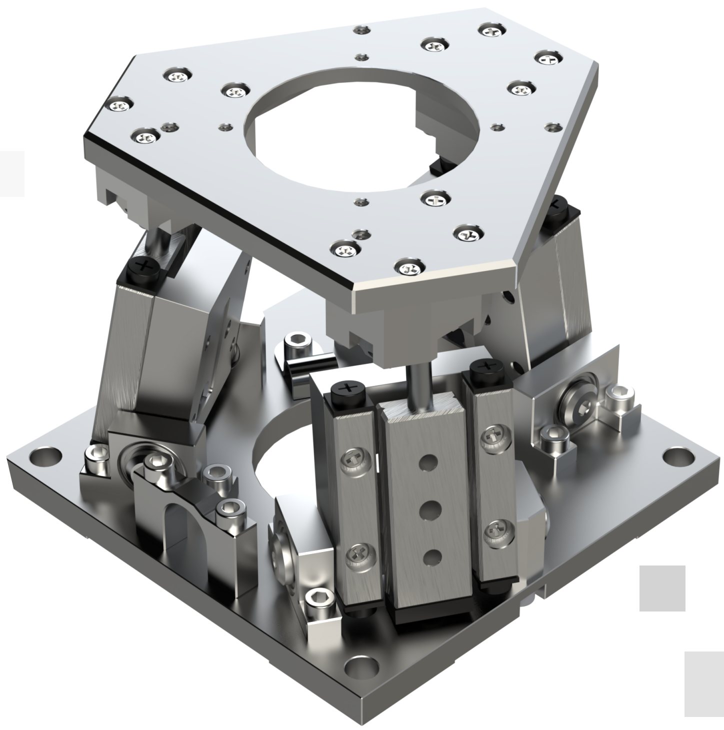
TRI-BOT-50

Series



Hexapod Positioning System

Reference Manual

micronix USA
PRECISION MOTION SOLUTIONS

TRI-BOT-50

Hexapod Positioning System

Reference Manual

Rev 1.0

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Contents

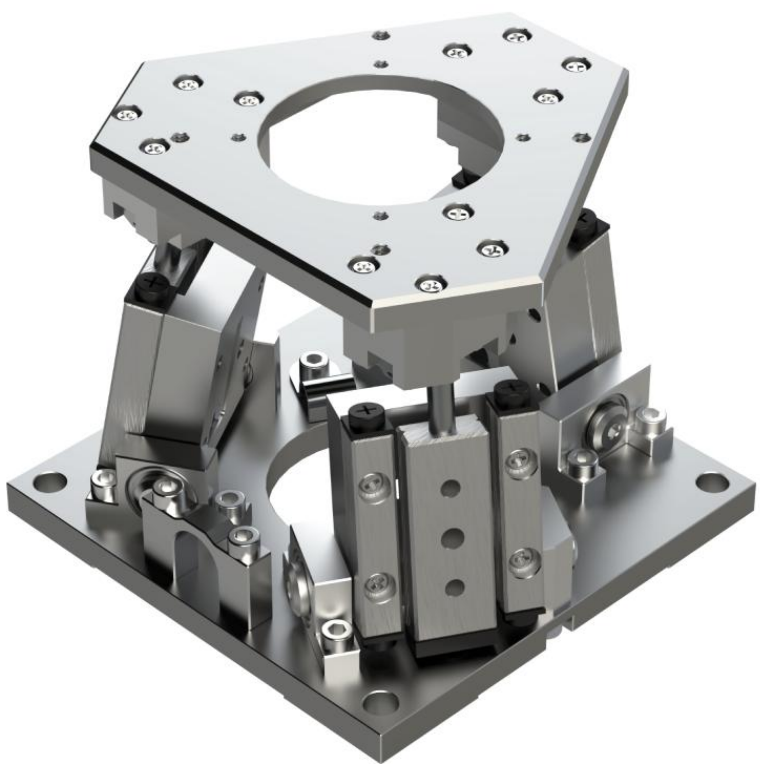
1. Introduction

1.1 Product Description

The TRI-BOT-50 is a miniature hexapod for the positioning and adjustment of precision components in 3 degrees of freedom (Z, *θx,* and *θy)*. It 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.

Features:

- Travel range of ±2.5 mm Z, ±9° by ±10° tilt from center
- Load capacity up to 300g
- Aperture diameter of 22 mm (Without PR-20 Rotational Stage)
- Crossed roller bearings
- 45.5 mm height at center position, 43 mm height at minimum position



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

1.2 Recommended Controllers

The TRI-BOT-50 includes a compatible controller stack with purchase.

1.3 Technical Data

See datasheet.

2. Model Configurations

2.1 TRI-BOT-50 Order Numbers

Order No.	TRI-BOT-50 -	1	1		0	

DRIVE	Piezo Motor PM-002	1
TRAVEL	See datasheet	1
ENCODER	None	0
	Digital (RS-422)	3
LIMIT SWITCH	None	0
ENVIRONMENT	Atmospheric	0
	High Vacuum (10^{-6}mbar)	6
	Ultra High Vacuum (10^{-9} mbar)	9
	Non-Magnetic	M

Contact MICRONIX USA for custom applications and stacking configurations.

3. Preparing to Install the TRI-BOT-50

3.1 Installation Preparation

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. It is required to use a surface with flatness tighter than the overall specified flatness of the base.

The stages are calibrated to be within specification at 20°C ±2°C unless otherwise specified. Be sure to use the TRI-BOT under the following conditions:

- Mount to a clean and flat surface that is free of debris, burrs or dings
    - We recommend that the flatness for the mounting surface be less than 10 microns for optimal performance.
- A clean indoor atmosphere free of corrosive gases, excessive dust, and condensation
- Temperature range of 10-40°C
- Relative humidity between 20-80%
- Wear clean latex gloves when handling vacuum products
- Locate away from water, heat, and electrical noise

3.2 Package Contents

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 Should Contain:

- TRI-BOT-50
- Reference Manual
- MMC-110
- HexaSoft™ (TRI-BOT Software Suite)
- Any agreed upon customizations such as mounting hardware, controller additions (ie. MMC-Ethernet), and software modifications.

4. Installing the TRI-BOT-50

The TRI-BOT-50 only requires four M3 socket head cap screws for base mounting.

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

4.1 TRI-BOT-50 Installation

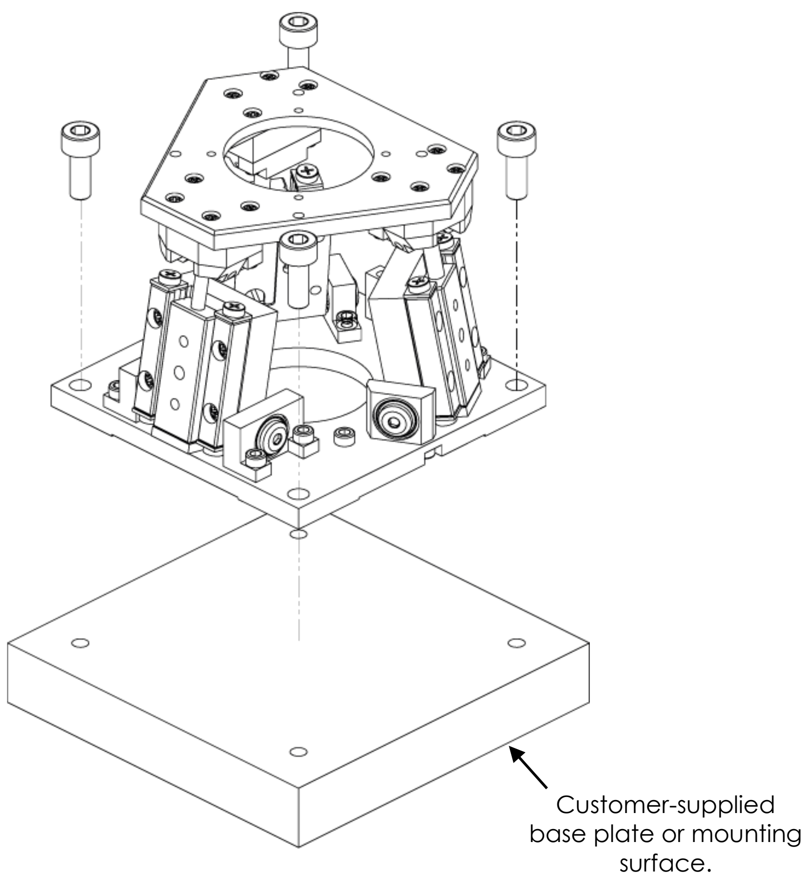
4.1.1 *General Mounting*

Refer to section 5.1.2 for recommended mounting pattern.

The TRI-BOT-50 can be mounted in any orientation (i.e. horizontally, vertical, or upside down)

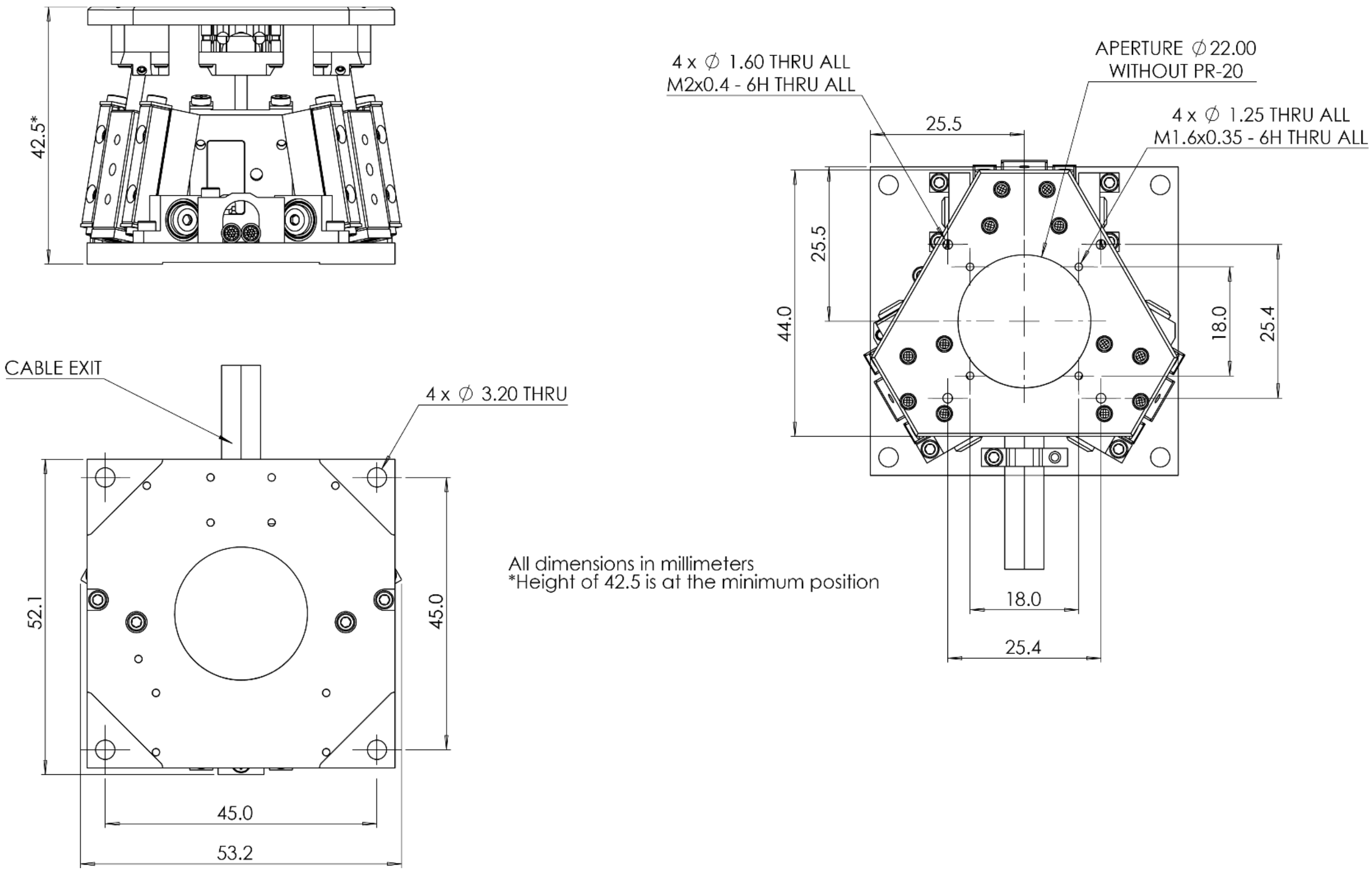
For general mounting, place and align the stage onto the mounting surface. Carefully move the carriage to access the mounting pattern if necessary. It is possible to move the carriage manually without damaging the stage.

Secure the stage using four M3 socket head cap screws at a recommended torque of 0.5 N-m.

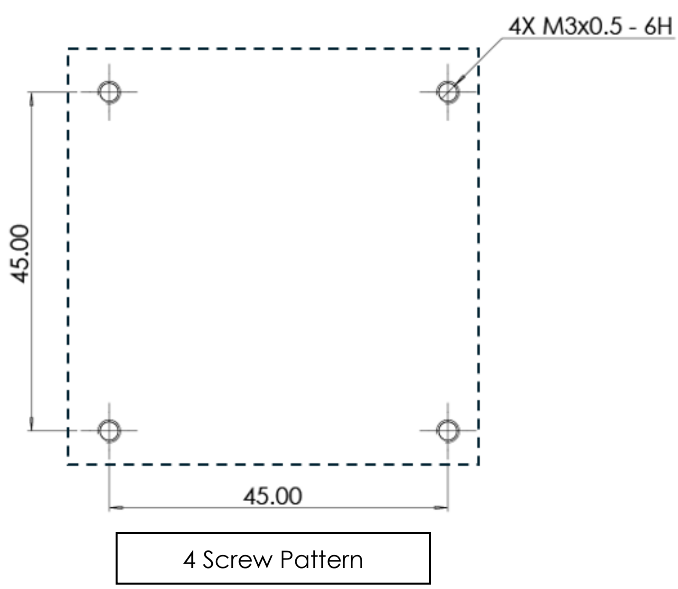


5. Dimensions

5.1.1 *TRI-BOT-50 Stage Dimensions*



5.1.2 *Recommended Mounting Pattern*



6. Stacking Configurations

6.1 Configurations with other Micronix Stages

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

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

7. Connecting the TRI-BOT-50

For controller information refer to the appropriate MMC controller manual.

7.1 Atmospheric Environments

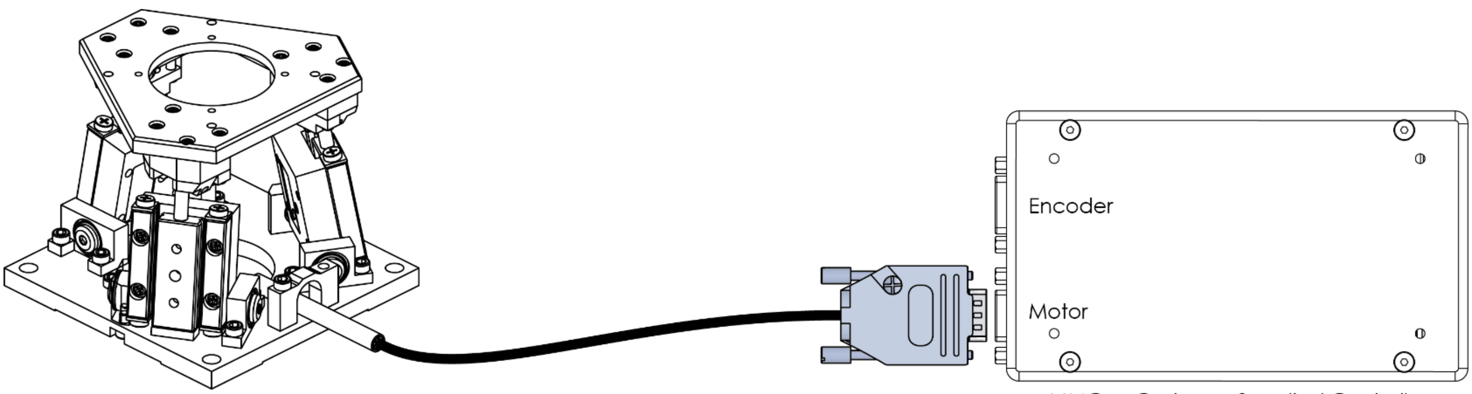
7.1.1 Open Loop Wiring Diagram

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.

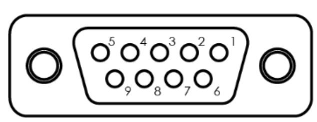
Standard Cable Description:

A. 3 Motor Cables (Male Dsub 9 Pin, 1.5m, Black Cable)

Note: For illustration purposes, only one axis connection is shown. Connectors for all axes are labeled accordingly. The TRI-BOT-50 is a 3-axis system. If a PR-20 is integrated, then it is a 4-axis system.

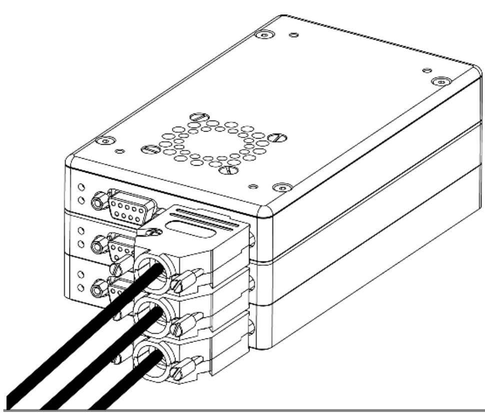


MMC or Customer Supplied Controller



Male Dsub9 Connector - Rear View

Please refer to section 9.4 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.

7.1.1 *Digital/Absolute Encoder Wiring Diagram*

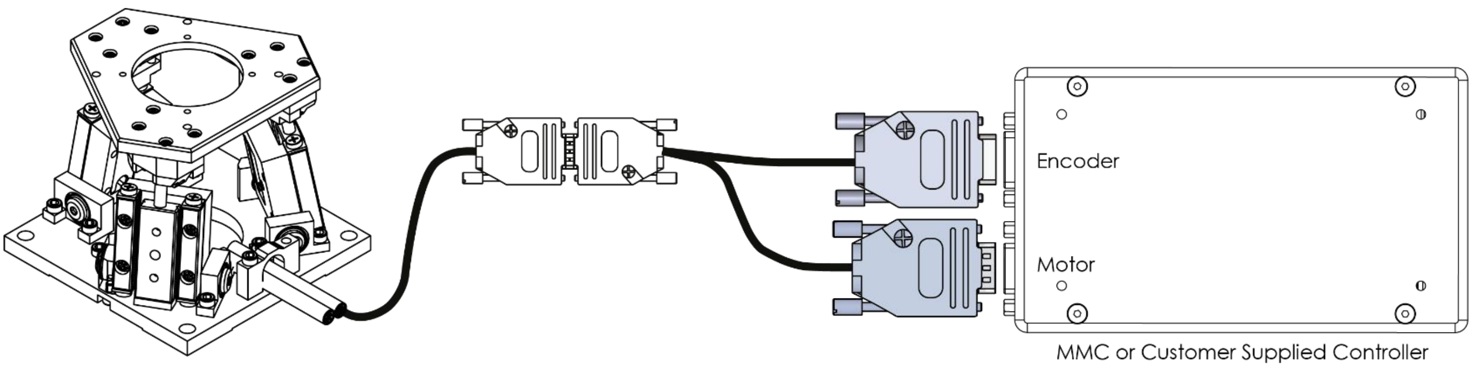
For use with digital encoders or (optional absolute encoders), connect the stage as shown using the supplied DSub 9 Pin cables to connect the encoder and motor to the controller.

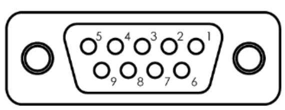
Standard Cable Description:

A. 3* Motor Cables (Male Dsub 9 Pin,1.5m, Black Cable)

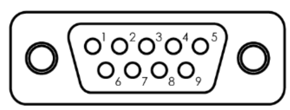
B. 3* Encoder Cables (Female Dsub 9 Pin, 1.5m, Black Cable)

Note: For illustration purposes, only one axis connection is shown. Connectors for all axes are labeled accordingly. The TRI-BOT-50 is a 3-axis system.
***If a PR-20 is integrated, then it is a 4-axis system instead of a 3-axis system.**



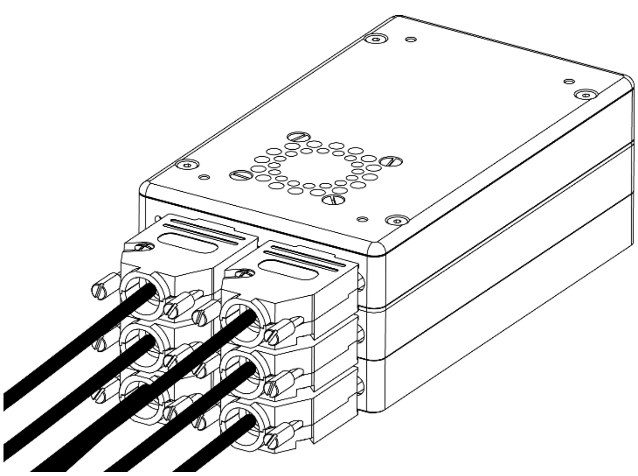


Male Dsub9 Connector - Rear View



Female Dsub9 Connector - Rear View

Please refer to section 9.4 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

7.1 Vacuum Environments

7.1.1 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 Dyiathilate 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

7.1.2 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 for details on the sample feed-through test connector.

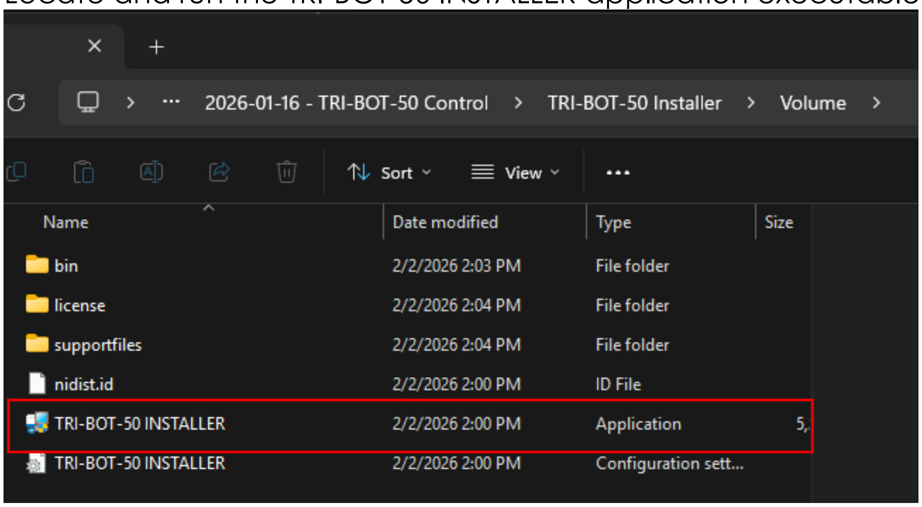
8. Software

8.1 Installation

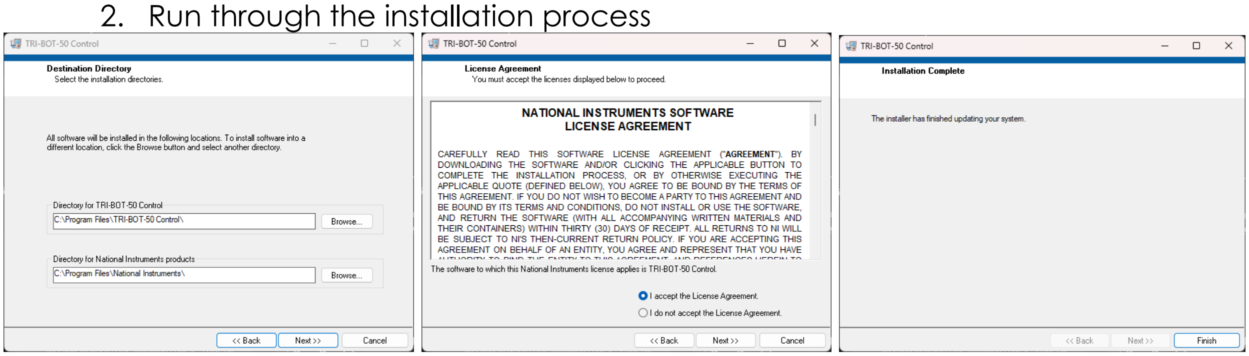
8.1.1 *TRI-BOT-50 Software*

Included in the TRI-BOT-50 package is a USB thumb drive that contains installation software 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



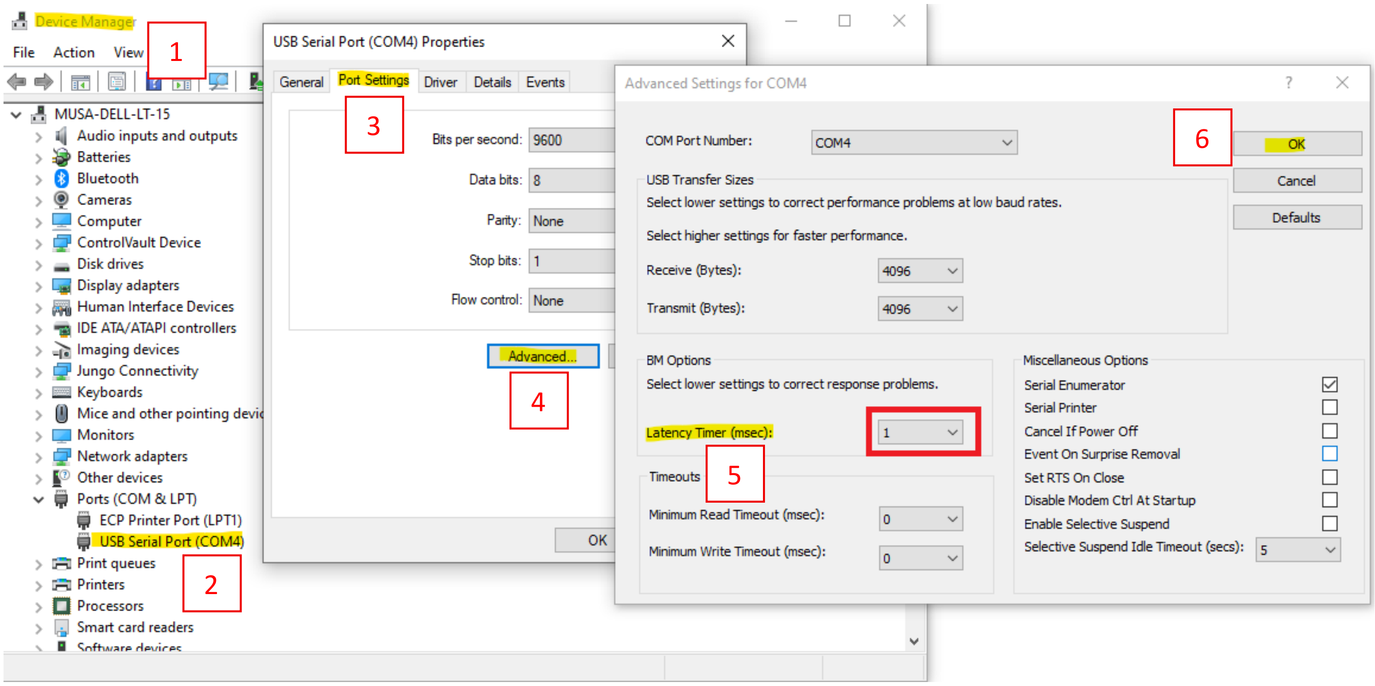
2. Run through the installation process



3. Once the installation is complete, restart the computer

8.2 USB Driver Optimization

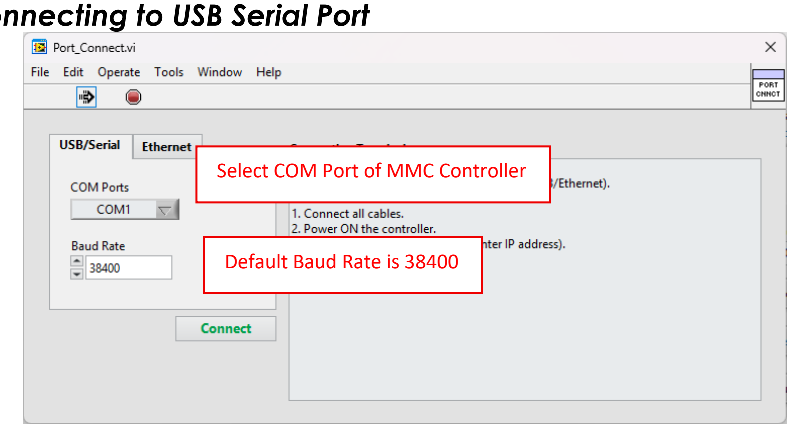
For optimal communication and performance of the Tri-Bot-50, please reduce the default latency on systems with Window OS.



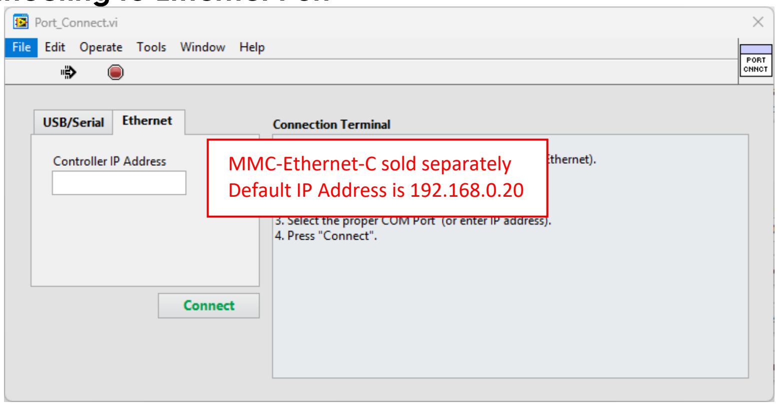
1. Navigate to Device Manager and locate the controller which is named "USB Serial Port (COMx)".
2. Right click on the USB Serial Port and select Properties
3. Navigate to the "Port Settings" tab
4. Click on Advanced… button
5. Change the default 16ms of Latency Timer (msec) to 1ms.
6. Confirm the changes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

8.3 Software Overview

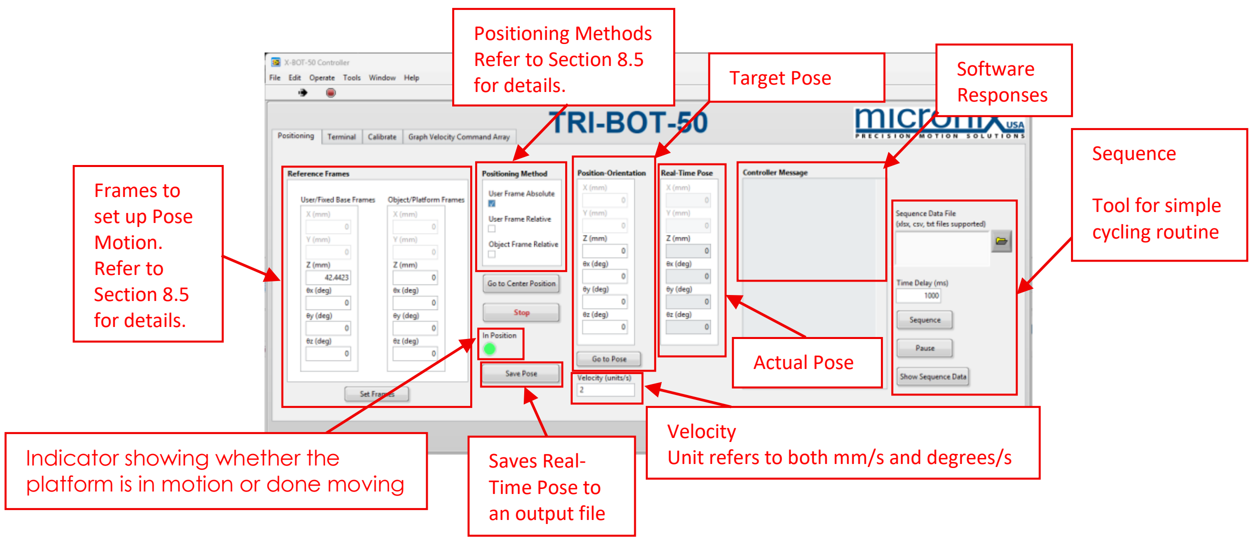
8.3.1 *Connecting to USB Serial Port*



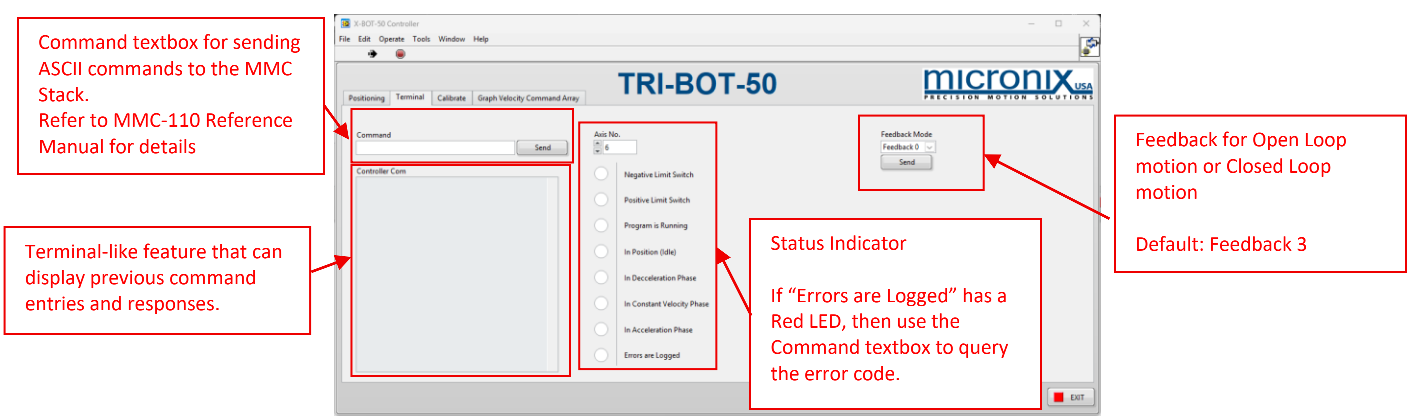
8.3.2 *Connecting to Ethernet Port*



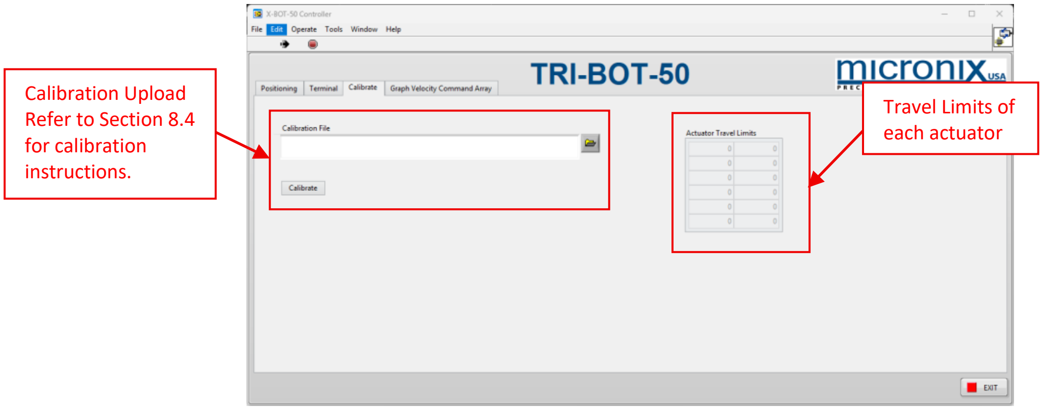
8.3.3 *Positioning Tab*



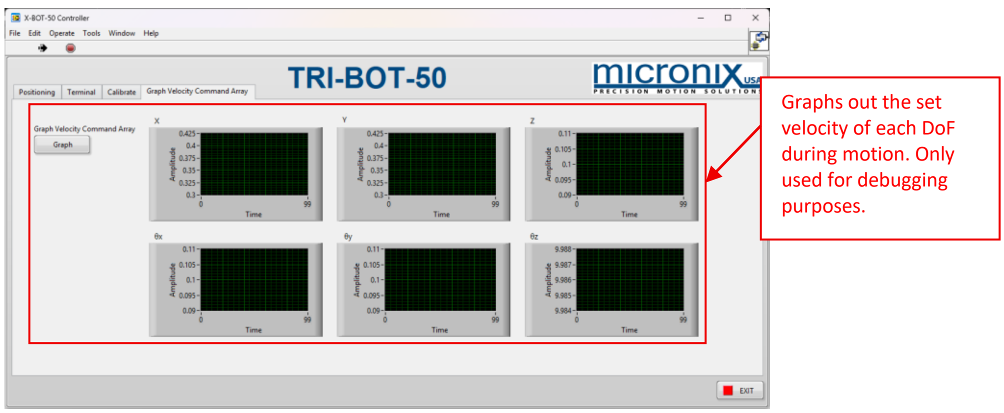
8.3.4 *Terminal Tab*



8.3.5 *Calibrate Tab*



8.3.6 *Graph Velocity Command Array Tab*

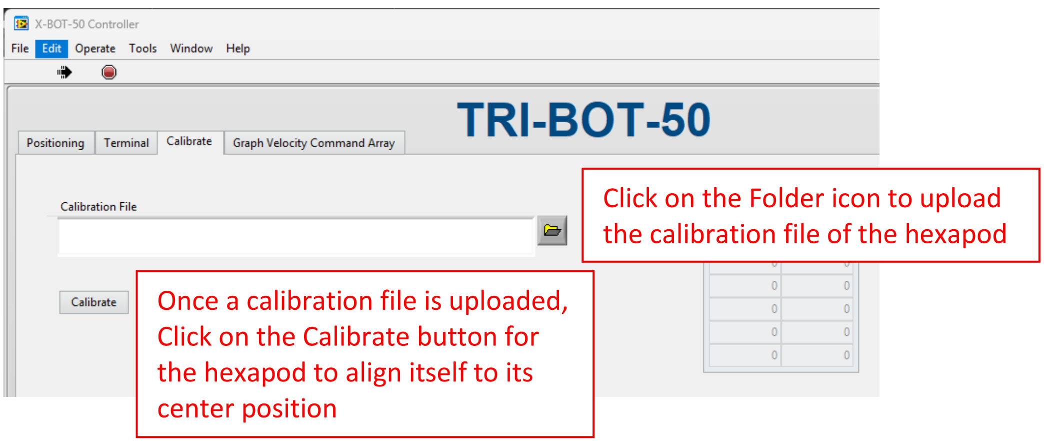


8.4 Calibration

On every start-up of the Tri-Bot-50 system, calibration is required to properly use the hexapod motion and positioning. This is due to the incremental encoders equipped on the positioners which do not retain their absolute position when powered off.

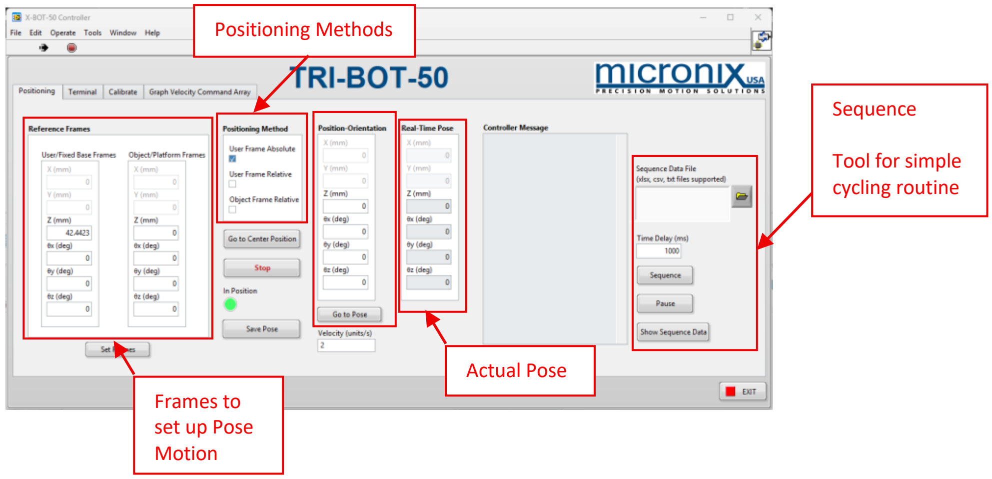
Due to tolerance and differences in manufacturing, each hexapod system will have their own calibration file to ensure that the hexapod system is calibrated to the specification as described on its datasheet.

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.



8.5 Motion

Once calibrated, the Tri-Bot-50 is ready to use. Navigate to the Positioning tab to start controlling the position-orientation (pose) of the Tri-Bot-50.



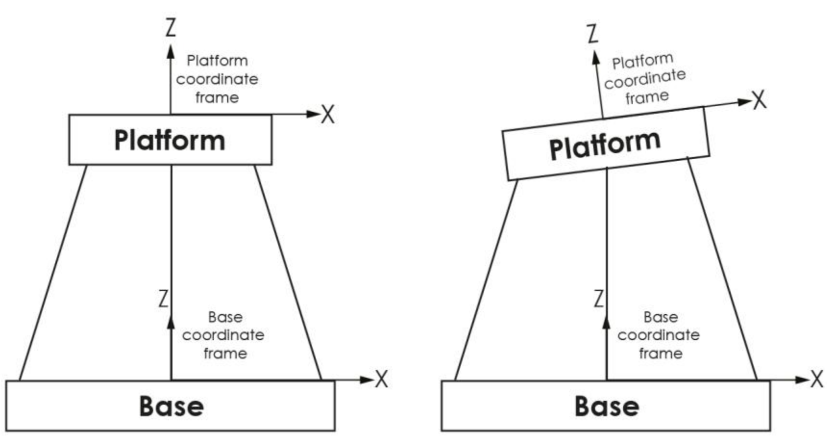
8.5.1 *Frames*

The movements of the Tri-Bot-50 are achieved by using multiple coordinate frames. These frames are divided into two categories:

1. Fixed (manufacturer-defined) coordinate frames

   The fixed coordinate frames consist of the <u>Base Coordinate Frame</u> and the <u>Platform Coordinate Frame</u>.

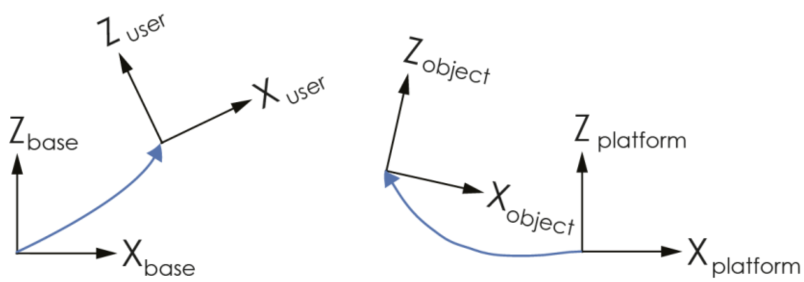
   - The Base Coordinate Frame is fixed on the top of the base surface of the Tri-Bot-50, with its origin at the center of the circular cutout of the base.
   - The Platform Coordinate Frame is fixed on the top of the platform surface, with its origin at the center of the circular cutout of the platform or coincident with the axis of the rotary stage.



2. User-defined coordinate frames

   Two user-defined coordinate frames can be assigned relative to the two fixed coordinate frames:

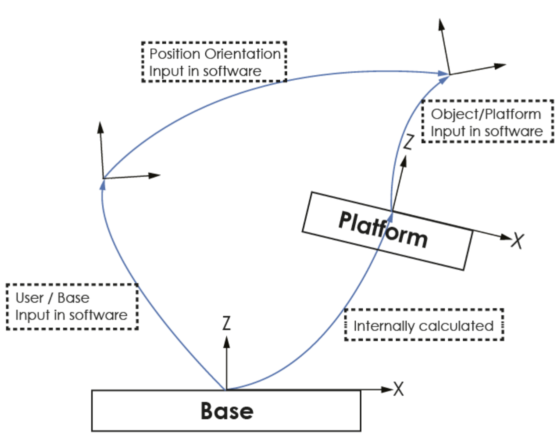
   a. User Coordinate Frame: Defined as relative to the Base Coordinate Frame
   b. Object Coordinate Frame: Defined relative to the Platform Coordinate Frame



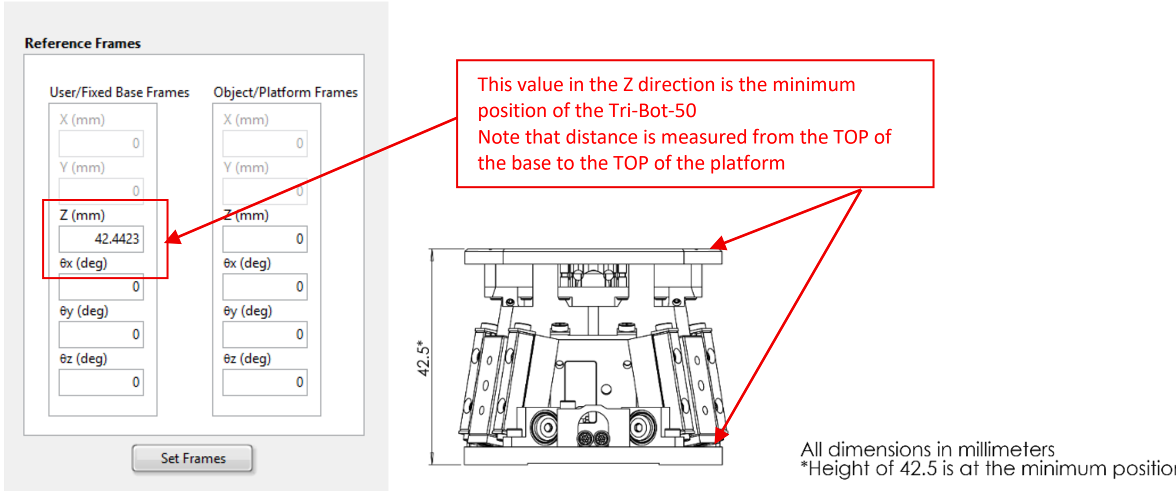
The Euler Type II convention is used to define the relative position/orientation between the user-defined coordinate frames and fixed coordinate frames. This convention involves three successive rotations about the axes of the original frame - first about the x-axis by an angle θx, then about the resulting y-axis by an angle θy, and finally about the resulting z-axis by an angle θz. The angles θx, θy, and θz are successive rotations in that specific order.

Example of Euler Type II pose: [1 2 3 4 5 6]
where x = 1 mm , y = 2 mm, z = 3 mm, θx = 4 degrees, θy = 5 degrees, θz = 6 degrees

The displacement of the origin is defined along each x, y, and z axis of the fixed coordinate frames. Figure 1. shows the fields on the software interface where the parameters are taken as inputs for the user defined coordinate frames. Figure 3. Illustrates how the position/orientation of the Tri-Bot-50 is realized using the fixed and user defined coordinate frames.

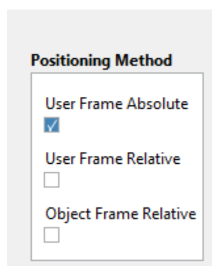


Why Does the User/Fixed Base Frame Have a Pre-Defined Value?



When the User/Fixed Base Frame is set to its minimum height, this value internally sets the starting position-orientation to [0 0 0 0 0 0] and is generally easier to start with.

8.5.2 *Positioning Method*



There are three modes of operation for the X-BOT-120 software:

1. Absolute Position/Orientation Control in the User Coordinate Frame

   This mode allows the user to control the Tri-Bot-50 by specifying the desired position and orientation of the platform in the User Coordinate Frame.

2. Relative Position/Orientation Control in the User Coordinate Frame

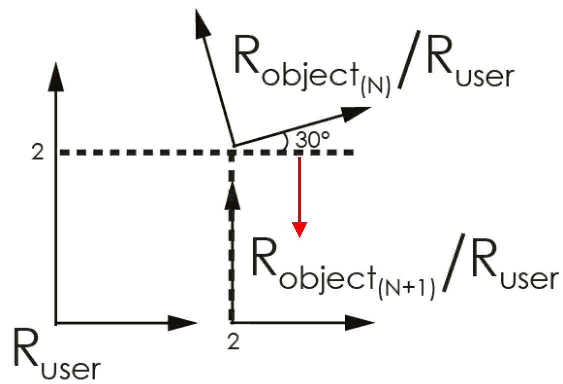
   This mode allows the user to control the Tri-Bot-50 by specifying the desired change in position and orientation of the platform relative to its current position and orientation in the User Coordinate Frame.

3. Relative Position/Orientation Control in the Object Coordinate Frame

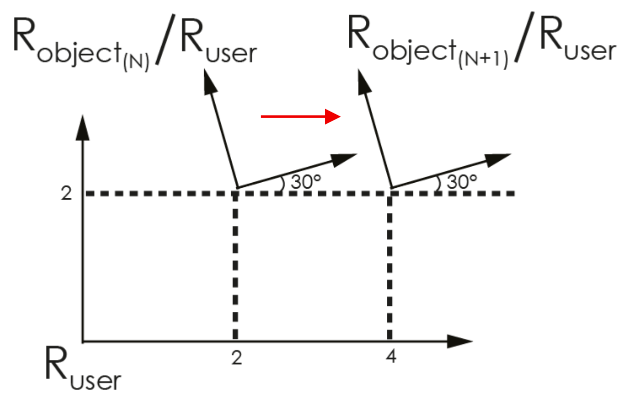
   This mode allows the user to control the Tri-Bot-50 by specifying the desired change in position and orientation of an object placed on the platform relative to its current position and orientation in the Object Coordinate Frame.

The following examples illustrate the positioning of the Object Coordinate frame relative to the User Coordinate frame (R_{object}/R_{user}) for the two consecutive position commands represented by [X Y Z θy θy θz], are Pose 1 [2 0 2 0 -30 0] and Pose 2 [2 0 0 0 0 0].

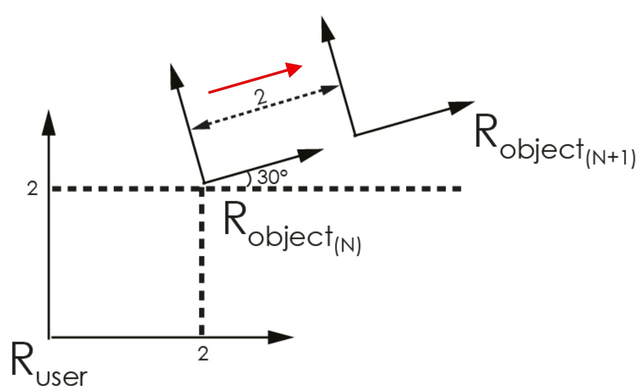
**The notation R_N and R_{N+1} denotes, coordinate Pose 1 relative to coordinate Pose 2.



User Frame Absolute control

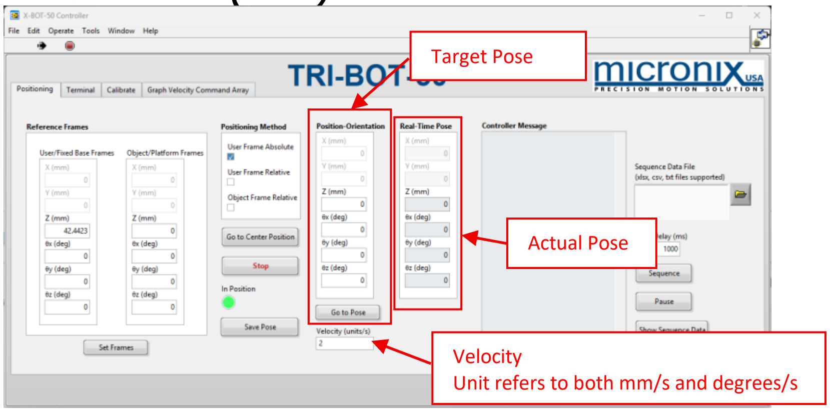


User Frame Relative control



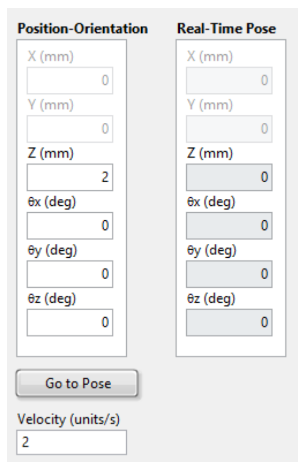
Object Frame Relative control

8.5.3 *Position-Orientation (Poses)*

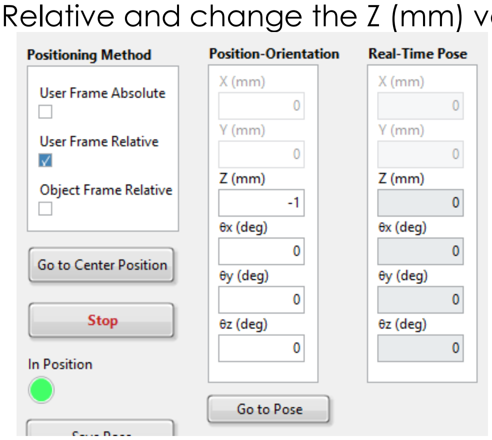


To set a target position-orientation (pose), fill in the positional values of each degree of freedom.

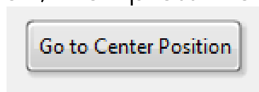
For example, if you wish to move the Tri-Bot-50 up in the Z-direction by 2mm from the center position (from [0 0 0 0 0 0] to [0 0 2 0 0 0]), then set 2 to the Z(mm) textbox and leave all other boxes as 0. Then press the "Go To Pose" button.



If you want to go down by 1 mm from the current location [0 0 2 0 0 0], then you can switch the Positioning Method to User Frame Relative and change the Z (mm) value to -1 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.

9. Supplementary Information

9.1 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.
- The TRI-BOT-50 system is a precision mechanical device and should be handled with care. Do not drop or mishandle the system.
- Do not touch with bare hands to avoid contamination that could jeopardize the longevity of 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.
- Follow the *Installation Preparation* requirements and use proper cable management to ensure a clean and safe operating environment.

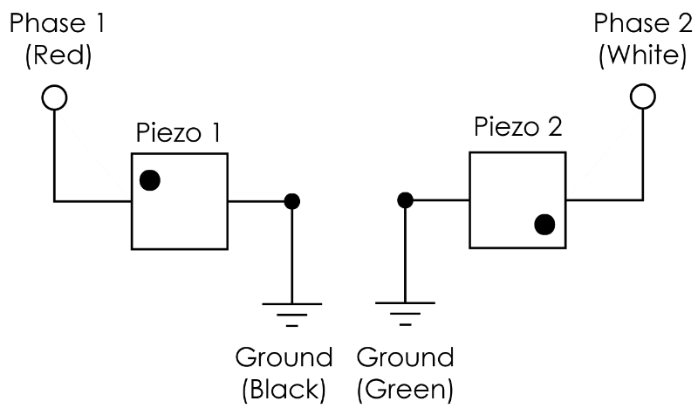
9.2 Units and Conversions

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

10. Appendix

10.1 2 Phase Piezo Motor Wiring Diagram



10.1.1 *Piezo Operating and Electrical Specifications*

Voltage	60V maximum
Capacitance	150nf ±15%
Operating Temperature	50°C maximum

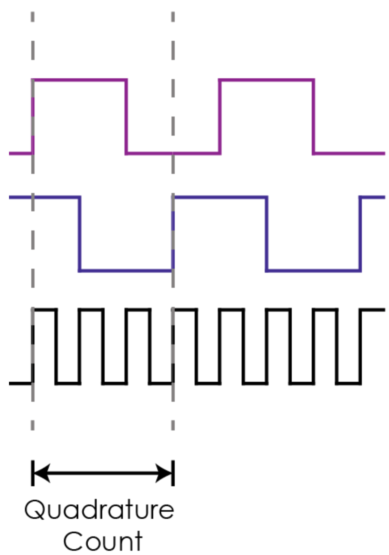
10.2 Using a Digital Encoder, overview

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).

10.2.1 *Operating and Electrical Specifications*

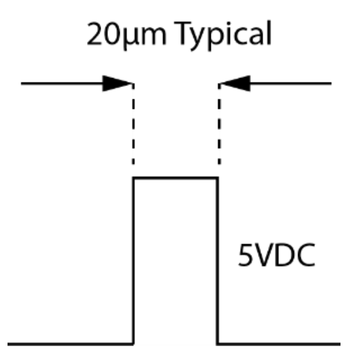
Power Supply	5VDC ±5%
Operating Temperature	0 to 40°C
Humidity	10 - 90% RH non-condensing

10.2.2 *Digital Square Wave Output (Pins 1,2,6, and 7)*



(RS-422 Standard)

10.2.3 *Index Window (Pins 3)*

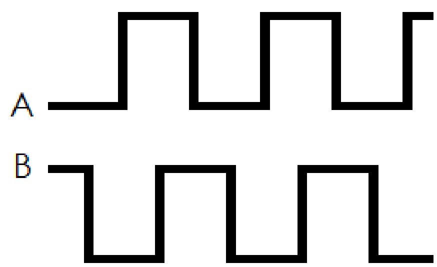


10.2.4 *Resolution*

The encoder resolution is programmed and is configured to the resolution specified in the sales order.

10.2.5 *Output Signals*

Quadrature TTL*

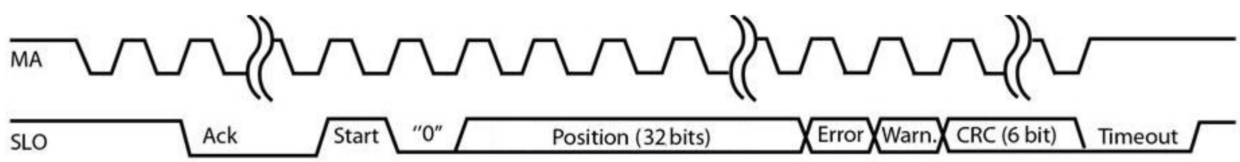


*Output signals are differential. Inverse signals are not shown for clarity.

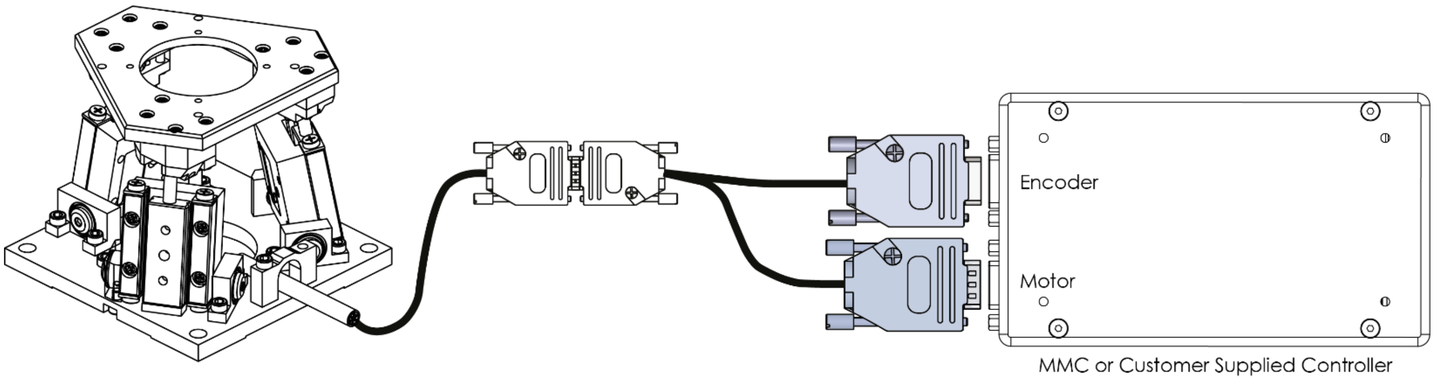
10.3 *Using an Absolute BiSS-C Encoder Interface*

10.3.1 *Absolute Encoder Signals BiSS C-Mode Interface*

The Micronix 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.

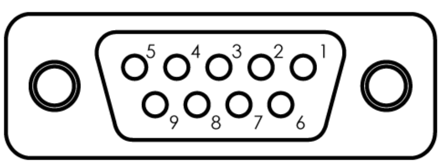


10.4 TRI-BOT Motor and Encoder Wiring Diagram

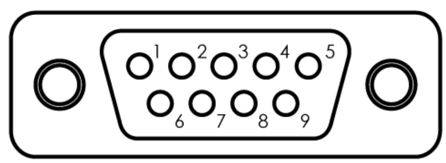


Motor	
Male Dsub 9 Pin	Function
1	Phase 1
2	Phase 2
3	N.C.
4	N.C.
5	Motor GND
6	N.C.
7	N.C.
8	N.C.
9	N.C.
Casing	Shield

Encoder [Digital (RS-422) / Absolute BiSS-C]		
Female Dsub 9 Pin	Function (Digital RS-422)	Function (Abs BiSS-C)
1	A+	SLO+ / Data+
2	B+	MA+ / Clock+
3	Index+	SLI+
4	GND	GND
5	+5VDC	+5VDC
6	A-	SLO- / Data-
7	B-	MA- / Clock-
8	Index-	SLI-
9	Not In Use	Not In Use
Casing	Shield	Shield



Male Dsub9 Connector - Rear View



Female Dsub9 Connector - Rear View