User Manual

Allen-Bradley

MP-Series Integrated Linear Stages

Catalog Numbers MPAS-A6*xxx*1-V05S*x*A, MPAS-A6*xxx*2-V20S*x*A, MPAS-A8*xxx*1-V05S*x*A, MPAS-A8*xxx*2-V20S*x*A, MPAS-A9*xxx*1-V05S*x*A, MPAS-A9*xxx*2-V20S*x*A, MPAS-B6*xxx*1-V05S*x*A, MPAS-B6*xxx*2-V20S*x*A, MPAS-B8*xxx*1-V05S*x*A, MPAS-B8*xxx*2-V20SxA, MPAS-B9*xxx*1-V05S*x*A, MPAS-B9*xxx*2-V20S*x*A, MPAS-A6*xxx*B-ALM*x*2C, MPAS-A8*xxx*E-ALM*x*2C, MPAS-A9*xxx*K-ALM*x*2C, MPAS-B8*xxx*F-ALM*x*2C, MPAS-B9*xxx*L-ALM*x*2C

Important User Information

Read this document and the documents listed in the additional resources section about installation, configuration, and operation of this equipment before you install, configure, operate, or maintain this product. Users are required to familiarize themselves with installation and wiring instructions in addition to requirements of all applicable codes, laws, and standards.

Activities including installation, adjustments, putting into service, use, assembly, disassembly, and maintenance are required to be carried out by suitably trained personnel in accordance with applicable code of practice.

If this equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

In no event will Rockwell Automation, Inc. be responsible or liable for indirect or consequential damages resulting from the use or application of this equipment.

The examples and diagrams in this manual are included solely for illustrative purposes. Because of the many variables and requirements associated with any particular installation, Rockwell Automation, Inc. cannot assume responsibility or liability for actual use based on the examples and diagrams.

No patent liability is assumed by Rockwell Automation, Inc. with respect to use of information, circuits, equipment, or software described in this manual.

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Throughout this manual, when necessary, we use notes to make you aware of safety considerations.

	**WARNING:** Identifies information about practices or circumstances that can cause an explosion in a hazardous environment, which may lead to personal injury or death, property damage, or economic loss.
	**ATTENTION:** Identifies information about practices or circumstances that can lead to personal injury or death, property damage, or economic loss. Attentions help you identify a hazard, avoid a hazard, and recognize the consequence.
IMPORTANT	Identifies information that is critical for successful application and understanding of the product.

Labels may also be on or inside the equipment to provide specific precautions.

	**SHOCK HAZARD:** Labels may be on or inside the equipment, for example, a drive or motor, to alert people that dangerous voltage may be present.
	**BURN HAZARD:** Labels may be on or inside the equipment, for example, a drive or motor, to alert people that surfaces may reach dangerous temperatures.
	**ARC FLASH HAZARD:** Labels may be on or inside the equipment, for example, a motor control center, to alert people to potential Arc Flash. Arc Flash will cause severe injury or death. Wear proper Personal Protective Equipment (PPE). Follow ALL Regulatory requirements for safe work practices and for Personal Protective Equipment (PPE).

This manual contains new and updated information. Changes throughout this revision are marked by change bars, as shown to the right of this paragraph.

New and Updated Information

This table contains the changes made to this revision.

Topic	Page
Studio 5000 Logix Designer™ application is the rebranding of RSLogix™ 5000 software	9
Update connector attachment procedure	34
Update the maximum air pressure rating	37
Updated connector and cable information	39…41
Updated dimension drawing for MP-Series Linear Stages (MPAS-A/B8xxx1/2-VxxSxA)	77
Update cable information	88…90

Notes:

Read this preface to familiarize yourself with the rest of the manual.

About This Publication

This manual provides detailed installation instructions for mounting, wiring, maintaining, and troubleshooting your MP-Series integrated linear stage. For ease of use, going forward, it is referred to as a linear stage.

Who Should Use This Manual

This manual is intended for engineers or technicians directly involved in the installation, wiring, and maintenance of linear stages. Any person that teaches, operates, or repairs these linear stages must be trained and demonstrate the competence to safely perform the assigned task.

If you do not have a basic understanding of linear stages, contact your local Allen-Bradley distributor or Rockwell Automation sales representative for information on available training courses before using this product.

Read this entire manual before you attempt to install a linear stage into your machine. Doing so familiarizes you with the linear stage components and their relationship to each other and the system. After installation, check all system parameters to be sure you have configured your Logix control system properly. Be sure to follow all instructions carefully and pay special attention to safety concerns.

Studio 5000 Environment

The Studio 5000™ Engineering and Design Environment combines engineering and design elements into a common environment. The first element in the Studio 5000 environment is the Logix Designer application. The Logix Designer application is the rebranding of RSLogix 5000 software and continues to be the product to program Logix5000™ controllers for discrete, process, batch, motion, safety, and drive-based solutions.

The Studio 5000 environment is the foundation for the future of Rockwell Automation® engineering design tools and capabilities. This environment is the one place for design engineers to develop all of the elements of their control system.

Additional Resources

These documents contain additional information concerning related products from Rockwell Automation..

Resource	Description
Kinetix Motion Control Selection Guide, publication GMC-SG001	Provides an overview of Kinetix servo drives, motors, actuators, and motion accessories designed to help make initial decisions for the motion control products best suited for your system requirements.
Kinetix 2000 Multi-axis Servo Drive User Manual, publication 2093-UM001	How to install, set up, and troubleshoot a Kinetix 2000 drive
Kinetix 6000 Multi-axis Servo Drive User Manual, publication 2094-UM001	How to install, set up, and troubleshoot a Kinetix 6000 drive
Logix5000™ Controllers General Instructions Reference Manual, publication 1756-RM003	The instructions needed to program a Logix5000™ application
ControlLogix System User Manual, publication 1756-UM001	Information on configuring and troubleshooting your ControlLogix controller system
SoftLogix Motion Card Setup and Configuration Manual, publication 1784-UM003	Information on configuring and troubleshooting your SoftLogix PCI card
System Design for Control of Electrical Noise Reference Manual, publication GMC-RM001	Information, examples, and techniques designed to minimize system failures caused by electrical noise
Motion Analyzer is available at http://www.ab.com/motion/software/analyzer.html	Drive and motor sizing with application analysis software
Rockwell Automation Product Certification website, publication available at http://ab.com/	For declarations of conformity (DoC) currently available from Rockwell Automation
National Electrical Code. Published by the National Fire Protection Association of Boston, MA.	An article on wire sizes and types for grounding electrical equipment
Allen-Bradley Industrial Automation Glossary, publication AG-7.1	A glossary of industrial automation terms and abbreviations
Drives and Motion Accelerator Toolkit Quick Start, publication IASIMP-QS019	Information on how Bulletin MPAS stages (referred to a gantry A and B in this publication are used in a drives and motion application.
Ultra3000 Digital Servo Drives Installation Manual, publication 2098-IN003	How to install, set up, and troubleshoot an Ultra™ 3000 drive
Ultra3000 Digital Servo Drives Integration Manual, publication 2098-IN005	
Home to Torque-level Example Application Notes, publication MOTION-AT001	Describes Logix Designer application homing routines

You can view or download publications at http://www.rockwellautomation.com/literature. To order paper copies of technical documentation, contact your local Allen-Bradley distributor or Rockwell Automation sales representative.

Safety

IMPORTANT Any person that teaches, operates, maintains, or repairs these linear stages must be trained and demonstrate the competence to safely perform the assigned task.

Safety Labels

To prevent injury and damage to the linear stage, review the safety labels and the details and location for each table before using the linear stage.

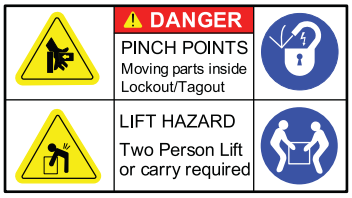
Location	Title	Label	Details
A	Danger-Pinch Points and Heavy Objects		The linear stage presents a muscle strain hazard if one person attempts to lift it. When attempting to move the linear stage use a two-person-lift to prevent personal injury or damage to the linear stage. To Installer - There exists a Crush and Cut hazard while installing the linear stage. The linear stage weighs from 13…63 kg (28…140 lb). To User - The Pinch Point label identifies a moving object hazard, caused by the movement of the carriage on the linear stage. Never put fingers, hands, or limbs near the linear stage while running motion commands. Before executing any motion command, check that all maintenance tools have been removed from linear stage. All types of linear stages, especially uncovered, present a pinch point hazard. This hazard may occur if fingers or hands come between the end cap and a moving carriage. Always lift the linear stage by the base and keep fingers and hands away from the opening and edges parallel to the carriage.
B	Danger-Hazardous Voltage		The Hazardous Voltage label identifies the junction box as a hazardous voltage area of the linear stage. To avoid injury be sure to follow Lockout-Tagout procedures before attempting maintenance on these linear stages.
C	Danger-Strong Magnets		The Strong Magnets label identifies non-ionizing radiation found in the linear stage. Magnet channels inside the linear stage are constructed with strong magnets. Strong magnets can disrupt the functionality of automatic implantable cardioverter defibrillators (AICD); people with a pacemaker should not work near the linear stage. Maintenance personnel working on the linear stage should avoid the use of metallic tools and secure items such as badge clip and other personal effects that could be attracted by the strong magnets. Strong magnets can erase magnetic media. Never allow credit cards or floppy disks to contact or come near the linear stage.
D	Do Not Lift by Junction Box		Do not attempt to move the linear stage by grasping the cable junction box. Moving the linear stage in this manner will damage the linear stage and create a pinch or crush hazard. The junction box is attached to the carriage, which is free to move. Lifting the linear stage in this manner will allow uncontrolled movement of the heavy base. Always use a two-person lift and grasp the linear stage by the base at the end caps. Always keep fingers clear of the carriage's path of travel.
E	Stay Clear		Do not put hands or objects on the linear stage cover. Doing so could deform the cover and damage the linear stage, causing excessive wear on the cover supports or scraping noises when the linear stage is in motion.
F	Sharp Edges		Always remove strip seals before removing the top or side covers. If it becomes necessary to remove the top or side covers or change the strip seal, exercise care when working near or on the strip seal. The edges of the strip seal are sharp and can cut if accidentally hit or if handled inappropriately.

Figure 1 - Label Locations for Direct Drive Linear Stages

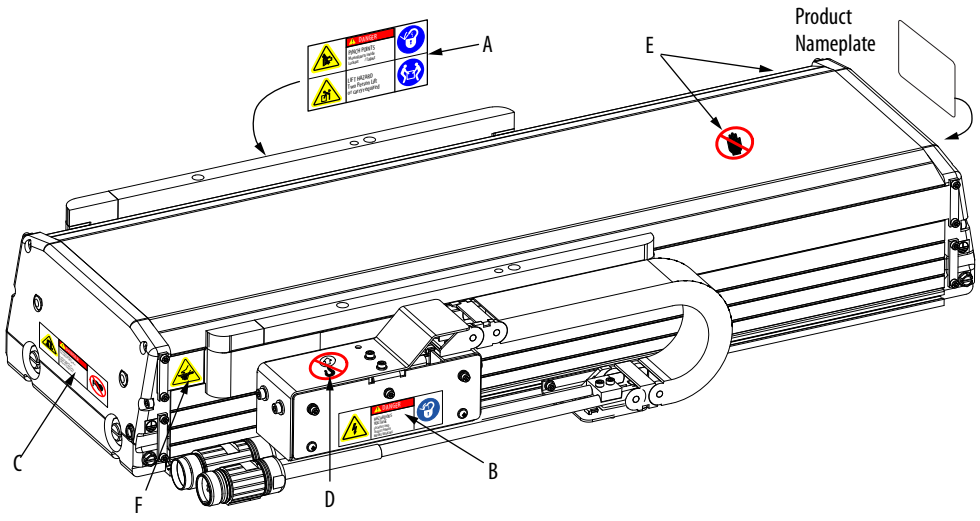
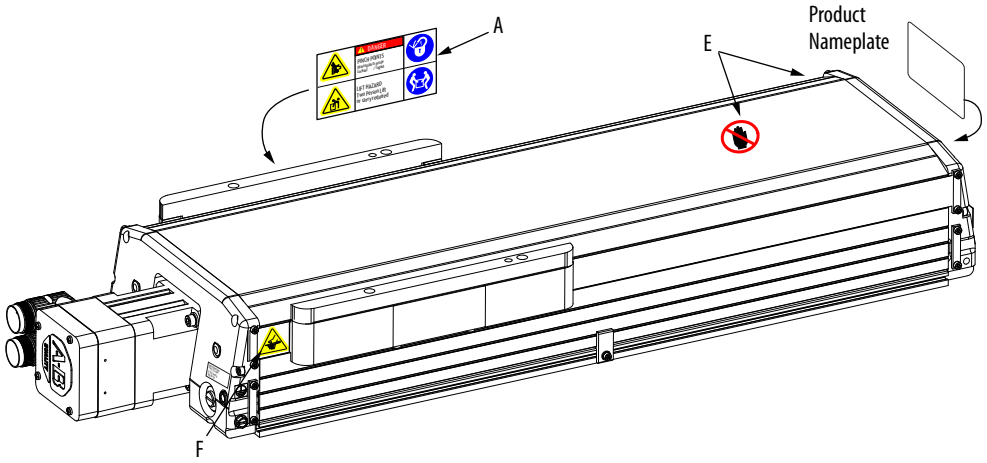


Figure 2 - Label Locations for Ball Screw Linear Stages



Clearances

Install the linear stage to avoid interference with the building, structures, utilities, other machines and equipment that can create a trapping hazard of pinch points.

Dress cables by using the Clearance Requirements on page 26 as a guide. Do not cross the path of motion or interfere with the cable carrier motion.

General Safety

Linear stages are capable of sudden and fast motion. In no event will Rockwell Automation, Inc. be responsible or liable for indirect or consequential damages resulting from the use or application of this equipment.

Heat

When the stage is running at its maximum rating, the temperature of the carriage can reach 75 ºC (167 ºF).

Vertical or Inclined Payload

A direct drive (linear motor driven) linear stage mounted vertically or on an incline does not maintain position when the power is removed. Under the influence of gravity the carriage and its payload falls to the low end of travel. Design engineers must account for this by using a ball screw driven linear stage with power-off holding brake, or designing in controlled power down circuits or mechanical controls to prevent the linear stage and its payload from being damaged when the power fails.

End of Travel Impacts

The internal bumpers of the linear stage are designed to take a large impact from uncontrolled motion. Setting Travel Limits on page 55 lists the energy that the bumpers can absorb before risking damage to the linear stage. The carriage payload must be secured to the carriage such that it does not sheer off in the event of an impact in excess of the bumper ratings.

The bolts securing the end caps are not be able to sustain multiple impacts and can eventually sheer. Correct the cause of the uncontrolled motion that caused the impact before continuing the use of the linear stage.

Air Freight Restrictions

When air freighting linear stages special preparations and precautions must be taken. The following information outlines the basic requirements at the publication date of this document. However, regulations are subject to change and additional area or carrier restrictions can be imposed. Always check with your carrier or logistics specialist regarding current local, regional, and national transportation requirements when shipping this product.

The 200 mm or a 250 mm direct drive linear stages (catalog numbers MPAS-A8*xxx*E-ALM*x*2C, MPAS-B8*xxx*F-ALM*x*2C, MPAS-A9*xxx*K-ALM*x*2C, or MPAS-B9*xxx*L-ALM*x*2C) contain magnetized material, as classified by International Air Transport Association (IATA) Dangerous Goods Regulations. An IATA trained individual must be involved when shipping this product via domestic or international air freight. Packing Instruction 902 provides information regarding the preparation of this product for air transportation. Follow these regulations for general marking and labeling requirements, the application of specific Magnetized Material Handling Labels, and instructions for preparing the Shipper's Declaration for Dangerous Goods.

As a minimum, refer to the following IATA Dangerous Goods Regulations:

- Subsection 1.5: Training
- Subsection 3.9.2.2: Classification as Magnetized Material
- Subsection 4.2: Identification as UN 2807, Magnetized Material, Class 9, Packing Instruction 902
- Subsection 7.1.5: Marking
- Subsection 7.2: Labeling
- Subsection 7.4.1: Magnetized Material Label
- Section 8: Shipper's Declaration for Dangerous Goods

When shipped via ground in the United States, these products are **not** considered a U.S. D.O.T. Hazardous Material and standard shipping procedures apply.

Standards

Standards and requirements applicable to this product include, but are not limited to, the following:

- ANSI/RIA R15.06, Industrial Robots and Robot Systems Safety Requirements - Teaching Multiple Robots
- ANSI/NFPA 79, Electrical Standard for Industrial Machinery
- CSA/CAN Z434, Industrial Robots and Robot Systems- General Safety Requirements
- EN60204-1, Safety of Machinery. Electrical Equipment of Machines
- UL 1740, UL Standard for Safety Industrial Robots and Robotic Equipment

Motor Model Identification

The nameplate on ball screw driven linear stages lists the specific MP-Series servo motor model used.

Notes:

Understanding Your Linear Stage

Identifying Your Linear Stage

Use the following key to identify your linear stage and its options.

MPAS - x x xxx x - x xx x x x

Cable
A = No cable track module (ballscrew only)
C = Cable track module with IP67 intercontec connectors (direct drive only)

Brake
2 = No brake
4 = 24V DC brake (ballscrew only)

Cover
S = Covered with strip seals (IP30 protection)
O = Open

Screw Lead/Direct Drive
05 = 5.0 mm/rev (0.19 in./rev) ballscrew with rotary motor
20 = 20.0 mm/rev (0.79 in./rev) ballscrew with rotary motor
LM = Linear motor (direct drive only)

Feedback
V = Multi-turn high-resolution encoder (absolute feedback) 128 cycle/rev. (ballscrew only)
A = 5 micron resolution incremental magnetic linear encoder (direct drive only)

Mechanical Drive/Motor Typ
1 = Ballscrew/MPLS-*x*210E-V
2 = Ballscrew/MPLS-*x*220H-V
B = Direct Drive/6-frame, 200V-class
K = Direct Drive/9-frame, 200V-class
E = Direct Drive/8-frame, 200V-class
L = Direct Drive/9-frame, 400V-class
F = Direct Drive/8-frame, 400V-class

Stroke Length (1)
xxx = *xxx* mm x 10

Frame Size (2)
6 = 150 mm base width
8 = 200 mm base width
9 = 250 mm base width

Voltage Class
A = 200V
B = 400V

Actuator Type
AS = Actuator, linear stage

Actuator Series
MP = MP-Series

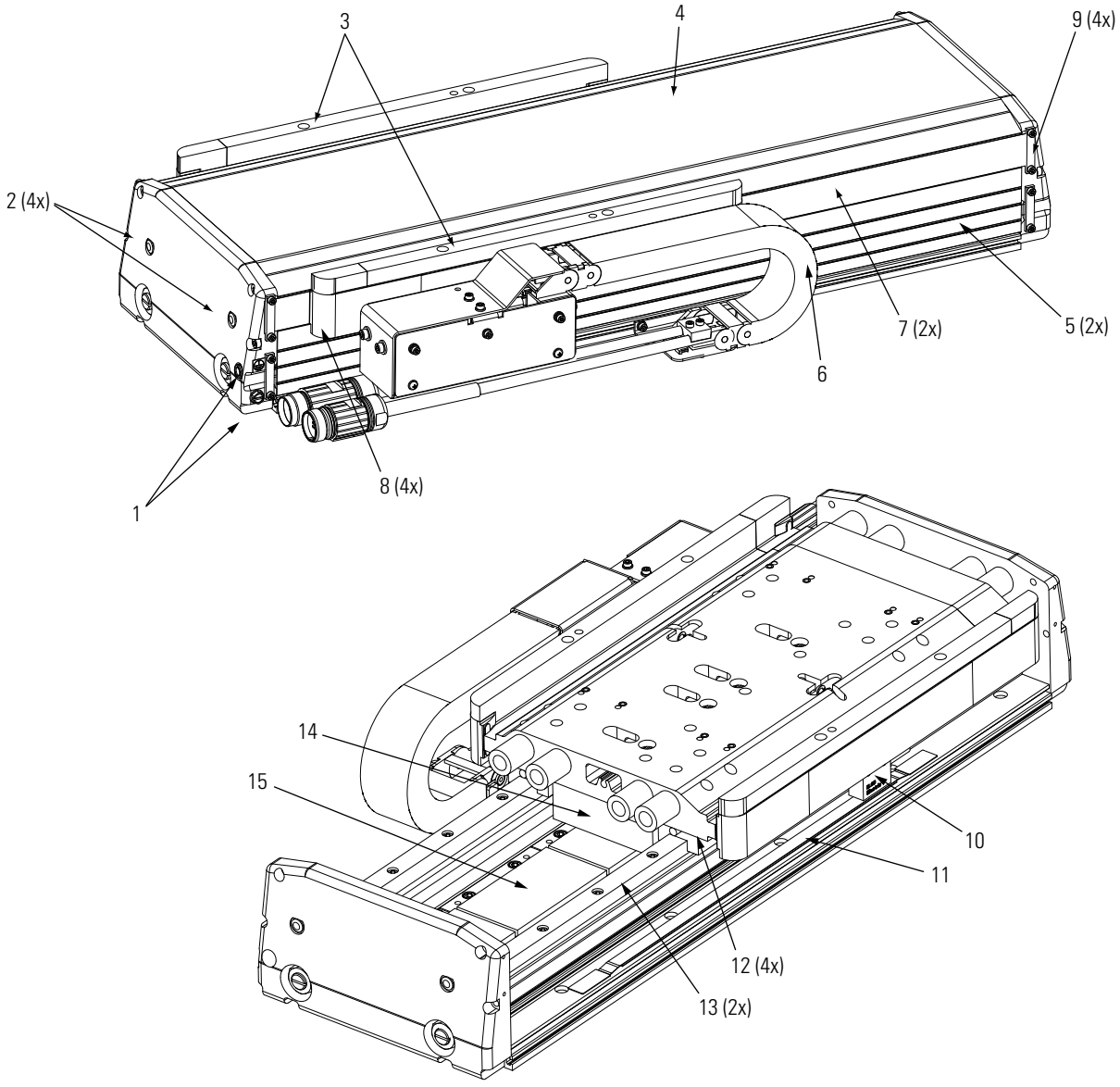
(1) For 6-frame direct-drive linear stages, variable xxx (mm stroke x 10) is 012, 018, 024, 030, 036, 042, 054, 066, 078, 090, 102, or 114.
For 8 and 9-frame direct-drive linear stages, variable xxx (mm stroke x 10) is 014, 020, 026, 032, 038, 044, 056, 068, 080, 092, 104, 128, 152, 176, or 194.
For 6-frame ballscrew linear stages, variable xxx (mm stroke x 10) is 012, 018, 024, 030, 036, 042, 054, or 066.
For 8 and 9-frame ballscrew linear stages, variable xxx (mm stroke x 10) is 012, 018, 024, 030, 036, 042, 054, 066, 078, 090, or 102.
(2) The 150 mm (6-frame) linear stages are available in ballscrew (200 and 400V-class) and direct drive (200V-class only).
The 200 mm (8-frame) linear stages are available in ballscrew and direct drive (200 and 400V-class).
The 250 mm (9-frame) linear stages are available in ballscrew and direct drive (200 and 400V-class).

Identifying the Components of Your Linear Stage

Use the diagrams and descriptions to identify individual components of the linear stages.

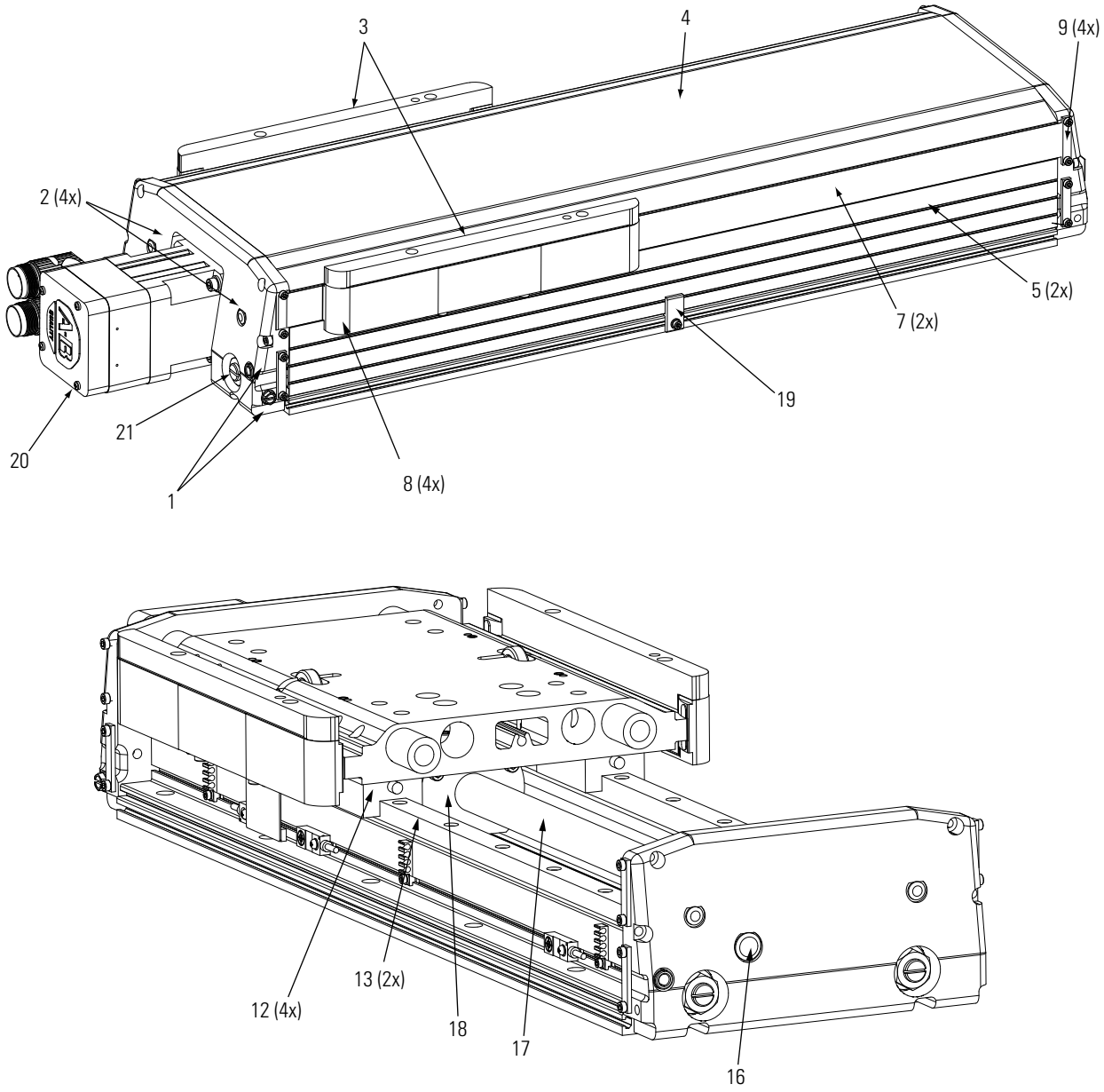
Not all components are part of the direct drive or the ball screw linear stage. For example, the direct drive linear stage does not have component 20 - Rotary Motor and the ball screw linear stage does not have component 6 - Cable Carrier Module.

Figure 3 - Components of the Direct Drive Linear Stage (MPAS-*xxxxxxx*-ALM*x*2C)



Refer to Component Descriptions beginning on page 21 for the name and description of each numbered item.

Figure 4 - Components of the Ball Screw Linear Stage (MPAS-*xxxxxx*-V*xx*S*x*A)



Refer to Component Descriptions beginning on page 21 for the name and description of each numbered item.

Component Descriptions

Item	Name	Notes
1	Ground Screw and Ground Label	Use the labeled M5 x 0.8 - 6H ground screw to connect the linear stage to a facility safety ground.
2	Bearing Lubrication Ports	These capped ports provide access to the linear bearings without dismantling the linear stage. In addition, these tapped holes (M10 x 1.5 -6H) can be used to secure lifting hooks (not provided).
.	Carriage	This is where your load mounts. The carriage has both mounting holes and pilot guide holes.
4	Top Cover	This protective cover has magnetic edges that keep the upper edge of the strip seals in place. A cover is an option on the direct drive linear stages.
5	Side Cover	These protective covers have magnetic edges that keep the lower edge of the strip seal in place. Side covers are an option on the direct drive linear stages.
6	Cable Carrier Module	This assembly contains the power and I/O wiring for direct drive linear stages. It facilitates quick and easy replacement of this wear item. It is available as a spare part.
7	Stainless Steel Strip Seal	These replaceable flexible stainless steel strips permit the linear stage to move while isolating the internal mechanism of the linear stage from the users environment. Keep the strip seals clean, and never apply a lubricant as this attracts contaminants.
8	Seal Guide	These guides lets the strip seal to move smoothly around the carriage of the linear stage.
9	Seal Strip Clamps	These clamps hold the strip seal in place. When replacing the seal strips, they are used to position it so it lays smooth against the top and side covers.
10	Magnetic Encoder Readhead	This encoder readhead has a 5 micron resolution and very low maintenance needs.
11	Encoder Strip	Part of the encoder system that provides magnetic encoded polarities to the encoder readhead.
12	Bearing	These support bearings guide the carriage on the bearing rail and require periodic lubrication.
13	Bearing Rail	These rails provide the linear track that the carriage assembly rides on, they must be kept free of debris.
14	Motor Coil	This coil is part of the two piece linear motor. When it is excited by a drive, it generates magnetic forces that interact with the magnet track creating motion.
15	Magnet Track	This track of powerful static magnets is the other half of a linear motor.
16	Ball Nut Lubrication Port	This capped ports provide access to the ball nut without dismantling the linear stage.
17	Ball Screw Shaft	This is part of the mechanical power system on ball screw linear stages. This shaft must be kept free of debris.
18	Ball Nut	Transfers mechanical power from the ball screw shaft to the carriage. It requires periodic lubrication.
19	Side Cover Support	These supports stabilize the side cover on long linear stages.
20	Rotary Motor	A Rockwell Automation MPLS rotary motor drives the ball screw mechanism. It is a specially configured MP-Series rotary motor, and is available as a spare part.
21	Air Port	Provides an external air supply connection for a ball screw linear stage. A maximum of 270 kPa (40 psi) of pressurized air can be applied to minimize the ingress of particulates from a dusty environment.

Maintenance Intervals

This section lists typical maintenance intervals for your linear stage, and references the section where maintenance procedures are described.

Lubrication Intervals

Refer to the Chapter 7 for lubrication procedures. The following lubrication intervals are recommended.

- Direct drive linear stages every 6 months or 5000 km of travel
- Ball screw linear stages every 3 months or 150,000,000 revolutions

Cable Carrier Replacement

The cable carrier module's useful lifetime is approximately 10,000,000 cycles. Refer to the Chapter 8 for removal and replacement procedures.

Planning Your Installation

Requirements to be met when mounting your linear stage include the following.

General Safety Standards for Linear Stage Installations

General safety standards and requirements include, but are not limited to, the following:

- ANSI/RIA R15.06, Industrial Robots and Robot Systems Safety Requirements - Teaching Multiple Robots
- ANSI/NFPA 79, Electrical Standard for Industrial Machinery
- CSA/CAN Z434, Industrial Robots and Robot Systems- General Safety Requirements
- EN60204-1, Safety of Machinery. Electrical Equipment of Machines

UL Safety Standards for Linear Stage Installations

All linear stage installations must follow UL 1740 - Standard for Safety for Robots and Robotic Equipment.

UL 1740 covers robots and robotic equipment rated at 600V or less and intended for installation in accordance with the National Electrical Code, ANSI/NFPA 70. Because end user installation of a robot and robotic equipment can vary for each user application, guidelines for end-product installation can be evaluated to the applicable sections of ANSI/RIA R15.06, Standard for Industrial Robots and Robot Systems-Safety Requirements. Portions of the requirements in this standard have been excerpted from the Robotic Industries Association's (RIA) Standard for Industrial Robots and Robot Systems – Safety Requirements, ANSI/RIA R15.06.

ANSI/RIA R15.06 specifically requires two safety features be in the design.

- A Power Enable light must be installed that meets all of these conditions:
  - Must be amber or yellow in color.
  - Must not have a screw type base or contain a filament.
  - Must be visible from all approaches to the work cell.
  - Must illuminate to indicate that drive power is available and motion is possible.

  For example, an Allen-Bradley 855T Control Tower Stack Light can be used with socket mount status indicators. Incandescent bulbs are not permitted.
- Provide a means of emergency movement without drive power available. This must include a provision for a brake release on a ball screw linear stage.

  For additional information, refer to the Emergency Brake Release for Ball Screw Linear Stage Example on page 38.

Unique features or functions associated with the robotic application, not specifically addressed in UL 1740, shall also be evaluated to other applicable standards and requirements. These can include, but are not limited to the following:

- UL 3101-1, Electrical Equipment for Laboratory Use; Part 1: General Requirements
- UL 544, Medical and Dental Equipment
- UL 79, Power Operated Pumps for Petroleum Product Dispensing Systems
- ANSI/NFPA 79, Electrical Standard for Industrial Machinery

Mounting Restrictions

When locating your MPAS stage include the following:

- Environmental Factors
- Mounting Surface Restrictions
- Mounting Orientations for Direct Drive Linear Stages
- Mounting Orientations for Ball Screw Linear Stages
- Clearance Requirements

Environmental Factors

Factor	Applicability
Temperature	The linear stage does not require any special cooling considerations. Avoid mounting it near any heat generating objects, such as a heat register. Sustained average operating temperature must not be greater than 40 °C (104 °F), nor less than 0 °C (32 °F).
Humidity	Avoid excessive humidity that can cause condensation on metal surfaces and consequently stage corrosion. The maximum permissible noncondensing humidity is 80% relative.
Access and interference	When possible, locate the system where sufficient working space is available to perform periodic maintenance. Avoid installing where a trapping hazard or pinch point occurs as a result of interference with the building, structures, utilities, and other machines and equipment.
Dust and airborne contaminants	Avoid placing the stage in areas where excessive dust or other airborne contaminants are present. Chemical fumes or vapors can cause damage to internal components.
Vibration	The linear stage must be installed in a location free of excessive vibration.
Ambient light	Sufficient light must be readily available to enable inspection, testing, and other functions to be performed on the stage.

Mounting Surface Restrictions

Surface	Restriction
Flatness	Stages are to be bolted or clamped to a flat, stable, and rigid surface along its entire length. Flatness deviation in the mounting surface must be less than or equal to 0.025 mm over a 300 x 300 mm (0.001 in. over a 12 x 12 in.) area. Flatness must be maintained during operation of the linear stage.

Mounting Orientations for Direct Drive Linear Stages

Mounting Orientation	Restriction
Ceiling - inverted surface	A ceiling mount (inverted on a horizontal surface) is not recommended. Stages mounted in this orientation are subject to premature cable carrier failure.
Wall - horizontal	Horizontal wall mount stages must be of the covered and sealed configuration. Stages mounted horizontally on a wall must have a travel of 1 m (3.28 ft) or less. Stages with a travel length greater than 1 m (3.28 ft) are subject to premature cable carrier failure.
Wall - vertical or incline	Vertical wall mount or inclined stages must be of the covered and sealed configuration. Stages mounted vertically on a wall must have a travel of 1 m (3.28 ft) or less. Stages with a travel length greater than 1 m (3.28 ft) are subject to premature cable carrier failure.

Mounting Orientations for Ball Screw Linear Stages

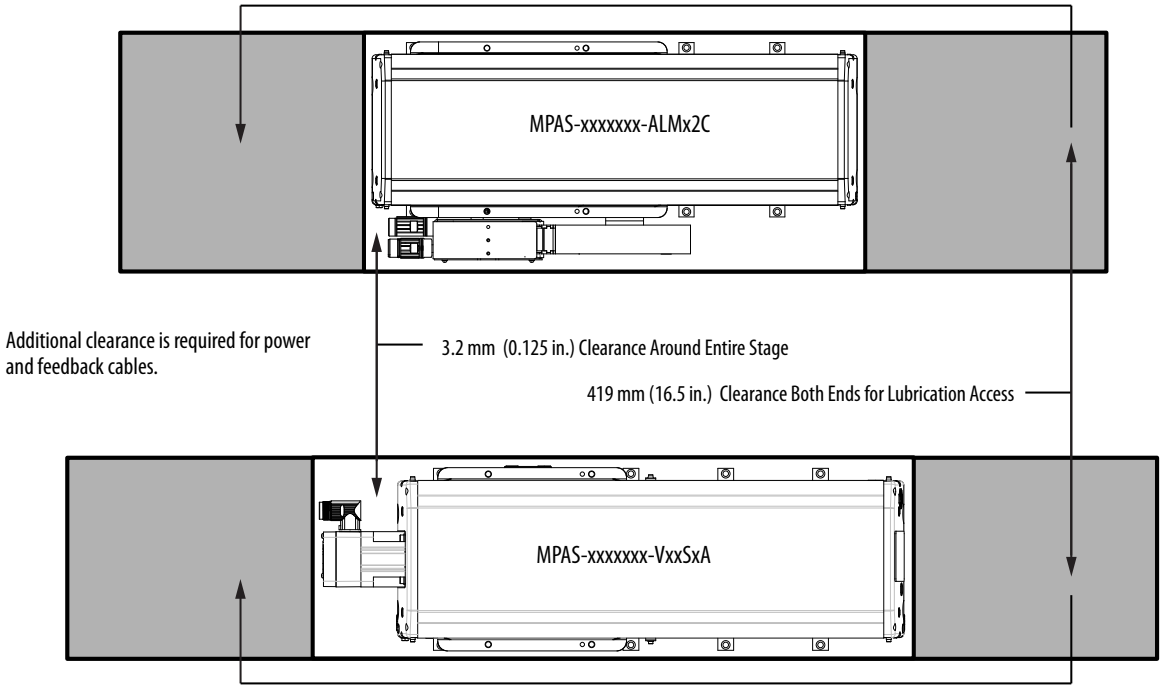
Mounting Orientation	Restriction
Ceiling - inverted surface	A ceiling mount (inverted on a horizontal surface) must be of the covered and sealed configuration, and have a travel of 300 mm (11.8 in.) or less.
Wall - horizontal	A horizontal wall mount stages must be of the covered and sealed configuration.
Wall - vertical or incline	Vertical wall mount or inclined stages must have a brake option. Application of the holding brake option through operating program settings prevents uncontrolled motion.

Clearance Requirements

The figures depict the minimum clearances for each stage type.

Power and feedback cables can impose additional clearance requirements. Refer to Installation, Maintenance, and Replacement Kits on page 83 for connector and bend radius requirements.

Figure 5 - Minimum Clearance Requirements



Mounting and Connecting

IMPORTANT Any person that teaches, operates, maintains, or repairs these linear stages must be trained and demonstrate the competence to safely perform the assigned task.

Unpacking, Handling, and Inspection

Inspect packaging to make certain no damage has occurred in shipment. Any damage or suspected damage must be immediately documented. Claims for damage due to shipment are usually made against the transportation company. Contact Allen-Bradley immediately for further advice.

Be sure the information listed on the purchase order correlates to the information on the packing slip for your linear stage and its accessories. Inspect the assemblies and confirm, if applicable, the presence of specified options.

ATTENTION: Direct drive linear stages contain powerful permanent magnets that require extreme caution during handling. Do not disassemble the linear stage. The forces generated by permanent magnets are very powerful and can cause bodily injury.

Persons with pacemakers or automatic implantable cardiac defibrillators (AICD) must maintain a minimum distance of 0.3 m (12 in.) from magnet assemblies.

Additionally, unless absolutely unavoidable, a minimum distance of 1.5 m (5 ft) must be maintained between magnet assemblies and other magnetic or ferrous composite materials. Calipers, micrometers, laser equipment, and other types of instrumentation must be nonmetallic.

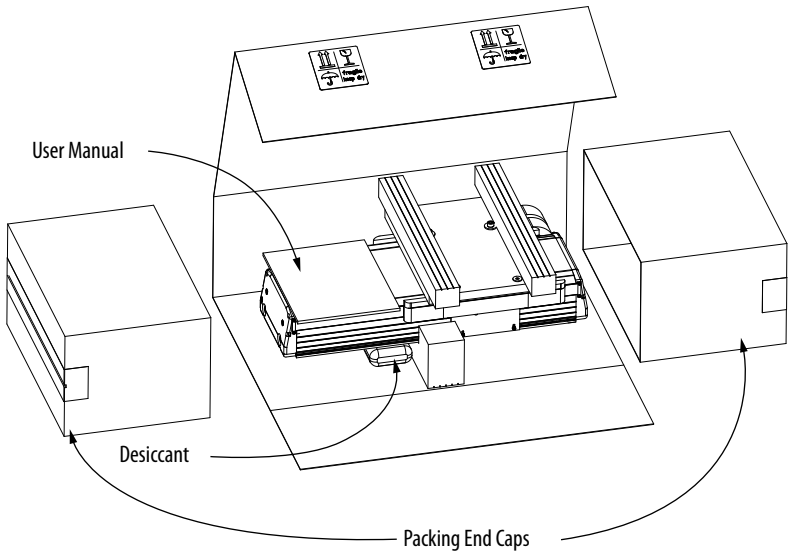
Unpacking Procedure

The following tools are recommended for unpacking the linear stage:

- Utility knife
- 2.5 mm, 5 mm, and 6 mm hex keys
- Packing tape

Unpack your linear stage by doing the following.

1. Place the carton on a flat stable surface with the tape seam side facing you.
2. Use a utility knife to score the packing tape at the edges of the carton.
3. Lift center cover to reveal the linear stage.

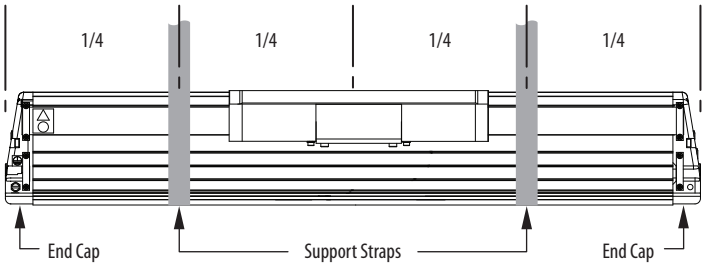


4. Remove the packing end caps.

ATTENTION: Never attempt a single-person lift.
Personal injury and equipment damage can occur if the linear stage is handled improperly

5. Remove the linear stage from the packaging supports.
   - **For stages shorter than 1 meter (39.3 in.)**, use two people and lift the linear stage by grasping only the base near the end caps.

- **For stages 1 meter (39.3 in.) or longer**, use support straps at the 1/4 and 3/4 length points to avoid distorting the base. Use this support system whenever the linear stage must be lifted.

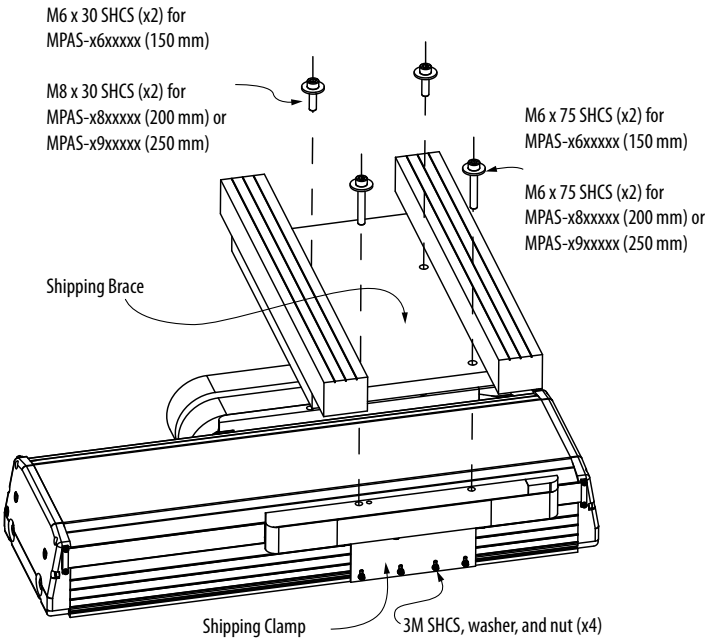


6. Move the linear stage to a solid support surface before removing the shipping brace.

ATTENTION: The carriage is free to move once the shipping brace is removed. Use additional care when handling the linear stage after the brace is removed. Unexpected carriage movement can cause personal injury.

7. Remove the four socket-head cap screws (SHCS) from the shipping brace.

   The figure below lists the correct hex wrench for each linear stage.



8. Lift the shipping brace off the linear stage and set it aside.
9. Remove the plastic wrap enclosing the linear stage and set it aside.
10. Remove the four SHCS that secure the shipping clamp.
11. Remove the four square nuts loosened in the previous step, by sliding each nut to the end of channel.

Store Packaging Material

Keep the carton and packing materials in case the linear stage needs to be returned for warranty service or stored for an extended period of time.

1. Tape screws and clamp hardware to the plywood board brace.
2. Put the end caps in their original positions on the center cover and place all packing material inside the carton.
3. Lightly tape carton closed and store in a dry place.

Linear Stage Storage

The linear stage storage area must be clean, dry, vibration free, and have a relatively constant temperature. Refer to Environmental Specifications for MP-Series Linear Stages in the Kinetix Linear Motion Specifications Technical Data GMC-TD002 for more detailed information.

Mounting the Linear Stage

This section discusses mounting methods and procedures for both linear stage types.

Before You Begin the Mechanical Installation

The machine designer is the best person to determine the number and type of fasteners to use when mounting your linear stage The following information is supplied to assist in your decision-making.

Determine the Number of Fasteners Required

The length of the linear stage determines the number of mounting fasteners that are required.

Use one of the following equations to calculate the required mounting hardware.

Figure 6 - Fasteners Required for Direct Drive Linear Stage (MPAS-*xxxxxxx*-ALM*x*2C)

$$\text{fasteners} = \left(\left(\frac{\text{stroke (cm)} + 36\ \text{(cm)}}{12}\right)\text{round down} + 1\right) \times 2$$

Figure 7 - Fasteners Required for Ball Screw Linear Stage (MPAS-*xxxxxxx*-V*xx*S*x*A)

$$\text{fasteners} = \left(\left(\frac{\text{stroke (cm)} + 26\ \text{(cm)}}{12}\right)\text{round down} + 1\right) \times 2$$

For example, if you are mounting an MPAS-B8194F-ALM02C linear stage.

$$1940\,mm \quad strokelength \;=\; 194.0cm$$

$$\text{fasteners} \;=\; \frac{194\ \text{cm} + 36}{12} = \frac{230}{12} = 19.167$$

$$\text{round down} \;=\; 19$$

$$\text{fasteners} \;=\; 19 + 1 \;=\; 20 \times 2 \;=\; 40\ \text{fasteners}$$

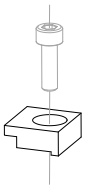
Determine the Type of Fastener to Use

There are three types of fasteners that can be used to mount the linear stage:

- Through bolt
- Toe clip
- Tee nut

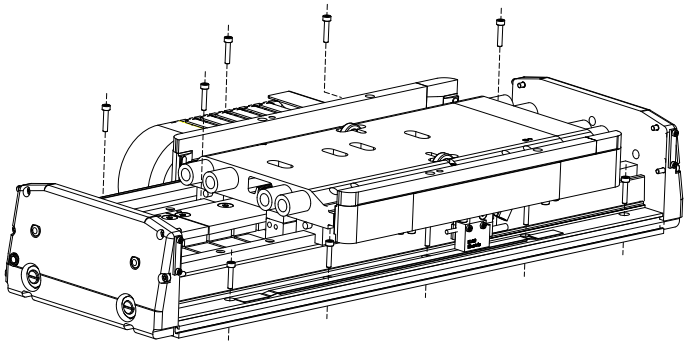
Toe clips are supplied with the catalog number MPAS-x6xxx linear stages, and covered types of the catalog number MPAS-x8xxx and MPAS-x9xxx linear stages. Refer to the following table for an illustration of each fastener type.

Table 1 - Mounting Fastener Options

Fastener	Catalog Number	Illustration	User Supplies (4)	Recommended For
Through bolt (1)	—		M5 x 1.0 x 16 mm (min)	Uncovered stages
Toe clip	MPAS-TOE		M6 x 1.0 x16mm (min)	Covered stages
Tee nut (2)	MPAS-*x*-TNUT(3)		M6 x 1.0	Securing a linear stage from beneath the mounting surface

(1) Through bolt mounting is not an option for the catalog number MPAS-*x6xxxx-xxxxx* (150 mm) linear stages.
(2) The Tee nut mount for a catalog number MPAS-*x8xxxx-xxxxx* (200 mm) linear stage is a square nut in a T-slot.
(3) Where *x* is the frame size of a stage, 6 = MPAS-*x6xxxx-xxxxx* (150 mm), 8 = MPAS-*x8xxxx-xxxxx* (200 mm), 9 = MPAS-*x9xxxx-xxxxx* (250 mm).
(4) You supply the bolts.

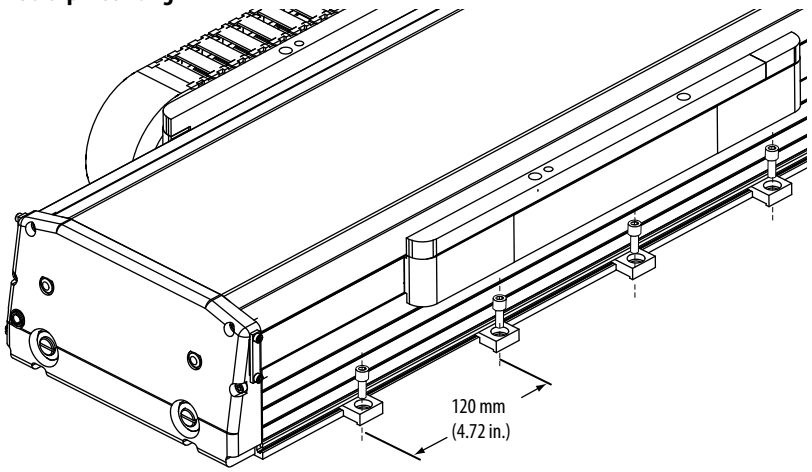
Figure 8 - Through Bolt Mounting



IMPORTANT	Through bolt mounting is not available for the catalog number MPAS-*x6xxxx-xxxxx* (150 mm) stages.

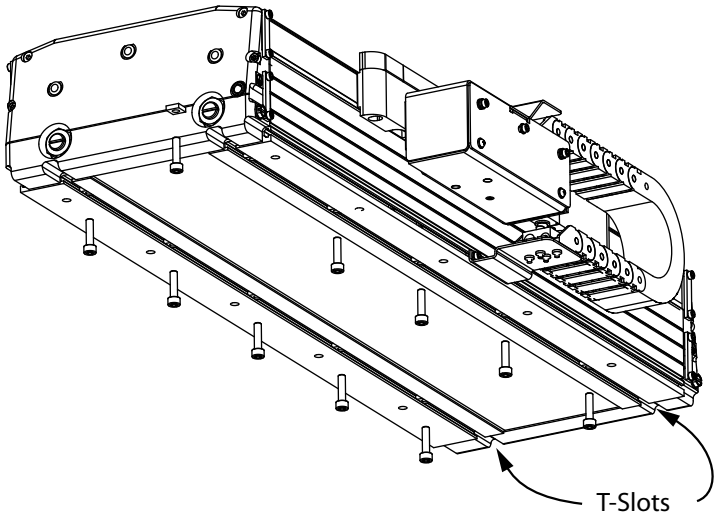
An uncovered linear stage is a good candidate for through bolt mounting.

Figure 9 - Toe Clip Mounting



For covered linear stages, toe clips are the easiest method for mounting. On both sides of the base, secure a toe clip every 120 mm (4.72 in.) with a M6 SHCS as shown in Figure 9. Use the slots formed into the outside edge of the linear stage base.

Figure 10 - Tee Nut Mounting



Tee nuts are used to mount the linear stage from underneath. Insert the Tee nuts every 120 mm (4.72 in.) in both T-slots on the bottom of the linear stage. Secure the Tee nuts by using M6 SHCS as shown in Figure 10.

Mount the Linear Stage

Follow these steps to install a linear stage on its mounting surface.

1. Be sure the mounting surface is clear of any and all foreign material.

IMPORTANT	Do not use abrasives to clean the surface.

   If necessary, stone the mounting surface (acetone or methanol can be applied as cleaning agent).

2. Verify the flatness of the mounting surface.

   The total indicator reading (TIR) is 0.0254 mm (0.001 in.) per 300 mm (12 in.). TIR or runout, correlates to an overall flatness of a surface .

ATTENTION: Do not attempt to move the linear stage by grasping the cable junction box. Moving the linear stage in this manner damages the linear stage and create a pinch or crush hazard. The junction box is attached to the carriage that is free to move. Lifting the linear stage in this manner creates uncontrolled movement of the heavy base. Always use a two-person lift and grasp the linear stage by the base at the end caps Keeping fingers clear of the carriage's path of travel.

Two M10 x 1.5 holes (for 150 mm and 200 mm stages) or two 9/16 - 12 UNC holes (for 250 mm stages) are on each end plate (four total). These tapped through holes can be used to install lifting hooks supplied by the customer.

Personal injury and equipment damage can occur if the linear stage is handled improperly.

3. Lift the linear stage onto the prepared mounting surface.
4. Align the stage on the mounting surface, and insert the correct number of mounting bolts. Refer to MP-Series Linear Stage Dimensions on page 75 for detailed mounting dimensions.
5. Torque all bolts to the values listed in Appendix F, Mounting Bolts and Torque Values, beginning on page 103.

   Observe these guidelines when securing the linear stage:

   - Consider both the mounting surface and the mounting hardware when selecting a torque value.
   - Always secure the linear stage by using all mounting holes.

Connecting the Linear Stage

The installation procedure assumes you have prepared your system for correct electrical bonding and understand the importance of electrical bonding for correct operation of the system. If you are unfamiliar with electrical bonding, the section Attach the Ground Strap and Interface Cables briefly describes and illustrates correct system grounding techniques.

ATTENTION: Plan the installation of your linear stage so that you can perform all cutting, drilling, tapping, and welding before installing the linear stage. Be careful to keep any metal debris from falling into the stage. Metal debris or other foreign matter can become lodged in the stage that can result in damage to the stage.

SHOCK HAZARD: To avoid hazard of electrical shock, perform all mounting and wiring of the linear stage prior to applying power. Once power is applied, connector terminals can have voltage present even when not in use.

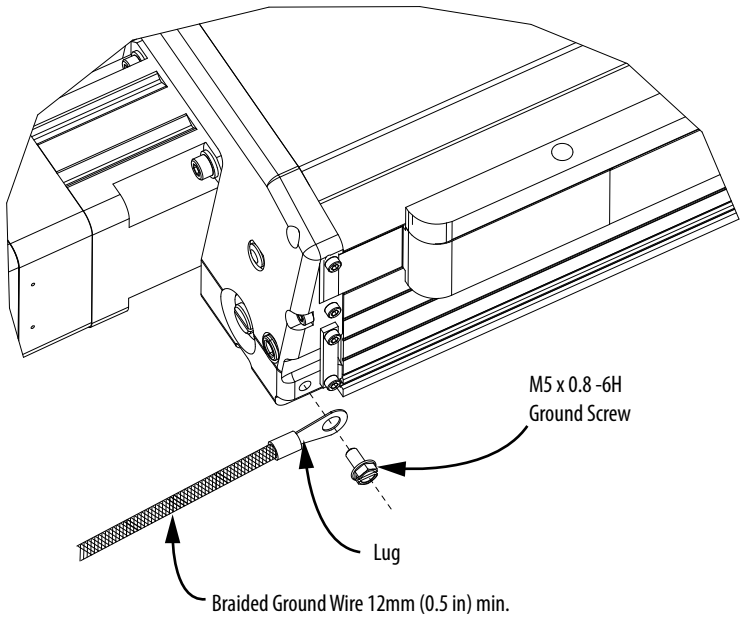
Attach the Ground Strap and Interface Cables

A ground strap and two cable connections are the only electrical connections necessary between the linear stage and the drive system. The flat surfaces on the power and feedback connectors must align during connection, and significant resistance must not be felt when tightening either connector.

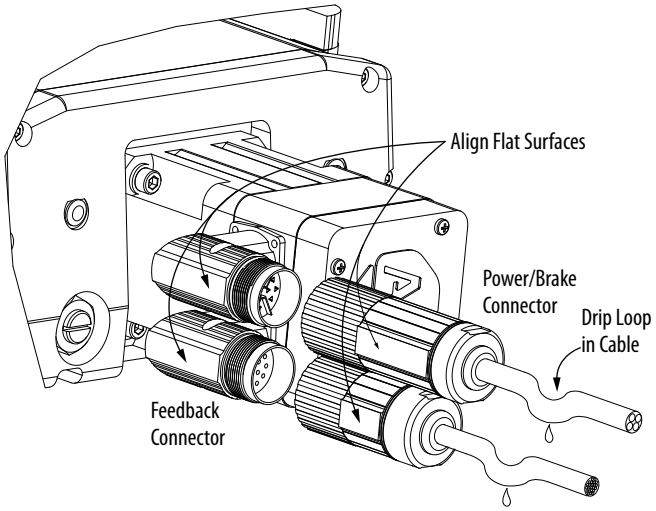
1. For electrical safety, connect the ground screw on the chassis of the linear stage to the groundbus for your system.

   To reduce the effects of electromagnetic interference (EMI), bond the stage with a braided ground strap, 12 mm (0.5 in.) wide minimum, to a grounded metal surface. This creates a low-impedance return path for high-frequency energy.

2. Torque the ground screw at the linear stage to 2 N•m (18 lb•in.).



3. Form a drip loop in each cable at a point directly before it attaches to the motor.



4. Attach the feedback cable, and the combination power and brake cable to the motor.

ATTENTION: Do not connect or disconnect the motor feedback cable, or the power and brake cable while power is applied to them.
Inadvertent pin connections can result in unexpected motion or result in irreversible damage to the components.

a. Carefully align each cable connector with the respective motor connector as shown in the diagram.
b. Do not apply excessive force when mating the cable and motor connectors.

   If the connectors do not go together with light hand force, realign and try again.

ATTENTION: Be sure that cables are installed and restrained to prevent uneven tension or flexing at the cable connectors. Excessive and uneven lateral force at the cable connectors can result in the connector's environmental seal opening and closing as the cable flexes.
Failure to observe these safety procedures could result in damage to the motor and its components.

ATTENTION: When installing a threaded DIN cable with a M4 designation, an O-ring must be installed in the groove immediately adjacent to the body of the linear thruster connector. This O-ring dampens the effects of vibration at the cable-to-linear thruster connection.
Cables requiring O-rings include 2090-XXNFMF-Sxx (standard, non-flex) feedback cables.

c. Fully seat the feedback connector and the power/brake connector.

- Hand tighten the collar of a threaded DIN (M4) connector six turns.
- Hand tighten the collar of a SpeedTec (M7) connector one-quarter turn.

ATTENTION: Keyed connectors must be properly aligned and hand-tightened.

Improper alignment is indicated by the need for excessive force, such as the use of tools, to fully seat connectors.

Connectors must be fully tightened for connector seals to be effective.
Failure to observe these safety procedures could result in damage to the motor, cables, and connector components.

About the Air Option for Ball Screw Linear Stages

A ball screw linear stage can connect to an external air supply via the air port, item 21 on page 20. This can reduce the ingress of particulates in a dusty environment.

- Air supplied to the ball screw stage must not exceed 270 kPa (40 psi).
- Plastic air tubing must be 6 mm (0.2362 in.) OD Teflon FEP tubing.

About the Brake Option for Ball Screw Linear Stages

The brakes offered as options on the ball screw linear stages are holding brakes. They are designed to hold the carriage in place up to the rated brake holding force. The brakes release when voltage is applied to the brake coil. Voltage and polarity supplied to the brake must be as specified to be sure of proper brake performance.

The brakes are not designed to stop the movement of a linear stage. Use the servo drive inputs to stop motion. The recommended method of stopping motion is to command the servo drive to decelerate to 0 mm/s (0 in/s), and engage the brake after the servo drive has decelerated the linear stage to 0 mm/s (0 in/s).

If system main power fails, the brakes can withstand use as stopping brakes. However, use of the brakes as stopping brakes creates rotational mechanical backlash that is potentially damaging to the system, increases brake pad wear, and reduces brake life. The brakes are not designed nor are they intended to be used as a safety device.

Table 2 - Brake Specifications for Ball Screw Linear Stage Motors

Motor Cat. No.	Backlash (brake engaged) µm (in.)	Holding Force N (lb)	Coil Current (at 24V DC) A	Brake Response Time		
				Release ms	Engage - Suppression via MOV ms	Engage - Suppression via Diode ms
MPAS-*xxxxxx*-V05*x*A	100 (0.004)	5187 (1166)	0.46…0.56	50	20	42
MPAS-*xxxxxx*-V20*x*A		1294 (291)				

Meeting UL Installation Standards for the Linear Stage

Linear stage installations must follow UL 1740 - Standard for Safety for Robots and Robotic Equipment.

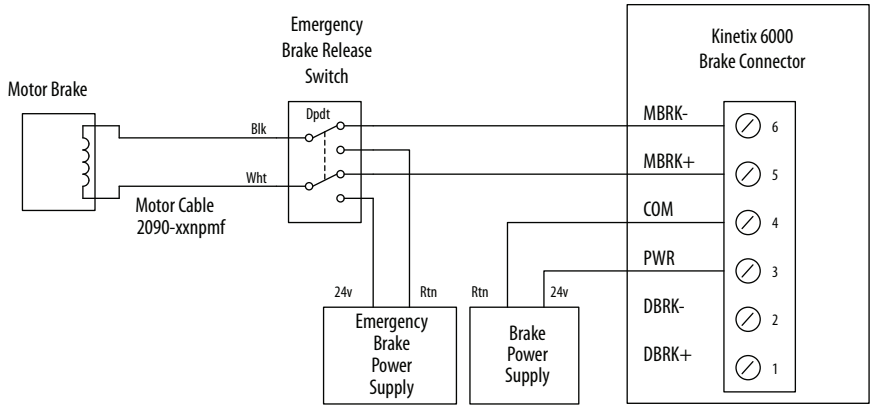
Refer to UL Safety Standards for Linear Stage Installations on page 24 for a brief description of this standard.

ATTENTION: UL 1740 requires all linear stage installations be equipped as described below.
The design, operation, and verification of this implementation is the machine builders responsibility.

A Power Enable light illuminates when drive power is applied and motion is possible.

Emergency movement must be possible when drive power is not available to a ball screw linear drive with a brake. See Figure 11 for an operator-controlled circuit for a Kinetix 6000 drive that applies emergency power to release the brake.

Figure 11 - Emergency Brake Release for Ball Screw Linear Stage Example



Connector Data

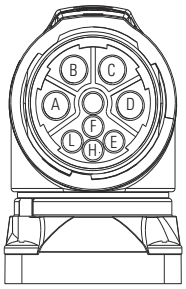
Linear Stage Power and Feedback Connections

The following tables identify the power and feedback pinouts for circular connectors for used with standard Allen-Bradley cables.

The direct drive and ball screw linear stages use different encoder types. Consequently, the feedback connector signals are different for each of these linear stage types.

Table 3 - Power Connector

Pin	Color (1)	Signal
A	Red	U (A) Phase
B	White	V (B) Phase
C	Black	W (C) Phase
D	Green/Yellow	Ground
F	White	Brake+ (2)
G	Black	Brake- (2)



Intercontec P/N BKUA145NN00480200000
Mating Allen-Bradley Power Cable
2090-CPWM7DF-16AAxx (standard) or
2090-CPWM7DF-16AFxx (continuous-flex) or
2090-CPBM7DF-16AAxx (with brake)

(1) These are the wire colors for the leads on the direct drive linear stages (catalog number MPAS-*xxxxxx*-ALM*x*2C). Wires for the ball screw linear stages (catalog number MPAS-*xxxxxx*-V0*xx*S*x*A) are not field accessible.

(2) Brake+ and Brake- are available on only the ball screw linear stages having a rotary motor with a brake.

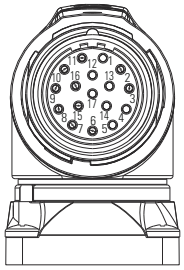
ATTENTION: Disconnect input power supply before installing or servicing stage.
Properly ground the stage as described in both this manual and the drive manual

Table 4 - Feedback Connector for Direct Drive Linear Stage

Pin	Signal Name	Wire Color (2)	Signal Description
1	AM+	Yellow	A Quad B TTL - A Differential
2	AM-	White/yellow	A Quad B TTL - A Differential
3	BM+	Brown	A Quad B TTL - B Differential
4	BM-	White/Brown	A Quad B TTL -B Differential
5	IM+	Violet	TTL - Index Mark Differential
6	IM-	White/Violet	TTL - Index Mark Differential
7	Reserved	—	—
8			
9	+5V DC	White/Red	Encoder and Hall Sensor Power
10	Common	Black	Common
11	Reserved	—	—
12			
13	PTC Temp+ (1)	Green	PTC Thermistor
14	Common	White/Black	Common
15	S1	White/Green	TTL - Trapezoidal Hall Commutation
16	S2	Blue	TTL - Trapezoidal Hall Commutation
17	S3	White/Blue	TTL - Trapezoidal Hall Commutation
Case	Shield	—	—

(1) PTC Temp- is connected to Common.

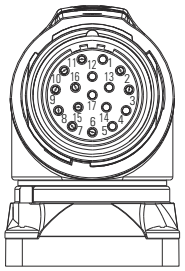
(2) These are the wire colors for the leads on the direct drive linear stages (catalog number MPAS-*xxxxxx*-ALM*x*2C). Refer to Appendix B, Accessories, for wire colors of interconnect cables.



Intercontec P/N AKU034NN004200000
Mating Cable Allen-Bradley Incremental Encoder Cable
2090-XXNFMF-Sxx (standard) flying leads or
2090-CFBM7DF-CDAF*xx* (continuous-flex) flying leads

Table 5 - Feedback Connector for Ball Screw Linear Stage

Pin	Signal Name MPAS-A*xxxxx* (230V)	Signal Description	Signal Name MPAS-B*xxxxx* (460V)
1	Sin+	Analog Differential 1V p-p	Sin+
2	Sin-	Analog Differential 1V p-p	Sin-
3	Cos+	Analog Differential 1V p-p	Cos+
4	Cos-	Analog Differential 1V p-p	Data-
5	Data+	Serial Data Differential Signal +	Data+
6	Data-	Serial Data Differential Signal -	Data-
7	Reserved	—	Reserved
8			
9	+5V DC	230V MPAS Encoder Power	
10	Common	230V MPAS Encoder Common	
11	Reserved	460V MPAS Encoder Power	+9V DC
12		460V MPAS Encoder Common	Common
13	TS+	PTC Thermistor	TS+
14	TS-	Common	TS-
15	Reserved	—	Reserved
16			
17			
Case	Shield	—	Shield



Intercontec P/N AEDC113NN00000222000
Mating Cable Allen-Bradley High Resolution Encoder Cable
2090-CFBM7DF-CEAA*xx* (standard) flying leads or
2090-CFBM7DD-CEAA*xx* (standard) D-sub or
2090-CFBM7DF-CEAF*xx* (continuous-flex) flying leads or
2090-CFBM7DD-CEAF*xx* (continuous-flex) D-sub

PTC Thermal Signal

Temperature °C (°F)	Resistance in Ohms (1)
Up to 100 (212)	≤ 750
Up to 105 (221)	≤ 7500
Up to 110 (230)	≥ 10,000

(1) Measure thermistor resistance in a direct drive linear stage at pins 13 and 14 on the feedback connector; see Feedback Connector for Direct Drive Linear Stage on page 40 for more information.

Configuration Guidelines

Required Files

Firmware revisions and software versions required to support the linear stages include the following:

- RSLogix 5000 software, version 16.xx or the Logix Designer application
- Kinetix 2000 or Kinetix 6000 multi-axis drives
  - Firmware revision 1.96 or later
  - Motion Database file, version 4.6 or later
- Ultra3000 drives
  - Firmware revision 1.52 or later
  - Motion Database (.mdb) file, dated July 2007 or later
- Motion Analyzer software, version 4.4 or later

Download these files from http://www.rockwellautomation.com/support/. Contact Rockwell Automation Technical Support at (440) 646-5800 for assistance.

Configuring Your Linear Stage

Configure the linear stage by using the parameter settings described in this chapter.

IMPORTANT You are responsible for verifying that the servo control system safely controls the linear stage with regard to maximum force, acceleration, and speed.

ATTENTION: Moving parts can injure. Before running the stage, make sure all components are secure.
Check that the linear stage is clear of foreign matter and tools. Objects hit by the moving stage can cause personnel injury or damage to the equipment.
Incorrect motor, Hall, or encoder wiring can cause uncontrolled motion.

The type of Allen-Bradley drive connected to the linear stage determines the configuration procedure. Refer to the following table to determine the configuration procedures to follow.

If your servo drive is	Start on page	Continue with page
Kinetix 2000 (2093-*xxxx-xxx*)	41	51
Kinetix 6000 (2094-*xxxx-xxx-x*)	41	
Ultra3000 SERCOS (2098-DSD-*xxxx*-SE)	41	N/A
Ultra3000 non-SERCOS (2098-DSD-*xxxx*)	49	

IMPORTANT If you are using a Kinetix 2000 or Kinetix 6000 drive, read and apply Appendix E, Home to Torque-level Example, to your system-level program.

This appendix provides information on using torque-level homing to reference a known (home) position by monitoring torque while driving an axis into a mechanical hard-stop.

Configuring the Logix Designer Application for Linear Stages with Kinetix Multi-axis Drives

The Logix Designer application parameters provide basic setup and tuning data for MP-Series Integrated Linear Stages.

- Setting Axis Properties in the Logix Designer Application provides basic drive parameters for a linear stage in a table specific to the type of linear stage, either direct drive linear or a ball screw.
- Tuning Linear Stages by Using the Logix Designer Application begins on page 44. It provides sections that describe how to complete these tasks:
  - Tune Your Linear Stage – only ball screw stages
  - Calculate and Configure the Loop Gain – only ball screw stages
  - Setting Travel Limits - both direct drive and ball screw stages

Setting Axis Properties in the Logix Designer Application

Use these parameter settings when configuring the ControlLogix drive system for your linear stage. Parameter settings differ between the direct drive and ball screw linear stages.

ATTENTION: Incorrect parameter settings can result in uncontrolled motion, with the potential for damage to the stage and machine.

Do not set the Positioning mode to Rotary for any linear stage. This results in incorrect positioning of the linear stage.

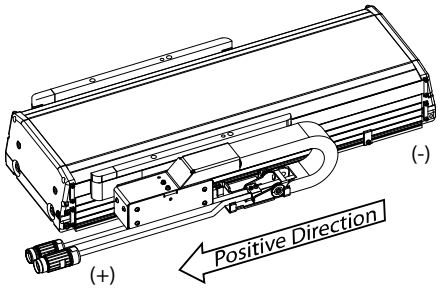
Initiating a motion command on a stage with an incorrect Position mode setting can result in damage to the stage and the machine.

The following steps assume the MP-Series linear stage and a Kinetix 2000 or Kinetix 6000 servo drive are installed and wired as one axis of a motion system.

Direct Drive Linear Stages

Set these parameters in the appropriate Axis Properties tab of the Logix Designer application for direct drive linear stages, catalog number MPAS-*xxxxxx*-ALM*x*2C.

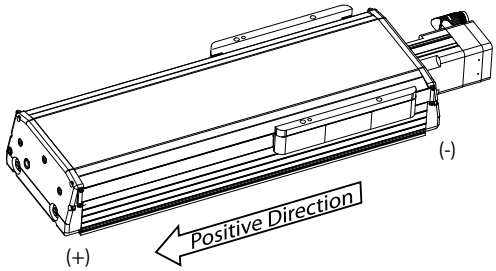
Axis Properties Tab	Parameter	Entry/Selection, with applicable distance unit settings	
		Millimeters	Inches
Drive/Motor	Motor Catalog Number	Select one from the list MPAS-A6*xxx*B-ALMO2C MPAS-A6*xxx*B-ALMS2C MPAS-A8*xxx*E-ALMO2C MPAS-A8*xxx*E-ALMS2C MPAS-A9*xxx*K-ALMO2C MPAS-A9*xxx*K-ALMS2C MPAS-B8*xxx*F-ALMO2C MPAS-B8*xxx*F-ALMS2C MPAS-B9*xxx*L-ALMO2C MPAS-B9*xxx*L-ALMS2C	
	Drive Resolution	200	
	Drive Counts per	Motor Millimeter	

Axis Properties Tab	Parameter	Entry/Selection, with applicable distance unit settings	
		Millimeters	Inches
Motor Feedback	Feedback Type	TTL with Hall	
	Cycles	50	
	Per	Millimeter	
Conversion	Positioning Mode	Linear	
	Conversion Constant	200 drive counts / 1.0 mm	5080 drive counts / 1.0 in.
Hookup [1]	Test Increment	70 mm, min for Ultra3000 drive 20 mm Kinetix 2000 drive 20 mm Kinetix 6000 drive	2.76 in. min for Ultra3000 drive 0.787 in. Kinetix 2000 drive 0.787 in. Kinetix 6000 drive
	Drive Polarity	Positive (see definition) 	
Homing	Mode	Active	
	Position	0 (or programmable)	
	Offset	5 mm, min	0.2 in., min
	Sequence	Torque Level-to-Marker	
	Direction	Reverse Bi-directional	
	Torque Level	80%, min Greater if the system friction, force, or weight exceeds 80% of the Continuous Force Rating at any point in the range of motion	
	Speed	50 mm/s	1.97 in/s
	Return Speed	10 mm/s	0.39 in/s
Software or Hardware Limits	Negative Limit or Positive Limit	Use Motion Analyzer to determine the maximum stopping distance in your application	

(1) The Command and Feedback test, accessed from the Hookup tab, does not verify the Hall Sensor wiring to a Kinetix 2000 or a Kinetix 6000 drive. The wire colors and continuity for the Hall signals must be manually verified.

Ball Screw Drive Stages

Set these parameters in the appropriate Axis Properties tab of the Logix Designer application for ball screw linear stages, catalog number MPAS-*xxxxxx*-V*xxxx*A.

Axis Properties Tab	Parameter	Entry/Selection, with applicable distance unit settings	
		Millimeters	Inches
Drive/Motor	Motor Catalog Number	Select one from the list MPAS-A*xxxx*1-V05S2A MPAS-A*xxxx*1-V05S4A MPAS-A*xxxx*2-V20S2A MPAS-A*xxxx*2-V20S4A MPAS-B*xxxx*1-V05S2A MPAS-B*xxxx*1-V05S4A MPAS-B*xxxx*2-V20S2A MPAS-B*xxxx*2-V20S4A	
	Drive Resolution	200,000	
	Drive Counts per	Motor Millimeter	
Conversion	Positioning Mode	Linear	
		**ATTENTION:** Setting the Positioning Mode to Rotary can cause damage to the stage or the machine due to incorrect positioning.	
	Conversion Constant	40,000 drive counts / 1.0 mm for	1,016,000 drive counts / 1.0 in. for
		MPAS-A*xxxx*1-V05S2A MPAS-A*xxxx*1-V05S4A MPAS-B*xxxx*1-V05S2A MPAS-B*xxxx*1-V05S4A	
	Conversion Constant	10,000 drive counts / 1.0 mm for	254,000 drive counts / 1.0 in. for
		MPAS-A*xxxx*2-V20S2A MPAS-A*xxxx*2-V20S4A MPAS-B*xxxx*2-V20S4A MPAS-B*xxxx*2-V20S4A	
Hookup	Test Increment	5 mm min	0.2 in., min
	Drive Polarity	Positive (see definition) 	

Axis Properties Tab	Parameter	Entry/Selection, with applicable distance unit settings	
		Millimeters	Inches
Homing	Mode	Active	
	Position	0 (or programmable)	
	Offset	5 mm, min	0.2 in., min
	Sequence	Torque Level-to-marker	
	Direction	Reverse Bi-directional	
	Torque Level	50%, min Greater if the system friction, force, or weight exceeds 50% of the Continuous Force Rating at any point in the range of motion.	
	Speed	50 mm/s	1.97 in./s
	Return Speed	10 mm/s	0.39 in./s
	Absolute Home is available for ball screw linear stages. For maximum range of motion, position the carriage so its proximal edge is 25.4 mm (1.0 in.) from the inside edge of the end plate.		
Software or Hardware Limits	Negative Limit or Positive Limit	Use Motion Analyzer to determine maximum stopping distance in your application	

Tuning Linear Stages by Using the Logix Designer Application

This section documents the steps necessary to tune linear stages by using the RSLogix 5000 software, version 16.xx or the Logix Designer application.

IMPORTANT **ATTENTION:** The Tuning and Loop Gain procedures apply to only the ball screw linear stages.

The Travel Limit procedures apply to both the direct drive and the ball screw linear stages.

- Tuning your linear stage requires you to calculate and configure the loop gain based on the actual measured inertia.
- Setting travel limits defines the minimum deceleration for your specific application.

Tune Your Linear Stage

IMPORTANT These procedures apply to only ball screw linear stages.

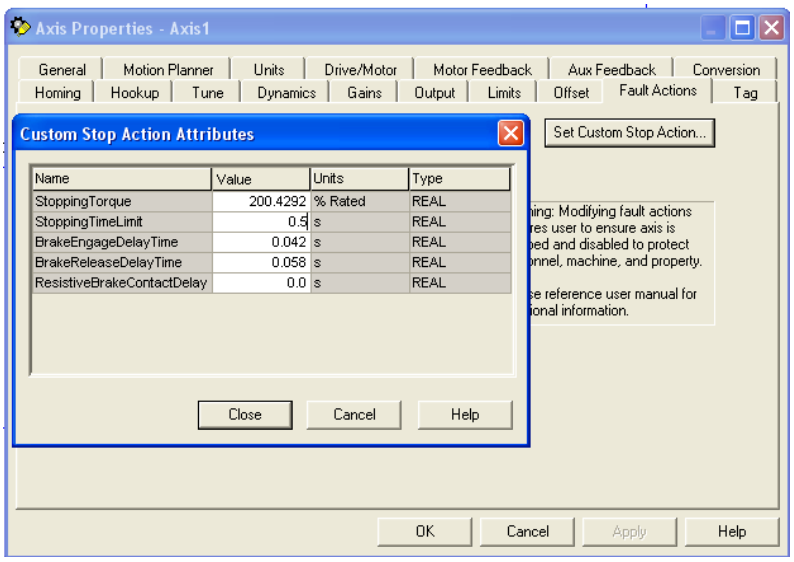
Set the following parameters in the Axis Properties tab of the Logix Designer application to tune a ball screw drive linear stage (catalog number MPAS-*xxxxxx*-V*xx*S*x*A).

1. In the Axis Properties dialog box, click Fault Actions > Set Custom Stop Action > Custom Stop Attributes.

   TIP These parameter settings work best if the linear stage is installed in a horizontal (table top) or a wall mount (vertical) orientation.

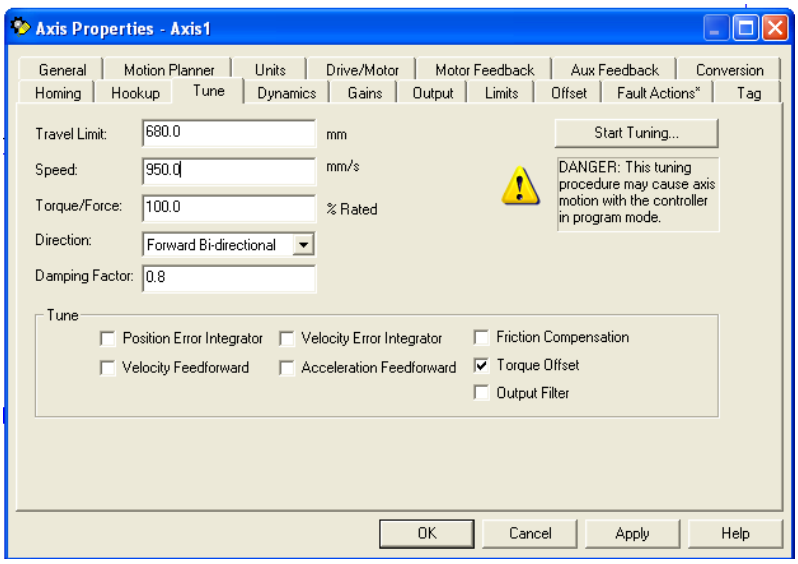
2. Set the Brake Engage and the Brake Release delay times to the values listed in Brake Specifications for Ball Screw Linear Stage Motors on page 89.
3. Reduce the default Stopping Time Limit from 10 seconds to 0.5 seconds, as shown in the following display.

IMPORTANT To prevent the carriage from moving, or falling when installed in a vertical orientation, the Stopping Time Limit must be set to 0.99 seconds or less.

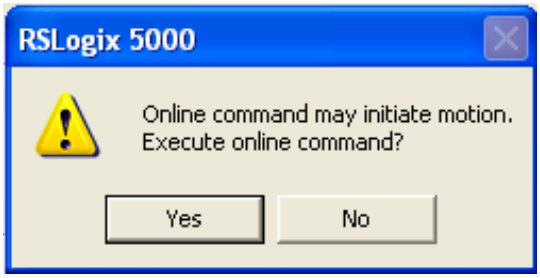


4. Select the Tune tab in the Axis Properties dialog box and enter the following parameters.
   a. Set the Travel Limit to no more than the travel length of the linear stage.
   b. Configure the appropriate Speed (velocity).
   c. Configure the appropriate Torque/Force.

IMPORTANT Check only Torque Offset, as shown below, if the linear stage is installed in a non-horizontal mount position.



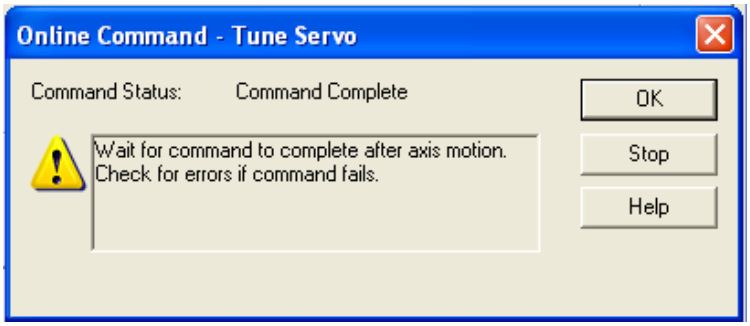
5. On the Tune tab, click Start Tuning to access the Motion Initiation dialog box.



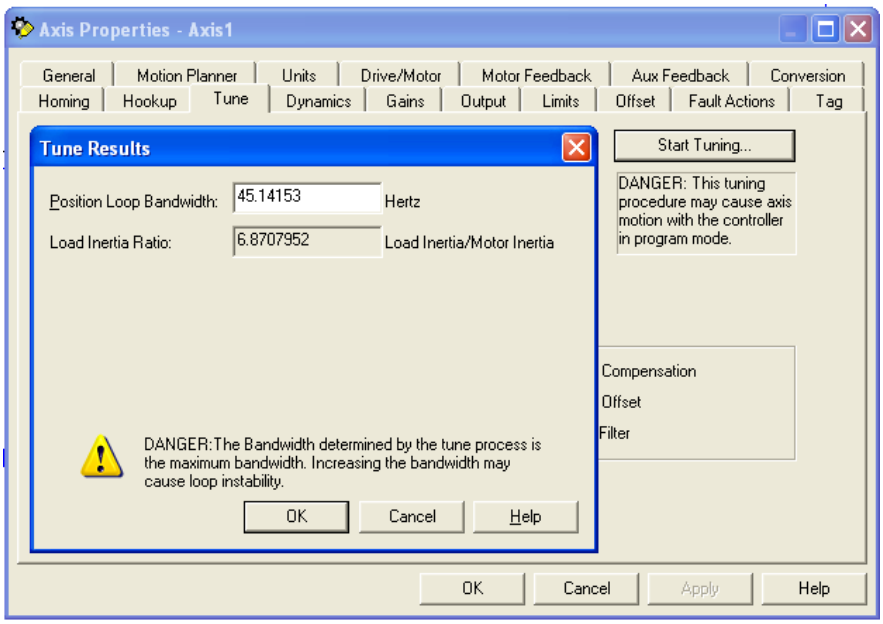
6. Click Yes to begin tuning the linear stage.

ATTENTION: Motion occurs immediately after clicking Yes

Tuning is complete when the Tune Servo dialog box appears.



7. Select Yes to exit Tuning, and display the Tune Results dialog box.



Calculate and Configure the Loop Gain

IMPORTANT These Loop Gain procedures apply to only ball screw linear stages.

You must calculate a position loop bandwidth based on the actual measured inertia. This is done by using the values from the Tune Results dialog box for a ball screw drive linear stage.

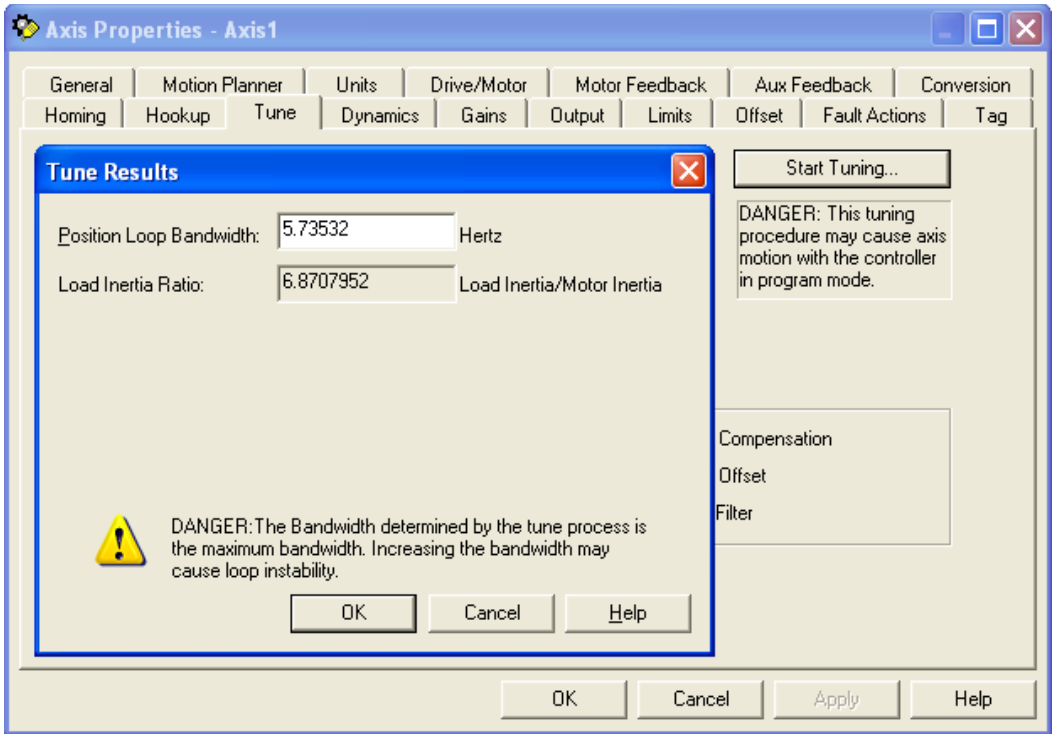
The Tune Results dialog box above shows a default Position Loop Bandwidth of 45.14153 Hz, and a Load Inertia Ratio of 6.8707952.

1. Calculate the Corrected Position Bandwidth as follows:

   Corrected Position Loop Bandwidth = (Initial Position Loop Bandwidth Result/(Initial Load Inertia Ratio Result +1)

   For example, 5.73532 = 45.14153 / 7.8707952.

2. Enter the Corrected Position Bandwidth value 5.73532 as the Position Loop Bandwidth and click OK.



3. Answer the remaining dialog boxes to apply the values.

The proper Position Bandwidth results in a stable starting point from that you can adjust the gains to fit the application requirements.

Configuring Ultraware Software for Linear Stages with Ultra3000 Drives

The following steps assume that the MP-Series linear stage and an Ultra3000 servo drive are installed and wired as one axis of a motion system.

1. Connect a serial cable model, catalog number 2090-DAPC-D09*xx*, to the CN3 connector on your Ultra3000 servo drive.
2. Apply ac input power to the Ultra3000 drive.
3. Establish communication with the Ultra3000 drive, and click Cancel when the Ultra3000 motor database dialog box appears.

   Clicking Cancel causes the Ultraware software to scan for online drives. When a drive is found, an Online Drive icon displays in the Workspace.
4. Double-click the Online Drive icon to view the main Drive setup dialog box.
5. Perform the action in the following table appropriate for your type of linear stage.

If your linear stage is a	Do this
Direct drive MPAS-*xxxxx*-ALM02C	Select your direct drive linear stage from the drop down in the Motor Model dialog box, and then verify the data in the Motor Field is correct for your direct drive linear stage.
Ball Screw MPAS-*xxxxx*-V05S2A, or MPAS-*xxxxx*-V20S2A	Verify the data in the Model Field is correct for your ball screw linear stage.

   Auto Motor Iden (identification) is enabled for only ball screw linear stages. Auto Motor Iden remotely identifies the motor, and then populates the model field with the appropriate motor information. Direct drive linear stages do not interact with Auto Motor Iden, and the model field data must be manually selected for the appropriate motor information to load.
6. From the Displayed Units pull-down menu, choose User.

   This programs Ultraware software to make distance moves in User Units (mm or in.).
7. In the Motor Encoder Units pull-down menu, enter the appropriate values from the following tables.

   Velocity, position, and acceleration counts per unit are based on the selected User Units (mm or in.).

Table 6 - Scaling Parameters Values

User Unit Scaling Parameters (1)	Distance Units for Ball Screw Linear Stages			
	Millimeters		Inches	
	MPAS-*xxxxxx*-V05*xx*A	MPAS-*xxxxxx*-V20*xx*A	MPAS-*xxxxxx*-V05*xx*A	MPAS-*xxxxxx*-V20*xx*A
Velocity Label	mm/s	mm/s	in./s	in./s
Velocity Scale	26214.4	6553.6	665845.76	166461.44
Position Label	mm	mm	in.	in.
Position Scale	26214.4	6553.6	665845.76	166461.44
Acceleration Label	mm/s/s	mm/s/s	in./s/s	in./s/s
Acceleration Scale	26214.4	6553.6	665845.76	166461.44

(1) User units are determined by the screw lead of the linear stage. The screw lead is defined in linear units of travel per revolution. For example, the travel per revolution of an MPAS-*xxxxxx*-V05*xx*A is 5 mm/rev and that of an MPAS-*xxxxxx*-V20*xx*A is 20 mm/rev. MP-Series linear stages with a ball screw use a feedback device that provides 128 sin/cos cycles per revolution of the motor. The Ultra3000 drive interpolates this signal by an additional 1024, causing the maximum count per internal motor revolution of the linear stage to be 131,072 counts/rev.

Table 7 - Direct Drive Linear Stage Distance Unit Settings

User Unit Scaling Parameters	Distance Units	
	Millimeters	Inches
Velocity Label	mm/s	in./s
Velocity Scale	200	5080
Position Label	mm	in.
Position Scale	200	5080
Acceleration Label	mm/s/s	in./s/s
Acceleration Scale	200	5080

Setting Travel Limits

MP-Series Integrated Linear Stages are designed to use the software overtravel limits available in the Logix Designer application and Ultraware software.

IMPORTANT These Travel Limit procedures apply to both direct drive or ball screw linear stages.

Overtravel limits must be set according to the maximum speed of the servo drive system and the payload of the application. The Deceleration Distance before the slide contacts the end-of-travel bumpers can be determined based on the Deceleration Rate of the load, and the available peak force from the stage-drive combination. Then use Motion Analyzer software to calculate the minimum deceleration distance at the maximum speed of your application. (1)

Software overtravel limits are preferred for these reasons.

- Hard-wired overtravel limit switches are typically in a position that does not let the linear stage decelerate before mechanical damage occurs.
- Software overtravel limit switches can be precisely set, based on maximum speed and load inertia. The stage comes to a complete stop before physical damage occurs.

In addition to software overtravel limits, the end of travel bumpers for the linear stage stops the carriage up to the ratings listed in the table.

Table 8 - Bumper Stop Energy Limits for Linear Stage End of Travel

Catalog Number	Energy Limit
MPAS-*x*6*xxx*1-V05*xx*A	37.3 J (330 in-lb)
MPAS-*x*6*xxx*1-V20*xx*A	
MPAS-*x*6*xxx*1-ALM*x2C*	

Catalog Number	Energy Limit
MPAS-*x*8*xxx*1-V05*xx*A	22.7 J (201 lb-in)
MPAS-*x*8*xxx*1-V20*xx*A	
MPAS-*x*8*xxx*1-ALM*x2C*	45.5 J (403 lb-in)

Catalog Number	Energy Limit
MPAS-*x*9*xxx*1-V05*xx*A	16.5 J (146 lb-in)
MPAS-*x*9*xxx*1-V20*xx*A	
MPAS-*x*9*xxx*1-ALM*x2C*	35.2 J (312 lb-in)

ATTENTION: If energy greater than the bumper capacity is anticipated in the application, you must provide additional mechanical means for safely stopping the carriage.

To calculate kinetic energy of the carriage with your payload use the formula

$$\left(J = \frac{1}{2} \times M \times V^2\right)$$

J = energy in Joules
M = moving mass (linear carriage + payload) [kg]
V = maximum velocity of stage in your application [m/s] (1)

(1) Velocity and kinetic energy can be much higher due to uncontrolled, worst-case motion that is constrained by the length of stroke and the power capacity of the motor-drive pairing.

Home to Torque Programming for Kinetix Multi-axis Drives with Linear Stages

If you are using a Kinetix 2000 or Kinetix 6000 drive, read and apply Appendix E, Home to Torque-level Example, to your system-level program.

IMPORTANT Perform Home to Torque Programming after you have tuned your drive and linear stage combination.

Successfully complete tuning by performing the steps starting on page 43.

This appendix provides information on using torque-level homing to reference a known (home) position by monitoring torque while driving an axis into a mechanical hard-stop.

Maintenance

IMPORTANT Any person that teaches, operates, maintains, or repairs these linear stages must be trained and demonstrate the competence to safely perform the assigned task.

Before You Begin

Use the following tools to lubricate and clean your linear stage.

ATTENTION: Lockout and tagout input power before servicing.

- 0.36 meter (14 inches) or larger clamp with soft jaws
- Grease pump kit (catalog number MPAS-GPUMP) with tip type installed and primed
- Grease cartridge (catalog number MPAS-CART), included in grease pump kit.
- Air line having a maximum pressure of 68 kPa (10 psi).
- Lint-free cloth
- Isopropyl alcohol, as necessary for cleaning

Recommended Maintenance Intervals

Recommended maintenance and lubrication intervals are:

- direct drive linear stages every 6 months or 5000 km of travel, whichever comes first
- ball screw linear stages every 3 months or 150,000,000 revolutions, whichever comes first

Bearing Lubrication

Lubricate the linear stage bearings as shown and described below. Use the MP-Series Integrated Linear Stage grease pump kit, and additional grease cartridges as necessary.

Figure 12 - Direct Drive Linear Stage Lubrication

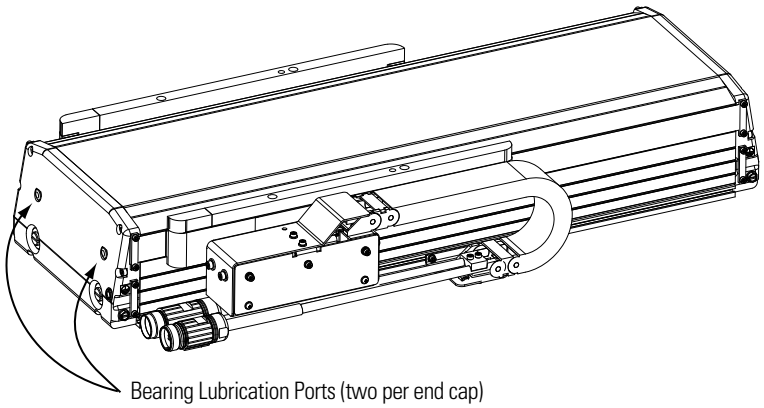
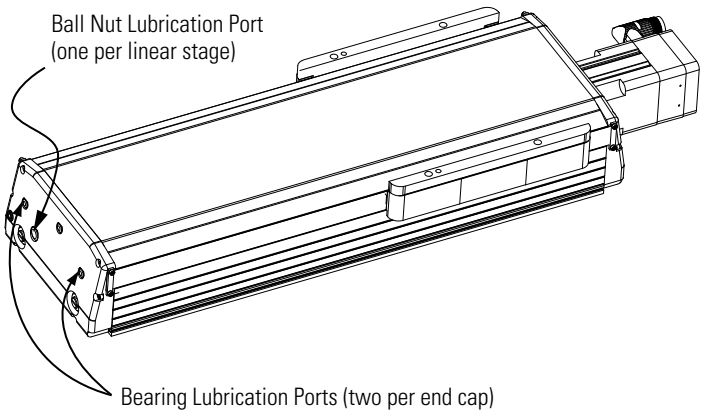


Figure 13 - Ball Screw Linear Stage Lubrication



1. Position the carriage at end of travel and clamp it to hold the linear stage against end block.

ATTENTION: Do not use clamp across the side panels. This deforms and damages the side panels.

2. Remove the lubrication port protective caps on each end cap.
3. Insert the tip of the grease pump into the lubrication port, pushing in until firm contact with the grease fitting is made.
4. Pump the handle until back pressure is felt, or a maximum of two strokes are made.
5. Repeat step 3 and step 4 to the other lubrication ports.
6. Move the carriage to opposite end of travel and repeat steps 1...5.

7. Remove the clamp.
8. Reinstall the protective caps on all the lubrication ports.

Strip Seal Cleaning

Clean the strip seals, if installed, by using a lint free cloth lightly saturated with isopropyl alcohol.

IMPORTANT Replace the strip seal if it cannot be cleaned, or if an uneven or scored surface is detected during cleaning.

A buildup of foreign material on the strip seal degrades the performance of the linear stage. This buildup coupled with rapid movement of the carrier and the resulting friction scores the surface and create a burnished appearance on the strip seal.

Elements contributing to a typical buildup on the strip seals are dust, grease, and other contaminants normally encountered in any operating environment that is not strictly controlled.

Refer to the Strip Seal Removal on page 63 and Strip Seal Replacement on page 64 when performing this task.

Cover Cleaning

Clean the covers at the same time you clean the strip seals. Use pressurized air and a lint free cloth lightly saturated with isopropyl alcohol to remove any dirt or grease.

Notes:

Removing and Replacing Components

ATTENTION: Lockout and tagout input power before servicing.

ATTENTION: These procedures are not applicable to both types of linear stages. Direct drive and ball screw linear stages have unique configurations

Before You Begin

Assemble these tools before you begin removal and replacement procedures.

- 2.5 mm, 3 mm, 4 mm, 5 mm, and 6mm hex keys
- 0.8 mm (0.03 in) shim
- Fine-point permanent marker
- Ruler
- Tin snips
- Loctite 222
- Phillips and flat-blade screwdrivers

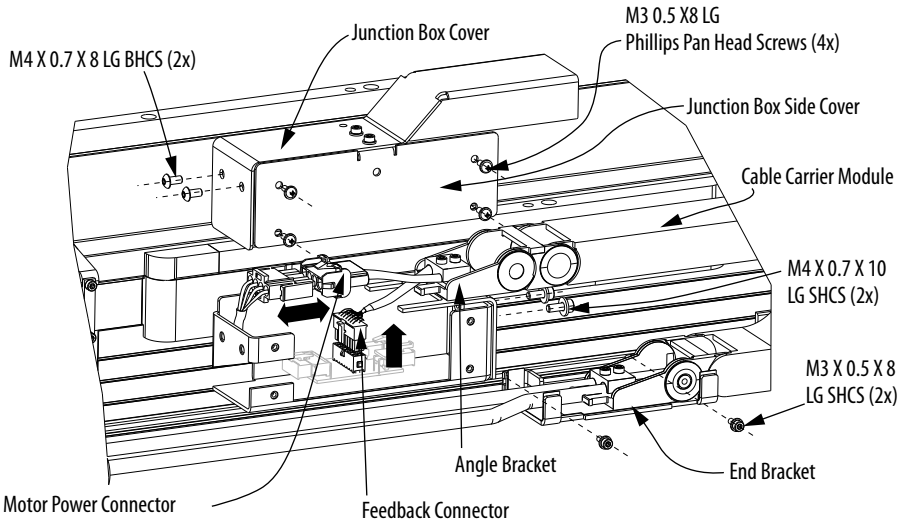
Cable Carrier Assembly Removal

Follow these directions to remove the cable carrier assembly.

TIP Mark the location of the end bracket before removing the cable carrier, this makes it easier to align it when reinstalling.

1. Remove the four pan head screws from junction box side cover.
2. Remove the two button head cap screws (BHCS) from the junction box cover.
3. Remove the junction box cover assembly.

Figure 14 - Cable Carrier Removal



ATTENTION: Never pull on wires when disconnecting power and feedback connectors. Damage to circuit continuity can occur.

4. Separate the motor power connector by squeezing the side tabs and pulling on the housing, but do not pull on the wires.
5. Separate the feedback connector from the circuit board by pushing on the center tab and pulling up on the connector housing, but do not pull on the wires.
6. Remove the two SHCS from the cable carrier angle bracket.
7. Lay the cable carrier out flat and mark the location of the end bracket.
8. Loosen, but not remove, the two SHCS securing the end bracket to the base of the linear stage.
9. Remove the cable carrier.

Cable Carrier Assembly Installation

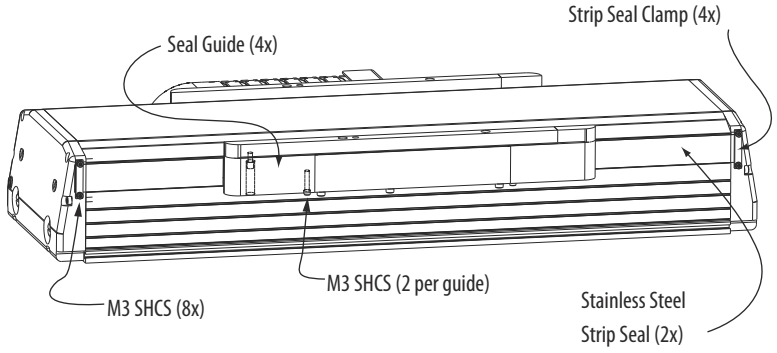
Follow the Cable Carrier Assembly Removal procedure in reverse.

Align the cable carrier by using the alignment marks made when the worn cable carrier was removed.

Strip Seal Removal

Follow these directions to remove a strip seal.

Figure 15 - Linear Stage Seal Components



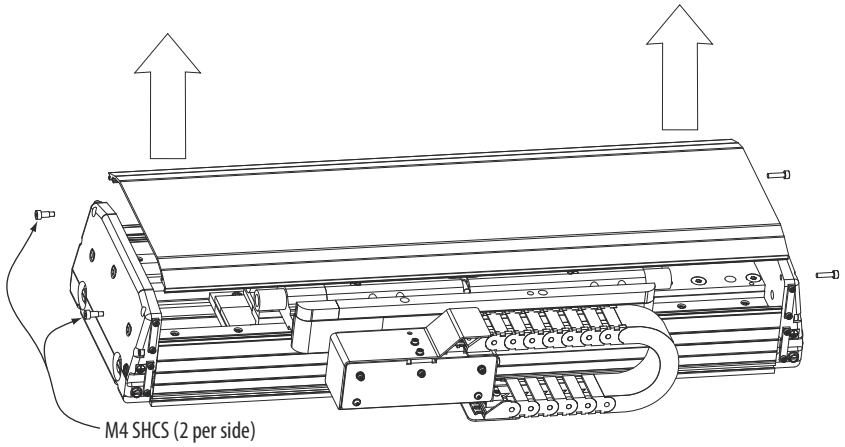
IMPORTANT Handle strip seal material with care. The strip seal has sharp edges that can cut if mishandled.

1. Loosen the strip seal clamps at each end of the linear stage.
2. Carefully grasp the end of the strip seal and slide it out of the linear stage.

Cover Removal

Follow these directions to remove a side cover.

1. Remove strip seals following the strip seal removal procedure.
2. Remove the four M4 screws securing the linear stage cover to the end caps.



3. Remove the cover.

Cover Installation

Follow these directions to install a cover.

1. Start at the end cap nearest the magnetic cautionary label or the MP motor, and install two M4 x 25 SHCS.
2. Torque the M4 x 25 SCHS to 4 N•m (35 lb•in).
3. Make sure the cover contacts the end cap.
4. On the opposite end install two M4 x 30 SHCS and bottom out the screw.

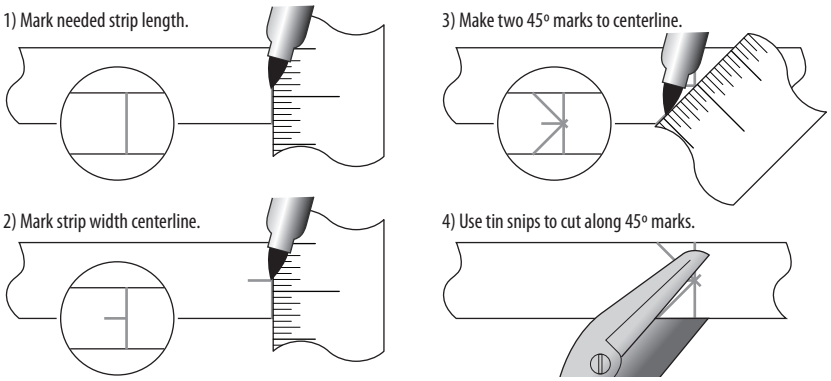
   The cover does not contact the end cap on this side and floats on the screw.

Strip Seal Replacement

Follow these directions to replace the strip seals.

ATTENTION: Handle strip seal material with care. The strip seal has sharp edges that can cause personal injury if mishandled.

1. Remove power from the linear stage, and lock out and tag the power source.
2. Follow the instructions below on how to measure, mark, and cut new strip seals.

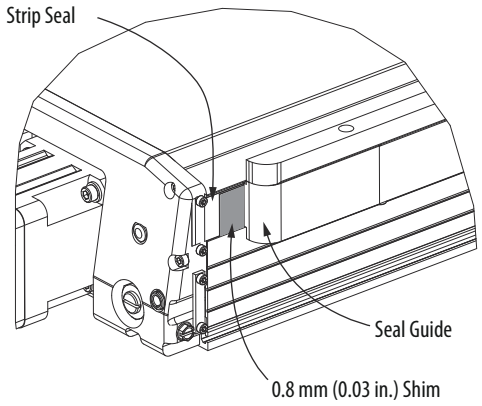


3. Position the carriage at the midpoint of stage travel.
4. Expose the center metal section of the carriage's seal strip guide by loosening the screws securing the end clamps and those at the carriage seal guide.
5. Thread the new strip seal, point end first, through the seal guides, the carriage, and then the end clamps.
6. Center and smooth the strip seal against the top cover and the side panel magnetic strips.
7. By using very light pressure, hold the seal guide against the strip seal, and then tighten the seal guide.
8. Tighten one end clamp, but do not tighten the clamp on the other end.

9. Move the carriage by hand through the complete range of travel and make sure the strip seal seats smoothly against the cover and side panel magnet strips.

   Pulling against the tightened end clamp helps to smooth the seal.

10. Once the seal lays flat and smooth against the top cover and side panel, tighten the second end clamp.
11. With the outside edge of the end clamps as a guide, use tin snips to cut and remove excess strip seal material.
12. Position the carriage at the far ends of travel.
13. Adjust the seal guide by inserting a 0.8 mm (0.03 in.) shim between the seal guide and the strip seal.



14. Return the linear stage to service.

Side Cover Installation

Follow these directions to install a side cover.

1. Insert a side cover into the base of the linear stage by holding it with the top slightly tilted outward and hooking the bottom of the side cover in the channel near the bottom of the base.

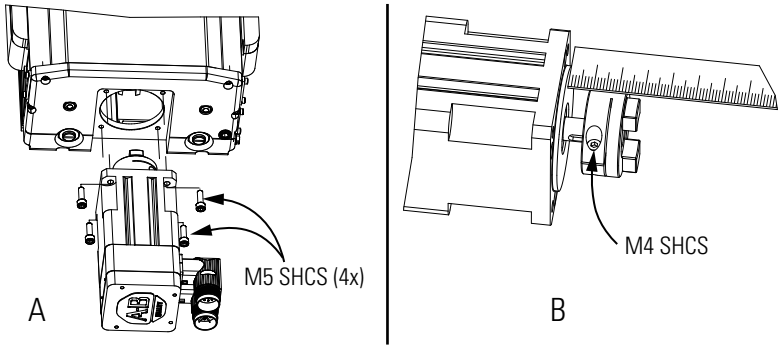
   TIP If installing the side cover with strip seals in place use a flat-blade screwdriver to lift the side cover by inserting the screwdriver under the cover between the cover and the base.

2. Starting at the end cap adjacent to the ground screw, install one M4 SHCS and torque it to 4 N•m (35 lb•in).
3. On the opposite end, install one M3 SHCS and torque it to 2.5 N•m (20 lb•in).

Rotary Motor Replacement

Follow these directions to replace a rotary motor.

1. Disconnect the motor cables.
2. Remove the four M5 SHCS and lock washers that secure the motor to the linear stage.

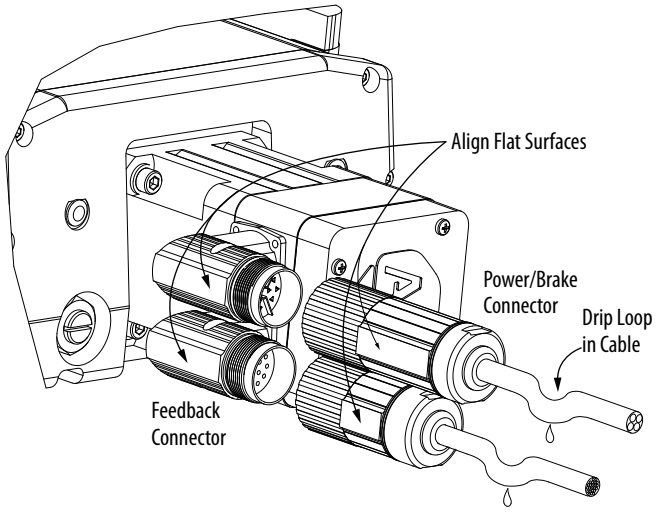


3. Remove the motor.

IMPORTANT	Measure the position of the coupling on the motor shaft as shown in panel B of the diagram above.

4. Mark the measured coupling position on the new motor shaft.
5. Loosen the M4 SHCS in the coupling and remove the coupling from old motor shaft.
6. Position the coupling on the new motor shaft, align it with the mark made in step 4, and then tighten the coupling.
7. Align the coupling halves and install the motor.
8. Secure the motor with four M5 SHCS and lock washers.
9. Torque each cap screw to 4 N•m (35 lb•in), by using a diagonal tightening sequence.

10. Attach the power and feedback cables to the motor, by aligning the flat edges on the cable connector with those on the motor connector.



Notes:

Troubleshooting

This chapter is divided into three sections:

- Use the diagnostic tables during axis commissioning
- Use the operational section to troubleshoot either a direct drive or ball screw linear stage after the axis is up and running
- Use the thermistor measurement section when direct-drive operational troubleshooting suggests

Troubleshooting During Commissioning and Start-up

Use this section to diagnose and correct troubles encountered while using Logix Designer application to commission and start your linear stage.

Symptom	Possible Cause	Solution
Initialization stops at SERCOS Level 3 and Logix software reports Motor Attribute Error.	Incorrect motor catalog number.	Enter correct motor catalog number.
	Incorrect drive firmware.	For Kinetix 6000 and Kinetix 2000 drives, verify the firmware revision is 1.96 or later, For a Ultra3000 drive, verify the firmware revision is 1.52 or later.
	From using a previously defined axis.	Delete and recreate the axis.
Drive reporting error E04, E11, or E07.	Incorrect feedback wiring.	Verify feedback wiring. Refer to Wiring Examples on page 87.

In the Hookup tab of Axis Properties, click on the Test Command and Feedback button to verify wiring and commissioning of your linear stage. The following table lists possible solutions for problems encountered while performing this test.

TIP Hookup testing can fail if friction and weight forces exceed 20% of the stage's continuous force rating.

Symptom	Possible Cause	Solution
Linear stage, direct drive or ball screw, passes Hookup testing but the carriage jumps position when the axis is enabled.	Wiring of the Hall signals with relation to the motor's power wiring is incorrect.	Verify wiring of Hall signals (S1, S2, and S3) and power wires (U, V, and W).
Direct drive linear stage fails Hookup testing, but wiring is known to be correct.	Incorrect drive firmware.	Verify the Kinetix 6000 drive or, Kinetix 2000 drive has revision 1.96 or later firmware. Verify you are using version 16.00 or later of Logix software.

Operational Troubleshooting

Use this section to diagnose and correct troubles with a direct drive or ball screw driven linear stage after it has been commissioned. Read the entire section to understand the kinds of troubles you can encounter and the possible fixes.

The evaluation procedures for both the direct drive and ball screw linear stages helps you determine if faulty stage operation simply indicates a need to lubricate the stage or a more fundamental problem. To interpret error codes reported by the drive, refer to Troubleshooting for Ball Screw Linear Stages on page 73 or the drive manuals referenced on page 10.

Direct Drive Linear Stage Evaluation Procedure

1. Power down the drive system.
2. Disconnect the drive from the linear stage.

ATTENTION: Lockout and tagout input power before servicing the linear stage.

3. By hand, move the carriage through the entire range of motion. The carriage must move freely and smoothly.
4. If excessive resistance is felt, clean and relubricate the linear bearings.
5. Perform the procedures for a direct drive linear stage listed in the troubleshooting tables starting on page 72.
6. If the problem persists, return for factory evaluation and possible repair.

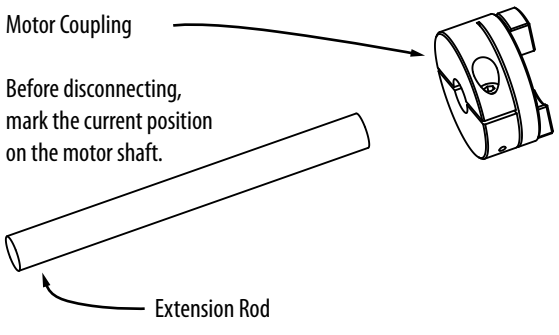
Ball Screw Linear Stage Evaluation Procedure

1. Power down the drive system.
2. Disconnect the drive from the linear stage.

ATTENTION: Lockout and tagout input power before servicing the linear stage.

3. Remove the rotary motor.
4. By hand, move the carriage through the entire range of motion. The carriage must move freely and smoothly.

TIP To make it easier to move a fine pitch stage, connect an 11 mm extension rod to the motor coupling. Move the stage by turning the extension with a hand wrench.



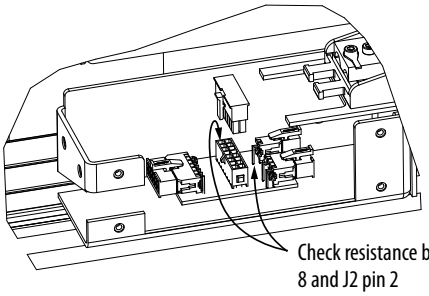
5. If excessive resistance is felt, clean and relubricate the linear bearings.
6. Perform the procedures for a ball screw linear stage listed in the troubleshooting tables starting on page 72.
7. If the problem persists, return for factory evaluation and possible repair.

ATTENTION: Lockout and tagout input power before servicing the linear stage.

Table 9 - Troubleshooting for Direct Drive or Ball Screw Linear Stages

Symptom	Possible Cause	Solution
Kinetix 6000 drive or Kinetix 2000 drive reporting error E19. Ultra3000 reporting error E19, E22, or E23.	For sealed stages excess friction can be caused by contamination on the strip seal.	Clean the strip seal with a clean, soft cloth wetted with isopropyl alcohol. If problem persists, replace strip seal. Refer to instructions for Strip Seal Removal on page 63 and Strip Seal Replacement on page 64.
	Stage received a large impact. The ball screw or linear bearings have become misaligned or there is damage to the rails.	Return stage to factory for evaluation and repair.
	Linear bearing has excess friction.	Refer to the Direct Drive Linear Stage Evaluation Procedure on page 71, or the Ball Screw Linear Stage Evaluation Procedure on page 71.

Table 10 - Troubleshooting for Direct Drive Linear Stages

Symptom	Possible Cause	Solution
Intermittent reporting of error E11, E07, or E20 by the drive.	Cable carrier module exceeds its useful life of 10,000,000 cycles and is starting to fail.	Replace cable carrier module. See Cable Carrier Assembly Removal on page 62 and Cable Carrier Assembly Installation on page 62.
Intermittent reporting of error E04 by the drive.	Ambient temperature of the stage exceeds 40 °C (104 °F).	Increase ventilation.
	Thermistor circuit is defective.	Disconnect the flex cable and probe the open Junction Box. At room temperature 25 °C (77 °F), verify the resistance of the circuit is 100…200 Ohms. If not in range, return for factory service.  Check resistance between J1 pin 8 and J2 pin 2 Refer to PTC Thermal Signal on page 42 for thermistor resistance values at other temperature ranges.
	Cable carrier module exceeds its useful life of 10,000,000 cycles and is starting to fail.	Replace cable carrier module. See Cable Carrier Assembly Removal on page 62 and Cable Carrier Assembly Installation on page 62.
Drive reporting error E07 or E20.	Environment is electrically noisy and cable shield is compromised.	Verify carrier cable module and extension cable shield termination are secure.

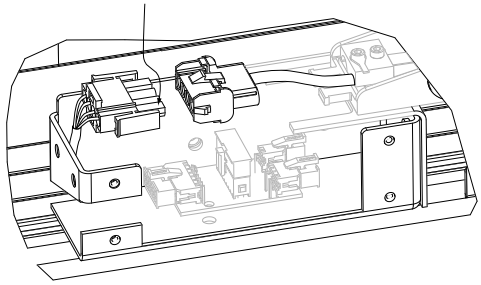
Symptom	Possible Cause	Solution
Drive reporting error E05.	Defective motor	Disconnect the flex cable and probe the Motor Power connector (white Mate-N-Lok) in the open Junction Box. 1. Measure the resistance between pins 1 and 2, pins 2 and 3, and pins 1 and 3, and evaluate the measurements with the following criteria: – The resistance values varies depending on the MPAS model, but must be less than 15 Ohms. – The difference between the three resistance measurements must be less than 1 Ohm. 2. There must be an open circuit between pins 1, 2, 3, and pin 4 (GND). If any measurement is not in range, return for factory service. Motor Power Connector Pin 1 
	Cable carrier module exceeds its useful life of 10,000,000 cycles and is starting to fail.	Replace cable carrier module. See Cable Carrier Assembly Removal on page 62 and Cable Carrier Assembly Installation on page 62.

Table 11 - Troubleshooting for Ball Screw Linear Stages

Symptom	Possible Cause	Solution
Carriage is not moving but the controls report axis motion.	Rotary motor coupling broken or slipping.	Remove rotary motor and verify integrity of coupling.
Excessive carriage play.	Motor coupling set screw is loose.	Tighten motor coupling set screw.
	Ball screw end blocks have excessive wear.	Return stage to factory for service.
Drive reporting error E05.	Motor is damaged.	Check that the phase-to-phase resistance of each motor phase. The resistance must be equal, and not shorted to ground or to the shield.
Kinetix 6000 drive or Kinetix 2000 drive reporting error E19. Ultra3000 drive reporting error E19, E22, or E23.	Brake on the motor does not release.	Manually release brake, and check that motor shaft is free to turn and the bearing feels smooth.

Notes:

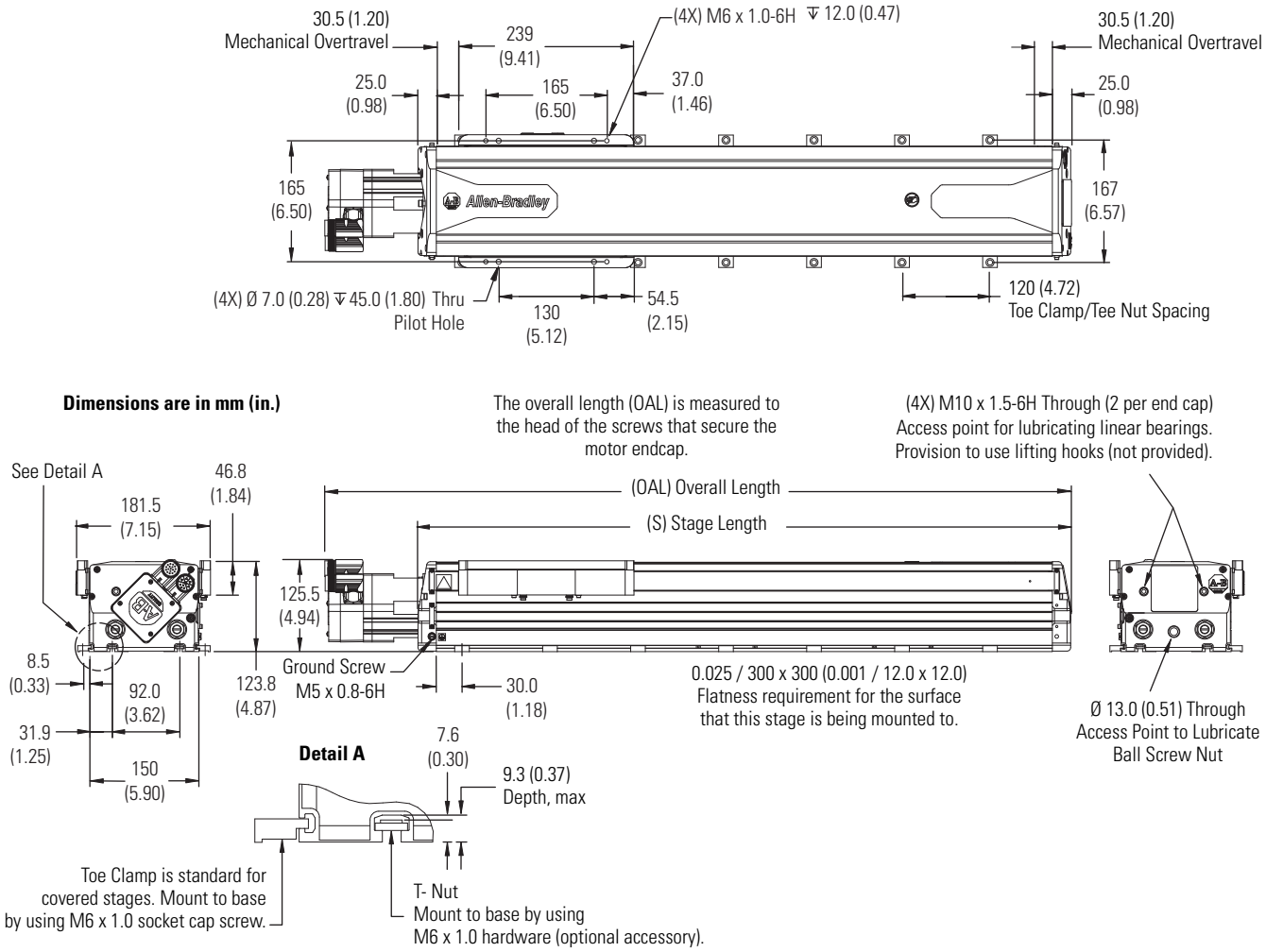
Dimensions

Associated Kinetix publications listed in Additional Resources on page 10 and information in product specifications can supersede the information in this appendix.

MP-Series Linear Stage Dimensions

Linear stages are designed to metric dimensions. Inch dimensions are conversions from millimeters. Untoleranced dimensions are for reference.

Figure 16 - MP-Series Linear Stages (MPAS-A/B6*xxx*1/2-V*xx*S*x*A)

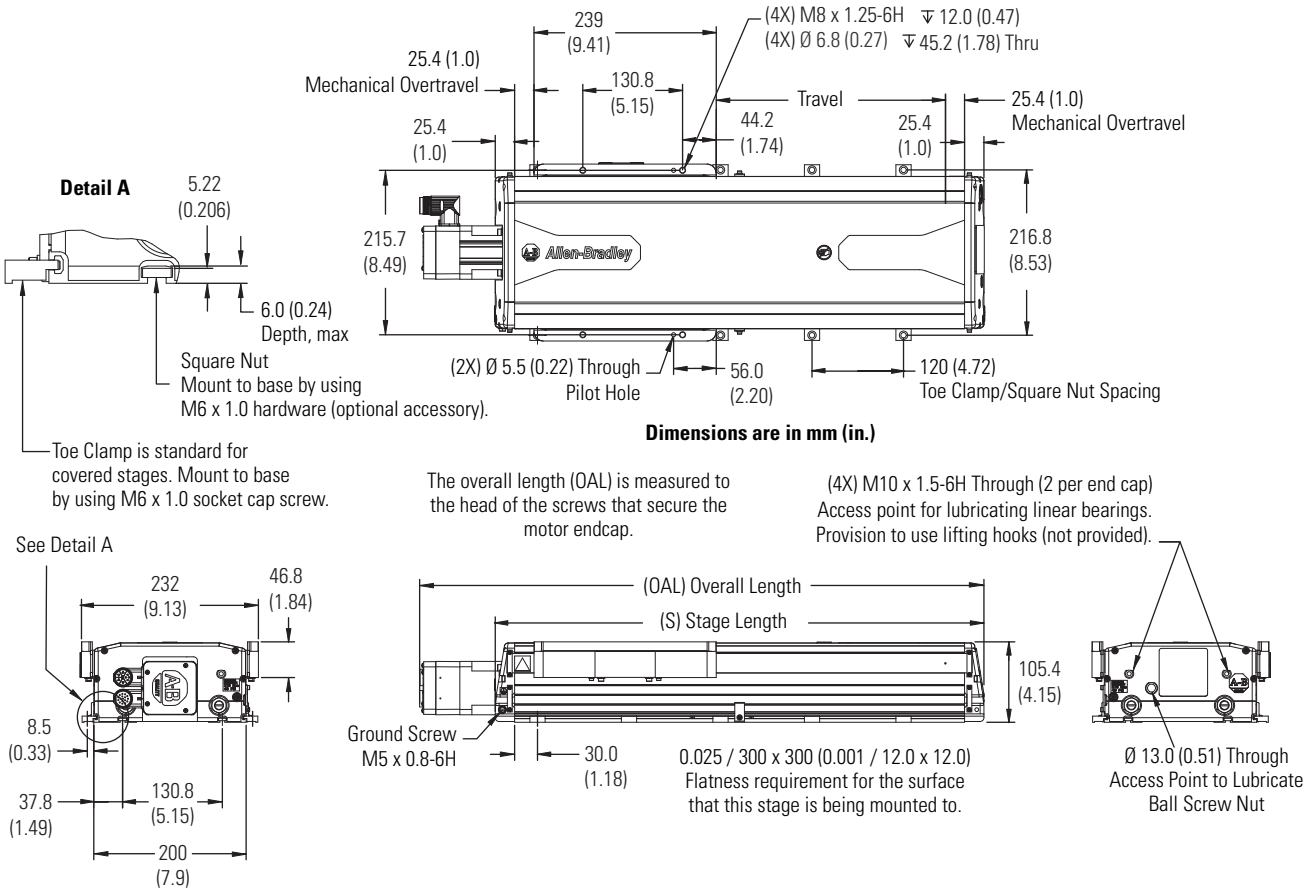


Cat. No. MPAS-	S mm (in.)	OAL (5 mm/rev) (1) mm (in.)	OAL (20 mm/rev) (2) mm (in.)
A/B6012*x*-V*xx*S*x*A	470 (18.5)	569 (22.4)	594 (23.4)
A/B6018*x*-V*xx*S*x*A	530 (20.9)	629 (24.8)	654 (25.7)
A/B6024*x*-V*xx*S*x*A	590 (23.2)	689 (27.1)	714 (28.1)
A/B6030*x*-V*xx*S*x*A	650 (25.6)	749 (29.5)	774 (30.5)

Cat. No. MPAS-	S mm (in.)	OAL (5 mm/rev) (3) mm (in.)	OAL (20 mm/rev) (2) mm (in.)
A/B6036*x*-V*xx*S*x*A	710 (28.0)	809 (31.9)	834 (32.8)
A/B6042*x*-V*xx*S*x*A	770 (30.3)	869 (34.2)	894 (35.2)
A/B6054*x*-V*xx*S*x*A	890 (35.0)	989 (38.9)	1014 (39.9)
A/B6066*x*-V*xx*S*x*A	1010 (39.8)	1109 (43.7)	1134 (44.6)

(1) If MPAS-A/B6*xxx*-V05S4A linear stage with brake, add 39 mm (1.53 in.) to dimension OAL.
(2) If MPAS-A/B6*xxx*-V20S4A linear stage with brake, add 39 mm (1.53 in.) to dimension OAL.
(3) If MPAS-A/B6*xxx*-V05S4A linear stage with brake, add 39 mm (1.53 in.) to dimension OAL.

Figure 17 - MP-Series Linear Stages (MPAS-A/B8*xxx*1/2-V*xx*S*x*A)



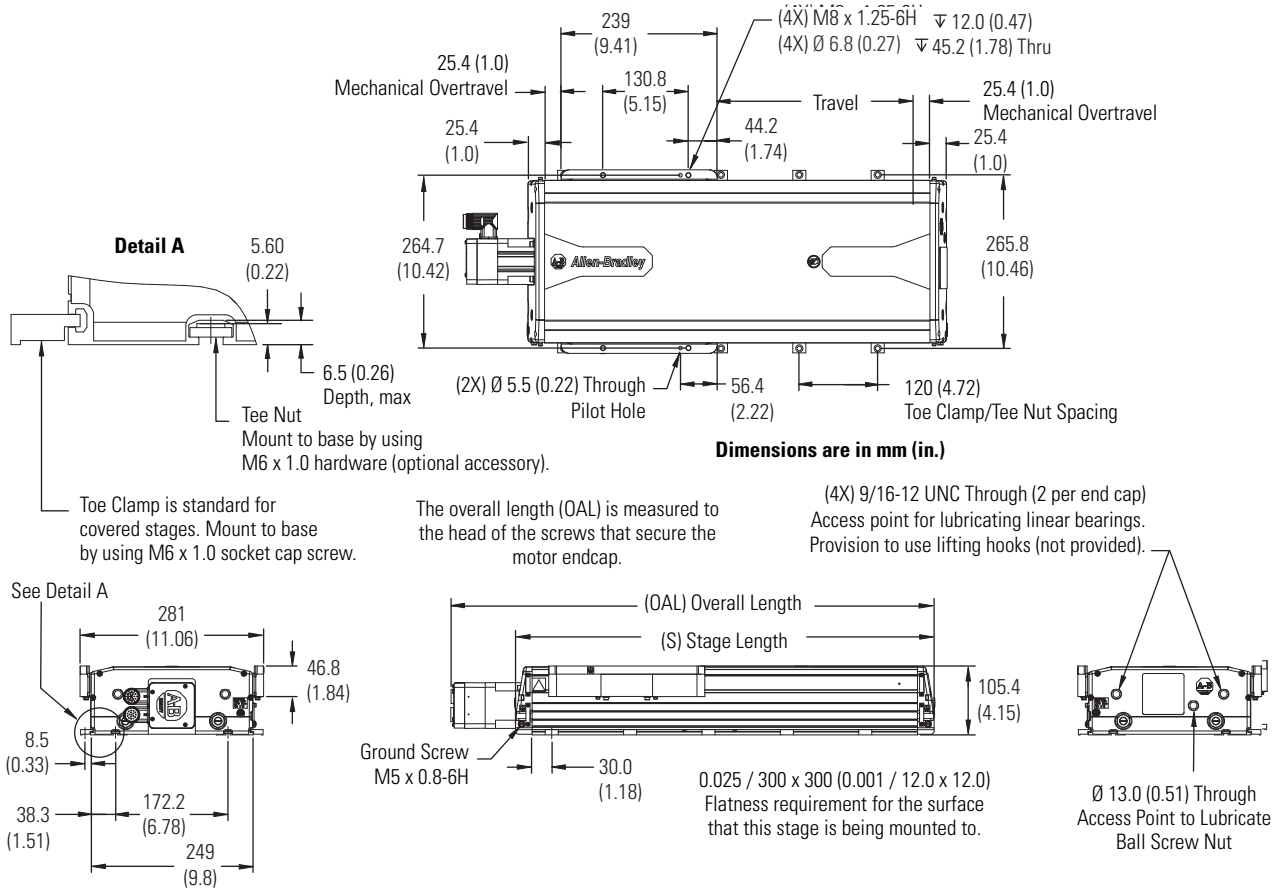
Cat. No. MPAS-	S mm (in.)	OAL (5 mm/rev) (1) mm (in.)	OAL (20 mm/rev) (2) mm (in.)
A/B8012*x*-V*xx*S*x*A	461 (18.1)	557 (21.9)	582 (22.9)
A/B8018*x*-V*xx*S*x*A	521 (20.5)	617 (24.3)	642 (25.3)
A/B8024*x*-V*xx*S*x*A	581 (22.9)	677 (26.6)	702 (27.6)
A/B8030*x*-V*xx*S*x*A	641 (25.2)	737 (29.0)	762 (30.0)
A/B8036*x*-V*xx*S*x*A	701 (27.6)	797 (31.4)	822 (32.4)
A/B8042*x*-V*xx*S*x*A	761 (29.9)	857 (33.7)	882 (34.7)

Cat. No. MPAS-	S mm (in.)	OAL (5 mm/rev) (1) mm (in.)	OAL (20 mm/rev) (2) mm (in.)
A/B8054*x*-V*xx*S*x*A	881 (34.7)	977 (38.5)	1002 (39.5)
A/B8066*x*-V*xx*S*x*A	1001 (39.4)	1097 (43.2)	1122 (44.2)
A/B8078*x*-V*xx*S*x*A	1121 (44.1)	1217 (47.9)	1242 (48.9)
A/B8090*x*-V*xx*S*x*A	1241 (48.8)	1337 (52.6)	1362 (53.6)
A/B8102*x*-V*xx*S*x*A	1361 (53.6)	1457 (57.4)	1482 (58.4)

(1) If MPAS-A/B6*xxx*-V05S4A linear stage with brake, add 39 mm (1.53 in.) to dimension OAL.

(2) If MPAS-A/B6*xxx*-V20S4A linear stage with brake, add 39 mm (1.53 in.) to dimension OAL.

Figure 18 - MP-Series Linear Stages (MPAS-A/B9*xxx*1/2-V*xx*S*x*A)

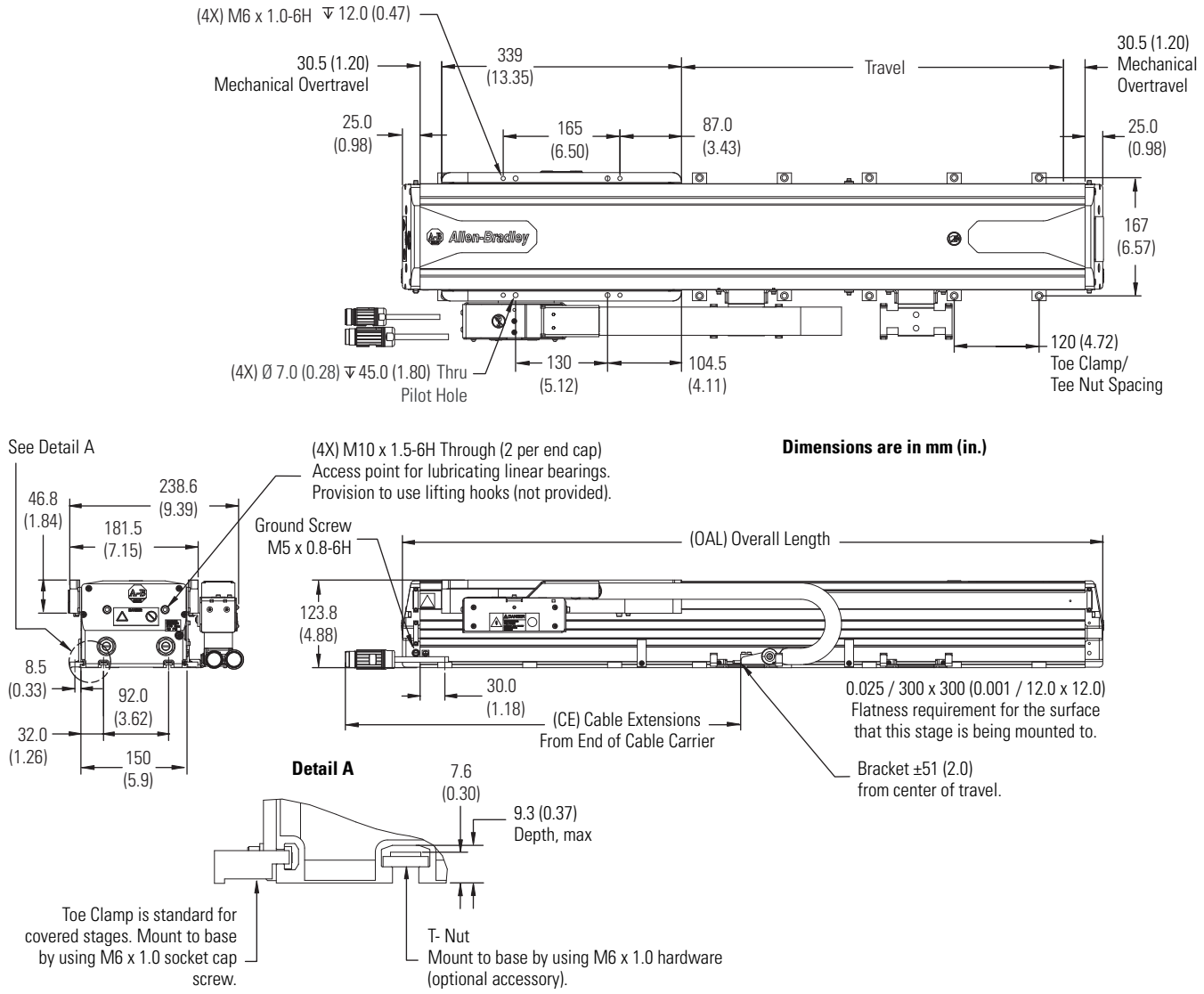


Cat. No. MPAS-	S mm (in.)	OAL (5 mm/rev) (1) mm (in.)	OAL (20 mm/rev) (2) mm (in.)
A/B9012*x*-V*xx*S*x*A	461 (18.1)	557 (21.9)	582 (22.9)
A/B9018*x*-V*xx*S*x*A	521 (20.5)	617 (24.3)	642 (25.3)
A/B9024*x*-V*xx*S*x*A	581 (22.9)	677 (26.6)	702 (27.6)
A/B9030*x*-V*xx*S*x*A	641 (25.2)	737 (29.0)	762 (30.0)
A/B9036*x*-V*xx*S*x*A	701 (27.6)	797 (31.4)	822 (32.4)
A/B9042*x*-V*xx*S*x*A	761 (29.9)	857 (33.7)	882 (34.7)

Cat. No. MPAS-	S mm (in.)	OAL (5 mm/rev) (1) mm (in.)	OAL (20 mm/rev) (3) mm (in.)
A/B9054*x*-V*xx*S*x*A	881 (34.7)	977 (38.5)	1002 (39.5)
A/B9066*x*-V*xx*S*x*A	1001 (39.4)	1097 (43.2)	1122 (44.2)
A/B9078*x*-V*xx*S*x*A	1121 (44.1)	1217 (47.9)	1242 (48.9)
A/B9090*x*-V*xx*S*x*A	1241 (48.8)	1337 (52.6)	1362 (53.6)
A/B9102*x*-V*xx*S*x*A	1361 (53.6)	1457 (57.4)	1482 (58.4)

(1) If MPAS-A/B6*xxx*-V05S4A linear stage with brake, add 39 mm (1.53 in.) to dimension OAL.
(2) If MPAS-A/B6*xxx*-V20S4A linear stage with brake, add 39 mm (1.53 in.) to dimension OAL.
(3) If MPAS-A/B6*xxx*-V20S4A linear stage with brake, add 39 mm (1.53 in.) to dimension OAL.

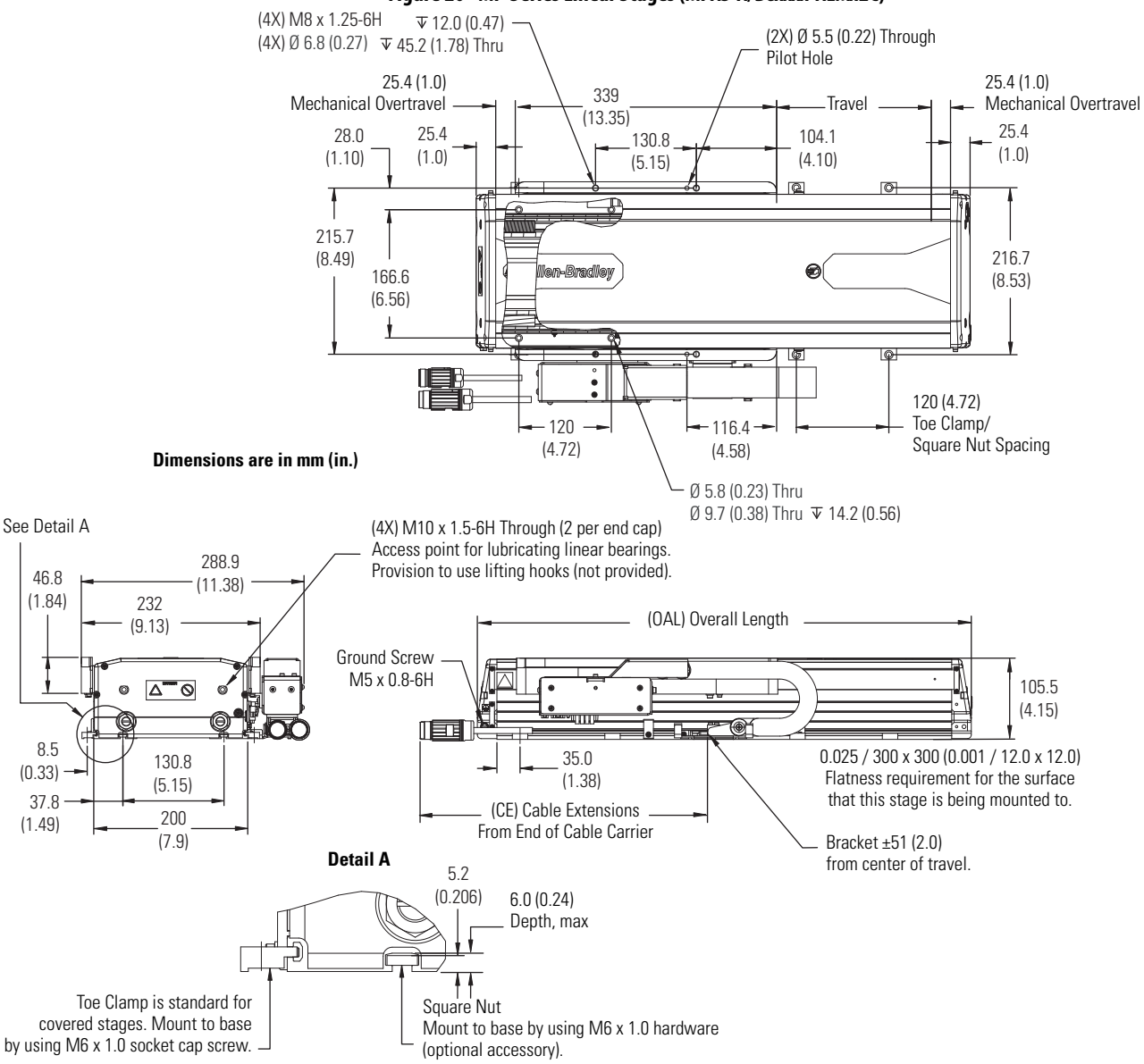
Figure 19 - MP-Series Linear Stages (MPAS-A6*xxx*B-ALM*x*2C)



Cat. No. MPAS-	OAL mm (in.)	CE mm (in.)
A6012B-ALM*x*2C	570 (22.4)	1220 (48.0)
A6018B-ALM*x*2C	630 (24.8)	1190 (47.0)
A6024B-ALM*x*2C	690 (27.2)	1170 (46.0)
A6030B-ALM*x*2C	750 (29.5)	1120 (44.0)
A6036B-ALM*x*2C	810 (31.9)	1090 (43.0)
A6042B-ALM*x*2C	870 (34.3)	1070 (42.0)

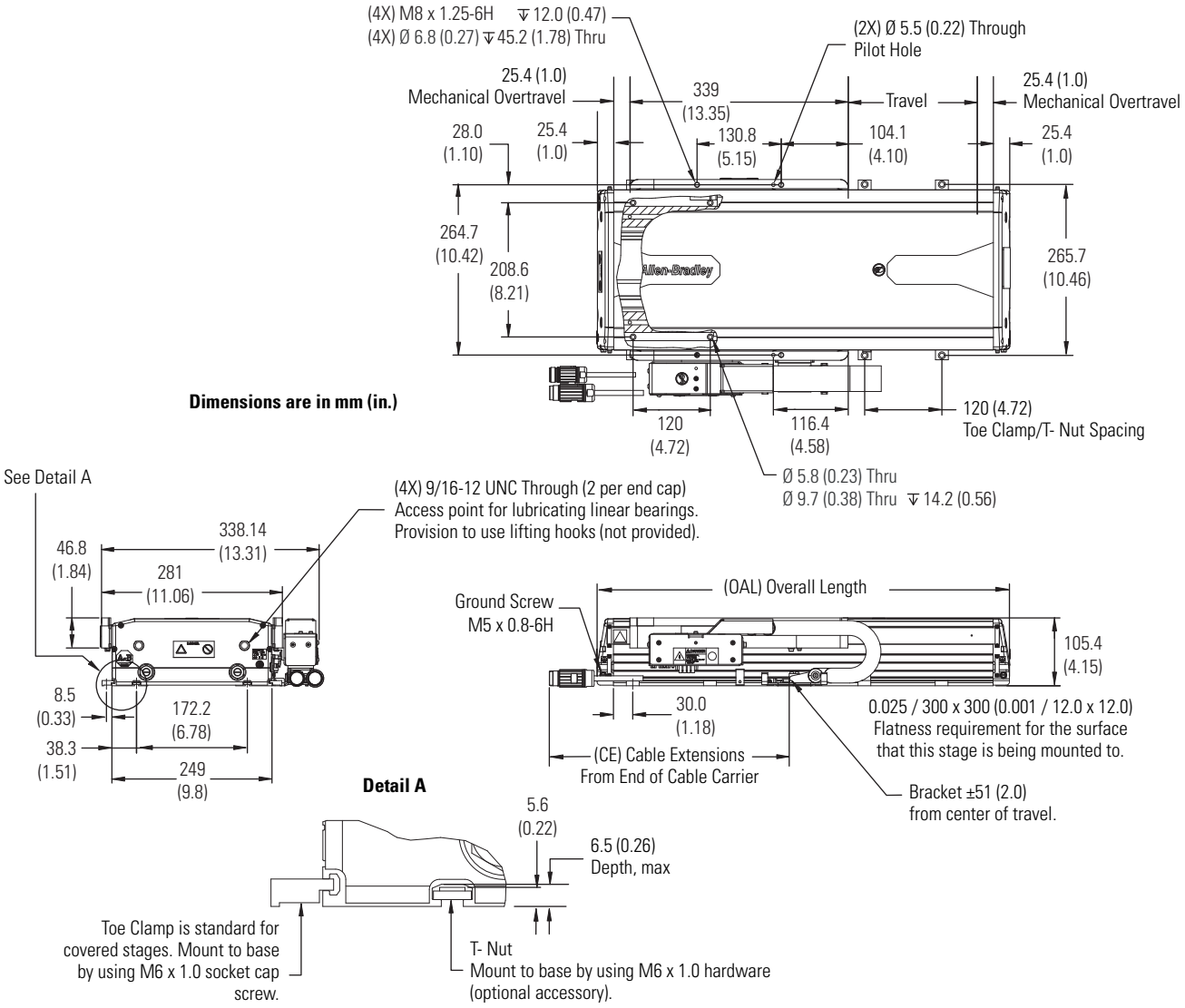
Cat. No. MPAS-	OAL mm (in.)	CE mm (in.)
A6054B-ALM*x*2C	990 (39.0)	1020 (40.0)
A6066B-ALM*x*2C	1110 (43.7)	940 (37.0)
A6078B-ALM*x*2C	1230 (48.4)	890 (35.0)
A6090B-ALM*x*2C	1350 (53.1)	810 (32.0)
A6102B-ALM*x*2C	1470 (57.9)	1780 (70.0)
A6114B-ALM*x*2C	1590 (62.6)	1720 (68.0)

Figure 20 - MP-Series Linear Stages (MPAS-A/B8*xxxx*-ALM*x*2C)



Cat. No. MPAS-	OAL mm (in.)	CE mm (in.)	Cat. No. MPAS-	OAL mm (in.)	CE mm (in.)	Cat. No. MPAS-	OAL mm (in.)	CE mm (in.)
A/B8014*x*-ALM*x*2C	581 (22.9)	1243 (49.0)	A/B8044*x*-ALM*x*2C	881 (34.7)	1093 (43.0)	A/B8104*x*-ALM*x*2C	1481 (58.3)	1793 (71.0)
A/B8020*x*-ALM*x*2C	641 (25.2)	1218 (48.0)	A/B8056*x*-ALM*x*2C	1001 (39.4)	1018 (40.0)	A/B8128*x*-ALM*x*2C	1721 (67.8)	1668 (66.0)
A/B8026*x*-ALM*x*2C	701 (27.6)	1168 (46.0)	A/B8068*x*-ALM*x*2C	1121 (44.1)	968 (38.0)	A/B8152*x*-ALM*x*2C	1961 (77.2)	1543 (61.0)
A/B8032*x*-ALM*x*2C	761 (30.0)	1143 (45.0)	A/B8080*x*-ALM*x*2C	1241 (48.9)	918 (36.0)	A/B8176*x*-ALM*x*2C	2201 (86.7)	1418 (56.0)
A/B8038*x*-ALM*x*2C	821 (32.3)	1118 (44.0)	A/B8092*x*-ALM*x*2C	1361 (53.6)	843 (33.0)	A/B8194*x*-ALM*x*2C	2381 (93.7)	1343 (53.0)

Figure 21 - MP-Series Linear Stages (MPAS-A/B9*xxxx*-ALM*x*2C)s



Cat. No. MPAS-	OAL mm (in.)	CE mm (in.)	Cat. No. MPAS-	OAL mm (in.)	CE mm (in.)	Cat. No. MPAS-	OAL mm (in.)	CE mm (in.)
A/B9014*x*-ALM*x*2C	581 (22.9)	1243 (49.0)	A/B9044*x*-ALM*x*2C	881 (34.7)	1093 (43.0)	A/B9104*x*-ALM*x*2C	1481 (58.3)	1793 (71.0)
A/B9020*x*-ALM*x*2C	641 (25.2)	1218 (48.0)	A/B9056*x*-ALM*x*2C	1001 (39.4)	1018 (40.0)	A/B9128*x*-ALM*x*2C	1721 (67.8)	1668 (66.0)
A/B9026*x*-ALM*x*2C	701 (27.6)	1168 (46.0)	A/B9068*x*-ALM*x*2C	1121 (44.1)	968 (38.0)	A/B9152*x*-ALM*x*2C	1961 (77.2)	1543 (61.0)
A/B9032*x*-ALM*x*2C	761 (30.0)	1143 (45.0)	A/B9080*x*-ALM*x*2C	1241 (48.9)	918 (36.0)	A/B9176*x*-ALM*x*2C	2201 (86.7)	1418 (56.0)
A/B9038*x*-ALM*x*2C	821 (32.3)	1118 (44.0)	A/B9092*x*-ALM*x*2C	1361 (53.6)	843 (33.0)	A/B9194*x*-ALM*x*2C	2381 (93.7)	1343 (53.0)

Notes:

Accessories

Installation, Maintenance, and Replacement Kits

Accessories available for installing linear stages, replacing items, and performing maintenance at regular intervals are listed in the tables that follow.

Table 12 - Accessories Common to Ball Screw and Direct Drive Linear Stages

Description	Catalog Number	Comments
Grease Pump Maintenance Kit	MPAS-GPUMP	Includes grease pump, one grease cartridge, and all necessary tips.
Grease Cartridge	MPAS-CART	Refill cartridge for grease pump.
Toe Clamp Installation Kit	MPAS-TOE	10 toe clamps per package
Tee Nut Installation Kit	MPAS-6-TNUT	10 Tee nuts per package
	MPAS-8-TNUT	
	MPAS-9-TNUT	

Table 13 - Accessories for Ball Screw Linear Stages

Description	Catalog Number	Comments
Couplers	MPAS-6-COUP	
	MPAS-8-COUP	
	MPAS-9-COUP	
Rotary Servo Motors	MPLS-A210E-V-*x*246	230V non-brake motor for 5 mm/rev ball screw
	MPLS-A210E-V-*x*247	230V brake motor for 5 mm/rev ball screw
	MPLS-B210E-V-*x*248	460V non-brake motor for 5 mm/rev ball screw
	MPLS-B210E-V-*x*249	460V brake motor for 5 mm/rev ball screw
	MPLS-A220H-V-*x*250	230V non-brake motor for 20 mm/rev ball screw
	MPLS-A220H-V-*x*251	230V brake motor for 20 mm/rev ball screw
	MPLS-B220H-V-*x*252	460V non-brake motor for 20 mm/rev ball screw
	MPLS-B220H-V-*x*253	460V brake motor for 20 mm/rev ball screw
Strip Seal Replacement Kits	MPAS-6*xxx*1-SEAL	*xxx* = cm stroke: 012, 018, 024, 030, 036, 042, 054, or 066
	MPAS-8*xxx*1-SEAL	*xxx* = cm stroke: 012, 018, 024, 030, 036, 042, 054, 066, 078, 090, or 102
	MPAS-9*xxx*1-SEAL	*xxx* = cm stroke: 012, 018, 024, 030, 036, 042, 054, 066, 078, 090, or 102

Table 13 - Accessories for Ball Screw Linear Stages (continued)

Description	Catalog Number	Comments
Side Covers Replacement Kits	MPAS-6*xxx*1-SIDE	*xxx* = cm stroke: 012, 018, 024, 030, 036, 042, 054, or 066
	MPAS-8*xxx*1-SIDE	*xxx* = cm stroke: 012, 018, 024, 030, 036, 042, 054, 066, 078, 090, or 102
	MPAS-9*xxx*1-SIDE	*xxx* = cm stroke: 012, 018, 024, 030, 036, 042, 054, 066, 078, 090, or 102
Top Cover Replacement Kits	MPAS-6*xxx*1-TOP	*xxx* = cm stroke: 012, 018, 024, 030, 036, 042, 054, or 066
	MPAS-8*xxx*1-TOP	*xxx* = cm stroke: 012, 018, 024, 030, 036, 042, 054, 066, 078, 090, or 102
	MPAS-9*xxx*1-TOP	*xxx* = cm stroke: 012, 018, 024, 030, 036, 042, 054, 066, 078, 090, or 102

Table 14 - Accessories for Direct Drive Linear Stages

Description	Catalog Number	Comments
Cable Carrier Modules	MPAS-6*xxx*B-CABLE	*xxx* = cm stroke: 012, 018, 024, 030, 036, 042, 054, 066, 078, 090, 102, or 114
	MPAS-8*xxx*E-CABLE	*xxx* = cm stroke: 014, 020, 026, 032, 038, 044, 056, 068, 080, 092, 104, 128, 152, 176, or 194
	MPAS-9*xxx*K-CABLE	*xxx* = cm stroke: 014, 020, 026, 032, 038, 044, 056, 068, 080, 092, 104, 128, 152, 176, or 194
Strip Seal Replacement Kits	MPAS-6*xxx*B-SEAL	*xxx* = cm stroke: 012, 018, 024, 030, 036, 042, 054, 066, 078, 090, 102, or 114
	MPAS-8*xxx*E-SEAL	*xxx* = cm stroke: 014, 020, 026, 032, 038, 044, 056, 068, 080, 092, 104, 128, 152, 176, or 194
	MPAS-9*xxx*K-SEAL	*xxx* = cm stroke: 014, 020, 026, 032, 038, 044, 056, 068, 080, 092, 104, 128, 152, 176, or 194
Side Covers Replacement Kit	MPAS-6*xxx*B-SIDE	*xxx* = cm stroke: 012, 018, 024, 030, 036, 042, 054, 066, 078, 090, 102, or 114
	MPAS-8*xxx*E-SIDE	*xxx* = cm stroke: 014, 020, 026, 032, 038, 044, 056, 068, 080, 092, 104, 128, 152, 176, or 194
	MPAS-9*xxx*K-SIDE	*xxx* = cm stroke: 014, 020, 026, 032, 038, 044, 056, 068, 080, 092, 104, 128, 152, 176, or 194
Top Cover Replacement Kit	MPAS-6*xxx*B-TOP	*xxx* = cm stroke: 012, 018, 024, 030, 036, 042, 054, 066, 078, 090, 102, or 114
	MPAS-8*xxx*E-TOP	*xxx* = cm stroke: 014, 020, 026, 032, 038, 044, 056, 068, 080, 092, 104, 128, 152, 176, or 194
	MPAS-9*xxx*K-TOP	*xxx* = cm stroke: 014, 020, 026, 032, 038, 044, 056, 068, 080, 092, 104, 128, 152, 176, or 194

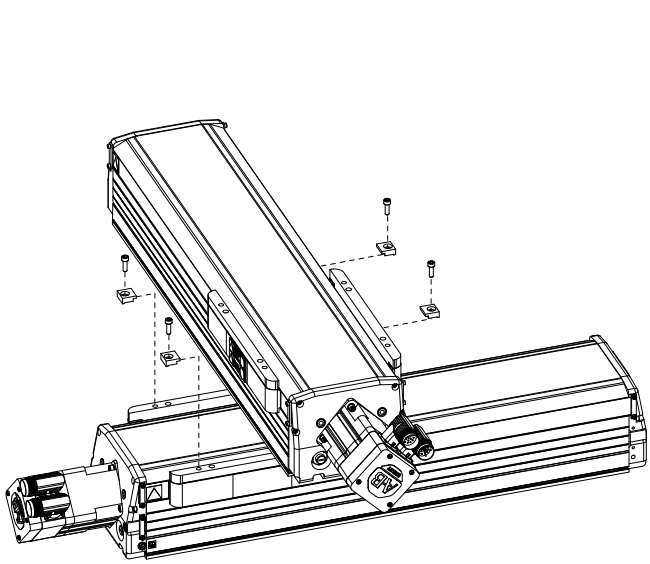
Stacking Stages

This appendix provides information about center-stacked stage configurations.

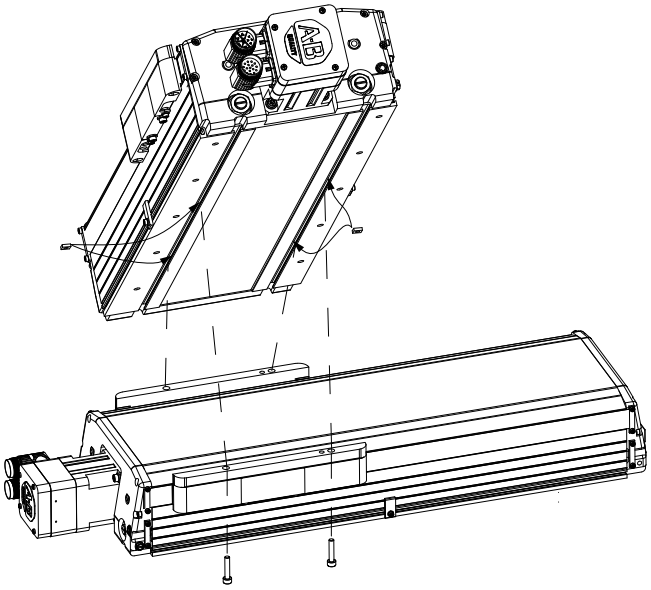
Stage Stacking

Certain combinations of MPAS linear stages are designed to be stacked on top of one another. Stacking forms an X-Y axis arrangement. A center-stack arrangement mounts the top axis in the middle of the bottom axis. The top stage is centered on the bottom stage.

Figure 22 - Stacking Stages



The MPAS-x6xxxx is capable of mounting to the top of another MPAS-x6xxxx by bolting through toe-clamps to the slide on the bottom stage.



The MPAS-x8xxxx is capable of mounting to the top of either a MPAS-x8xxxx or a MPAS-x9xxxx by bolting through the slide on the bottom stage and into T-nut slots on the top stage.

Specifications for Stacked Stages

Linear stage specifications are based on mounting the stage to a precision base along the entire length of the stage, and stage specifications follow this convention. In the case of stacked stages, the top axis is no longer supported along its entire length, and this alters both the precision and the load carrying capability of that stage. Furthermore, linear stage specifications are based on a specified test payload with a low center of gravity that is centered on the carriage. Deviations from the test payload condition impacts the performance of both the top and bottom linear stages.

The following table provides information about the payload that the top stage, or axis, can carry without derating the life of its bearings from those specified for the same stage mounted as a single-axis stage on a precision base.

Table 15 - Centered Stack Combinations Not Requiring Derating

Catalog Numbers of Centered Stack Linear Stages	Y-axis Travel	Allowable Mass of Payload (1)
MPAS-*x6xxxx* on MPAS-*x6xxxx* Ball Screw or Direct Drive	300	10.0 kg (22 lb)
	420	8.0 kg (17.6 lb)
	540	5.0 kg (11 lb)
	660	4.0 kg (8.8 lb)
MPAS-*x8xxxx* on MPAS-*x8xxxx* Direct Drive	320	14.0 kg (30.8 lb)
	560	6.5 kg (14.3 lb)
	800	3.0 kg (6.6 lb)
MPAS-*x8xxxx* on MPAS-*x9xxxx* Direct Drive	320	14.0 kg (30.8 lb)
	560	6.5 kg (14.3 lb)
	800	3.0 kg (6.6 lb)
MPAS-*x8xxxx* on MPAS-*x8xxxx* Ball Screw	300	14.0 kg (30.8 lb)
	540	6.5 kg (14.3 lb)
	780	3.0 kg (6.6 lb)
MPAS-*x8xxxx* on MPAS-*x9xxxx* Ball Screw	300	14.0 kg (30.8 lb)
	540	6.5 kg (14.3 lb)
	780	3.0 kg (6.6 lb)

(1) Payload is based solely on bearing and structure limitations.

For other stacking arrangements, please contact Rockwell Automation and ask for Application Engineering.

Interconnect Diagrams

This appendix provides wiring examples to assist you in wiring an Bulletin MPAS linear stage to a Allen-Bradley drive.

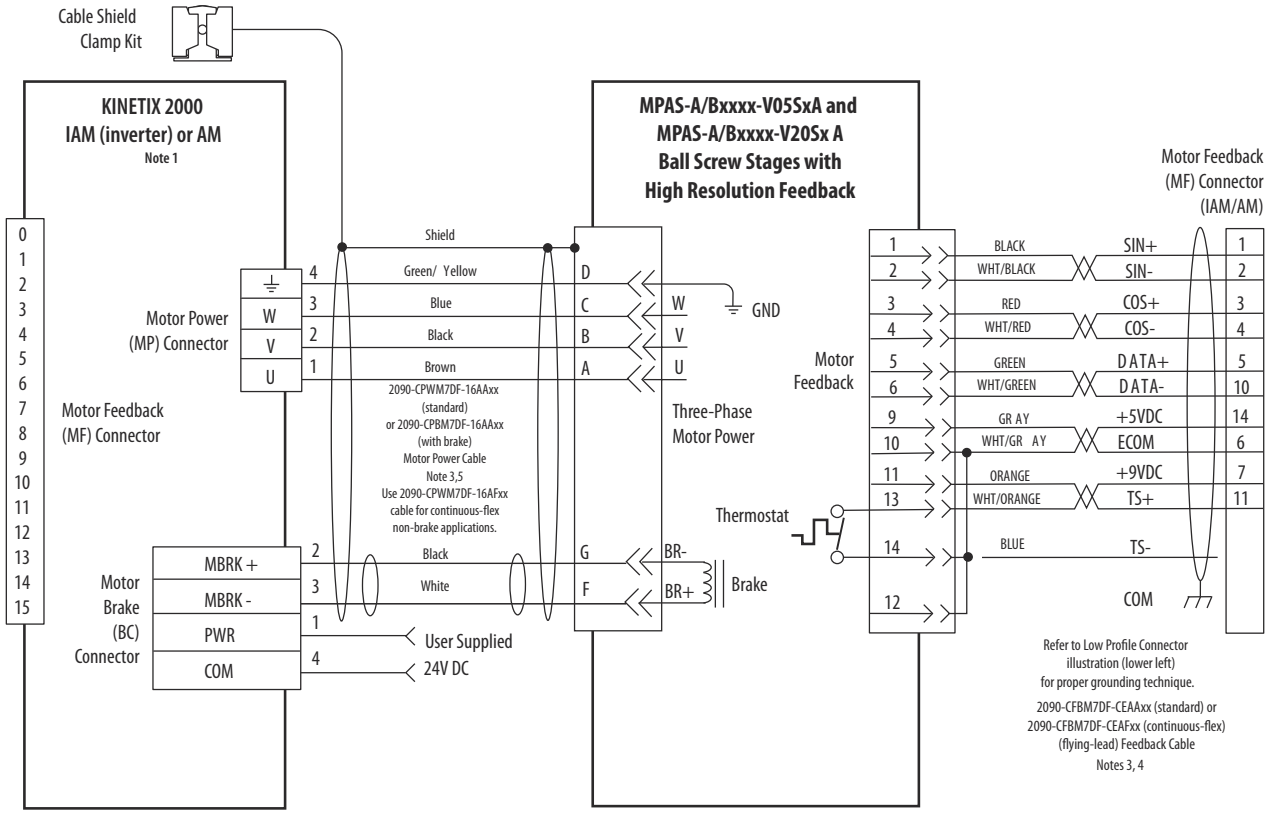
Wiring Examples

The notes below apply to the wiring examples on the pages that follow. Not all of the notes apply to each example.

Note	Information
1	Cable shield clamp must be used to meet CE requirements. No external connection to ground is required.
2	The Kinetix 2000 or Kinetix 6000 axis module referenced is either an individual axis module or the same axis module that resides within an multi-axis system.
3	For motor cable specifications, refer to the Kinetix Motion Control Accessories Technical Data, publication GMC-TD004.
4	MPAS-A*xxxxxx* encoders use the +5V DC supply. MPAS-B*xxxxxx* encoders use +9V DC.
5	Use a flyback diode for noise suppression of the motor brake coil of an Ultra3000 drive. For more information, refer to System Design for Control of Electrical Noise, publication GMC-RM001.

Motor/Axis Module Wiring Examples

Figure 23 - Wiring Examples for MP-Series Linear Stages and Kinetix 2000 Drives



Grounding Technicque for Feedback Cable Shield Connection to Drive

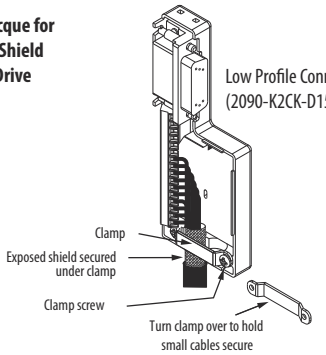


Figure 24 - Wiring Examples for MP-Series Linear Stages and Kinetix 6000 Drives

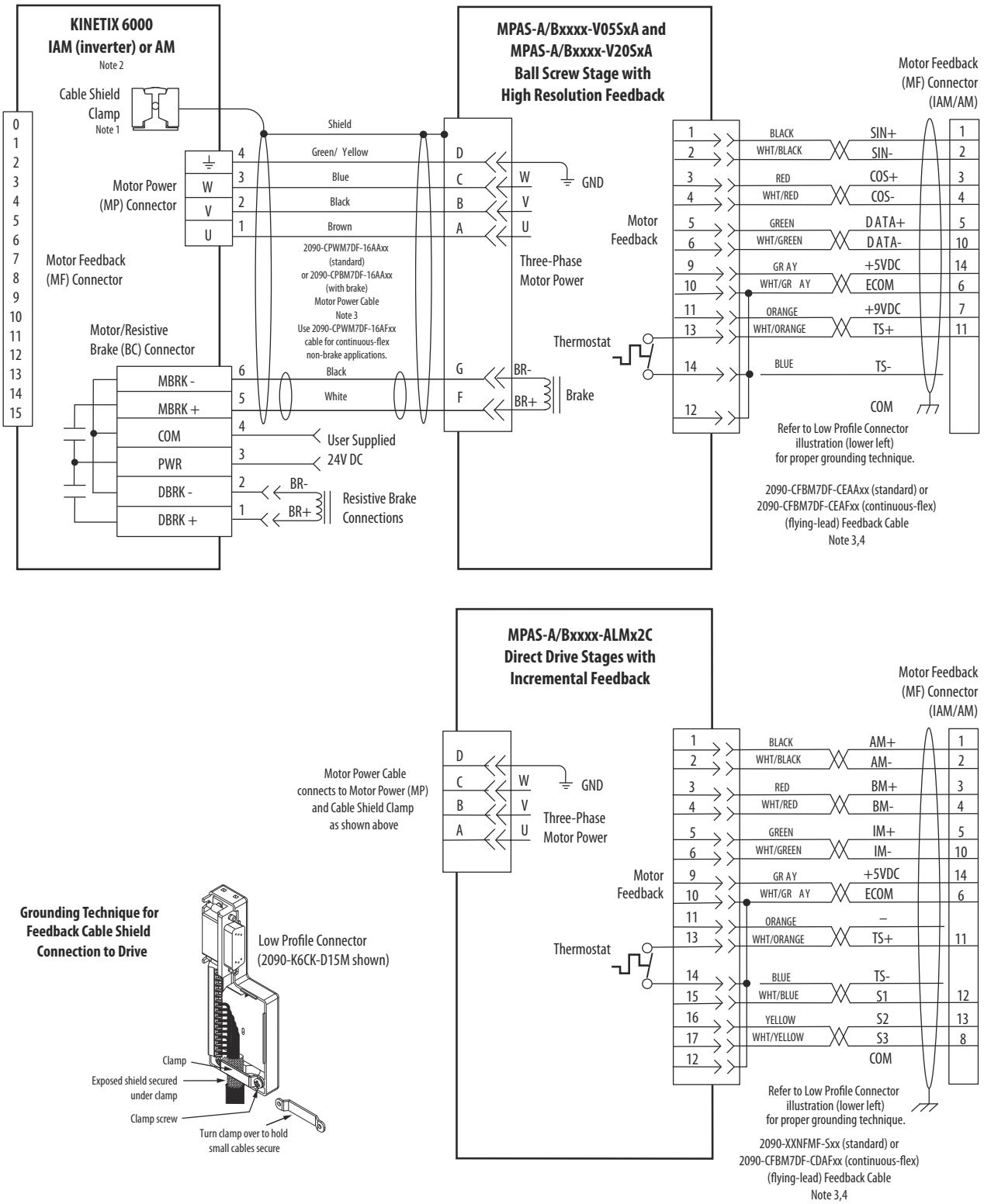
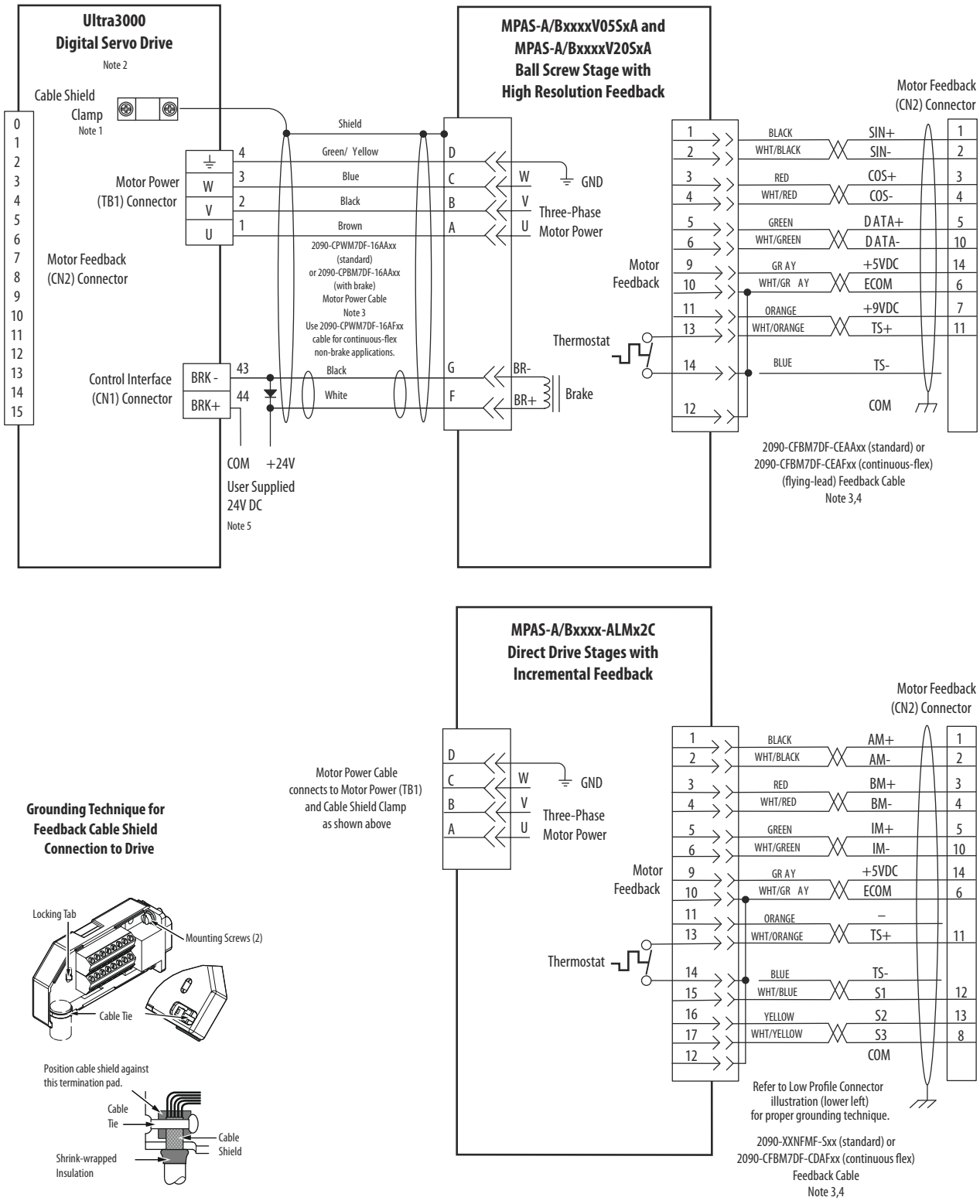


Figure 25 - Wiring Examples for MP-Series Linear Stages and Ultra3000 Drives



Home to Torque-level Example

Use this appendix to become familiar with the Home to Torque-level sequence in RSLogix 5000 software, version 16.xx or later or the Logix Designer application, and the considerations required when using this homing method.

This document provides an example for a typical homing program routine. The example shown does not claim to be complete and does not apply to any specific application.

Applicable Drives

This information in this document applies to the following drives.

Drive Type	Catalog Number
Kinetix 2000	2093-AC05-MP*x*, 2093-AM*xx*
Kinetix 6000	2094-AC*xx*-M*xx*, 2094-AM*xx*, 2094-AC*xx*-M*xx*-S, 2094-AM*xx*-S, 2094-BC*xx*-M*xx*, 2094-BM*xx*, 2094-BC*xx*-M*xx*-S, 2094-BM*xx*-S

About Home to Torque-level Homing

Home to torque-level homing is a process that references a known position by monitoring torque while driving an axis into a mechanical hard-stop. Once the actual torque level reaches or exceeds a specified torque level for a set time of 500 ms, a status flag is set in the controller.

IMPORTANT	Because the process of home to torque-level requires axis motion, the axis homing mode must be configured as Active.

Figure 26 - Axis Properties - Homing Tab

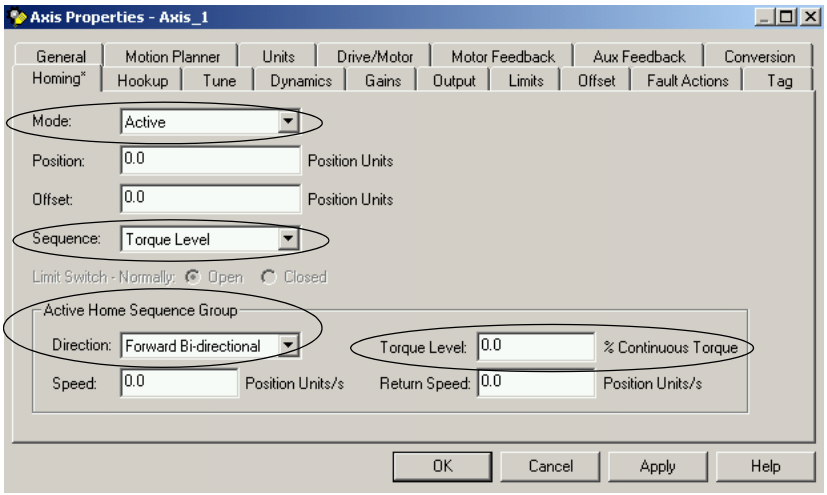


Table 16 - Torque-level Homing

Sequence Type	Description
Torque Level	Sets the Home Position after the output torque reaches the Torque Level value, reverses direction, and moves until the Homing Torque Above Threshold bit is low and the status bit sets.
Torque Level - Marker	Sets the Home Position after the output torque reaches the Torque Level value, reverses direction, and encounters an encoder marker.

When either the Torque Level or Torque Level - Marker homing option is selected on the Homing tab, the Torque Level field is activated in the Active Home Sequence Group. The units for this field are a percentage of the continuous torque of the motor (% Continuous Torque) limited by the drive-rated current/motor-rated current ratio. This number is interpreted in the drive as an absolute value and the range is 0 through the TorqueLimitPositive value.

The options for the Direction field when Torque Level or Torque Level - Marker homing sequence is selected are only Forward Bi-directional and Reverse Bi-directional. Uni-directional homing is not possible, because the Home to Torque-level sequence relies on a mechanical hard-stop.

Figure 27 - Position/Velocity Diagram for Torque-level Homing

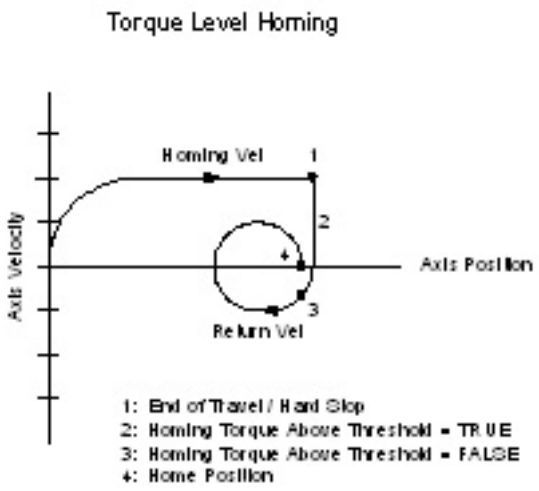
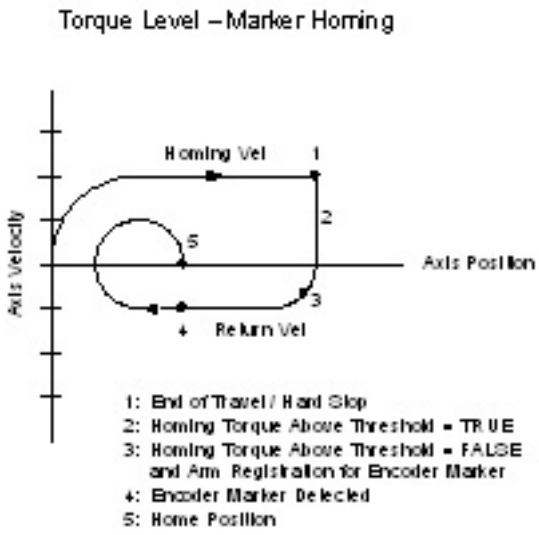


Figure 28 - Position/Velocity Diagram for Torque-level - Marker Homing



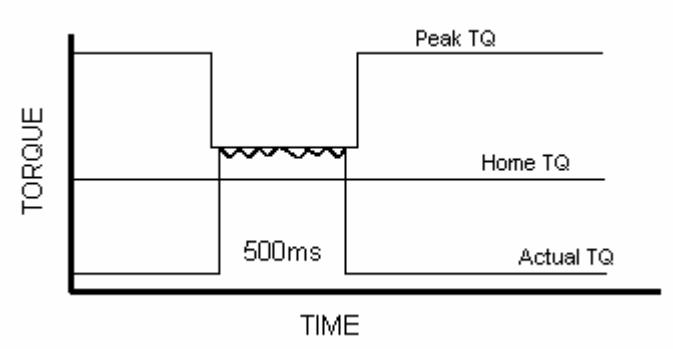
Drive Bipolar Torque Limit Adjustment

When homing an axis to a mechanical hard-stop, set the Home Torque-level value above the torque value required to move the system, but low enough not to cause problems with the system mechanics. As part of the process of homing to a torque limit, limit the Peak Torque value to a level 10% above the Home Torque value to reduce the stresses on the mechanics and to eliminate the chance of an over-current error.

IMPORTANT	The 10% value is an estimated starting point. This value can need adjustment based on the application requirements.

Limit the Peak Torque value before issuing the homing instruction (MAH) and reset the Peak Torque field to the original value after homing completes.

Figure 29 - Bipolar Torque Limit Adjustment



Disable Soft Overtravel Limit

If the application requires the use of soft-overtravel limits (Limits tab) to safeguard the system mechanics, disable the Soft Travel Limits for the axis to home. The Soft Travel Limits are disabled to prevent an error from occurring during the homing operation, but re-enable them after homing completes.

IMPORTANT	Those responsible for the application must determine when it is safe and appropriate to disable soft-overtravel checking.

Ladder Code Example

This example shows how to adjust the peak torque limit and disable the soft-overtravel limit checking when homing to a torque limit. The code uses a state model methodology in that each rung of code needs to complete successfully before moving to the next rung.

IMPORTANT	Because the home to torque-level sequence relies on the mechanical end of travel for operation, Uni-directional homing is not possible. You must choose between Forward Bi-directional or Reverse Bi-directional.

Rung 11 of the ladder code checks to make sure that the axis position, after homing, is within the Soft Travel Limits before re-enabling soft-overtravel limit checking. In this example a 1.15 cm Offset move is configured in the Homing tab and that is the final home position. The 0.5 cm is within the Soft Travel Limits set on the Limits tab.

Table 17 - Tags Used

Tag Name	Data Type	Description
Saved_FaultConfig	DINT	Storage location for FaultConfigurationBits (motion attributes) Bit 0 = soft-overtravel limit checking
Clear_SoftOT_Mask	DINT	Set to -2. This masks the off soft-overtravel enable bit without changing the other configuration bits.
Temp_FaultConfig	DINT	Temporary hold word for FaultConfigurableBits
SoftOT_Disabled	BOOL	Soft-overtravel checking disabled status bit
Saved_TQLim_Bipolar	REAL	Storage location for Peak Torque (TorqueLimitBipolar)
HomeTQ_Level	REAL	Home Torque Level from the Home tab in Axis Properties
Temp_TQLim_Bipolar	REAL	Temporary Peak Torque for Homing (10% higher than Home Torque Limit)
Axis_01_MI.MAH	MOTION_INSTRUCTION	Control for MAH instruction (by using a UDT)
Positive_Overtravel	REAL	Max Positive Soft-overtravel value
Negative_Overtravel	REAL	Max Negative Soft-overtravel value
Saved_PosErrorTol	REAL	Storage location for Actual Position Error value
Temp_PosErrorTol	REAL	Temporary Position Error value for Homing

Figure 30 - Axis Properties - Homing Tab

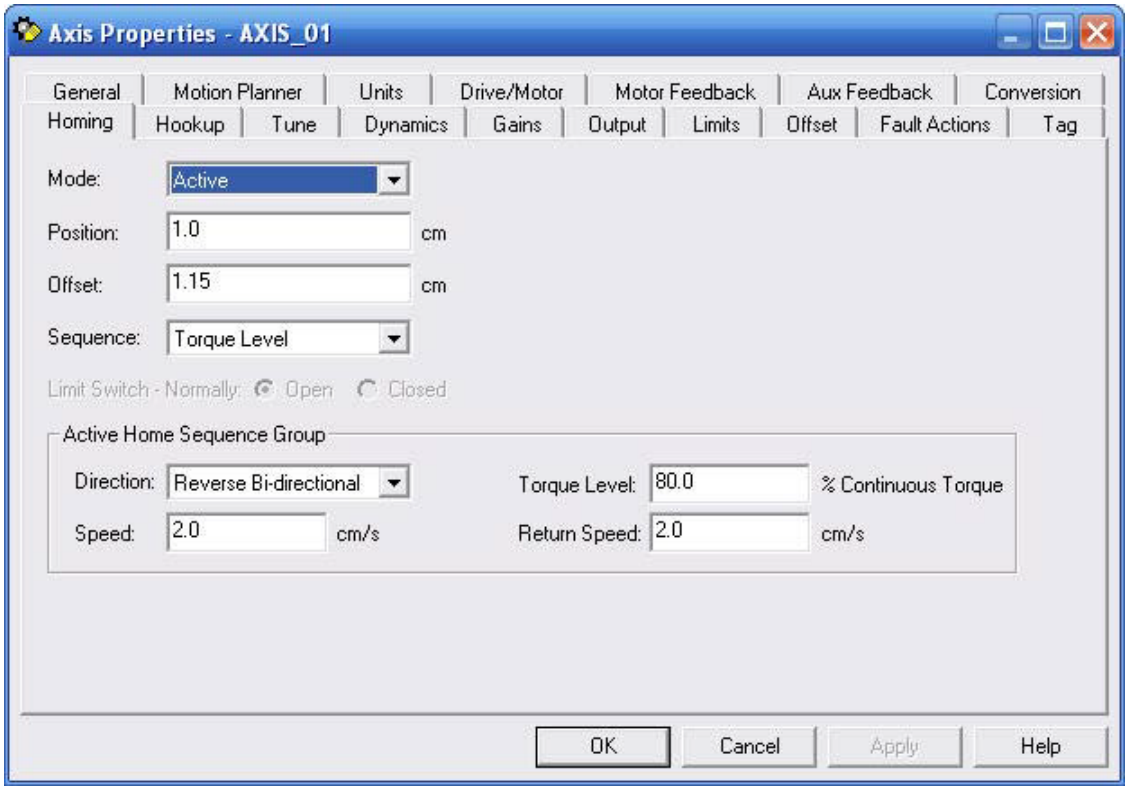


Figure 31 - Axis Properties - Limits Tab

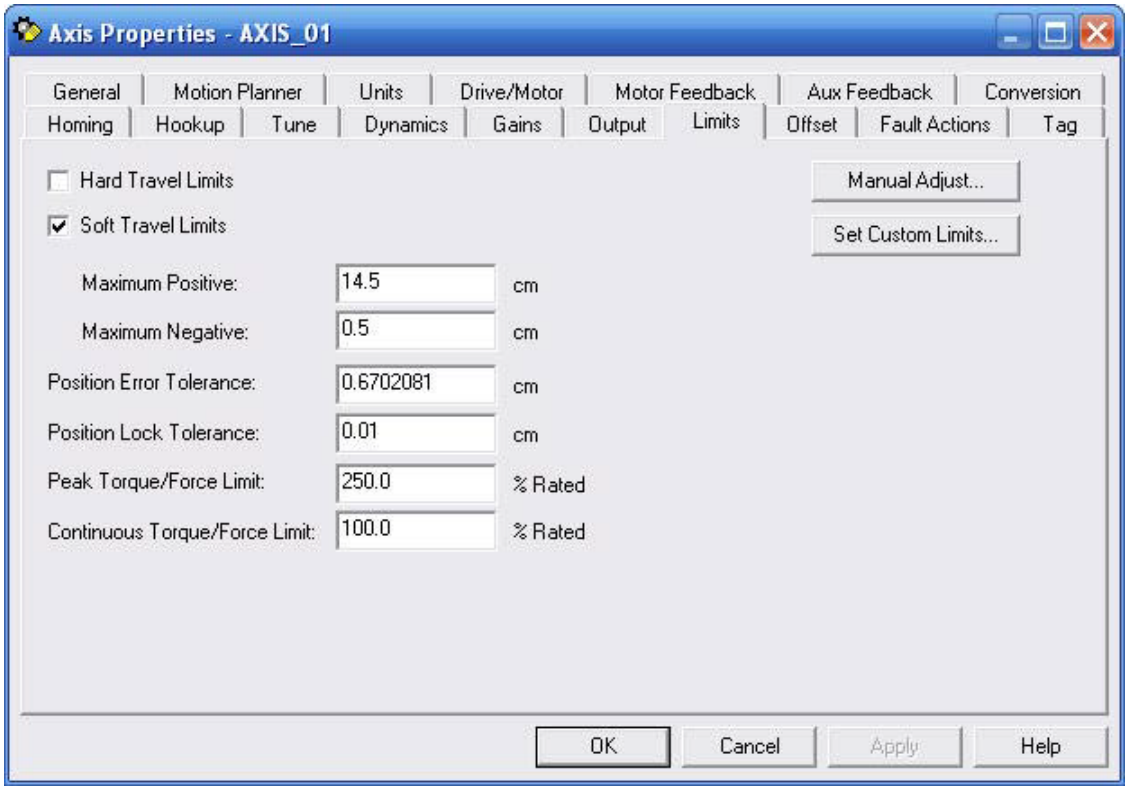


Figure 32 - Ladder Code Example

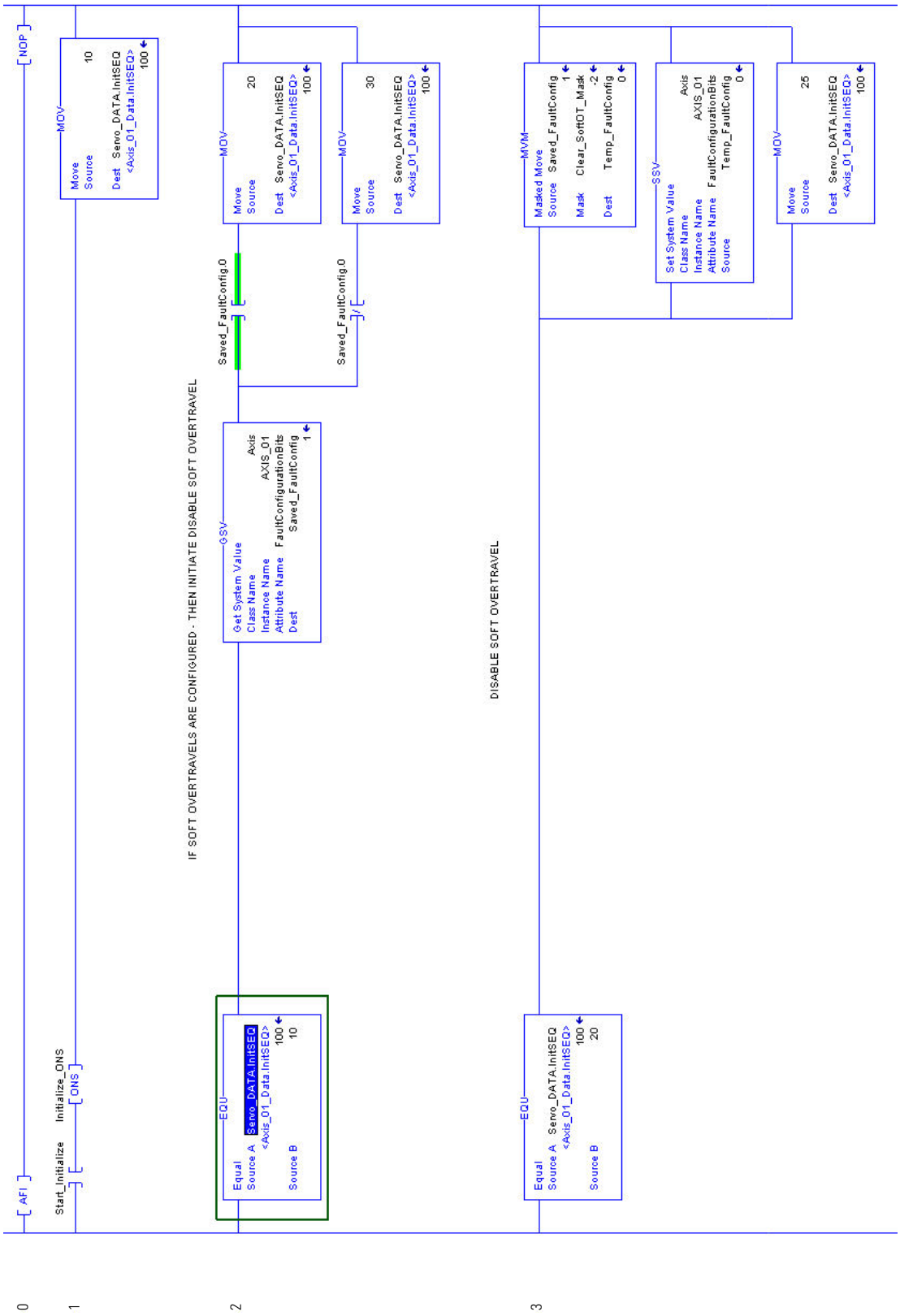


Figure 33 - Ladder Code Example, continued

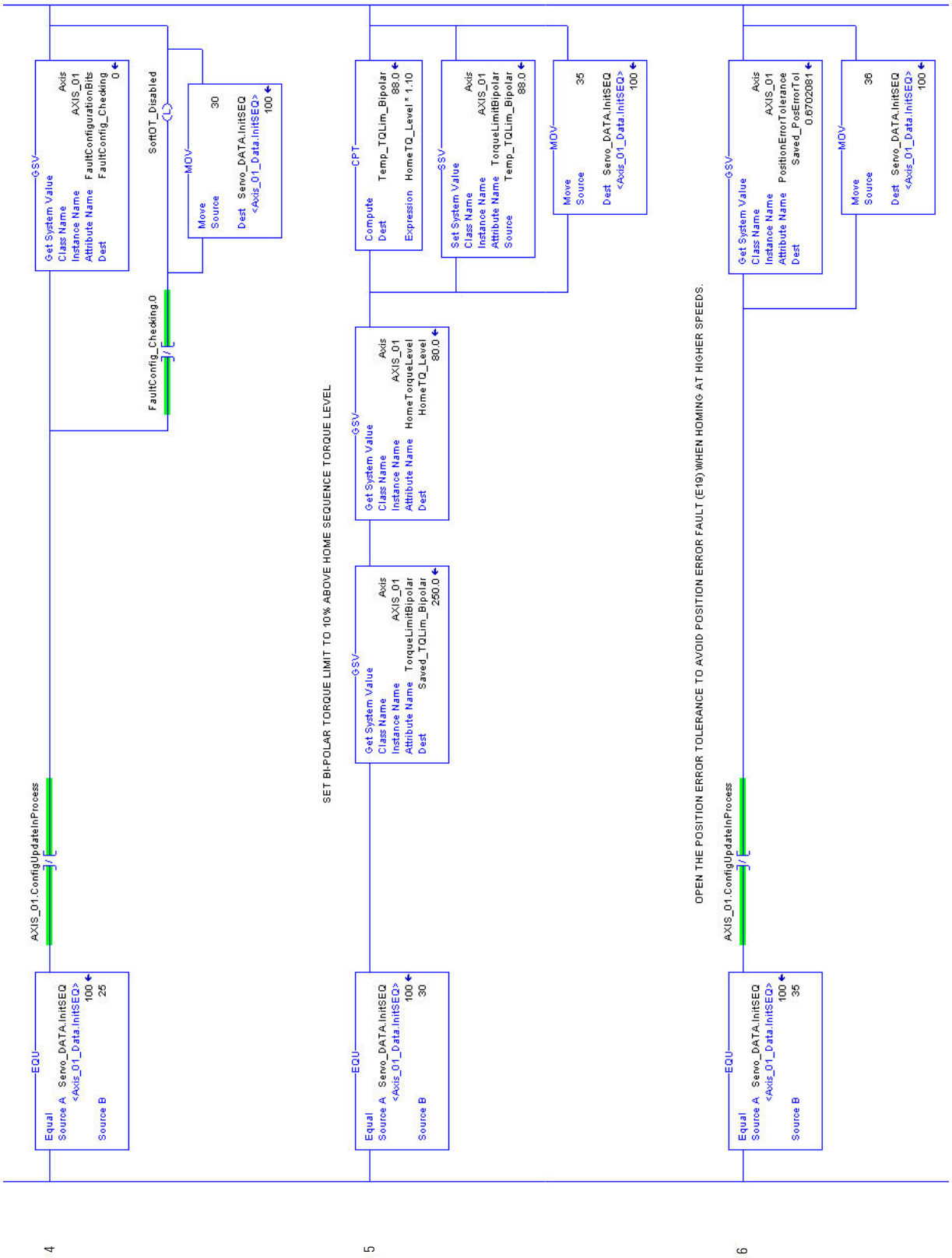


Figure 34 - Ladder Code Example, continued

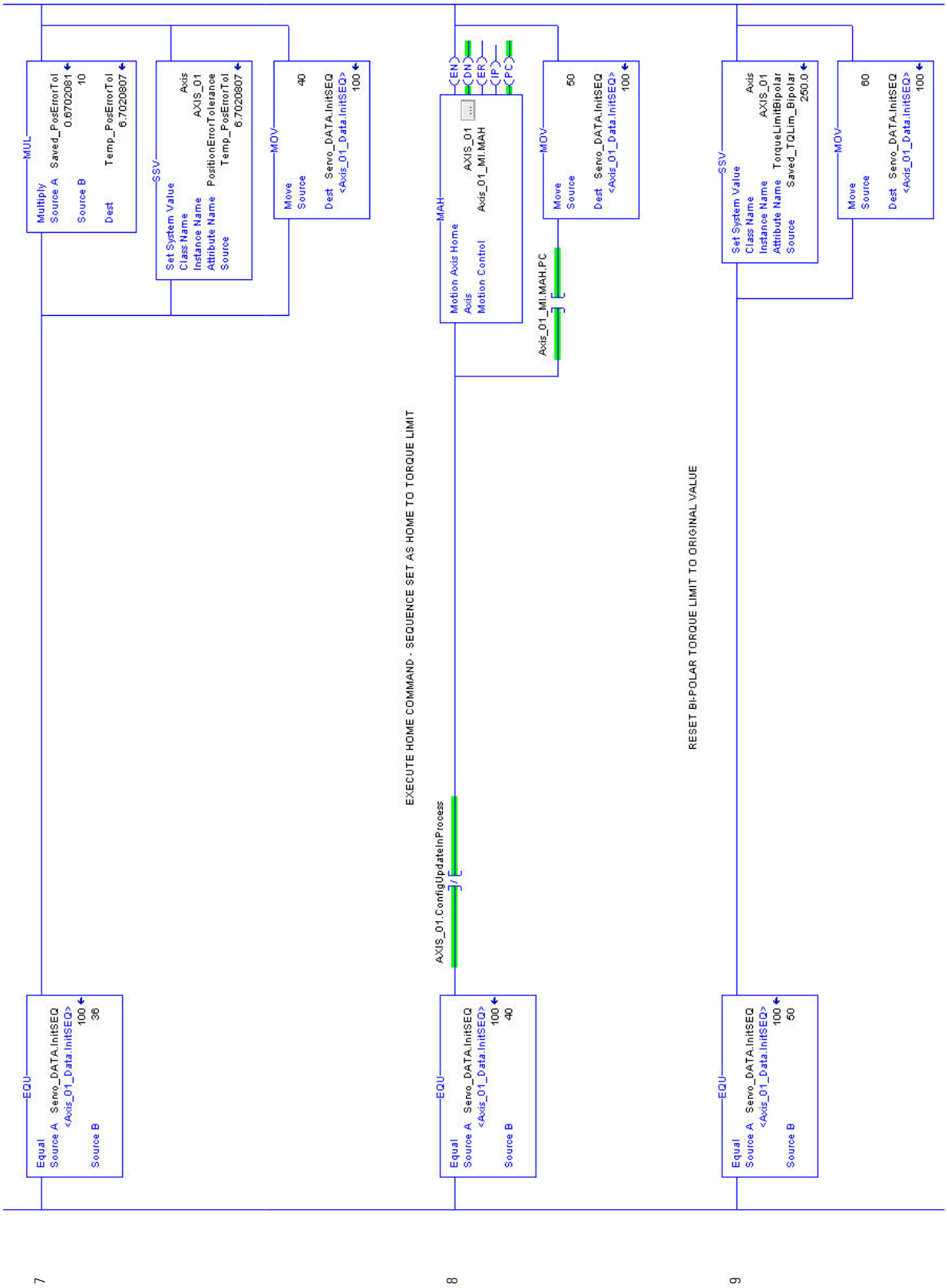


Figure 35 - Ladder Code Example, continued

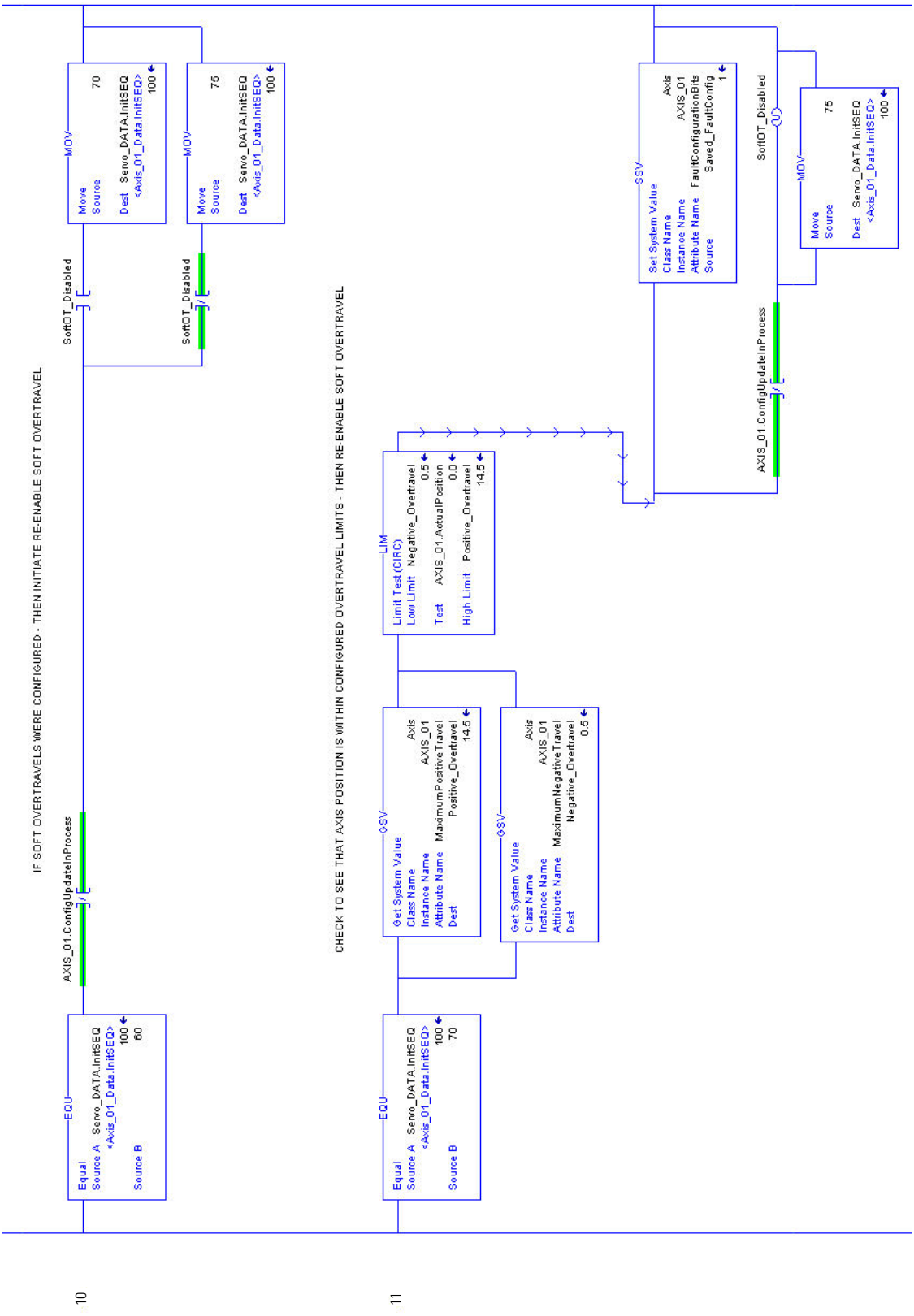
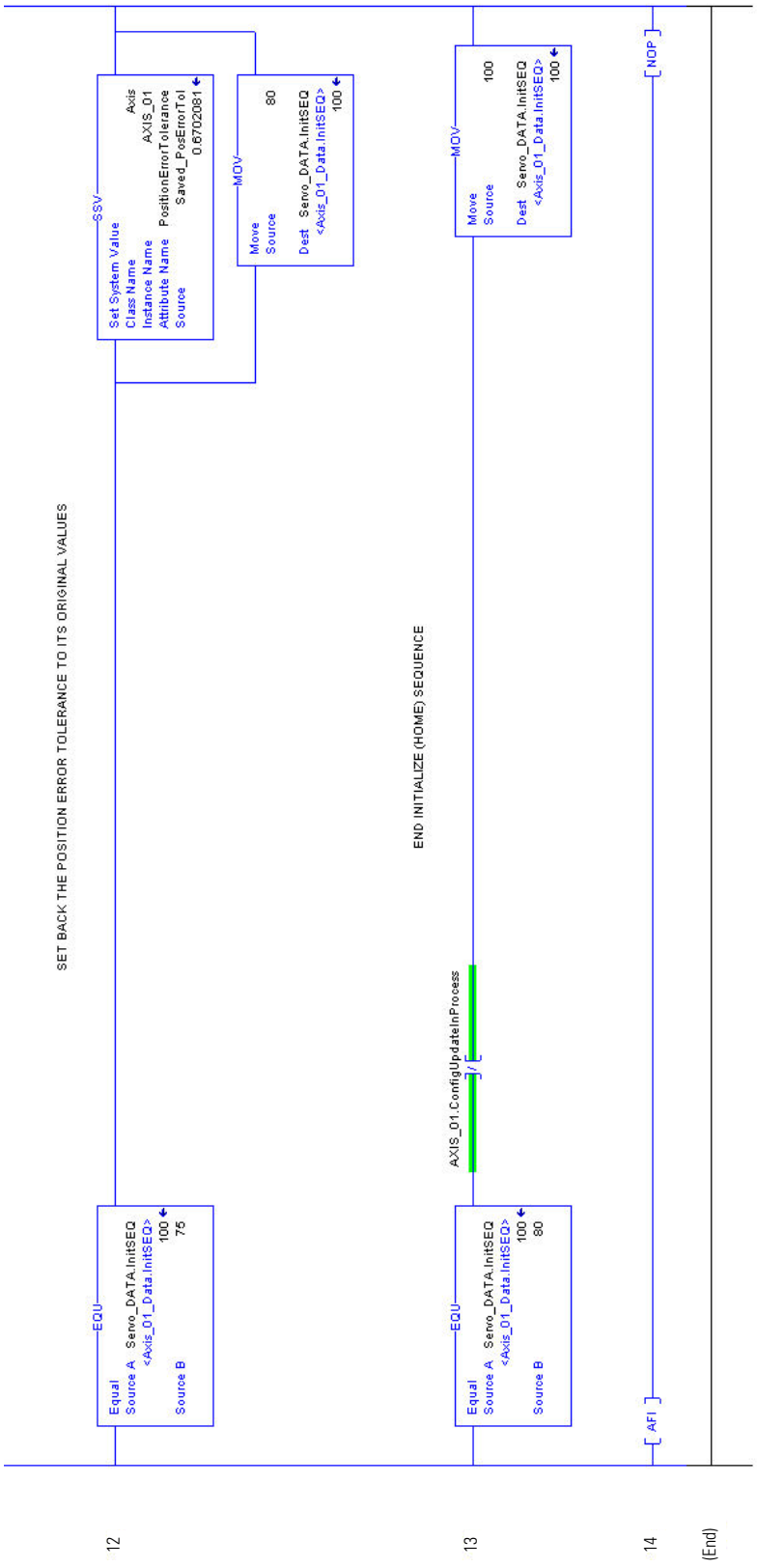


Figure 36 - Ladder Code Example, continued



Potential for Position Error

When executing a torque limit homing procedure there is potential for a position error. As mentioned earlier, for the home to torque limit to complete, the output torque to the motor must reach or exceed the specified torque level for a set time of 500 ms. During this time the axis is against the mechanical hard-stop, and following error is increasing in the position loop. If the Position Error Tolerance value is exceeded before completion of the homing instruction, a Position Error (E19) results.

There are two ways to limit the occurrence of an E19.

- Set the Position Error Tolerance value on the Limits tab of the Axis Properties to a value high enough to eliminate an error from occurring.
- Modify the Position Error Tolerance value via an SSV instruction similar to the method used in code above to change the Bipolar Torque Limit.

TIP The second method is preferred because it temporarily sets Position Error Tolerance to a value appropriate for homing to a mechanical hard-stop and then resets it to the original value set in the Axis Properties dialog.

Rung 6 of the ladder code opens the Position Error window. This lets the Homing to complete without causing a Position Error. The original value is reset after Homing completes.

Mounting Bolts and Torque Values

This appendix provides typical torque values for standard and metric bolts.

Table 18 - Recommended Seating Torque for Metric Bolts

Bolt Size (Metric) (1)	Pitch	Plain	Cadmium Plated	Zinc
		N•m (lb•in.)	N•m (lb•in.)	N•m (lb•in.)
M1.6 (2)	0.35	0.29 (2.6)	0.22 (1.95)	0.41(3.64)
M2 (2)	0.40	0.60 (5.3)	0.45 (3.98)	0.84 (7.42)
M2.5 (2)	0.45	1.24 (11)	0.93 (8.25)	1.74 (15.4)
M3	0.5	2.15 (19)	1.61 (14.25)	3.00 (26.6)
M4	0.7	4.6 (41)	3.47 (30.75)	6.48 (57.4)
M5	0.8	9.6 (85)	7.20 (63.75)	13.4 (119)
M6	1.0	15.8 (140)	11.9 (105)	22.1 (196)
M8	1.25	39.5 (350)	29.7 (262.5)	55.4 (490)
M10	1.5	76.8 (680)	57.6 (510)	115.2 (1020)

(1) Mounting hardware is ISO 898/1 socket head cap bolt that meets or exceeds ANSI B113M, ISO 261, ISO 262 (only coarse series).
(2) Microsize bolt.

Table 19 - Recommended Seating Torque for Mild Steel Rb 87 or Cast Iron Rb 83

Bolt Size (1), (2)	UNC		UNF	
	Plain	Cadmium Plated	Plain	Cadmium Plated
	N•m (lb•in.)	N•m (lb•in.)	N•m (lb•in.)	N•m (lb•in.)
#0	—	—	0.24 (2.1) (3)	0.18 (1.6) (3)
#1	0.44 (3.89) (3)	0.53 (4.7) (3)	0.46 (4.1) (3)	0.34 (3.0) (3)
#2	0.71 (6.3) (3)	0.53 (4.7) (3)	0.76 (6.8) (3)	0.58 (5.1) (3)
#3	1.08 (9.6) (3)	0.81 (7.2) (3)	1.16 (10.3) (3)	0.87 (7.7) (3)
#4	1.52 (13.5) (3)	1.13 (10) (3)	1.67 (14.8) (3)	1.2 (11) (3)
#5	2.3 (20) (3)	1.7 (15) (3)	2.37 (21) (3)	1.8 (16) (3)
#6	2.8 (25) (3)	2.1 (19) (3)	3.2 (28) (3)	2.4 (21) (3)
#8	5.2 (46) (3)	3.8 (34) (3)	5.4 (48) (3)	4.1 (36) (3)
#10	7.6 (67) (3)	5.6 (50) (3)	8.6 (76) (3)	6.4 (57) (3)
1/4	17.8 (158) (3)	13.4 (119) (3)	20.3 (180) (3)	15.4 (136) (3)
5/16	36.8 (326) (3)	27.7 (245) (3)	40.7 (360) (3)	30.5 (270) (3)
3/8	65.5 (580) (3)	49.1 (435)	71.7 (635)	53.7 (476)
7/16	105 (930) (3)	78.9 (698) (3)	117.5 (1,040) (3)	88.1 (780) (3)
1/2	160 (1420) (3)	172.8 (1530) (3)	254.2 (2250)	190.9 (1690)) (3)

(1) Mounting hardware is 1960-series socket head cap bolt that meets or exceeds ANSI B18.3.

(2) Torque is based on 80,000 psi bearing stress under the head of the bolt.

(3) Denotes torque based on 100,000 psi tensile stress, with both threads up to one inch in diameter.

Table 20 - Recommended Seating Torque for Brass Rb 72

Bolt Size (1), (2)	UNC		UNF	
	Plain	Cadmium Plated	Plain	Cadmium Plated
	N•m (lb•in.)	N•m (lb•in.)	N•m (lb•in.)	N•m (lb•in.)
#0	—	—	0.24 (2.1) (3)	0.18 (1.6) (3)
#1	0.43(3.8) (3)	0.33 (2.9) (3)	0.46 (4.1)	0.34 (3.0) (3)
#2	0.71 (6.3) (3)	0.53 (4.7) (3)	0.77 (6.8) (3)	0.58 (5.1) (3)
#3	1.08 (9.6) (3)	0.81 (7.2) (3)	1.16 (10.3) (3)	0.87 (7.7) (3)
#4	1.52 (13.5) (3)	1.1 (10) (3)	1.67 (14.8) (3)	1.24 (11) (3)
#5	2.2 (20) (3)	1.7 (15) (3)	2.4 (21) (3)	1.8 (16) (3)
#6	2.8 (25) (3)	2.1 (19) (3)	3.2 (28) (3)	2.4 (21) (3)
#8	5.2 (46) (3)	3.8 (34)	5.4 (48) (3)	4.1 (36) (3)
#10	7.6 (67) (3)	5.6 (50) (3)	8.6 (76) (3)	6.4 (57) (3)
1/4	15.3 (136)	11.5 (102)	15.4 (136)	11.5 (102)
5/16	25.8 (228)	19.3 (171)	25.8 (228)	19.3 (171)
3/8	53.7 (476)	40.3 (357)	53.7 (476)	40.3 (357)
7/16	76.8 (680)	57.6 (510)	76.8 (680)	57.6 (510)

(1) Mounting hardware is 1960-series socket head cap bolt that meets or exceeds ANSI B18.3.
(2) Torque is based on 60,000 psi bearing stress under the head of the bolt.
(3) Denotes torques based on 100,000 psi tensile stress with both threads up to one inch in diameter.

Table 21 - Recommended Seating Torque for Aluminum Rb 72 (2024-T_4)

Bolt Size (1), (2)	UNC		UNF	
	Plain	Cadmium Plated	Plain	Cadmium Plated
	N•m (lb•in.)	N•m (lb•in.)	N•m (lb•in.)	N•m (lb•in.)
#0	—	—	0.24 (2.1) (3)	0.18 (1.6) (3)
#1	0.44 (3.8) (3)	0.33 (2.9) (3)	0.46 (4.1) (3)	0.34 3.0v
#2	0.71 (6.3) (3)	0.53 (4.7) (3)	0.77 (6.8) (3)	0.58 (5.1) (3)
#3	1.08 (9.6) (3)	0.81 (7.2) (3)	1.16 (10.3) (3)	0.87 (7.7) (3)
#4	1.52 (13.5) (3)	1.1 (10) (3)	1.67 (14.8) (3)	1.24 (11) (3)
#5	2.3 (20) (3)	1.7 (15) (3)	2.37 (21) (3)	1.8 (16) (3)
#6	2.8 (25) (3)	2.1 (19) (3)	3.2 (28) (3)	2.37 (21) (3)
#8	5.2 (46) (3)	3.8 (34) (3)	3.2 (48) (3)	4.1 (36) (3)
#10	7.6 (67) (3)	5.6 (50) (3)	8. 6 (76) (3)	6.4 (57) (3)
1/4	12.8 (113)	9.6 (85)	12.8 (113)	9.6 (85)
5/16	21.5 (190)	16.1 (143)	21.5 (190)	16.1 (143)
3/8	44.8 (397)	33.6 (298)	44.8 (397)	33.7 (298)
7/16	64.4 (570)	48.0 (425)	64.4 (570)	48.0 (425)
1/2	159.3 (1410)	119.8 (1060)	159.3 (1410)	119.8 (1060)

(1) Mounting hardware is 1960-series socket head cap bolt that meets or exceeds ANSI B18.3.
(2) Torque is based on 50,000 psi bearing stress under the head of the bolt.
(3) Denotes torques based on 100,000 psi tensile stress with both threads up to one inch in diameter.

A

B

C

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V

Notes:

Rockwell Automation Support

Rockwell Automation provides technical information on the Web to assist you in using its products. At http://www.rockwellautomation.com/support you can find technical and application notes, sample code, and links to software service packs. You can also visit our Support Center at https://rockwellautomation.custhelp.com/ for software updates, support chats and forums, technical information, FAQs, and to sign up for product notification updates.

In addition, we offer multiple support programs for installation, configuration, and troubleshooting. For more information, contact your local distributor or Rockwell Automation representative, or visit http://www.rockwellautomation.com/services/online-phone.

Installation Assistance

If you experience a problem within the first 24 hours of installation, review the information that is contained in this manual. You can contact Customer Support for initial help in getting your product up and running.

United States or Canada	1.440.646.3434
Outside United States or Canada	Use the Worldwide Locator at http://www.rockwellautomation.com/rockwellautomation/support/overview.page, or contact your local Rockwell Automation representative.

New Product Satisfaction Return

Rockwell Automation tests all of its products to help ensure that they are fully operational when shipped from the manufacturing facility. However, if your product is not functioning and needs to be returned, follow these procedures.

United States	Contact your distributor. You must provide a Customer Support case number (call the phone number above to obtain one) to your distributor to complete the return process.
Outside United States	Please contact your local Rockwell Automation representative for the return procedure.

Documentation Feedback

Your comments will help us serve your documentation needs better. If you have any suggestions on how to improve this document, complete this form, publication RA-DU002, available at http://www.rockwellautomation.com/literature/.

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