



APR Hardware Manual

Revision: 1.02.00



Global Technical Support

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EU Declaration of Incorporation

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

herewith declares that the product:
APR Stage

is intended to be incorporated into machinery to constitute machinery covered by the Directive 2006/42/EC as amended;

and that the following harmonized European standards have been applied:

EN ISO 12100:2010

Safety of machinery - Basic concepts, general principles for design

EN 60204-1:2010

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

and further more declares that

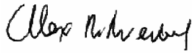
it is not allowed to put the equipment into service until the machinery into which it is to be incorporated or of which it is to be a component has been found and declared to be in conformity with the provisions of the Directive 2006/42/EC and with national implementing legislation, i.e., as a whole,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

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

2011/65/EU

RoHS 2 Directive

Authorized Representative: Simon Smith, European Director
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Position Engineer Verifying Compliance
Location Pittsburgh, PA
Date 6/13/2018



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Safety Procedures and Warnings

Read this manual in its entirety before installing, operating, or servicing this product. If you do not understand the information contained herein, contact an Aerotech representative before proceeding. Strictly adhere to the statements given in this section and other handling, use, and operational information given throughout the manual to avoid injury to you and damage to the equipment.

The following statements apply wherever the Warning or Danger symbol appears within this manual. Failure to observe these precautions could result in serious injury to those individuals performing the procedures and/or damage to the equipment.



DANGER: This product contains potentially lethal voltages. To reduce the possibility of electrical shock, bodily injury, or death the following precautions must be followed.

1. Access to the APR and component parts must be restricted while connected to a power source.
2. Do not connect or disconnect any electrical components or connecting cables while connected to a power source.
3. Disconnect electrical power before servicing equipment.
4. All components must be properly grounded in accordance with local electrical safety requirements.
5. Operator safeguarding requirements must be addressed during final integration of the product.



WARNING: To minimize the possibility of electrical shock, bodily injury or death the following precautions must be followed.

1. Moving parts can cause crushing or shearing injuries. Access to all stage and motor parts must be restricted while connected to a power source.
2. Cables can pose a tripping hazard. Securely mount and position all system cables to avoid potential hazards.
3. Do not expose this product to environments or conditions outside of the listed specifications. Exceeding environmental or operating specifications can cause damage to the equipment.
4. The APR stage must be mounted securely. Improper mounting can result in injury and damage to the equipment.
5. Use care when moving the APR stage. Lifting or transporting the APR stage improperly can result in injury or damage to the APR.
6. This product is intended for light industrial manufacturing or laboratory use. Use of this product for unintended applications can result in injury and damage to the equipment.
7. If the product is used in a manner not specified by the manufacturer, the protection provided by the product can be impaired and result in damage, shock, injury, or death.
8. The motor case temperature may exceed 75°C.
9. Operators must be trained before operating this equipment.
10. All service and maintenance must be performed by qualified personnel.

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Chapter 1: Overview

NOTE: Aerotech continually improves its product offerings; listed options may be superseded at any time. All drawings and illustrations are for reference only and were complete and accurate as of this manual's release. Refer to www.aerotech.com for the most up-to-date information.

Table 1-1: Model Numbering System

APR High-Precision Mechanical Bearing Rotary Stage	
APR150DR-115	Rotary table with 50 mm clear aperture and 2.85 N·m continuous torque
APR150DR-135	Rotary table with 50 mm clear aperture and 5.06 N·m continuous torque
APR150DR-180	Rotary table with 50 mm clear aperture and 9.29 N·m continuous torque
APR200DR-155	Rotary table with 75 mm clear aperture and 11.12 N·m continuous torque
APR200DR-185	Rotary table with 75 mm clear aperture and 15.93 N·m continuous torque
APR260DR-160	Rotary table with 100 mm clear aperture and 19.71 N·m continuous torque
APR260DR-180	Rotary table with 100 mm clear aperture and 29.09 N·m continuous torque
Feedback (Required)	
-E1	Incremental encoder, 1 Vpp
-E2	Incremental encoder, TTL x1000 interpolation
-E3	Incremental encoder, x10000 interpolation
-E4	Absolute encoder
-E5	High-accuracy, incremental encoder, TTL, x1000 interpolation
-E6	High-accuracy incremental encoder, TTL, x10000 interpolation
Note: -E5 and -E6 options are not available with APR150DR-115	
Motor (Required)	
-M1	Low current, -A winding
-M2	Low voltage, -B winding
Note: -M2 option not available with APR260DR models	
Tabletop (Optional)	
-TT1	Metric graduated tabletop
-TT2	English graduated tabletop
Travel (Required)	
-TRCNT	Continuous travel
-TR010	Limited travel, ±5 degrees
-TR020	Limited travel, ±10 degrees
-TR040	Limited travel, ±20 degrees
-TR060	Limited travel, ±30 degrees
-TR080	Limited travel, ±40 degrees
-TR100	Limited travel, ±50 degrees
-TR120	Limited travel, ±60 degrees
-TR140	Limited travel, ±70 degrees
-TR160	Limited travel, ±80 degrees
-TR180	Limited travel, ±90 degrees
-TR200	Limited travel, ±100 degrees
-TR220	Limited travel, ±110 degrees
-TR240	Limited travel, ±120 degrees
-TR270	Limited travel, ±135 degrees
Note: -TRxxx options have an extra 1.5 degrees between the nominal travel and the electrical limit on each side (Ex: -TR270 has ±135 degrees of nominal travel, with ±136.5 degrees of travel between electrical limits).	

APR High-Precision Mechanical Bearing Rotary Stage (continued)	
Hardstop (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
Note : -BK option not available with APR260DR models	
Metrology (Required)	
-P3	Metrology, uncalibrated with performance plots
-P4	Metrology, calibrated (HALAR) with performance plots

1.1. Environmental Specifications



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

Table 1-2: Environmental Specifications

Ambient Temperature	Operating: The optimal operating temperature is 20° C ±2° C (68° F ±4° F). If at any time the operating temperature deviates from 20° C, degradation in performance could occur.
	Storage: 0° to 40° C (32° to 104° F) in original shipping packaging
Humidity	Operating: 20% to 60% RH
	Storage: 10% to 70% RH, non-condensing in original packaging.
Altitude	Operating: 0 m to 2,000 m (0 ft to 6,562 ft) above sea level Contact Aerotech if your specific application involves use above 2,000 m or below sea level.
Vibration	Use the system in a low vibration environment. Excessive floor or acoustical vibration can affect system performance. Contact Aerotech for information regarding your specific application.
Protection Rating	The APR stages are not suited for dusty or wet environments. This equates to an ingress protection rating of IP30.
Use	Indoor use only

1.2. Basic Specifications

NOTE: Aerotech continually improves its product offerings; listed options may be superseded at any time. All drawings and illustrations are for reference only and were complete and accurate as of this manual's release. Refer to www.aerotech.com for the most up-to-date information.

Table 1-3: APR150DR Series Specifications

		APR150DR-115	APR150DR-135	APR150DR-180	
Travel		Continuous (Optional 270° Max Limited)			
Accuracy	-E1, -E2, -E3, -E4	Uncalibrated	45 arc sec		
		Calibrated	4.00 arc sec		
	-E5, -E6	Uncalibrated	N/A	4.00 arc sec	4.00 arc sec
		Calibrated	N/A	2.00 arc sec	2.00 arc sec
Resolution (Minimum Incremental Motion)		0.08 arc sec			
Bidirectional Repeatability ⁽¹⁾		1.50 arc sec			
Unidirectional Repeatability		0.75 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			
Maximum Acceleration		450 rad/s ²	625 rad/s ²	805 rad/s ²	
Aperture		50 mm			
Maximum Torque (Continuous)		2.85 N·m	5.06 N·m	9.29 N·m	
Load Capacity	Axial	45 kg			
	Radial	32 kg			
Rotor Inertia (Unloaded)		0.0047 kg·m ²	0.0060 kg·m ²	0.0086 kg·m ²	
Stage Mass ⁽⁴⁾		6.5 kg	8.5 kg	12.3 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 (assuming a 340 V bus). Actual speed may be lower due to motor back emf or encoder bandwidth (see Encoder Bandwidth table). 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 if brake and tabletop masses are desired.</p>					

Table 1-4: 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	
Maximum Acceleration		380 rad/s ²	440 rad/s ²
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 (assuming a 340 V bus). Actual speed may be lower due to motor back emf or encoder bandwidth (see Encoder Bandwidth table). 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 if brake and tabletop masses are desired.</p>			

Table 1-5: APR260DR Series Specifications

		APR260DR-160	APR260DR-180
Travel		Continuous (Optional 270° Max Limited)	
Accuracy	-E1, -E2, -E3, -E4	Uncalibrated	25 arc sec
		Calibrated	2.00 arc sec
	-E5, -E6	Uncalibrated	2.00 arc sec
		Calibrated	1.50 arc sec
Resolution (Minimum Incremental Motion)		0.04 arc sec	
Bidirectional Repeatability ⁽¹⁾		0.75 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	375 rpm	
	-M2	N/A	
Maximum Acceleration		175 rad/s ²	215 rad/s ²
Aperture		100 mm	
Maximum Torque (Continuous)		19.71 N·m	29.09 N·m
Load Capacity	Axial	250 kg	
	Radial	135 kg	
Rotor Inertia (Unloaded)		0.10 kg·m ²	0.12 kg·m ²
Stage Mass ⁽⁴⁾		29.8 kg	35.4 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 (assuming a 340 V bus). Actual speed may be lower due to motor back emf or encoder bandwidth (see Encoder Bandwidth table). 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 if brake and tabletop masses are desired.</p>			

Table 1-6: Max Speed (rpm) Per Encoder Bandwidth

Model	-E1	-E4	-E2, -E5	-E3, -E6
APR150DR	Motor Limited	Motor Limited	118	11
APR200DR	Motor Limited	Motor Limited	82	8
APR260DR	375	375	59	5

1.3. Vacuum Operation

Contact the factory for information regarding operation in a vacuum environment.

Preparation and considerations for operation in a vacuum environment:

- Lubrication with vacuum-compatible lubricants
- Use of materials, fasteners, and coatings with vacuum outgas performance compatible with the level of vacuum specified
- For high vacuum stages, elimination of situations that may allow gases to become temporarily trapped during pump down
- Extensive cleaning prior to assembly in a clean environment and packaging in a special polyethylene bag
- Use of components able to withstand elevated temperatures (non-operating) for bake-out performances

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.

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Chapter 2: Mechanical Specifications and Installation



WARNING: APR installation must be in accordance to instructions provided by this manual and any accompanying documentation. Failure to follow these instructions could result in injury or damage to the equipment.

2.1. Unpacking and Handling the Stage



DANGER/HEAVY: Do not attempt to manually lift a stage that is too heavy (in excess of 18 kg). Refer to [Section 1.2](#) for stage mass specifications.

- Do not attempt to manually lift heavy loads single handed.
- With two or more people, only manually lift from the specified surfaces (if lifting hardware hasn't been supplied).
- Lift only from the base.
- Do not use any of the cables as lifting points.
- Use a fork lift or cart to transport the stage.



WARNING: It is the customer's responsibility to safely and carefully lift the stage.

- Make sure that all moving parts are secure before moving the APR. Unsecured moving parts may shift and cause bodily injury.
- Improper handling could adversely affect the performance of the APR. Use care when moving the APR.

NOTE: If any damage has occurred during shipping, report it immediately.

Carefully remove the APR from its protective shipping container. Gently set the APR on a smooth, flat, and clean surface.

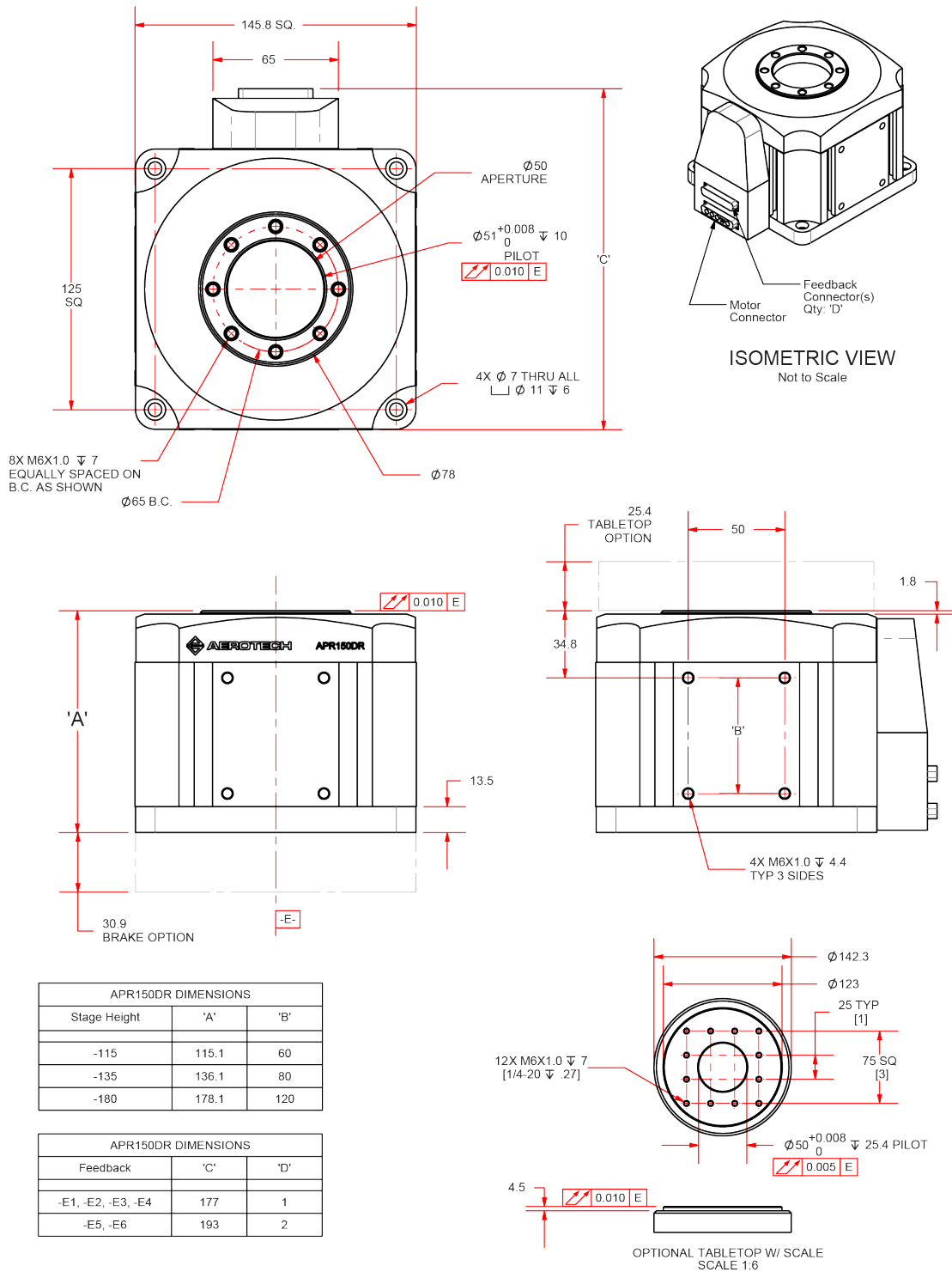
Before operating the APR, it is important to let it stabilize at room temperature for at least 12 hours. Allowing it to stabilize to room temperature will ensure that all of the alignments, preloads, and tolerances are the same as they were when tested at Aerotech. Use compressed nitrogen or clean, dry, oil-less air to remove any dust or debris that has collected during shipping.

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

Shipping Clamps

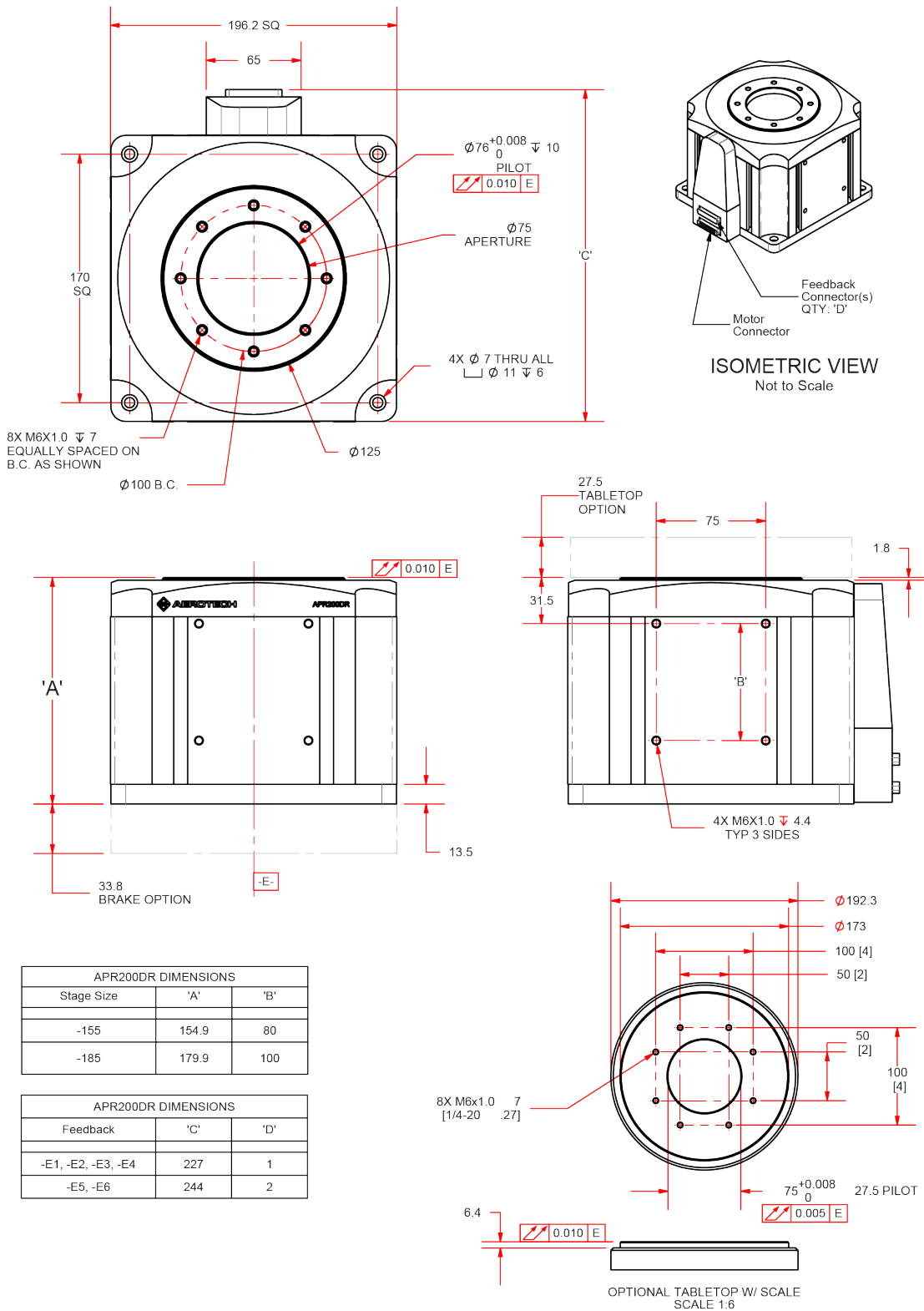
If the APR has shipped as part of a system, shipping clamps (typically red, anodized aluminum) may have been installed to secure the system prior to shipment. The shipping clamps, if installed, will need to be removed prior to machine start up.

2.2. Dimensions



DIMENSIONS: MILLIMETERS [INCHES]

Figure 2-1: APR150DR Dimensions

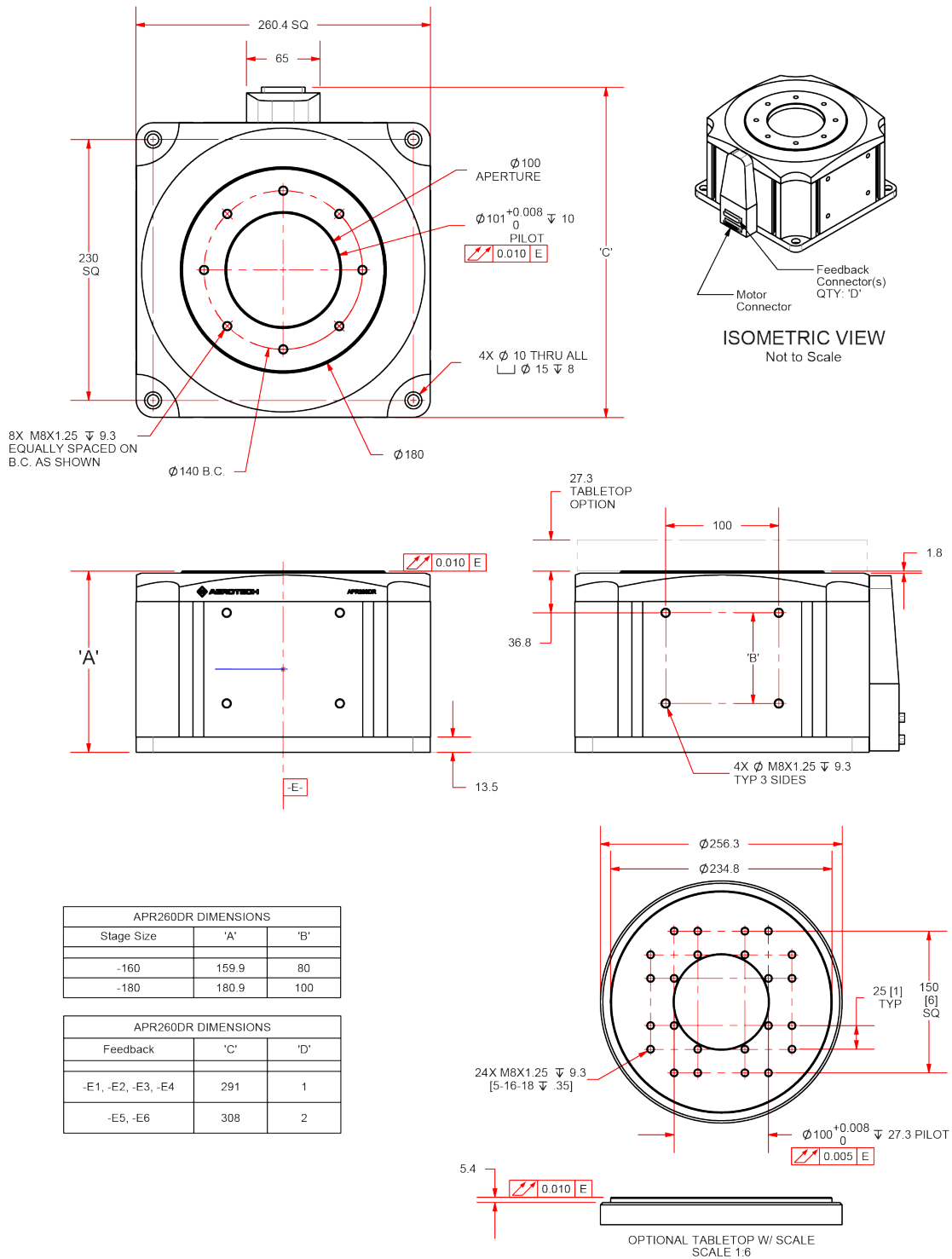


APR200DR DIMENSIONS		
Stage Size	'A'	'B'
-155	154.9	80
-185	179.9	100

APR200DR DIMENSIONS		
Feedback	'C'	'D'
-E1, -E2, -E3, -E4	227	1
-E5, -E6	244	2

DIMENSIONS: MILLIMETERS [INCHES]

Figure 2-2: APR200DR Dimensions



APR260DR DIMENSIONS		
Stage Size	'A'	'B'
-160	159.9	80
-180	180.9	100

APR260DR DIMENSIONS		
Feedback	'C'	'D'
-E1, -E2, -E3, -E4	291	1
-E5, -E6	308	2

DIMENSIONS: MILLIMETERS [INCHES]

Figure 2-3: APR260DR Dimensions

2.3. Securing the Stage to the Mounting Surface



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



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

The mounting surface must be flat and have adequate stiffness in order to achieve the maximum performance from the APR stage. When it is mounted to a non-flat surface, the stage can be distorted as the mounting screws are tightened. This distortion will decrease overall accuracy. Adjustments to the mounting surface must be done before the stage is secured.

Inspect the mounting surface for dirt or unwanted residue and clean if necessary. Use precision flatstones on the mounting surface to remove any burrs or high spots. Clean the mounting surface with a lint-free cloth and acetone or isopropyl alcohol and allow the cleaning solvent to completely dry. Gently place the stage on the mounting surface.

NOTE: To maintain accuracy, the mounting surface must be flat to within 5 μm over the entire stage footprint.

NOTE: The APR is precision machined and verified for flatness prior to product assembly at the factory. If machining is required to achieve the desired flatness, it should be performed on the mounting surface rather than the APR. Shimming should be avoided if possible. If shimming is required, it should be minimized to retain maximum rigidity of the system.

APR series stages have a fixed mounting pattern available to secure the stage to a mounting surface. [Figure 2-4](#) shows the main mounting holes in the base of the stage. These counter-bored holes are designed for M6 socket head cap screws for the APR150DR and APR200DR models and M8 socket head cap screws for the APR260DR models.

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 2-1](#) are typical values and may not be accurate for your mounting surface. Refer to [Section 2.2](#) for specific model mounting locations and dimensions.

Table 2-1: Stage to Mounting Surface Hardware

Mounting Hardware	Typical Screw Torque
APR150DR and APR200DR: M6 SHCS	7 N·m
APR260DR: M8 SHCS	17 N·m

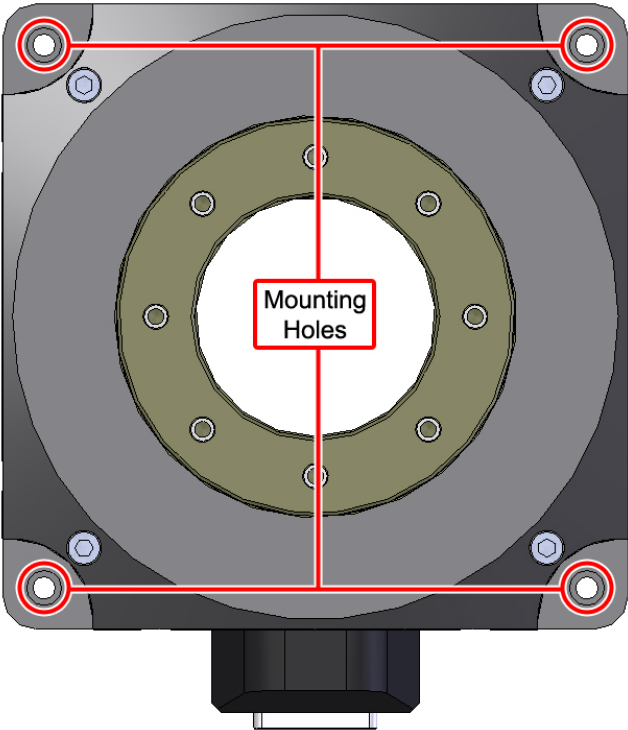


Figure 2-4: APR Stage Mounting Holes

2.4. 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.

Aerotech recommends that customers use a representative payload during start-up to prevent accidental damage to the stage and the payload. Proceed with the electrical installation and test the motion control system in accordance with the system documentation. Document all results for future reference. For information on electrical installation refer to [Chapter 3](#) and the documentation delivered with the stage.

NOTE: If your APR was purchased with Aerotech controls, it might have been tuned with a representative payload based on the information provided at the time of order. If the APR is started up without a payload, the servo gains provided by Aerotech with the shipment may not be appropriate and servo instability can occur. Refer to the controller help file for tuning assistance.

The payload must be flat, rigid, and comparable to the stage in quality to maintain optimum performance.

NOTE: For valid system performance, the mounting interface should be flat within 5 μm .

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

Refer to [Section 1.2](#) for maximum load carrying capacity specifications. If cantilevered loads are applied, refer to [Figure 2-5](#) through [Figure 2-7](#) to find the maximum allowable load.

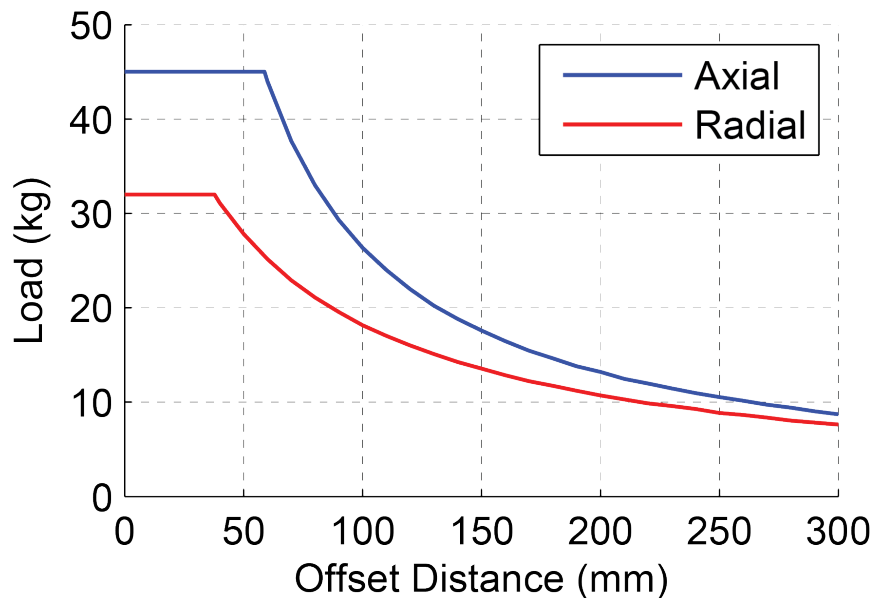


Figure 2-5: APR150DR Cantilevered Load Capabilities

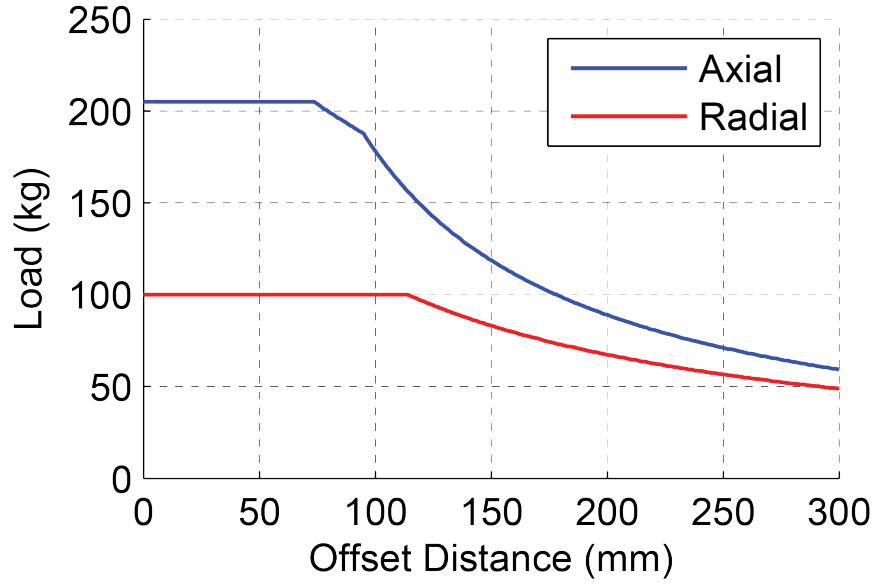


Figure 2-6: APR200DR Cantilevered Load Capabilities

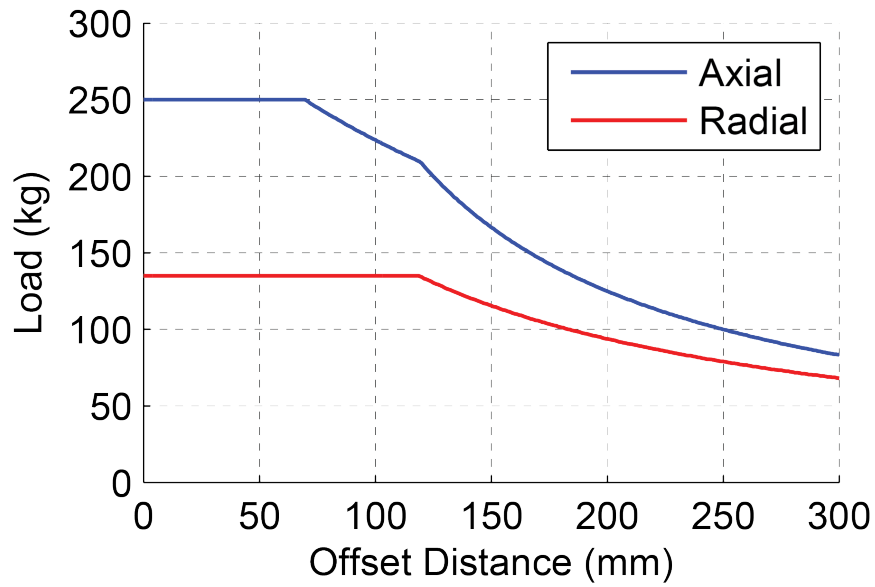


Figure 2-7: APR260DR Cantilevered Load Capabilities

2.5. Travel Adjustment

2.5.1. Optical Limit Adjustment

Stages with the limit option have the optical limits set at the factory prior to shipment. Stages shipped with the limits option but without the brake option can be retrofitted to achieve a different limit travel. Determine the amount of travel required and contact Aerotech to order the appropriate Limit Flag.



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

The following procedure describes how to adjust the optical limits.

1. Disconnect all electrical power from stage.
2. Remove the [QTY. 3] M3 Flat-Head Screws to remove bottom cover from stage (refer to [Figure 2-8](#)).
3. Note the orientation of the Alignment Slot ([Figure 2-8](#)) 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 ([Figure 2-8](#)) securing the Limit Flag to the shaft and remove the Limit Flag.
5. Place the new Limit Flag on the shaft. The Unpainted Arcs ([Figure 2-8](#)) 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.

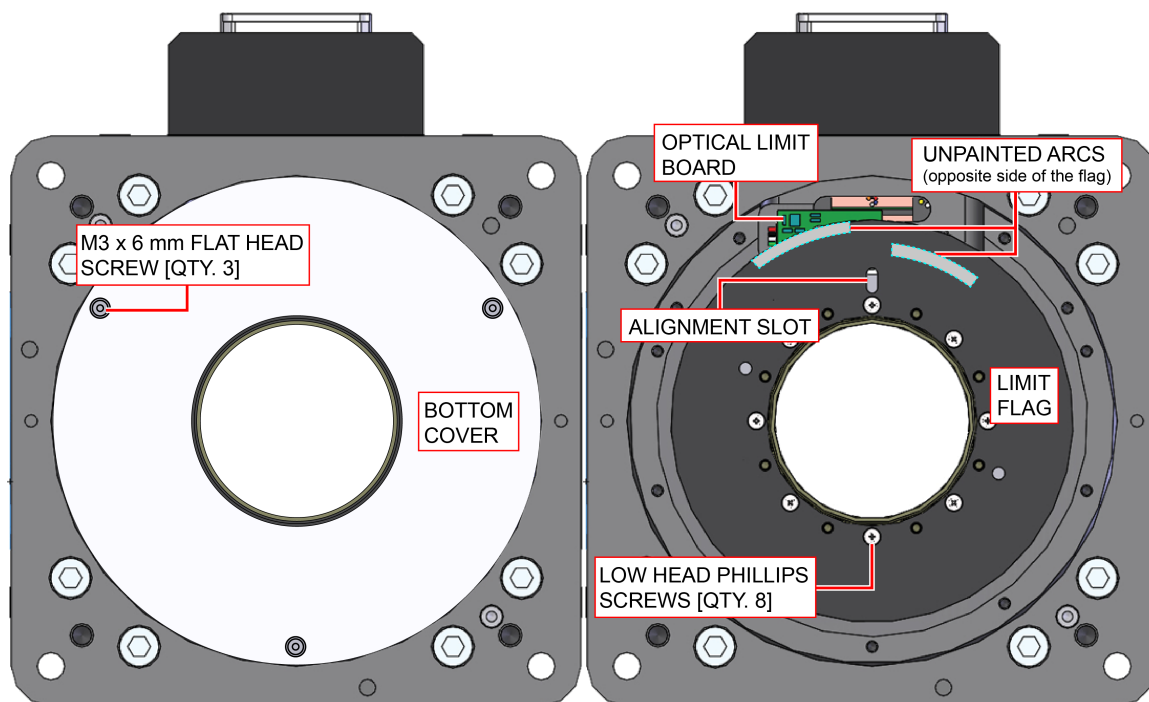


Figure 2-8: APR Limit Flag Adjustment

2.5.2. Hard Stop Adjustment

APR stages equipped with the hard stop option (-HS) have the hard stops set at the factory prior to shipment. The hard stops are user-adjustable.



WARNING: Do not adjust the hard stops to an angle smaller than the stage's limit travel. Doing so could result in damage to the stage and payload and the possibility of bodily injury. Maintain at least $\pm 5^\circ$ of travel between the optical limits and the hard stops. You should leave enough overtravel between the electrical limit and the hard stop for the stage to completely decelerate and stop before impacting the hard stop.

The procedure that follows describes how to adjust the hard stops. See [Figure 2-9](#) and [Figure 2-10](#) 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 (M8 SHCS on the APR260). 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. See [Table 2-2](#) for the angle change per mounting screw.

Table 2-2: Angle Change Per Mounting Screw

Stage	Degree Change
APR150DR	11.25°
APR200DR	5.63°
APR260DR	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. Run the M6/M8 SHCS that attached the tabletop to the shaft down into the counterbores until they just sit in the counterbore. Do not tighten M6/M8 SHCS.
 - 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 socket head cap screws to 8 N·m for M6 and 17 N·m for M8. Work up to the final torque incrementally, and check the radial runout periodically during the tightening process. Readjust as necessary.

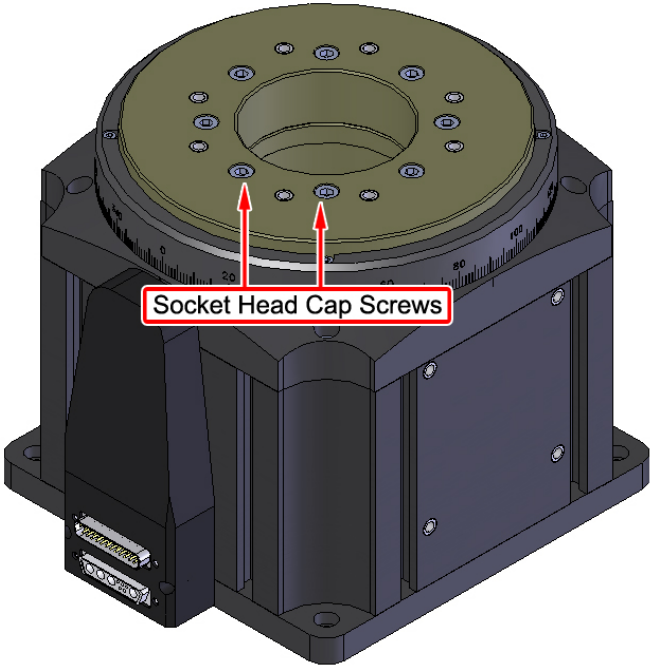


Figure 2-9: Tabletop Screw Locations

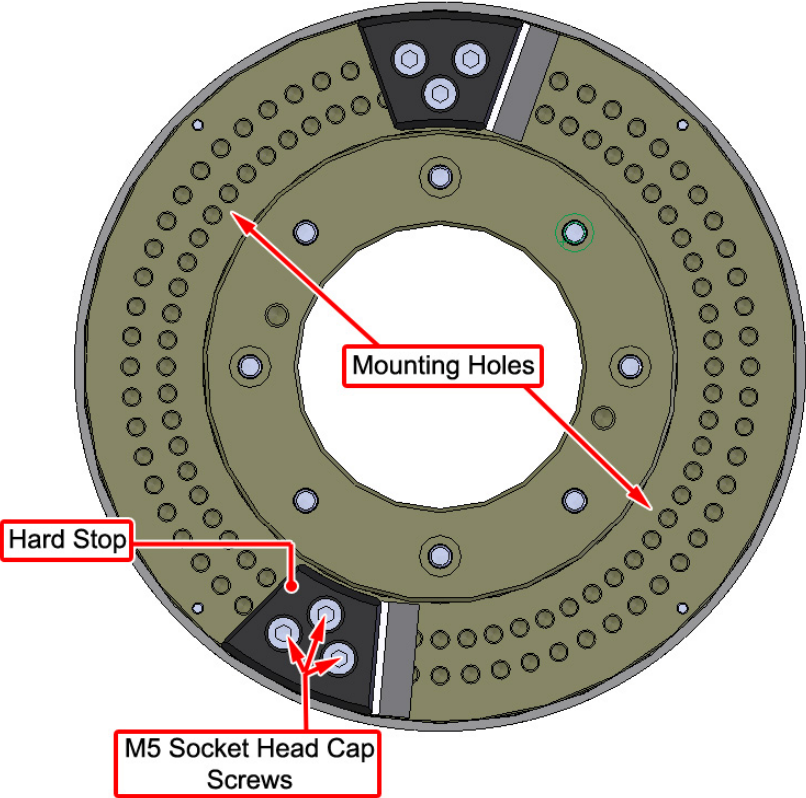


Figure 2-10: Upside Down Assembly Showing Hard Stops

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Chapter 3: Electrical Specifications and Installation



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

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

If system level integration was purchased, an electrical drawing showing system interconnects has been supplied with the system (separate from this documentation).

The electrical wiring from the motor and encoder are integrated at the factory. Refer to the sections that follow for standard motor wiring and connector pinouts.



DANGER: Remove power before connecting or disconnecting electrical components or cables. Failure to do so may cause electric shock or damage to the equipment.



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

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

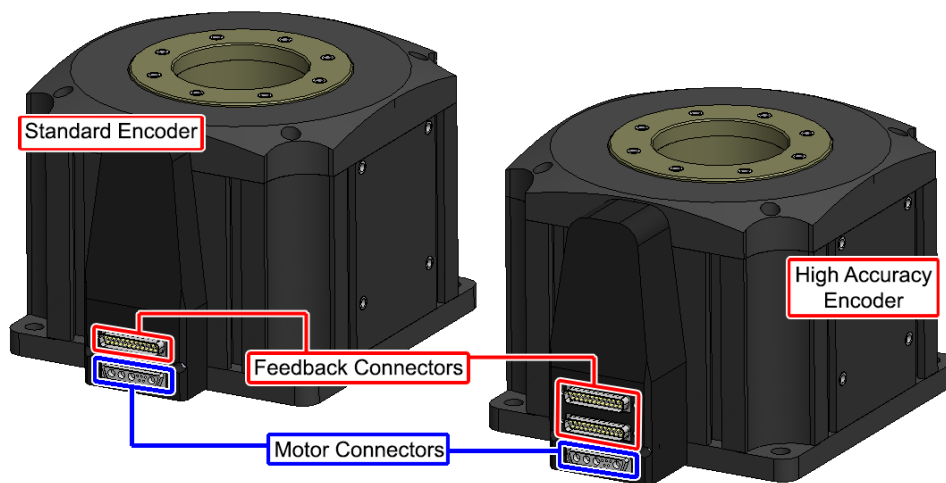


Figure 3-1: Electrical Connections

3.1. Motor and Feedback Connectors

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

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

The protective ground connection of the APR 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: Remove power before connecting or disconnecting electrical components or cables. Failure to do so may cause electric shock or damage to the equipment.



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



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



CAUTION: The stage controller must provide over-current and over-speed protection. Failure to do so may result in permanent damage to the motor and stage components.

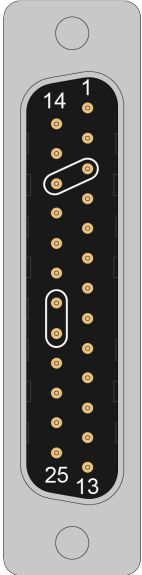
Table 3-1: High Power D-Style Motor Connector Pinout

Pin	Description	Connector
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)	

Mating Connector	Aerotech P/N	Third Party P/N
Backshell	ECK00656	Amphenol #17E-1726-2
Sockets [QTY. 4]	ECK00659	ITT Cannon #DM537446
Connector	ECK00657	ITT Cannon #DBM9W4SA197

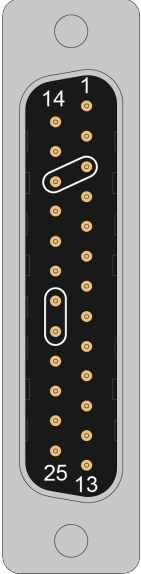
The wiring of the feedback connector depends on the encoder option selected (standard or absolute). For the standard encoder (-E1), refer to [Table 3-2](#). For the absolute encoder (-E4), refer to [Table 3-3](#).

Table 3-2: Analog Sine Feedback Connector Pinout

Pin	Description	Connector
1	Reserved	
2	Over-Temperature Thermistor sensor	
3	+5 V power supply	
4	Reserved	
5	Hall Effect sensor, phase B	
6	Marker-N	
7	Marker	
8	Reserved	
9	Reserved	
10	Hall Effect sensor, phase A	
11	Hall Effect sensor, phase C	
12	Signal indicating maximum travel produced by positive/CW stage direction	
13	Brake -	
14	Cosine	
15	Cosine-N	
16	+5 V power supply	
17	Sine	
18	Sine-N	
19	Reserved	
20	Common ground	
21	Common ground	
22	Reserved	
23	Reserved	
24	Signal indicating stage maximum travel produced by negative/CCW stage direction	
25	Brake +	

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

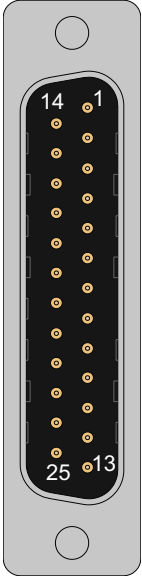
Table 3-3: Absolute Feedback Connector Pinout

Pin	Description	Connector
1	Reserved	
2	Over-Temperature Thermistor sensor	
3	+5 V power supply	
4	Reserved	
5	Hall Effect sensor, phase B	
6	Differential compliment of CLK signal	
7	BiSS® C clock signal	
8	Differential compliment of DATA signal	
9	Reserved	
10	Hall Effect sensor, phase A	
11	Hall Effect sensor, phase C	
12	Signal indicating maximum travel produced by positive/CW stage direction	
13	Brake -	
14	Reserved	
15	Reserved	
16	+5 V power supply	
17	Reserved	
18	Reserved	
19	BiSS® C serial data signal	
20	Common ground	
21	Common ground	
22	Reserved	
23	Reserved	
24	Signal indicating stage maximum travel produced by negative/CCW stage direction	
25	Brake +	

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

The high accuracy encoder option includes a secondary feedback connector.

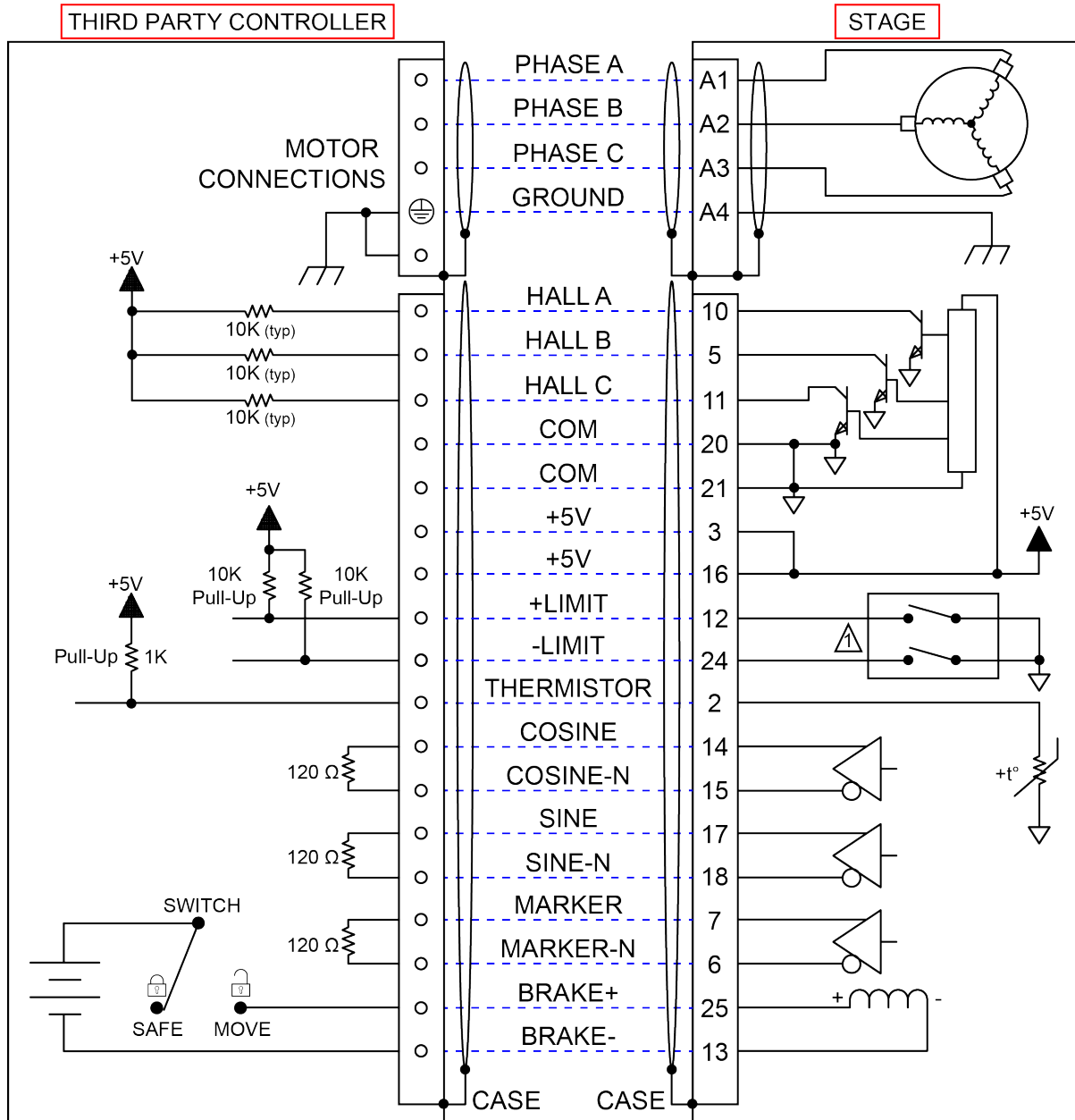
Table 3-4: Secondary Feedback Connector Pinout

Pin	Description	Connector
1	Reserved	
2	Reserved	
3	+5 V power supply	
4	Reserved	
5	Reserved	
6	Marker-N	
7	Marker	
8	Reserved	
9	Reserved	
10	Reserved	
11	Reserved	
12	Reserved	
13	Reserved	
14	Cosine	
15	Cosine-N	
16	Reserved	
17	Sine	
18	Sine-N	
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	

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

3.2. Motor and Feedback Wiring

All motor and controller manufacturers have their own designations for motor phases A/B/C and Hall signals A/B/C (refer to Section 3.5. for motor phasing). Shielded cables are required for the motor and feedback connections.



Limited travel models only (continuous travel models do not have this feature).

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

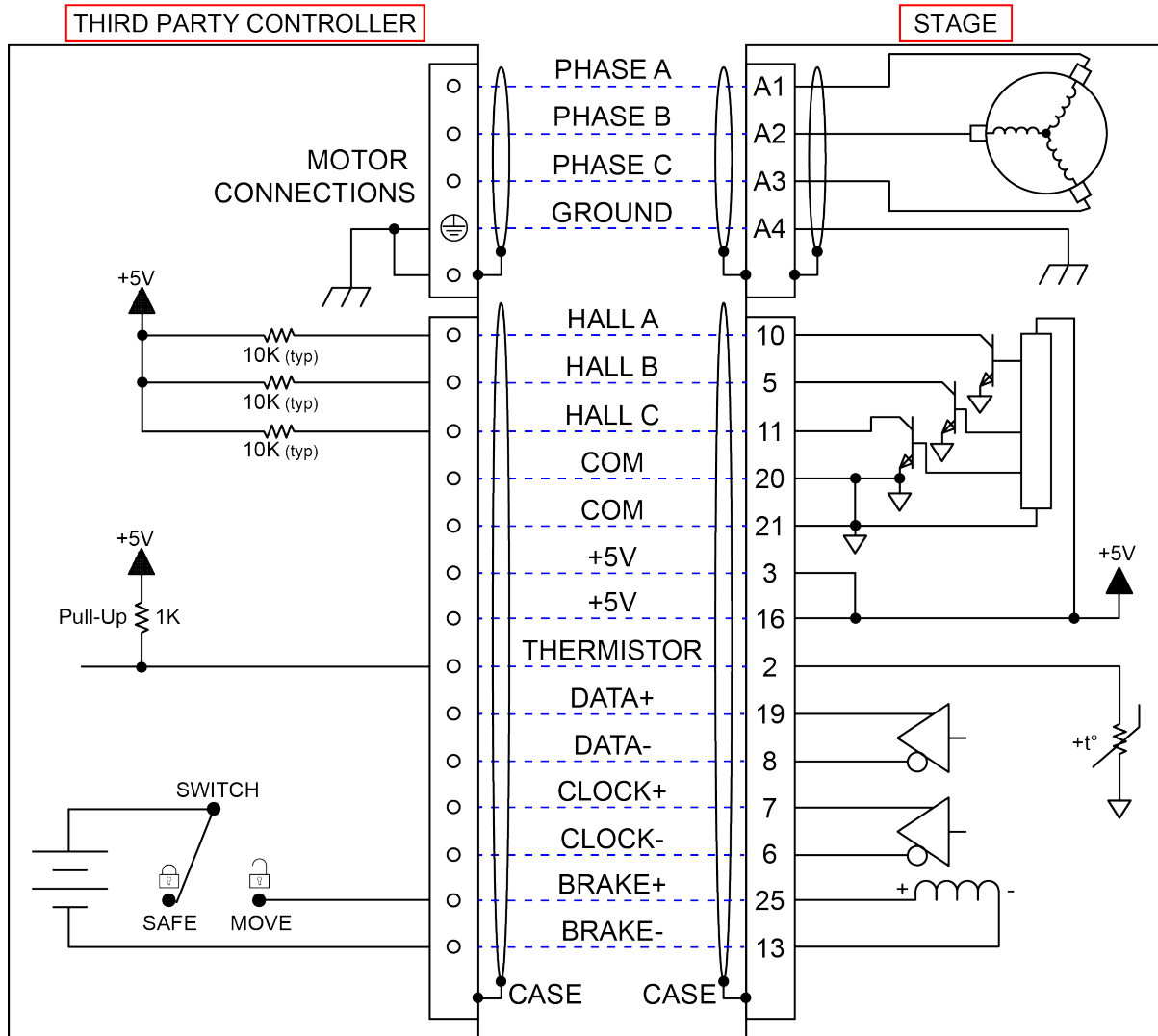


Figure 3-3: Motor and Feedback Wiring (-E4)

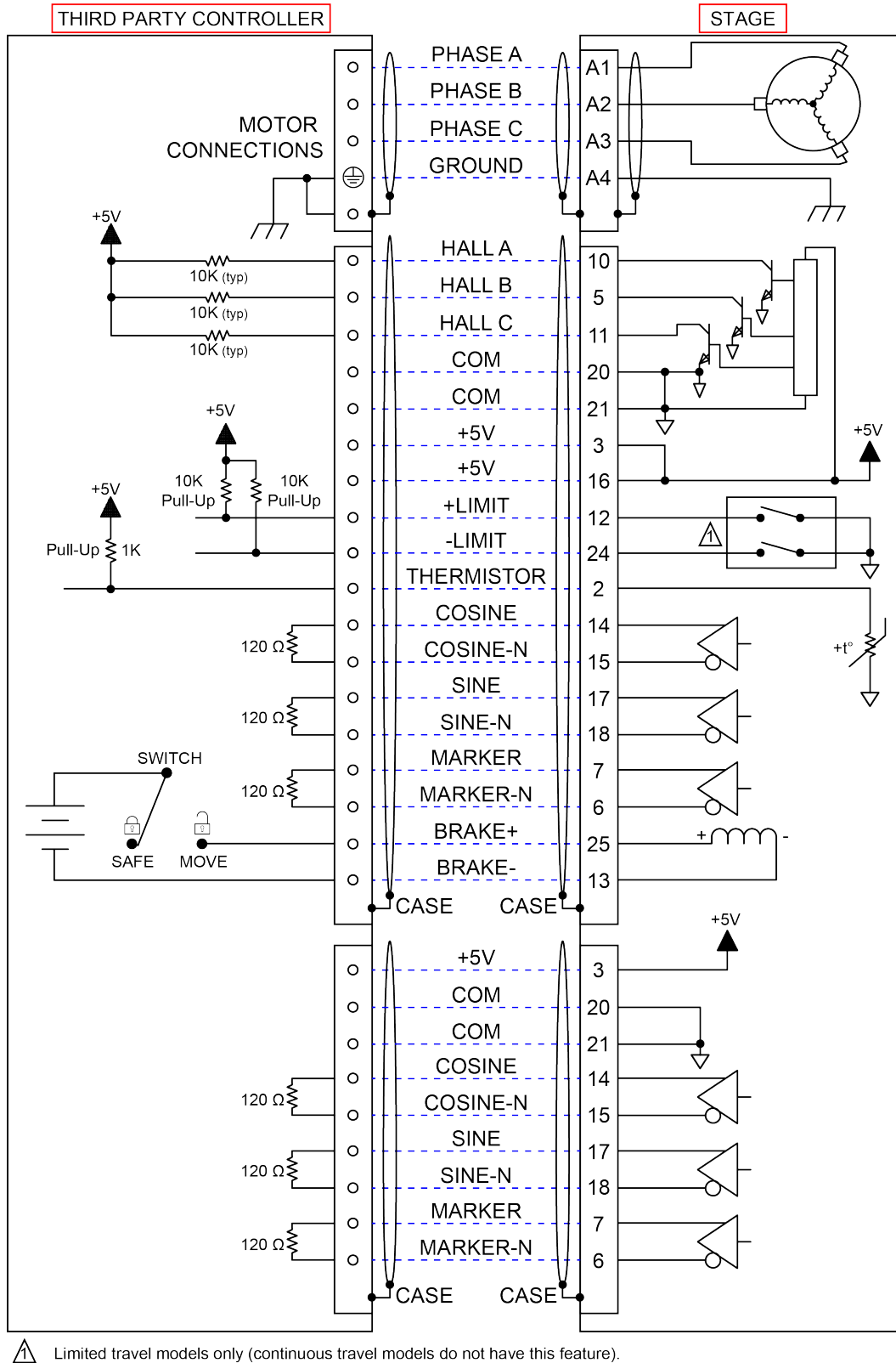


Figure 3-4: Motor and Feedback Wiring (-E5, -E6)

3.3. Motor and Feedback Specifications

Table 3-5: Feedback Specifications

Hall-Effect Sensors Specifications	
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)

Thermistor Specifications	
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.	

Encoder Specifications	
Supply Voltage	5 V \pm 5%
Supply Current	250 mA
Output Signals	Sinusoidal Type (Incremental Encoder): 1 V _{pk-pk} into 120 Ω Load (differential signals SIN+, SIN-, COS+, COS- are .5 V _{pk-pk} relative to ground.)
	Digital Output (Incremental Encoder): RS422/485 compatible
	Serial Output (Absolute Encoder): Biss C (unidirectional)

Limit Switch Specifications	
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	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)
Notes:	
<ul style="list-style-type: none"> If the APR 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. 	

Brake Specifications	
Brake Supply Voltage	24 VDC
Brake Supply Current (typical) ⁽¹⁾	500 mA Typical
(1) Current through the brake coil is required to release the brake and allow motion.	

Table 3-6: APR150DR Motor Specifications

		APR150DR-115		APR150DR-135		APR150DR-180	
Performance Specifications^(1,5)							
Motor Option		-M1	-M2	-M1	-M2	-M1	-M2
Stall Torque, Cont. ⁽²⁾	N·m	2.36		4.18		7.69	
Peak Torque ⁽³⁾	N·m	9.42		16.73		30.75	
Electrical Specifications⁽⁵⁾							
Motor Option		-M1	-M2	-M1	-M2	-M1	-M2
BEMF Const., line-line, Max	$V_{pk}/krpm$	75.1	37.5	148.9	74.4	300.2	150.1
Continuous Current, Stall ⁽²⁾	A_{pk}	3.8	7.6	3.4	6.8	3.1	6.2
	A_{rms}	2.7	5.4	2.4	4.8	2.2	4.4
Peak Current, Stall ⁽²⁾	A_{pk}	15.2	30.4	13.6	27.2	12.4	24.8
	A_{rms}	10.7	21.5	9.6	19.2	8.8	17.5
Torque Constant ^(4, 9)	$N·m/A_{pk}$	0.62	0.31	1.23	0.62	2.48	1.24
	$N·m/A_{rms}$	0.88	0.44	1.74	0.88	3.5	1.75
Motor Constant ^(2, 4)	$N·m/\sqrt{W}$	0.265		0.446		0.71	
Resistance, 25°C, line-line	Ω	5.6	1.4	7.8	2.0	12.5	3.1
Inductance, line-line	mH	1.70	0.43	1.80	0.45	3.67	0.92
Maximum Bus Voltage	V_{DC}	340		340		340	
Thermal Resistance	$^{\circ}C/W$	0.95		0.85		0.64	
Number of Poles	--	18		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>							

Table 3-7: 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>					

Table 3-8: APR260DR Motor Specifications

		S-240-63	S-240-83
		(APR260DR-160)	(APR260DR-180)
Performance Specifications (1,5)			
Motor Option		-M1	-M1
Stall Torque, Cont. (2)	N·m	19.71	29.09
Peak Torque (3)	N·m	78.82	116.37
Electrical Specifications (5)			
Motor Option		-M1	-M1
BEMF Const., line-line, Max	$V_{pk}/krpm$	404.3	607.2
Continuous Current, Stall (2)	A_{pk}	5.9	5.8
	A_{rms}	4.2	4.1
Peak Current, Stall (2)	A_{pk}	23.6	23.2
	A_{rms}	16.7	16.4
Torque Constant (4, 9)	$N·m/A_{pk}$	3.34	5.02
	$N·m/A_{rms}$	4.72	7.09
Motor Constant (2, 4)	$N·m/\sqrt{W}$	1.405	1.893
Resistance, 25°C, line-line	Ω	5.8	7.2
Inductance, line-line	mH	2.90	4.30
Maximum Bus Voltage	V_{DC}	340	340
Thermal Resistance	$^{\circ}C/W$	0.38	0.32
Number of Poles	--	26	26
<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 (thermistors trip 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>			

Table 3-9: Encoder Specifications (APR150DR)

Model	APR150DR-115	APR150DR-135	APR150DR-180
Fundamental Resolution	16384 Lines/Rev		
-E1 ⁽¹⁾	0.020/0.005 arc sec/line		
-E4 (2 ³²)	0.000301 arc sec/line		
-E5 ⁽²⁾	0.079 arc sec/line		
-E6 ⁽²⁾	0.0079 arc sec/line		
1. -E1 shows x4000/x16000 total interpolation.			
2. -E5 and -E6 not available with the APR150DR-115			

Table 3-10: Encoder Specifications (APR200DR and APR260DR)

Model	APR200DR-155	APR260DR-160
Fundamental Resolution	23600 Lines/Rev	32768 Lines/Rev
-E1 ⁽¹⁾	0.014/0.0034 arc sec/line	0.010/0.0025 arc sec/line
-E4 (2 ³²)	0.000301 arc sec/line	0.000301 arc sec/line
-E5	0.055 arc sec/line	0.04 arc sec/line
-E6	0.0055 arc sec/line	0.004 arc sec/line
1. -E1 shows x4000/x16000 total interpolation.		

3.4. Limits, Marker, and Machine Direction

Aerotech stages are configured to have positive and negative "machine" directions. The machine direction defines the phasing of the feedback and motor signals and is dictated by the stage wiring (refer to [Section 3.5](#) for Motor and Feedback phasing information). Programming direction of a stage is set by the controller that is used to move the stage. Programming direction is typically selectable in the controller, while machine direction is hardwired in the stage. [Figure 3-5](#) shows the machine direction of APR stages.

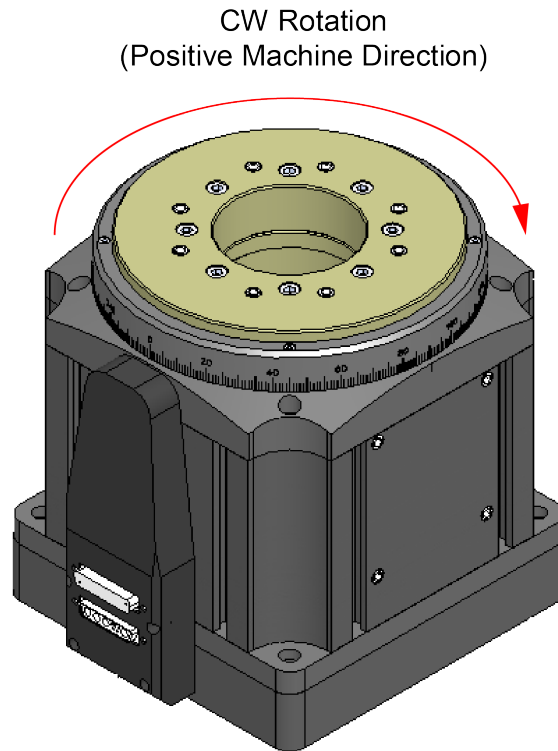
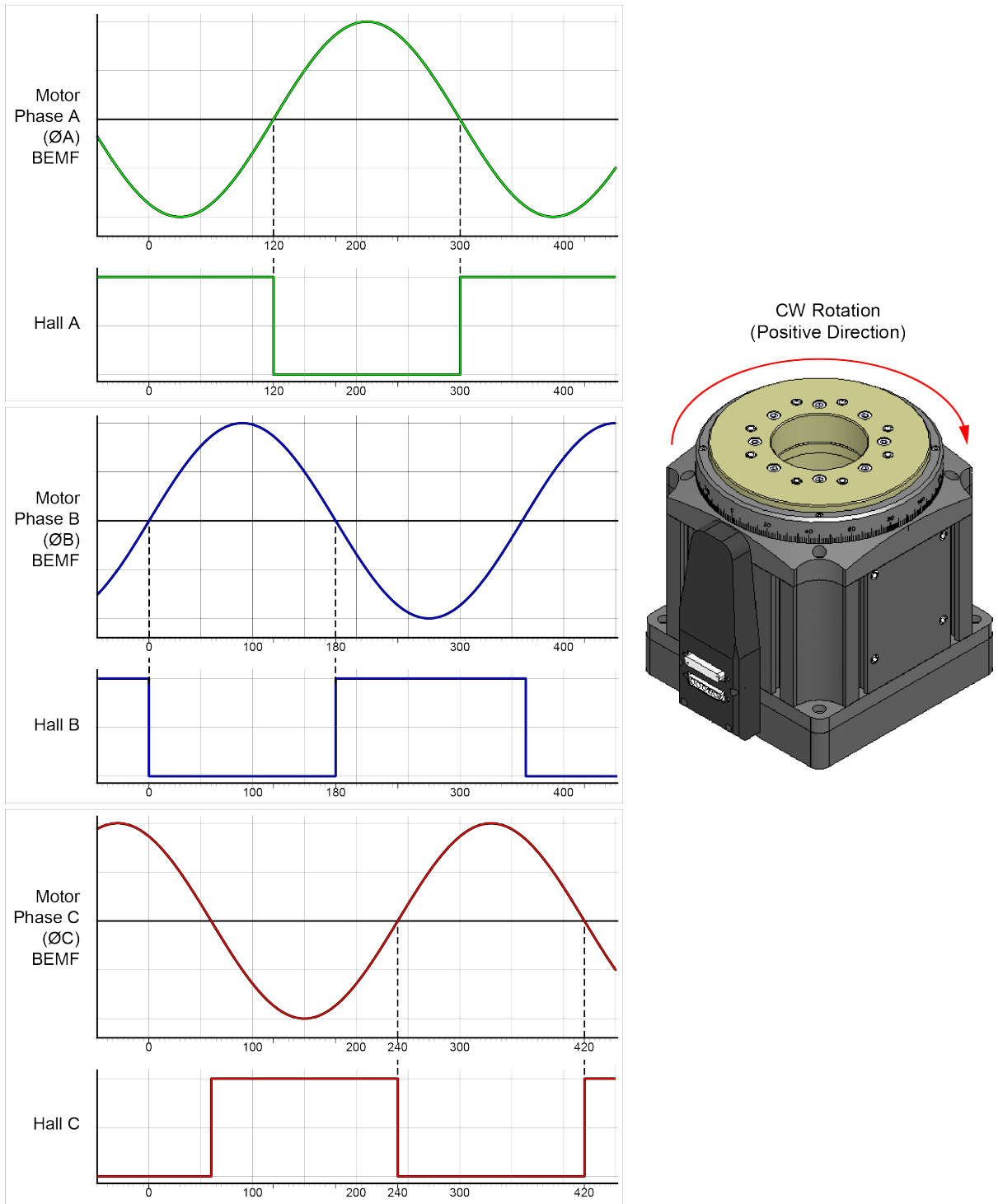


Figure 3-5: Machine Direction

3.5. Motor and Feedback Phasing

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



Positive MOVE (Clockwise) →

Figure 3-6: Hall Phasing

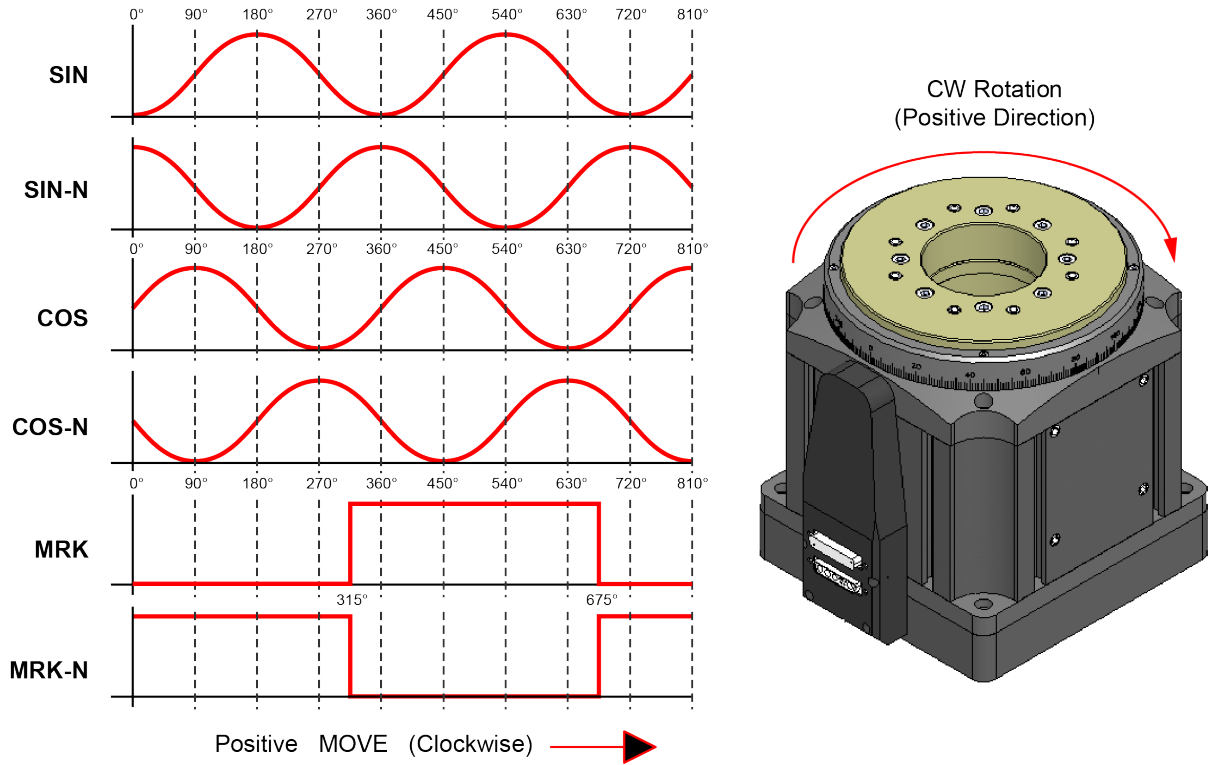


Figure 3-7: Analog Encoder Phasing Reference Diagram

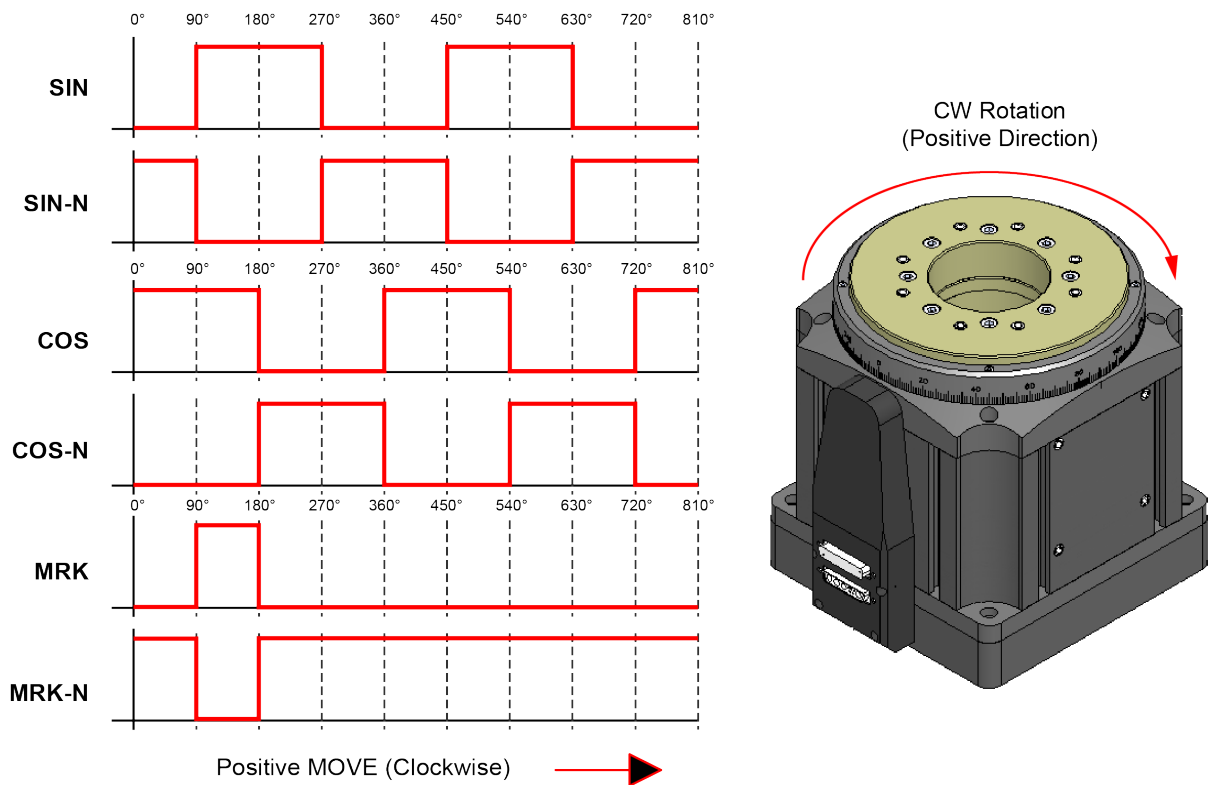


Figure 3-8: Encoder Phasing Reference Diagram (Standard)

Chapter 4: Maintenance

The APR series stages are designed to be maintenance free positioning systems. Periodic inspection and maintenance is recommended.



DANGER: To minimize the possibility of bodily injury or death, disconnect all electrical power prior to performing any maintenance or making adjustments to the equipment.

4.1. Service and Inspection Schedule

Inspect the APR at least once per month. A longer or shorter inspection interval may be required depending on the specific application, and conditions such as the duty cycle, speed, and environment.

In general, stages operating in a clean environment should be cleaned annually. For stages operating under conditions involving excessive debris, stages should be cleaned every six months. 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.

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. The motor is completely non-contact and requires no lubrication.

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

4.2. Cleaning and Lubrication

The bearings, motors, and encoders for the APR series require no added lubrication or maintenance. Periodic cleaning is recommended.

Recommended Cleaning Solvents

Before using a cleaning solvent on any part of the APR, blow away small particles and dust with nitrogen or, less preferably, clean, dry, compressed air.

Any external metal surface of the APR can be cleaned with isopropyl alcohol on a lint-free cloth. Avoid getting excess cleaning solvent on the surfaces, as it could damage the delicate electronics inside.



DANGER: To minimize the possibility of bodily injury or death, disconnect all electrical power prior to performing any maintenance or making adjustments to the equipment.

4.3. 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.• In Limit condition. Check limits (refer to Section 3.4.) 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 and Controller documentation).• Motor Connections (refer to Chapter 3 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).

Appendix A: Warranty and Field Service

Aerotech, Inc. warrants its products to be free from harmful defects caused by faulty materials or poor workmanship for a minimum period of one year from date of shipment from Aerotech. Aerotech's liability is limited to replacing, repairing or issuing credit, at its option, for any products that are returned by the original purchaser during the warranty period. Aerotech makes no warranty that its products are fit for the use or purpose to which they may be put by the buyer, whether or not such use or purpose has been disclosed to Aerotech in specifications or drawings previously or subsequently provided, or whether or not Aerotech's products are specifically designed and/or manufactured for buyer's use or purpose. Aerotech's liability on any claim for loss or damage arising out of the sale, resale, or use of any of its products shall in no event exceed the selling price of the unit.

THE EXPRESS WARRANTY SET FORTH HEREIN IS IN LIEU OF AND EXCLUDES ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED, BY OPERATION OF LAW OR OTHERWISE. IN NO EVENT SHALL AEROTECH BE LIABLE FOR CONSEQUENTIAL OR SPECIAL DAMAGES.

Return Products Procedure

Claims for shipment damage (evident or concealed) must be filed with the carrier by the buyer. Aerotech must be notified within thirty (30) days of shipment of incorrect material. No product may be returned, whether in warranty or out of warranty, without first obtaining approval from Aerotech. No credit will be given nor repairs made for products returned without such approval. A "Return Materials Authorization (RMA)" number must accompany any returned product(s). The RMA number may be obtained by calling an Aerotech service center or by submitting the appropriate request available on our website (www.aerotech.com). Products must be returned, prepaid, to an Aerotech service center (no C.O.D. or Collect Freight accepted). The status of any product returned later than thirty (30) days after the issuance of a return authorization number will be subject to review.

Visit <https://www.aerotech.com/global-technical-support.aspx> for the location of your nearest Aerotech Service center.

Returned Product Warranty Determination

After Aerotech's examination, warranty or out-of-warranty status will be determined. If upon Aerotech's examination a warranted defect exists, then the product(s) will be repaired at no charge and shipped, prepaid, back to the buyer. If the buyer desires an expedited method of return, the product(s) will be shipped collect. Warranty repairs do not extend the original warranty period.

Fixed Fee Repairs - Products having fixed-fee pricing will require a valid purchase order or credit card particulars before any service work can begin.

All Other Repairs - After Aerotech's evaluation, the buyer shall be notified of the repair cost. At such time the buyer must issue a valid purchase order to cover the cost of the repair and freight, or authorize the product(s) to be shipped back as is, at the buyer's expense. Failure to obtain a purchase order number or approval within thirty (30) days of notification will result in the product(s) being returned as is, at the buyer's expense.

Repair work is warranted for ninety (90) days from date of shipment. Replacement components are warranted for one year from date of shipment.

Rush Service

At times, the buyer may desire to expedite a repair. Regardless of warranty or out-of-warranty status, the buyer must issue a valid purchase order to cover the added rush service cost. Rush service is subject to Aerotech's approval.

On-site Warranty Repair

If an Aerotech product cannot be made functional by telephone assistance or by sending and having the customer install replacement parts, and cannot be returned to the Aerotech service center for repair, and if Aerotech determines the problem could be warranty-related, then the following policy applies:

Aerotech will provide an on-site Field Service Representative in a reasonable amount of time, provided that the customer issues a valid purchase order to Aerotech covering all transportation and subsistence costs. For warranty field repairs, the customer will not be charged for the cost of labor and material. If service is rendered at times other than normal work periods, then special rates apply.

If during the on-site repair it is determined the problem is not warranty related, then the terms and conditions stated in the following "On-Site Non-Warranty Repair" section apply.

On-site Non-Warranty Repair

If any Aerotech product cannot be made functional by telephone assistance or purchased replacement parts, and cannot be returned to the Aerotech service center for repair, then the following field service policy applies:

Aerotech will provide an on-site Field Service Representative in a reasonable amount of time, provided that the customer issues a valid purchase order to Aerotech covering all transportation and subsistence costs and the prevailing labor cost, including travel time, necessary to complete the repair.

Service Locations

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

USA, CANADA, MEXICO Aerotech, Inc. Global Headquarters Phone: +1-412-967-6440 Fax: +1-412-967-6870	CHINA Aerotech China Full-Service Subsidiary Phone: +86 (21) 5508 6731	GERMANY Aerotech Germany Full-Service Subsidiary Phone: +49 (0)911 967 9370 Fax: +49 (0)911 967 93720
JAPAN Aerotech Japan Full-Service Subsidiary Phone: +81 (0)50 5830 6814 Fax: +81 (0)43 306 3773	TAIWAN Aerotech Taiwan Full-Service Subsidiary Phone: +886 (0)2 8751 6690	UNITED KINGDOM Aerotech United Kingdom Full-Service Subsidiary Phone: +44 (0)1256 855055 Fax: +44 (0)1256 855649

Have your customer order number ready before calling.

Appendix B: Revision History

Revision	General Information
1.02.00	Product update
1.01.00	Full review/revision
1.00.00	New manual

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