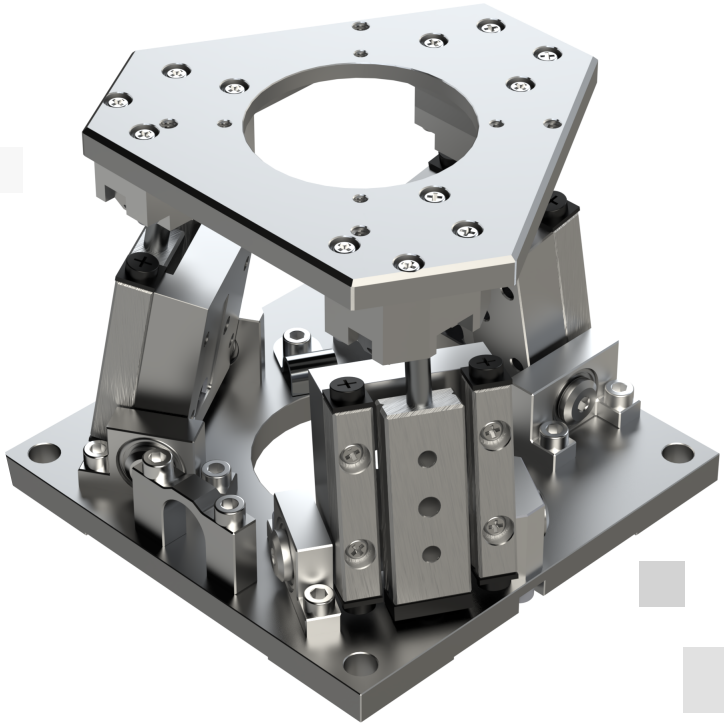
TRI-BOT-50 Series



Hexapod Positioning System
Reference Manual

micronix USA
PRECISION MOTION SOLUTIONS

TRI-BOT-50

Hexapod Positioning System
Reference Manual

Rev 2.0

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Table of Contents

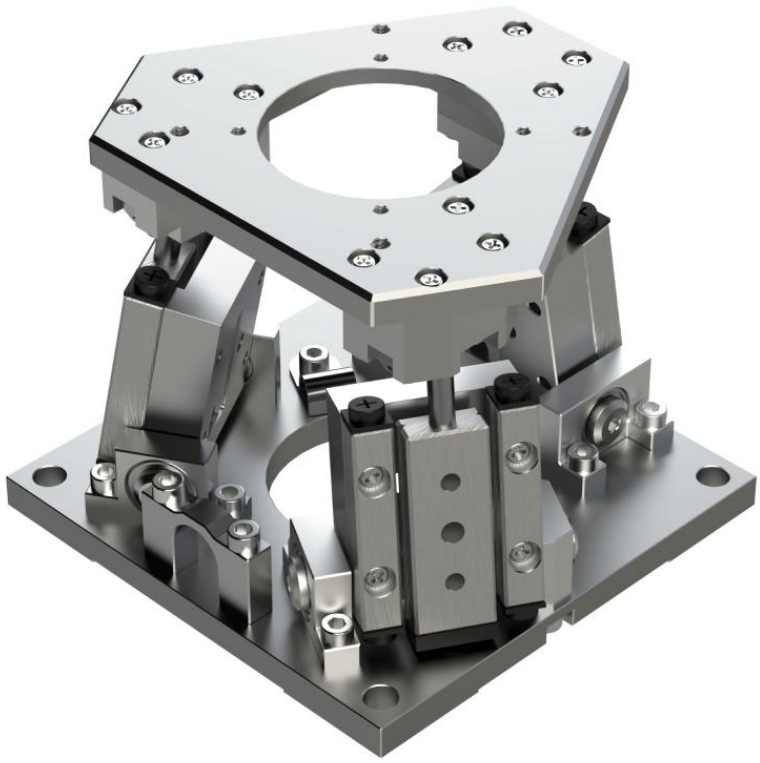
1. Introduction

1.1 Product Description

The TRI-BOT-50 is a miniature tripod for the positioning and adjustment of precision components in 3 degrees of freedom (Z, *θx,* and *θy)*. It comes with software that includes inverse kinematics and allows for carriage positioning in degrees/mm. The TRI-BOT-50 is 43 mm tall and has sub-micron resolution. 360° z-rotation can be integrated into the carriage for 4 degrees of freedom (Z, *θx, θy,* and *θz)*. HV, UHV, and non-magnetic versions are available. Custom travel ranges are available upon request.

The 4th degree of freedom (θz) 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	**Z-axis**	**θX&θY-axes**
Travel from Center	±2.5 mm	±9° by ±10° tilt
Max Speed (MMC-110)	5 mm/s	10°/s
Resolution (digital encoder)	<40 nm	100 µ°
Bi-directional Repeatability	±200 nm	±200 µ°
Max Load	3 N	2 N
Environment	Atmospheric, HV, UHV, Non-Magnetic	



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

1.2 Recommended Controllers

The TRI-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 TRI-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
MMC-100	—
MMC-110	✓
NanoDrive	—
MMX-120	—

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 TRI-BOT-50 product page on the MICRONIX USA website (www.micronixusa.com).

2. Preparing to Install the TRI-BOT-50

2.1 Installation Cautionary Notes

When mounting the TRI-BOT system, it is important to consider the flatness of the mounting surface, as the TRI-BOT's base will conform to its shape. A mounting surface that is not flat can adversely affect the performance and structural integrity of the product.

- 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°C ±2°C unless otherwise specified. Be sure to use the TRI-BOT-50 under the following requirements:

- Stage mounting surface flatness: less than 25 µm for optimal performance.
- Payload mounting surface flatness: 25 µm or better.
- Temperature range of 5-40°C.
- Relative humidity between 20-80%.

2.3 Product Handling

The TRI-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.
- 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 contamination that could jeopardize the longevity of the stage.
- Allow for easy access to the stage in case of servicing.
- The stage is calibrated prior to shipment, and a calibration file is provided. Any adjustments to the stage could affect the Z, θX, and/or θY-axes and nullify the calibration file.
- For non-magnetic versions, which use ceramic bearings, do not forcibly move any of the 3 linear axes 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 TRI-BOT-50 stage 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

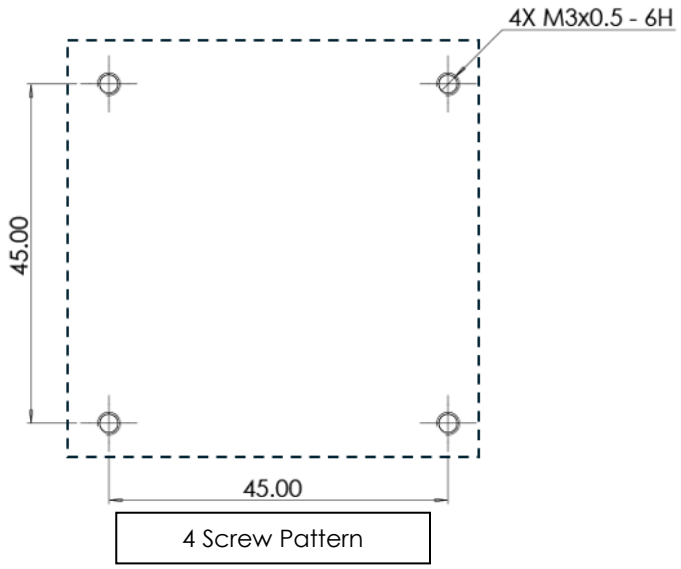
- TRI-BOT-50
- Reference Manual
- Controller Stack (Specified During Sale)
- HexaSoft™ (TRI-BOT Software Suite)
- Any agreed upon customizations such as mounting hardware, controller additions (i.e. MMC-Ethernet), and software modifications.

3. Installing the TRI-BOT-50

3.1 TRI-BOT-50 Installation

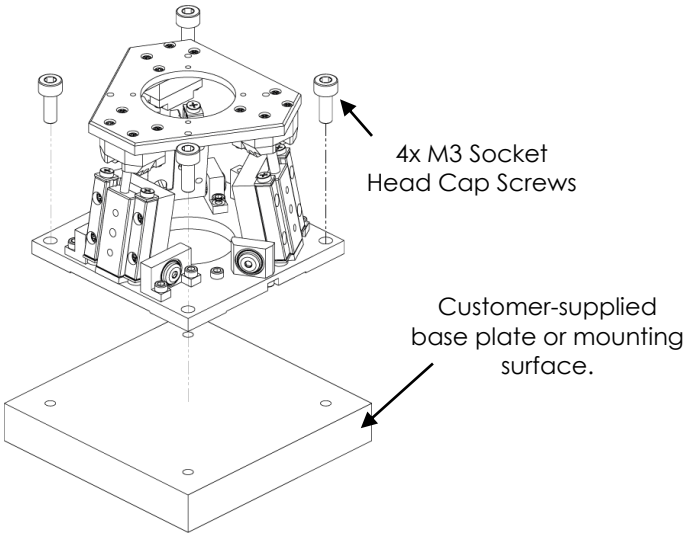
3.1.1 *General Mounting*

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 TRI-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 TRI-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.



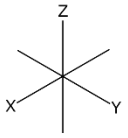
3.2 Mounting to the TRI-BOT-50

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



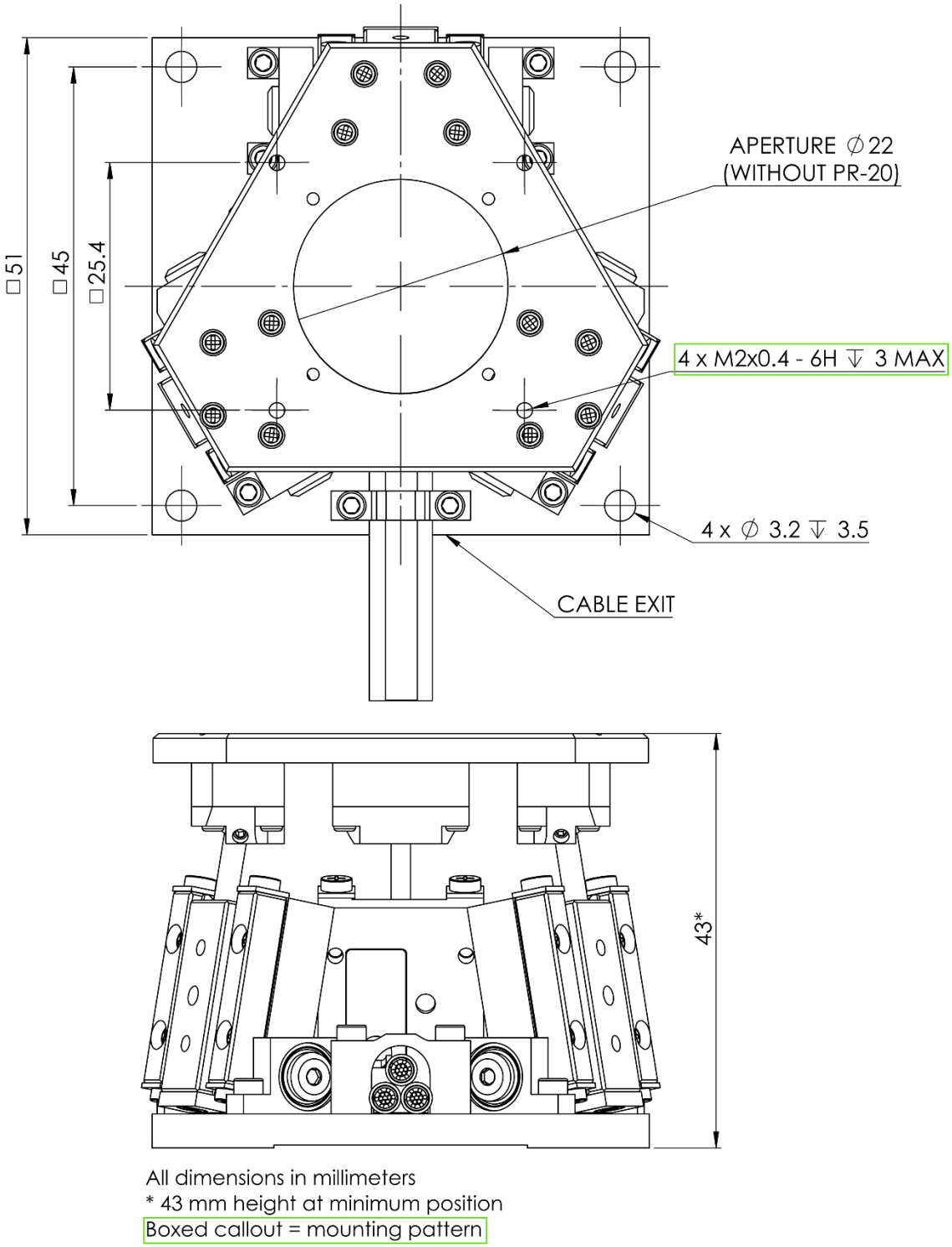
4.1 Configurations with Other Micronix Stages

4.1.1 *TRI-BOT-50 with PR-20, Rotational Stage*

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

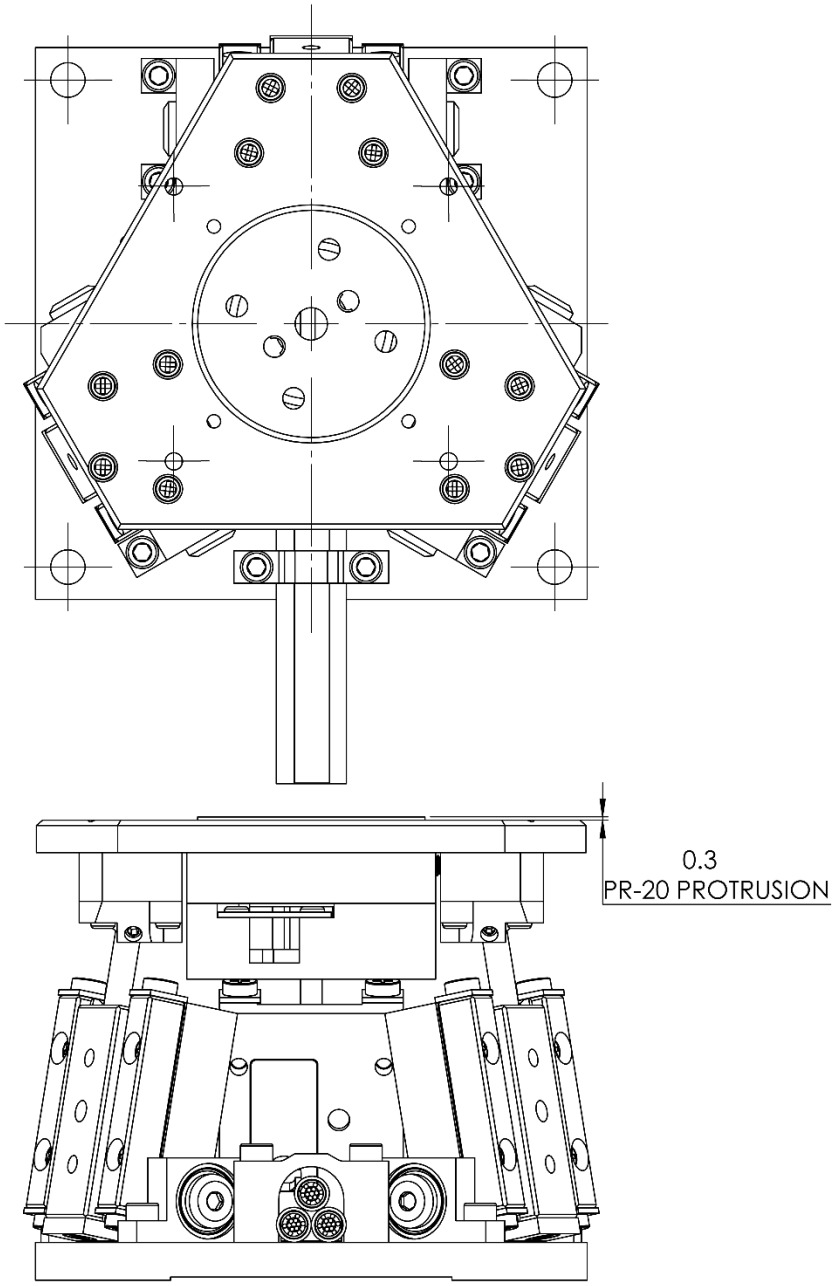
5. Dimensions

5.1 TRI-BOT-50 Stage Dimensions without PR-20



All dimensions in millimeters
* 43 mm height at minimum position
Boxed callout = mounting pattern

5.2 TRI-BOT-50 Stage Dimensions with PR-20



All dimensions in millimeters

6. Connecting the TRI-BOT-50

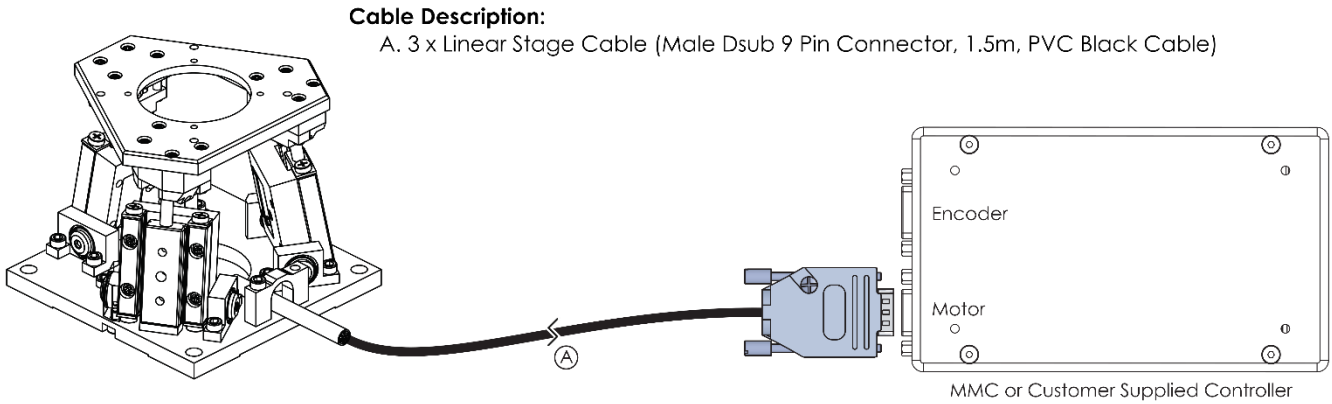
For controller information refer to the appropriate MMC controller manual.

6.1 Atmospheric Environments

6.1.1 *Open Loop Wiring Diagram*

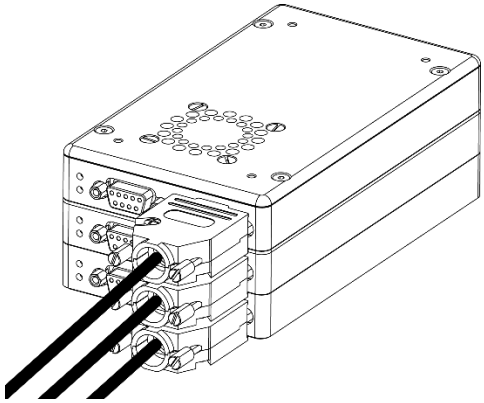
To use in open loop, connect the stage as shown below. This connection only requires that the Dsub 9 Pin Motor Cable is connected to a compatible controller. No other cables or components are needed.

NOTE: For illustration purposes, only one axis connection is shown. Connectors for all axes are labeled Axis 1 through Axis 3. If a PR-20 is integrated, the connectors are labeled Axis 1 through Axis 4.



Male Dsub9 Connector - Rear View

Please refer to Section A.3 for the wiring pinout



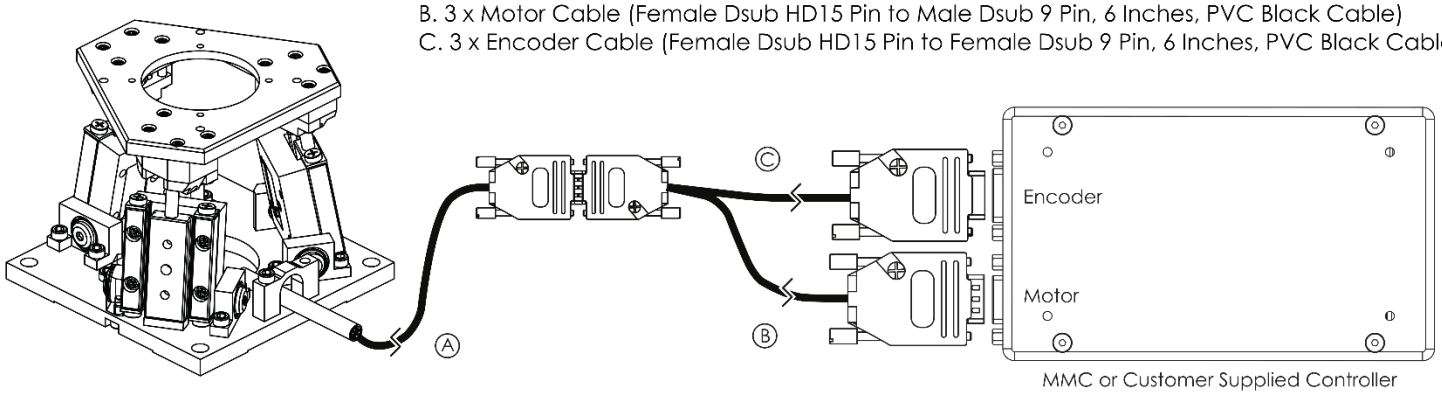
For proper connection, make sure that the Dsub9 connectors are fully inserted into the controllers and securely fastened using the connector's jackscrews.

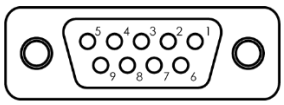
6.1.2 *Digital Encoder Wiring Diagram*

For TRI-BOT-50 with digital 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 **Error! Reference source not found.**3.

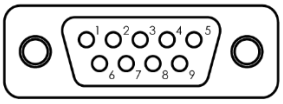
NOTE: For illustration purposes, only one axis connection is shown. Connectors for all axes are labeled Axis 1 through Axis 3.
***If a PR-20 is integrated, the connectors are labeled Axis 1 through Axis 4 instead of Axis 1 through Axis 3.

Cable Descriptions:
A. 3 x Linear Stage Cable (Male Dsub HD15 Pin Connector, 1.5m, PVC Black Cable)
B. 3 x Motor Cable (Female Dsub HD15 Pin to Male Dsub 9 Pin, 6 Inches, PVC Black Cable)
C. 3 x Encoder Cable (Female Dsub HD15 Pin to Female Dsub 9 Pin, 6 Inches, PVC Black Cable)



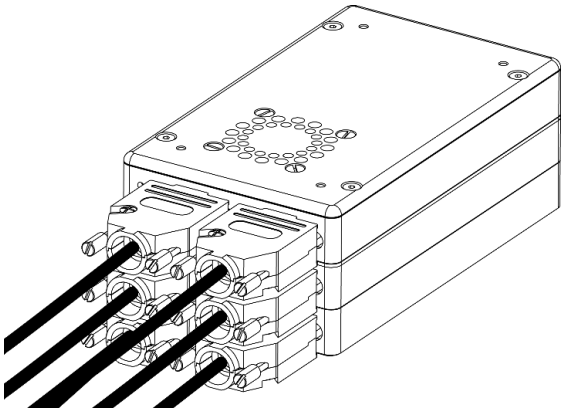


Male Dsub9 Connector - Rear View



Female Dsub9 Connector - Rear View

Please refer to Section A.3 for the wiring pinout



For proper connection, make sure that the Dsub9 connectors are fully inserted into the controllers and securely fastened using the connector's jackscrews

6.2 *Vacuum Environments*

6.2.1 *Handling and Preparation*

When handling the stages for vacuum environments, take the necessary precautions, 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, 111653)	Nickel-plated Zinc Backshell Strain Relief
Ultra High Vacuum D-Subminiature	PEEK	T1 Female Crimps, Gold Pins (Accuglass P/N: 100180, 100181)	PEEK UHV Strain Relief

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

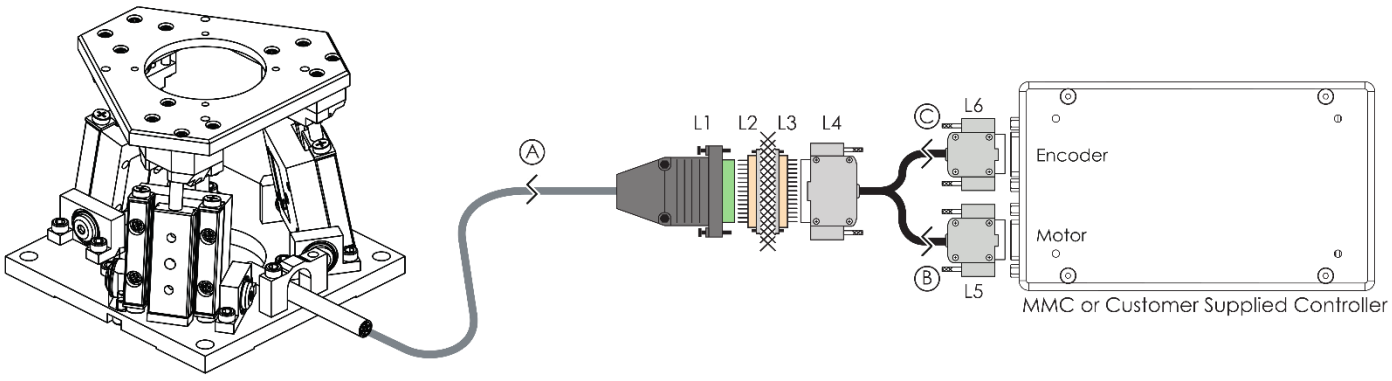
6.2.2 *Vacuum Wiring Diagram*

Connecting the TRI-BOT-50 in a vacuum chamber requires the use of a feed-through connector at the vacuum chamber wall. The vacuum-compatible TRI-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 3. If a PR-20 is integrated, the connectors are labeled Axis 1 through Axis 4.

Cable Descriptions:

A. 3 x Vacuum Cable (Female Dsub15 Peek or DAP, 1.5m Silver Braided Cable)
B. 3 x Atmospheric Motor Breakout Cable (Female Dsub 15 Pin to Male Dsub 9 Pin, 1.5m PVC Black Cable)
C. 3 x Atmospheric Encoder Breakout Cable (Female Dsub 15 Pin to Female Dsub 9 Pin, 1.5m PVC Black Cable)



Please refer to Section A.4 for the wiring pinout

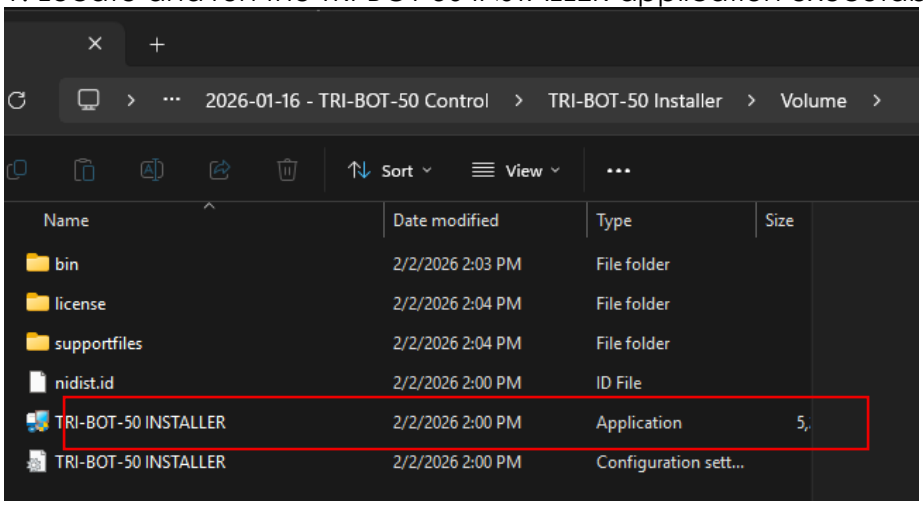
7. Software

7.1 Software Installation

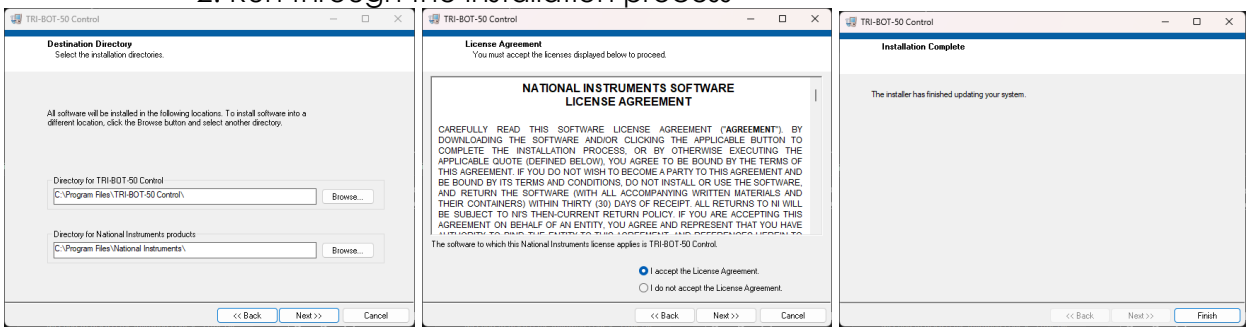
7.1.1 *TRI-BOT-50 Software*

Included in the TRI-BOT-50 package is a USB thumb drive that contains The TRI-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 TRI-BOT-50 INSTALLER application executable



2. Run through the installation process

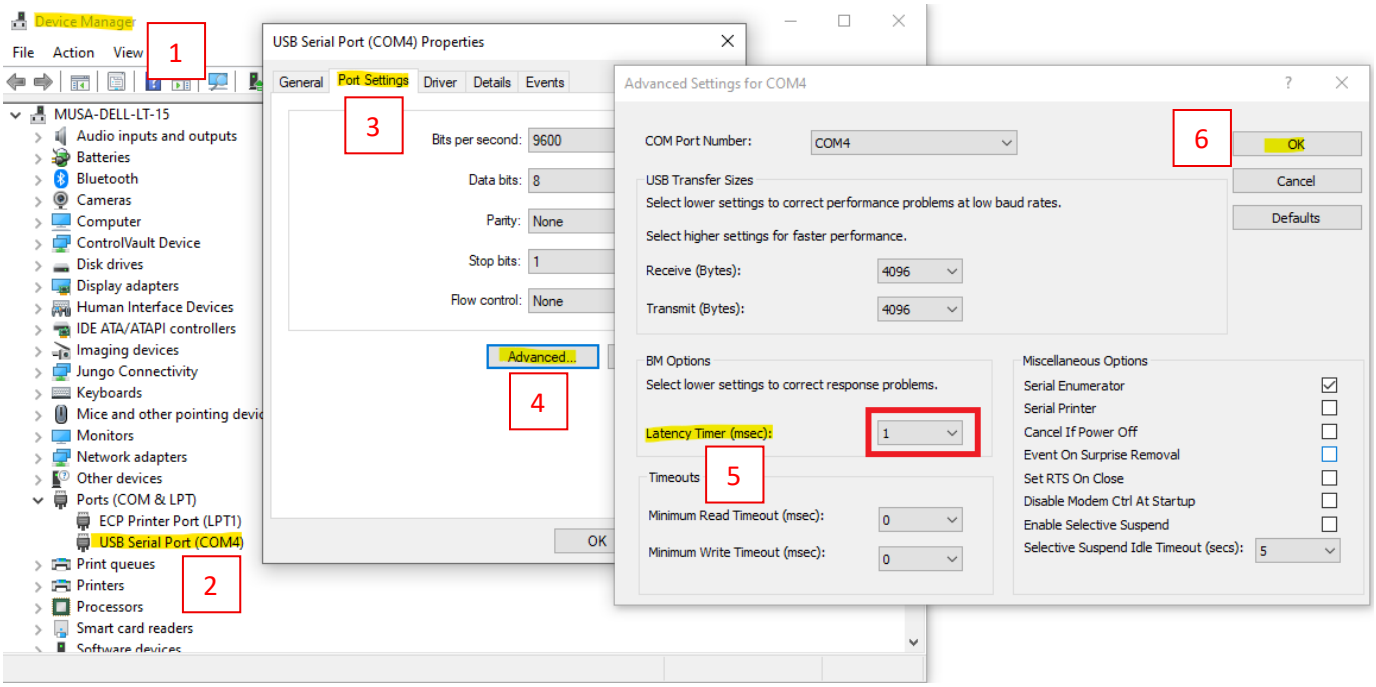


3. Once the installation is complete, restart the computer

7.2 USB Driver Optimization

7.2.1 Configuring USB Drivers

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

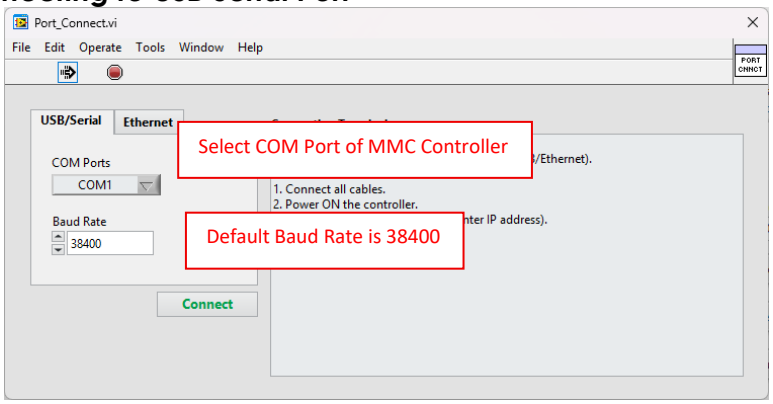


1. Navigate to Device Manager and locate the controller which is named "USB Serial Port (COMx)".
2. Right click on the USB Serial Port and select Properties.
3. Navigate to the "Port Settings" tab.
4. Click on Advanced… button.
5. Change the default 16ms of Latency Timer to 1ms.
6. Confirm the changes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

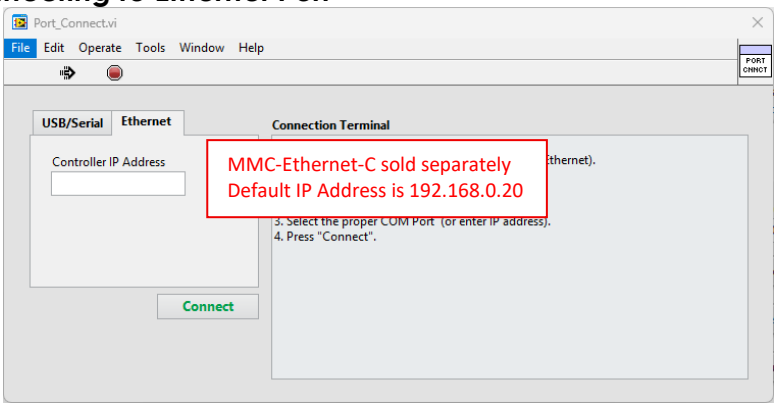
7.3 Software Overview

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

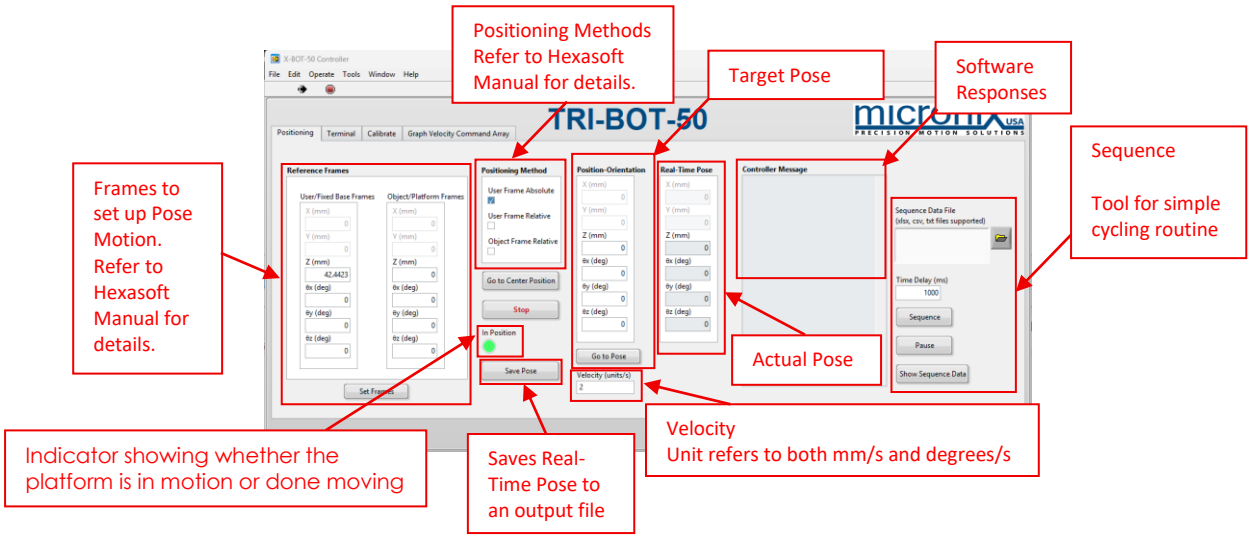
7.3.1 *Connecting to USB Serial Port*



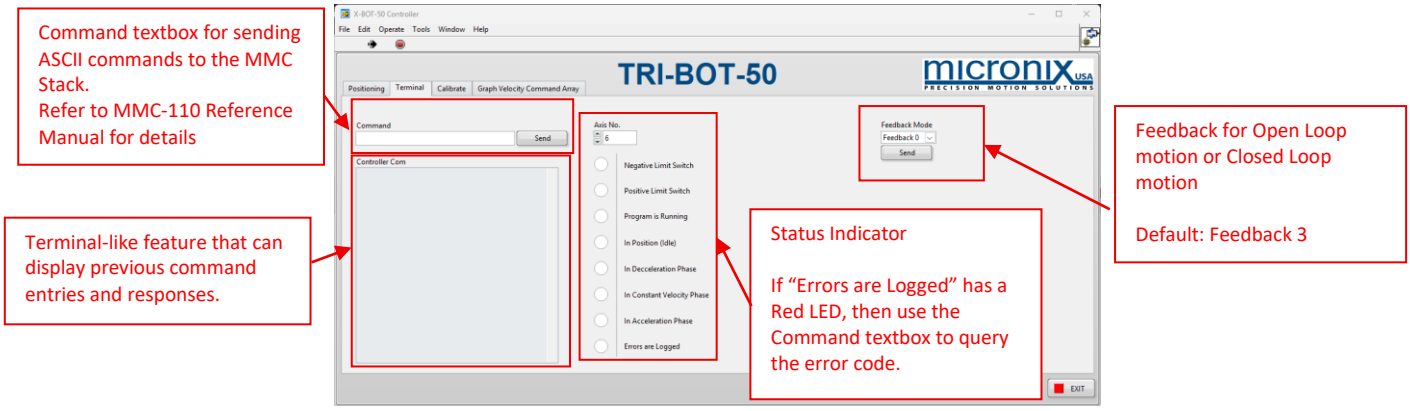
7.3.2 *Connecting to Ethernet Port*



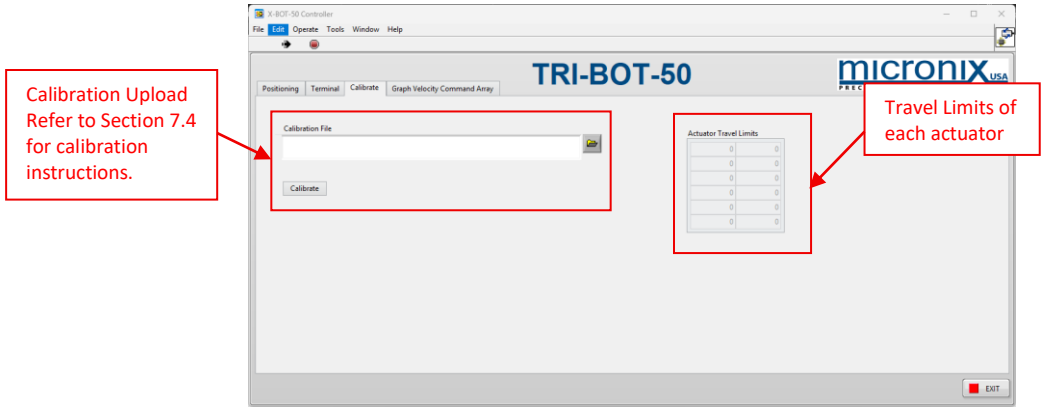
7.3.3 *Positioning Tab*



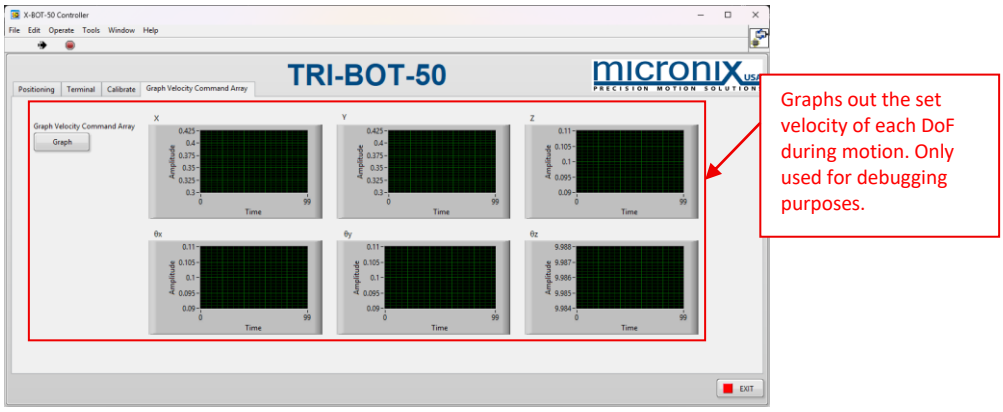
7.3.4 *Terminal Tab*



7.3.5 *Calibrate Tab*



7.3.6 *Graph Velocity Command Array Tab*

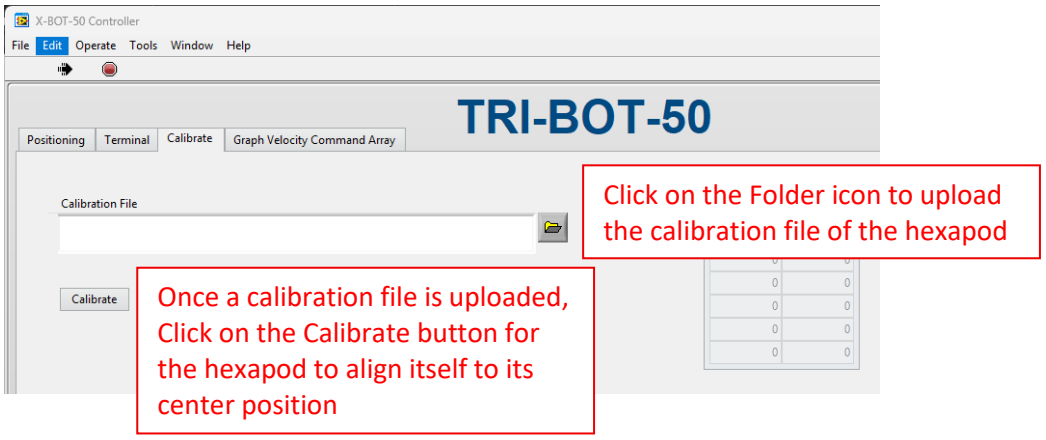


7.4 Calibration

The TRI-BOT-50 ships pre-calibrated from the factory. On every start-up of the TRI-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.

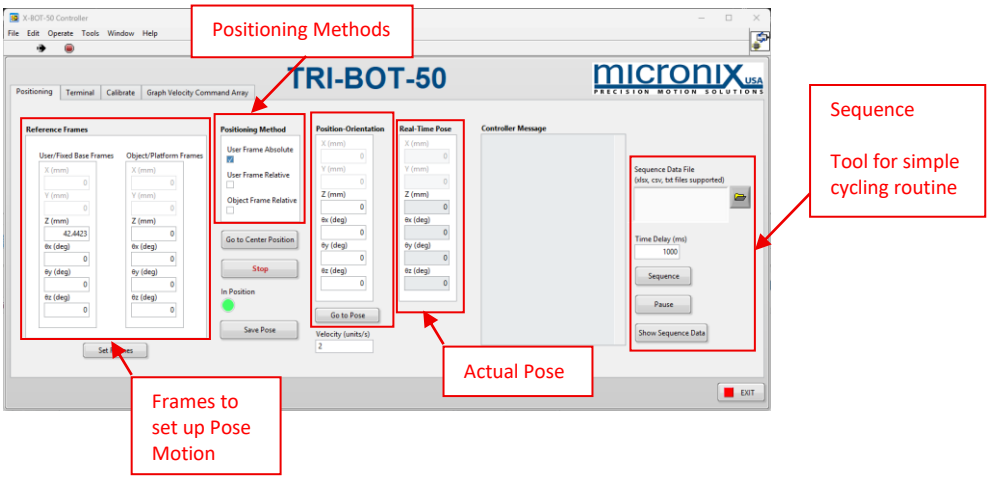
Due to tolerance and differences in manufacturing, each hexapod system will have their own calibration file to ensure that the hexapod system is calibrated to the specification as described on its datasheet.

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 TRI-BOT-50 according to the advertised datasheet specifications.



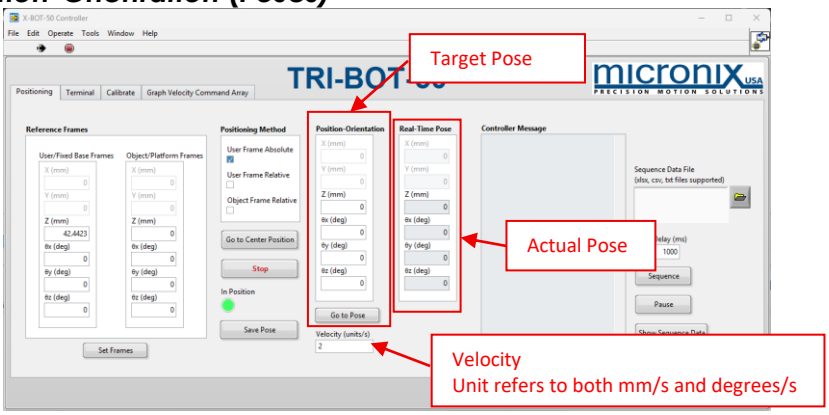
7.5 Motion

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



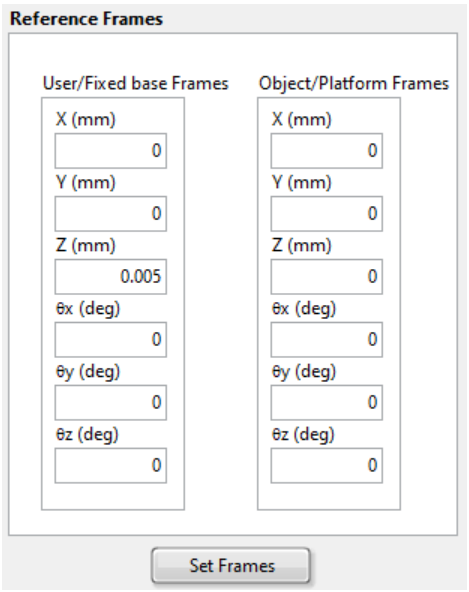
More information about coordinate frames and positioning methods can be found in the HexaSoft™ Manual.

7.5.1 *Position-Orientation (Poses)*

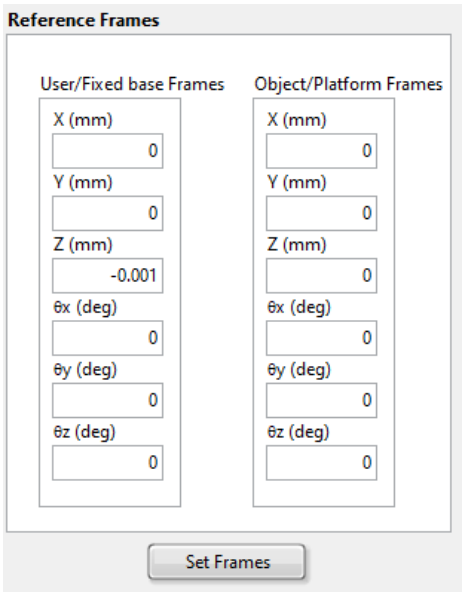


To set a target position-orientation (pose), fill in the positional values of each degree of freedom.

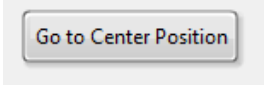
For example, if you wish to move the TRI-BOT-50 up in the Z-direction by 5 µm from the center position (from [0 0 0 0 0 0] to [0 0 0.005 0 0 0]), then set 0.005 to the Z(mm) textbox and leave all other boxes as 0. Then press the "Go To Pose" button.



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"



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 TRI-BOT-50 datasheet for the exact travel ranges.

8. Supplementary Information

8.1 Maintenance

The TRI-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 to the original specifications, please contact MICRONIX USA.

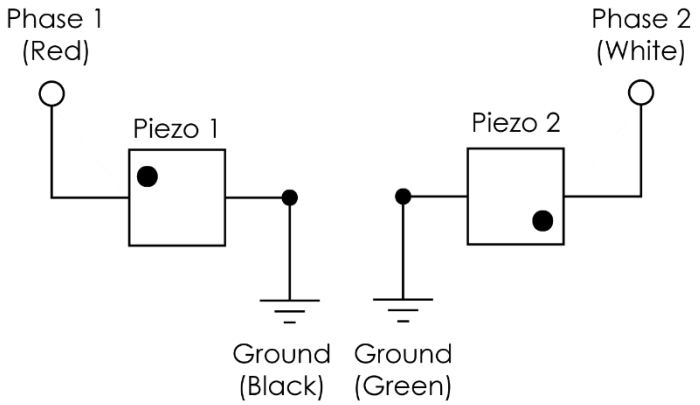
8.2 Units and Conversions

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 2 Phase Piezo Motor Wiring Diagram



A.1.1 *Piezo Operating and Electrical Specifications*

Voltage	60V maximum
Capacitance	150nf ±15%

A.2 Using a Digital Encoder, overview

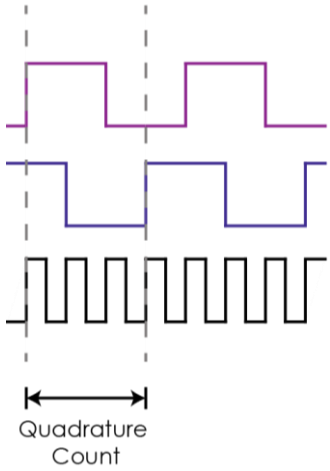
The TRI-BOT-50 with digital encoder will need to be paired with an appropriate controller. The MMC-110 has a digital incremental option and an Absolute BiSS-C option (if paired with a PR-20 stage).

This appendix covers three encoder types: the PP-18 incremental encoder (used on the TRI-BOT-50's base Z, θX, and θY axes), the PR-20 incremental encoder, and the PR-20 absolute encoder. The PP-18 and PR-20 incremental encoders both output the digital square wave and index signals described below; the PR-20 absolute encoder does not use an index signal.

A.2.1 *Operating and Electrical Specifications*

Power Supply	5VDC ±5%

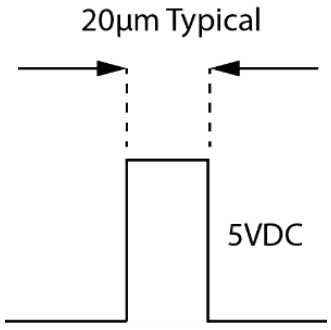
A.2.2 *Digital Square Wave Output (Pins 1,2,6, and 7)*



(RS-422 Standard)

A.2.3 *Index Window (Pins 3)*

Applies to PR-20 with an incremental encoder only. The PR-20 with an absolute encoder and Linear Stages do not have an index.



A.2.4 *Resolution*

A resolution of <20 nm is achievable with a Micronix controller. The digital encoder module interpolates to a higher resolution as specified in the sales order.

A.3 TRI-BOT-50 Pinout

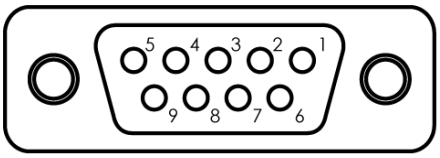
Pinout for TRI-BOT-50

Motor (male)

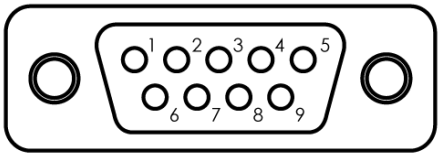
Description	Pin
Motor, Phase 1	1
Motor, Phase 2	2
Motor, Ground	5
Shield	Casing

Encoder (female)

Description (Digital RS-422)	Pin
A +	1
B +	2
Index+	3
GND	4
+5VDC	5
A -	6
B -	7
Index-	8
Shield	Casing



Male Dsub9 Connector - Rear View



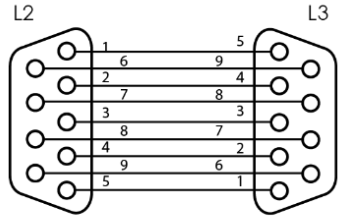
Female Dsub9 Connector - Rear View

For PR-20 absolute encoder pinout information, refer to the PR-20 Manual.

A.4 TRI-BOT-50 Vacuum Pinout

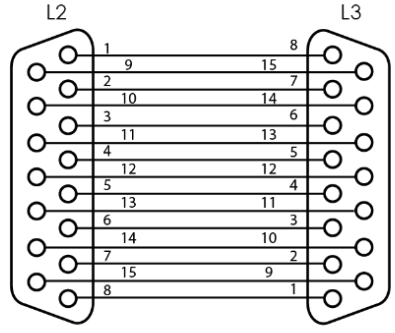
	Pinout for TRI-BOT-50		Cable A&B D-sub 15F	Feedthrough D-sub 15M			D-sub 15F	Cable C D-sub 9M	Cable D D-sub 9F
	Description	**Color**	**L1**	**L2**	**L3**	**Color**	**L4**	**L5**	**L6**
MOTOR A & C	Motor, Phase 1	Red	1	1	8	Red	8	1	-
	Motor, Phase 2	White (Green TP)	2	2	7	White (Green TP)	7	2	-
	Motor, Ground	White (Blue TP)	11	11	13	White (Blue TP)	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



Male DB9 **Male DB9**

Straight Through 15-Pin Feed-through



Male DB15 **Male DB15**