



AGR Gear-Driven Rotary Stage

HARDWARE MANUAL

Revision 2.00



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EU Declaration of Incorporation

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



herewith declares that the product:

AGR stage

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

EN ISO 12100:2010

Safety of Machinery - Basic concepts, general principles for design

EN 60204-1:2010

Safety of Machinery - Electrical equipment of machines - Part 1: General requirements

and further more declares that

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

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

EU 2015/863

Directive, Restricted Substances (RoHS 3)

Authorized Representative:

/ Norbert Ludwig

Managing Director
 Aerotech GmbH
 Gustav-Weißkopf-Str. 18
 90768 Fürth
 Germany

Engineer Verifying Compliance

/ Alex Weibel

Aerotech, Inc.
 101 Zeta Drive
 Pittsburgh, PA 15238-2811
 USA
 7/21/2023

Date

UKCA Declaration of Incorporation

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



herewith declares that the product:

AGR stage

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

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 12100:2010

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 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:

A handwritten signature in black ink, appearing to read 'Simon Smith'.

/ Simon Smith

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Engineer Verifying Compliance

A handwritten signature in black ink, appearing to read 'Alex Weibel'.

/ Alex Weibel

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

Date

7/21/2023

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.
- Make sure that the product is securely mounted before you operate it.
- 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 use or operate a stage or 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.



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!

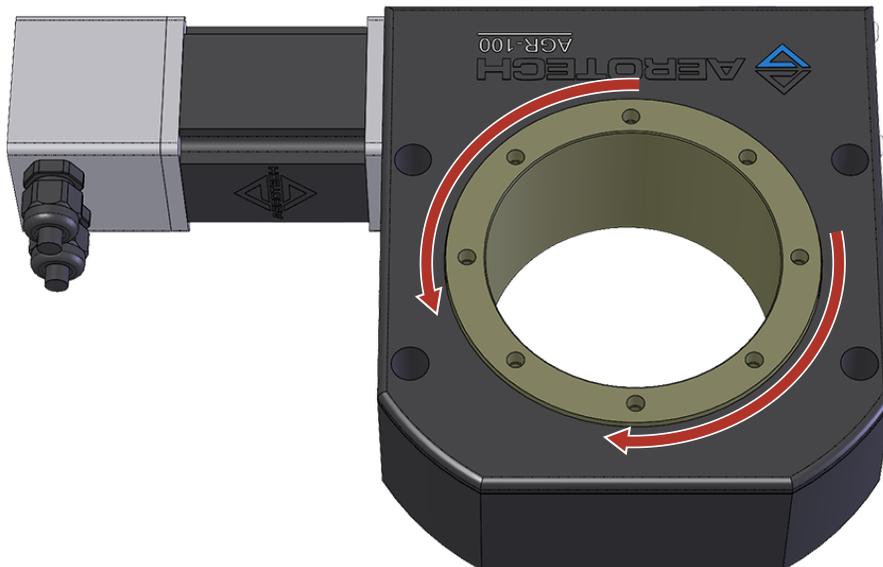
- System travel can cause crush, shear, or pinch injuries.
- Only trained operators should operate this equipment.
- Do not put yourself in the travel path of machinery.
- Restrict access to all motor and stage parts
 - when the system moves under power (during normal operation, for example).
 - when 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 1: Typical Pinch Point Locations



DANGER: Rotating Machinery Hazard!
Keep hands and loose objects away from the stage while it is in motion.



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. You could damage the power supply or drives if you fail to observe the correct ESD practices.

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.
- 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.

Shipping Brackets

If the AGR has shipped as part of a system, shipping brackets (typically red, anodized aluminum) might have been installed to secure the system prior to shipment. The shipping clamps, if installed, will need to be removed prior to machine start up.

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

Table 1-1: Model Numbers and Ordering Options

AGR Series Gear-Driven Rotary Stages	
Model (Required)	
AGR50	Gear-driven rotary stage, 50 mm diameter clear aperture
AGR75	Gear-driven rotary stage, 75 mm diameter clear aperture
AGR100	Gear-driven rotary stage, 100 mm diameter clear aperture
AGR150	Gear-driven rotary stage, 150 mm diameter clear aperture
AGR200	Gear-driven rotary stage, 200 mm diameter clear aperture
Motor (Optional)	
-M1	BMS35 brushless motor and 2000-line digital RS422 line-driver encoder (AGR50, AGR75)
	BMS60 brushless motor and 2500-line digital RS422 line-driver encoder (AGR100, AGR150)
	BMS280 brushless motor and 2500-line digital RS422 line-driver encoder (AGR200)
-M2	BMS35 brushless motor and 2000-line digital RS422 line-driver encoder with brake (AGR50, AGR75)
	BMS60 brushless motor and 2500-line digital RS422 line-driver encoder with brake (AGR100, AGR150)
	BMS280 brushless motor and 2500-line digital RS422 line-driver encoder with brake (AGR200)
-M3	BMS35 brushless motor and 1000-line 1 Vp-p sine-wave encoder (AGR50, AGR75)
	BMS60 brushless motor and 1000-line 1 Vp-p sine-wave encoder (AGR100, AGR150)
	BMS280 brushless motor and 1000-line 1 Vp-p sine-wave encoder (AGR200)
-M4	BMS35 brushless motor and 1000-line 1 Vp-p sine-wave encoder with brake (AGR50, AGR75)
	BMS60 brushless motor and 1000-line 1 Vp-p sine-wave encoder with brake (AGR100, AGR150)
	BMS280 brushless motor and 1000-line 1 Vp-p sine-wave encoder with brake (AGR200)
-M5	BM75 brushless motor and 2500-line digital RS422 line-driver encoder (AGR100, AGR150)
	BM250 brushless motor and 2500-line digital RS422 line-driver encoder (AGR200)
-M6	BM75 brushless motor and 2500-line digital RS422 line-driver encoder with brake (AGR100, AGR150)
	BM250 brushless motor and 2500-line digital RS422 line-driver encoder with brake (AGR200)
-M7	SM35 stepper motor (AGR50, AGR75)
	BM75 brushless motor and 1000-line 1 Vp-p sine-wave encoder (AGR100, AGR150)
	BM250 brushless motor and 1000-line 1 Vp-p sine-wave encoder (AGR200)
-M8	SM35 stepper motor with brake (AGR50, AGR75)
	BM75 brushless motor and 1000-line 1 Vp-p sine-wave encoder with brake (AGR100, AGR150)
	BM250 brushless motor and 1000-line 1 Vp-p sine-wave encoder with brake (AGR200)
-M9	SM60 high voltage stepper motor (AGR100, AGR150)
	SM280 high voltage stepper motor (AGR200)
-M10	SM60 high voltage stepper motor with brake (AGR100, AGR150)
	SM280 high voltage stepper motor with brake (AGR200)
-M11	BM24 brushless servomotor and 2500-line TTL encoder (AGR50, AGR75)
-M12	BM24 brushless servomotor and 2500-line TTL encoder with brake (AGR50, AGR75)
-M13	BM24 brushless servomotor and 1000-line 1 Vpp encoder (AGR50, AGR75)
-M14	BM24 brushless servomotor and 1000-line 1 Vpp encoder with brake (AGR50, AGR75)
Motor Location (Required) (refer to Figure 1-2)	
-ML1	Motor located on right side of stage housing, standard
-ML2	Motor located on left side of stage housing

Motor Orientation (Optional) (refer to Figure 1-3)	
-2	Motor orientation 2
-3	Motor orientation 3, standard
-4	Motor orientation 4
-5	Motor orientation 5
Travel (Required)	
	Continuous travel (Standard)
-TR015	Limited travel, $\pm 7.5^\circ$
-TR030	Limited travel, $\pm 15^\circ$
-TR045	Limited travel, $\pm 22.5^\circ$
-TR060	Limited travel, $\pm 30^\circ$
-TR075	Limited travel, $\pm 37.5^\circ$
-TR090	Limited travel, $\pm 45^\circ$
-TR105	Limited travel, $\pm 52.5^\circ$
-TR120	Limited travel, $\pm 60^\circ$
-TR135	Limited travel, $\pm 67.5^\circ$
-TR150	Limited travel, $\pm 75^\circ$
-TR165	Limited travel, $\pm 82.5^\circ$
-TR180	Limited travel, $\pm 90^\circ$
-TR195	Limited travel, $\pm 97.5^\circ$
-TR210	Limited travel, $\pm 105^\circ$
-TR225	Limited travel, $\pm 112.5^\circ$
-TR240	Limited travel, $\pm 120^\circ$
-TR255	Limited travel, $\pm 127.5^\circ$
-TR270	Limited travel, $\pm 135^\circ$
Note: -TRxxx limited travel options contain an extra 2° of overtravel between the nominal travel and the electrical limit on each side (Ex: -TR270 contains $\pm 135^\circ$ of nominal travel, with $\pm 137^\circ$ of travel between the electrical limits).	
Limits (Required with Limited Travel Configurations)	
-LI1	Normally-closed, end-of-travel limit switches with 9-pin connector
-LI2	Normally-open, end-of-travel limit switches with 9-pin connector
Direct Rotary Feedback (Optional)	
-E1	Direct, amplified-sine output encoder
-E2	Direct digital RS422 line-driver encoder, X5 multiplication
-E3	Direct digital RS422 line-driver encoder, X50 multiplication
Tabletop (Optional)	
-TT1	Metric tabletop
-TT2	English tabletop
Mounting Plate (Optional)	
-MP1	Universal English/metric mounting plate
-MP2	Metric mounting plate, side mounting option
Seals (Optional) (refer to Figure 1-5)	
-SL1	Labyrinth seal
Metrology (Required)	
-PL0	No metrology performance plots
-PL1	Metrology, uncalibrated with performance plots
-PL2	Metrology, calibrated (HALAR) with performance plots

Figure 1-1: Standard Features

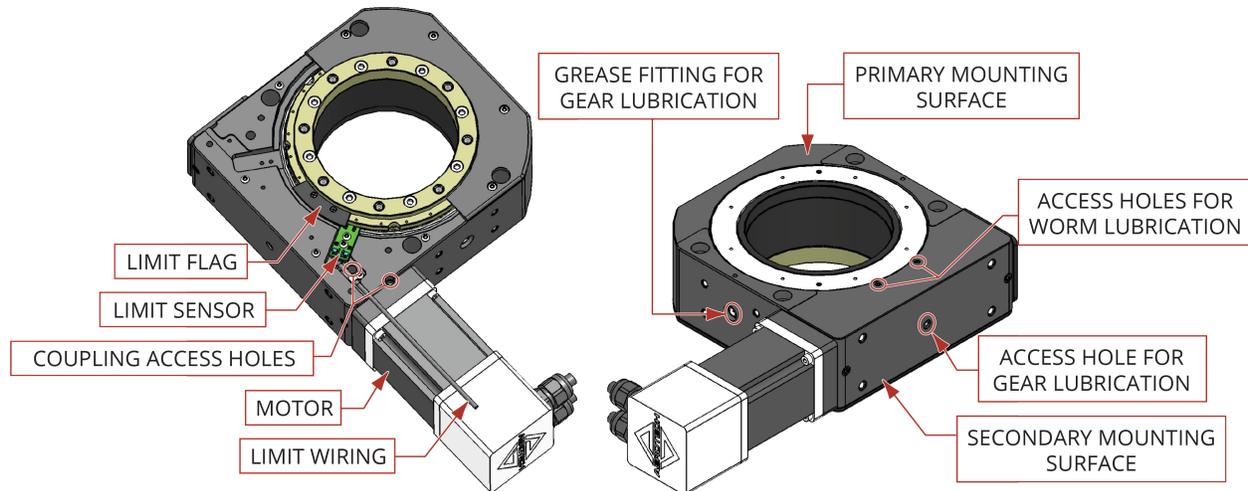


Figure 1-2: Motor Location Options

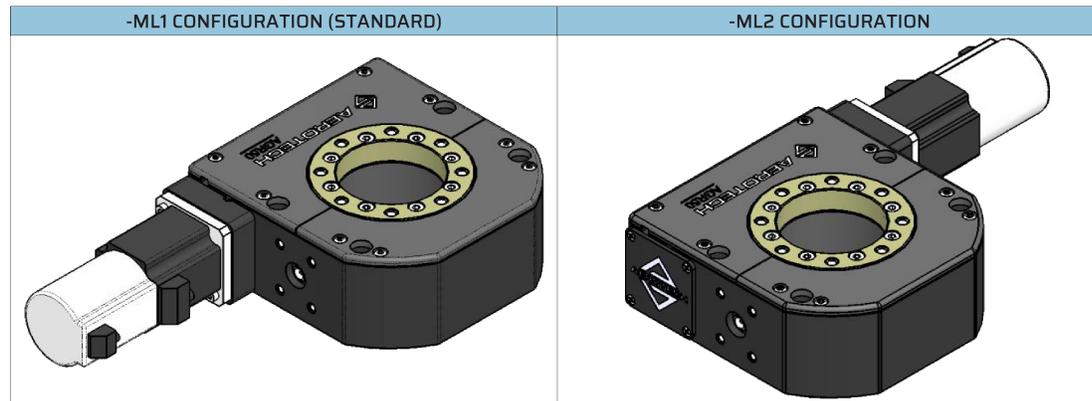


Figure 1-3: Motor Orientation Options

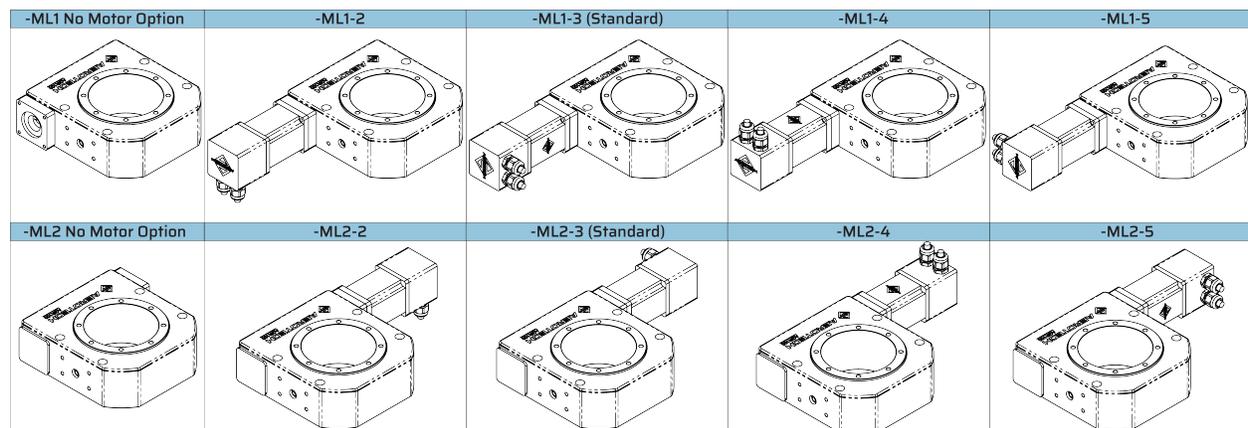


Figure 1-4: Encoder Option

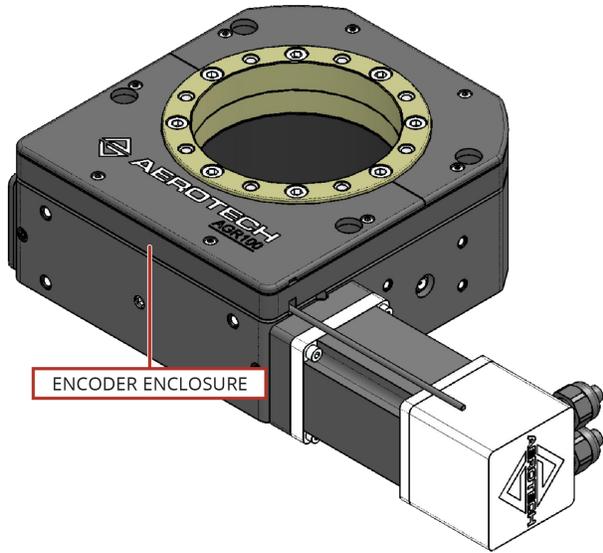


Figure 1-5: Seal Option

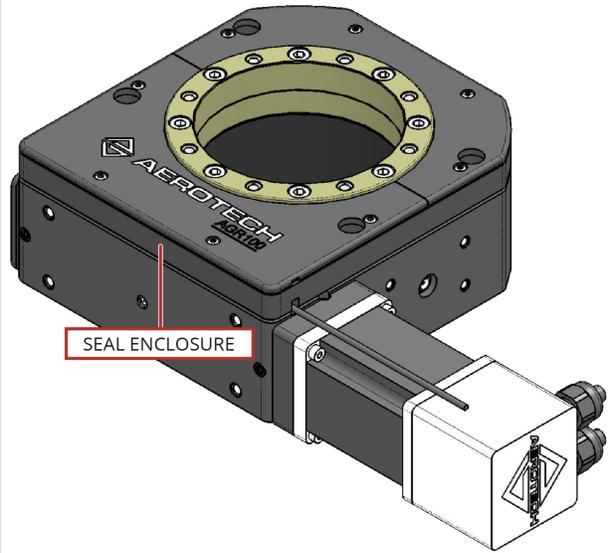


Figure 1-6: Stage Accessories

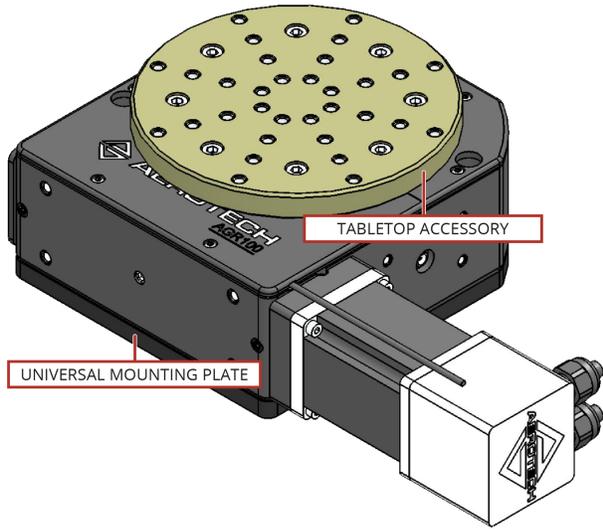
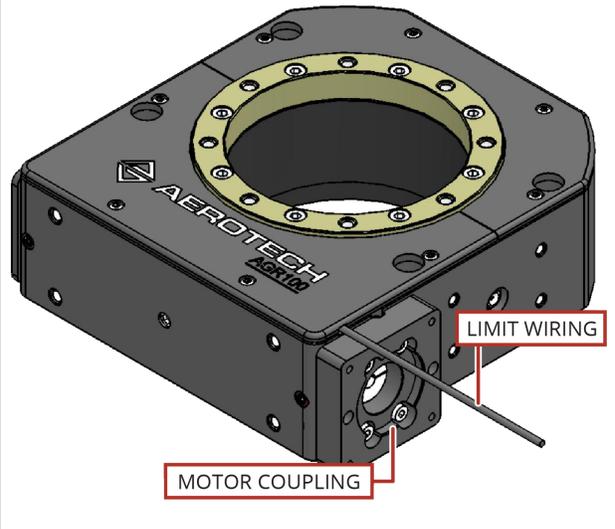


Figure 1-7: No Motor Option



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 ±2 °C (68 °F ±4 °F). If at any time the operating temperature deviates from 20 °C degradation in performance could occur.
Humidity	Storage: 0 °C to 40 °C (32 °F to 104 °F) in original shipping packaging
	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	Limited protection against dust, but not water (IP40 equivalent ingress protection rating).
	With the Seal (-SL1) option, AGR stages have limited protection against dust, but no protection against 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.

1.3. Basic Specifications

Table 1-3: AGR Series Specifications (AGR50, AGR75, AGR100)

		AGR50	AGR75	AGR100
Travel		360° (Limited Travel Versions Available)		
Frame Size		NEMA17	NEMA17	NEMA23
Accuracy	Uncalibrated	0.87 mrad (180 arc sec)	0.87 mrad (180 arc sec)	0.58 mrad (120 arc sec)
	Calibrated	0.29 mrad (60 arc sec)	0.24 mrad (50 arc sec)	0.24 mrad (50 arc sec)
	Uncalibrated with Direct Encoder Option	97 µrad (20 arc sec)		
	Calibrated with Direct Encoder Option	58 µrad (12 arc sec)	49 µrad (10 arc sec)	49 µrad (10 arc sec)
Repeatability (Unidirectional)	Standard	49 µrad (10 arc sec)		
	Direct Encoder ⁽¹⁾	24 µrad (5 arc sec)		
Repeatability (Bidirectional)	Standard ⁽²⁾	0.22 mrad (45 arc sec)		
	Direct Encoder ⁽¹⁾	39 µrad (8 arc sec)	39 µrad (8 arc sec)	29 µrad (6 arc sec)
Tilt Error Motion		49 µrad (10 arc sec)		
Axial Error Motion		5 µm		
Radial Error Motion		10 µm		
Gear Ratio		51:1	67:1	85:1
Maximum Speed ⁽³⁾	with Brushless Servomotor (BM and BMS models)	180°/s		
	with Stepper Motor	60°/s	60°/s	40°/s
Maximum Acceleration ⁽⁴⁾		720°/s ²		
Aperture		50 mm	75 mm	100 mm
Load Capacity	Axial	40 kg	100 kg	200 kg
	Radial	20 kg	50 kg	100 kg
	Moment	See Moment Load Capacity: Section 2.3 .		
Maximum Torque Load to Stage Shaft		2.5 N·m	3.5 N·m	12 N·m
Rotor Inertia (Unloaded)		0.00052 kg·m ²	0.0013 kg·m ²	0.0035 kg·m ²
Stage Mass (No Motor)	Standard	1.9 kg	2.4 kg	4.5 kg
	Direct Encoder	2.5 kg	3.1 kg	5.6 kg
Material		Aluminum		
<p>(1) Direct encoder repeatability specifications are for systems using the -E1 or -E3 direct encoder options only.</p> <p>(2) Requires the use of an Aerotech controller. Consult factory if using a third-party controller.</p> <p>(3) Maximum speed is load dependent. Contact an Aerotech Application Engineer if imbalanced loads are present.</p> <p>(4) Unloaded acceleration.</p> <p>(5) On-axis loading is listed.</p> <p>(6) Specifications are for single-axis systems measured 25 mm above the tabletop above the tabletop. Performance of multi-axis systems is payload and workpoint dependent. Consult factory for multi-axis or non-standard applications.</p>				

Table 1-4: AGR Series Specifications (AGR150 and AGR200)

		AGR150	AGR200
Travel		360° (Limited Travel Versions Available)	
Frame Size		NEMA23	NEMA34
Accuracy ⁽¹⁾	Uncalibrated	0.58 mrad (120 arc sec)	
	Calibrated	0.24 mrad (50 arc sec)	
	Uncalibrated with Direct Encoder Option	97 µrad (20 arc sec)	
	Calibrated with Direct Encoder Option	49 µrad (10 arc sec)	
Repeatability (Unidirectional)	Standard	49 µrad (10 arc sec)	
	Direct Encoder ⁽¹⁾	24 µrad (5 arc sec)	
Repeatability (Bidirectional)	Standard ⁽²⁾	0.22 mrad (45 arc sec)	
	Direct Encoder ⁽¹⁾	29 µrad (6 arc sec)	
Tilt Error Motion		49 µrad (10 arc sec)	
Axial Error Motion		5 µm	
Radial Error Motion		10 µm	
Gear Ratio		117:1	126:1
Maximum Speed ⁽³⁾	with Brushless Servomotor (BM and BMS Models)	180°/s	120°/s
	with Stepper Motor	40°/s	
Maximum Acceleration ⁽⁴⁾		720°/s ²	480°/s ²
Aperture		150 mm	200 mm
Load Capacity	Axial	300 kg	425 kg
	Radial	125 kg	200 kg
	Moment	See Moment Load Capacity: Section 2.3 .	
Maximum Torque Load to Stage Shaft		20 N·m	80 N·m
Rotor Inertia (Unloaded)		0.011 kg·m ²	0.076 kg·m ²
Stage Mass (No Motor)	Standard	6.1 kg	18.6 kg
	Direct Encoder	7.6 kg	21.7 kg
Material		Aluminum	
<p>(1) Direct encoder repeatability specifications are for systems using the -E1 or -E3 direct encoder options only.</p> <p>(2) Requires the use of an Aerotech controller. Consult factory if using a third-party controller.</p> <p>(3) Maximum speed is load dependent. Contact an Aerotech Application Engineer if imbalanced loads are present.</p> <p>(4) Unloaded acceleration.</p> <p>(5) On-axis loading is listed.</p> <p>(6) Specifications are for single-axis systems measured 25 mm above the tabletop above the tabletop. Performance of multi-axis systems is payload and workpoint dependent. Consult factory for multi-axis or non-standard applications.</p>			

1.4. Vacuum Operation

Vacuum option preparations are available as special orders. Contact Aerotech for more information.

There are two vacuum preparation options:

- Low Vacuum (for use in atmospheric pressures down to 10^{-3} Torr)
- High Vacuum (preparation for 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).

Chapter 2: Installation



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: AGR50 Dimensions

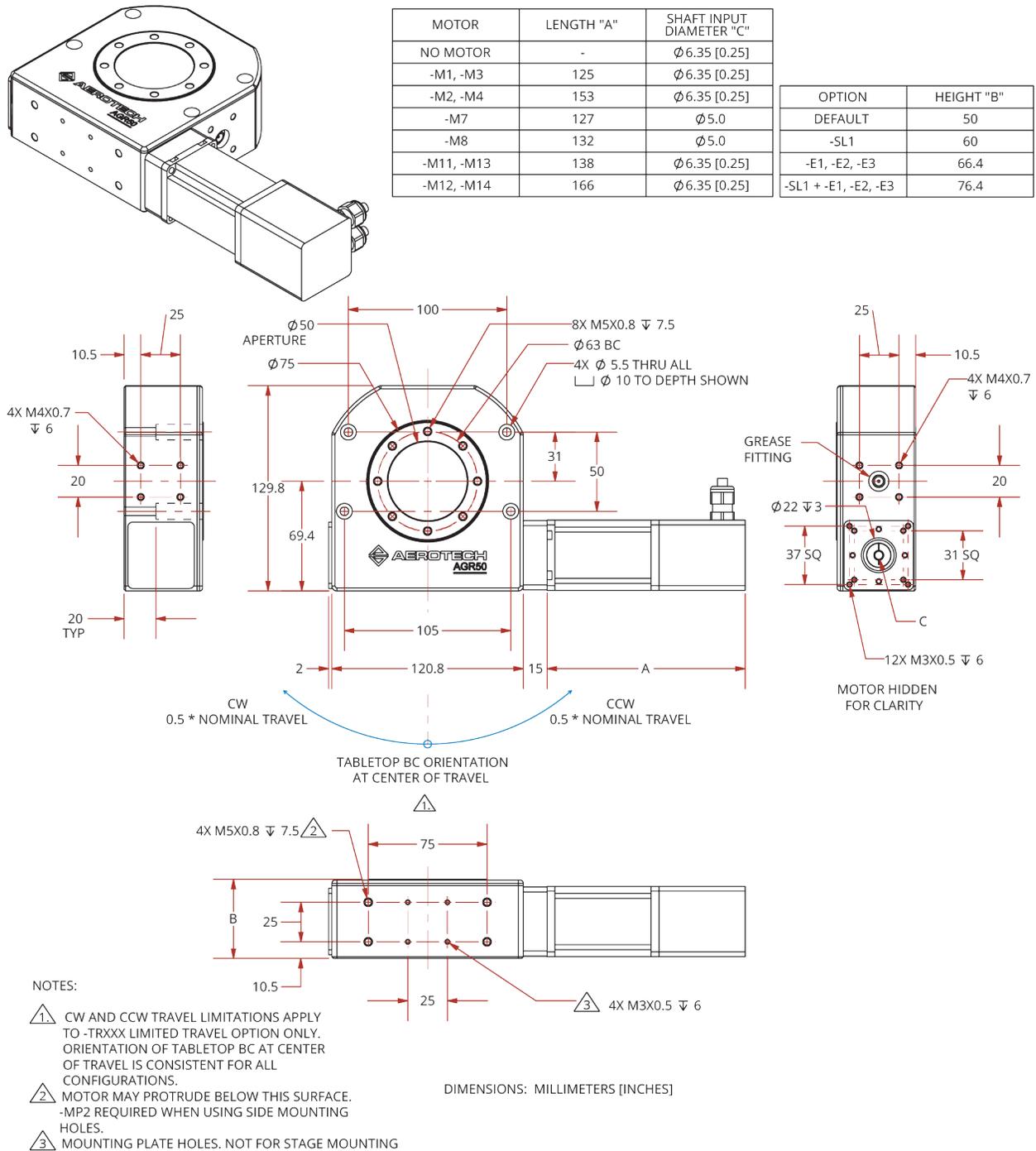
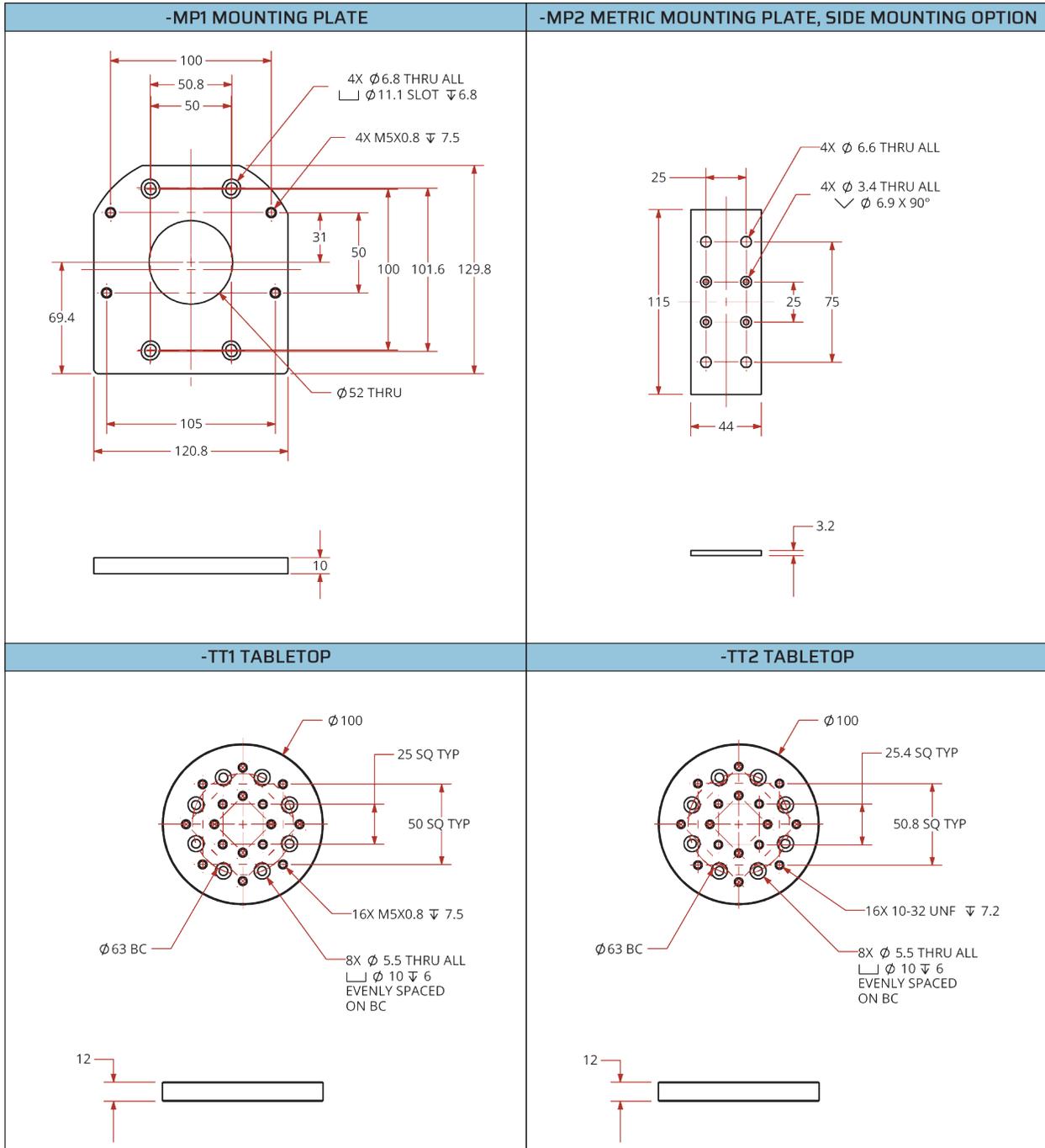
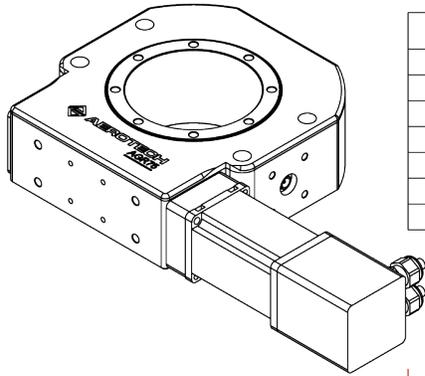


Figure 2-2: AGR50 Accessories Dimensions



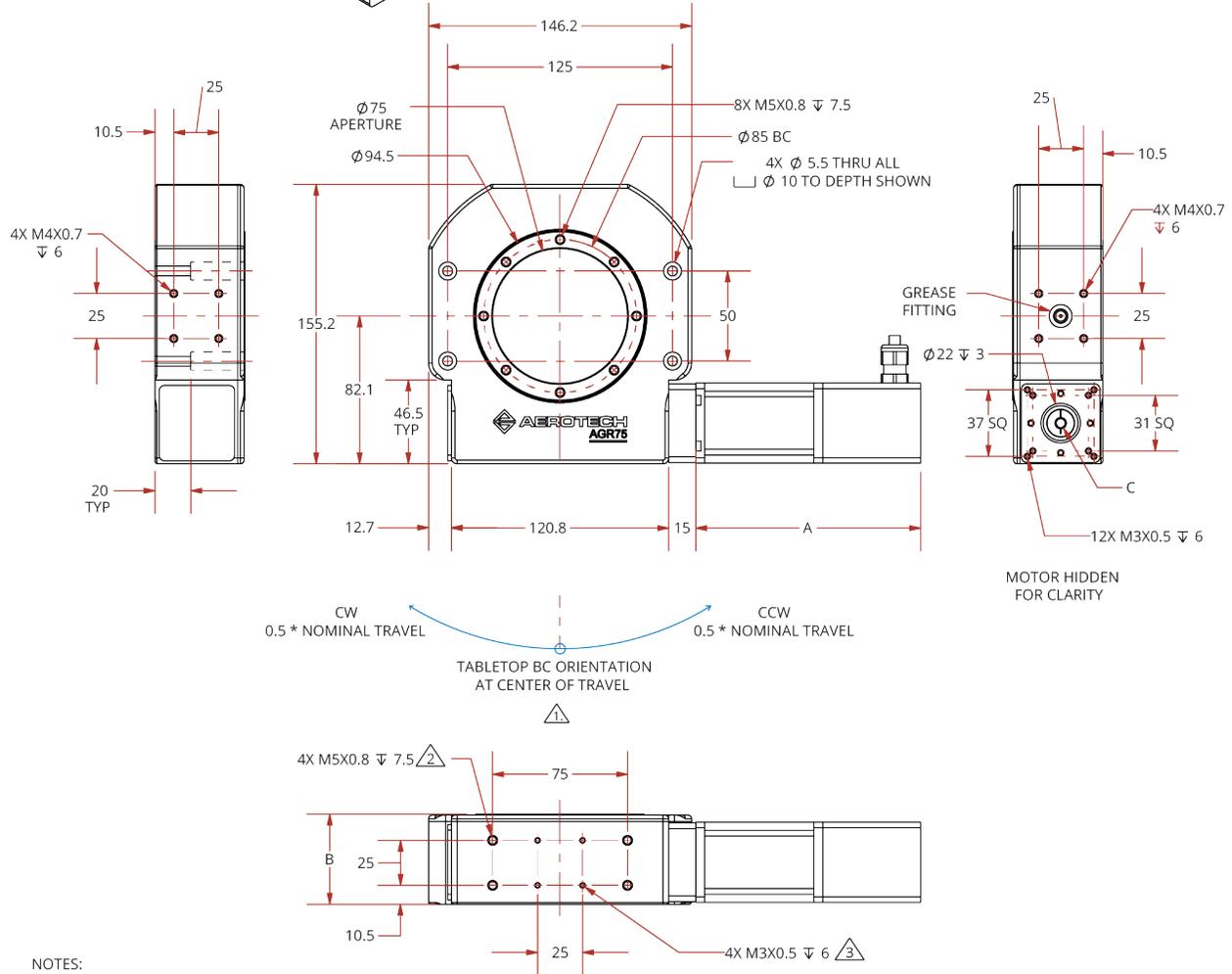
DIMENSIONS: MILLIMETERS

Figure 2-3: AGR75 Dimensions



MOTOR	LENGTH "A"	SHAFT INPUT DIAMETER "C"
NO MOTOR	-	Ø6.35 [0.25]
-M1, -M3	125	Ø6.35 [0.25]
-M2, -M4	153	Ø6.35 [0.25]
-M7	127	Ø5.0
-M8	132	Ø5.0
-M11, -M13	138	Ø6.35 [0.25]
-M12, -M14	166	Ø6.35 [0.25]

OPTION	HEIGHT "B"
DEFAULT	50
-SL1	60
-E1, -E2, -E3	66.4
-SL1 + -E1, -E2, -E3	76.4

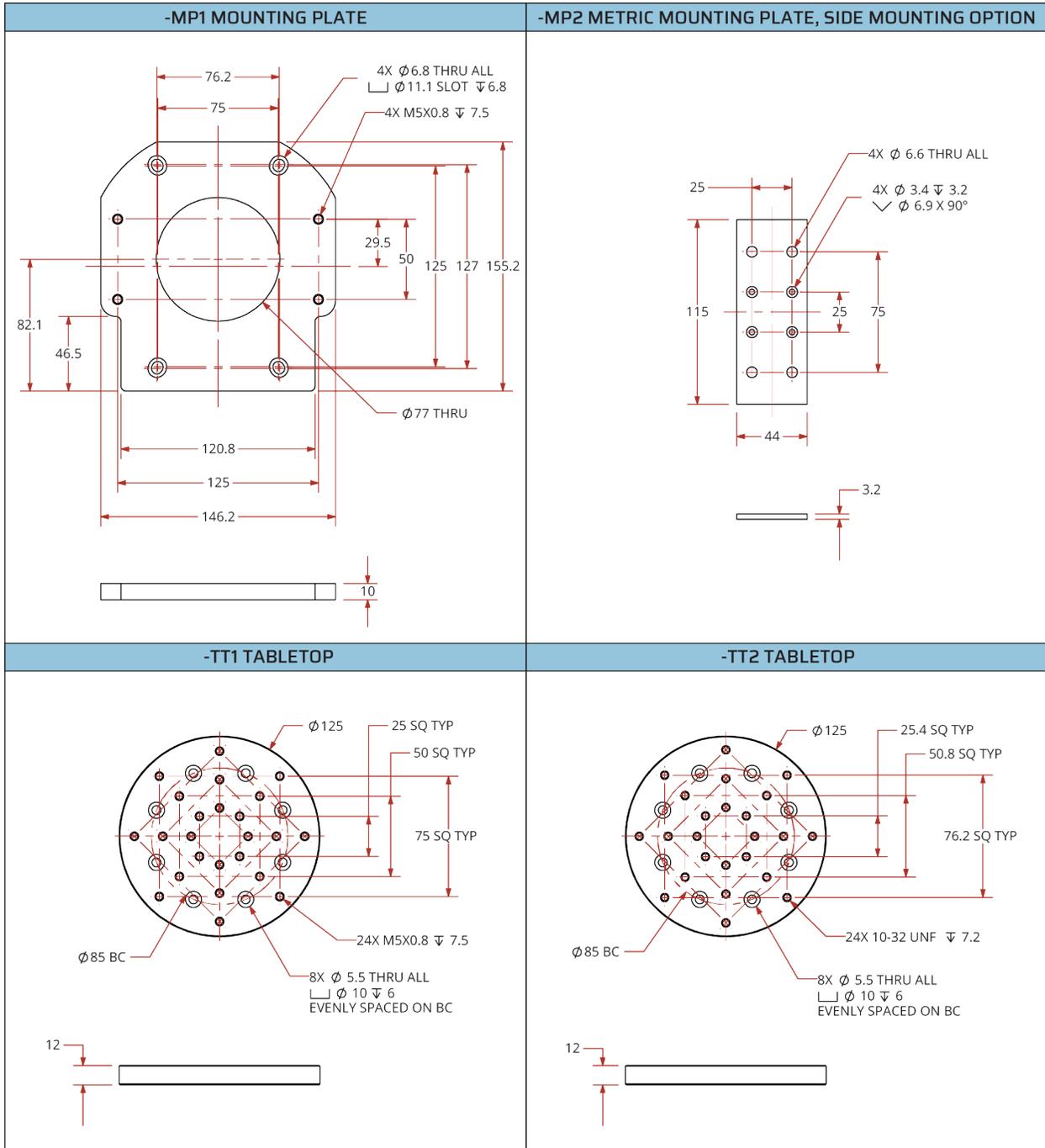


NOTES:

- ⚠ CW AND CCW TRAVEL LIMITATIONS APPLY TO -TRXXX LIMITED TRAVEL OPTION ONLY. ORIENTATION OF TABLETOP BC AT CENTER OF TRAVEL IS CONSISTENT FOR ALL CONFIGURATIONS.
- ⚠ MOTOR MAY PROTRUDE BELOW THIS SURFACE. -MP2 REQUIRED WHEN USING SIDE MOUNTING HOLES.
- ⚠ MOUNTING PLATE HOLES. NOT FOR STAGE MOUNTING

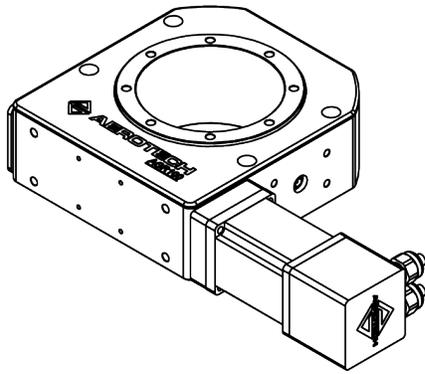
DIMENSIONS: MILLIMETERS [INCHES]

Figure 2-4: AGR75 Accessories Dimensions



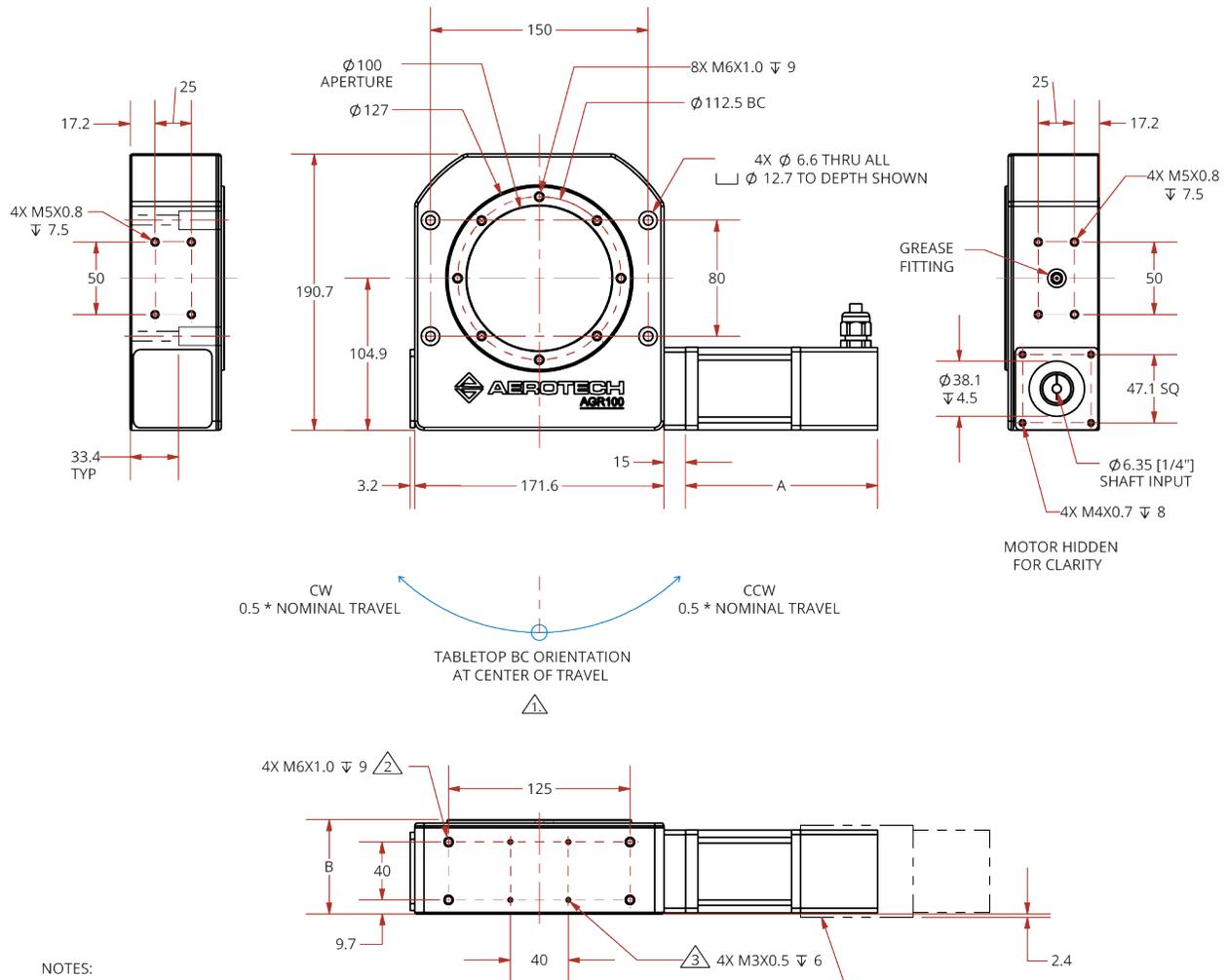
DIMENSIONS: MILLIMETERS

Figure 2-5: AGR100 Dimensions



MOTOR	LENGTH "A"
-M1, -M3, -M5, -M7	132.3
-M2, -M4, -M6, -M8	209.5
-M9	110.9
-M10	111.9

OPTION	HEIGHT "B"
DEFAULT	65
-SL1	78
-E1, -E2, -E3	81
-SL1 + -E1, -E2, -E3	94

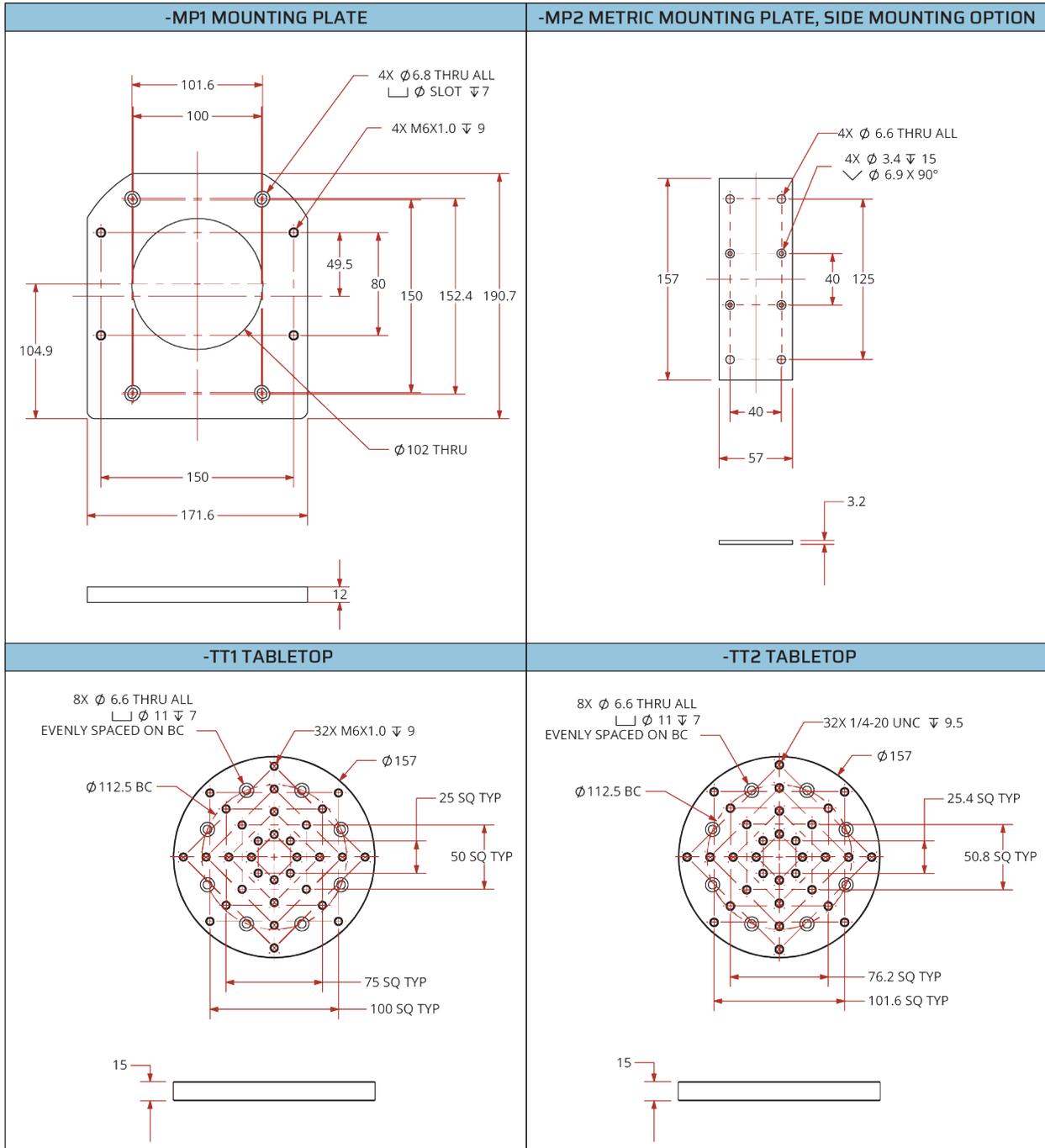


NOTES:

- 1 CW AND CCW TRAVEL LIMITATIONS APPLY TO -TRXXX LIMITED TRAVEL OPTION ONLY. ORIENTATION OF TABLETOP BC AT CENTER OF TRAVEL IS CONSISTENT FOR ALL CONFIGURATIONS.
- 2 MOTOR MAY PROTRUDE BELOW THIS SURFACE. -MP2 REQUIRED WHEN USING SIDE MOUNTING HOLES.
- 3 MOUNTING PLATE HOLES. NOT FOR STAGE MOUNTING

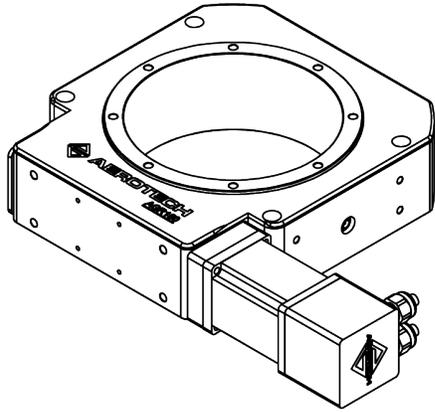
DIMENSIONS: MILLIMETERS

Figure 2-6: AGR100 Accessories Dimensions



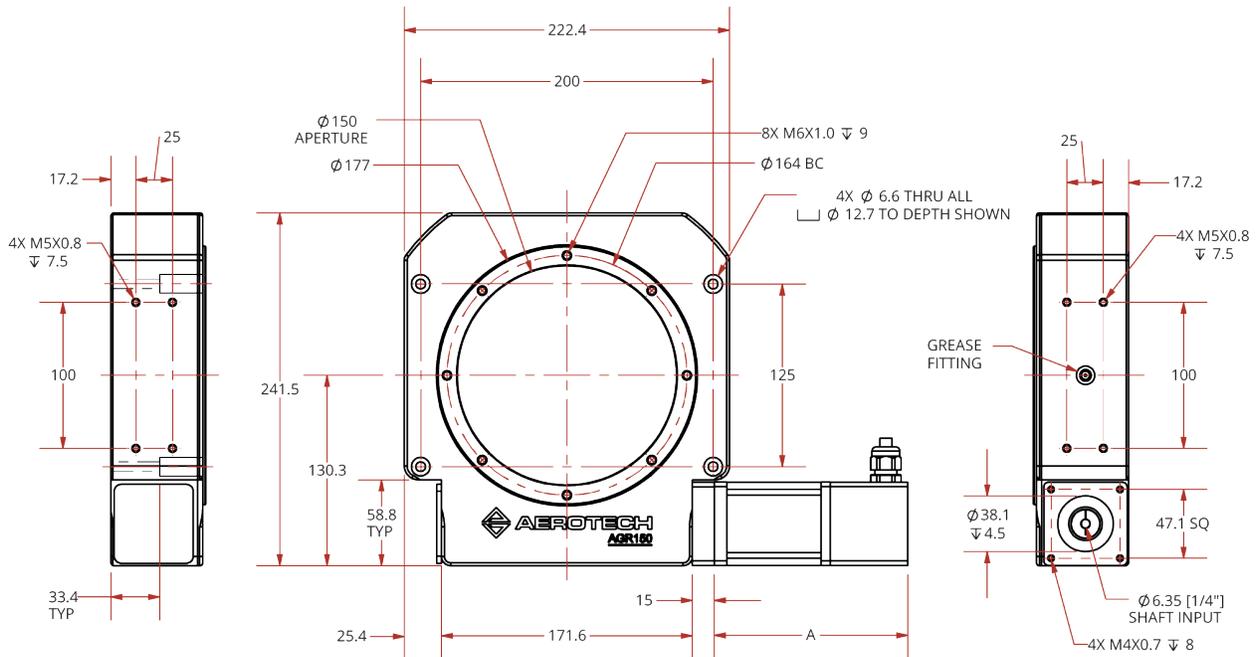
DIMENSIONS: MILLIMETERS

Figure 2-7: AGR150 Dimensions

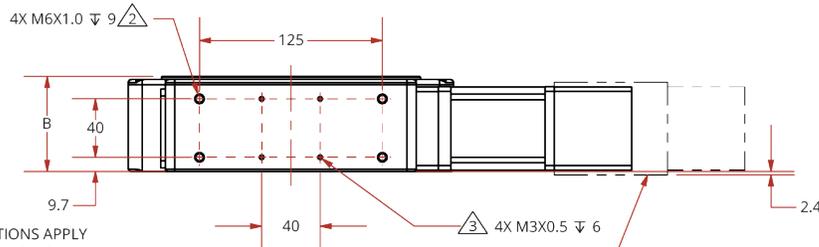


MOTOR	LENGTH "A"
-M1, -M3, -M5, -M7	132.3
-M2, -M4, -M6, -M8	209.5
-M9	110.9
-M10	111.9

OPTION	HEIGHT "B"
DEFAULT	65
-SL1	78
-E1, -E2, -E3	81
-SL1 + -E1, -E2, -E3	94



TABLETOP BC ORIENTATION AT CENTER OF TRAVEL



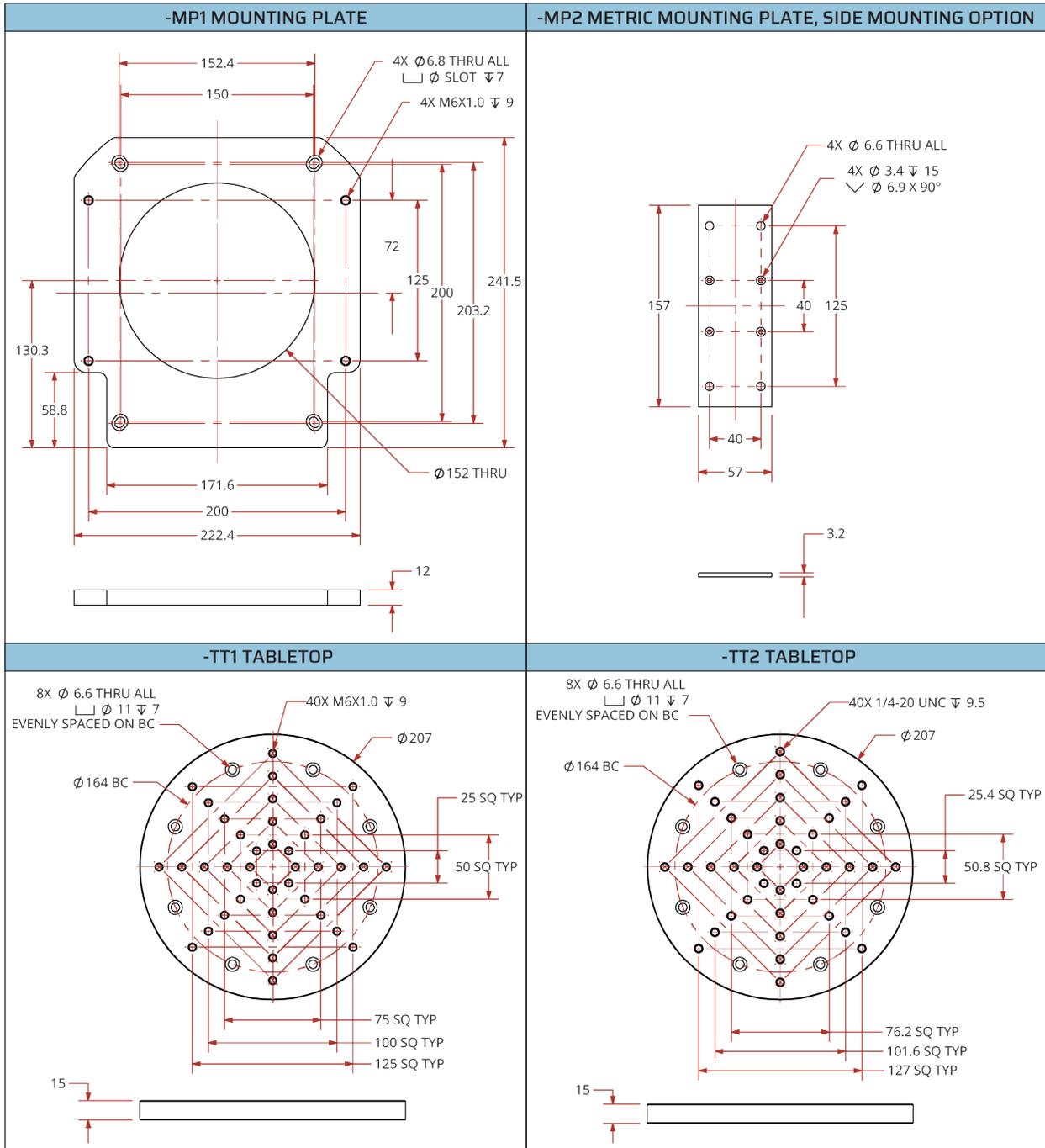
NOTES:

- ⚠️ CW AND CCW TRAVEL LIMITATIONS APPLY TO -TRXXX LIMITED TRAVEL OPTION ONLY. ORIENTATION OF TABLETOP BC AT CENTER OF TRAVEL IS CONSISTENT FOR ALL CONFIGURATIONS.
- ⚠️ MOTOR MAY PROTRUDE BELOW THIS SURFACE. -MP2 REQUIRED WHEN USING SIDE MOUNTING HOLES.
- ⚠️ MOUNTING PLATE HOLES. NOT FOR STAGE MOUNTING

NOTE: BRAKE OPTIONS PROTRUDE BELOW MOUNTING SURFACE

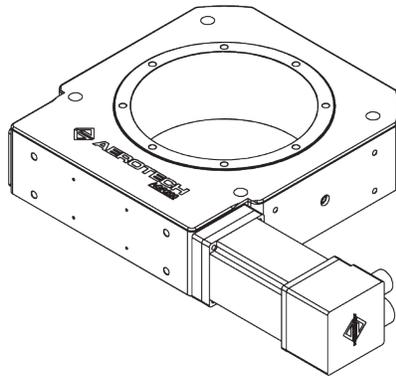
DIMENSIONS: MILLIMETERS

Figure 2-8: AGR150 Accessories Dimensions



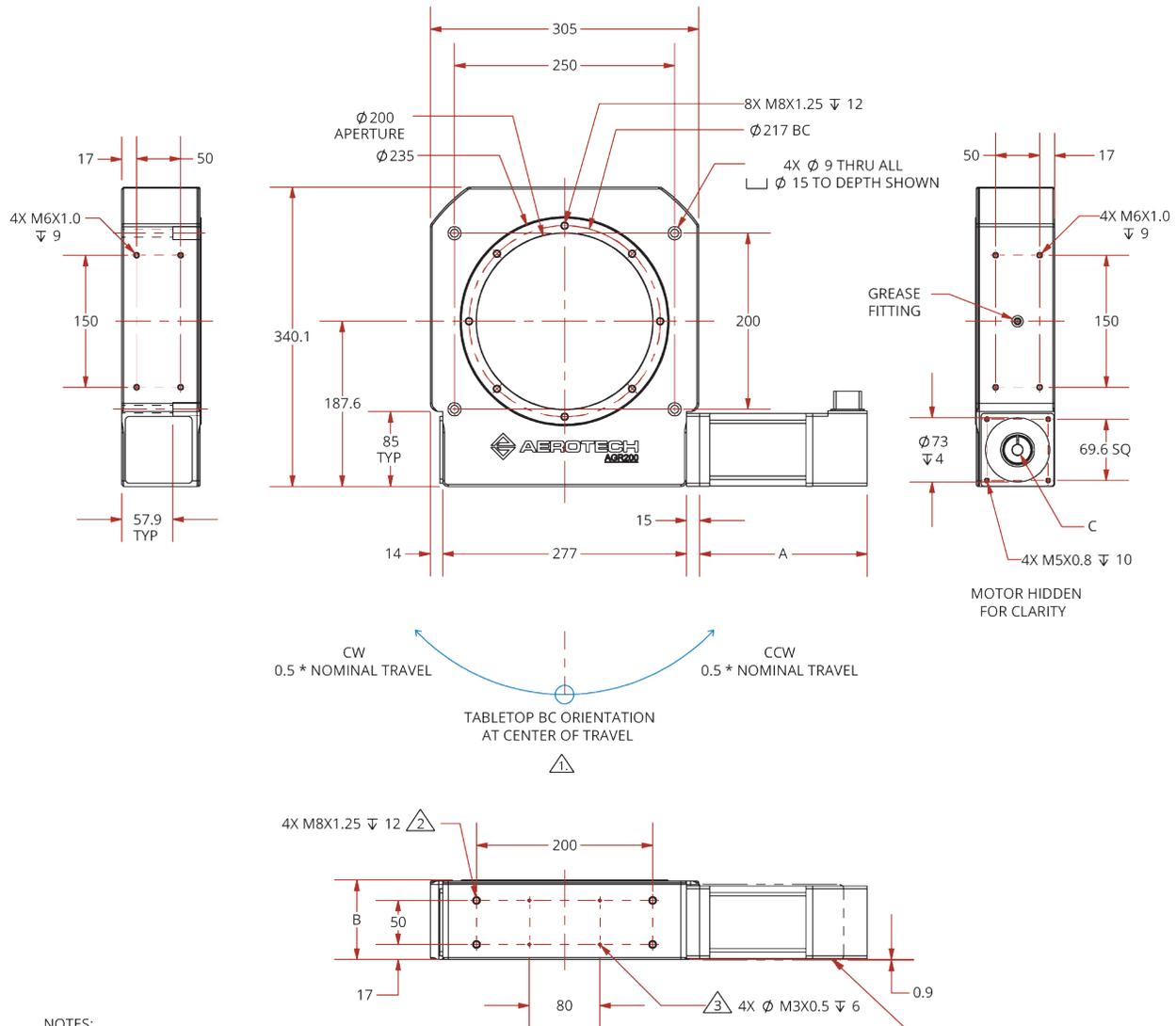
DIMENSIONS: MILLIMETERS

Figure 2-9: AGR200 Dimensions



MOTOR	LENGTH "A"	SHAFT INPUT DIAMETER "C"
-M1, -M3, -M5, -M7	190	Ø 12.7 [0.5]
-M2, -M4, -M6, -M8	245.6	Ø 12.7 [0.5]
-M9	177.1	Ø 9.5 [0.375]
-M10	187.1	Ø 9.5 [0.375]

OPTION	HEIGHT "B"
DEFAULT	90
-SL1	107
-E1, -E2, -E3	108.5
-SL1 + -E1, -E2, -E3	125.5



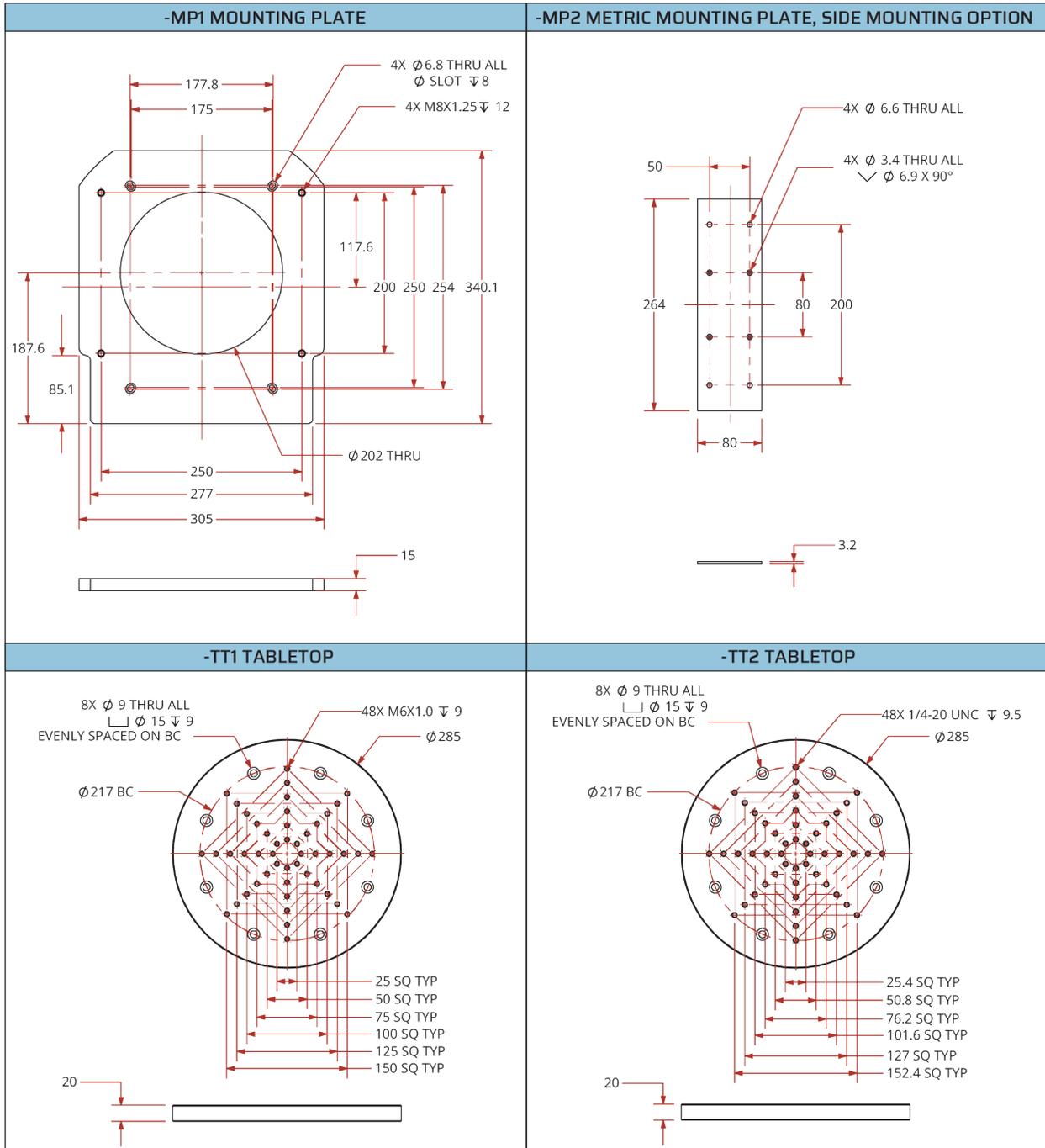
NOTES:

- ⚠ CW AND CCW TRAVEL LIMITATIONS APPLY TO -TRXXX LIMITED TRAVEL OPTION ONLY. ORIENTATION OF TABLETOP BC AT CENTER OF TRAVEL IS CONSISTENT FOR ALL CONFIGURATIONS.
- ⚠ MOTOR MAY PROTRUDE BELOW THIS SURFACE. -MP2 REQUIRED WHEN USING SIDE MOUNTING HOLES.
- ⚠ MOUNTING PLATE HOLES. NOT FOR STAGE MOUNTING

NOTE: STEPPER MOTOR OPTION PROTRUDES BELOW MOUNTING SURFACE

DIMENSIONS: MILLIMETERS [INCHES]

Figure 2-10: AGR200 Accessories Dimensions



DIMENSIONS: MILLIMETERS

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 at the factory.



- Do not machine the stage housing. If you must machine a surface to achieve a required flatness, machine the mounting surface.
- Keep the use of shims to a minimum when you mount the stage to the mounting surface. The use of shims could reduce the rigidity of the system.

Table 2-1: Stage Mounting Surface Flatness Requirement

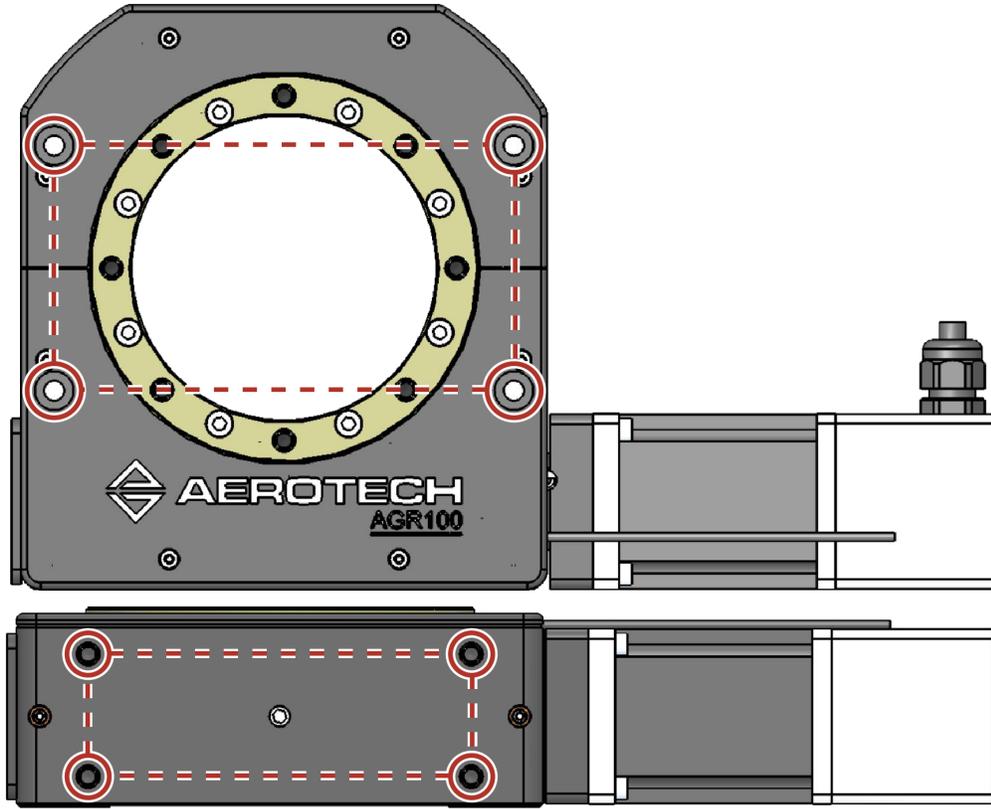
Stage	Flatness Requirement
All Frame Sizes	10 μm

AGR series stages have a fixed mounting pattern available to secure the stage to a mounting surface. [Figure 2-11](#) shows the main mounting holes in the base of the stage. 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 specific model mounting locations and dimensions.

Table 2-2: Stage to Mounting Surface Hardware

Mounting Hardware	Typical Screw Torque
M5 SHCS	4.1 N·m
M6 SHCS	7.0 N·m
M8 SHCS	17.0 N·m

Figure 2-11: Stage Mounting Holes



2.3. Attaching the Payload or Fixturing 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. 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.



WARNING: General Hazard Warning!

Be careful when you attach the payload to the stage table.

- Refer to the dimensions in [Section 2.1](#), for maximum allowable thread engagement.



IMPORTANT: If your AGR 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 AGR 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: Mounting Interface Flatness Requirement

Stage Travel	Flatness Requirement
All Travels	10 μ m

Applied loads should be symmetrically distributed whenever possible. The payload should be centered on the stage table and the entire stage should be centered on the support structure.

Refer to [Section 1.3](#), for maximum load carrying capacity specifications. If cantilevered loads are applied, refer to the figures that follow ([Figure 2-12](#) through [Figure 2-16](#)) to find the maximum allowable load.



IMPORTANT: Where possible, use 3-point mounting when you attach the payload to the stage.

Figure 2-12: AGR50 Cantilevered Load Capabilities

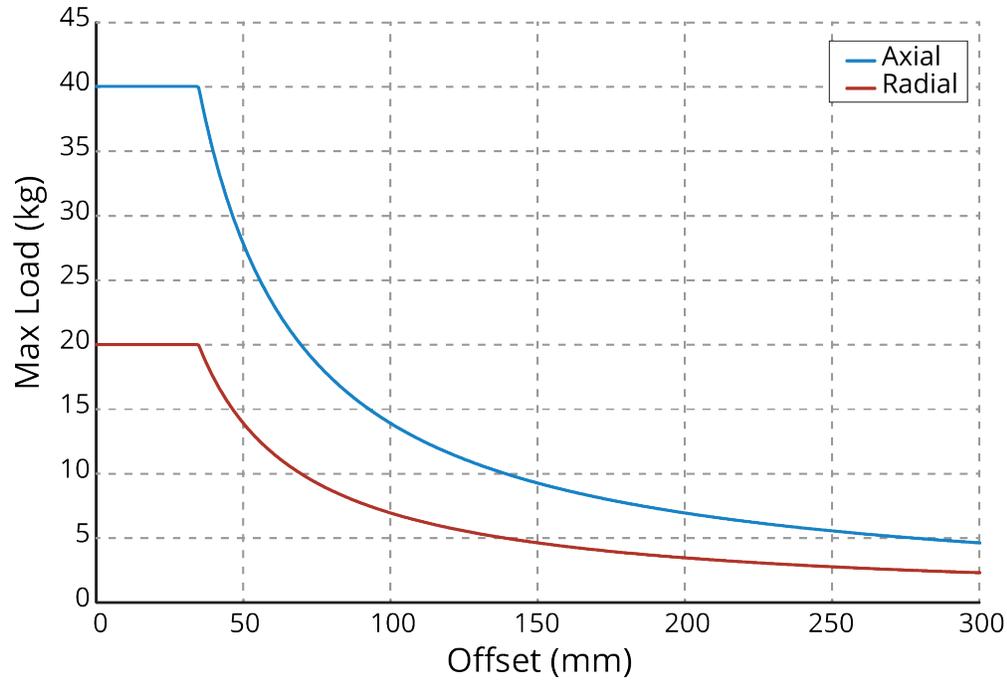


Figure 2-13: AGR75 Cantilevered Load Capabilities

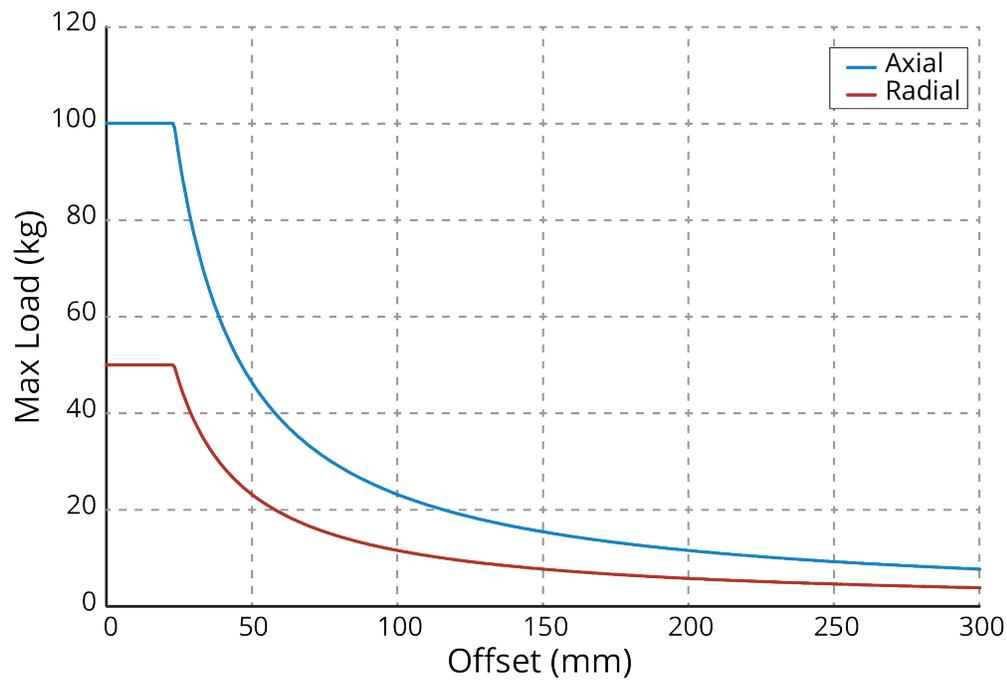


Figure 2-14: AGR100 Cantilevered Load Capabilities

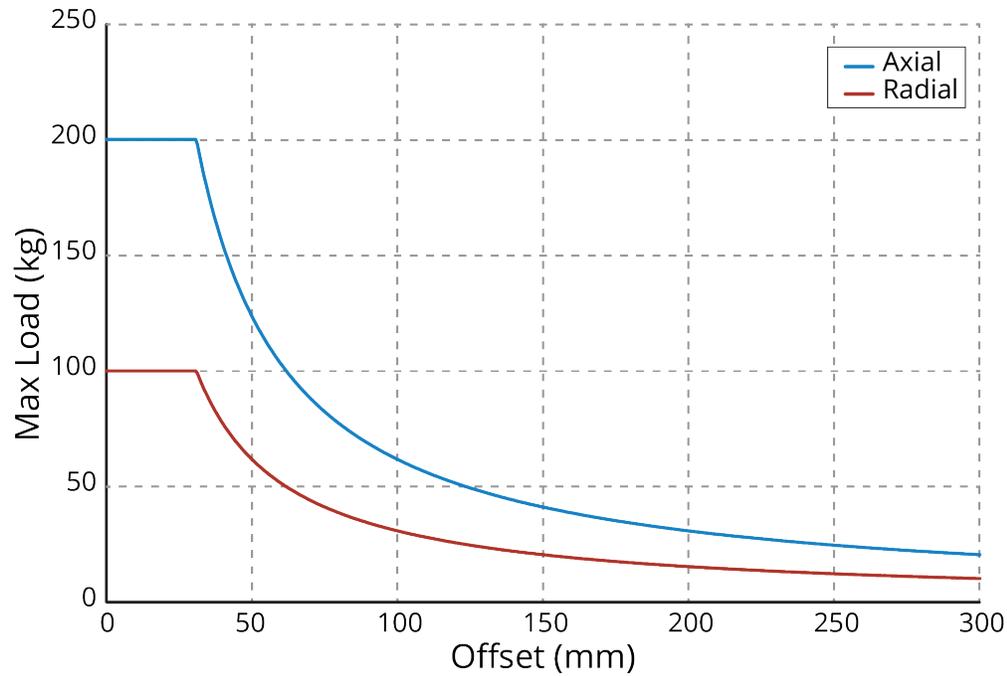


Figure 2-15: AGR150 Cantilevered Load Capabilities

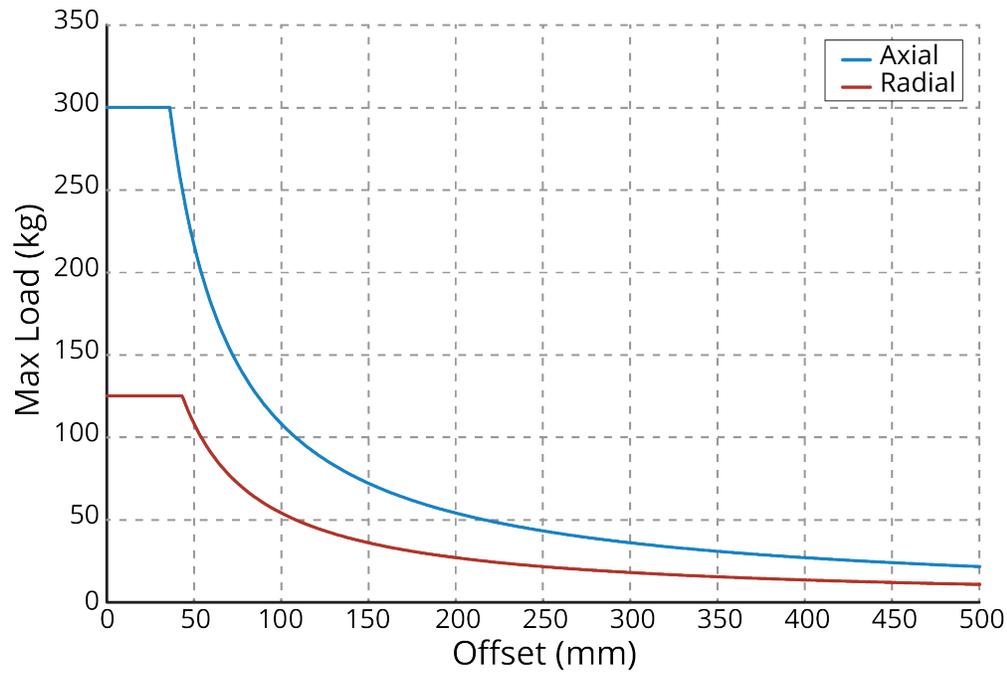
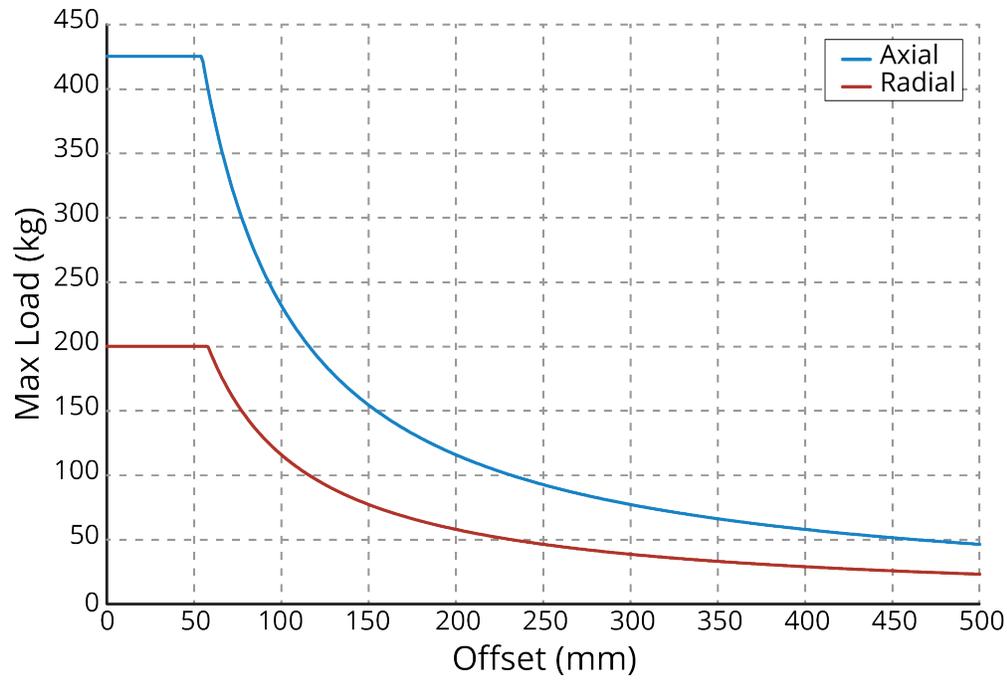


Figure 2-16: AGR200 Cantilevered Load Capabilities



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 AGR 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 AGR 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 AGR 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 AGR 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 (AGR50, AGR75, AGR100, AGR150)

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 D-Style Motor Connectors

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 Connector Pinout (AGR200)

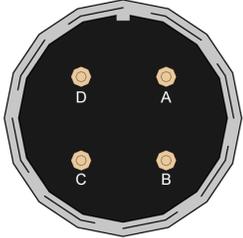
Pin	Description	Connector
A	Motor Phase A	 <p>P/N: MS3101A18-10P</p>
B	Motor Phase B	
C	Motor Phase C	
D	Frame Ground (motor protective ground)	
Backshell	Motor Cable Shield	

Table 3-4: Mating Connector Part Numbers for MS-Style Motor Connectors

Mating Connector	Aerotech P/N	Third Party P/N
Plug	MCM00475	Amphenol MS3106A18
Insert	MCM00495	Amphenol 9718-10S
Bushing	MCM00481	DDK MS3055-18-10
Clamp	MCM00477	Amphenol MS3057A-10

Note: All parts are nickel-plated

Table 3-5: Stepper Motor Connector Pinout

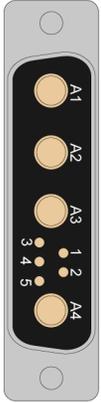
Pin	Description	Connector
Case	Shield Connection	
A1	Motor Phase A	
A2	Motor Phase B	
A3	Motor Phase A Return	
1	Brake - (with Brake Option)	
2	Brake + (with Brake Option)	
3	Reserved	
4	Frame Ground (motor protective ground)	
5	Frame Ground (motor protective ground)	
A4	Motor Phase B Return	

Table 3-6: Mating Connector Part Numbers for D-Style Motor Connectors

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

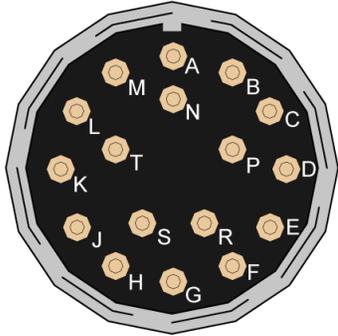
Table 3-7: Feedback Connector Pinout (AGR50, AGR75, AGR100, AGR150)

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	
21	Common ground	
22	Reserved	
23	Reserved	
24	Reserved	
25	Reserved	
	Brake + (with Brake Option)	

Table 3-8: Mating Connector Part Numbers for D-Style Feedback Connectors

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

Table 3-9: Feedback Connector Pinout (AGR200)

Pin	Description	Connector
Case	Shield Connection	 <p>P/N: MS3102R20-29P</p>
A	COS+ (Encoder Cosine+)	
B	COS- (Encoder Cosine-)	
C	SIN+ (Encoder Sine+)	
D	SIN- (Encoder Sine-)	
E	MRK+ (Encoder Marker+)	
F	MRK- (Encoder Marker-)	
G	Common ground	
H	5V Power Supply Input	
J	Reserved	
K	Hall Effect Sensor (Phase A)	
L	BMS Motors: Over-Temperature Thermistor Sensor ⁽¹⁾ BM Motors: Reserved	
M	Hall Effect Sensor (Phase B)	
N	Reserved	
P	Hall Effect Sensor (Phase C)	
R	Reserved	
S	Reserved Brake + (with Brake Option) ⁽¹⁾	
T	Reserved Brake - (with Brake Option) ⁽¹⁾	

(1) 24 VDC @ 1 A max

Table 3-10: Mating Connector Part Numbers for MS-Style Feedback Connectors

Mating Connector	Aerotech P/N	Third Party P/N
Plug	MCM00454	Amphenol MS3106A-20
Insert	MCM00464	Amphenol MS20-29S
Clamp	MCM00457	97-3057-1012
Bushing	MCM00493	Amphenol AN3055-22-12

Note: All parts are nickel-plated

Table 3-11: Stepper Motor Feedback Connector Pinout

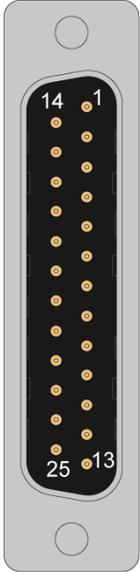
Pin	Description	Connector
Case	Shield Connection	
1	Reserved	
2	Reserved	
3	5V Power Supply Input	
4	Reserved	
5	Reserved	
6	MRK- (Encoder Marker-)	
7	MRK+ (Encoder Marker+)	
8	Reserved	
9	Reserved	
10	Reserved	
11	Reserved	
12	Reserved	
13	Reserved	
14	COS+ (Encoder Cosine+)	
15	COS- (Encoder Cosine-)	
16	5V Power Supply Input	
17	SIN+ (Encoder Sine+)	
18	SIN- (Encoder Sine-)	
19	Reserved	
20	Common	
21	Common	
22	Reserved	
23	Reserved	
24	Reserved	
25	Reserved	

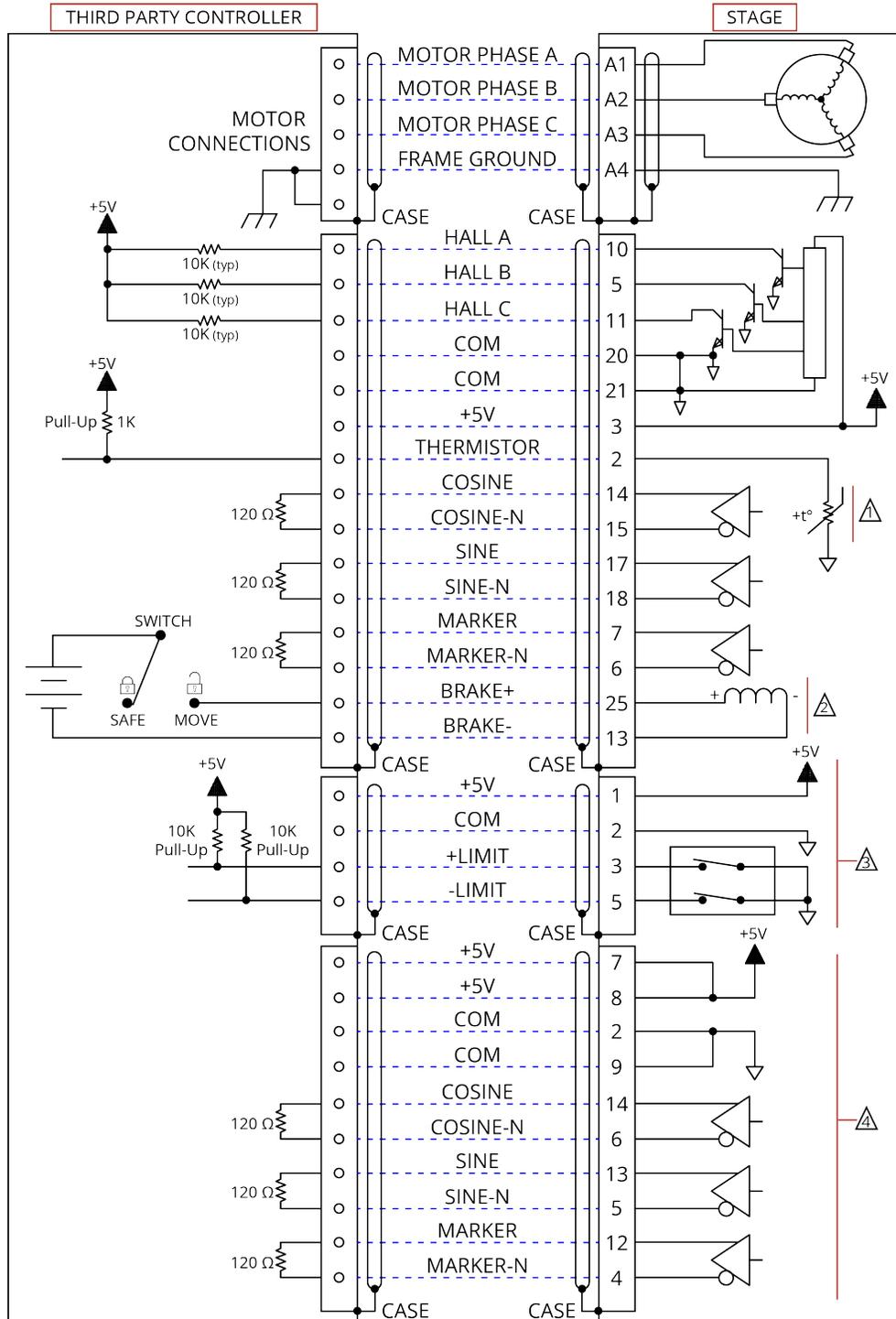
Table 3-12: Mating Connector Part Numbers for D-Style Feedback Connectors

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

3.2. Motor and Feedback Wiring

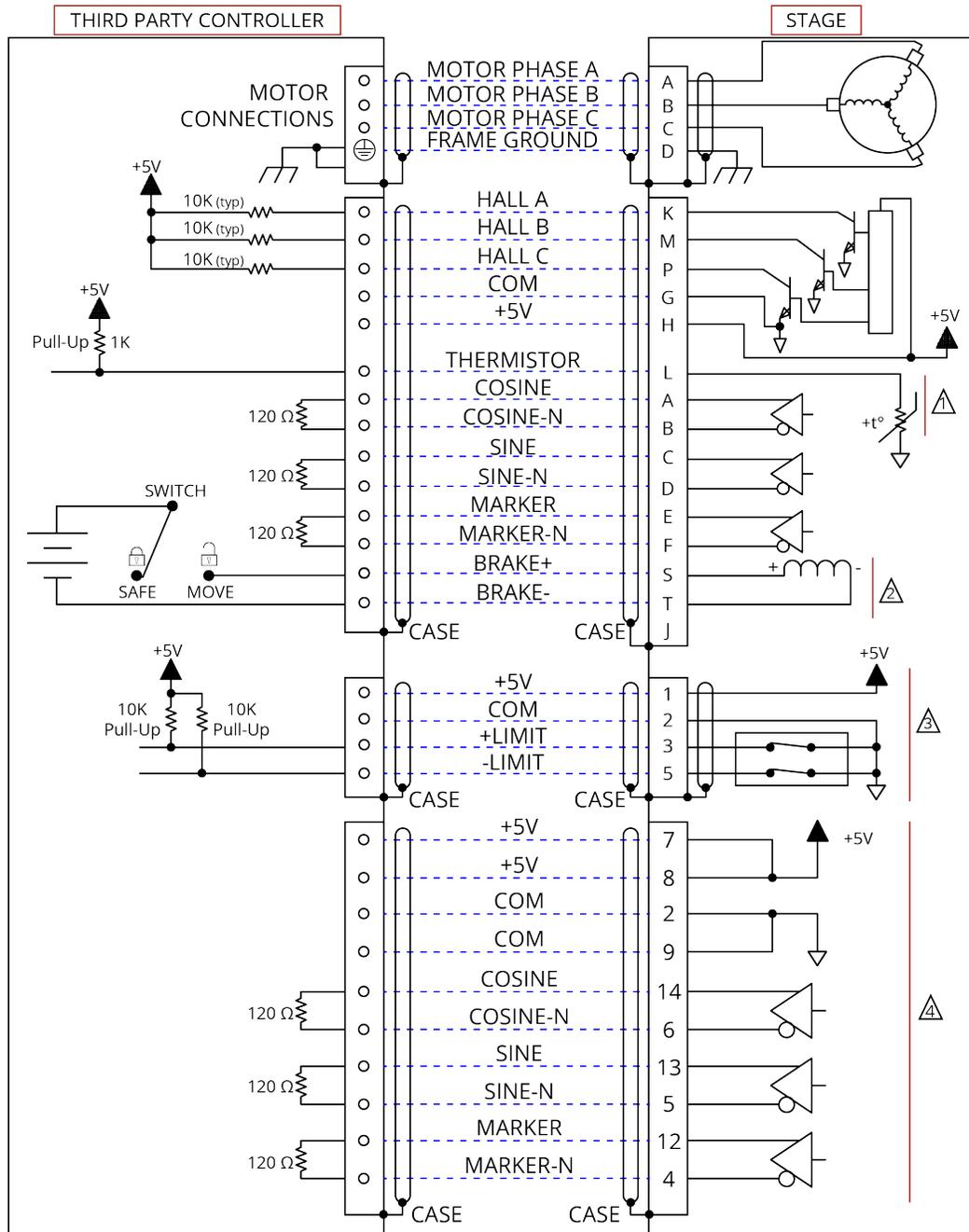
Shielded cables are required for the motor and feedback connections.

Figure 3-1: Brushless Motor and Feedback Wiring (AGR50, AGR75, AGR100, AGR150)



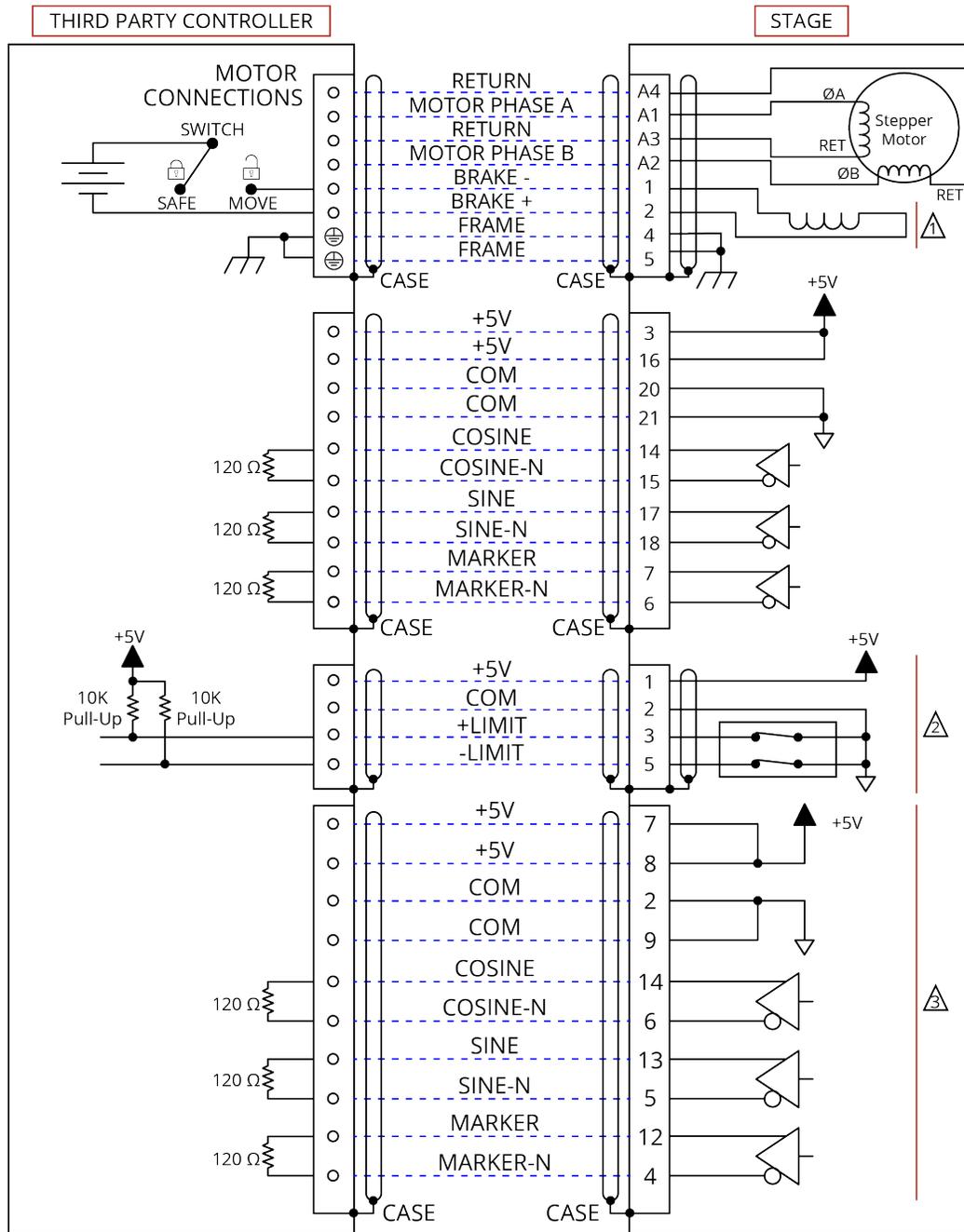
- ⚠ Thermistor is only available on BMS motors (options -M1, -M2, -M3, and -M4).
- ⚠ Brake is optional (options -M2, -M4, -M6, -M8, -M12, -M14).
- ⚠ Limited travel models only. Limit options are factory-configured as Normally Closed [-L1] or Normally Open [-L2]
- ⚠ Only with direct rotary feedback (options -E1, -E2, and -E3)

Figure 3-2: Brushless Motor and Feedback Wiring (AGR200)



- ⚠ Thermistor is only available on BMS motors (options -M1, -M2, -M3, and -M4).
- ⚠ Brake is optional (options -M2, -M4, -M6, -M8).
- ⚠ Limited travel models only. Limit options are factory-configured as Normally Closed [-LI1] or Normally Open [-LI2]
- ⚠ Only with direct rotary feedback (options -E1, -E2, and -E3)

Figure 3-3: Stepper Motor and Feedback Wiring



- ⚠ Brake is optional (options -M8 and -M10).
- ⚠ Limited travel models only. Limit options are factory-configured as Normally Closed [-LI1] or Normally Open [-LI2]
- ⚠ Only with direct rotary feedback (options -E1, -E2, and -E3)

3.3. Motor and Feedback Specifications

Table 3-13: Hall-Effect Sensor Specifications

	Specification
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)

Table 3-14: Thermistor Specifications

	Specification
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.	

Table 3-15: Limit Switch Specifications

	Specification
Supply Voltage	5 V ±5%
Supply Current	25 mA
Output Type	Open Collector
Output Voltage	5 V
Output Current	10 mA (sinking)
Output Polarity (Factory Configured)	Normally Closed (NC) <ul style="list-style-type: none"> Sinks current to ground (Logic "0") when not in limit High impedance (Logic "1") when in limit Requires external pull-up to +5 V (10 kΩ recommended)
	Normally Open (NO) <ul style="list-style-type: none"> Sinks current to ground (Logic "0") when in limit High impedance (Logic "1") when not in limit Requires external pull-up to +5 V (10 kΩ recommended)

Table 3-16: Brake Specifications

	Specification
Supply Voltage	24 VDC
Supply Current ⁽¹⁾	250 mA Typical (AGR50, AGR75, AGR100, AGR150, AGR200) 500 mA Typical (AGR200)
(1) Required to release the brake and allow motion.	

Table 3-17: Encoder Specifications

	Specification
Supply Voltage	5 V \pm 5%
Supply Current	250 mA (typical)
Output Signals (-E1)	Sinusoidal Type (Incremental Encoder): Analog: SIN+, SIN-, COS+, COS-, 1V _{pk-pk} ; Digital (RS422): MRK+, MRK- signals.
Output Signals (-E2, -E3)	Digital Output (Incremental Encoder): TTL Encoder line-driver signals; RS422/485 compatible

Table 3-18: Encoder Resolution

Model	AGR50	AGR75
SM ⁽¹⁾	6.353 arc sec/line	4.836 arc sec/line
BMS (TTL)	3.176 arc sec/line	2.418 arc sec/line
BM (TTL)	2.541 arc sec/line	1.934 arc sec/line
BM/BMS (Amplified Sine) ⁽²⁾	6.353/3.176 arc sec/line	4.836/2.418 arc sec/line
Direct Rotary Encoder	15744 lines/rev	18000 lines/rev
-E1 ⁽²⁾	0.021/0.010 arc sec/line	0.018/0.009 arc sec/line
-E2	4.116 arc sec/line	3.600 arc sec/line
-E3	0.412 arc sec/line	0.360 arc sec/line

1. 1.8° step angle, 20 microsteps
2. BMS (Amplified Sine) and -E1 show x4000 / x8000 total interpolation

Model	AGR100	AGR150
SM ⁽¹⁾	3.812 arc sec/line	2.769 arc sec/line
BM/BMS (TTL)	1.525 arc sec/line	1.108 arc sec/line
BMS (Amplified Sine) ⁽²⁾	3.812/1.906 arc sec/line	2.769/1.385 arc sec/line
Direct Rotary Encoder	23600 lines/rev	31488 lines/rev
-E1 ⁽²⁾	0.014/0.007 arc sec/line	0.010/0.005 arc sec/line
-E2	2.746 arc sec/line	2.058 arc sec/line
-E3	0.275 arc sec/line	0.206 arc sec/line

1. 1.8° step angle, 20 microsteps
2. BMS (Amplified Sine) and -E1 show x4000 / x8000 total interpolation

Model	AGR200
SM ⁽¹⁾	2.571 arc sec/line
BM/BMS (TTL)	1.029 arc sec/line
BMS (Amplified Sine) ⁽²⁾	2.571/1.286 arc sec/line
Direct Rotary Encoder	40000 lines/rev
-E1 ⁽²⁾	0.008/0.004 arc sec/line
-E2	1.62 arc sec/line
-E3	0.162 arc sec/line

1. 1.8° step angle, 20 microsteps
2. BMS (Amplified Sine) and -E1 show x4000 / x8000 total interpolation

Table 3-19: BMS35 and BMS60 Motor Specifications

		BMS35 (AGR50, AGR75)	BMS60 (AGR100, AGR150)
Performance Specifications			
Stall Torque, Continuous ^(1,2,3)	N·m (oz·in)	0.27 (38.0)	0.33 (46.2)
Peak Torque ^(1,2,4)	N·m (oz·in)	1.07 (152.0)	1.31 (184.9)
Rated Power Output, Continuous	W	96	116
Electrical Specifications			
BEMF Constant (Line-Line, Max) ⁽¹⁾	V_{pk}/k_{rpm}	12.9	19.0
Continuous Current, Stall ^(1,2)	$A_{pk} (A_{rms})$	2.5 (1.7)	2.3 (1.6)
Peak Current, Stall ^(1,3)	$A_{pk} (A_{rms})$	9.8 (6.9)	9.2 (6.5)
Torque Constant ^(1,4,5)	$N·m/A_{pk}$ (oz·in/ A_{pk})	0.110 (15.50)	0.140 (20.10)
	$N·m/A_{rms}$ (oz·in/ A_{rms})	0.150 (21.90)	0.200 (28.40)
Motor Constant ^(1,4,5)	$N·m/\sqrt{W}$ (oz·in/ \sqrt{W})	0.046 (6.52)	0.050 (7.02)
Resistance, 25°C (Line-Line) ⁽¹⁾	Ω	5.80	8.40
Inductance (Line-Line) ⁽¹⁾	mH	1.70	1.30
Maximum Bus Voltage ⁽¹⁾	V_{DC}	340	340
Thermal Resistance ⁽¹⁾	°C/W	2.21	1.73
Number of Poles	--	8	8
<p>(1) All performance and electrical specifications have a tolerance of ±10%.</p> <p>(2) Values shown at 75 °C rise above a 25 °C ambient temperature, with housed motor mounted to a 250 mm x 250 mm x 6 mm aluminum heat sink.</p> <p>(3) Peak torque assumes correct rms current; consult Aerotech.</p> <p>(4) Torque constant and motor constant specified at stall.</p> <p>(5) All Aerotech amplifiers are rated A_{pk}; use torque constant in $N·m/A_{pk}$ when sizing.</p>			

Table 3-20: BMS280 Motor Specifications

		BMS280 (AGR200)
Performance Specifications		
Stall Torque, Continuous ^(1,2,3)	N·m (oz·in)	1.60 (227.0)
Peak Torque ^(1,2,4)	N·m (oz·in)	6.41 (908.0)
Rated Power Output, Continuous	W	381
Electrical Specifications		
BEMF Constant (Line-Line, Max) ⁽¹⁾	V_{pk}/k_{rpm}	57.0
Continuous Current, Stall ^(1,2)	A_{pk} (A_{rms})	3.8 (2.7)
Peak Current, Stall ^(1,3)	A_{pk} (A_{rms})	15.2 (10.7)
Torque Constant ^(1,4,5)	$N\cdot m/A_{pk}$ (oz·in/ A_{pk})	0.420 (59.70)
	$N\cdot m/A_{rms}$ (oz·in/ A_{rms})	0.600 (84.50)
Motor Constant ^(1,4,5)	$N\cdot m/\sqrt{W}$ (oz·in/ \sqrt{W})	0.179 (25.34)
Resistance, 25°C (Line-Line) ⁽¹⁾	Ω	5.70
Inductance (Line-Line) ⁽¹⁾	mH	1.10
Maximum Bus Voltage ⁽¹⁾	V_{DC}	340
Thermal Resistance ⁽¹⁾	°C/W	0.93
Number of Poles	--	14
<p>(1) All performance and electrical specifications have a tolerance of $\pm 10\%$.</p> <p>(2) Values shown at 75 °C rise above a 25 °C ambient temperature, with housed motor mounted to a 250 mm x 250 mm x 6 mm aluminum heat sink.</p> <p>(3) Peak torque assumes correct rms current; consult Aerotech.</p> <p>(4) Torque constant and motor constant specified at stall.</p> <p>(5) All Aerotech amplifiers are rated A_{pk}; use torque constant in $N\cdot m/A_{pk}$ when sizing.</p>		

Table 3-21: BM24 and BM75 Motor Specifications

		BM24 (AGR50, AGR75)	BM75 (AGR100, AGR150)
Performance Specifications			
Stall Torque, Continuous	N·m (oz·in)	0.17 (24.2) ^(1,2,4)	0.51 (72.0) ^(1,2,3)
Peak Torque ^(1,2,5)	N·m (oz·in)	0.51 (72.5)	1.30 (181.0)
Rated Power Output, Continuous ^(1,2)	W	53	192
Electrical Specifications			
BEMF Constant (Line-Line, Max)	V_{pk}/k_{rpm}	6.6	9.0
Continuous Current, Stall	$A_{pk} (A_{rms})$	3.1 (2.2) ^(2,4)	9.0 (6.4) ^(2,3)
Peak Current, Stall ^(2,5)	$A_{pk} (A_{rms})$	9.3 (6.6)	22.5 (15.9)
Torque Constant ^(2,6)	$N·m/A_{pk}$ (oz·in/ A_{pk})	0.055 (7.79)	0.06 (8.0)
	$N·m/A_{rms}$ (oz·in/ A_{rms})	0.078 (11.02)	0.08 (11.4)
Motor Constant	$N·m/\sqrt{W}$ (oz·in/ \sqrt{W})	0.054 (7.62) ^(4,6)	0.055 (7.84) ^(3,6)
Resistance, 25°C (Line-Line) ⁽²⁾	Ω	1.07	1.00
Inductance (Line-Line) ⁽²⁾	mH	0.75	1.42
Maximum Bus Voltage ⁽²⁾	V_{DC}	80	340
Thermal Resistance ⁽²⁾	$^{\circ}C/W$	N/A	1.18
Maximum Coil Temperature	$^{\circ}C$	100	N/A
Number of Poles	--	6	8
(1) Performance is dependent upon heat sink configuration, system cooling conditions, and ambient temperature. (2) All performance and electrical specifications have a tolerance of $\pm 10\%$. (3) Values shown at 130 °C rise above a 25 °C ambient temperature, with housed motor mounted to a 305 mm x 305 mm x 12.7 mm aluminum heat sink. (4) Values shown at 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. (5) Peak torque assumes correct rms current; consult Aerotech. (6) Torque constant and motor constant specified at stall.			

Table 3-22: BM250 Motor Specifications

		BM250 (AGR200)
Performance Specifications		
Stall Torque, Continuous ^(1,2,3)	N·m (oz·in)	2.30 (322.0)
Peak Torque ^(1,2,4)	N·m (oz·in)	5.70 (805.0)
Rated Power Output, Continuous ^(1,2)	W	739
Electrical Specifications		
BEMF Constant (Line-Line, Max)	V_{pk}/k_{rpm}	28.0
Continuous Current, Stall ^(2,3)	A_{pk} (A_{rms})	10.3 (7.3)
Peak Current, Stall ^(2,4)	A_{pk} (A_{rms})	25.6 (18.1)
Torque Constant ^(2,5)	$N\cdot m/A_{pk}$ (oz·in/ A_{pk})	0.220 (31.40)
	$N\cdot m/A_{rms}$ (oz·in/ A_{rms})	0.310 (44.40)
Motor Constant ^(3,5)	$N\cdot m/\sqrt{W}$ (oz·in/ \sqrt{W})	0.206 (29.22)
Resistance, 25°C (Line-Line) ⁽²⁾	Ω	1.10
Inductance (Line-Line) ⁽²⁾	mH	2.74
Maximum Bus Voltage ⁽²⁾	V_{DC}	340
Thermal Resistance ⁽²⁾	°C/W	0.82
Number of Poles	--	8
<p>(1) Performance is dependent upon heat sink configuration, system cooling conditions, and ambient temperature. (2) All performance and electrical specifications have a tolerance of $\pm 10\%$. (3) Values shown at 130 °C rise above a 25 °C ambient temperature, with housed motor mounted to a 305 mm x 305 mm x 12.7 mm aluminum heat sink. (4) Peak torque assumes correct rms current; consult Aerotech. (5) Torque constant and motor constant specified at stall.</p>		

Table 3-23: SM35 Stepper Motor Specifications

	SM35
NEMA Motor Frame Size	NEMA 17
Stall Torque	0.78 N·m (111 oz·in)
Rated Amps per Phase	3.0 A
Maximum Voltage Across the Motor	35 V
Mechanical Rotor Inertia	1.02E-05 kg·m ² (0.0014 oz·in·s ²)
Full Step Angle	1.8°
Accuracy	±0.09°
Maximum Radial Load	2.9 kg (6.3 lb)
Maximum Thrust Load	1.0 kg (2.2 lb)
Weight	0.50 kg (1.1 lb)

Table 3-24: SM60 Stepper Motor Specifications

	SM60-VT2
NEMA Motor Frame Size	NEMA 23
Stall Torque	1.41 N·m (200 oz·in)
Rated Phase Current	0.84 A
Maximum Voltage Across the Motor	160 V
Mechanical 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)

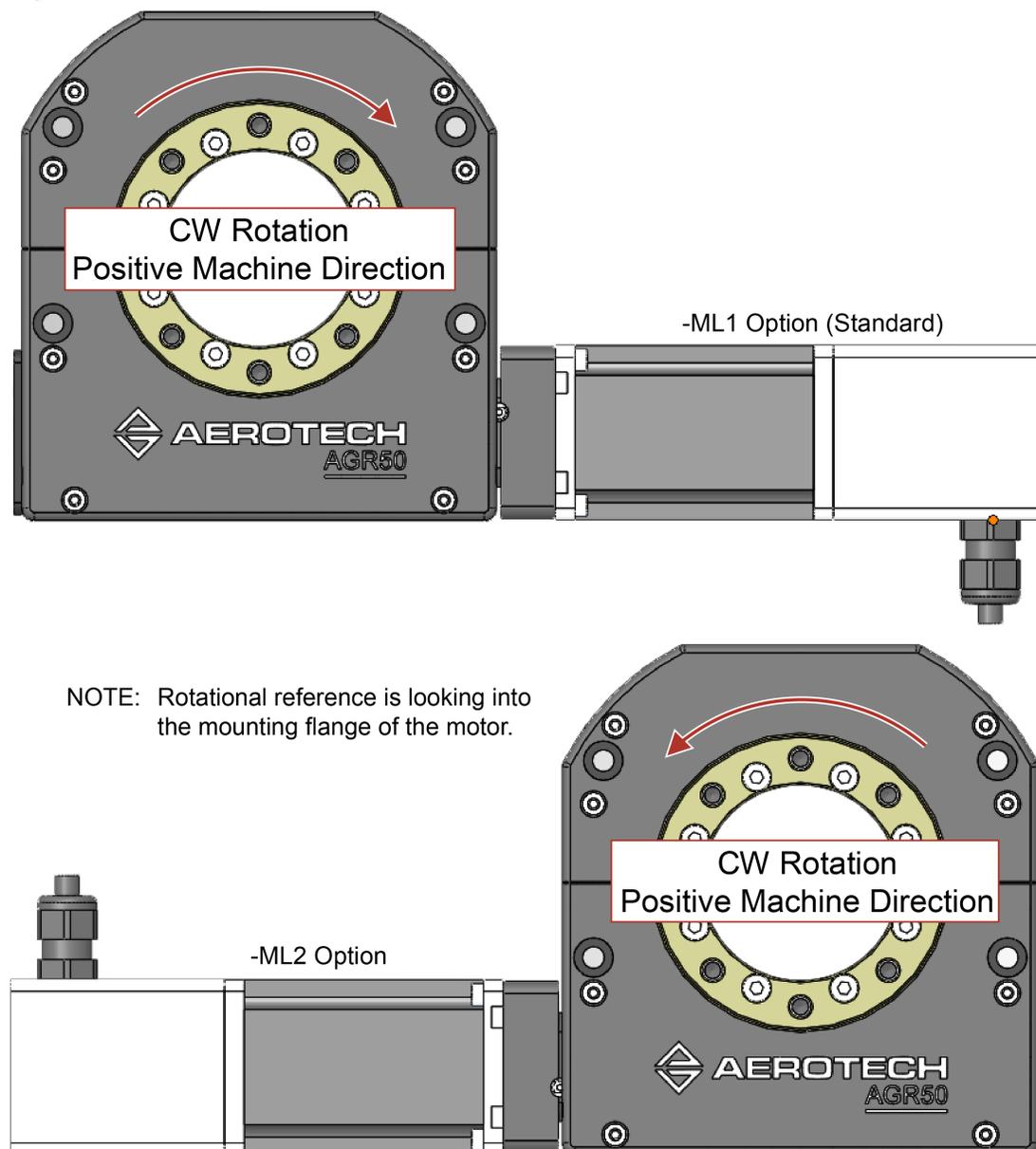
Table 3-25: SM280 Stepper Motor Specifications

	SM280-VT2
NEMA Motor Frame Size	NEMA 34
Stall Torque	8.75 N·m (1238 oz·in)
Rated Phase Current	3.04 A
Maximum Voltage Across the Motor	160 V
Mechanical Rotor Inertia	2.70E-04 kg·m ² (0.038 oz·in·s ²)
Full Step Angle	1.8°
Accuracy	±0.09°
Maximum Radial Load	22.5 kg (50 lb)
Maximum Thrust Load	6.1 kg (14 lb)
Weight	3.8 kg (8.4 lb)

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 3.2](#)). 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 3-4](#) shows the machine direction of AGR stages.

Figure 3-4: Machine Direction



Limited Travel Stages

Limited travel stages (-TRxxx option) have limit flags that can be adjusted to change the travel range of the stage unless the stage is equipped with either the seal or encoder options. If the stage is equipped with a seal or encoder, the stage would need to be sent back to the factory for adjustments.

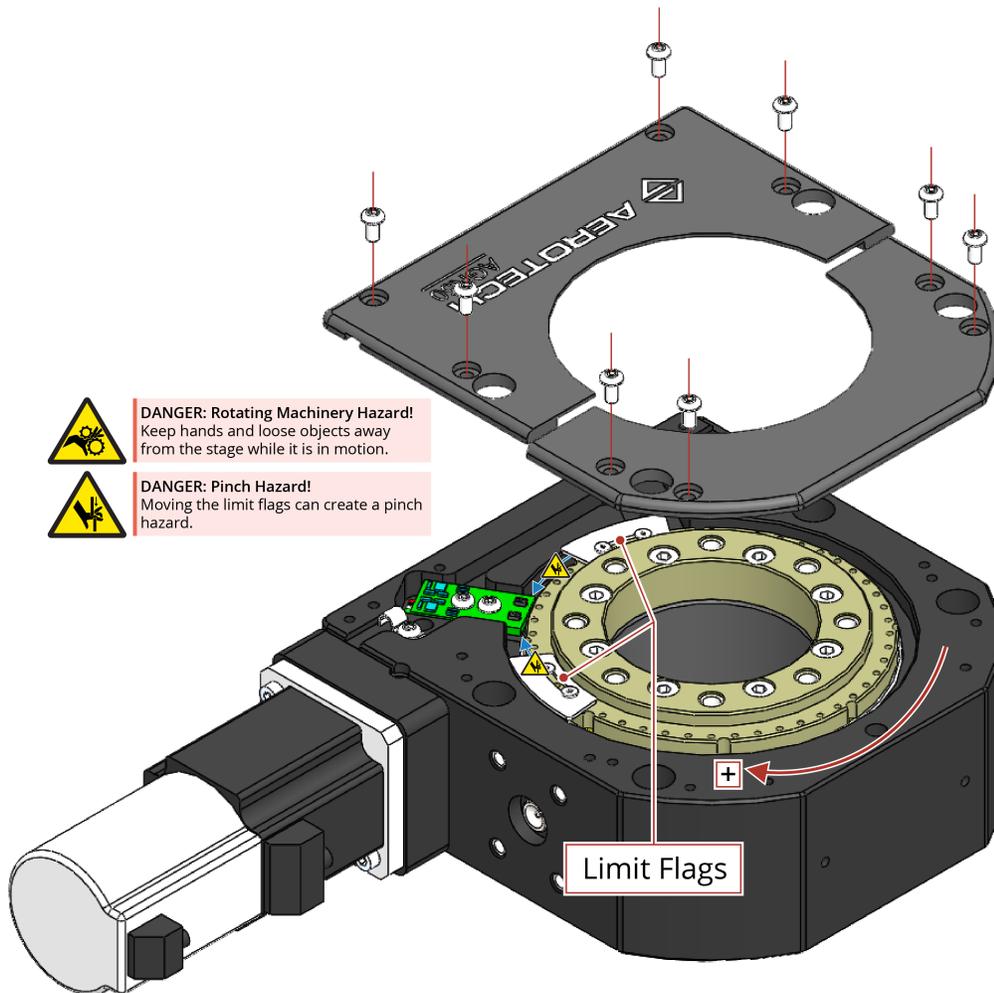


DANGER: Electrical Shock Hazard!

- Before you set up or do maintenance, disconnect electrical power

To make adjustments to the limits, remove the two covers and, if applicable, the tabletop (-TTx option). When you reinstall the covers (and tabletop), make sure that there is no contact between the covers and the stage shaft.

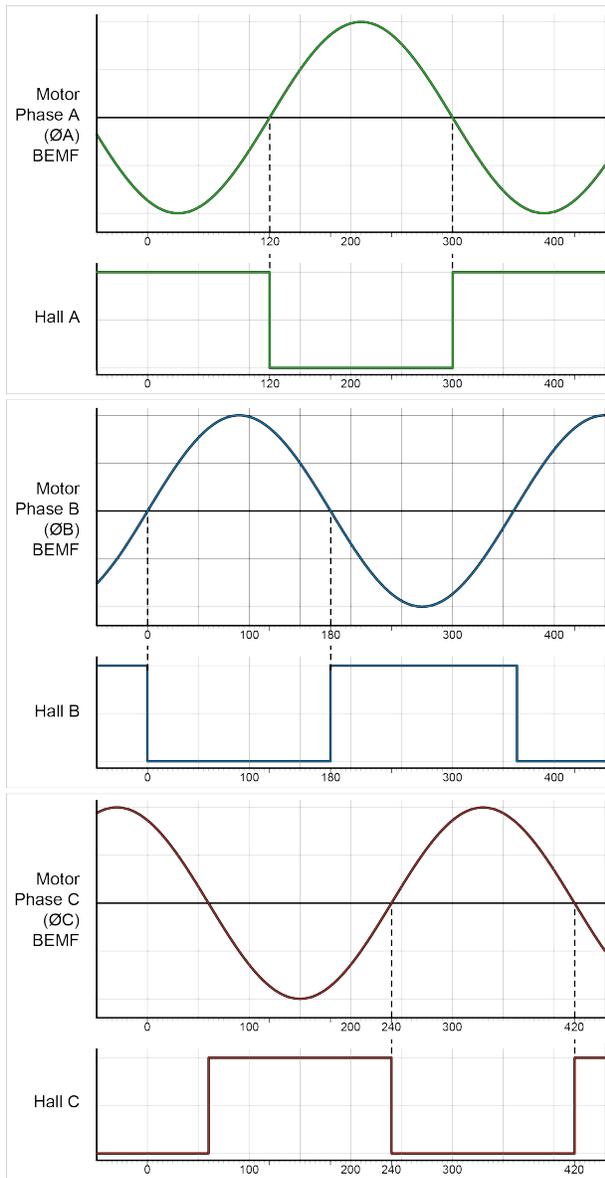
Figure 3-5: Limit Flag Locations



3.5. Motor and Feedback Phasing

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

Figure 3-6: Hall Phasing Diagram



Positive MOVE (Clockwise) →

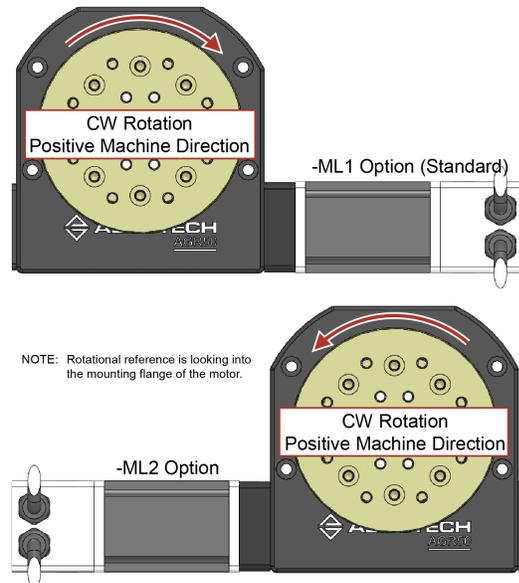


Figure 3-7: Encoder Phasing Reference Diagram (Standard/Square Wave)

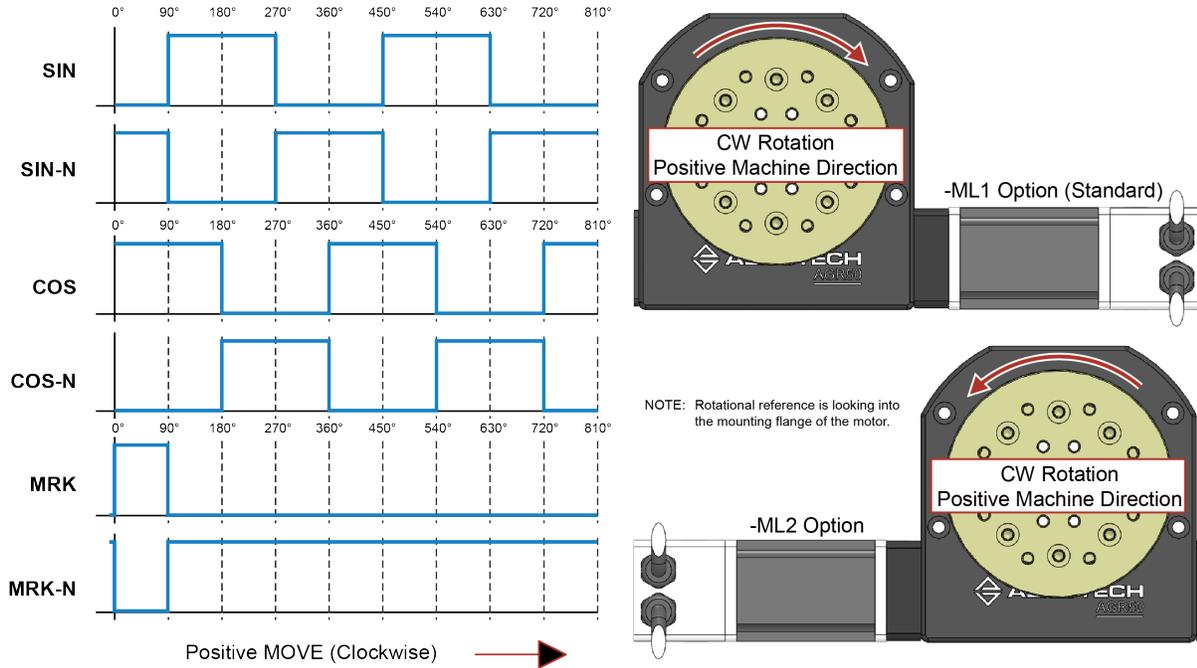
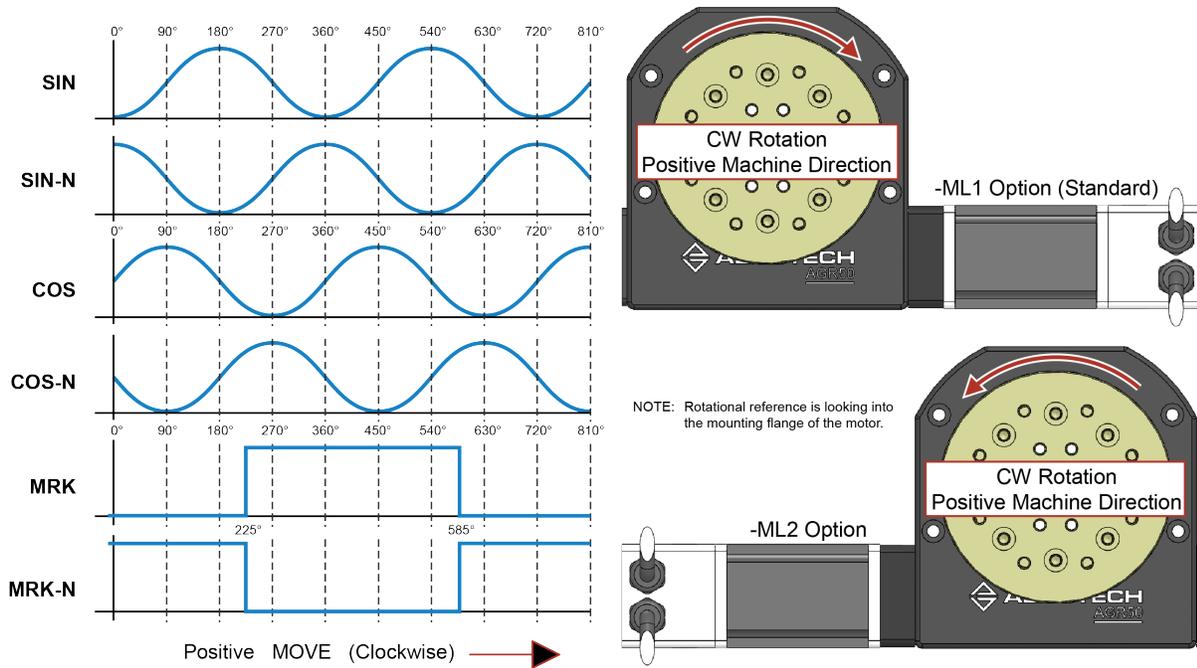


Figure 3-8: Encoder Phasing Reference Diagram (Analog/Sine Wave)



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 AGR 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 AGR and any components and cables as needed.
- Repair any damage before operating the AGR.
- 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.

Cleaning

When you clean components of the AGR series stage:

1. Use a clean, dry, soft, lint-free cloth.
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. 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.
4. 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.

Use isopropyl alcohol on a lint-free cloth to clean any external metal surface of the AGR.



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

Lubrication

In general, stages that operate in a clean environment at 50% duty cycle or less must be lubricated monthly or every 75,000 revolutions (whichever comes first). For long-term reliability, we recommend that you return the stage to Aerotech after 300,000 rotation cycles for cleaning, relubrication, and gearing adjustments. For stages that operate at higher duty cycles, lubrication once every two weeks is recommended.

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 and worm drive.

For the worm gear drive mechanism, use **Mobilith SHC 100** grease.



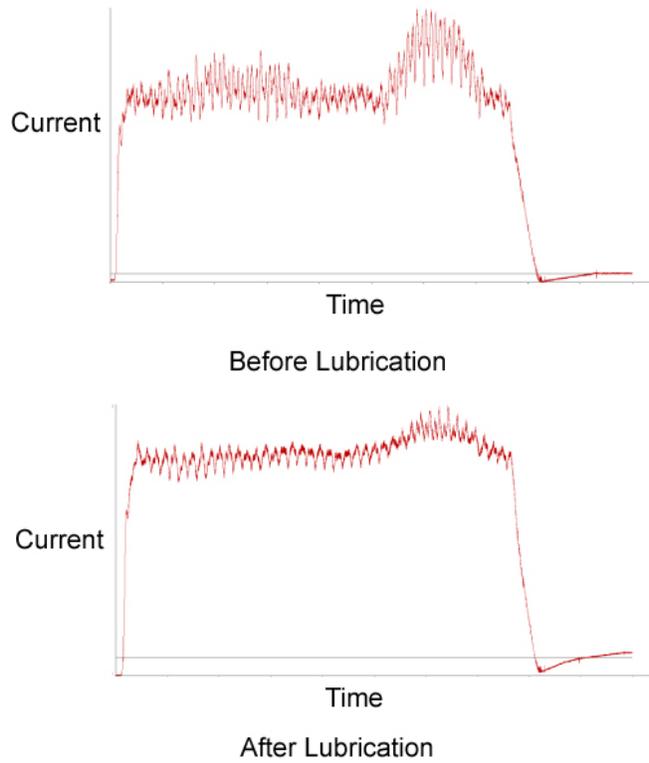
IMPORTANT: AGR stages were previously assembled using **Klubersynth BEM 44-461 US** grease. Klubersynth BEM 44-461 US is compatible with the new Mobilith SHC 100 grease; however, AGR stages that were assembled with Klubersynth can continue to use Klubersynth for regular maintenance lubrication.

AGR rotary stages are designed for easy maintenance of the worm drive system. The drive mechanism can be lubricated while the stage is under power and integrated in upper level systems providing access to the lubrication ports are maintained. Access to the lubrication ports are provided by removing the port cover screws shown in [Figure 1-1](#). Prior to removing the screws, make sure the surrounding surface is clean.

While the stage rotates (<5 rpm), slowly inject approximately 6 cc's of lubricant into the ports. Wipe clean any excess lubricant and reinstall the port cover screws.

Figure 4-1 shows the effect of the addition of lubricant to the current draw of a typical AGR stage. With the added lubricant the resulting current pull is much smoother, leading to much better mechanical performance and maximum life of the product.

Figure 4-1: View of the Current Draw Before and After Lubrication (Typical)



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

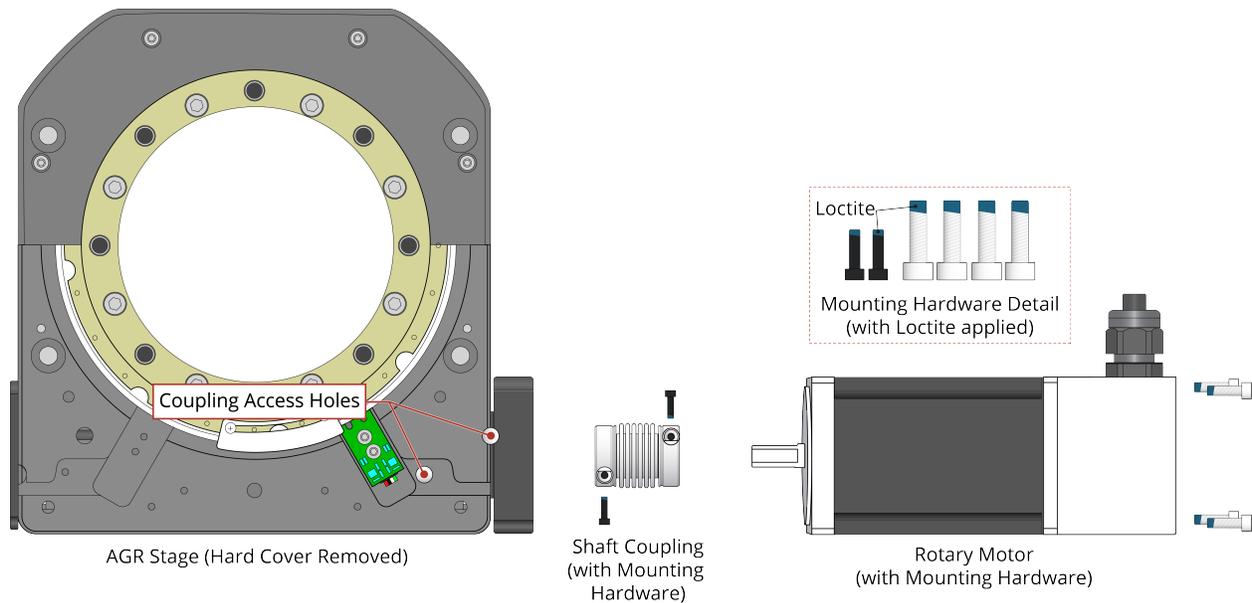
Motor Screw Size	Shaft Coupling Screw Size	Coupling Screw Bit Size	Coupling Screw Torque
M4	M2.5	2 mm Hex	7 in·lbs
M4	M3	2.5 mm Hex	13 in·lbs
M5	M4	3 mm Hex	44 in·lbs



IMPORTANT: Use Loctite 242 or Loctite 248 on the motor and coupling adapter hardware (Figure 4-2). 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.

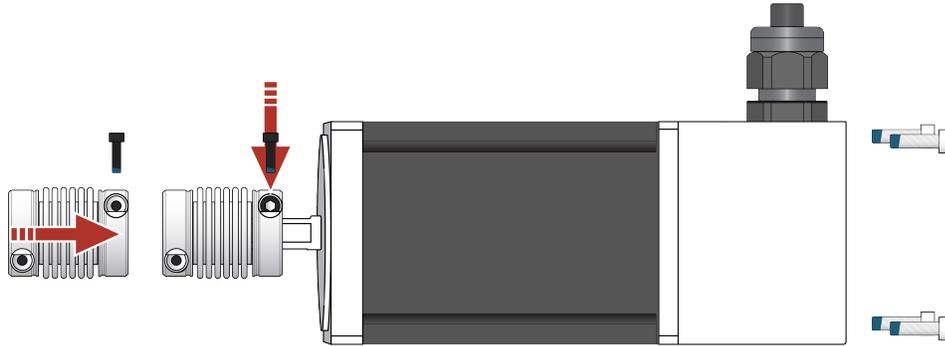
Figure 4-2: Motor Mounting Overview



How to Mount a Motor

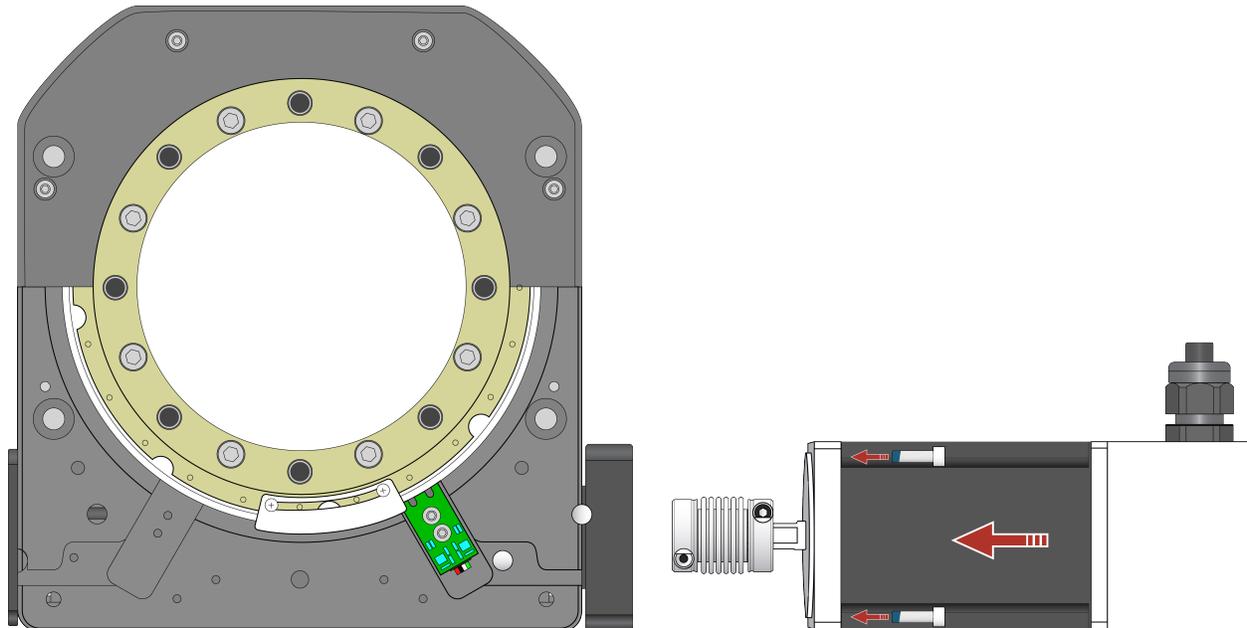
1. Remove the hard cover from the stage.
2. Locate the Shaft Coupling access holes (refer to [Figure 4-2](#)).
3. Test fit the Motor and Shaft Coupling to the Stage to ensure that you have access to the Shaft Coupling clamp screws.
4. Apply a small quantity of either Loctite 242 or Loctite 248 to motor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

Figure 4-3: Attach the Coupling Adapter to the Motor Shaft



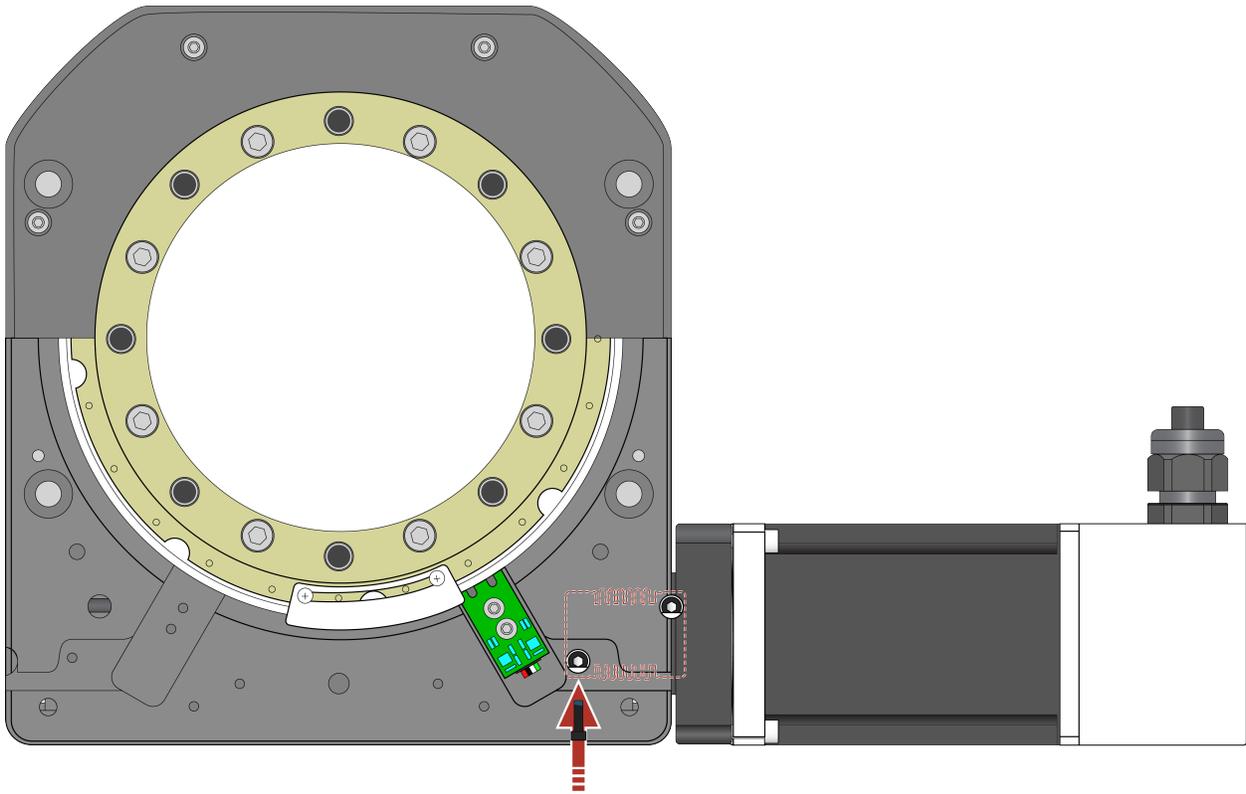
6. Attach the Motor to the Stage in the correct orientation ([Figure 4-4](#)). Use a hex wrench to ensure that the motor flange is fully seated and the hardware is tight. The motor housing prevents the use of a torque wrench.

Figure 4-4: Attach the Motor the Stage



7. Tighten the Shaft Coupling to the drive screw (Figure 4-5). Refer to Table 4-1 for the correct hardware and torque requirements.

Figure 4-5: Tighten the Shaft Coupling to the Drive Screw



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

4.4. Troubleshooting

Table 4-2: Troubleshooting

Symptom	Possible Cause and Solution
Stage will not move	<ul style="list-style-type: none"> • Brake not released (if equipped with brake; refer to stage documentation). • 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	<ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • Gains misadjusted (refer to the Controller documentation). • Encoder signals (refer to the Controller documentation).
The “no motor” option has been selected or for motor service	Access to the motor coupling is provided by removing half of the split top cover that is directly above the rotary motor (refer to Figure 1-1 for locations of the coupling access holes).

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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	General Information
2.00	<ul style="list-style-type: none">• Product update• Updated safety information• Updated EU Declaration of Incorporation• Added UKCA Declaration of Incorporation
1.06	Revision changes have been archived. If you need a copy of this revision, contact Aerotech Global Technical Support.
1.05	
1.04	
1.03	
1.02	
1.01	
1.00	

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