PlanarDL Hardware Manual

Revision: 1.04.00

Global Technical Support

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Safety Procedures and Warnings

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

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

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 PlanarDL 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.
6. Moving parts can cause crushing or shearing injuries. Access to all stage and motor parts must be restricted while connected to a power source.
7. **PINCH POINT!** Keep Hands Clear while the stage is in motion.
8. **MAGNETS!** Strong rare-earth magnets are present in the linear motor magnet track. Attraction to metal objects (tools, watches, keys, etc.) may cause personal injury and/or damage to the equipment.

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

1. Cables can pose a tripping hazard. Securely mount and position all system cables to avoid potential hazards.
2. 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.
3. The PlanarDL stage must be mounted securely. Improper mounting can result in injury and damage to the equipment.
4. Use care when moving the PlanarDL stage. Lifting or transporting the PlanarDL stage improperly can result in injury or damage to the PlanarDL.
5. 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.
6. The stage forcer temperature may exceed 75°C.
7. Operators must be trained before operating this equipment.
8. All service and maintenance must be performed by qualified personnel.

Pinch Point Hazard

The edges of the stationary cover next to where the moving carriages pass are pinch points and could cause injury. The danger points are on the short sides of the cover next to the middle carriage lower axis motion, and the long top edge that is covered by the upper carriage when it moves toward the positive end of travel.

Figure 1: Pinch Point Locations

EU Declaration of Incorporation

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

herewith declares that the product:
PlanarDL 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 RoHS 3 Directive

Authorized Representative: Simon Smith, European Director
Address: Aerotech Ltd
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Hampshire RG26 5PR
UK

Name / Alex Weibel
Position Engineer Verifying Compliance
Location Pittsburgh, PA
Date 2/20/2020

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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 Options

PlanarDL Two Axis, Mechanical Bearing, Direct-Drive Linear Stage	
PlanarDL-100XY	Two axis mechanical-bearing direct-drive linear stage, 100 x 100 mm travel
PlanarDL-200XY	Two axis mechanical-bearing direct-drive linear stage, 200 x 200 mm travel
PlanarDL-300XY	Two axis mechanical-bearing direct-drive linear stage, 300 x 300 mm travel
Motor (Required) - Not Applicable for PlanarDL-100XY	
-M1	1 motor on upper axis; 1 motor on lower axis
-M2	2 motors on upper axis; 1 motor on lower axis
-M3	1 motor on upper axis; 2 motors on lower axis
-M4	2 motors on upper axis; 2 motors on lower axis
Feedback (Required)	
-E1	Incremental encoders, 1 Vpp on upper and lower axes
-E2	Incremental encoders, 0.1 µm Digital RS422 on upper axis, 1 Vpp on lower axis
-E3	Incremental encoders, 1 Vpp on upper axis, 0.1 µm Digital RS422 on lower axis
-E4	Incremental encoders, 0.1 µm Digital RS422 on upper and lower axes
Cable Management (Optional)	
-CMS1	Cable management for air/vacuum line
-CMS2	Cable management for air/vacuum line and 3rd axis motor/feedback
Performance Grade (Required)	
-PL1	Base performance
-PL3	High-accuracy performance, PLUS
-PL4	Ultra-high accuracy 2D performance, ULTRA
Note: -PL3 and -PL4 performance grades require an Aerotech controller.	

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. The stage should be packaged with desiccant if it is to be stored for an extended time.
Altitude	Operating: 0 m to 2,000 m (0 ft to 6,562 ft) above sea level Contact Aerotech if your specific application involves use above 2,000 m or below sea level.
Vibration	Use the system in a low-vibration environment. Excessive floor or acoustical vibration can affect system performance. Contact Aerotech for information regarding your specific application.
Protection Rating	The PlanarDL has some protection from contamination due to the cutting process. However, the stage is not sealed. Dust and chips from the cutting process should be removed from the cut point with blow-off gas and a vacuum. Failure to control this debris could result in damage to the stage. The ingress protection rating is IP00.
Use	Indoor use only

1.1.1. Accuracy and Temperature Effects

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

The encoder scale in the PlanarDL stage has a coefficient of thermal expansion (CTE) of 3.25×10^{-6} / °C. As the stage deviates from 20°C, travel of the stage as seen by the encoder will change at that rate.

1.2. Basic Specifications

Table 1-3: PlanarDL-100XY Series Specifications

		-PL1(5)	-PL3(1,5)	-PL4(1,5)
Travel		100 mm x 100 mm		
Accuracy		±3 µm	±0.4 µm	±0.4 µm
Bidirectional Repeatability(2)		±0.1 µm		
Resolution (Minimum Incremental Motion)		3 nm		
Straightness		±1 µm	±1 µm	±0.4 µm
Flatness		±1 µm		
Pitch		12 arc sec		
Roll		12 arc sec		
Yaw		6 arc sec		
Orthogonality		20 arc sec	5 arc sec	1 arc sec
Maximum Speed (Upper Axis)		500 mm/s		
Maximum Acceleration (No Load / Upper Axis)		1.5 g (No Load)		
Maximum Force (Continuous)		26 N		
Load Capacity (Horizontal) (3)		15 kg		
Moving Mass	Upper Axis	2.9 kg		
	Lower Axis	8.4 kg		
Stage Mass(4)		11 kg		
Material		Black Anodized Aluminum		
Mean Time Between Failure		30,000 Hours		

1. Requires the use of an Aerotech controller.
2. Repeatability specification assumes a feedback resolution of 20 nm or less.
3. Axis orientation for on-axis loading is listed (refer to Section 2.4. for offset loading behavior).
4. Stage mass is a function of motor configuration.
5. Specifications for -PL1 and -PL3 options are per axis measured 25 mm above the tabletop. Specifications for -PL4 are XY measured 25 mm above the tabletop.

Table 1-4: PlanarDL-200XY Series Specifications

		-PL1(5)	-PL3(1,5)	-PL4(1,5)
Travel		200 mm x 200 mm		
Accuracy		±4 µm	±0.5 µm	±0.5 µm
Bidirectional Repeatability(2)		±0.1 µm		
Resolution (Minimum Incremental Motion)		3 nm		
Straightness		±1.5 µm	±1.5 µm	±0.5 µm
Flatness		±1.5 µm		
Pitch		15 arc sec		
Roll		15 arc sec		
Yaw		8 arc sec		
Orthogonality		20 arc sec	5 arc sec	1 arc sec
Maximum Speed (Upper Axis)		750 mm/s		
Maximum Acceleration (No Load / Upper Axis)		1.0 g (x1 motor) 1.5 g (x2 motors)		
Maximum Force (continuous)		31 N (x1 motor) 62 N (x2 motors)		
Load Capacity (Horizontal) (3)		20 kg		
Moving Mass	Upper Axis	6.3 kg (-M1 or -M3 Motor) 7.4 kg (-M2 or -M4 Motor)		
	Lower Axis	16.8 kg (-M1 Motor) 17.8 kg (-M2 or -M3 Motor) 19.0 kg (-M4 Motors)		
Stage Mass (4)		23-25 kg		
Material		Black Anodized Aluminum		
Mean Time Between Failure		30,000 Hours		

1. Requires the use of an Aerotech controller.
2. Repeatability specification assumes a feedback resolution of 20 nm or less.
3. Axis orientation for on-axis loading is listed (refer to Section 2.4. for offset loading behavior).
4. Stage mass is a function of motor configuration.
5. Specifications for -PL1 and -PL3 options are per axis measured 25 mm above the tabletop. Specifications for -PL4 are XY measured 25 mm above the tabletop.

Table 1-5: PlanarDL-300XY Series Specifications

		-PL1(5)	-PL3(1,5)	-PL4(1,5)
Travel		300 mm x 300 mm		
Accuracy		±5 µm	±0.75 µm	±0.75 µm
Bidirectional Repeatability(2)		±0.1 µm		
Resolution (Minimum Incremental Motion)		3 nm		
Straightness		±2 µm	±2 µm	±0.75 µm
Flatness		±2 µm		
Pitch		18 arc sec		
Roll		18 arc sec		
Yaw		10 arc sec		
Orthogonality		20 arc sec	5 arc sec	1 arc sec
Maximum Speed (Upper Axis)		1000 mm/s		
Maximum Acceleration (No Load / Upper Axis)		1.0 g (x1 motor) 1.5 g (x2 motors)		
Maximum Force (continuous)		78 N (x1 motor) 156 N (x2 motors)		
Load Capacity (Horizontal) (3)		30 kg		
Moving Mass	Upper Axis	16.3 kg (-M1 or -M3 Motor) 19.1 kg (-M2 or -M4 Motor)		
	Lower Axis	45.0 kg (-M1 Motor) 48.1 kg (-M2 or -M3 Motor) 50.9 kg (-M4 Motors)		
Stage Mass (4)		53-63 kg		
Material		Black Anodized Aluminum		
Mean Time Between Failure		30,000 Hours		

1. Requires the use of an Aerotech controller.
2. Repeatability specification assumes a feedback resolution of 20 nm or less.
3. Axis orientation for on-axis loading is listed (refer to Section 2.4. for offset loading behavior).
4. Stage mass is a function of motor configuration.
5. Specifications for -PL1 and -PL3 options are per axis measured 25 mm above the tabletop. Specifications for -PL4 are XY measured 25 mm above the tabletop.

1.3. Vacuum Operation

Aerotech can specially prepare the PlanarDL for operation in vacuum environments. Aerotech offers two vacuum preparation options; one for low vacuum (for use in atmospheric pressures to 10^{-3} Torr) and one for high vacuum (preparation for environments from 10^{-3} to 10^{-6} Torr). As part of this preparation, attention to detail during modification, cleaning, and assembly results in products with optimal performance in vacuum applications.

To make sure that the PlanarDL 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).

- Do not remove the PlanarDL from its sealed bag until it is ready to use.
- Always handle the PlanarDL in a clean environment and use powder-free polyethylene gloves to prevent any contaminants from adhering to the surface of the PlanarDL.
- During installation, use cleaned, vented, stainless steel fasteners when securing the PlanarDL.
- 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.
- For vacuum applications, the recommended lubricant is a small quantity of Braycote® 602EF grease or a compatible substitute of equal quality.
- Baking vacuum components significantly reduces outgassing at initial pump-down to vacuum pressure and evaporates water vapor that impregnates porous surfaces on the aluminum and Teflon cables. Aerotech recommends that customers bake out vacuum systems when first installing them in the vacuum chamber. Contact Aerotech for bakeout temperatures and times for your application.

Chapter 2: Mechanical Specifications and Installation

WARNING: PlanarDL 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

The PlanarDL has different lifting configurations based on the travel and the CMS option (shown in Figure 2-1).

DANGER/HEAVY: Manually lifting and moving the stage requires a minimum of two people on either side of the stage. Refer to Section 1.2. for stage mass specifications.

- Do not attempt to lift heavy loads single handed.
- Follow the lifting instructions and only manually lift from the specified surfaces (if lifting hardware hasn't been supplied).
- Do not use any of the cables as lifting points.

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

- Only lift the PlanarDL with the shipping clamps attached.
- Make sure that all moving parts are secure before moving the PlanarDL. Unsecured moving parts may shift and cause bodily injury.
- Improper handling could adversely affect the performance of the PlanarDL. Use care when moving the PlanarDL.

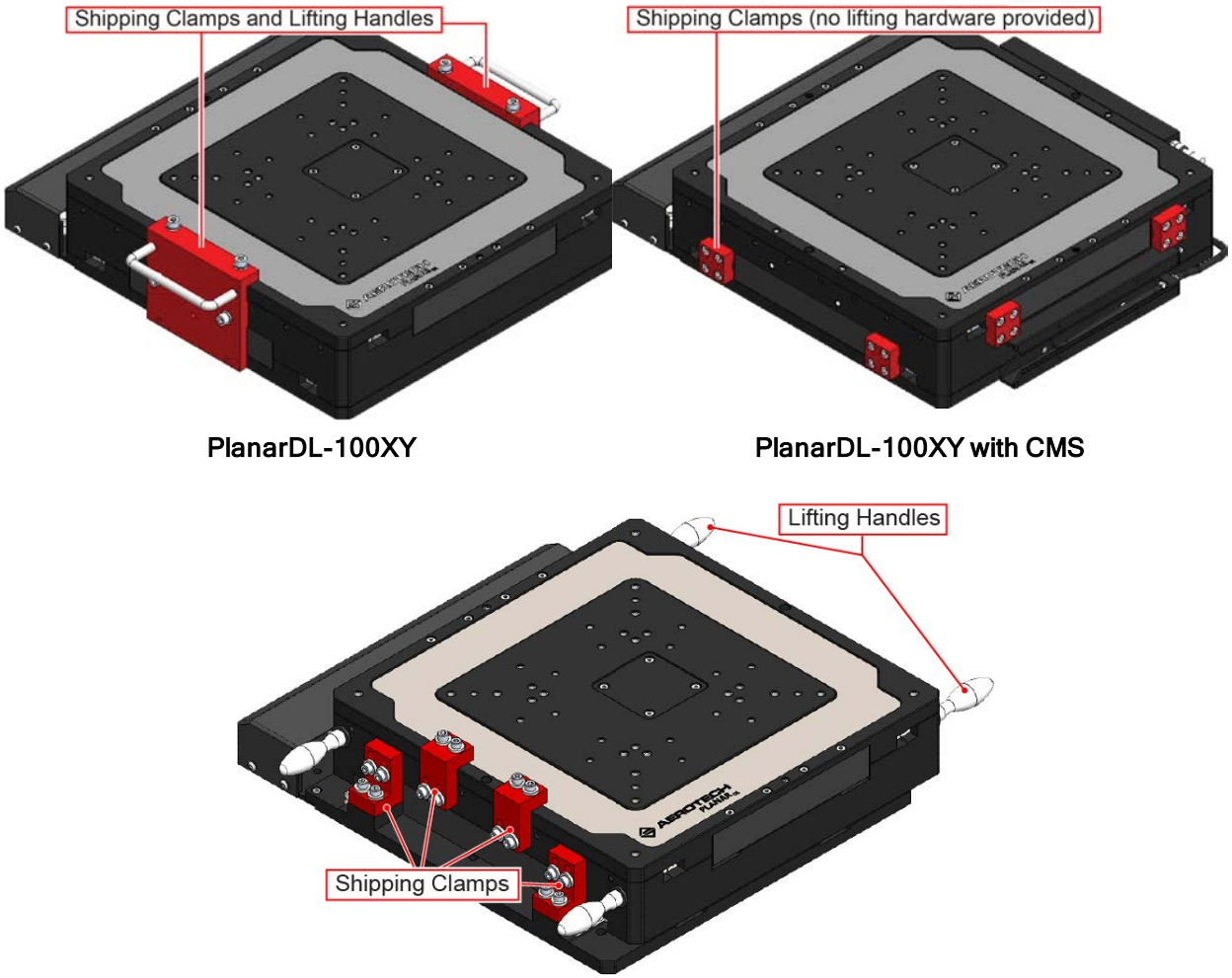
Carefully remove the PlanarDL from its protective shipping container. Gently set the PlanarDL on a smooth, flat, and clean surface.

Before operating the PlanarDL, 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-free air to remove any dust or debris that has collected during shipping.

Each PlanarDL 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 Brackets

Red, anodized aluminum shipping brackets have been installed to prevent unwanted motion and potential damage from occurring during shipment. The brackets must be removed before the PlanarDL can be operated. Careful assembly is required when installing the shipping brackets. It is important that the bracket is fully seated on both mounting surfaces before the screws are tightened. If this step is not done, the carriage parts will deform when the bracket is mounted, which could adversely affect stage performance or possibly cause a failure during shipment. Retain the brackets and hardware for future use.



PlanarDL-100XY

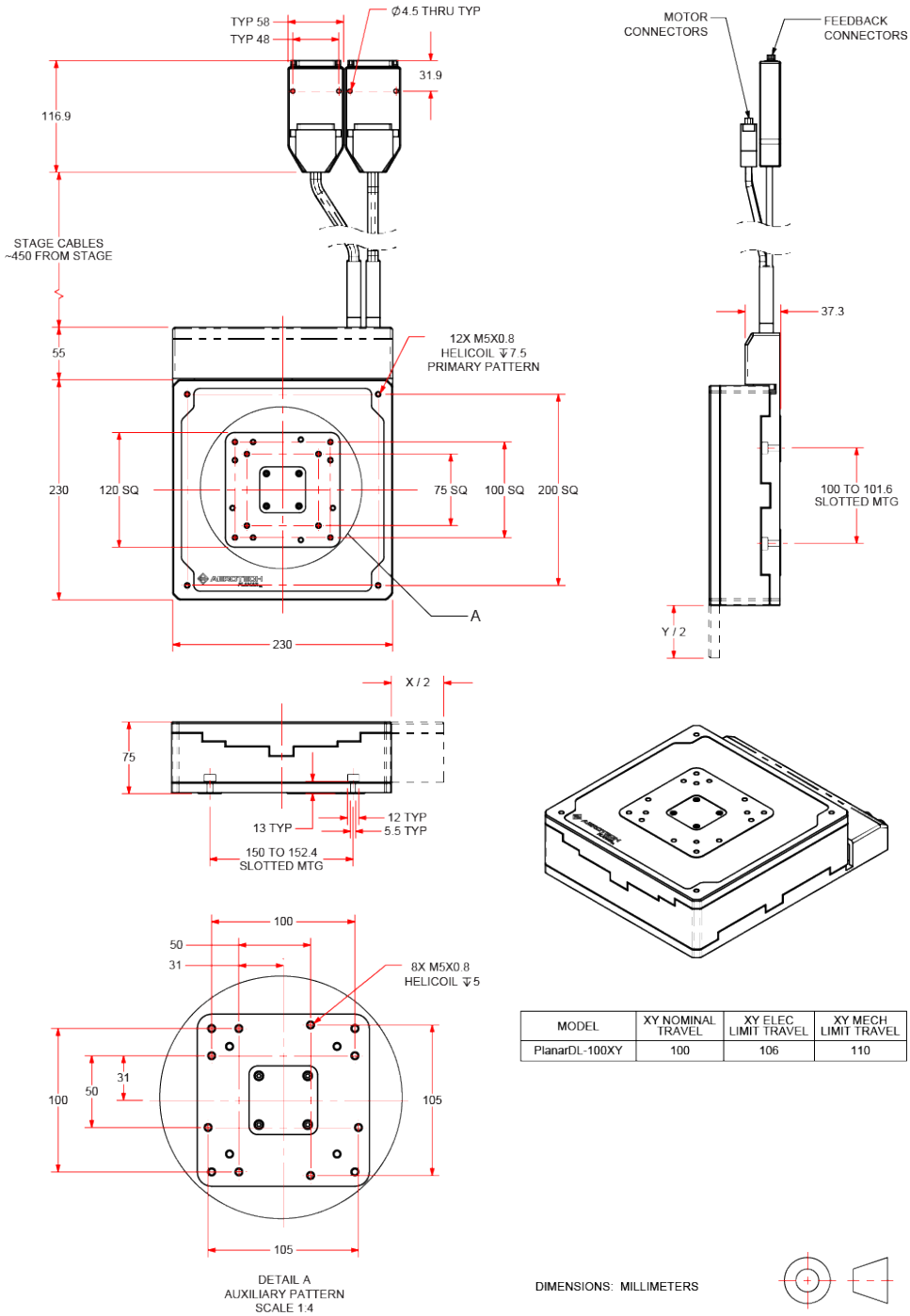
PlanarDL-100XY with CMS

PlanarDL-200XY & PlanarDL-300XY

Figure 2-1: Lifting Hardware and Shipping Brackets

2.2. Dimensions

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.



MODEL	XY NOMINAL TRAVEL	XY ELEC LIMIT TRAVEL	XY MECH LIMIT TRAVEL
PlanarDL-100XY	100	106	110

Figure 2-2: PlanarDL-100XY Dimensions without Cable Management

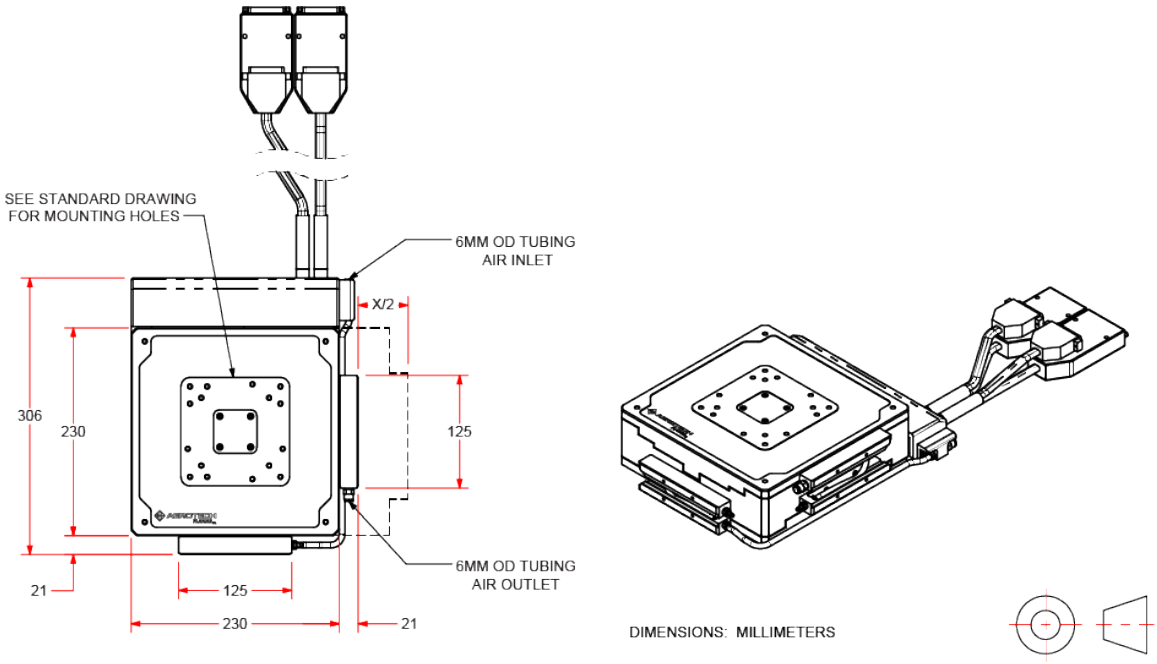


Figure 2-3: PlanarDL-100XY-CMS1 Dimensions

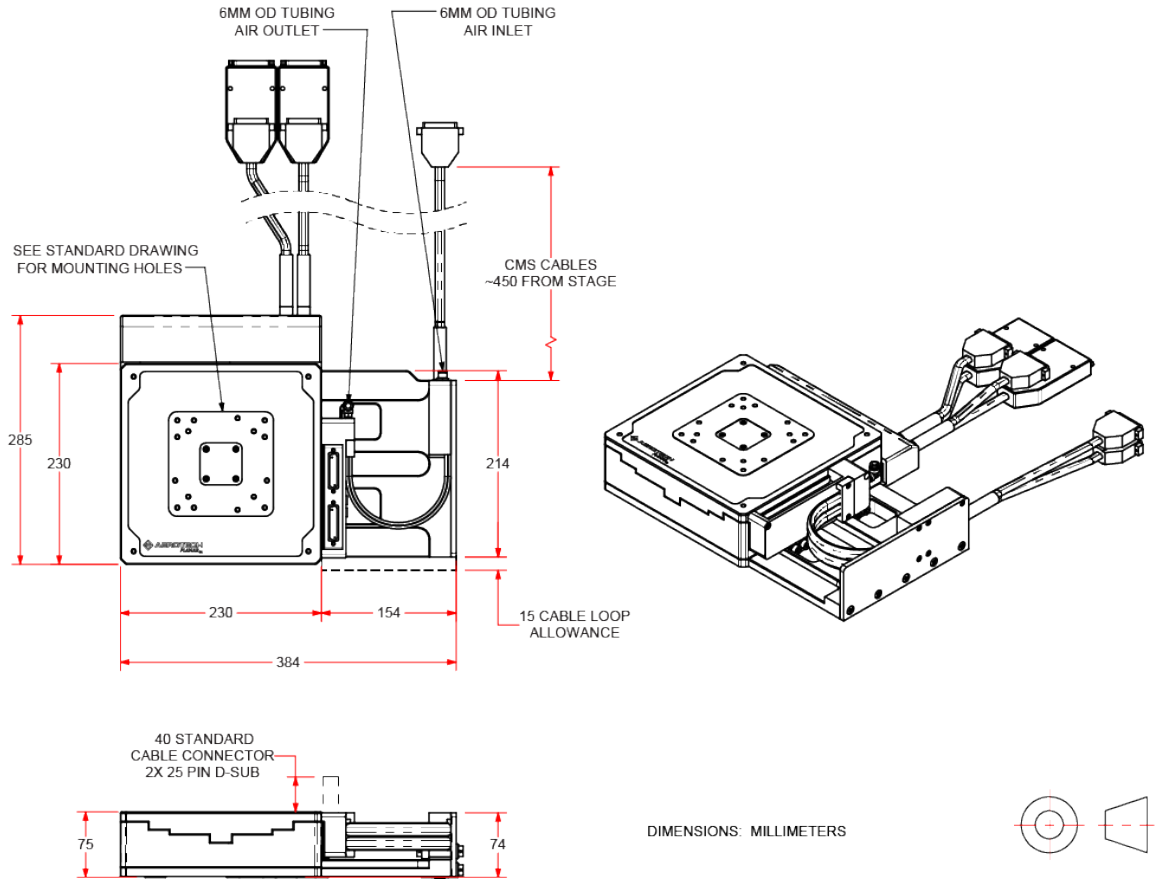


Figure 2-4: PlanarDL-100XY-CMS2 Dimensions

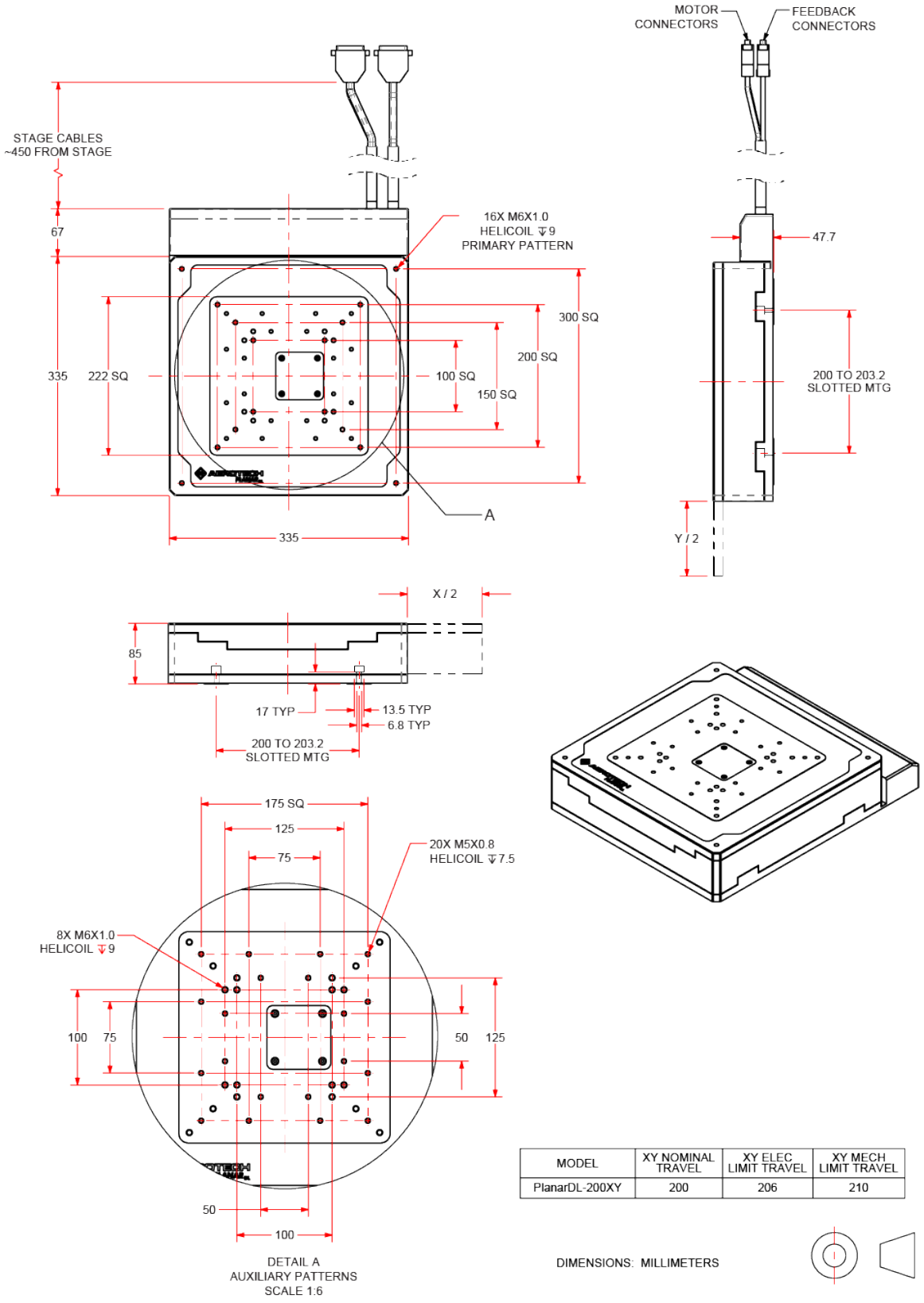


Figure 2-5: PlanarDL-200XY Dimensions without Cable Management

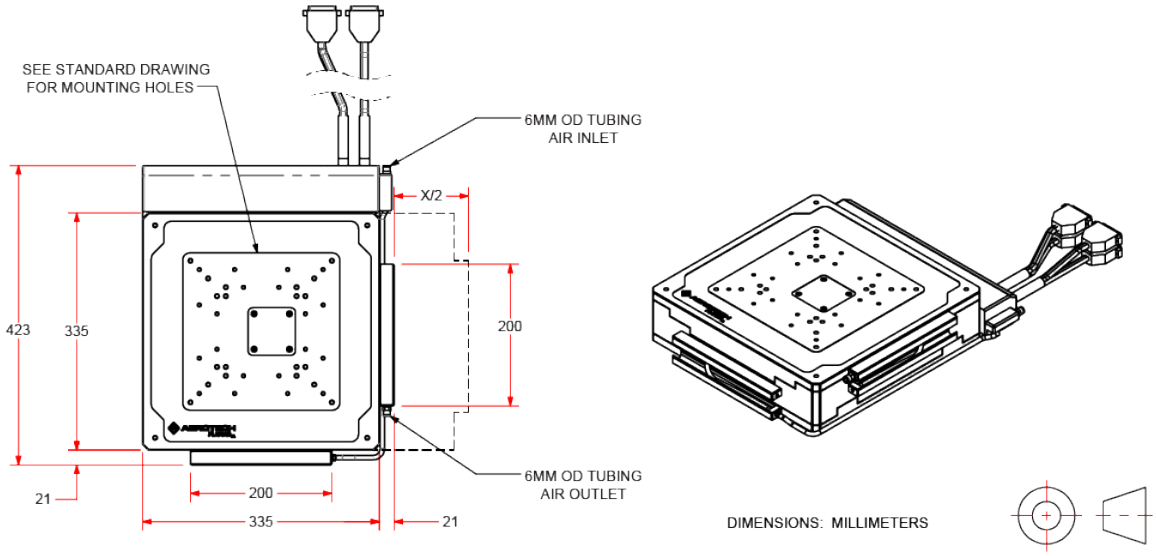


Figure 2-6: PlanarDL-200XY-CMS1 Dimensions

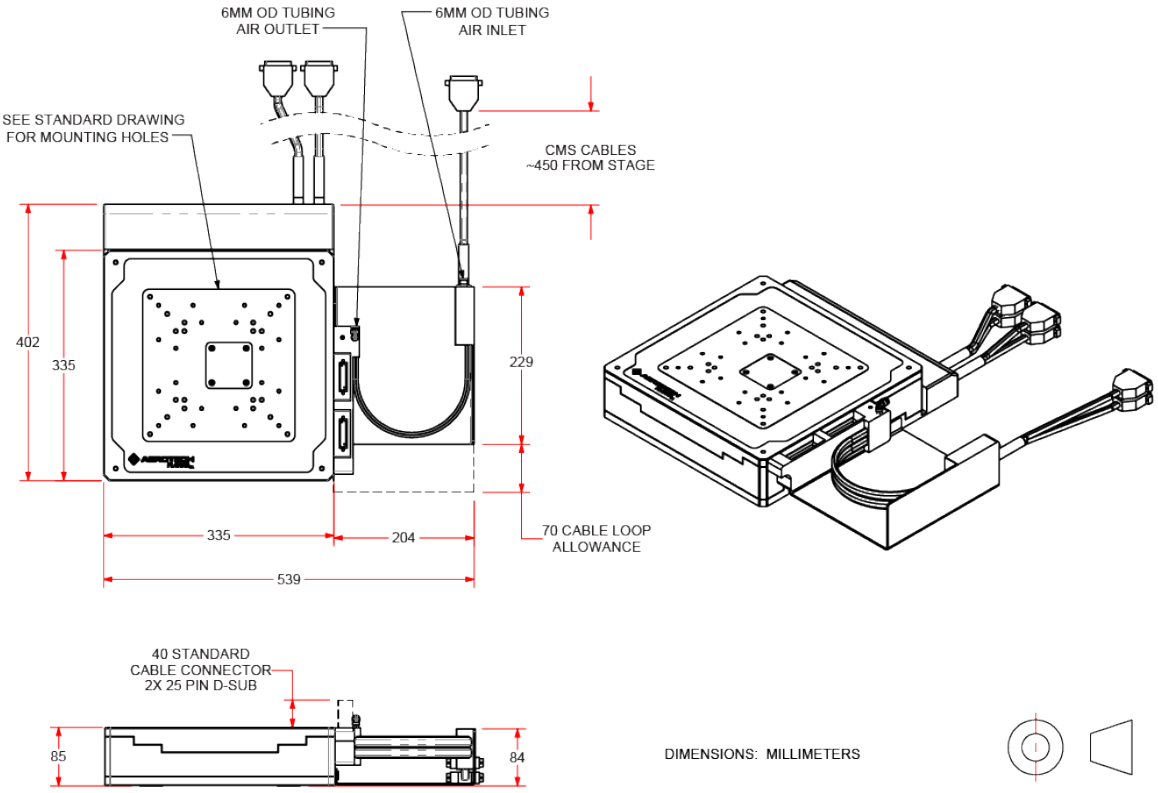
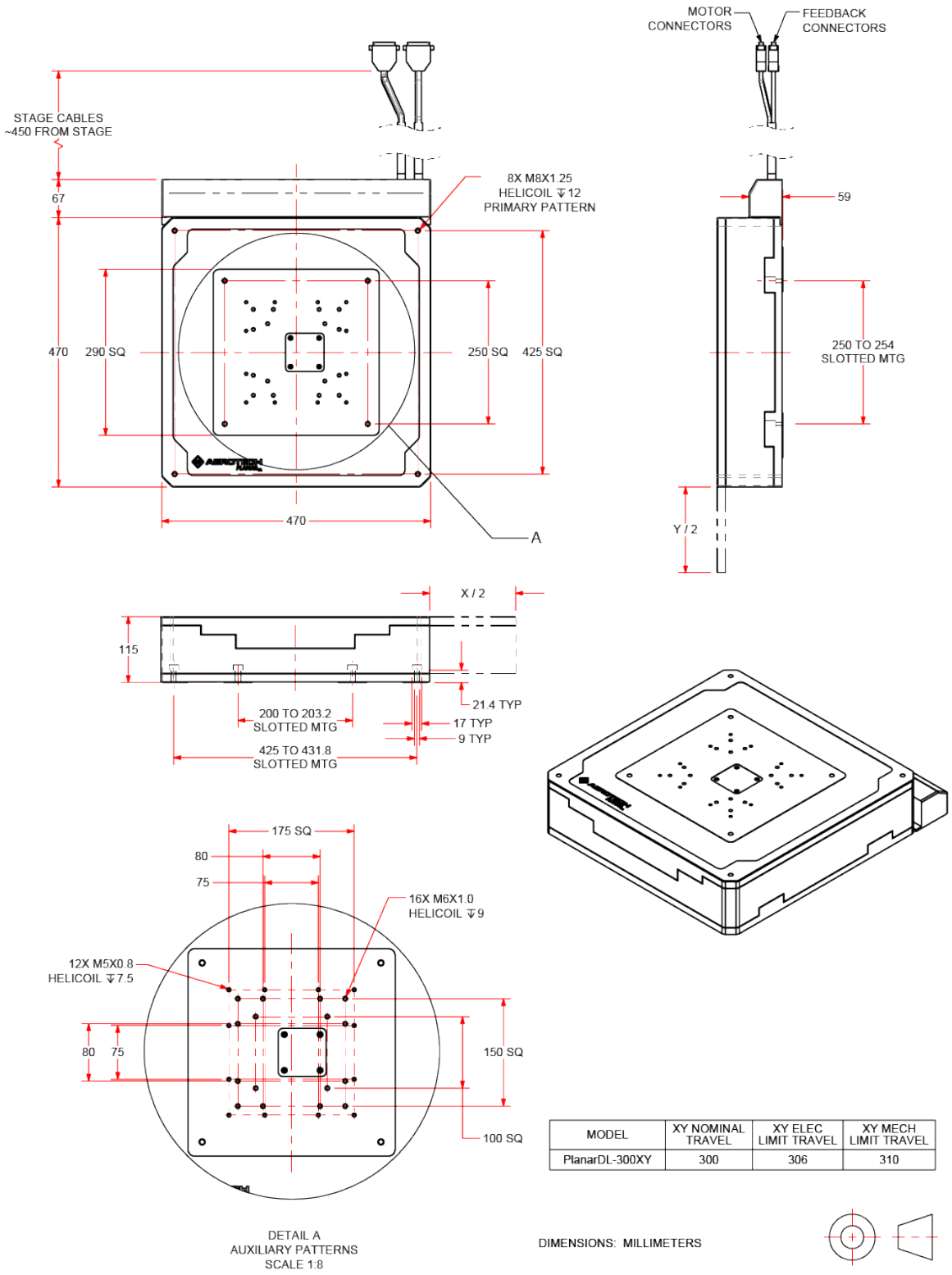


Figure 2-7: PlanarDL-200XY-CMS2 Dimensions



MODEL	XY NOMINAL TRAVEL	XY ELEC LIMIT TRAVEL	XY MECH LIMIT TRAVEL
PlanarDL-300XY	300	306	310

Figure 2-8: PlanarDL-300XY Dimensions without Cable Management

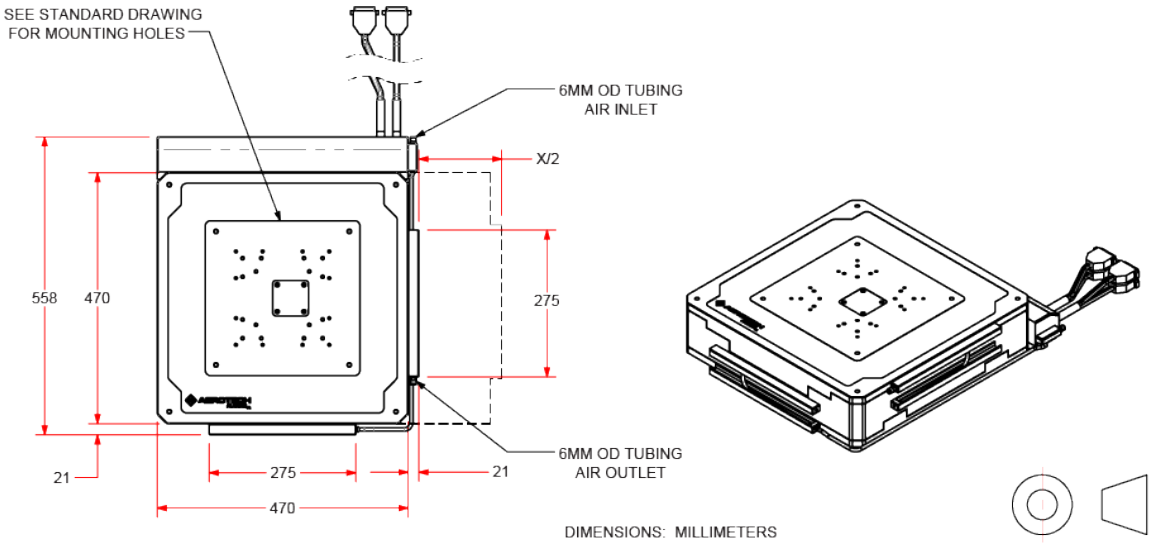


Figure 2-9: PlanarDL-300XY-CMS1 Dimensions

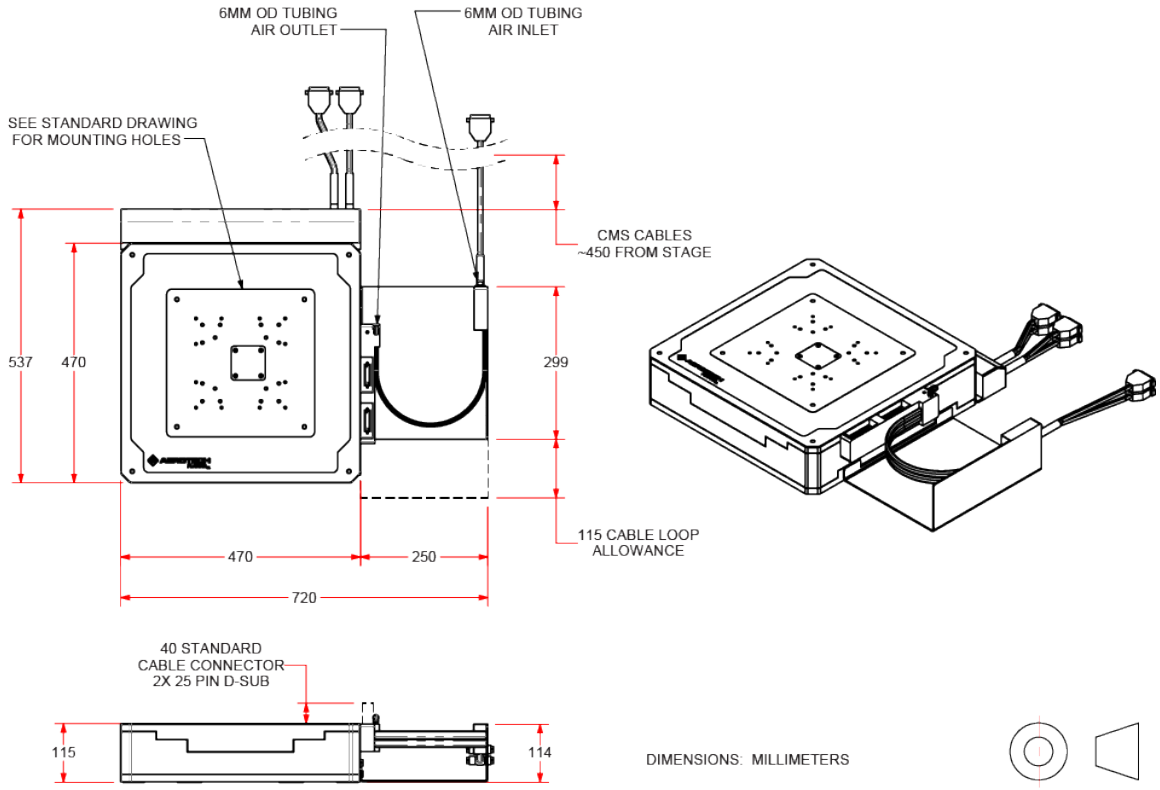


Figure 2-10: PlanarDL-300XY-CMS2 Dimensions

2.3. Securing the Stage to the Mounting Surface

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

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

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

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

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

NOTE: To maintain accuracy, the mounting surface must be flat to within 5 µm over the entire stage footprint for PlanarDL-100XY and PlanarDL-200XY stages. For PlanarDL-300XY stages, the mounting surface must be flat to within 7.5 µm.

NOTE: The PlanarDL 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 PlanarDL. Shimming should be avoided if possible. If shimming is required, it should be minimized to retain maximum rigidity of the system.

Access the mounting holes in the base of the PlanarDL stage by sliding the carriage all the way to either end of travel (as shown in Figure 2-11). Refer to the Safety and Warning section at the beginning of this manual for a description of the stage pinch points. The user must be aware at all times of the pinch point dangers while the stage is in motion.

A part of the cable management system (-CMS1 only) must be removed to access two of the mounting holes on the PlanarDL-100XY and PlanarDL-300XY (refer to Figure 2-12). The CMS bracket is held in place with two M3-0.5 x 8mm long button head cap screws. When reinstalling the bracket after the stage is mounted, tighten the M3 button head screws to 0.7 N-m (6 in-lb).

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
PlanarDL-100XY	M5 x 22 mm long socket head cap screw, Stainless steel with flat washer	3.3 N·m
PlanarDL-200XY	M6 x 30 mm long socket head cap screw, Stainless steel with flat washer	5.6 N·m
PlanarDL-300XY	M8 x 30 mm long socket head cap screw, Stainless steel with flat washer	13.5 N·m

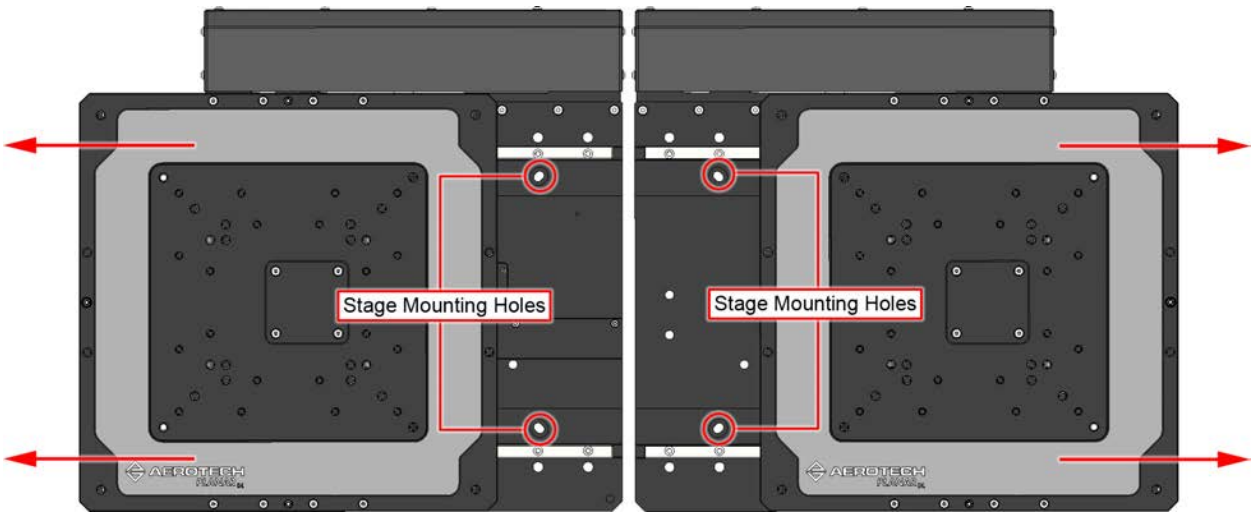


Figure 2-11: Mounting Hole Locations

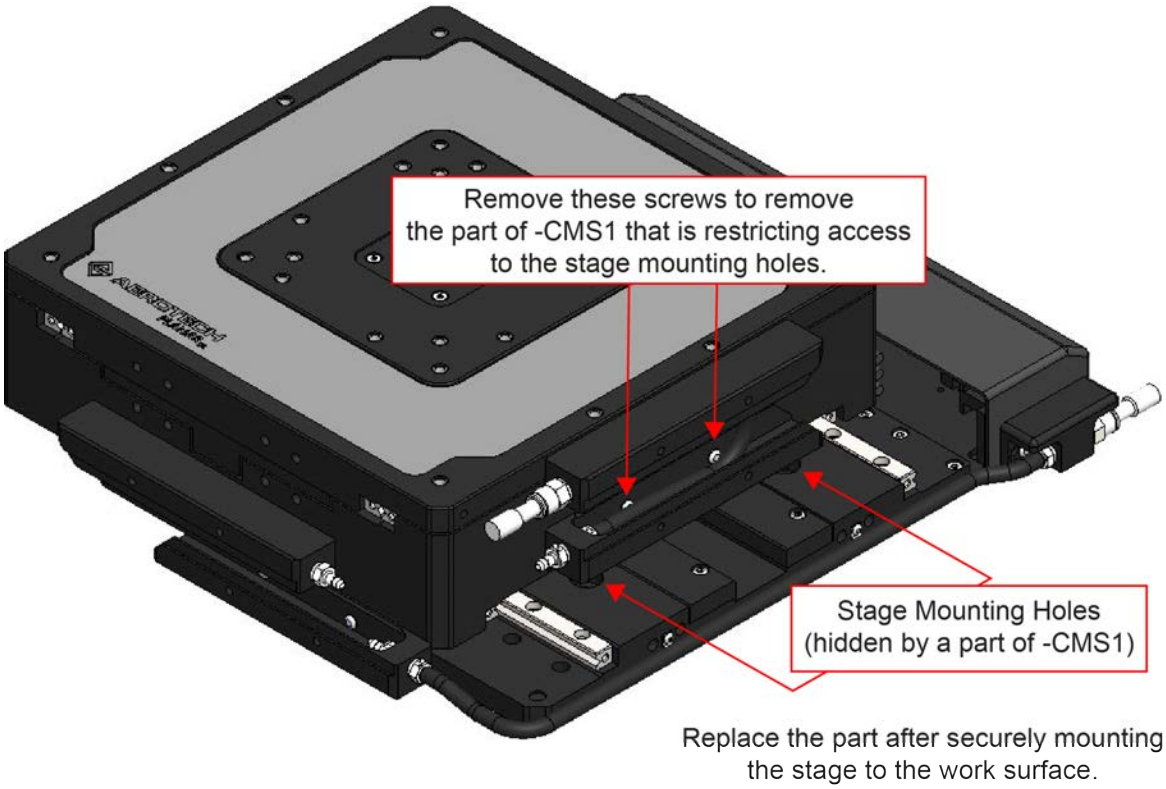


Figure 2-12: Mounting Hole Locations Hidden by -CMS1

2.4. Attaching the Payload to the Stage

Inspect the mounting surface for dirt or unwanted residue and clean if necessary. Clean the mounting surface with a lint-free cloth and acetone or isopropyl alcohol and allow the cleaning solvent to completely dry.

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

NOTE: If your PlanarDL 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 PlanarDL 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.

WARNING: Refer to the dimensions in Section 2.2. for maximum allowable thread engagement. A screw extending through the stage table can affect travel and damage the stage.

NOTE: Use 3-point mounting, if possible, when attaching the payload to the stage.

NOTE: For valid system performance, the mounting interface should be flat within 7.5 µm over the tabletop area.

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 2-13 through Figure 2-15 to find the maximum allowable load.

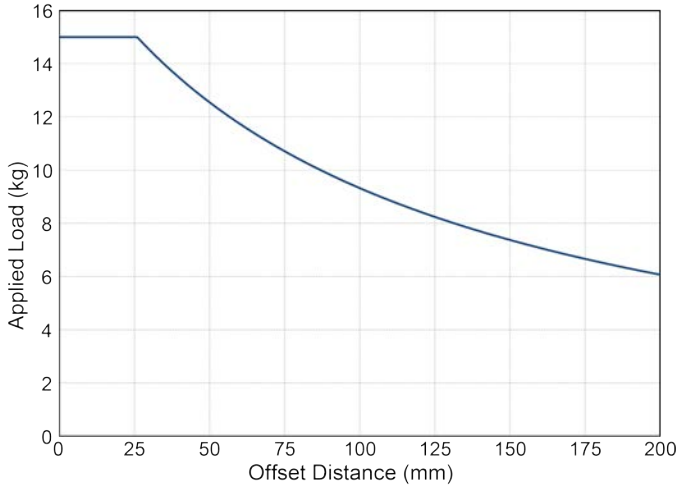


Figure 2-13: PlanarDL 100XY Cantilevered Load Capabilities

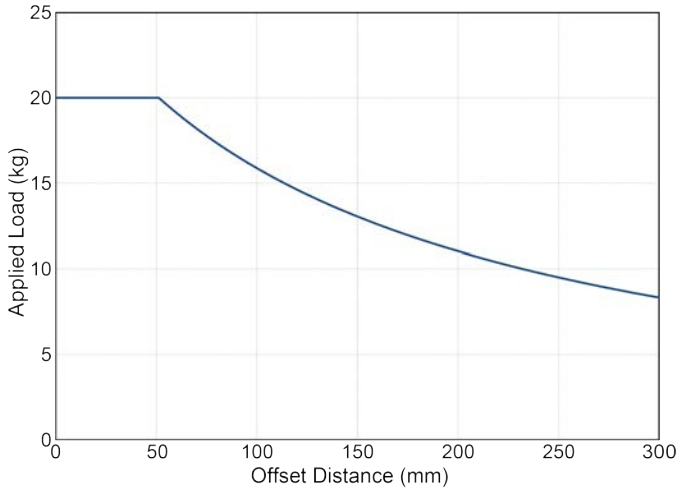


Figure 2-14: PlanarDL 200XY Cantilevered Load Capabilities

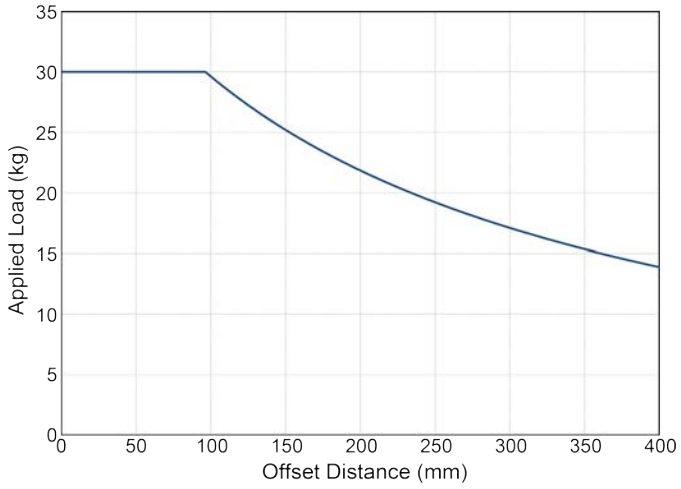


Figure 2-15: PlanarDL 300XY Cantilevered Load Capabilities

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Chapter 3: Electrical Specifications and Installation

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

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

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

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

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

WARNING: Applications requiring access to the stage while it is energized will require additional grounding and safeguards. The System Integrator or qualified installer is responsible for determining and meeting all safety and compliance requirements necessary for the integration of this stage into the final application.

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

3.1. Motor and Feedback Connectors

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

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

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

The protective ground connection of the PlanarDL 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.

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: 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

Table 3-3: Feedback Connector Pinout

Pin	Description	Connector
Case	Shield Connection	
1	Reserved	
2	Over-Temperature Thermistor sensor	
3	+5 V supply input for feedback devices	
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	Positive (CW) hardware limit	
13	Reserved	
14	Cosine	
15	Cosine-N	
16	+5 V power supply	
17	Sine	
18	Sine-N	
19	Reserved	
20	Common ground to limit switch	
21	Common ground to encoder power	
22	Reserved	
23	Reserved	
24	Negative (CCW) hardware limit	
25	Reserved	

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

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

Table 3-5: -CMS2 Third-Axis Motor Pinout

Pin	Description	Wire Gauge AWG [mm^2]	Connector
Case	Shield Connection	22 [0.326]	
A1	Motor Phase A	22 [0.326]	
A2	Motor Phase B	22 [0.326]	
A3	Motor Phase C	22 [0.326]	
1	Reserved	--	
2	Reserved	--	
3	Reserved	--	
4	Reserved	--	
5	Reserved	--	
A4	Frame Ground (motor protective ground)	22 [0.326]	

Table 3-6: Mating Connector Part Numbers for the -CMS2 Third-Axis Motor Connector

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

Table 3-7: -CMS2 Third-Axis Feedback Connector Pinout

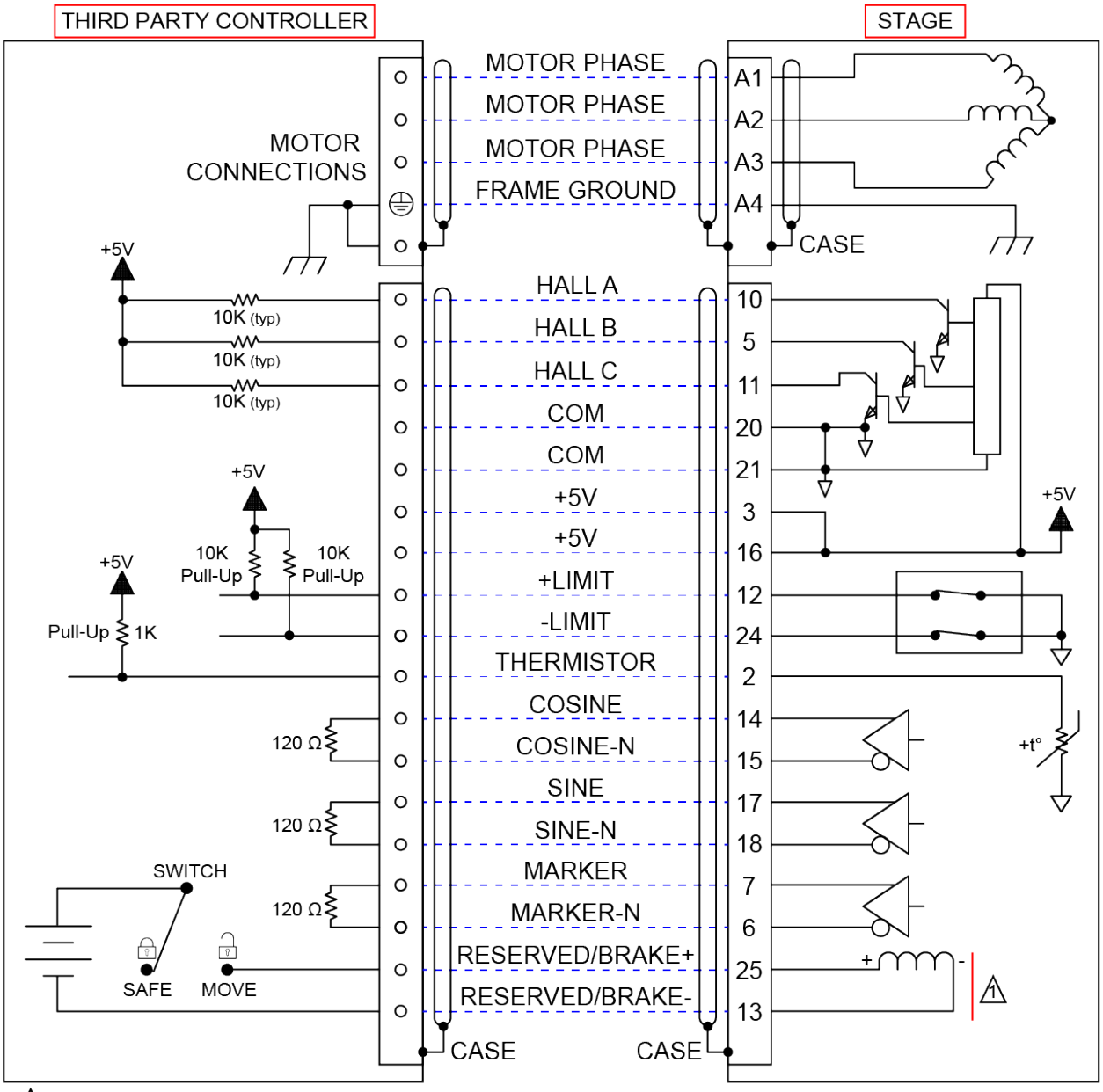
Pin	Description	Wire Gauge AWG [mm^2]	Connector
Case	Shield Connection	--	
1	Reserved	--	
2	Over-Temperature Thermistor sensor	26 [0.129]	
3	+5 V supply input for optical encoders	26 [0.129]	
4	Reserved	--	
5	Hall Effect sensor, phase B	26 [0.129]	
6	Marker-N	26 [0.129]	
7	Marker	26 [0.129]	
8	Reserved	--	
9	Reserved	--	
10	Hall Effect sensor, phase A	26 [0.129]	
11	Hall Effect sensor, phase C	26 [0.129]	
12	Positive (CW) hardware limit	26 [0.129]	
13	Brake -	26 [0.129]	
14	Cosine	26 [0.129]	
15	Cosine-N	26 [0.129]	
16	+5 V power supply	26 [0.129]	
17	Sine	26 [0.129]	
18	Sine-N	26 [0.129]	
19	Reserved	--	
20	Common ground to limit switch	22 [0.326]	
21	Common ground to encoder power	22 [0.326]	
22	Reserved	--	
23	Reserved	--	
24	Negative (CCW) hardware limit	26 [0.129]	
25	Brake +	26 [0.129]	

Table 3-8: Mating Connector Part Numbers for the -CMS2 Third-Axis Feedback Connector

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.



1 Brake pins are available only on the -CMS2 option connectors and Reserved otherwise.

Figure 3-1: Motor and Feedback Wiring

3.3. Motor and Feedback Specifications

Table 3-9: Feedback Specifications

Hall-Effect Sensors Specifications	
Supply Voltage	5 V ±5%
Supply Current	50 mA
Output Type	Open Collector
Output Voltage	24 V max (pull up)
Output Current	5 mA (sinking)

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

Encoder Specifications	
Supply Voltage	5 V ±5%
Supply Current	250 mA typical
Output Signals	**Sinusoidal Type (Incremental Encoder)**: 1 V_{pk-pk} into 120 Ω Load (differential signals SIN+, SIN-, COS+, COS- are 0.5 V_{pk-pk} relative to ground.)
	Digital Output (Incremental Encoder): RS422/485 compatible

Limit Switch Specifications (Limit switches are integral to the encoder)	
Output Type	Open Collector connected to pull-up resistor
Pullup Supply Voltage	5 V to 24V DC
Max Current (sinking)	Not to exceed 20 mA
Output Polarity	Normally Closed (NC) • Sinks current to ground (Logic "0") when not in limit • High impedance (Logic "1") when in limit • Requires external pull-up to DC Supply (10 kΩ recommended)
Note: If the PlanarDL 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 (-CMS2 Option Only)	
Supply Voltage	24 VDC
Supply Current (typical)	0.25A to 0.7A (Current required to release the brake and allow motion.)

NOTE: The PlanarDL-100XY has two motors per axis wired in parallel.

Table 3-10: PlanarDL-100XY Motor Specifications

		Two Motors Per Axis
Performance Specifications(1,5)		
Continuous Force (2)	N (lb)	25.7 (5.78)
Peak Force (3)	N (lb)	102.8 (23.1)
Electrical Specifications(5)		
BEMF Constant (Line to Line, Max)	V/m/s (V/in/s)	4.77 (0.12)
Continuous Current (2)	A_{pk} (A_{rms})	6.20 (4.38)
Peak Current, Stall (3)	A_{pk} (A_{rms})	24.80 (17.5)
Force Constant, Sine Drive (4, 8)	N/A_{pk} (lb/A_{pk})	4.15 (0.93)
	N/A_{rms} (lb/A_{rms})	5.87 (1.32)
Motor Constant (2,4)	$N/\sqrt{W}$ ($lb/\sqrt{W}$)	2.25 (0.51)
Resistance, 25°C (Line to Line)	ohms	3.25
Inductance (Line to Line)	mH	0.44
Thermal Resistance	°C/W	0.76
Maximum Bus Voltage	V_{DC}	340
Magnetic Pole Pitch	mm	16.00

1. Performance is dependent upon heat sink configuration, system cooling conditions, and ambient temperature
2. Values shown @ 100°C rise above a 25°C ambient temperature, with motor mounted to the specified aluminum heat sink.
3. Peak force assumes correct rms current; consult Aerotech.
4. Force constant and motor constant specified at stall
5. All performance and electrical specifications ±10%
6. Maximum winding temperature is 125°C.
7. Ambient operating temperature range 0 °C - 25 °C; consult Aerotech for performance in elevated ambient temperatures
8. All Aerotech amplifiers are rated Apk; use force constant in N·m/Apk when sizing.

NOTE: The PlanarDL-200XY can be configured with one or two motors per axis. In the case where the stage is configured with two motors per axis, the motors are wired in parallel.

Table 3-11: PlanarDL-200XY Motor Specifications

		Single Motor Per Axis	Two Motors Per Axis
Performance Specifications (1) (5)			
Continuous Force, No Forced Cooling (2)	N (lb)	30.6 (6.9)	61.2 (13.8)
Peak Force (3)	N (lb)	187.6 (42.17)	244.8 (55.2)
Electrical Specifications(5)			
BEMF Constant (line-line, max)	V/(m/s) (V/(in/s))	11.35 (0.29)	11.35 (0.29)
Continuous Current, No Forced Cooling (2)	A_{pk} (A_{rms})	3.10 (2.19)	6.20 (4.38)
Peak Current, Stall (3)	A_{pk} (A_{rms})	19.00 (13.44)	38.00 (26.88)
Force Constant, Sine Drive (4) (8)	N/A_{pk} (lb/A_{pk})	9.87 (2.22)	9.87 (2.22)
	N/A_{rms} (lb/A_{rms})	13.96 (3.14)	13.96 (3.14)
Motor Constant (2) (4)	$N/\sqrt{W}$ ($lb/\sqrt{W}$)	3.78 (0.85)	5.36 (1.21)
Resistance, 25°C (line-line)	Ω	6.5	3.25
Inductance (line-line)	mH	0.87	0.44
Thermal Resistance, No Cooling	°C/W	1.52	0.76
Maximum Bus Voltage	V_{DC}	340	340
Magnetic Pole Pitch	mm	16	16

1. Performance is dependent upon heat sink configuration, system cooling conditions, and ambient temperature
2. Values shown @ 100°C rise above a 25°C ambient temperature, with motor mounted to the specified aluminum heat sink.
3. Peak force assumes correct rms current; consult Aerotech.
4. Force constant and motor constant specified at stall
5. All performance and electrical specifications ±10%
6. Maximum winding temperature is 125°C.
7. Ambient operating temperature range 0 °C - 25 °C; consult Aerotech for performance in elevated ambient temperatures
8. All Aerotech amplifiers are rated Apk; use force constant in N·m/Apk when sizing.

NOTE: The PlanarDL-300XY can be configured with one or two motors per axis. In the case where the stage is configured with two motors per axis, the motors are wired in parallel.

Table 3-12: PlanarDL-300XY Motor Specifications

		Single Motor Per Axis	Two Motors Per Axis
Performance Specifications (1) (5)			
Continuous Force, No Forced Cooling (2)	N (lb)	77.7 (17.5)	155.4 (34.94)
Peak Force (3)	N (lb)	481.2 (108.2)	622.8 (140.0)
Electrical Specifications(5)			
BEMF Constant (line-line, max)	V/(m/s) (V/(in/s))	21.28 (0.54)	21.28 (0.54)
Continuous Current, No Forced Cooling (2)	A_{pk} (A_{rms})	4.20 (2.97)	8.40 (5.94)
Peak Current, Stall (3)	A_{pk} (A_{rms})	26.00 (18.38)	52.00 (36.76)
Force Constant, Sine Drive (4) (8)	N/A_{pk} (lb/A_{pk})	18.51 (4.16)	18.51 (4.16)
	N/A_{rms} (lb/A_{rms})	26.17 (5.88)	26.17 (5.88)
Motor Constant (2) (4)	$N/\sqrt{W}$ ($lb/\sqrt{W}$)	8.24 (1.85)	11.65 (2.62)
Resistance, 25°C (line-line)	Ω	4.8	2.4
Inductance (line-line)	mH	1.33	0.67
Thermal Resistance, No Cooling	°C/W	1.12	0.56
Maximum Bus Voltage	V_{DC}	340	340
Magnetic Pole Pitch	mm	25	25

1. Performance is dependent upon heat sink configuration, system cooling conditions, and ambient temperature
2. Values shown @ 100°C rise above a 25°C ambient temperature, with motor mounted to the specified aluminum heat sink.
3. Peak force assumes correct rms current; consult Aerotech.
4. Force constant and motor constant specified at stall
5. All performance and electrical specifications ±10%
6. Maximum winding temperature is 125°C.
7. Ambient operating temperature range 0 °C - 25 °C; consult Aerotech for performance in elevated ambient temperatures
8. All Aerotech amplifiers are rated Apk; use force constant in N·m/Apk when sizing.

Table 3-13: Encoder Specifications

	Fundamental Signal Period	Digital Resolution
1 Vpp	20 µm	-
1 Vpp (with x4000 Interpolation[1])		5 nm
1 Vpp (with x16000 Interpolation[1])		1.25 nm
0.1 µm TTL[1]		100 nm

1. Quadrature decoding included in interpolated resolution calculations

3.4. Limits, Marker, and Machine Direction

Aerotech stages are configured to have positive and negative "machine" directions. The machine direction defines the phasing of the feedback and motor signals and is dictated by the stage wiring (refer to Section 3.5. for Motor and Feedback phasing information). Programming direction of a stage is set by the controller that is used to move the stage. Programming direction is typically selectable in the controller, while machine direction is hardwired in the stage. Figure 3-2 shows the machine direction of PlanarDL stages.

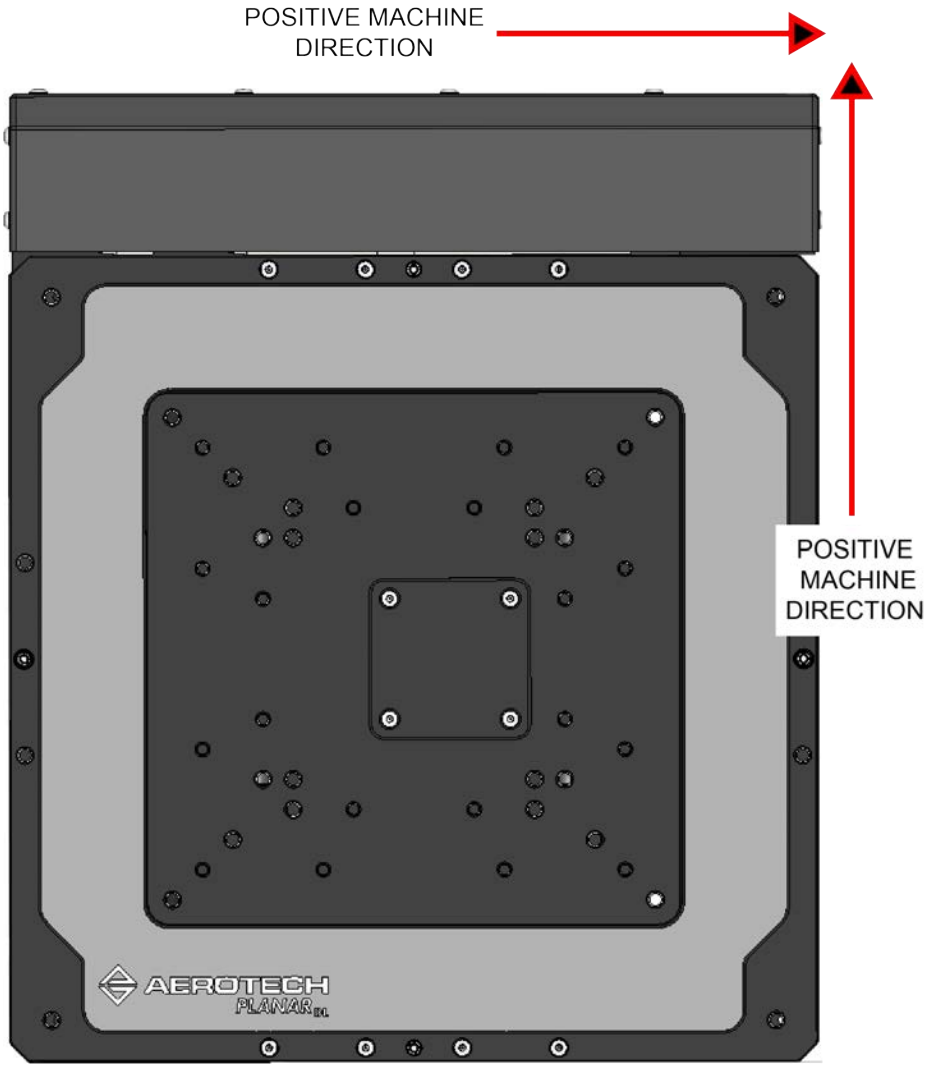
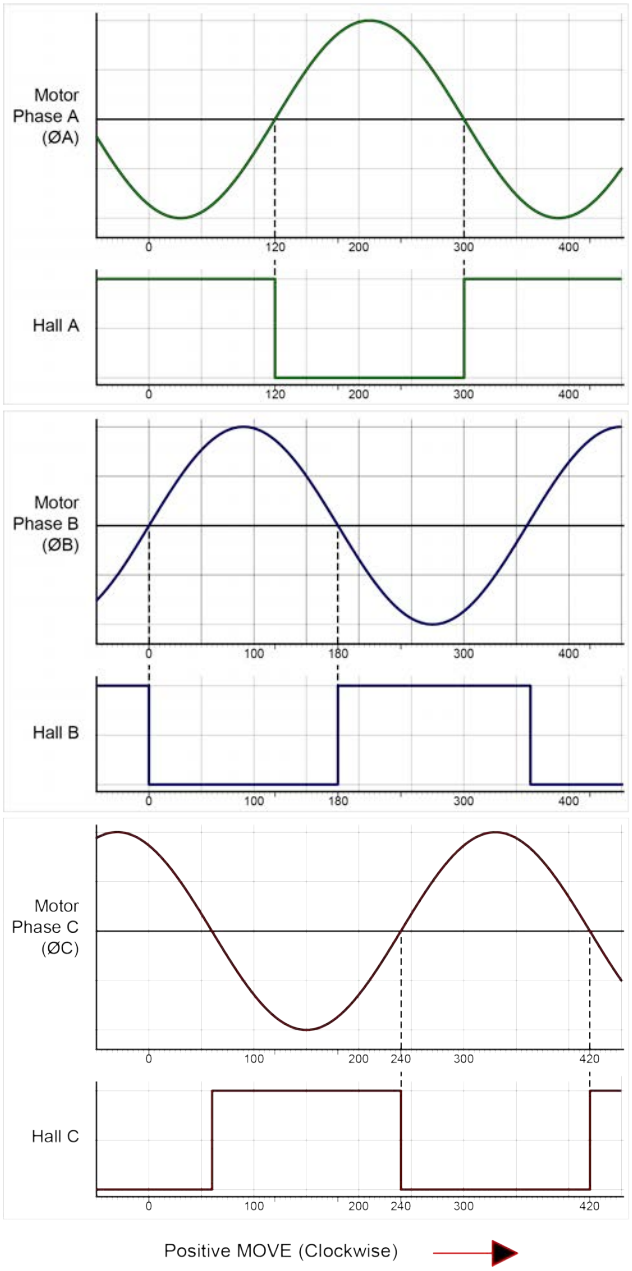


Figure 3-2: Machine Direction

3.5. Motor and Feedback Phasing

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



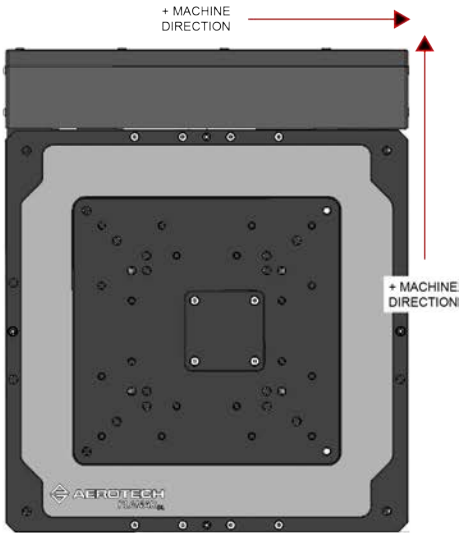


Figure 3-3: Hall Phasing

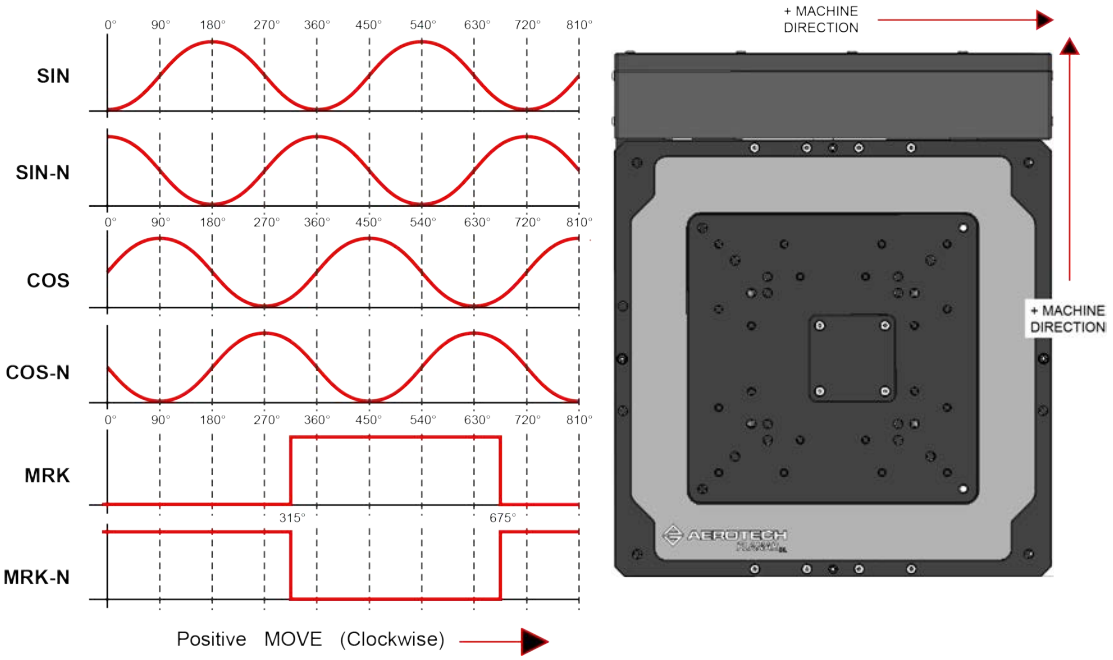


Figure 3-4: Analog Encoder Phasing Reference Diagram

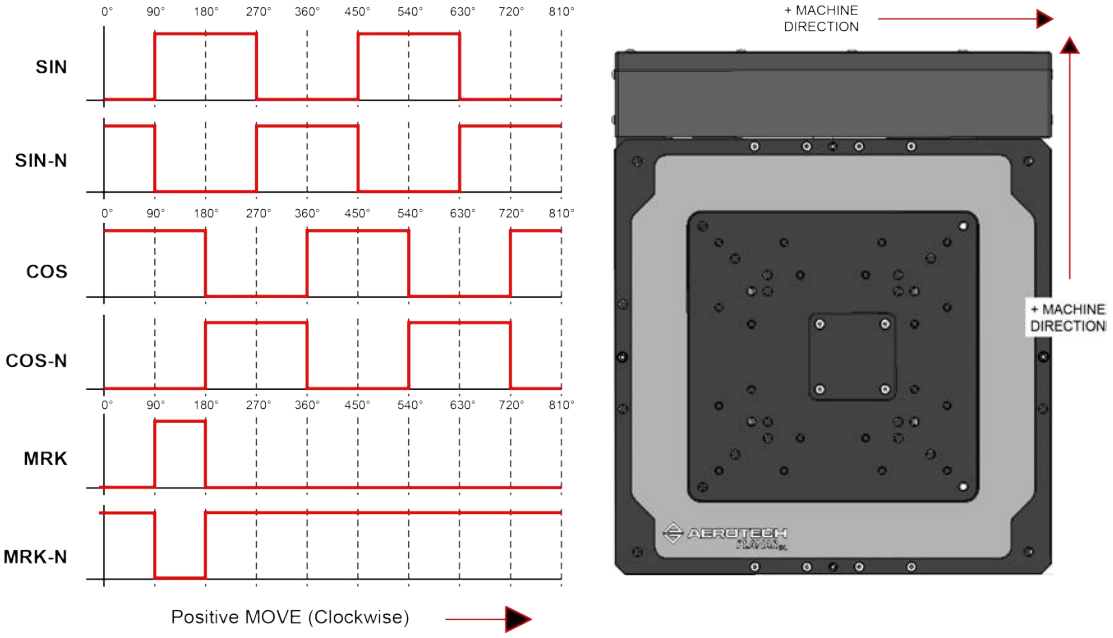


Figure 3-5: Encoder Phasing Reference Diagram (Standard)

Chapter 4: Maintenance

NOTE: If the bearing area is not kept free of foreign matter and moisture, the performance and life expectancy of the stage will be reduced.

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

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

4.1. Service and Inspection Schedule

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

In general, stages operating in a clean environment should be cleaned and lubricated every six months or 100 km (whichever comes first). For stages operating under dirtier or harsher conditions, the cleaning and lubrication interval should occur more frequently as determined by the end-user monitoring the application. For high-speed applications (those near max speed at a duty cycle of 50%), more frequent maintenance with standard lubricants may be required.

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

4.2. Cleaning and Lubrication

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.

WARNING: In applications that have multiple stages bolted together to form multi-axis systems, the orthogonality may be lost if the stage tables of the support stages are loosened. Precision aligned stages should not be loosened or disassembled.

WARNING: Further disassembly of the stage is not recommended because proper assembly and calibration can only be done at the factory. In addition, a laser interferometer is required for post assembly verification to maintain warranties. Contact Aerotech for more information.

Cleaning

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

Any external metal surface of the PlanarDL can be cleaned with isopropyl alcohol on a lint-free cloth.

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

Lubrication

For the bearings, use Kluberplex BEM 34-132 grease. Only use the specified grease as other greases may be incompatible.

If the application process uses only a small portion of travel for most of the duty cycle, periodically drive the stage through full travel to redistribute the lubrication in the bearings.

NOTE: During the lubrication procedure, inspect the linear motion guides for any damage or signs of wear.

Lubrication Procedure

1. Drive the lower axis carriage to one end of travel and remove power to the stage.
2. Blow off the interior of the stage with clean, dry compressed air or nitrogen.
3. Remove all dirty or dried lubricant from the v-channels of the linear bearing rails. Use a small application of isopropyl alcohol with a clean, lint-free cloth or cotton swab.
4. Using a grease syringe, apply an approximate 2 mm diameter bead of lubricant to the relief area below the bearing v-channels as close to the bearing cage as possible equal to roughly 1/4 of the overall length of the bearing rail. Repeat this for both rails.
5. Manually move the lower axis carriage to the opposite end of travel. Then repeat steps 2 through 4 for the opposite sides of the bearing rails.
6. Manually move the lower axis carriage through full travel three or more times to distribute the lubricant.
7. Repeat the grease application process three more times to reach the total replacement grease quantity.

8. Repeat steps 1 through 7 for the upper axis carriage. The two moving carriages should move smoothly with light resistance.
9. Restore power to the stage.

4.3. Troubleshooting

Symptom	Possible Cause and Solution
Stage will not move	• 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) and refer to the Controller documentation for polarity and compatibility requirements (Example: voltage requirements). • Controller trap or fault (refer to the Controller documentation).
Stage moves uncontrollably	• Encoder (sine and cosine) signal connections (refer to Chapter 3 and Controller documentation). • Motor Connections (refer to Chapter 3 and the Controller documentation).
Stage oscillates or squeals	• Gains misadjusted (refer to the Controller documentation). • Encoder signals (refer to the Controller documentation).

Appendix A: Warranty and Field Service

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

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

Return Products Procedure

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

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

Returned Product Warranty Determination

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

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

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

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

Rush Service

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

On-site Warranty Repair

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

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

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

On-site Non-Warranty Repair

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

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

Service Locations

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

USA, CANADA, MEXICO	CHINA	GERMANY
Aerotech, Inc. Global Headquarters Phone: +1-412-967-6440 Fax: +1-412-967-6870	Aerotech China Full-Service Subsidiary Phone: +86 (21) 5508 6731	Aerotech Germany Full-Service Subsidiary Phone: +49 (0)911 967 9370 Fax: +49 (0)911 967 93720

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Appendix B: Revision History

Revision	Description
1.04.00	• Dimensions drawings updated in Section 2.2. • Figure 2-1 updated (Lifting Hardware and Shipping Brackets)
1.03.00	Dimensions drawings updated in Section 2.2.
1.02.00	• Product updates • Model Options updated in Table 1-1 • Basic Specifications updated in Table 1-3, Table 1-4, and Table 1-5 • Dimensions drawings updated in Section 2.2. • Screw Torques updated for the Stage to Mounting Surface Hardware in Section 2.3. • Motor Pin specifications updated in Table 3-1 and Table 3-5 • Feedback Pin specifications updated in Table 3-3 and Table 3-7 • Motor and Feedback Wiring drawing updated for Figure 3-1 • Encoder, Limit Switch, and Brake specifications updated in Table 3-9 • Motor specifications updated in Table 3-11 and Table 3-12 • Encoder specifications updated in Table 3-13 • Lubrication procedure updated in Section 4.2.
1.01.00	• General revision • Mounting Surface specifications updated in Section 2.3. and Section 2.4.
1.00.00	New Manual

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