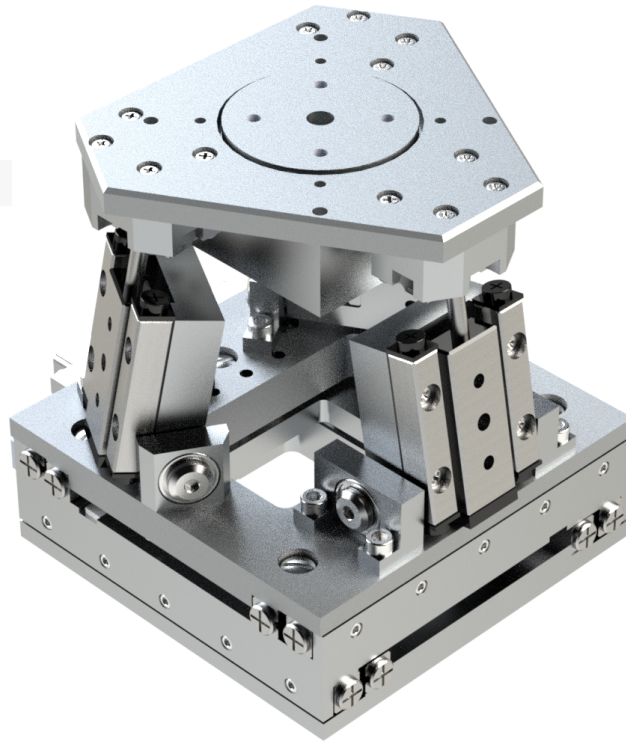


X-BOT-50

Series



6 Degree of Freedom Platform Reference Manual (Open and Closed Loop Versions)

X-BOT-50

Hexapod Positioning System Reference Manual

Rev 2.0

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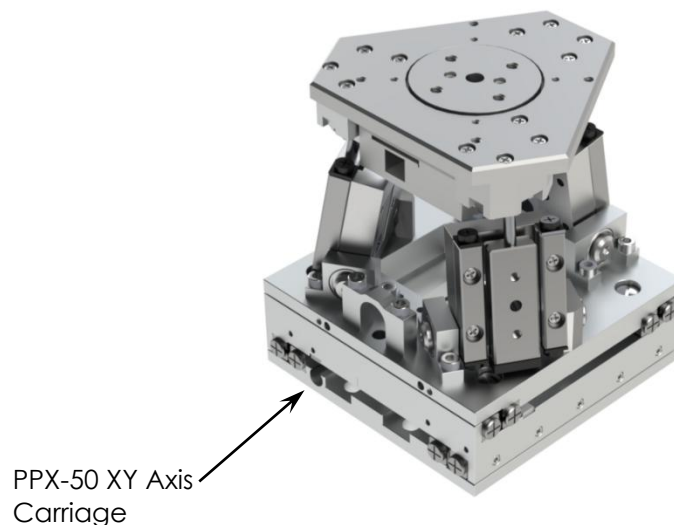
1. Introduction

1.1. Product Description

The X-BOT-50 is a miniature hexapod for the positioning and adjustment of precision components in 5 degrees of freedom (X, Y, Z, θ_x , and θ_y). It comes with software that includes inverse kinematics and allows for carriage positioning in degrees/mm. The X-BOT-50 is 57 mm tall and has sub-micron resolution. 360° z-rotation can be integrated into the carriage for 6 degrees of freedom (X, Y, Z, θ_x , θ_y , and θ_z). HV, UHV, and non-magnetic versions are available. Custom travel ranges are available upon request.

The 6th degree of freedom (θ_z) is achieved using the optional PR-20 rotational stage, which is factory-installed under the carriage. Refer to the [PR-20 Manual](#) for details about the PR-20.

Product Specifications	X&Y axes	Z-axis	θ_x & θ_y -axes
Travel from Center	± 14 mm	± 2.5 mm	$\pm 9^\circ$ by $\pm 10^\circ$ tilt
Max Speed (MMC-110)	5 mm/s		10°/s
Resolution (digital encoder)	<20 nm	<40 nm	100 μ°
Resolution (absolute encoder)	25 nm	N/A	200 μ°
Bi-directional Repeatability	± 200 nm		± 200 μ°
Max Load	2 N	3 N	2 N
Environment	Atmospheric, HV, UHV, Non-Magnetic		



X-BOT-50
(Shown at the minimum position)

1.2. Recommended Controllers

The X-BOT-50 includes a dedicated MMC-110 controller stack and MICRONIX HexaSoft™ software suite with each purchase. The MMC-110 is pre-configured for the X-BOT-50 and supports both open loop and closed loop operation with digital incremental and absolute BiSS-C encoder options. A separate controller is needed for the optional PR-20.

Controller	Compatible
<u>MMC-100</u>	—
<u>MMC-110</u>	✓
<u>NanoDrive</u>	—
<u>MMX-120</u>	—

For additional controller information, refer to the MMC-110 reference manual or visit the MICRONIX USA website.

1.3. Technical Data and Ordering Information

Detailed specifications and ordering information can be found on the [X-BOT-50](#) product page on the MICRONIX USA website (www.micronixusa.com).

2. Preparing to Install the X-BOT-50

2.1. Installation Cautionary Notes

When mounting the X-BOT system, it is important to consider the flatness of the mounting surface, as the X-BOT's base will conform to the shape of that surface. The stage's performance and structural integrity are impacted by the mounting flatness.

- Mount to a clean and flat surface that is free of debris, burrs or dings.
- Indoor atmosphere is free of corrosive gases, excessive dust, and condensation.
- Wear clean latex gloves when handling vacuum products. Nitrile gloves can be used for atmospheric products.
- The stage is located away from water, heat, and electrical noise.

2.2. Installation Requirements

The stages are calibrated to be within specification at $20^{\circ}\text{C} \pm 2^{\circ}\text{C}$ unless otherwise specified. Be sure to use the X-BOT-50 under the following requirements:

- Stage mounting surface flatness: less than $25\text{ }\mu\text{m}$ for optimal performance.
- Payload mounting surface flatness: $25\text{ }\mu\text{m}$ or better.
- Temperature range of $5\text{-}40^{\circ}\text{C}$.
- Relative humidity between 20-80%.

2.3. Product Handling

The X-BOT-50 stage is a precision mechanical device and should be handled with care.

- Do not drop or mishandle the stage.
- Use proper cable management to ensure a clean and safe operating environment.
- Properly connect the stage to the controller before powering on the controller. Failure to do so can result in damage to the stage.
- Allow for easy access to the stage in case of servicing.
- Do not de-rail the bearing as this will affect stage performance if re-installation is attempted. Please contact MICRONIX USA if this occurs.
- Do not touch with bare hands to avoid contaminating the motor friction surface and avoid contamination that could jeopardize the longevity of the stage.
- The stage is calibrated prior to shipment, and a calibration file is provided. Any adjustments to the stage could affect the axes and nullify the calibration file.
- For non-magnetic versions, which use ceramic bearings, do not forcibly move any of the stages against the end stops when manually moving the stage.

NOTE: Piezo stages use friction-based motion with ceramic components that are sensitive to oils. Wear powder-free nitrile gloves when handling the stage to avoid contamination.

NOTE: It is possible to gently move the carriage manually without damaging the stage.



WARNING: Keep hands clear of all moving parts while the stage is in motion to avoid personal injury.

2.4. **Package Contents**

The package contains all necessary components for the X-BOT-50 setup. If the product is damaged or there are missing components, contact MICRONIX USA immediately. Do not discard product packaging in case of return shipment.

Package Contents:

- X-BOT-50
- Reference Manual
- MMC-110
- USB drive with calibration file and HexaSoft™ (X-BOT Software Suite)
- Any agreed upon customizations, such as mounting hardware, controller additions, and software modifications.

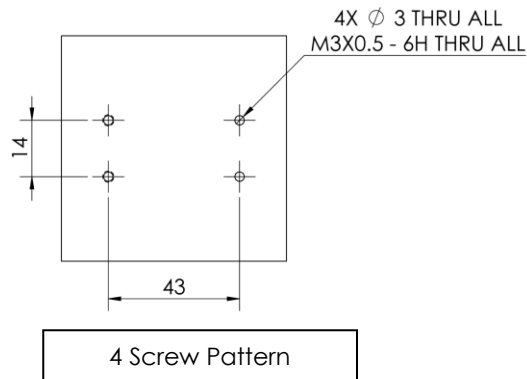
3. Installing the X-BOT-50

3.1. X-BOT-50 Installation

3.1.1. General Mounting Pattern

Mounting surface hole pattern (mm).

For best performance, the mounting surface should have a flatness of 25 μm or better.

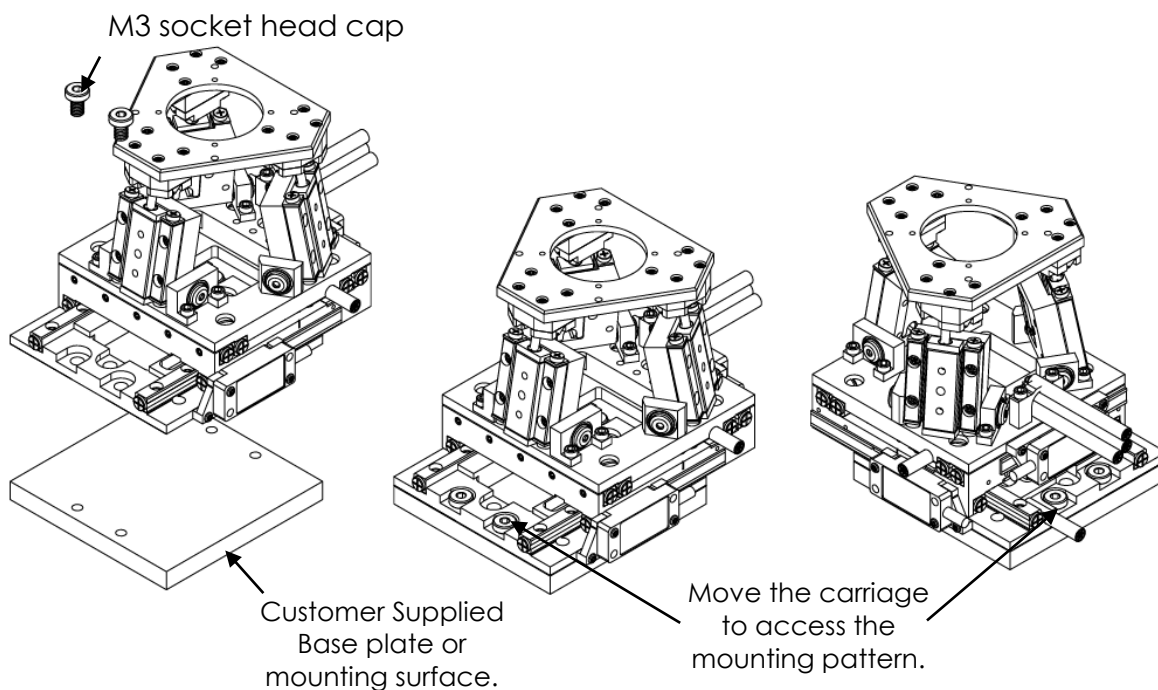


NOTE: Stages assembled in factory do not require disassembly for base mounting.

NOTE: The X-BOT-50 can be mounted in any orientation (horizontally, vertical, or inverted).

NOTE: It is possible to gently move the carriage manually without damaging the stage.

1. The X-BOT-50 only requires four M3 socket head cap screws for base mounting.
2. For general mounting, place and align the stage onto the mounting surface. Carefully move the carriage to access the mounting pattern if necessary.
3. Secure the stage using four M3 socket head cap screws at 0.5Nm recommended torque.
4. Cables may need to be moved to access mounting holes.



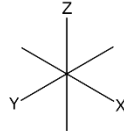
3.2. Mounting to the X-BOT-50

The payload mounts to the X-BOT-50 (without PR-20) via the carriage on top of the stage. To mount to the X-BOT-50 with a PR-20, refer to the [PR-20 Manual](#). The recommended specifications for mounting to the X-BOT-50 are found below:

- Use 4 x M2X0.4 - 6H screws with a max depth of 3 mm. Exceeding the specified screw length will result in damage to the X-BOT's internal components.
- For best performance, torque all 4 screws to 0.16 Nm.
- For best performance, the payload mating surface should have a flatness of 25 μm or better.

4. Stacking Configurations

- Additional configurations may be available upon request.
- Images are positioned according to:



4.1. Configurations with other MICRONIX Stages

4.1.1. X-BOT-50 with PR-20, Rotational Stage

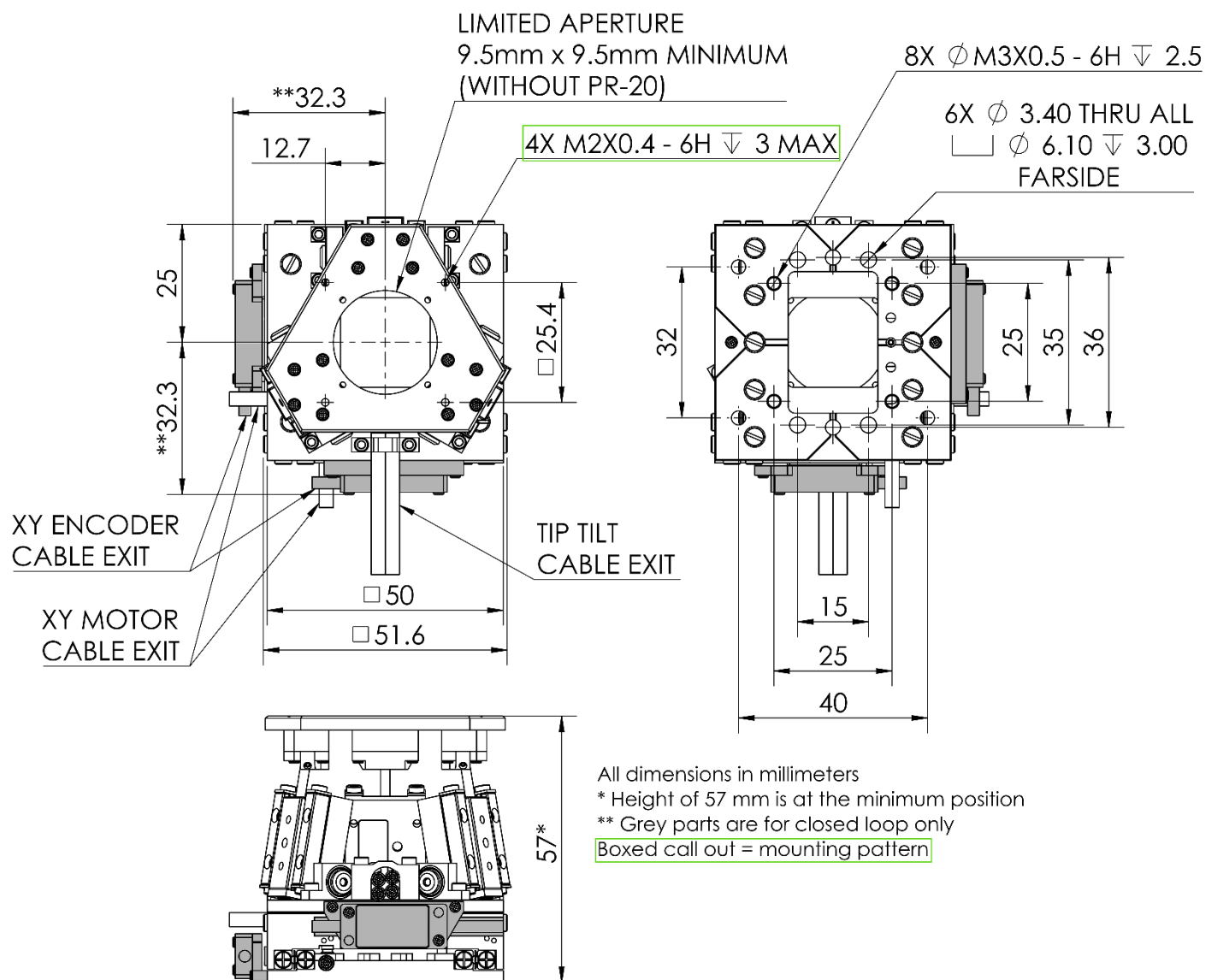
The X-BOT-50 can optionally be integrated with full 360° rotation stage [PR-20 stage](#) (factory installed).



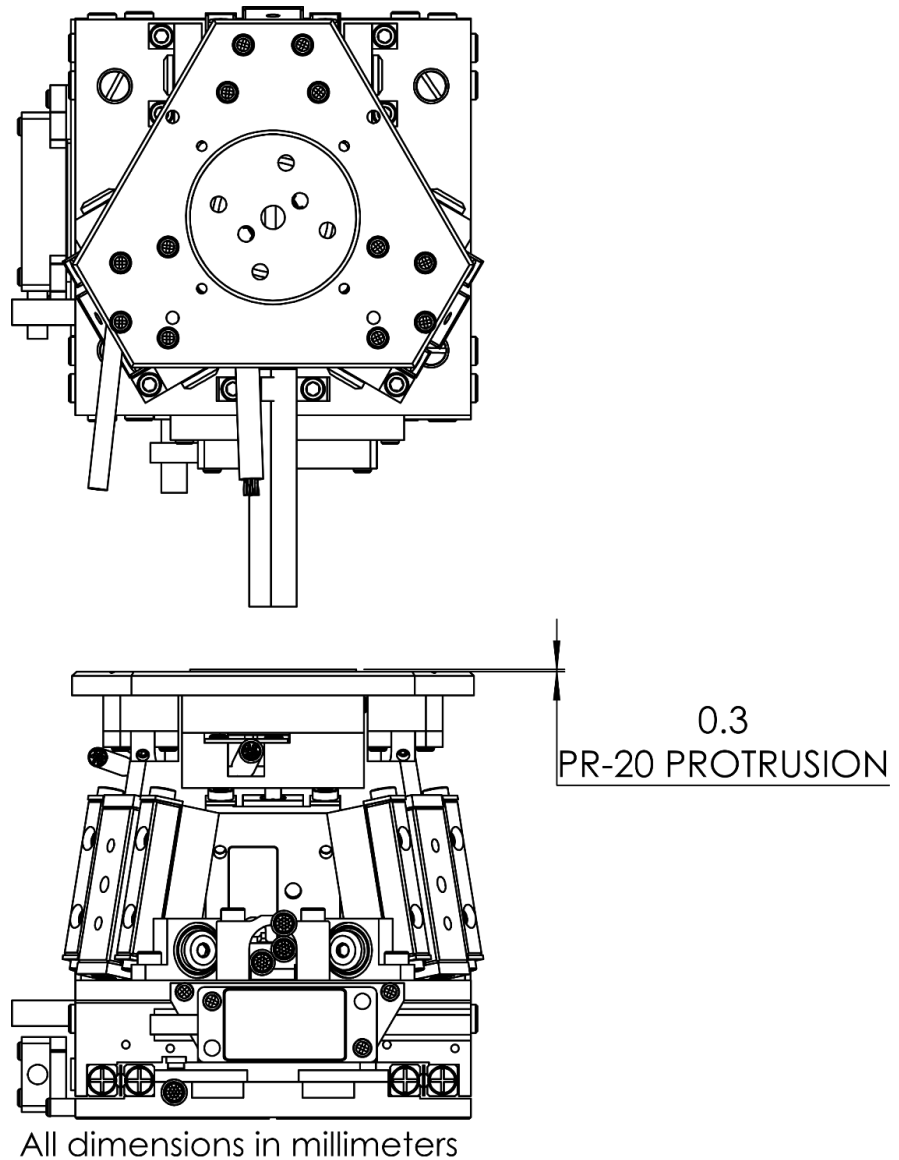
X-BOT-50 & PR-20

5. Dimensions

5.1. X-BOT-50 Stage Dimensions



5.2. X-BOT-50 Stage Dimensions with PR-20



6. Connecting the X-BOT-50

For controller information, refer to the appropriate MMC controller manual.

6.1. Atmospheric Environments

6.1.1. Digital/Absolute Encoder Wiring Diagram

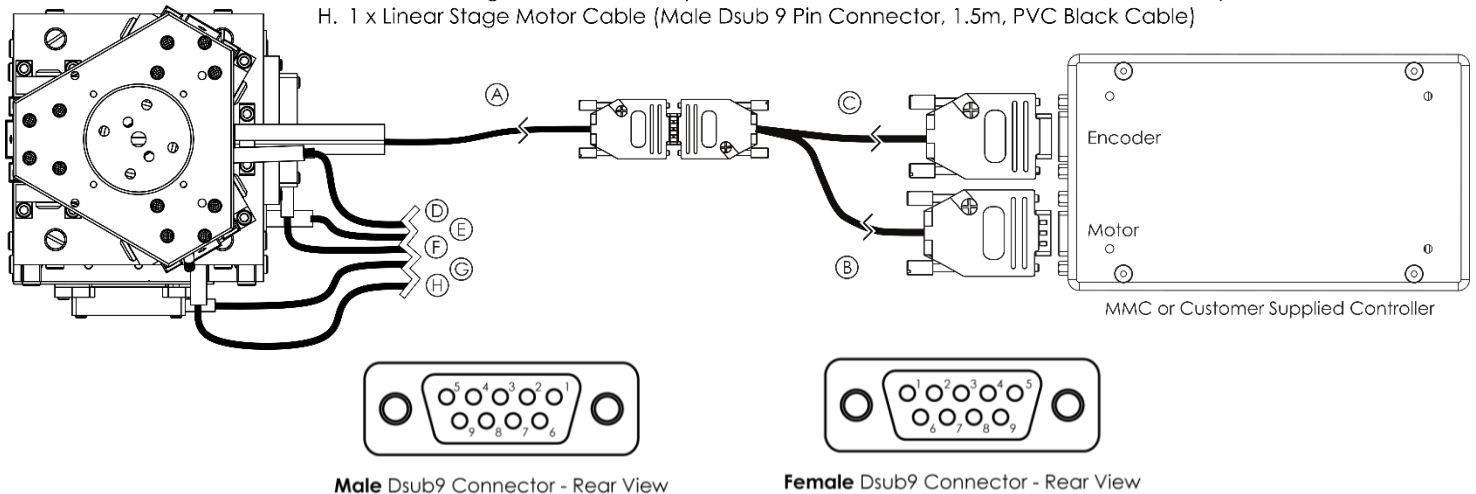
For X-BOT-50 with digital encoders or optional absolute encoders, connect the stage as shown using the supplied D-sub 9 Pin cables to connect the encoder and motor to the controller. For details regarding the pinout see Section 0.

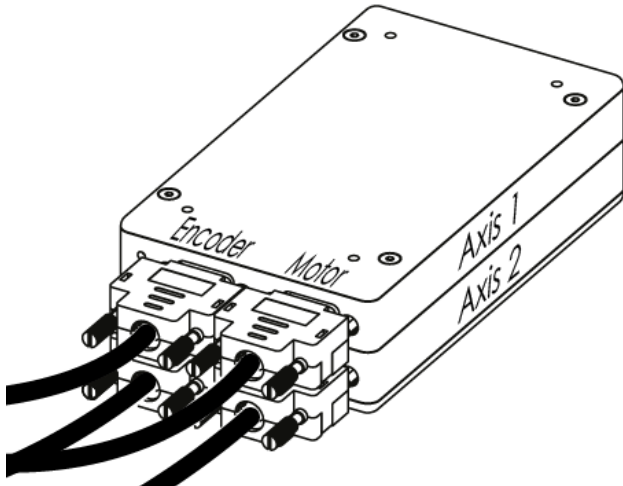
NOTE: For illustration purposes, only one axis connection is shown. Connectors for all axes are labeled Axis 1 through Axis 5.

*If a PR-20 is integrated, the connectors are labeled Axis 1 through Axis 6.

Cable Descriptions:

- A. 3 x Linear Stage Cable (Male Dsub HD15 Pin Connector, 1.5m, PVC Black Cable)
- B. 3 x Adapter Motor Cable (Female Dsub HD15 Pin to Male Dsub 9 Pin, 6 Inches, PVC Black Cable)
- C. 3 x Adapter Encoder Cable (Female Dsub HD15 Pin to Female Dsub 9 Pin, 6 Inches, PVC Black Cable)
- D. 2 x Rotational Stage Cable (Female, Male Dsub 9 Pin Connector, 1.5m, PVC Black Cable)
- E. 1 x Linear Stage Motor Cable (Male Dsub 9 Pin Connector, 1.5m, PVC Black Cable)
- F. 1 x Linear Stage Encoder Cable (Male Dsub 9 Pin Connector, 1.5m, PVC Black Cable)
- G. 1 x Linear Stage Encoder Cable (Male Dsub 9 Pin Connector, 1.5m, PVC Black Cable)
- H. 1 x Linear Stage Motor Cable (Male Dsub 9 Pin Connector, 1.5m, PVC Black Cable)





For proper connection, make sure that the D-sub 9 connectors are fully inserted into the controllers and securely fasten using the connector's jackscrews. For illustration purposes, only two axes are shown.

6.2. Vacuum Environments

6.2.1. Handling and Preparation

When handling the stages for vacuum environments, take the necessary precautions when handling the stages, such as wearing clean latex gloves, clean room clothing, etc. Avoid any contaminants. Maximum bake-out temperature is 100°C. MICRONIX USA optionally supplies the stage with vacuum compatible connectors, see chart below.

Connector Description	Connector Material	Contacts	Backshell
High Vacuum Glass- filled Diallyl Phthalate D-Subminiature	DAP	T2 Female Crimps, Gold Pins (Accuglass P/N: 111652)	Nickel-plated Zinc Backshell Strain Relief
Ultra-High Vacuum D-Subminiature	PEEK	T1 Female Crimps, Gold Pins (Accuglass P/N: 100180)	PEEK UHV Strain Relief

Environment	Open Loop	Closed Loop
High Vacuum (10^{-6} mbar)	9 Pin Female DAP	15 Pin Female DAP
Ultra-High Vacuum (10^{-9} mbar)	9 Pin Female PEEK	15 Pin Female PEEK

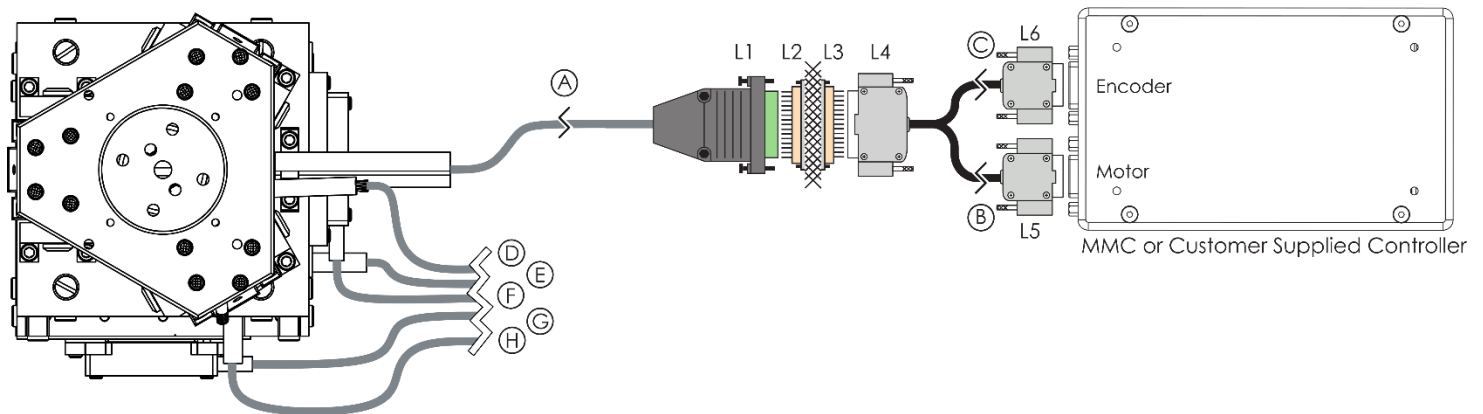
6.2.2. Vacuum Wiring Diagram

Connecting the X-BOT-50 in a vacuum chamber requires the use of a feedthrough connector at the vacuum chamber wall. The vacuum-compatible X-BOT-50 will be supplied with wiring for a straight through feed-through, not a cross over gender changer. MICRONIX USA supplies test connectors that simulate the vacuum feed-through to allow functionality testing prior to installation in a vacuum chamber. Contact MICRONIX USA for details on the sample feed-through test connector.

NOTE: For illustrative purposes, only one axis connection is shown. Connectors for all axes are labeled Axis 1 through Axis 5. If a PR-20 is integrated, the connectors are labeled Axis 1 through Axis 6.

Cable Descriptions:

- A. 3 x Linear Stage Vacuum Cable (Female Dsub15 Peek or DAP, 1.5m Silver Braided Cable)
- B. 6 x Adapter Motor Cable (Female Dsub15 Pin to Male Dsub 9 Pin, 6 Inches, PVC Black Cable)
- C. 6 x Adapter Encoder Cable (Female Dsub15 Pin to Female Dsub 9 Pin, 6 Inches, PVC Black Cable)
- D. 2 x Rotational Stage Vacuum Cable (Female Dsub15 Peek or DAP, 1.5m Silver Braided Cable)
- E. 1 x Linear Stage Motor Vacuum Cable (Female Dsub15 Peek or DAP, 1.5m Silver Braided Cable)
- F. 1 x Linear Stage Encoder Vacuum Cable (Female Dsub15 Peek or DAP, 1.5m Silver Braided Cable)
- G. 1 x Linear Stage Encoder Vacuum Cable (Female Dsub15 Peek or DAP, 1.5m Silver Braided Cable)
- H. 1 x Linear Stage Motor Vacuum Cable (Female Dsub15 Peek or DAP, 1.5m Silver Braided Cable)



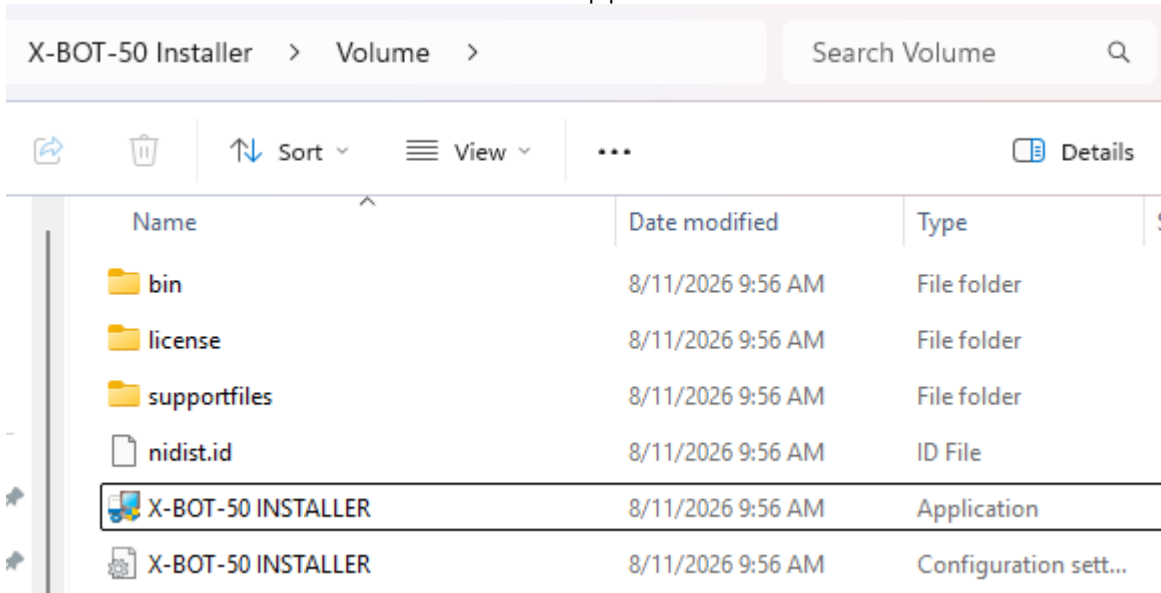
7. Software

7.1. HexaSoft™ Installation

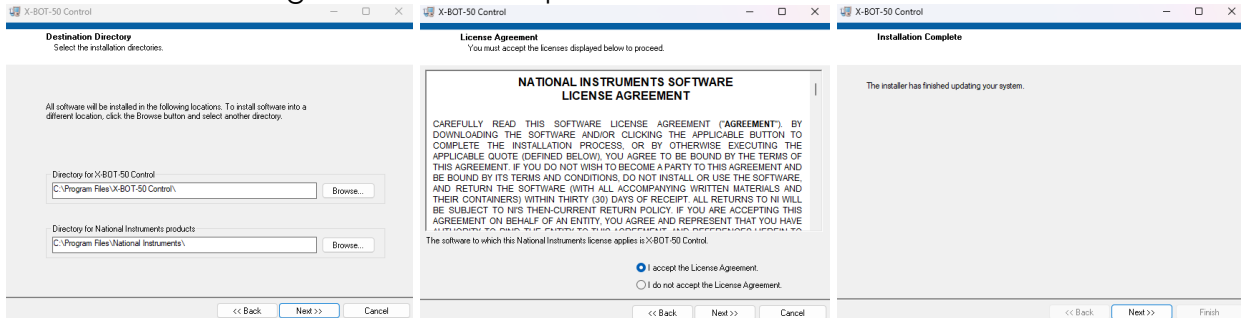
7.1.1. X-BOT-50 Software

Included in the X-BOT-50 package is a USB thumb drive that contains the X-BOT-50 Installer and additional calibration file required for initialization. If a USB thumb drive is not included, then please contact MICRONIX USA for the backup software and files to be sent.

1. Locate and run the X-BOT-50 INSTALLER application executable.



2. Run through the installation process.

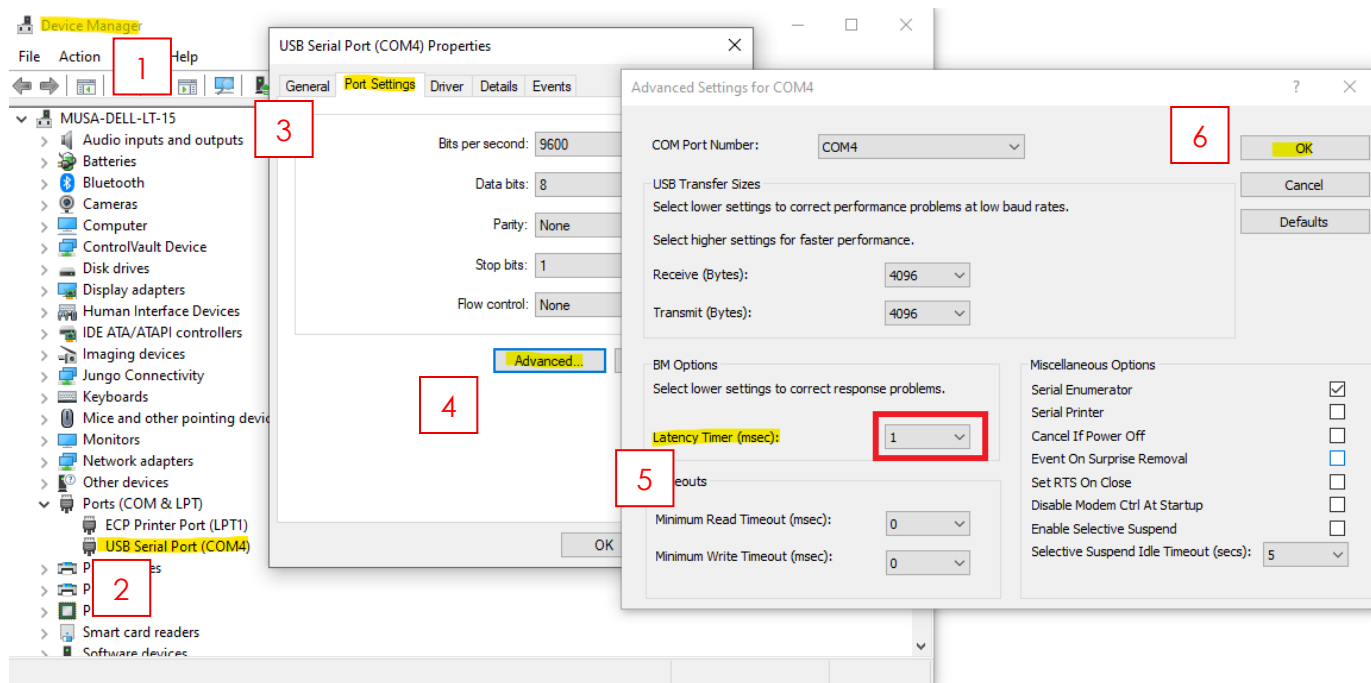


3. Once the installation is complete, restart the computer.

7.2. USB Driver Optimization

7.2.1. Configuring USB Drivers

For optimal communication and performance of the X-BOT-50, please reduce the default latency on systems with Windows OS.

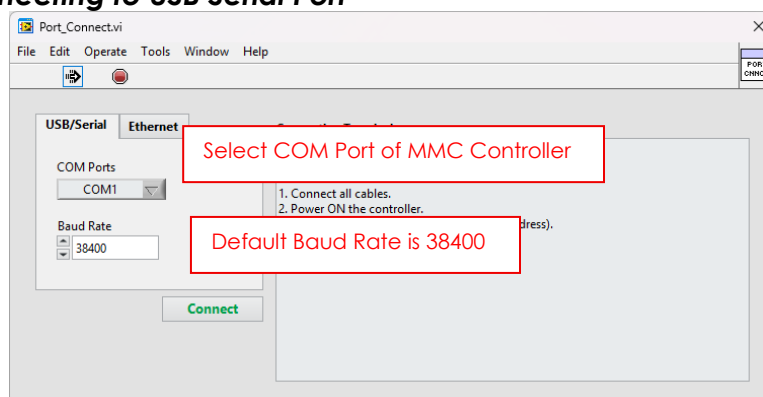


1. Navigate to Device Manager and locate the controller which is named "USB Serial Port (COMx)".
2. Right click on the USB Serial Port and select Properties.
3. Navigate to the "Port Settings" tab.
4. Click on the Advanced... button.
5. Change the default 16ms of Latency Timer to 1ms.
6. Confirm the changes by pressing OK.

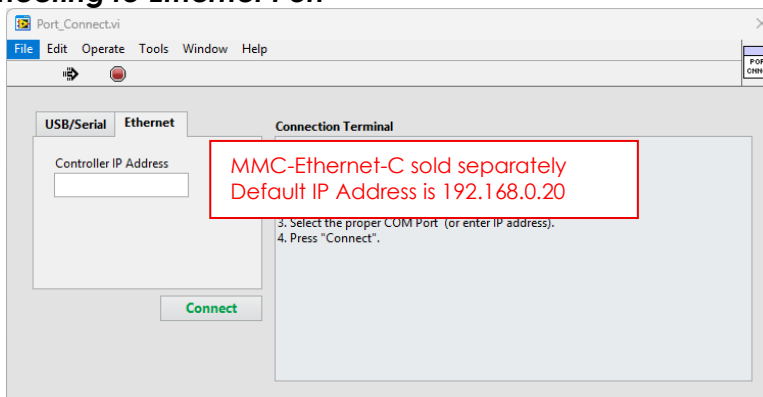
7.3. Software Overview

Refer to the HexaSoft™ Manual for more information about the software.

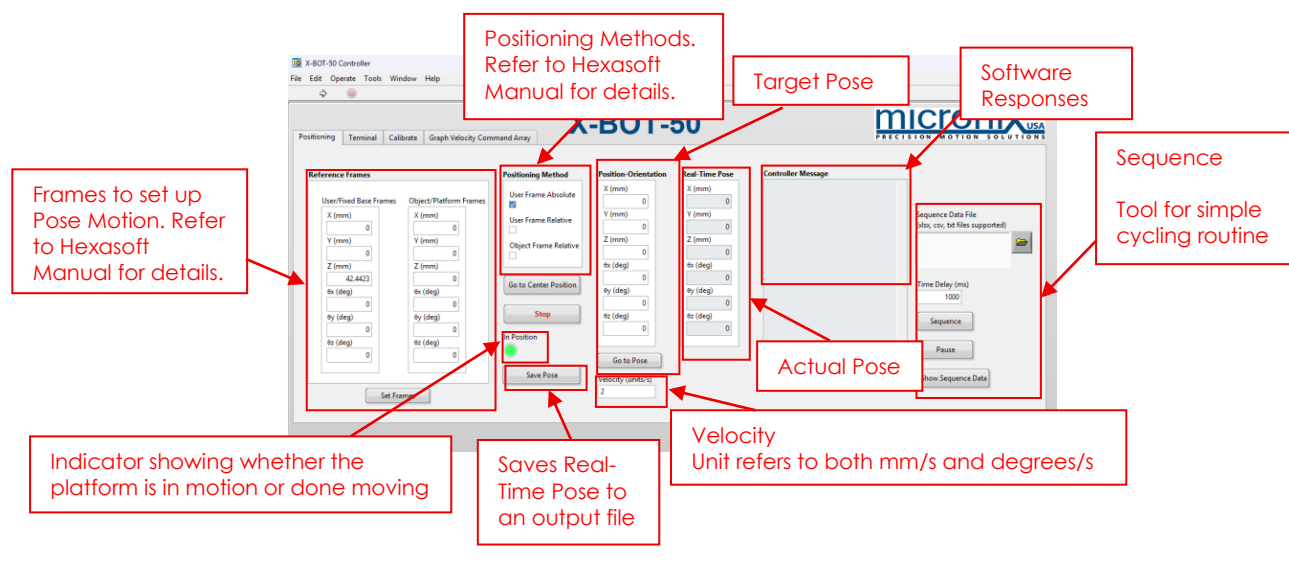
7.3.1. Connecting to USB Serial Port



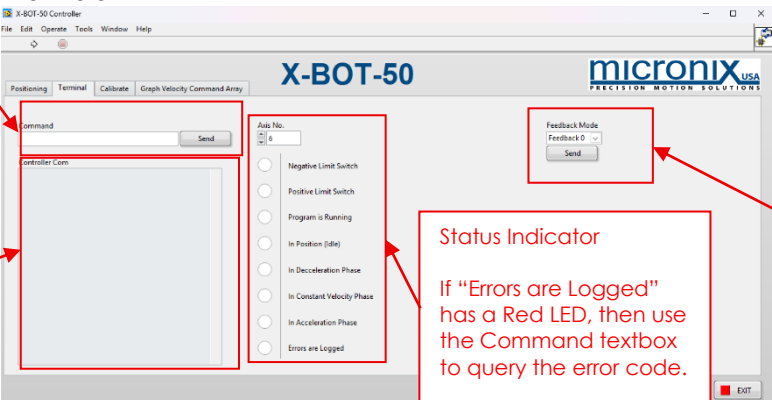
7.3.2. Connecting to Ethernet Port



7.3.3. Positioning Tab



7.3.4. Terminal Tab



Command textbox for sending ASCII commands to the MMC Stack. Refer to MMC-110 Reference Manual for details.

Terminal-like feature that can display previous command entries and responses.

Status Indicator

If "Errors are Logged" has a Red LED, then use the Command textbox to query the error code.

Feedback for Open Loop motion or Closed Loop motion

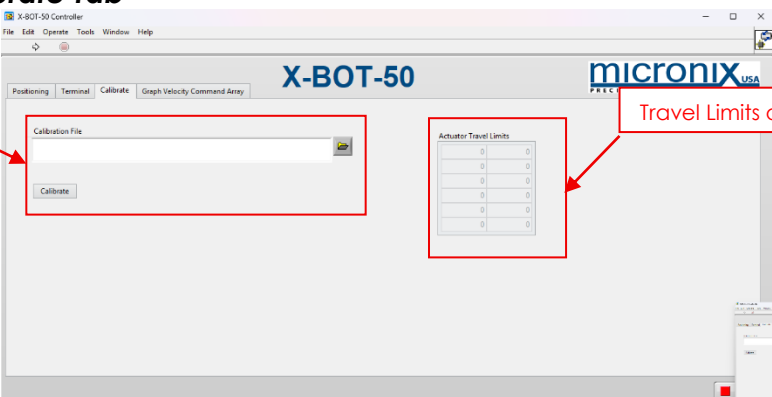
Default: Feedback 3

Feedback Mode
Feedback 0
Send

Aut. No.
8

Negative Limit Switch
Positive Limit Switch
Program is Running
In Position (Idle)
In Deceleration Phase
In Constant Velocity Phase
In Acceleration Phase
Errors are Logged

7.3.5. Calibrate Tab



Calibration Upload
Refer to Section 7.4 for calibration instructions.

Calibration File

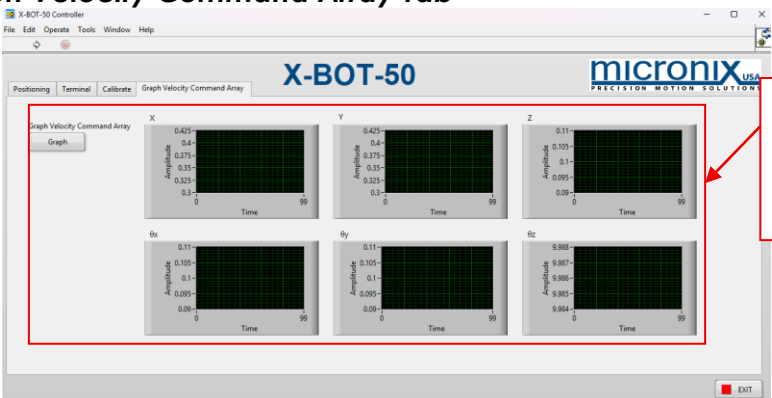
Calibrate

Travel Limits of each actuator

Actuator Travel Limits

0	0
0	0
0	0
0	0
0	0
0	0

7.3.6. Graph Velocity Command Array Tab



Graphs out the set velocity of each DoF during motion. Only used for debugging purposes.

Graph Velocity Command Array

Graph

X

Y

Z

6x

6y

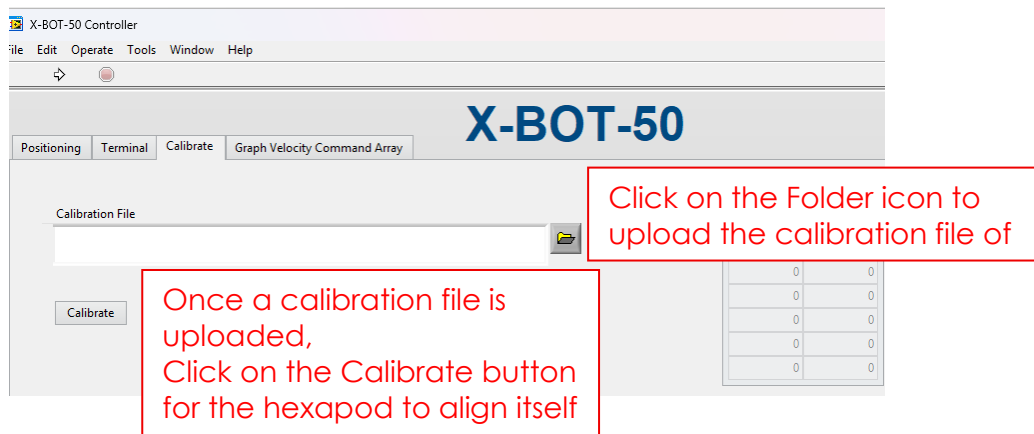
6z

7.4. Calibration

The X-BOT-50 ships pre-calibrated from the factory. On every start-up of the X-BOT-50 system, the software references this calibration file to properly use the hexapod motion and positioning; this is required because the incremental encoders equipped on the positioners do not retain their absolute position when powered off. Customers can also run their own calibration using the Calibrate tab (see Section 7.3.5) if needed.

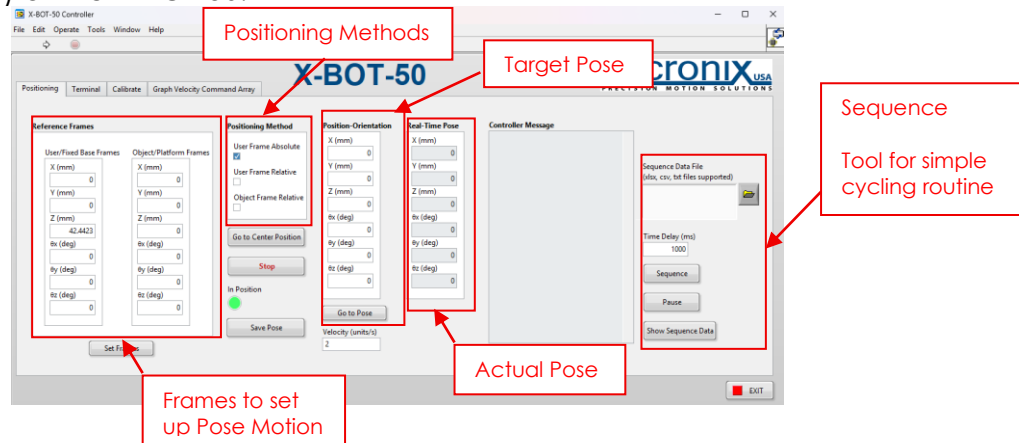
Due to tolerance and differences in manufacturing, each hexapod system will have its own calibration file to ensure that the hexapod system is calibrated to the specification as described on its datasheet.

A calibration file is provided in the accompanying USB. If the calibration file is not provided, then please contact MICRONIX USA support for the necessary files and software needed to run the X-BOT-50 according to the advertised datasheet specifications.



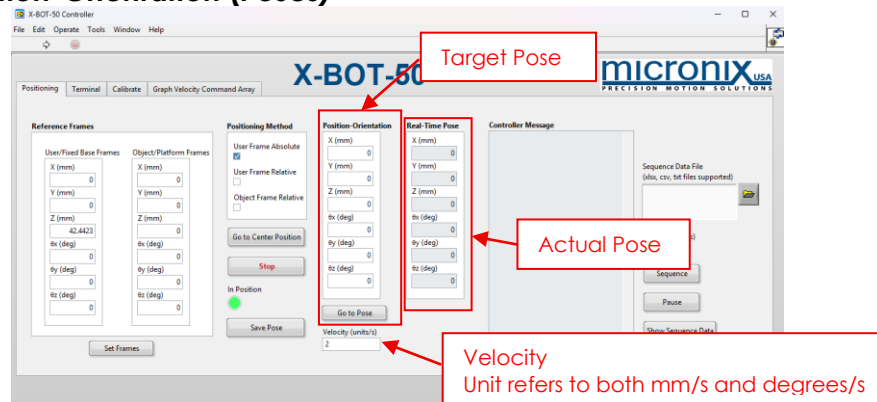
7.5. Motion

To move the X-BOT-50, navigate to the Positioning tab to start controlling the position-orientation (pose) of the X-BOT-50.



More information about coordinate frames and positioning methods can be found in the HexaSoft™ Manual.

7.5.1. Position-Orientation (Poses)



To set a target position-orientation (pose), fill in the positional values of each degree of freedom.

For example, if you wish to move the X-BOT-50 up in the Z-direction by 5 μm from the center position (from [0 0 0 0 0 0] to [0 0 0.005 0 0 0]), then set 0.005 to the Z(mm) textbox and leave all other boxes as 0. Then press the "Go To Pose" button.

Reference Frames

User/Fixed base Frames	Object/Platform Frames
X (mm) 0	X (mm) 0
Y (mm) 0	Y (mm) 0
Z (mm) 0.005	Z (mm) 0
θ_x (deg) 0	θ_x (deg) 0
θ_y (deg) 0	θ_y (deg) 0
θ_z (deg) 0	θ_z (deg) 0

If you want to go down by 1 μm from the current location [0 0 0.005 0 0 0], then you can switch the Positioning Method to User Frame Relative and change the Z (mm) value to -0.001 and press "Go To Pose".

Reference Frames

User/Fixed base Frames	Object/Platform Frames
X (mm) 0	X (mm) 0
Y (mm) 0	Y (mm) 0
Z (mm) -0.001	Z (mm) 0
θ_x (deg) 0	θ_x (deg) 0
θ_y (deg) 0	θ_y (deg) 0
θ_z (deg) 0	θ_z (deg) 0

To reset the pose back to the center position, then press the "Go To Center Position" button.

Note that there is a limited amount of possible motion that is internally calculated. The Controller Message will display whether the pose is reachable or not. Please refer to the X-BOT-50 datasheet for the exact travel ranges.

8. Supplementary Information

8.1. **Maintenance**

The X-BOT-50 series of modular linear stages utilizes a maintenance free design. Do not modify the stages or perform any maintenance unless specifically instructed to do so by MICRONIX USA personnel. If the stage is not performing up to the original specifications, please contact MICRONIX USA.

8.2. **Units and Conversions**

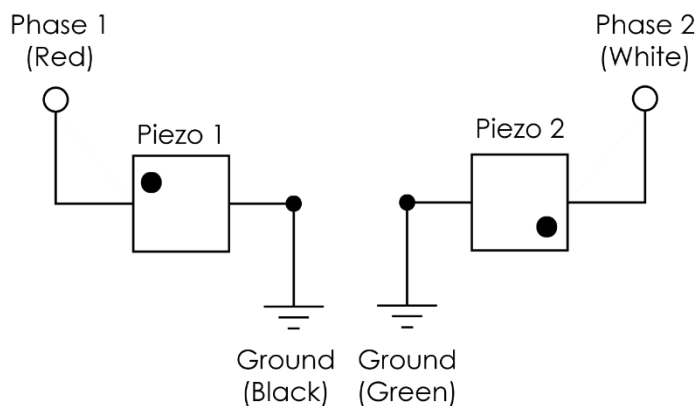
All measurements in this document are in the metric system of units.

Metric Unit	English Unit
1 millimeter	0.0394 inches
1 micron	0.0000394 inches
1 Newton	0.2248 lbs
1 Newton-meter	8.85 in-lbs

A. Appendix

A.1. Piezo Motor Electrical Specification

A.1.1. 2 Phase Piezo Motor Wiring Diagram



A.1.2. Piezo Operating and Electrical Specifications

Voltage	60V maximum
Capacitance	150nF $\pm$ 15%

A.2. Piezo Motor Wiring Pinouts

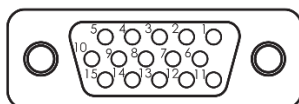
Pinout for X-BOT-50

Motor (male Dsub9)	Description	Pin	Color
	Motor, Phase 1	1	Red
	Motor, Phase 2	2	White (Green TP)
	Motor, Ground	5	Black/Green
	Shield	Casing	-

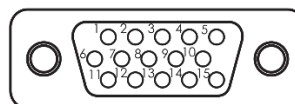
Encoder (female Dsub9)	Description (Digital RS-422)	Description (Abs BiSS-C)	Pin	Color
	A +	SLO+ / Data+	1	Brown
	B +	MA+ / Clock+	2	Blue
	Index+	SLI+	3	Violet
	GND	GND	4	Grey
	+5VDC	+5VDC	5	White (Grey TP)
	A -	SLO- / Data-	6	White (Brown TP)
	B -	MA- / Clock-	7	White (Blue TP)
	Index-	SLI-	8	White (Violet TP)
	Shield	Shield	Casing	-

*SLI signals available upon request

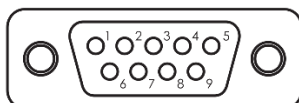
Motor	Pinout for Linear Stage (X-BOT)		Cable A		Cable B		Cable C
	Description:	Color	Dsub HD15M	Dsub HD15F	Dsub9M	Dsub9F	
			L1	L2	L3	L4	
	Phase 1	Red	1	1	1	-	-
	Phase 2	White (Green TP)	2	2	2	-	-
Encoder	Ground	Black/Green	5	5	5	-	-
	Shield	-	Casing	Casing	Casing	-	-
	A+	Brown	8	8	-	1	
	B+	Blue	9	9	-	2	
	Index+	Violet	10	10	-	3	
	GND	Grey	12	12	-	4	
	+5V	White (Grey TP)	11	11	-	5	
	A-	White (Brown TP)	13	13	-	6	
	B-	White (Blue TP)	14	14	-	7	
	Index-	White (Violet TP)	15	15	-	8	
	Shield	-	Casing	Casing	-	Casing	



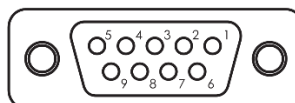
HD15F - Front View
15 Pin High Density Female Connector



HD15M - Front View
15 Pin High Density Male Connector



Dsub9M - Front View
9 Pin Male Connector

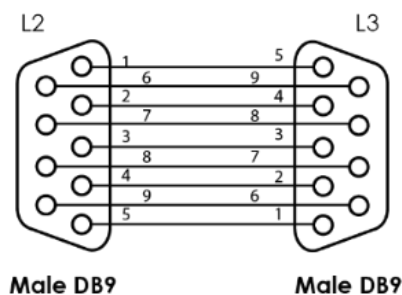


Dsub9F - Front View
9 Pin Female Connector

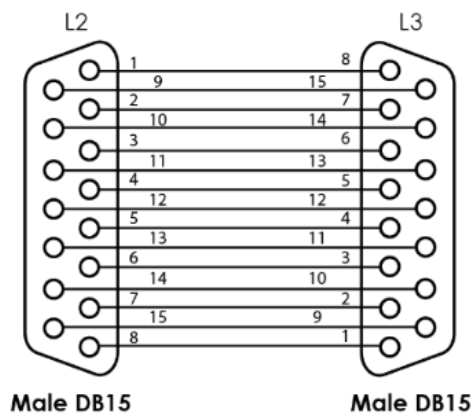
A.3. Feedthrough Pinout

	Pinout for TRI-BOT-50	Cable A&B D-sub 15F			Feedthrough D-sub 15M			Cable C D-sub 9M		Cable D D-sub 9F	
		L1	L2	L3	Color	L4	L5	L6			
MOTOR A & C	Motor, Phase 1	Red	1	1	8	Red	8	1	-		
	Motor, Phase 2	White (Green TP)	2	2	7	White (Green TP)	7	2	-		
	Motor, Ground	White (Blue TP)	11	11	13	Black / Green	13	4	-		
	Shield	-	10	10	14	-	14	Casing	-		
Encoder B & D	Encoder GND	White	8	8	1	Grey	1	-	4		
	A+	Red	7	7	2	Brown	2	-	1		
	+5V	Brown	6	6	3	White (Grey TP)	3	-	5		
	A-	Blue	5	5	4	White (Brown TP)	4	-	6		
	B+	Yellow	4	4	5	Blue	5	-	2		
	B-	Green	12	12	12	White (Blue TP)	12	-	7		
	Index-	Grey	13	13	11	White (Violet TP)	11	-	8		
	Index+	Violet	14	14	10	Violet	10	-	3		
	Encoder Shield	-	15	15	9	-	9	-	Casing		

Straight Through 9-Pin Feed-through



Straight Through 15-Pin Feed-through



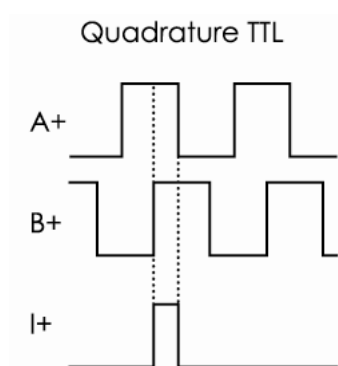
A.4. Using a Digital Encoder

The X-BOT-50 with digital encoder will need to be paired with an appropriate controller. The MMC-110 has a digital incremental option and an Absolute BiSS-C option (if paired with a PR-20 stage).

A.4.1. Operating and Electrical Specifications

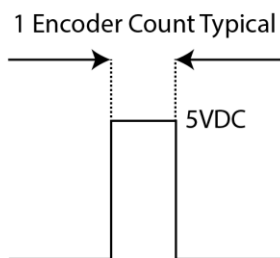
Power Supply	5VDC $\pm 10\%$ @ < 35mA (No outputs terminated) @ < 85mA (A, B, I, and both limits terminated); 50mA at the sensor
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A.4.2. Digital Square Wave Output)



NOTE: The index pulse may be aligned with A- or B- at some interpolation values

A.4.3. Index Window



A.4.4. Resolution

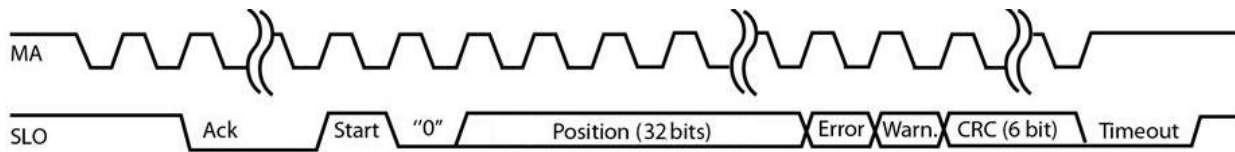
The encoder resolution is programmed in the analog to digital interpolator module (attached to the cabling of the stage).

A.5. Using an Absolute BiSS-C Encoder Interface

A.5.1. Absolute Encoder Signals BiSS C-Mode Interface

The MICRONIX USA absolute encoder operates using standard BiSS C-mode (continuous) interface, transmitting 32-bits of position data on each request. The controller will clock position acquisitions via the MA signal. The SLO signal will transmit position data from the encoder.

By default, the SLI signal is not used for the absolute encoder interface, however it can be made available on customer request.



A.5.2. Absolute Encoder Pinout

Pin	Description
1	SLO+ / DATA+
2	MA+ / CLK+
3	SLI+
4	Ground
5	+5VDC
6	SLO- / DATA-
7	MA- / CLK-
8	SLI-
9	Not In Use

*SLI signals available upon request