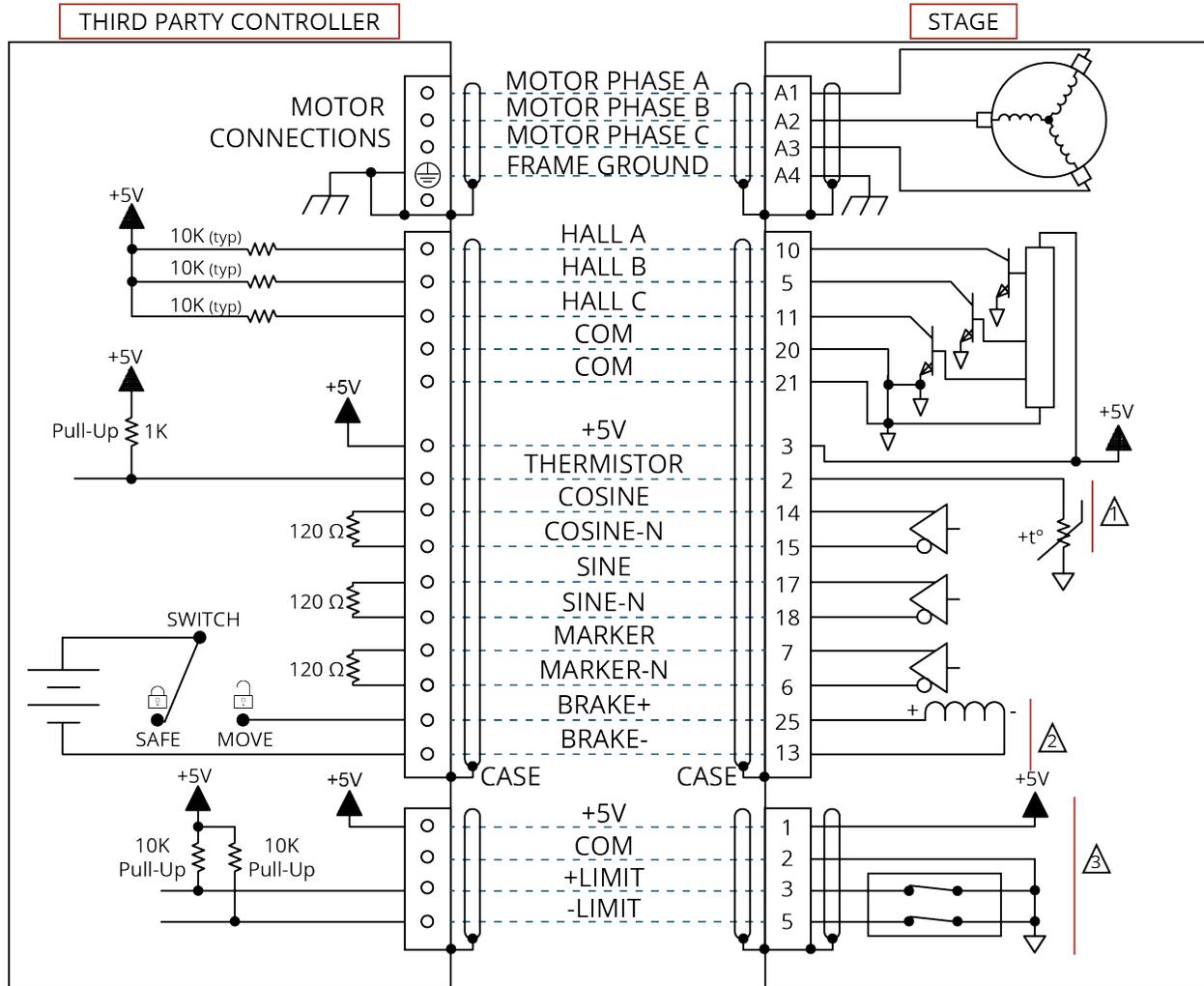
Table 3-8: Mating Connector Part Numbers for the Limit Connector

Mating Connector	Aerotech P/N	Third Party P/N
9-Pin D-Connector	ECK00340	FCI DE09S064TLF
Backshell	ECK01021	Amphenol 17E-1724-2

3.2. Motor and Feedback Wiring

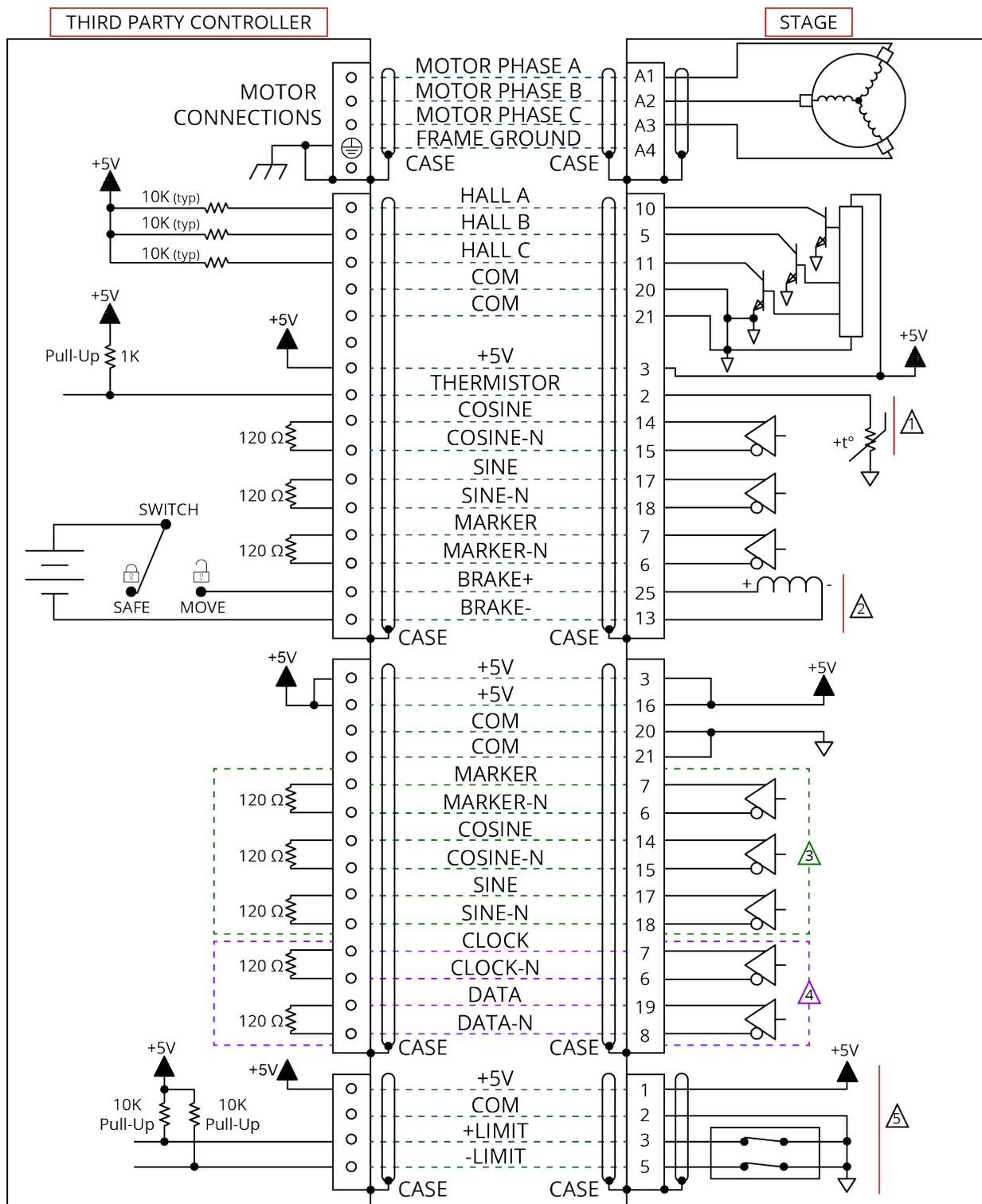
Shielded cables are required for the motor and feedback connections.

Figure 3-1: Brushless Motor and Feedback Wiring [-SL Option]



-  Thermistor is only available on BMS motors.
-  Brake is optional.
-  Limit options are factory-configured as normally closed or normally open.

Figure 3-2: Brushless Motor and Feedback Wiring [-SLE Option]



- ⚠ Thermistor is only available on BMS motors.
- ⚠ -E3 Encoder Option ONLY.
- ⚠ Brake is optional.
- ⚠ Limit options are factory-configured as normally closed or normally open.
- ⚠ -E1, -E2, -E4 Encoder Option ONLY.

3.3. Motor and Feedback Specifications



IMPORTANT: All 5 V supplies share one common connection within the stage.

Table 3-9: Hall-Effect Sensor Specifications

	Specification
Supply Voltage	5 V \pm 5%
Supply Current	50 mA
Output Type	Open Collector
Output Voltage	24 V max (pull up)
Output Current	5 mA (sinking)

Table 3-10: Thermistor Specifications (BMS Motor Options)

	Specification
Polarity	Logic "0" (no fault)
	Logic "1" (over-temperature fault)
Cold Resistance	\sim 100 Ω
Hot Resistance	\sim 10 K
Note: 1K pull-up to +5V recommended.	

Table 3-11: Encoder Specifications

	Specification
Supply Voltage	5 V \pm 5%
Supply Current	250 mA (typical)
Output Signals (Differential)	Sinusoidal Type (Incremental Encoder): Analog: SIN+, SIN-, COS+, COS-, 1V _{pk-pk} ; Digital (RS422): MRK+, MRK- signals.
	Digital Output (Incremental Encoder): TTL Encoder line-driver signals; RS422/485 compatible
	Serial Output (Absolute Encoder): EnDat 2.2 with 36 bit word

Table 3-12: Rotary Encoder Resolution Specifications

Encoder Option	Fundamental Signal Period	Digital Resolution
-M1, -M2, -M5, -M6 (2500 line TTL signal)	2 μ m	0.5 μ m
-M3, -M4, -M7, -M8 (1000 line 1Vpp Amplified Sine signal)	5 μ m	--
-M3, -M4, -M7, -M8 with 1000x Interpolation ⁽¹⁾ (1000 line 1Vpp Amplified Sine signal)	5 μ m	5 nm
-M3, -M4, -M7, -M8 with 4000x Interpolation ⁽¹⁾ (1000 line 1Vpp Amplified Sine signal)	5 μ m	1.25 nm
1. Quadrature decoding included in interpolated resolution calculations		

Table 3-13: Linear Encoder Resolution Specifications

Encoder Option	Fundamental Signal Period	Digital Resolution
-E1	20 μ m	--
-E1 with x4000 Interpolation ⁽¹⁾	20 μ m	5 nm
-E1 with x16000 Interpolation ⁽¹⁾	20 μ m	1.25 nm
-E2	20 μ m	100 nm
-E3	--	1 nm
-E4	20 μ m	0.5 μ m

1. Quadrature decoding included in interpolated resolution calculations

Table 3-14: Limit Switch Specifications

	-LI1 Option	-LI2 Option	-LI3 Option
Supply Voltage	5 V	5 V	24 V
Supply Current	25 mA		
Output Type	Open Collector		
Output Voltage	5 V	5 V	24 V
Output Current	10 mA (sinking)	10 mA (sinking)	10 mA (sourcing)
Output Polarity (Factory Configured)	Normally Closed (NC) <ul style="list-style-type: none"> Not In Limit: Sinks current to ground (Logic "0") In Limit: High impedance (Logic "1") 	Normally Open (NO) <ul style="list-style-type: none"> Not In Limit: High impedance (Logic "1") In Limit: Sinks current to ground (Logic "0") 	Normally Closed (NC) <ul style="list-style-type: none"> Not In Limit: 24 V output In Limit: High impedance

Notes:

- If you drive the PRO165SL/SLE beyond the electrical limit, it will encounter a mechanical stop. An impact against the mechanical stop could cause damage to the stage.
- LI1 and -LI2 must have an external pull-up to +5 V (10 k Ω recommended).

Table 3-15: Brake Specifications

	Specification
Supply Voltage	24 VDC
Supply Current (typical)	250 mA (current required to release the brake and allow motion)

Table 3-16: PRO165SL/SLE Motor Specifications (BMS100)

		BMS100
Performance Specifications		
Continuous Stall Torque	N·m	0.59
Peak Torque	N·m	2.4
Rated Power	W	146.7
Electrical Specifications		
BEMF Constant (Line-Line)	V/krpm	34.0
Continuous Current, Stall	A	2.1
Peak Current, Stall	A	8.4
Torque Constant	N·m/A	0.281
Motor Constant	N·m/ \sqrt{W}	0.077
Resistance, 25 °C (Line-Line)	Ω	13.60
Inductance (Line-Line)	mH	3.40
Thermal Resistance	°C/W	1.28
Maximum DC Bus Voltage	V	340
Number of Poles	--	8
Maximum Coil Temperature	°C	100
<p>(1) Performance is dependent upon heat sink configuration, system cooling conditions, and ambient temperature.</p> <p>(2) Values shown at maximum coil temperature, with housed motor mounted to a 250x250x6 mm aluminum heat sink.</p> <p>(3) Peak torque assumes correct rms current; consult Aerotech.</p> <p>(4) Torque constant and motor constant specified at stall.</p> <p>(5) All performance and electrical specifications have a tolerance of $\pm 10\%$.</p> <p>(6) Ambient operating temperature range 0 °C - 25 °C; consult Aerotech for performance in elevated ambient temperatures.</p> <p>(7) All Aerotech motors and amplifiers are rated using vector amplitude values. For sinusoidal signals, use sine wave peak value.</p>		

Table 3-17: PRO165SL/SLE Motor Specifications (BM130)

		BM130
Performance Specifications		
Stall Torque, Continuous	N·m	1.02
Peak Torque	N·m	2.50
Rated Power Output, Continuous	W	333
Electrical Specifications		
BEMF Constant (Line-Line, Max)	V/krpm	19.0
Continuous Current, Stall	A	6.9
Peak Current, Stall	A	17.
Torque Constant	N·m/A	0.15
Motor Constant	N·m/ \sqrt{W}	0.101
Resistance, 25 °C (Line-Line)	Ω	2.00
Inductance (Line-Line)	mH	3.52
Maximum Bus Voltage	VDC	340
Thermal Resistance	°C/W	1.04
Maximum Coil Temperature	°C	130
Number of Poles	--	8
<p>(1) Performance is dependent upon heat sink configuration, system cooling conditions, and ambient temperature.</p> <p>(2) All performance and electrical specifications have a tolerance of $\pm 10\%$.</p> <p>(3) Values shown at maximum coil temperature, with housed motor mounted to a 305x305x12.7 mm³ aluminum heat sink.</p> <p>(4) Peak torque assumes correct rms current; consult Aerotech.</p> <p>(5) Torque constant and motor constant specified at stall.</p> <p>(6) Ambient operating temperature range 0 °C - 25 °C; consult Aerotech for performance in elevated ambient temperatures.</p> <p>(7) All Aerotech motors and amplifiers are rated using vector amplitude values. For sinusoidal signals, use sine wave peak value.</p>		

3.4. Limits, Marker, and Machine Direction

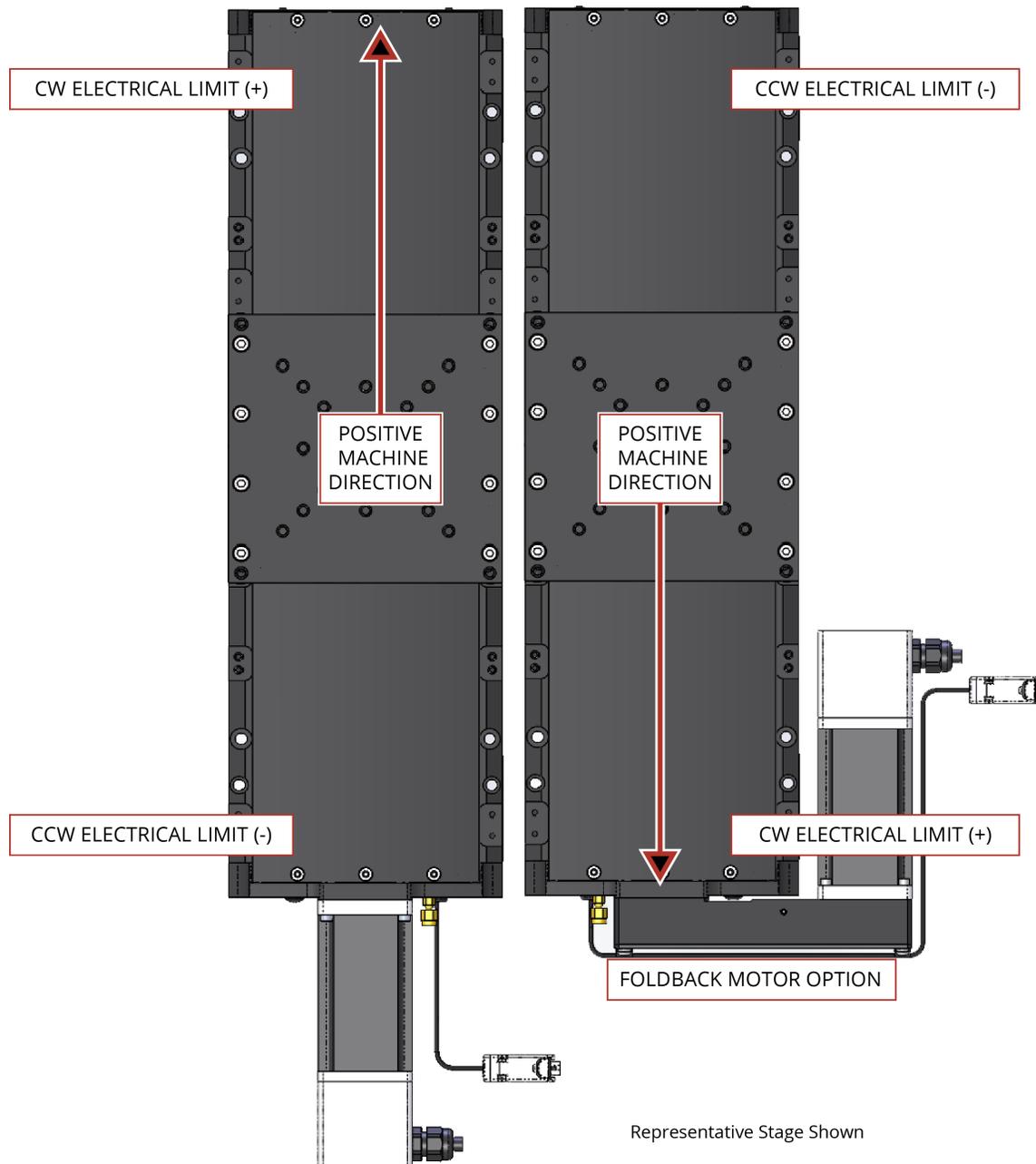
Aerotech stages have both a positive and negative **Machine Direction** and a positive and negative **Programming Direction**.

Machine Direction: The machine direction is defined by how the encoder and motor are mounted and the electrical wiring connections in the stage.

Programming Direction: Your system controller defines the programming direction of the stage and is application specific. A positive programmed move may or may not agree with the machine positive direction. Refer to your programming help documentation for more information.

The home marker is located near the center of travel on stages with a linear encoder (SLE models). For stages without the linear encoder option (SL models), the marker is located in the rotary motor and will be triggered near the designated home limit.

Figure 3-3: Machine Direction



3.5. Motor and Feedback Phasing

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

Figure 3-4: Hall Phasing Diagram

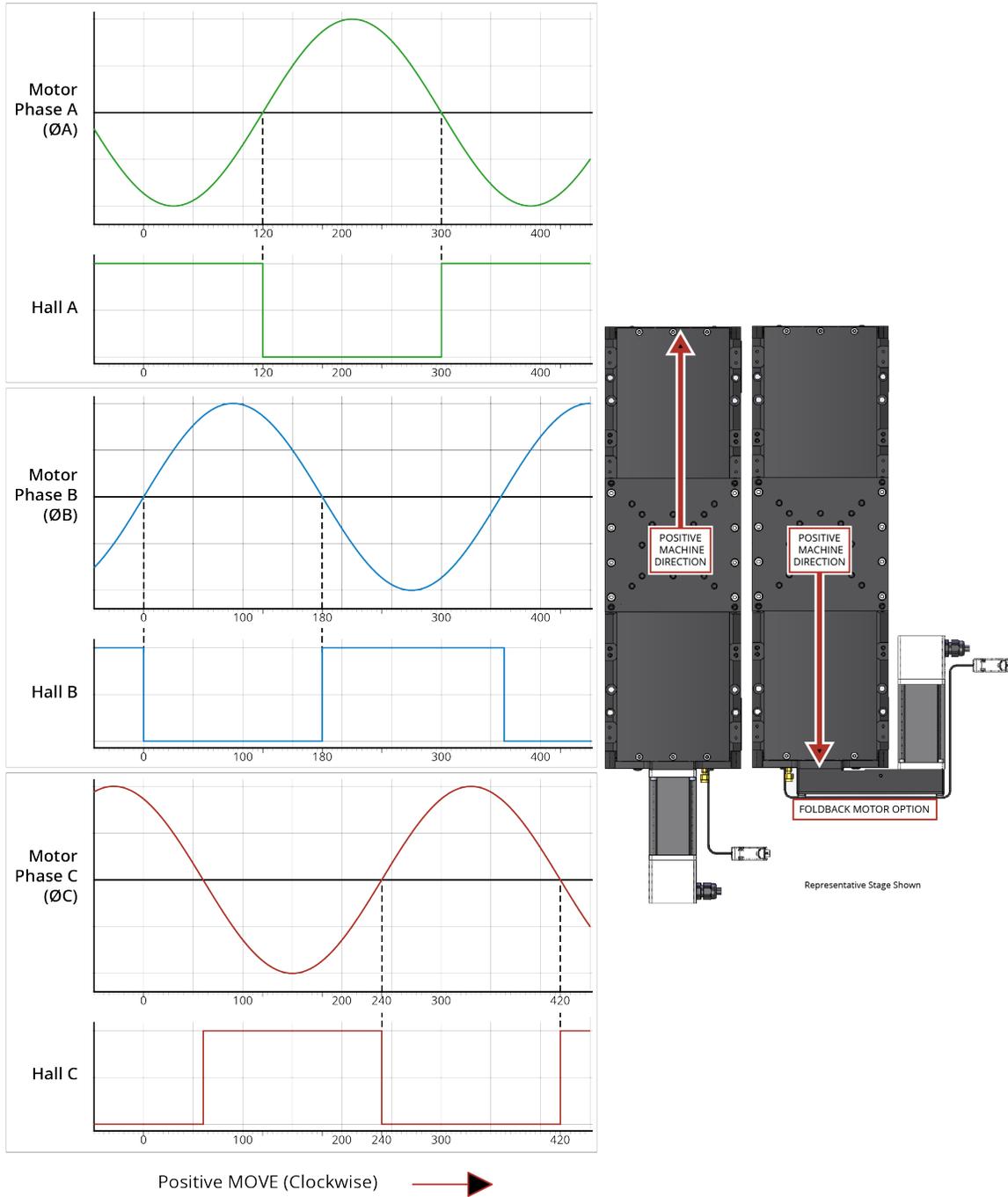


Figure 3-5: Encoder Phasing Reference Diagram (Standard/Square Wave)

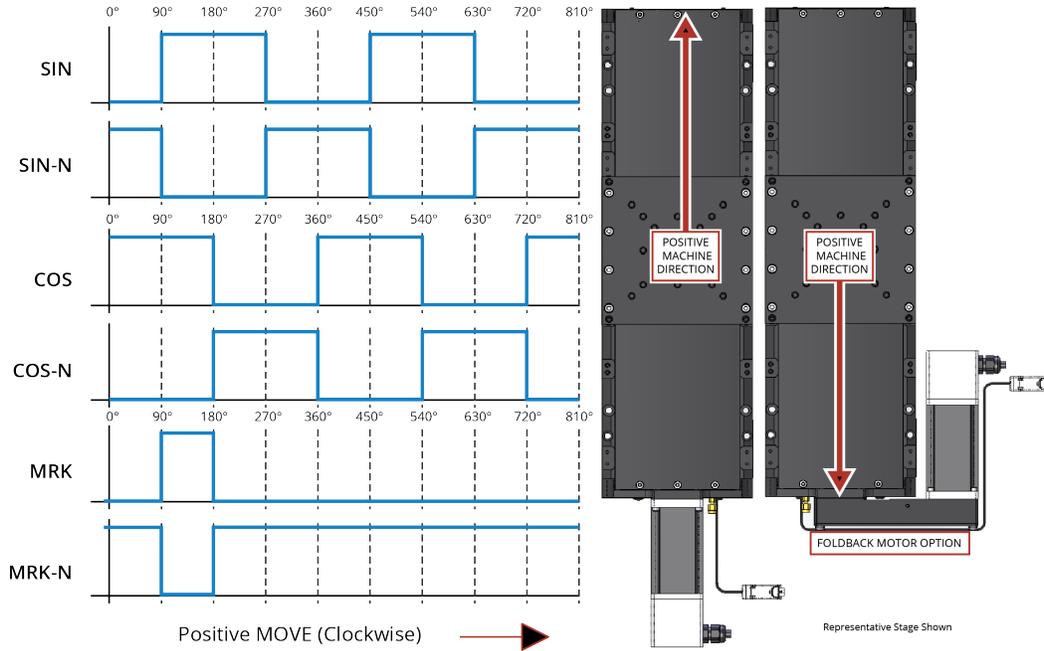
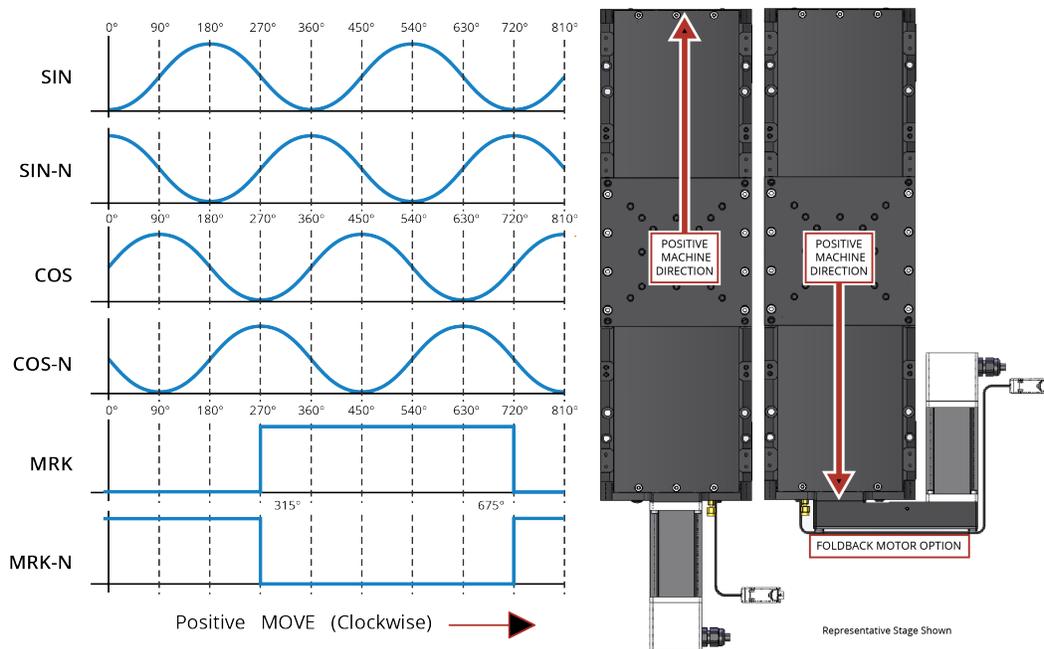


Figure 3-6: Encoder Phasing Reference Diagram (Sine Wave)



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Chapter 4: Maintenance



IMPORTANT: Read the [Safety Procedures and Warnings](#) (on [Page 8](#)) before you do maintenance to the stage.



IMPORTANT: Keep the bearing area free of foreign matter and moisture or the performance and life expectancy of the stage will be reduced.

4.1. Service and Inspection Schedule

Inspect the PRO165SL/SLE at least once per month. The need for a longer or shorter inspection interval will depend on the application and conditions, such as the duty cycle, speed, and environment.

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 PRO165SL/SLE and any components and cables as needed.
- Repair any damage before operating the PRO165SL/SLE.
- Inspect and perform an operational check on all safeguards and protective devices.

4.2. Cleaning and Lubrication



DANGER: Electrical Shock Hazard! Before you do maintenance to the equipment, disconnect the electrical power.



IMPORTANT: Wear appropriate personal protective equipment (PPE) when you use cleaning solvents or lubricants.

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

When you clean and/or lubricate components of the PRO165SL/SLE series stage:

1. Use a clean, dry, soft, lint-free cloth for cleaning.
2. Before you use a cleaning solvent on any part of the stage, 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 can be lost if the stage tables of the support stages are loosened. Precision aligned stages should not be loosened or disassembled.
5. We recommend that you do not disassemble the stage beyond the instructions given in this manual. Proper assembly and calibration can only be done at the factory. Contact Aerotech for more information.

For stages equipped with foldback motors, you should check the belt tension when you clean or lubricate the stage. Refer to [Section 4.5](#).

Cleaning

Use isopropyl alcohol if you must use a solvent to clean the stage. Harsher solvents, such as acetone, could damage the plastic and rubber seals on the ball screw and bearing trucks.



WARNING: General Hazard Warning! Make sure that all solvent has completely evaporated before you move the stage.

Lubrication

You should only use Kluberplex BEM 34-132 as the standard lubricant for PRO165SL/SLE **second generation** stages. Second generation stages can be distinguished from first generation stages by the curved hardcover on the second generation stage.



IMPORTANT: First Generation stages were manufactured with THK AFE-CA grease as the standard lubricant. THK AFE-CA grease is not chemically compatible with Kluberplex BEM 34-132 and the two should not be used interchangeably. First generation stages in the field should continue to use THK AFE-CA grease for regular maintenance lubrication.

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.



IMPORTANT: During the lubrication procedure, inspect the bearings and ball screw for any damage or signs of wear.



DANGER: Mechanical Hazards!

Use extreme caution when you operate the stage without the hardcover.



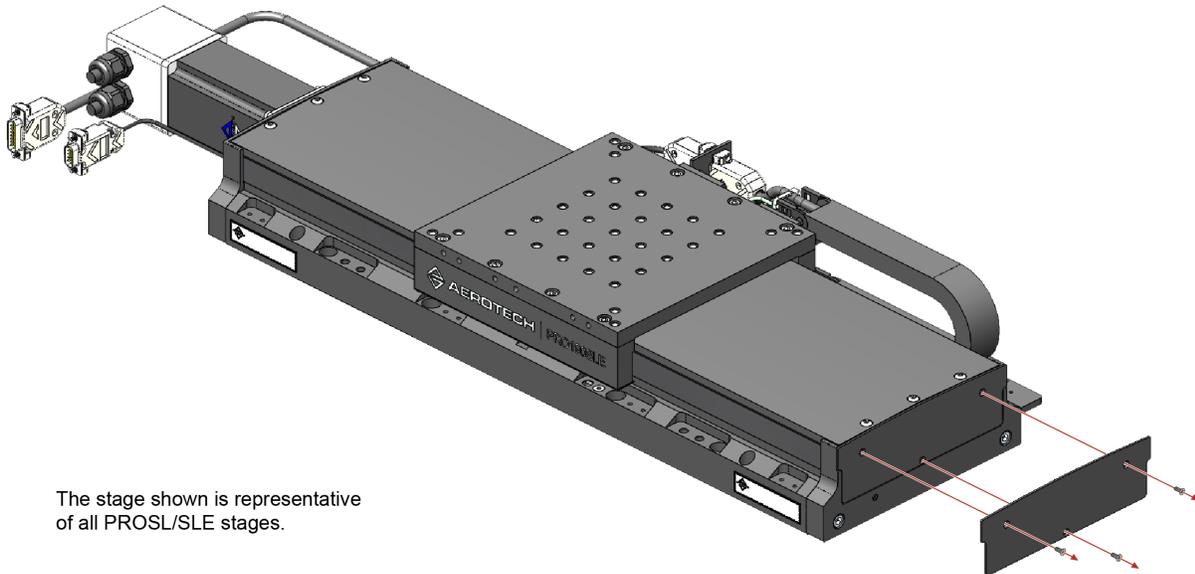
- **Entanglement Hazard!** The side belts can present an entanglement hazard.



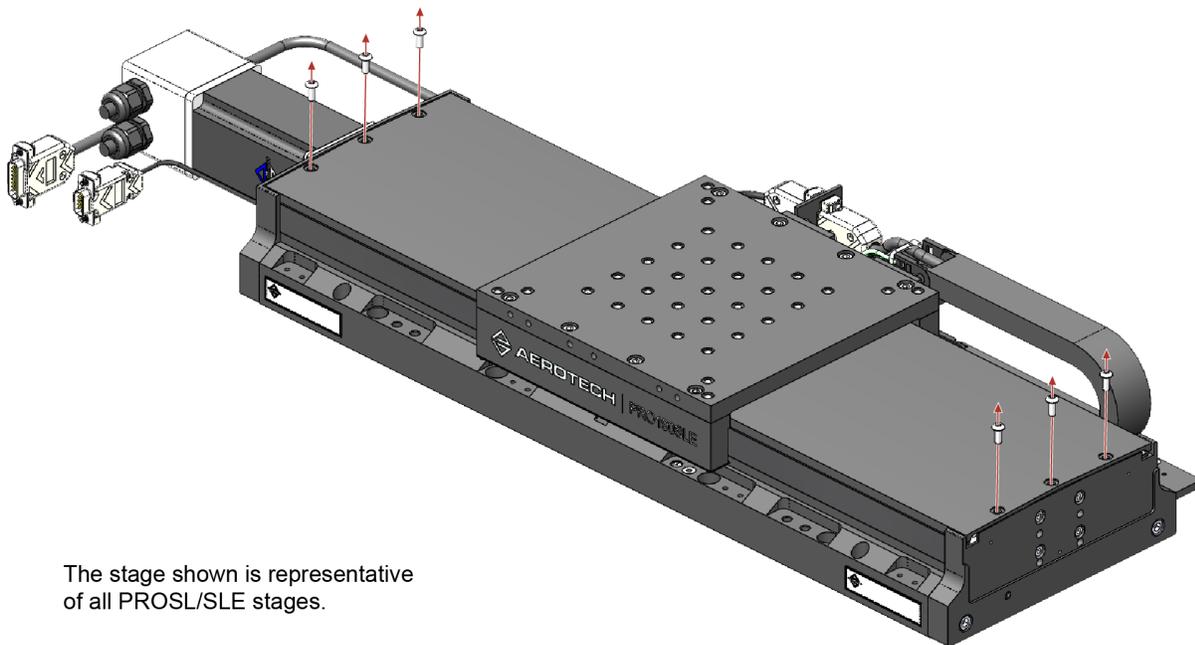
- **Rotating Machinery!** The ball screw can present a rotating machinery hazard.

- **Pinch Point!** The stage tabletop can present a pinch hazard.

1. Drive the stage table to one end of travel and remove power to the stage.
2. Remove the cover attached to the rear end plate on the side opposite of the motor (Figure 4-1).
3. Remove the hardcover screws (Figure 4-2).
4. Carefully slide the hardcover away from the stage (Figure 4-3). This can be done without removing the table.
5. Remove any accumulated dust or debris from the inside of the assembly.
6. Remove any dirty or dried lubricant from the ball screw.
 - Use a clean, lint-free cloth with a side-to-side motion.
 - Use a swab soaked in Isopropyl Alcohol to remove stubborn debris.
7. Move the stage to the opposite end of travel. If the stage has an optional brake, the stage cannot be moved by hand.
 - If the stage has a brake: restore power to the stage, drive it to the desired position, then remove power
 - Redo Steps 5 and 6 for any areas covered by the previous table position.
8. Clean the end of the ball-screw nut and wiper with a clean, lint-free cloth or swab.
9. Clean the linear bearing guides with a clean, lint-free cloth or swab.
10. Apply a thin, continuous film of lubricant to the ball-screw threads and linear bearing guides. Aerotech recommends that you use a good quality, natural bristle artist's brush.
11. Move the stage to the opposite end of travel. If the stage has an optional brake, the stage cannot be moved by hand.
 - If the stage has a brake: restore power to the stage, drive it to the desired position, then remove power.
 - Redo Steps 8 through 10 for any areas covered by the previous table position.
12. Refasten the hardcover.
13. Restore power to the stage and drive the stage table back to its original position to redistribute lubricants.

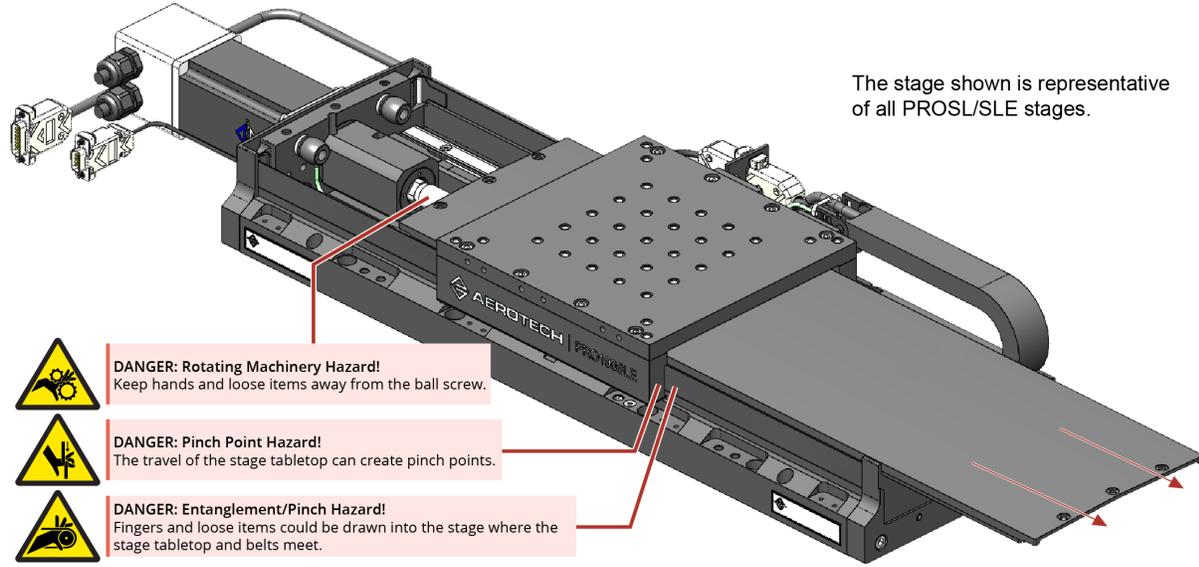
Figure 4-1: Hardcover Rear End Plate Removal

The stage shown is representative of all PROSL/SLE stages.

Figure 4-2: Hardcover Screw Removal

The stage shown is representative of all PROSL/SLE stages.

Figure 4-3: Hardcover Removal



4.3. Motor Mounting



DANGER: Electrical Shock Hazard!

- Do not connect or disconnect electrical components, wires, and cables while this product is connected to a power source.
- Before you do maintenance to the equipment, disconnect the electrical power.
- Uncouple or otherwise prevent motion of motor-coupled machinery when you do service to the equipment.

Table 4-1: Hardware Requirements

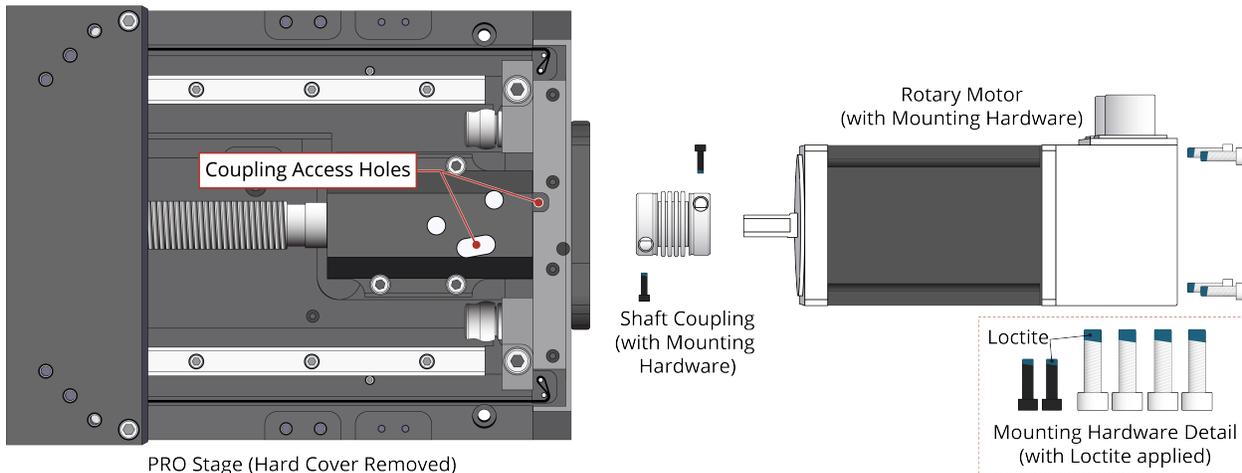
Stage	Motor Screw Size	Shaft Coupling Screw Size	Coupling Screw Bit Size	Coupling Screw Torque	Special Coupling Hardware
PRO165SL/SLE (GEN 1)	M4	M2.5	T8 Torx	7 in·lbs	MIH01258
PRO165SL/SLE (GEN 2)	M4	M2.5	2 mm Hex	7 in·lbs	N/A



IMPORTANT: Use Loctite 242 or Loctite 248 on the motor and coupling adapter hardware (Figure 4-4). Loctite products are printed with an expiration date. Before use, be sure that the expiration date is legible and the product has not expired.

If your stage is used in a vacuum or cleanroom environment, contact Aerotech.

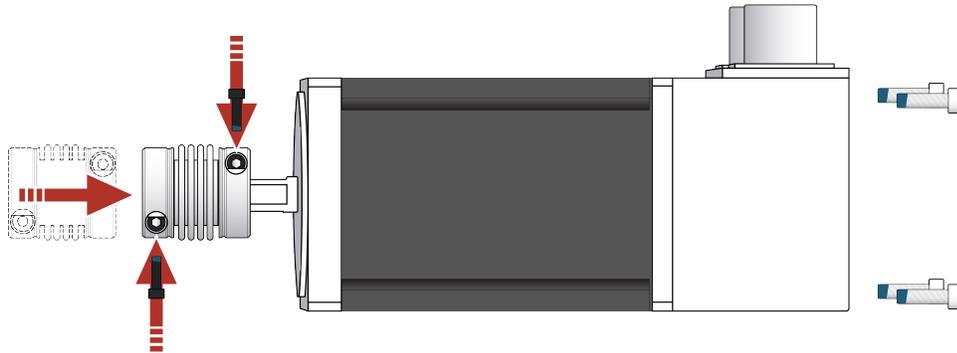
Figure 4-4: Motor Mounting Overview



How to Mount a Motor

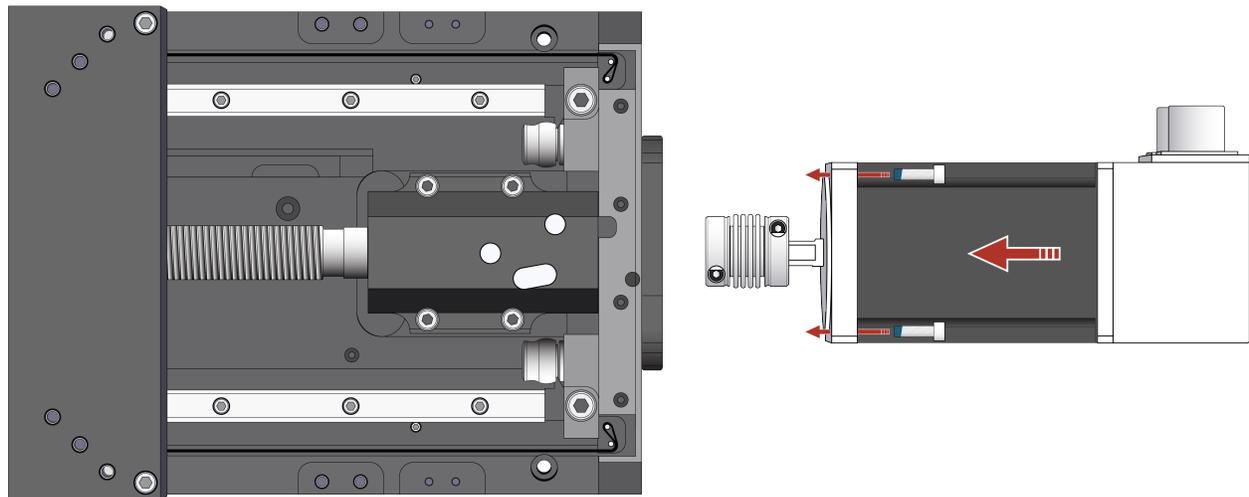
1. Remove the hard cover from the stage.
2. Locate the Shaft Coupling access holes (refer to [Figure 4-4](#)).
3. Test fit the Motor and Shaft Coupling to the Stage to ensure that you have access to the Shaft Coupling clamp screws.
4. Apply a small quantity of either Loctite 242 or Loctite 248 to motor and coupling hardware.
5. Attach the Shaft Coupling to the Motor shaft (refer to [Figure 4-5](#)). Refer to [Table 4-1](#) for the correct hardware and torque requirements.

Figure 4-5: Attach the Coupling Adapter to the Motor Shaft



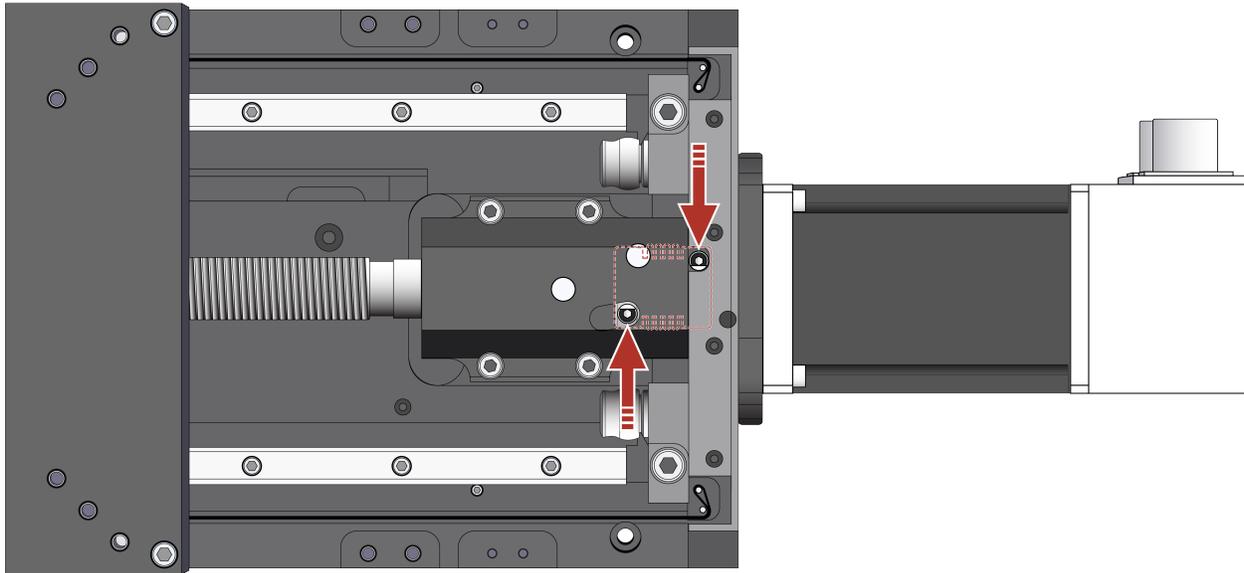
6. Attach the Motor to the Stage in the correct orientation ([Figure 4-6](#)). Use a hex wrench to ensure that the motor flange is fully seated and the hardware is tight. The motor housing prevents the use of a torque wrench.

Figure 4-6: Attach the Motor the Stage



7. Tighten the Shaft Coupling to the drive screw (Figure 4-7). Refer to Table 4-1 for the correct hardware and torque requirements.

Figure 4-7: Tighten the Shaft Coupling to the Drive Screw



8. Rotate the drive screw by hand to ensure that the drive screw rotates freely.



IMPORTANT: You must reapply Loctite to the mounting hardware if the Motor or Shaft Coupling screws are removed, adjusted, loosened, or replaced.

4.4. Side Seal Belt Replacement

The side seal belts on this stage protect it from the ingress of dust and debris. Over time, the side seal belts could fray and deteriorate due to normal use. To order replacement side seal belt kits (referred to as “belt replacement kits”), refer to [Table 4-2](#) and contact Aerotech Global Technical Support.



IMPORTANT: Side seal belt replacement should only be attempted on stages that are in working order without any damages other than the worn side seal belts. If there are other issues or inconsistencies in performance, contact Aerotech Global Technical Support.



DANGER: Electrical Shock Hazard!

- Do not connect or disconnect stage/motor interconnections while connected to a live electrical power source.



DANGER: Mechanical Hazard!

- System travel can cause crush, shear, or pinch injuries.
- Restrict access to all motor and stage parts
 - when the system moves under power (during normal operation, for example).
 - when the system is moved manually (during the installation process or when you do maintenance, for example).



IMPORTANT: Do not disassemble the stage more than we recommended in these instructions. Further dis-assembly will result in loss of calibration and alignment.

Table 4-2: Side Seal Belt Replacement Kit Ordering Guide

Stage Travel Length	Description	Part Number
≤400 mm	Regular Length Belt Replacement Kit	MFB32957
≥500 mm	Long Length Belt Replacement Kit	MFB32958

Side Seal Belt Replacement

Required Materials:

- Belt Replacement Kit (refer to [Table 4-2](#))
- Instant adhesive super glue (cyanoacrylate glue)
- Sharp scissors (to cut the belt to length)

Replacement Procedure:

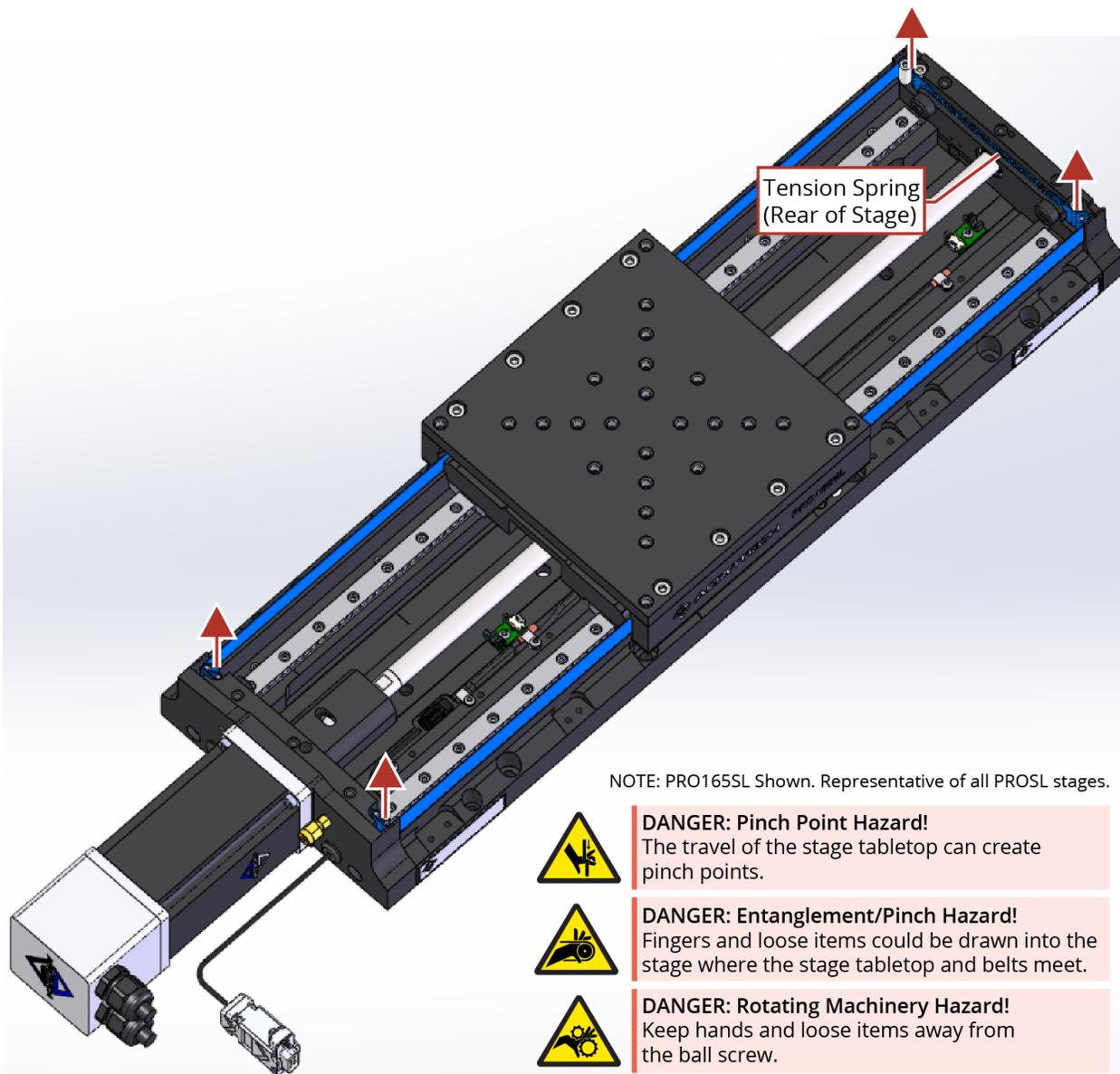
1. Remove the hardcover. Clean and lubricate the stage (optional but recommended).
 - a. Refer to [Section 4.2](#).
 - b. DO NOT replace hardcover or rear end plate after you clean and lubricate the stage.



IMPORTANT: Inspect the stage for any damage that could have caused the old side seal belts to need replacement. Do not continue with this procedure if there are signs of damage. Contact Aerotech Global Technical Support for assistance.

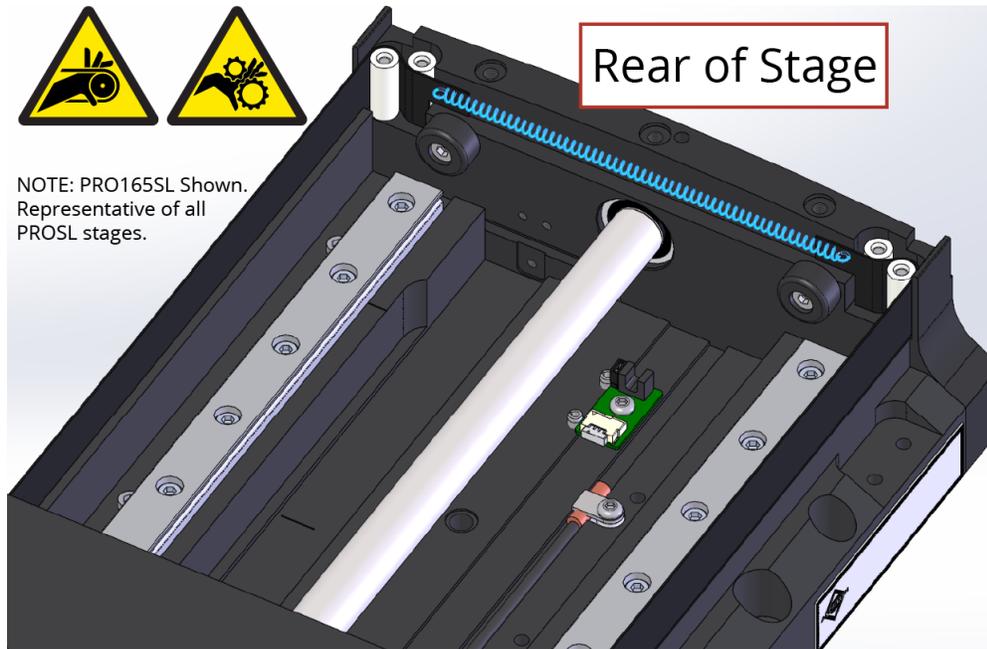
2. Remove the old side seal belt.
 - a. DO NOT pull the belt out of the stage table if the belt is intact.
 - b. Note which side of the stage holds the tension spring, this will be referred to as the rear of the stage.
 - c. Pull the belt up at the attachment pins ([Figure 4-8](#)).

Figure 4-8: Belt Removal at the Attachment Pins



3. Install the new side seal belt at the rear of the stage.
 - a. Slide the belt into the attachment pins at the rear of the stage.
 - b. Refer to [Figure 4-9](#) for the correct belt/pin orientation. The belt and spring will not sit correctly until tension is applied in later steps.

Figure 4-9: Spring Location Detail



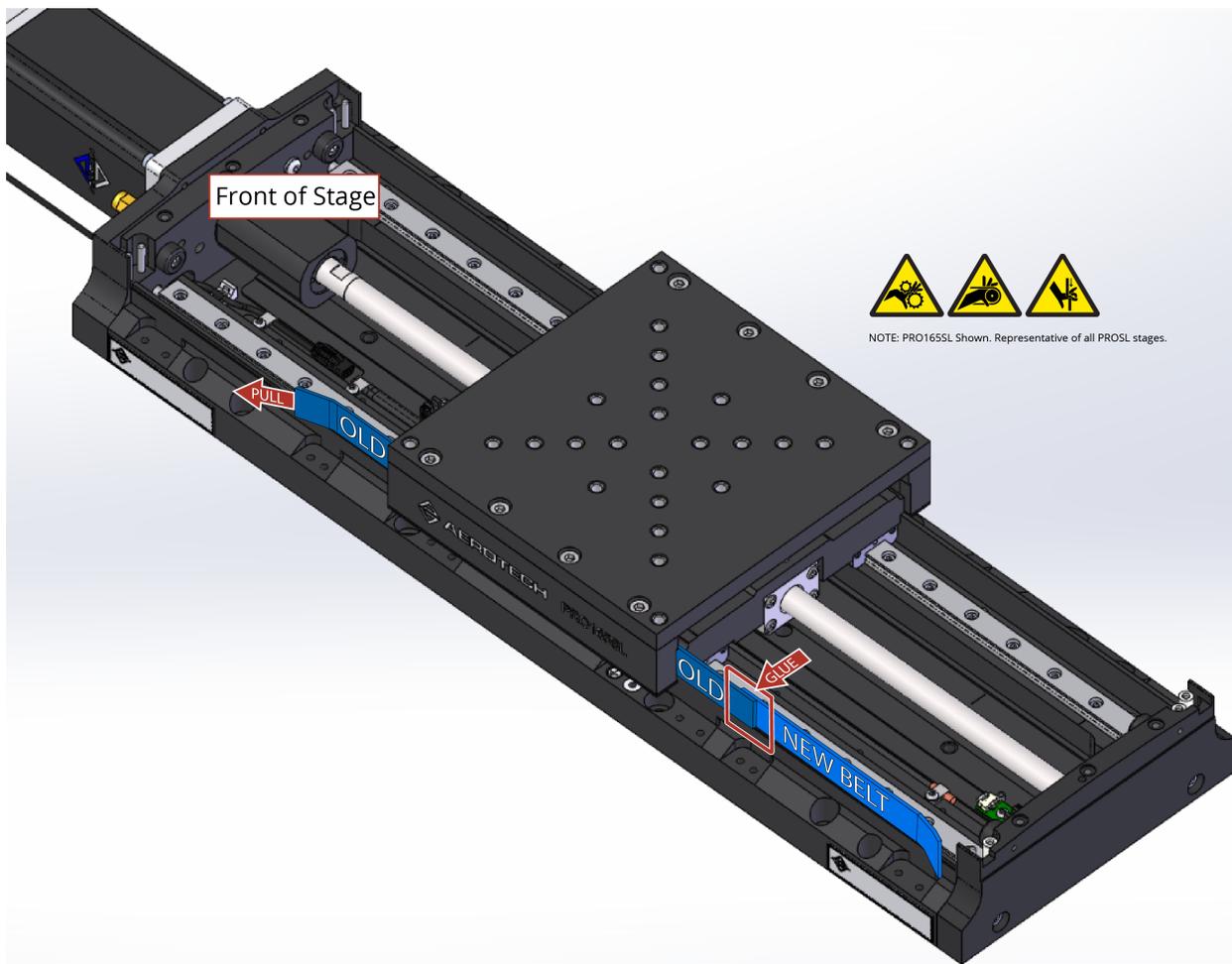
There are two methods that you can use to install the new belt through the stage table:

Pull Through Method: Use this method if the old belt is intact and fed through the stage table.

Manual Feed Method: Use this method if the old belt is not fed through the stage table.

4. (**Pull Through Method**) Install the new belt through the stage table. Refer to [Figure 4-10](#).
 - a. Make a clean, perpendicular cut on the rear portion of one side of the old side seal belt.
 - b. Attach the loose end of the new side seal belt to the old belt with super glue.
 - i. Overlap the old belt and new belt by 10 mm.
 - ii. The new belt should be on the inside of the old belt.
 - iii. Make sure there are no twists in the glued side seal belts and that the glue connection is secure.
 - c. Carefully pull on the old side seal belt to thread the new side seal belt through the stage table.
 - d. After the new belt is pulled through the stage table, cut off the old side seal belt from the new belt with a perpendicular cut.
 - e. Repeat steps "a" through "d" on the opposite side of the stage.

Figure 4-10: Pull Through Method





DANGER: You will invalidate the alignment and could invalidate the calibration if you unmount a stage from its mounting surface.



IMPORTANT: A minimum of two (2) people are required to tilt the stage on its side to avoid injury to the user.



DANGER: If the stage has a brake, you will have to apply power to the stage and motor and enable them to allow this movement. Disable and disconnect the stage electrical power before you continue with this step.

5. **(Manual Feed Method)** Install the new belt through the stage table.
 - a. Carefully tilt the stage onto its side. Do not pinch any wires or damage any machined surfaces.
 - b. Manually position the stage table to provide access to the cover plate mounting screws. Refer to [Figure 4-11](#).
 - c. Remove the cover plate.
 - d. Push the new side seal belt around the rollers. Refer to [Figure 4-12](#).
 - e. Reinstall the cover plate and screws.
 - f. Repeat steps "a" through "e" on the opposite side of the stage.

Figure 4-11: Stage Table Cover Plate Removal

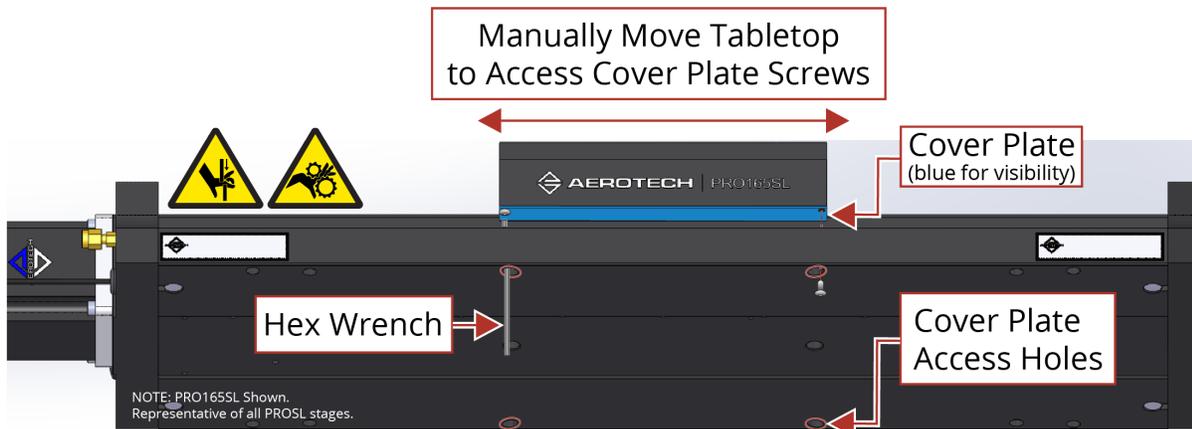
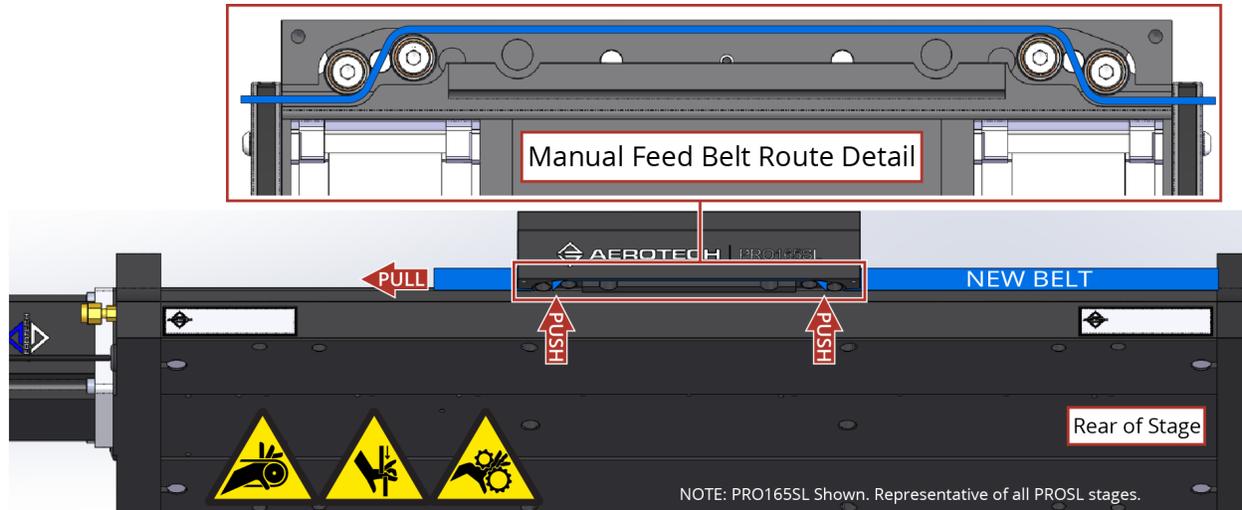
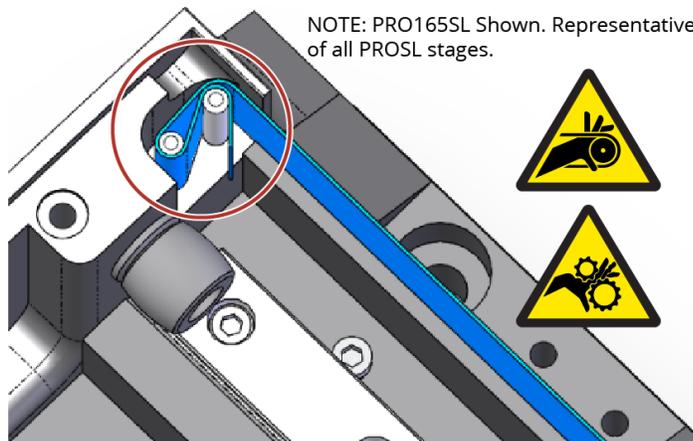


Figure 4-12: Manual Feed Method



6. Manually pull the new belt back and forth through the table. Confirm that the side seal belt feeds through smoothly without friction or snagging. If there appears to be damages preventing successful installation, contact Aerotech Global Technical Support .
7. Apply equal tension to both loose ends of the new side seal belt to stretch the spring. With the spring stretched, the spring and belt assembly should look like [Figure 4-9](#) at the rear of the stage.
8. While you are still holding tension in the belt, wrap the ends of the side seal belt around the front pins as shown in [Figure 4-13](#). The side seal belt should hold the tension without glue if it is properly wrapped around the pins and there is enough spring tension.

Figure 4-13: Belt Wrap



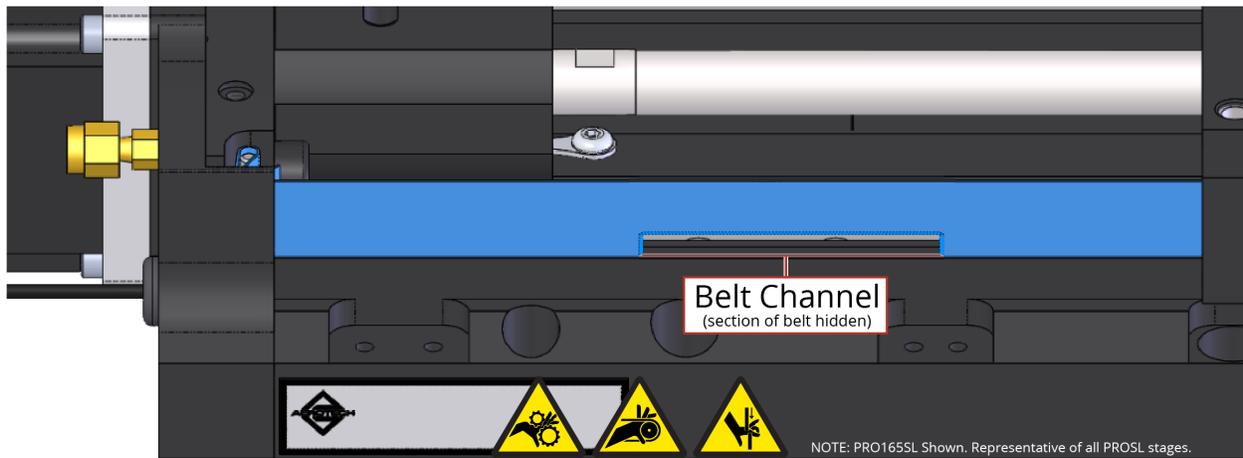
9. Adjust the tension on the left and right sides. Make sure that the spring is centered and stretched. Make sure that there is enough tension in the spring to satisfy all alignment requirements.
10. Trim the side seal belts. Leave approximately 50 mm of overlap for adjustments and glue.



DANGER: If the stage has a brake, you will have to apply power to the stage and motor and enable them to allow this movement. Disable and disconnect the stage electrical power before you continue with this step.

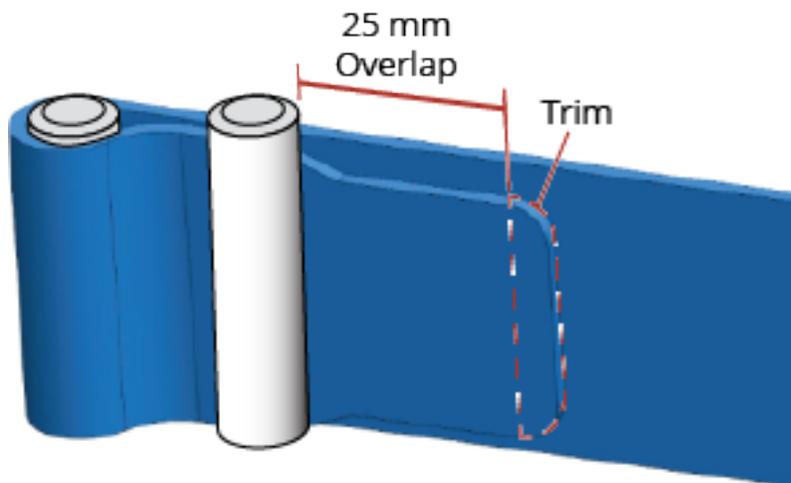
11. With the belts secured in place and holding tension without glue, manually move the stage table through its full travel to confirm belt alignment.
 - a. The side seal belt must run parallel to the direction of travel and the belt must ride within its channel to avoid damaging the belt. Refer to [Figure 4-14](#).
 - b. Adjust the tension and placement of the new side seal belt until it is correctly aligned.

Figure 4-14: Belt Alignment



- Once the belt is fully adjusted, trim the ends of the belt as shown in [Figure 4-15](#).

Figure 4-15: Belt Trim



- Create a permanent loop on both ends of the side seal belt by applying a small amount of super glue (cyanoacrylate glue) to the overlapping end tabs. The belt can be removed from the pins to avoid getting excess glue on stage components.
- Reinstall the hardcover and rear end plate. Refer to [Section 4.2](#).
- With the stage fully reassembled, do a final test of the belt alignment. Move the stage through full travel to observe if there is interference with the hardcover. Repeat installation steps as needed to improve belt alignment.

4.5. Foldback Motor 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 you clean or lubricate the stage. Deflection in the belt should be within $\pm 10\%$ of 1.5 mm when applying a 5 N downward force directly between the pulleys. If the deflection exceeds this value, you will need to adjust the belt tension.

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. Use Parker Super O-Lube (silicone-based) for standard polyurethane belts.

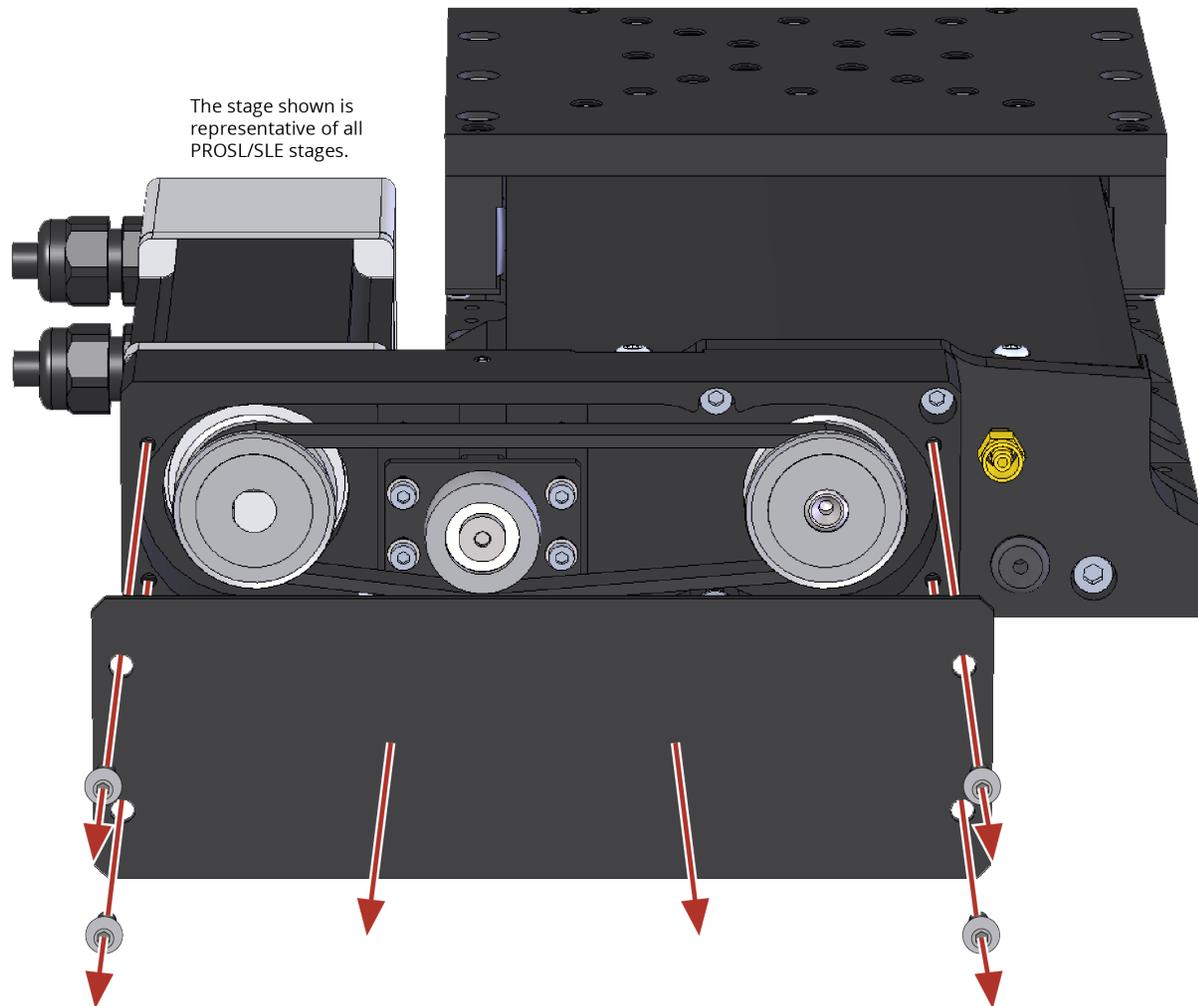


DANGER: Rotating Machinery Hazard!

Fingers and loose articles can get caught in the foldback belt or pulleys.

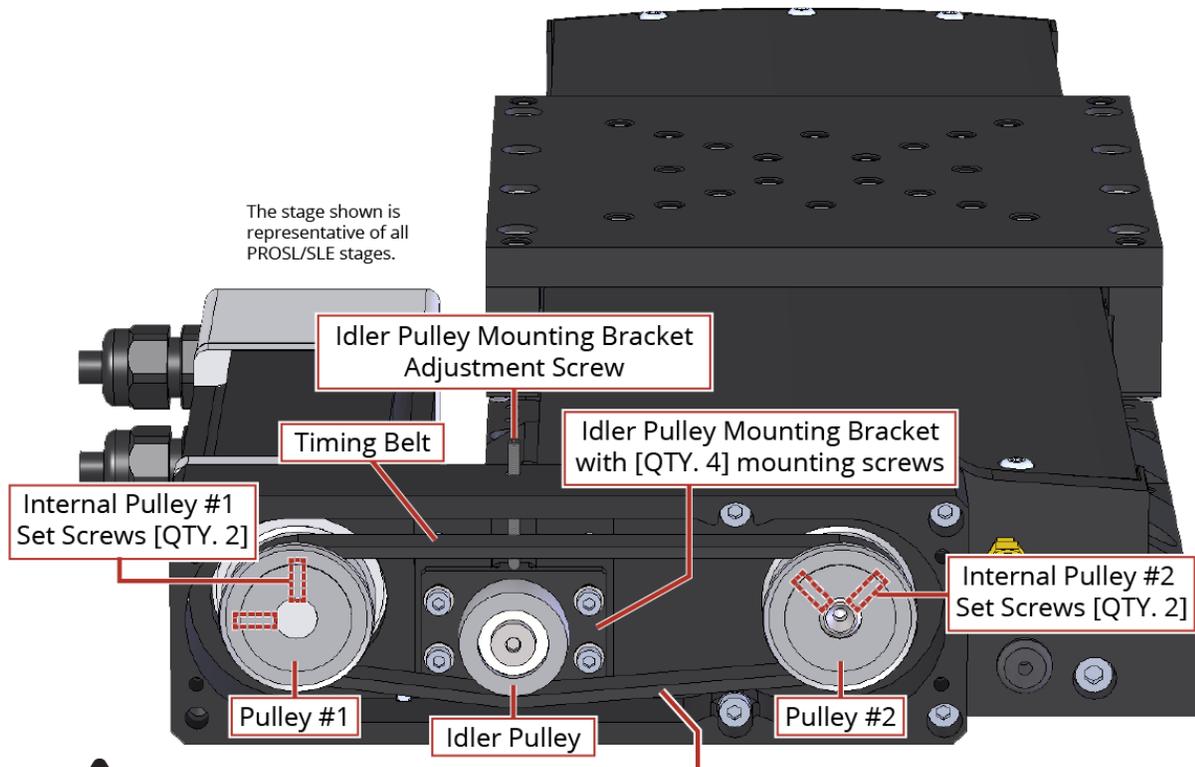
Belt Tension Adjustment Procedure

1. Remove power to the stage.
2. Remove the four mounting screws for the foldback cover ([Figure 4-16](#)).
3. Check that the pulleys are tight on their respective shafts ([Figure 4-17](#)).
 - 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.
5. If adjustment is required, loosen (but do not remove) the mounting screws for the idler pulley mounting bracket.
6. Remove the M4 set screw to gain access to the tapped hole above the idler pulley mounting bracket.
7. Insert an M4 screw or threaded stud long enough to contact the idler pulley mounting bracket.
8. Use the threaded stud to drive the idler pulley mounting bracket downward and increase belt tension.
9. Tighten the mounting screws for the idler pulley mounting bracket.
10. Measure the belt deflection again and repeat the previous steps until the belt tension adjustment is complete.
11. Check the pulley flanges for lubrication.
12. Add small amounts of Parker Super O-Lube lubricant around the circumference of both pulley flanges ([Figure 4-18](#)).
13. Replace the foldback cover and mounting screws.
14. Restore power to the stage and resume normal use.

Figure 4-16: Foldback Motor Cover Removal

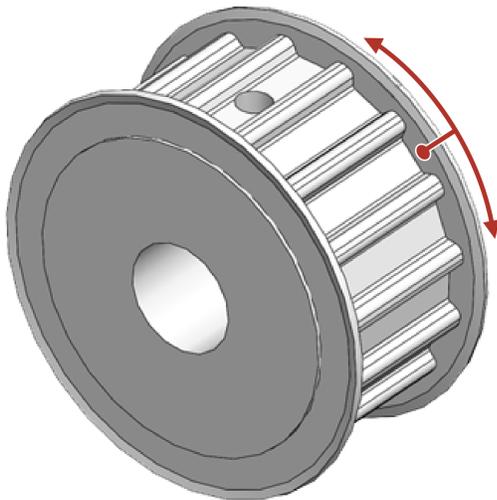
IMPORTANT: If the stage has been calibrated (-PL2 option), note the orientation of the two pulleys with regard to each other or recalibration might be required.

Figure 4-17: Foldback Motor Part Callouts



DANGER: Rotating Machinery Hazard!
Fingers and loose items can get caught in the foldback belt or pulleys.

Figure 4-18: Lubricate the Pulley Flanges



4.6. Troubleshooting

Symptom	Possible Cause and Solution
Stage will not move	Shipping brackets still installed. Remove the red anodized shipping brackets. Brake not released (if equipped with brake). In Limit condition. Check limits (refer to Chapter 3: Electrical Installation) 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: Electrical Installation and Controller documentation). Motor Connections (refer to Chapter 3: Electrical Installation 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 [Global Technical Support Portal](#) 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

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

USA, CANADA, MEXICO

Aerotech, Inc.
Global Headquarters

CHINA

Aerotech China
Full-Service Subsidiary

GERMANY

Aerotech Germany
Full-Service Subsidiary

TAIWAN

Aerotech Taiwan
Full-Service Subsidiary

UNITED KINGDOM

Aerotech United Kingdom
Full-Service Subsidiary

Appendix B: Revision History

Revision	Description
2.03	Ordering options updated (Table 1-1)
2.02	Declaration of Incorporation updated
2.01	<ul style="list-style-type: none"> • Safety section updated • Added Section 4.4.
2.00	Updates have been made to: <ul style="list-style-type: none"> • Section 1.3. Basic Specifications • Section 4.3. Motor Mounting
1.09	Revision changes have been archived. If you need a copy of this revision, contact Aerotech Global Technical Support.
1.08	
1.07	
1.06	
1.05	
1.04	
1.03	
1.02	
1.01	
1.00	

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