



APR200DR High-Precision Mechanical Bearing 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:

APR200DR 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
6/15/2023

Date

UKCA Declaration of Incorporation

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



herewith declares that the product:

APR200DR 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

Managing Director
Aerotech Ltd
The Old Brick Kiln, Ramsdell, Tadley
Hampshire RG26 5PR
UK

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
6/15/2023

Date

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.
- Make sure that all pneumatic lines are securely connected.
- Use care when you move the APR200DR 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 of 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!

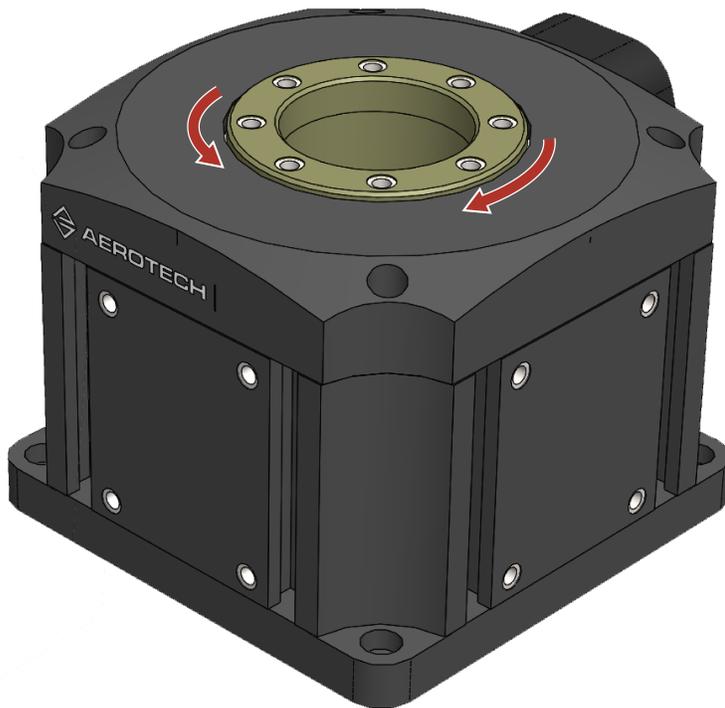


- System travel can cause crush, shear, or pinch injuries.
- Only trained operators should operate this equipment.
- Do not put yourself in the travel path of machinery.
- Restrict access to all motor and stage parts
 - when the system moves under power (during normal operation, for example).
 - when 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 APR200DR 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.

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.

Shipping Brackets

If the APR200DR 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

APR200

APR High-Precision Mechanical Bearing Rotary Stage			
APR200DR-155			
APR200DR-185			
Feedback (Required)			
-E1	Incremental Encoder: Analog 1 Vpp		
-E2	Incremental Encoder: Digital RS422, x1000 interpolation		
-E3	Incremental Encoder: Digital RS422, x10000 interpolation		
-E4	Absolute Encoder		
-E5	High-Accuracy Incremental Encoder: Digital RS422, x1000 interpolation		
-E6	High-Accuracy Incremental Encoder: Digital RS422, x10000 interpolation		
Motor (Required)			
-M1	Low current, -A winding		
-M2	Low voltage, -B winding		
Tabletop (Optional)			
-TT1	Metric graduated tabletop		
-TT2	English graduated tabletop		
Limited Travel (Optional)			
	Continuous travel	-TR120	±60 degrees
-TR010	±5 degrees	-TR140	±70 degrees
-TR020	±10 degrees	-TR160	±80 degrees
-TR040	±20 degrees	-TR180	±90 degrees
-TR060	±30 degrees	-TR200	±100 degrees
-TR080	±40 degrees	-TR240	±120 degrees
-TR100	±50 degrees	-TR270	±135 degrees
NOTE: -TRxxx options have an extra 1.5 degrees between the nominal travel and the electrical limit on each side. For example: -TR270 has ±135 degrees of nominal travel, with ±136.5 degrees of travel between electrical limits.			
Hardstops (Optional)			
-HS	Mechanical hard stops		
NOTE: -HS option requires the selection of a tabletop option (-TTx) and a limited travel option (-TRxxx).			
Brake (Optional)			
-BK	Holding brake		
Metrology (Required)			
-PL3	Uncalibrated with performance plots		
-PL4	Calibrated (HALAR) with performance plots		
Integration (Required)			
-TAS	Test as system: Testing, integration, and documentation of a group of components as a complete system that will be used together.		
-TAC	Test as components: Testing and integration of individual items as discrete components that ship together.		

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 of 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° to 35° C (50° 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.
Humidity	Storage: 0° to 40° C (32° 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	These stages are not suited for dusty or wet environments. This equates to an ingress protection rating of IP30.
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](#).

1.3. Basic Specifications

Resolution is dependent on encoder resolution and controller interpolation.

Table 1-3: APR200DR Series Specifications

			APR200DR-155	APR200DR-185
Travel			Continuous (Optional 270° Max Limited)	
Accuracy	-E1, -E2, -E3, -E4	Uncalibrated	33 arc sec	
		Calibrated	3.00 arc sec	
	-E5, -E6	Uncalibrated	3.00 arc sec	
		Calibrated	1.75 arc sec	
Resolution (Minimum Incremental Motion)			0.06 arc sec	
Bidirectional Repeatability ⁽¹⁾			1.00 arc sec	
Unidirectional Repeatability			0.50 arc sec	
Total Tilt Error Motion ⁽²⁾			2.00 arc sec	
Total Axial Error Motion ⁽²⁾			1.50 μm	
Total Radial Error Motion ⁽²⁾			1.50 μm	
Maximum Speed ⁽³⁾	-M1		600 rpm	
	-M2		800 rpm	
Aperture			75 mm	
Maximum Torque (Continuous)			11.12 N·m	15.93 N·m
Load Capacity	Axial		205 kg	
	Radial		100 kg	
Rotor Inertia (Unloaded)			0.026 kg·m ²	0.032 kg·m ²
Stage Mass ⁽⁴⁾			17.8 kg	22 kg
Material			Aluminum; Hardcoat/Anodize Finish	
MTBF (Mean Time Between Failure)			20,000 hours	
<p>(1) Certified with each stage.</p> <p>(2) All error motion specifications are measured at 60 rpm.</p> <p>(3) Maximum speed listed is stage and motor dependent (and assumes a 340 V bus). The actual speed could be lower due to motor back emf or encoder bandwidth. Consult an Aerotech Applications Engineer for more details.</p> <p>(4) Mass listed is for the standard stage option (no brake and no tabletop). Consult Aerotech for brake and tabletop masses. Mass listed is for the standard stage option (no brake and no tabletop). Consult Aerotech for brake and tabletop masses.</p>				

1.4. Vacuum Operation

There are two vacuum preparation options:

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

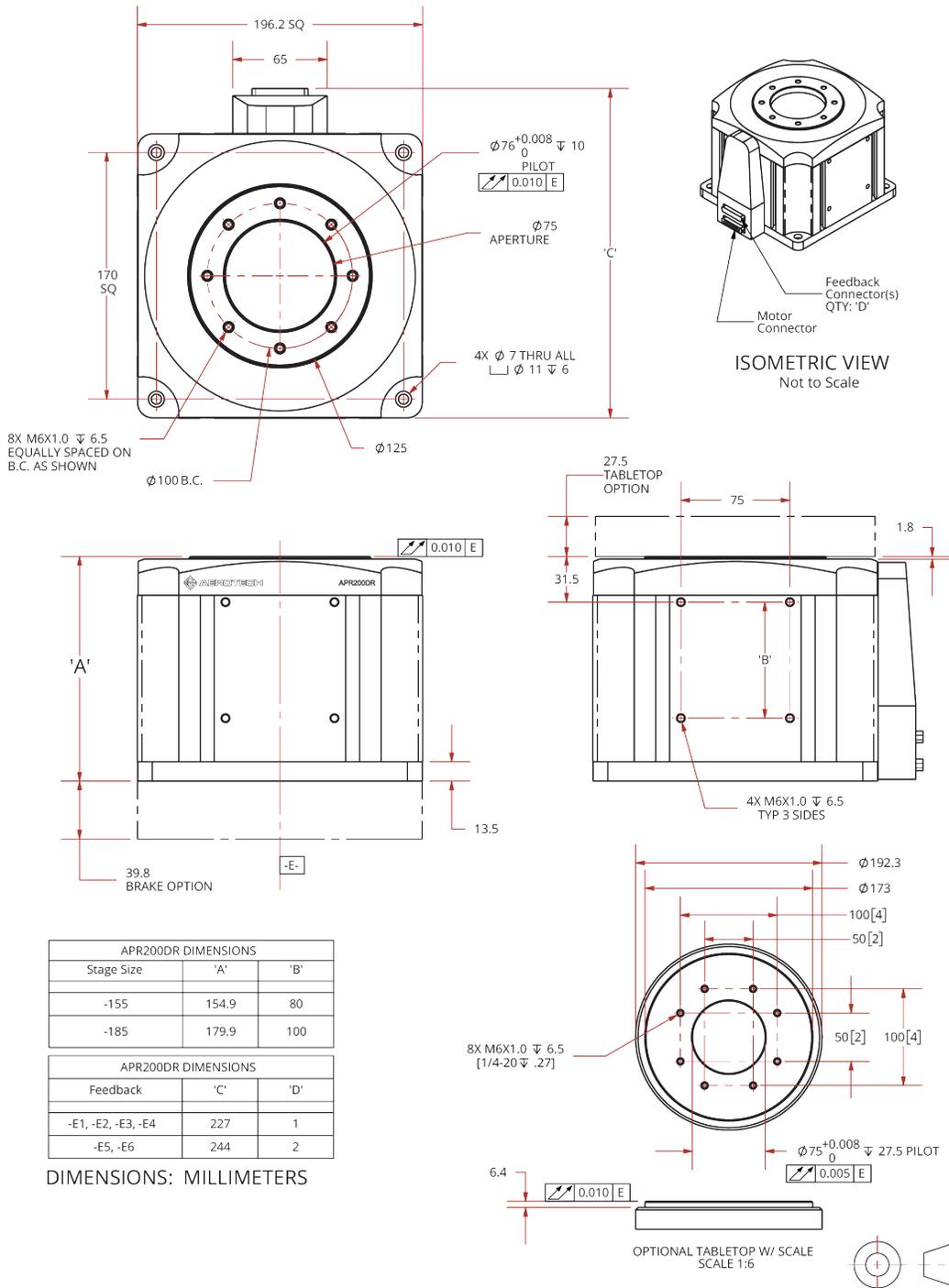
Chapter 2: Installation



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: APR200DR Dimensions



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

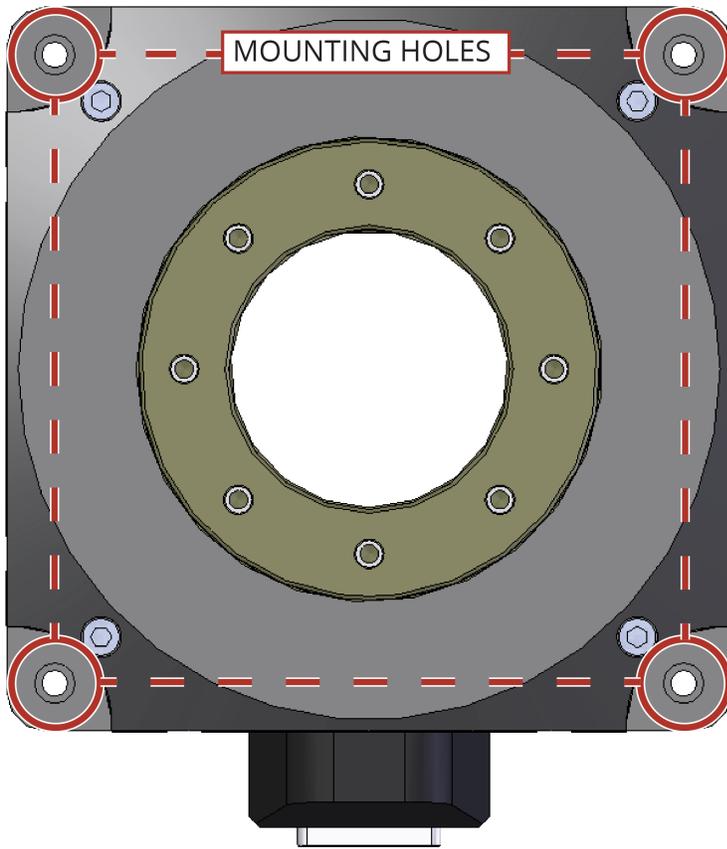
Stage	Flatness Requirement
All Frame Sizes	5 μm

APR200DR series stages have a fixed mounting pattern available to secure the stage to a mounting surface. [Figure 2-2](#) 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
M6 SHCS	7 N·m

Figure 2-2: APR200DR 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 APR200DR 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 APR200DR 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	5 μ m

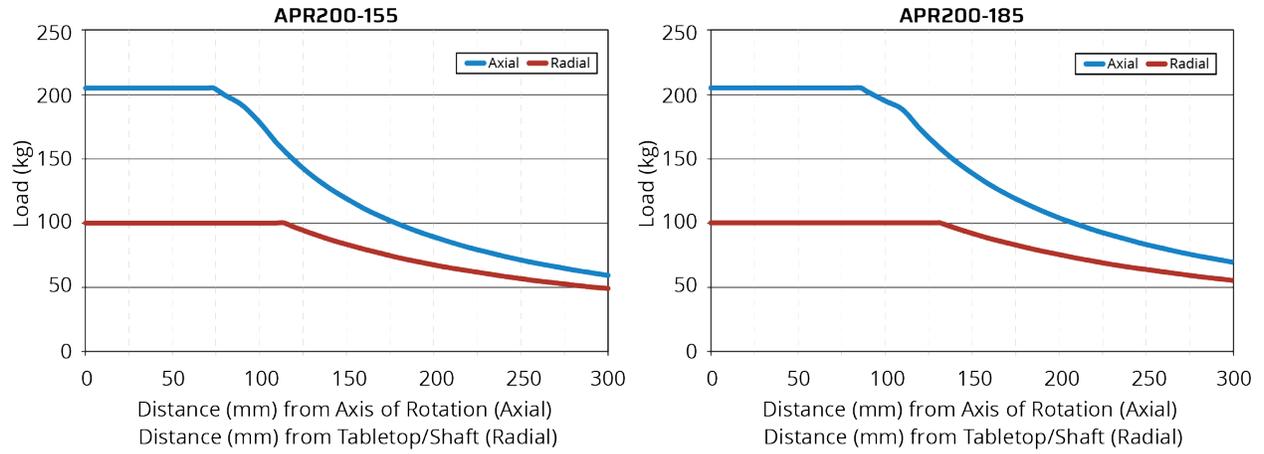
Applied loads should be symmetrically distributed whenever possible. The payload should be centered on the stage table and the entire stage should be centered on the support structure.

Refer to [Section 1.3](#). for maximum load carrying capacity specifications. If cantilevered loads are applied, refer to the [Figure 2-3](#) to find the maximum allowable load.



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

Figure 2-3: Cantilevered Load Capabilities



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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 APR200DR 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 APR200DR 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 APR200DR 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 APR200DR 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.

Figure 3-1: Electrical Connections

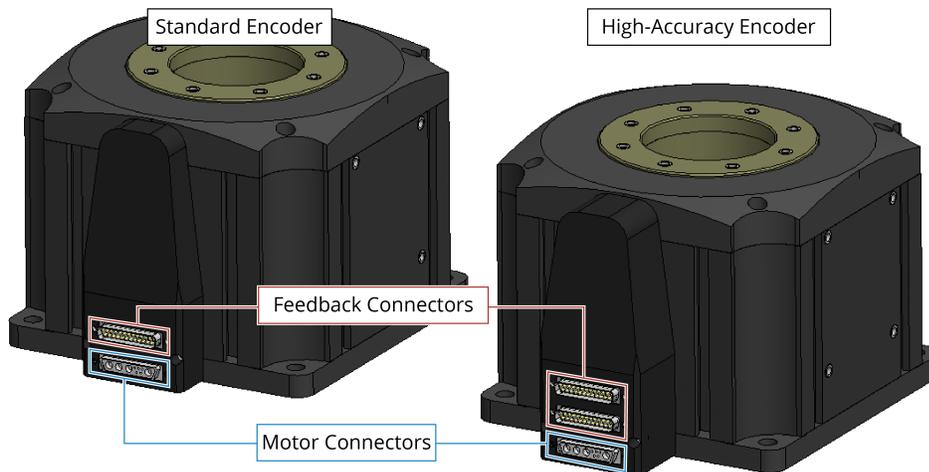


Table 3-1: High Power D-Style Motor Connector Pinout

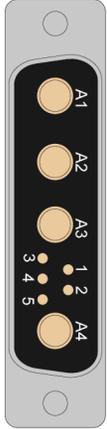
Pin	Description	Connector
Case	Shield Connection	
A1	Motor Phase A	
A2	Motor Phase B	
A3	Motor Phase C	
1	Reserved	
2	Reserved	
3	Reserved	
4	Reserved	
5	Reserved	
A4	Frame Ground (motor protective ground)	

Table 3-2: Mating Connector Part Numbers for the 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

The wiring of the feedback connector depends on the encoder option selected (sine wave (analog) or absolute).

Table 3-3: Feedback Connector Pinout (-E1, -E2, -E3, -E5, -E6 options)

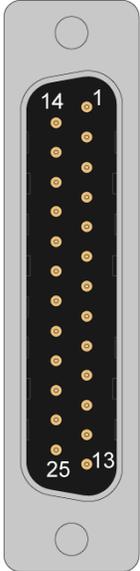
Pin	Description	Connector
Case	Shield Connection	
1	Reserved	
2	Over-Temperature Thermistor Sensor	
3	Encoder 5V Supply Input	
4	Reserved	
5	Hall Effect Sensor (Phase B)	
6	MRK- (Encoder Marker-)	
7	MRK+ (Encoder Marker+)	
8	Reserved	
9	Reserved	
10	Hall Effect Sensor (Phase A)	
11	Hall Effect Sensor (Phase C)	
12	+ /CW LMT (End-of travel limit signal that indicates maximum permitted stage travel in the "machine positive" or "machine clockwise" direction.) [with the Limited Travel option]	
13	Brake - [with -BK option]	
14	COS+ (Encoder Cosine+)	
15	COS- (Encoder Cosine-)	
16	Encoder 5V Supply Input	
17	SIN+ (Encoder Sine+)	
18	SIN- (Encoder Sine-)	
19	Reserved	
20	Common ground (internally connected to PIN-21)	
21	Common ground (internally connected to PIN-20)	
22	Reserved	
23	Reserved	
24	- /CCW LMT (End-of travel limit signal that indicates maximum permitted stage travel in the "machine negative" or "machine counter-clockwise" direction.) [with the Limited Travel option]	
25	Brake + [with -BK option]	

Table 3-4: Mating Connector Part Numbers for the 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: Feedback Connector Pinout (-E4 option)

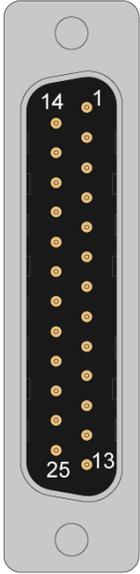
Pin	Description	Connector
Case	Shield Connection	
1	Reserved	
2	Over-Temperature Thermistor Sensor	
3	Encoder 5V Supply Input	
4	Reserved	
5	Hall Effect Sensor (Phase B)	
6	CLK- (Absolute Encoder Clock-)	
7	CLK+ (Absolute Encoder Clock+)	
8	DATA- (Absolute Encoder Data-)	
9	Reserved	
10	Hall Effect Sensor (Phase A)	
11	Hall Effect Sensor (Phase C)	
12	+ /CW LMT (End-of travel limit signal that indicates maximum permitted stage travel in the “machine positive” or “machine clockwise” direction.) [with the Limited Travel option]	
13	Brake - [with -BK option]	
14	Reserved	
15	Reserved	
16	Encoder 5V Supply Input	
17	Reserved	
18	Reserved	
19	DATA+ (Absolute Encoder Data+)	
20	Common ground (internally connected to PIN-21)	
21	Common ground (internally connected to PIN-20)	
22	Reserved	
23	Reserved	
24	- /CCW LMT (End-of travel limit signal that indicates maximum permitted stage travel in the “machine negative” or “machine counter-clockwise” direction.) [with the Limited Travel option]	
25	Brake + [with -BK option]	

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

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

The high-accuracy encoder options include a secondary feedback connector.

Table 3-7: Secondary Feedback Connector Pinout (-E5 and -E6 options)

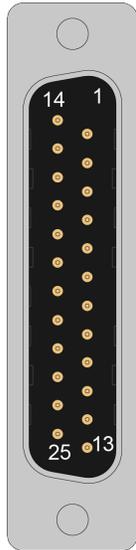
Pin	Description	Connector
Case	Shield Connection	
1	Reserved	
2	Reserved	
3	5V Power Supply Input	
4	Reserved	
5	Reserved	
6	MRK- (Encoder Marker-)	
7	MRK+ (Encoder Marker+)	
8	Reserved	
9	Reserved	
10	Reserved	
11	Reserved	
12	Reserved	
13	Reserved	
14	COS+ (Encoder Cosine+)	
15	COS- (Encoder Cosine-)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

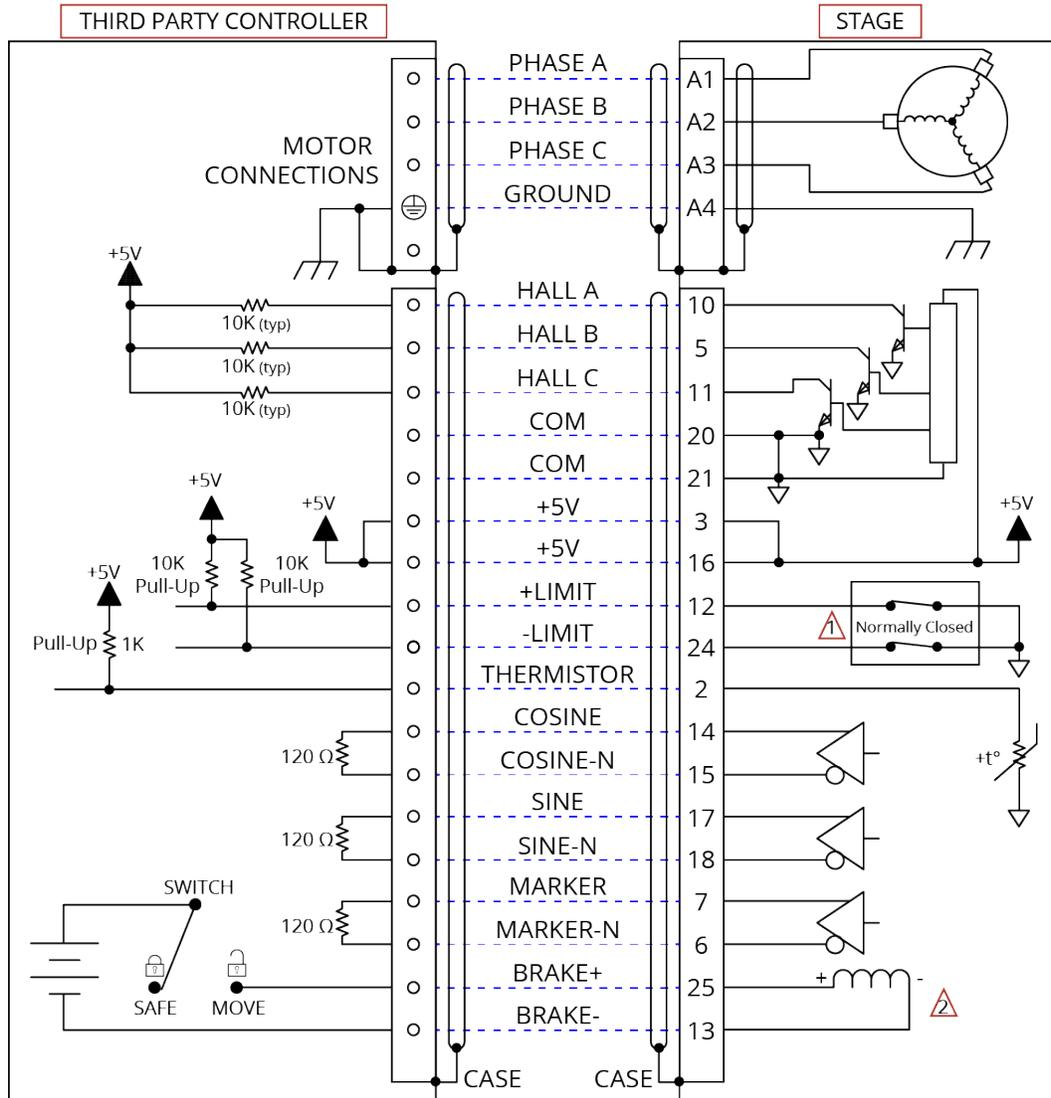
Table 3-8: Mating Connector Part Numbers for the Feedback Connector

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

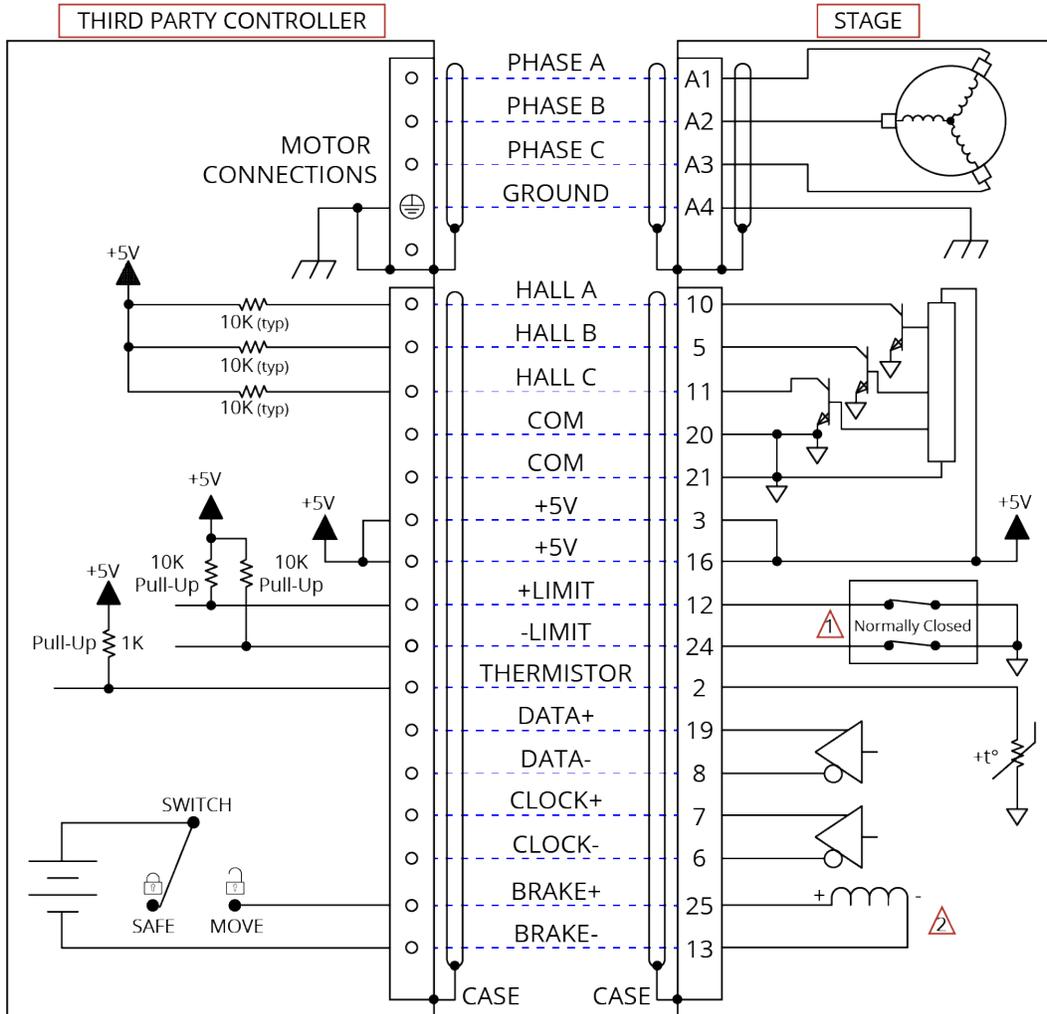
Shielded cables are required for the motor and feedback connections.

Figure 3-2: APR200DR Motor and Feedback Wiring (-E1, -E2, -E3)



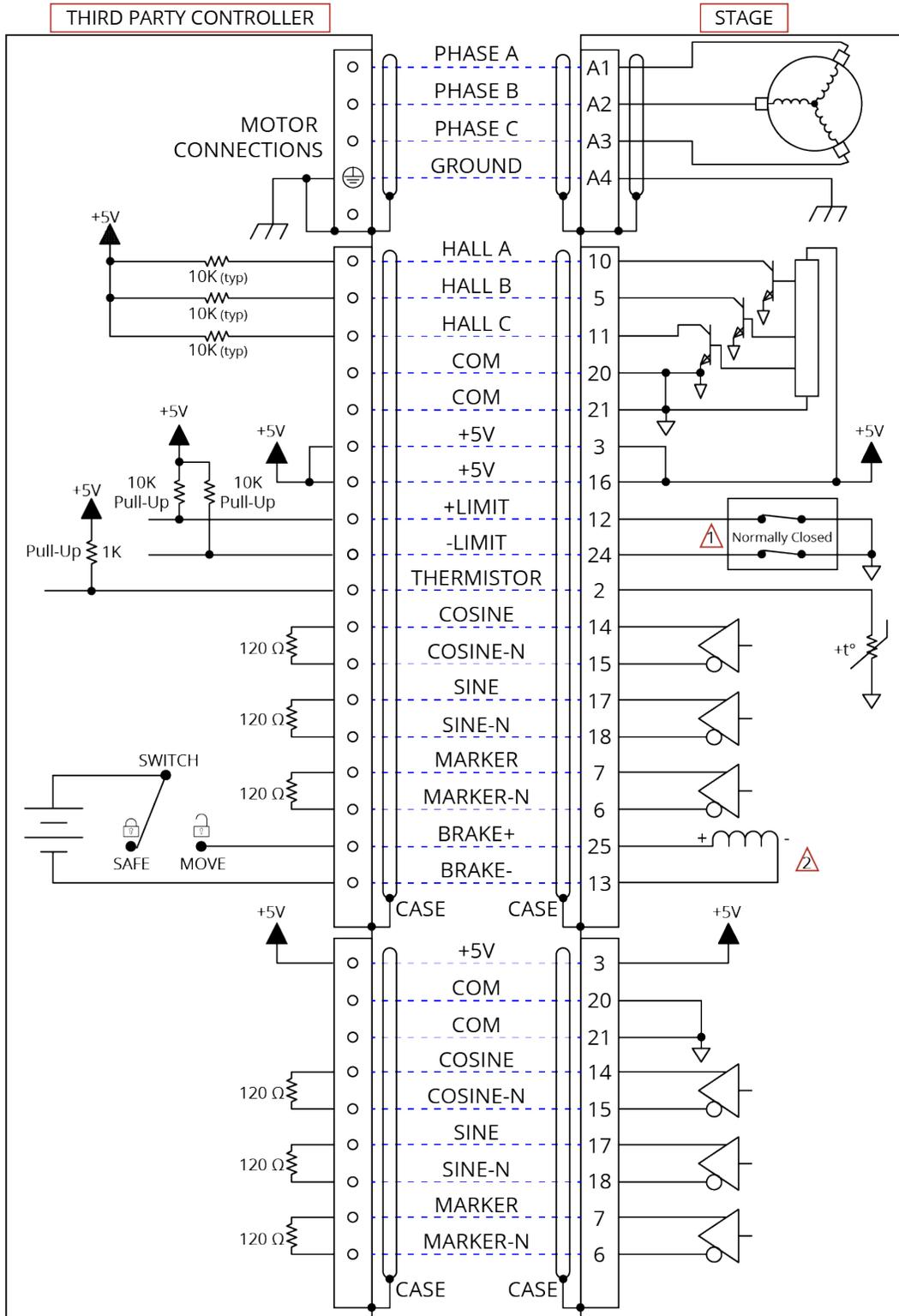
-  Limited travel models only (continuous travel models do not have this feature).
-  With -BK option.

Figure 3-3: APR200DR Motor and Feedback Wiring (-E4)



- Limited travel models only (continuous travel models do not have this feature).
- With -BK option.

Figure 3-4: APR200DR Motor and Feedback Wiring (-E5, -E6)



-  Limited travel models only (continuous travel models do not have this feature).
-  With -BK option.

3.3. Motor and Feedback Specifications

Hall Effect, Encoder, and Limit wiring share a common 5V supply connection inside the feedback connector.

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

	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)
Differential Output Signals (-E1)	Sinusoidal Type (Incremental Encoder): Analog: SIN+, SIN-, COS+, COS-, 1V _{pk-pk} ; Digital (RS422): MRK+, MRK- signals.
Differential Output Signals (-E2, -E3, -E5, -E6)	Digital Output (Incremental Encoder): TTL Encoder line-driver signals; RS422/485 compatible
Differential Output Signals (-E4)	Serial Output (Absolute Encoder): BiSS C, 32Bit, RS485/RS422 CLK & DATA Differential Line Driven Signals

Table 3-12: Encoder Resolution

Model	APR200DR-155
Fundamental Resolution	23600 Lines/Rev
-E1 ⁽¹⁾	0.014/0.0034 arc sec/line
-E4	0.000301 arc sec/line
-E5	0.055 arc sec/line
-E6	0.0055 arc sec/line
(1) -E1 shows x4000/x16000 total interpolation.	

Table 3-13: Max Speed Per Encoder Bandwidth

Model	-E1	-E4	-E2, -E5	-E3, -E6
APR200DR	Motor Limited	Motor Limited	82 rpm	8 rpm

Table 3-14: Limit Switch Specifications

	Specification
Supply Voltage	5 V \pm 5%
Supply Current	25 mA
Output Type	Open Collector
Output Voltage	5 V
Output Current	10 mA (sinking)
Output Polarity (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)
Note: If the APR200DR is driven beyond the electrical limit, it will encounter a mechanical stop. Impacting the mechanical stop could cause damage to the stage even at low speeds.	

Table 3-15: Brake Specifications

	Specification
Supply Voltage	24 VDC
Supply Current ⁽¹⁾	500 mA Typical
(1) Required to release the brake and allow motion.	

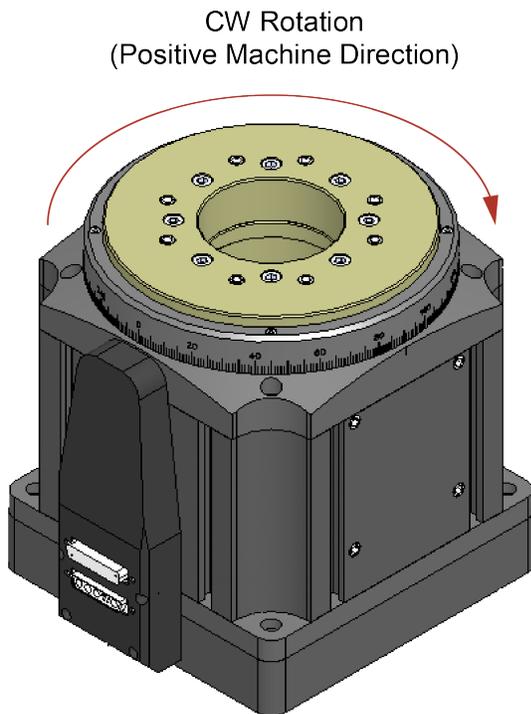
Table 3-16: APR200DR Motor Specifications

		S-180-69		S-180-94	
		(APR200DR-155)		(APR200DR-185)	
Performance Specifications^(1,5)					
Motor Option		-M1	-M2	-M1	-M2
Stall Torque, Cont. ⁽²⁾	N·m	11.12		15.93	
Peak Torque ⁽³⁾	N·m	44.47		63.70	
Electrical Specifications⁽⁵⁾					
Motor Option		-M1	-M2	-M1	-M2
BEMF Const., line-line, Max	$V_{pk}/krpm$	263.9	131.9	393.4	196.7
Continuous Current, Stall ⁽²⁾	A_{pk}	5.1	10.2	4.9	9.8
	A_{rms}	3.6	7.2	3.5	6.9
Peak Current, Stall ⁽²⁾	A_{pk}	20.4	40.8	19.6	39.2
	A_{rms}	14.4	28.9	13.9	27.7
Torque Constant ^(4, 9)	$N·m/A_{pk}$	2.18	1.09	3.25	1.63
	$N·m/A_{rms}$	3.08	1.54	4.60	2.30
Motor Constant ^(2, 4)	$N·m/\sqrt{W}$	1.053	1.053	1.391	1.391
Resistance, 25°C, line-line	Ω	4.4	1.1	5.6	1.4
Inductance, line-line	mH	1.70	0.43	2.60	0.65
Maximum Bus Voltage	V_{DC}	340		340	
Thermal Resistance	$^{\circ}C/W$	0.67		0.57	
Number of Poles	--	18		18	
<p>1. Performance is dependent upon heat sink configuration, system cooling conditions, and ambient temperature.</p> <p>2. Values shown @ 75°C rise above a 25 °C ambient temperature, with housed motor mounted to a 330 mm x 330 mm x 13 mm aluminum heat sink</p> <p>3. Peak force 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 $\pm 10\%$.</p> <p>6. Specifications given are for the motor only. When integrated into a housing with bearings additional losses should be considered.</p> <p>7. Maximum winding temperature is 100 °C (thermistor trips at 100 °C).</p> <p>8. Ambient operating temperature range 0 °C - 25 °C; consult Aerotech for performance in elevated ambient temperatures.</p> <p>9. All Aerotech amplifiers are rated A_{pk}; use torque constant in $N·m/A_{pk}$ when sizing.</p>					

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 3-5](#) shows the machine direction of APR200DR stages.

Figure 3-5: Machine Direction



3.5. Motor and Feedback Phasing

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

Figure 3-6: Hall Phasing Diagram

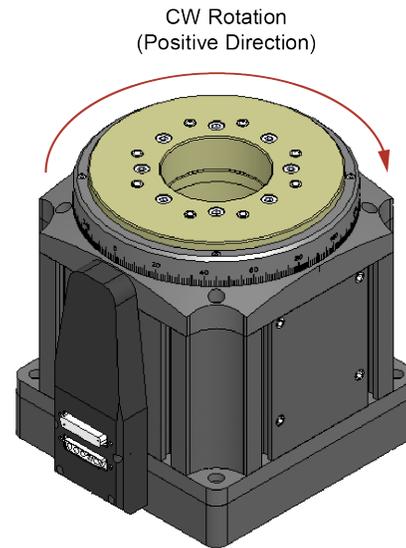
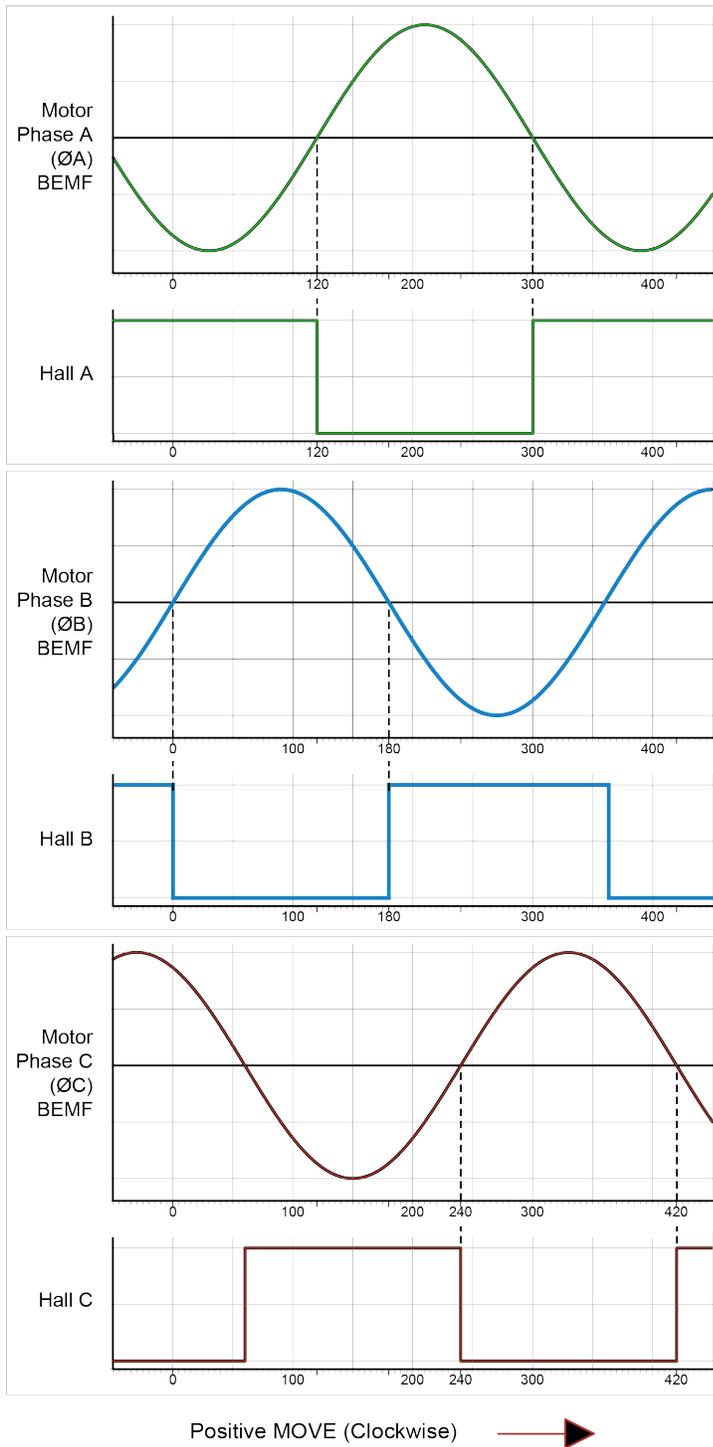


Figure 3-7: Encoder Phasing Reference Diagram (Standard/Square Wave)

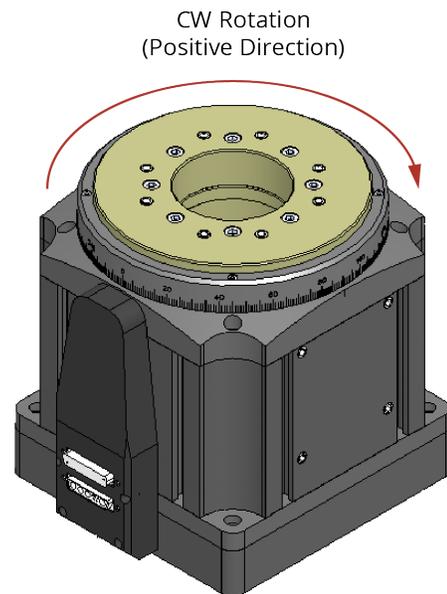
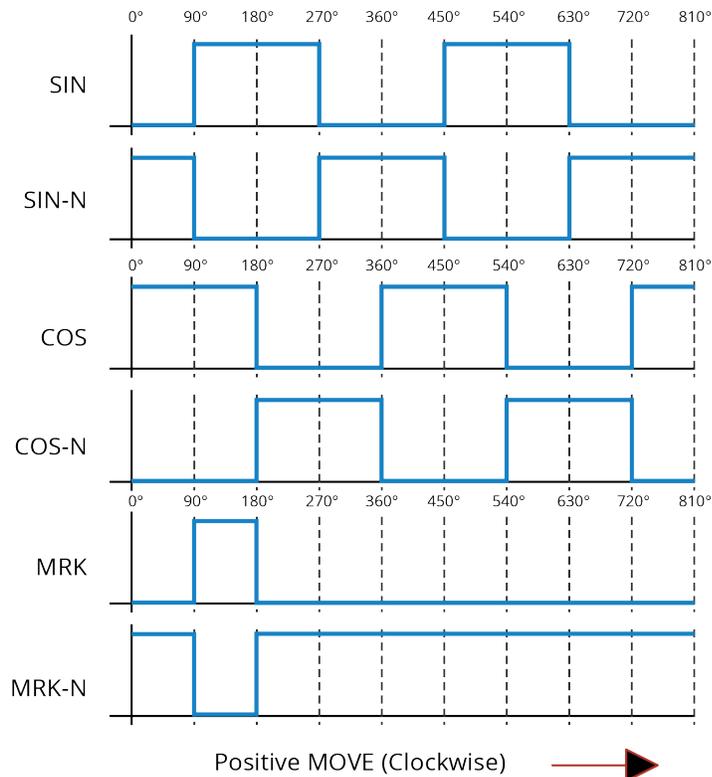
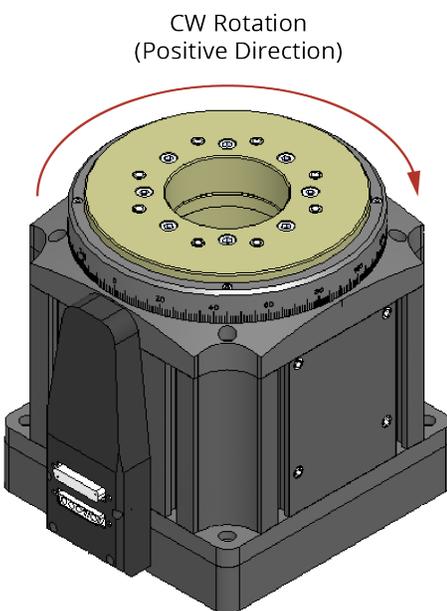
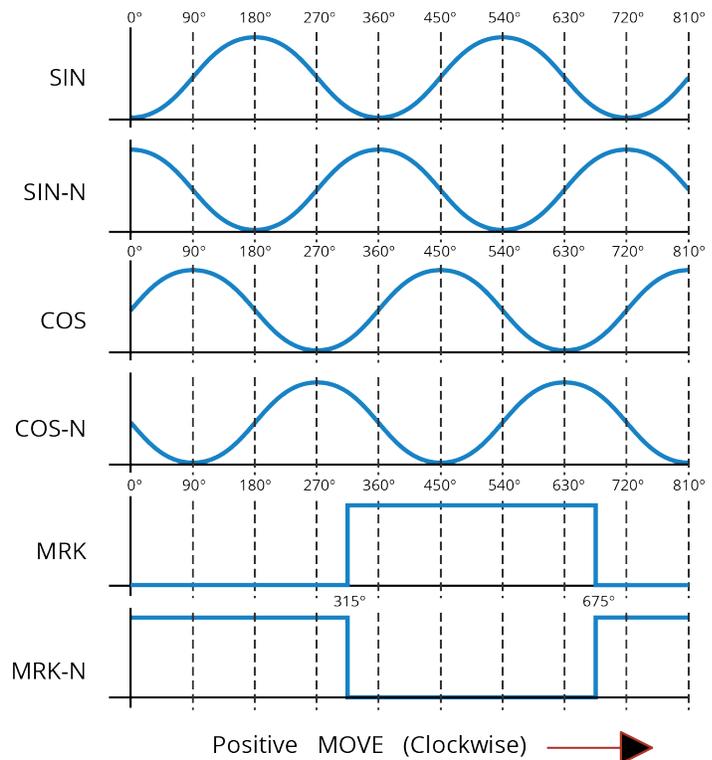


Figure 3-8: Encoder Phasing Reference Diagram (Analog/Sine Wave)



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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 APR200DR 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 APR200DR and any components and cables as needed.
- Repair any damage before operating the APR200DR.
- 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 normal operating conditions and with proper cleanliness of the stage, the bearing will not require lubrication or maintenance for the life of the stage. The motor is completely non-contact and requires no lubrication under normal circumstances.

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.

When you clean components of the APR200DR 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.

Cleaning

Use isopropyl alcohol on a lint-free cloth to clean any external metal surface of the APR200DR.



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

4.3. Travel Adjustment



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



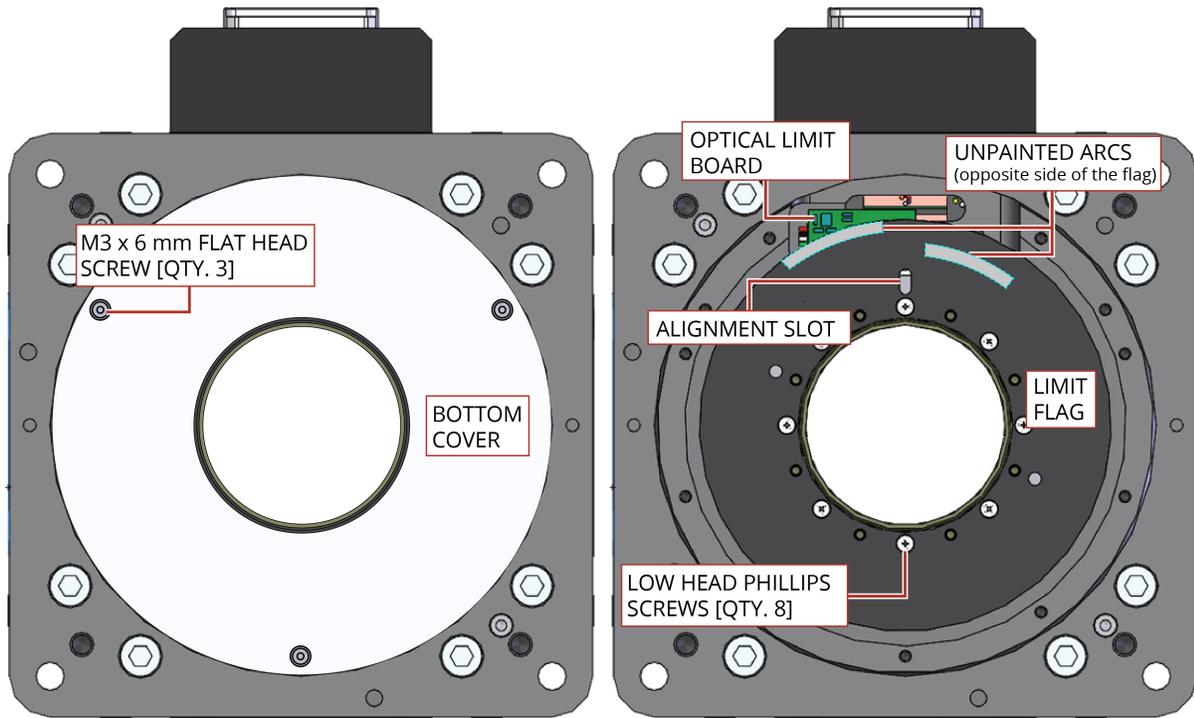
WARNING: Mechanical Hazard! Do not adjust the optical limits to an angle greater than the hard stop travel. Doing so could result in damage to the stage and payload and the possibility of injury. Maintain at least $\pm 5^\circ$ of overtravel between the optical limits and the hard stops.

4.3.1. Optical Limit Adjustments

The following procedure describes how to adjust the optical limits. Refer to [Figure 4-1](#).

1. Disconnect all electrical power from stage.
2. Remove the [QTY. 3] M3 Flat-Head Screws to remove bottom cover from stage.
3. Note the orientation of the Alignment Slot in the Limit Flag with respect to the shaft. Temporarily mark the shaft with tape or marker to indicate the location of the Alignment Slot in the Limit Flag.
4. Remove the [QTY. 8] Low-Head Phillips Screws securing the Limit Flag to the shaft and remove the Limit Flag.
5. Place the new Limit Flag on the shaft. The Unpainted Arcs on the new Limit Flag should face up into the stage (towards the Optical Limit Board). Orient the Alignment Slot to the same location as the previous Limit Flag (use the temporary mark you placed in Step 3).
6. Re-secure the Limit Flag with the [QTY. 8] Low-Head Phillips Screws.
7. Reattach the bottom cover to the stage with the [QTY. 3] M3 Flat-Head Screws.

Figure 4-1: APR200DR Limit Flag Adjustment



4.3.2. Mechanical Hard Stop Adjustments

Stages equipped with the hard stop option (-HS) have the hard stops set at the factory prior to shipment. Although the hard stops are adjustable, contact Aerotech before you change their position because the optical limits could need to be updated. If you change the hard stop position but do not update the optical limits, the stage travel could hit a hard stop and cause damage the stage or payload.



WARNING: Mechanical Hazard! Do not adjust the hard stops to an angle smaller than the limit travel of the stage. Maintain at least $\pm 5^\circ$ of travel between the optical limits and the hard stops. Allow for enough over-travel between the electrical limit and the hard stop for the stage to completely decelerate and stop before it hits the hard stop. If the stage hits the hard stop, that could result in damage to the stage and payload and the possibility of injury.

Use the procedure that follows to adjust the hard stops. Refer to [Figure 4-2](#) and [Figure 4-3](#) for details. Consult the factory if more information is required.

1. Disconnect all electrical power from the stage.
2. Remove the tabletop/graduated scale assembly with [QTY. 8] M6 socket head cap screws. Remember the orientation of the assembly so that you can put it back on in the same position.
3. Flip the tabletop assembly upside down and remove the [QTY. 3] M5 SHCS from one of the hard stops. Be sure to leave the hard stop over the holes it was mounted to.
4. Gradually slide the hard stop to the required mounting hole. The angle change for the mounting screw is 5.63°
5. Reconnect the hard stop with the M5 SHCS.
6. Repeat steps 3 through 5 with the second hard stop.
7. Loosely reattach the tabletop assembly to the shaft in the same orientation as it was in when you removed it.
8. You will now need to realign the tabletop to the shaft.
 - A. Insert the [QTY. 8] M6 screws that attached the tabletop to the shaft down into the counterbores until they just sit in the counterbore. Do not tighten.
 - B. Use an indicator to measure the radial runout of the inside diameter of the tabletop.
 - C. Spin the stage by hand and adjust the location of the tabletop until the radial runout of the reference surface is 5 microns or less.
 - D. Tighten the M6 socket head cap screws to 8 N·m. Work up to the final torque incrementally, and check the radial runout periodically during the tightening process. Readjust as necessary.

Figure 4-2: Tabletop Screw Locations

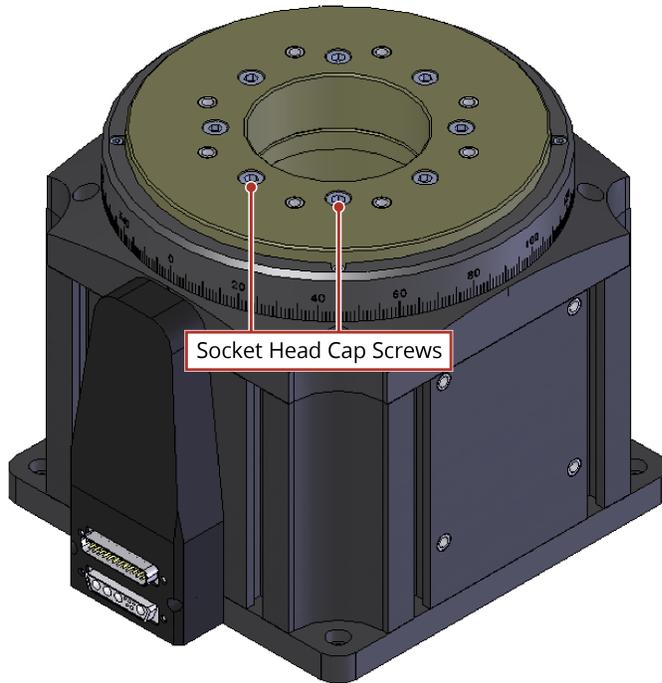
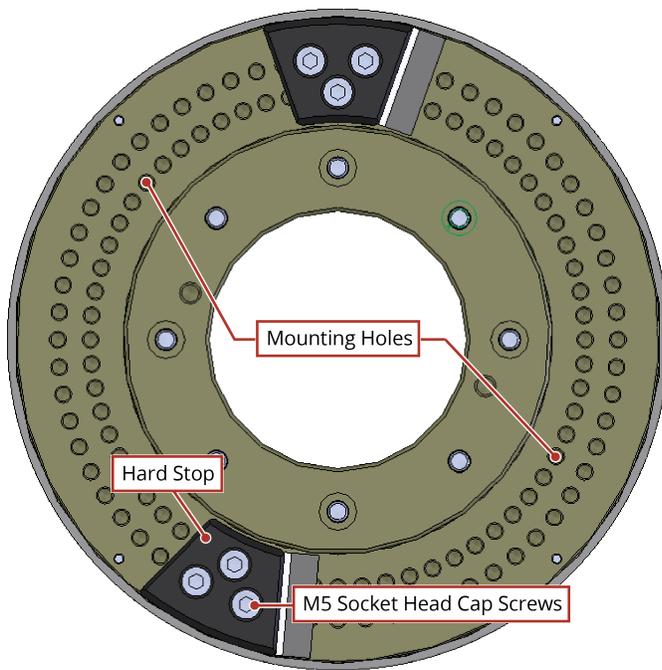


Figure 4-3: Upside Down Assembly Showing Hard Stops



4.4. Troubleshooting

Table 4-1: Troubleshooting

Symptom	Possible Cause and Solution
Stage will not move	<ul style="list-style-type: none"> • Shipping restraints still installed. Remove the red anodized shipping brackets. • 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).

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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
1.02.00	Product update
1.01.00	Full review/revision
1.00.00	New manual

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