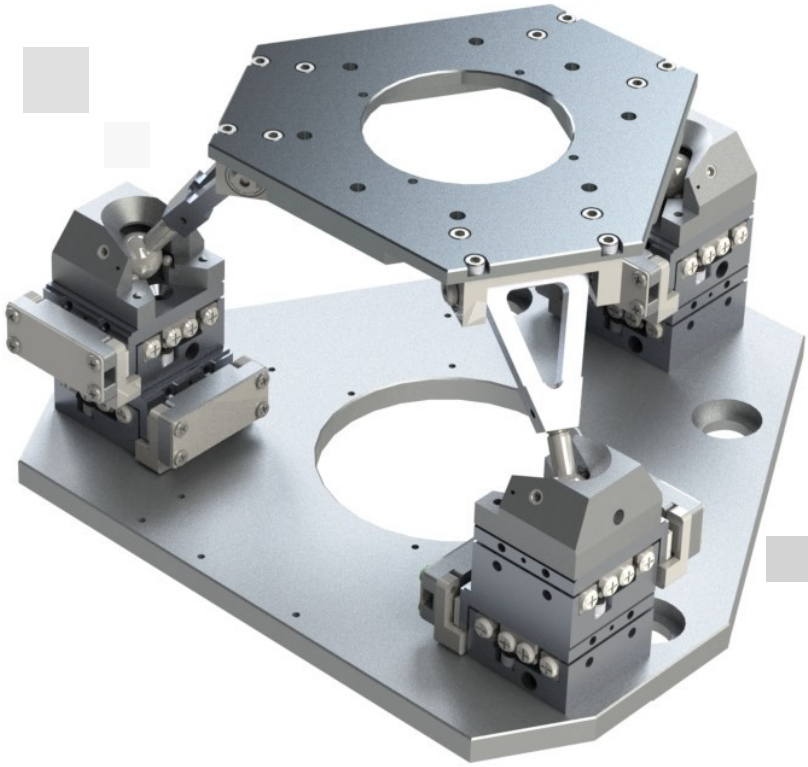
X-BOT-120 Series



6 Degree of Freedom Platform

Reference Manual

(Open and Closed Loop Versions)

micronix USA
PRECISION MOTION SOLUTIONS

X-BOT-120

Hexapod Positioning System
Reference Manual

Rev 2.0

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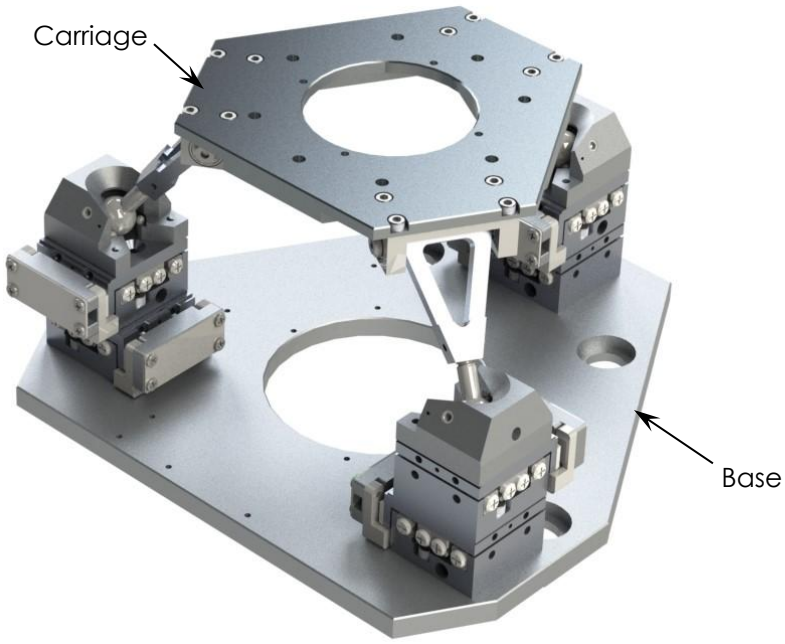
1. Introduction

1.1 Product Description

The X-BOT-120 is a miniature hexapod for the positioning and adjustment of precision components in 6 degrees of freedom (X, Y, Z, θx, θy and θz). It comes with software that includes inverse kinematics and allows for carriage positioning in degrees/mm. The X-BOT-120 is 70 mm tall and has sub-micron resolution. 360° z-rotation can be integrated into the carriage with a PR-32L. HV, UHV, and non-magnetic versions are available. Custom travel ranges are available upon request.
The 360° z-rotation is achieved using the optional PR-32L rotational stage, which is factory-installed under the carriage – see Section 4.1 for this configuration. Refer to the PR-32L Manual for details about the PR-32L.

Product Specifications	**X&Y**	**Z-axis**	**θX-axis**	**θY-axis**	**θZ-axis**
Travel from Center	±6mm	+3.5/-6mm	+7/-9°	±9°	±6°
Max Speed (MMC-110)	5 mm/s		3°/s		
Resolution (absolute encoder)	25 nm		100 µ°		
Bi-directional Repeatability	± 200 nm		± 200 µ°		
Max Load	2 N	5 N	N/A		
Environment	Atmospheric, HV, UHV, Non-Magnetic				



X-BOT-120
(Shown in center position)

1.2 Recommended Controllers

The X-BOT-120 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-120 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-32L.

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 X-BOT-120 product page on the MICRONIX USA website (www.micronixusa.com).

2. Preparing to Install the X-BOT-120

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°C ± 2°C unless otherwise specified. Be sure to use the X-BOT-120 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 X-BOT-120 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-120 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-120
- 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-120

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

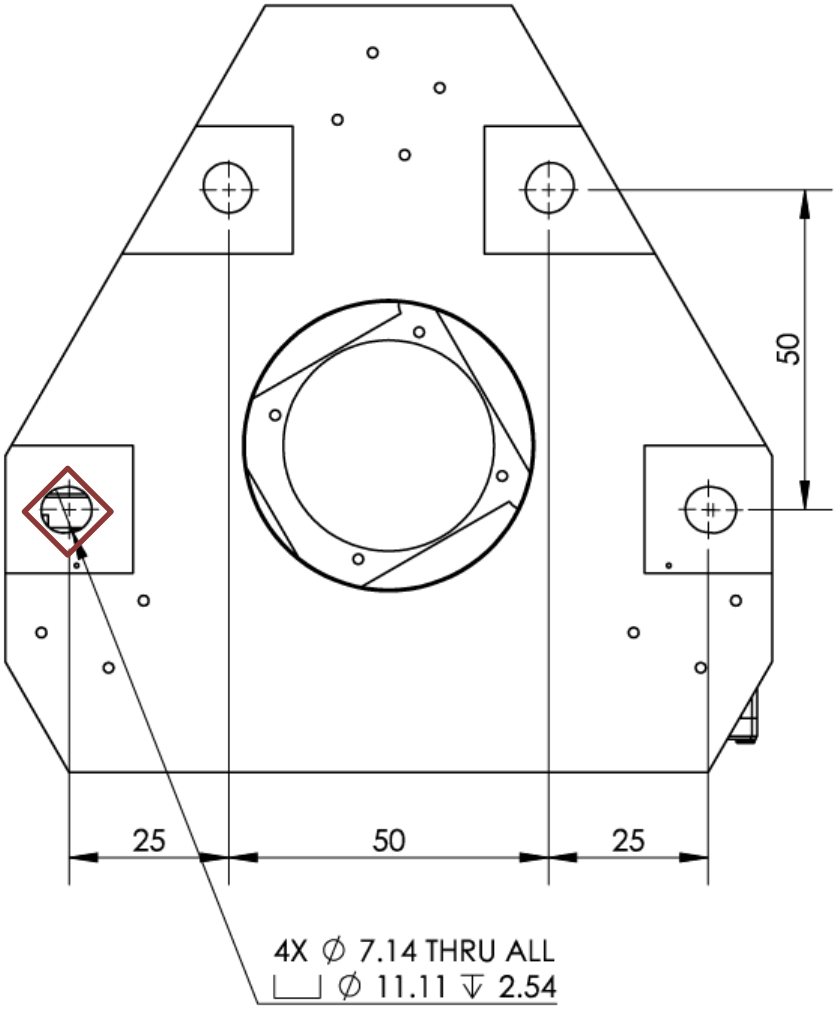
3.1 X-BOT-120 Installation

3.1.1 *General Mounting Patterns*

Mounting surface hole pattern. For best performance, the mounting surface should have a flatness of 25 µm or better. The X-BOT-120 Base supports mounting on either metric or imperial optical tables. See X-BOT-120 dimensions in Section 5.

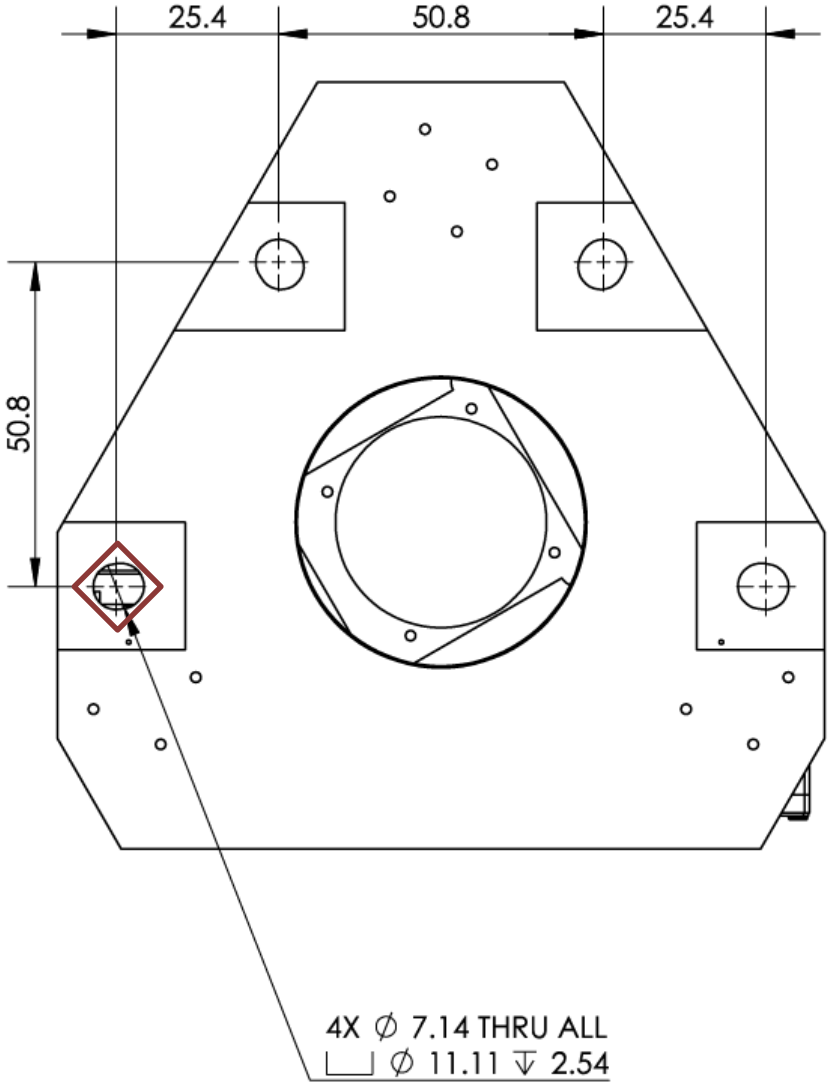
X-BOT-120, Metric mounting hole pattern:

NOTE 1: PPS-20 stage at the lower left mounting hole (marked with a diamond) potentially interferes with the mounting hole. The stage can be moved by hand to allow access to above the base.
NOTE 2: All dimensions are in mm.



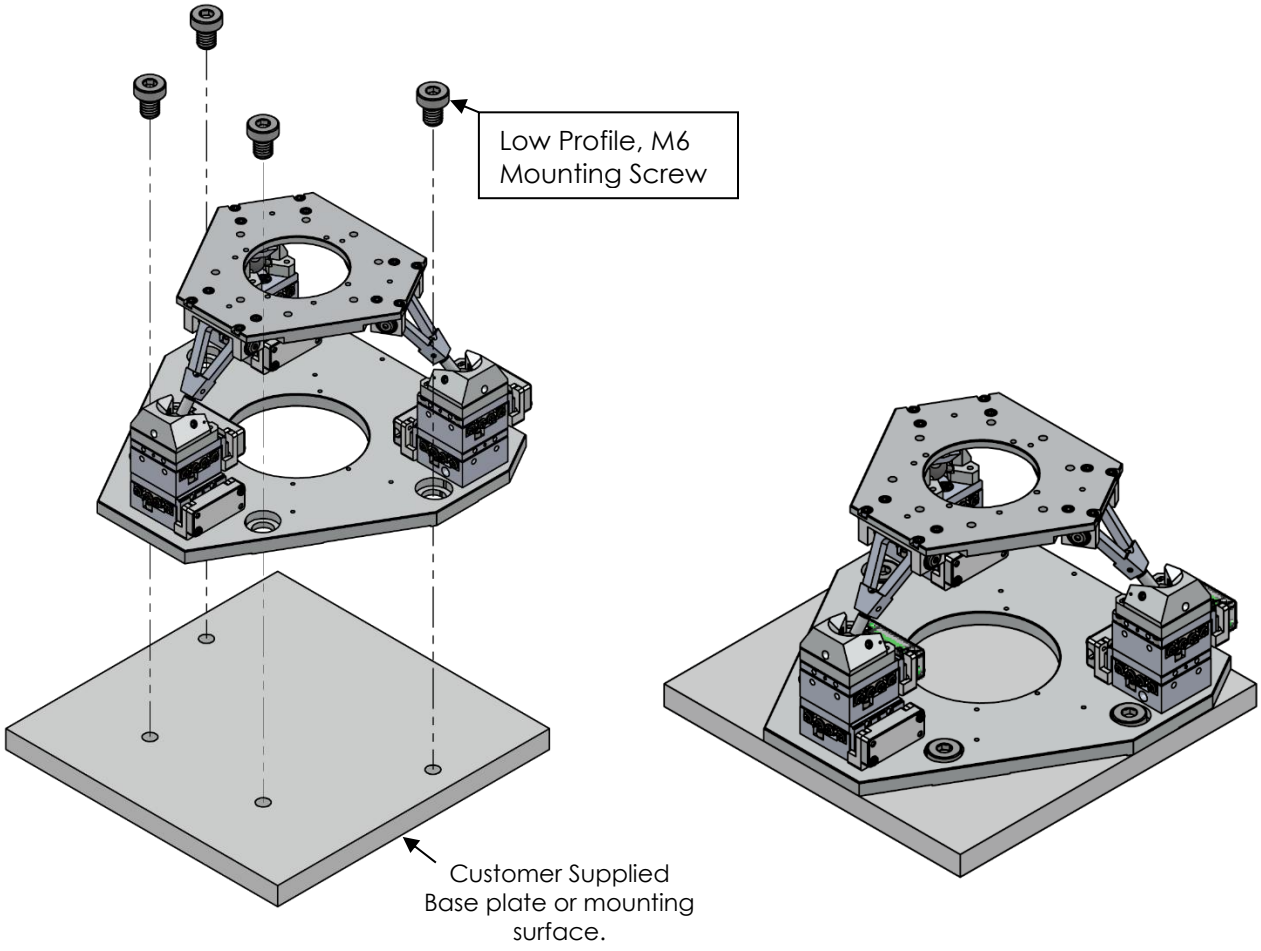
X-BOT-120, Imperial mounting hole pattern:

NOTE 1: PPS-20 stage at the lower left mounting hole (marked with a diamond) potentially interferes with the mounting hole. The stage can be moved by hand to allow access to above the base.
NOTE 2: All dimensions are in mm.



3.1.2 *General Mounting*

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



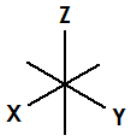
3.2 Mounting to the X-BOT-120

The payload mounts to the X-BOT-120 (without PR-32L) via the carriage on top of the stage. To mount to the X-BOT-120 with a PR-32L, refer to the PR-32L Manual. The recommended specifications for mounting to the X-BOT-120 are found below:

- Use 8 x M3X0.5 - 6H screws with a max depth of 5 mm.
- For best performance, torque all screws to 0.16 Nm.
- For best performance, the payload mating surface should have a flatness of 25 µm or better.

4. Stacking Configurations

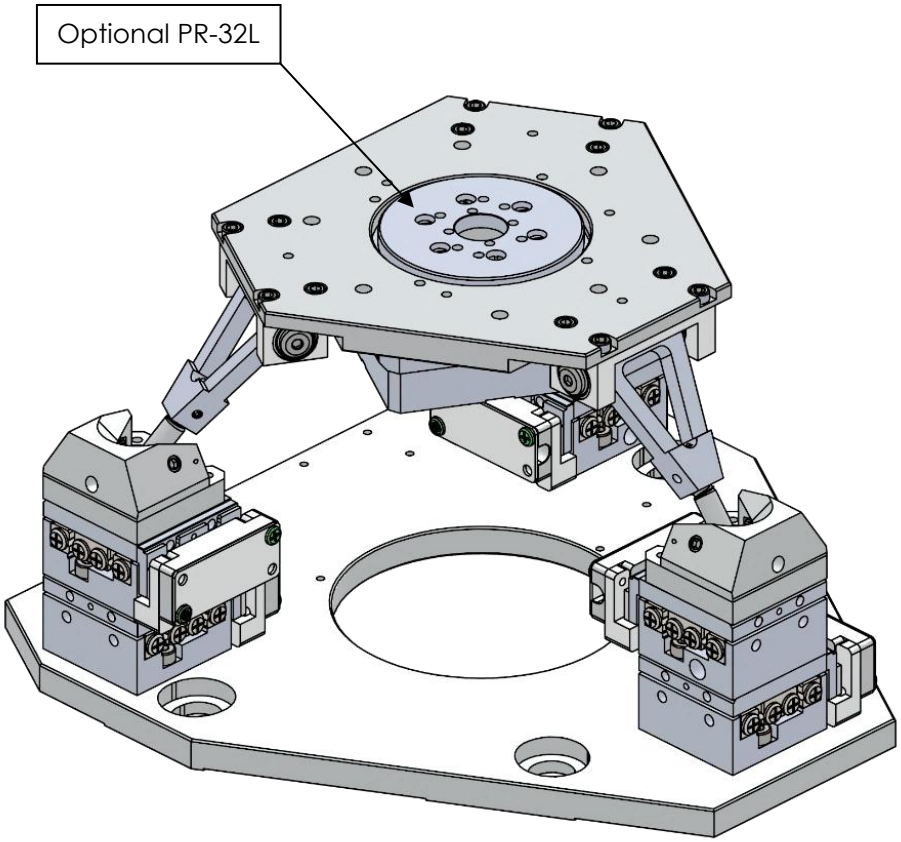
- Additional configurations may be available upon request.
- Images are positioned according to:



4.1 Configurations with other Micronix Stages

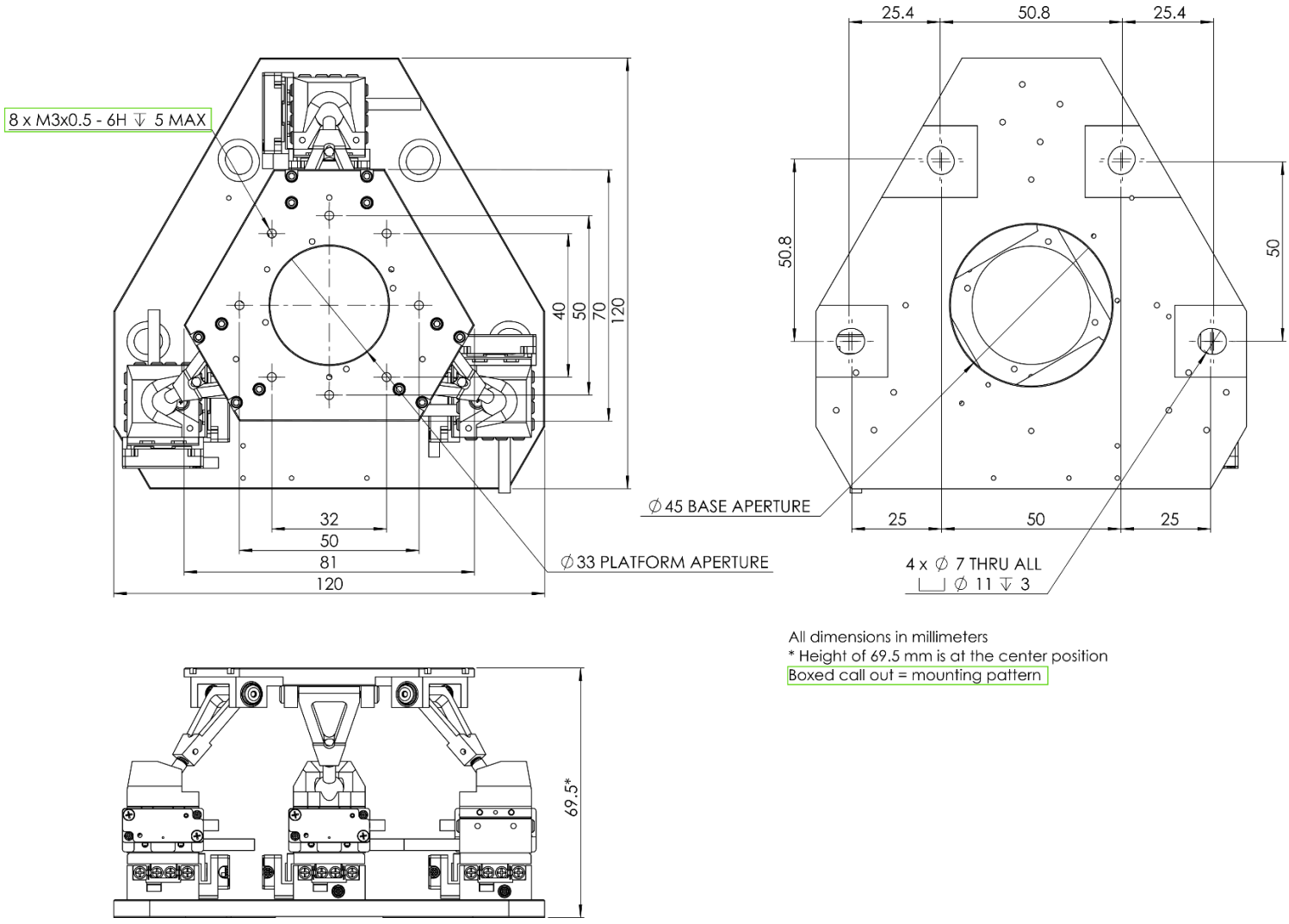
4.1.1 *X-BOT-120 with PR-32L, Rotational Stage*

The X-BOT-120 can optionally be integrated with full 360° rotation stage PR-32L stage (factory installed).



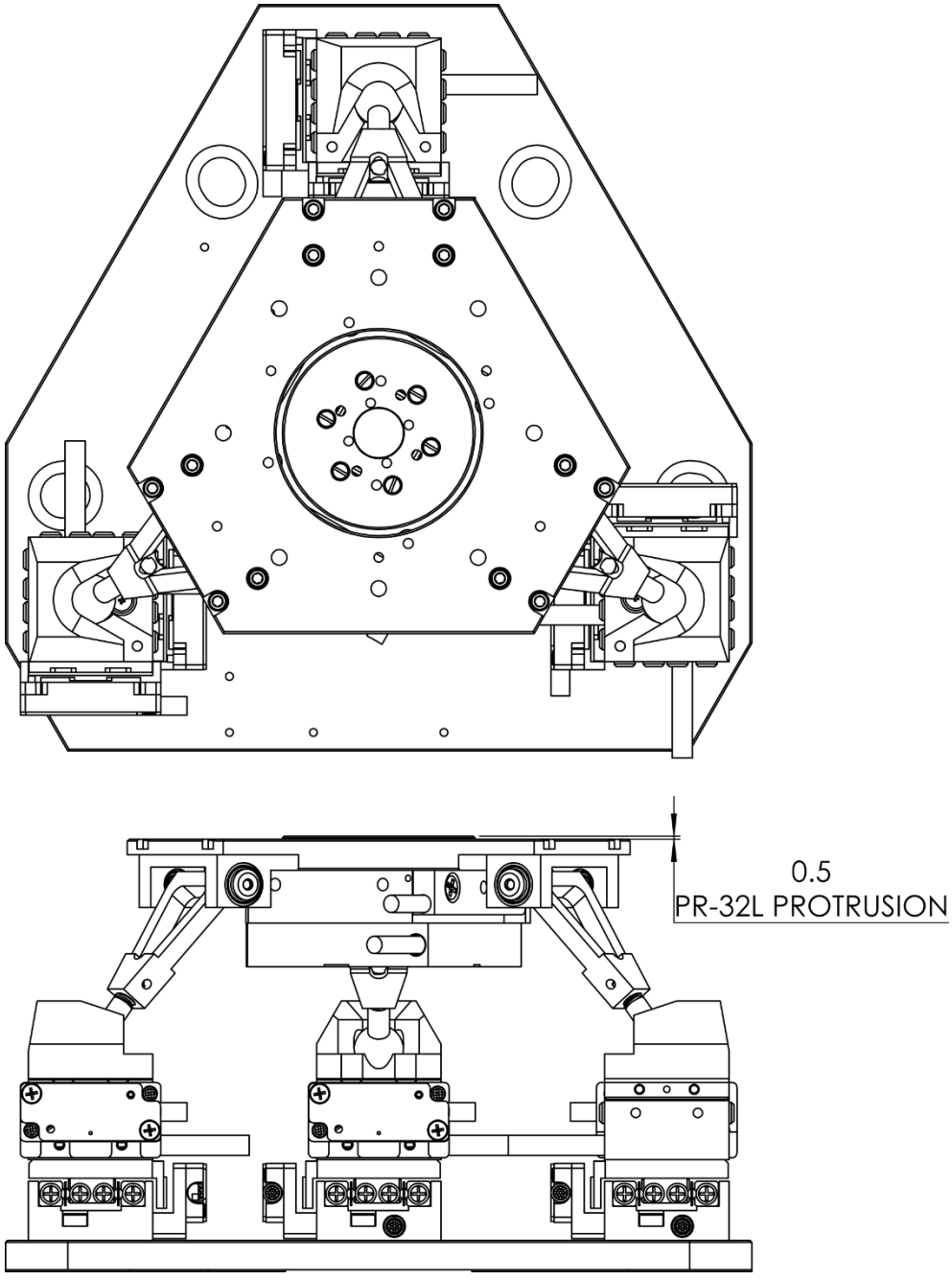
5. Dimensions

5.1 X-BOT-120 Stage Dimensions



All dimensions in millimeters
* Height of 69.5 mm is at the center position
Boxed call out = mounting pattern

5.2 X-BOT-120 Stage Dimensions with PR-32L



6. Connecting the X-BOT-120

For controller information refer to the appropriate MMC controller manual.

6.1 Atmospheric Environments

6.1.1 *Absolute Encoder Wiring Diagram*

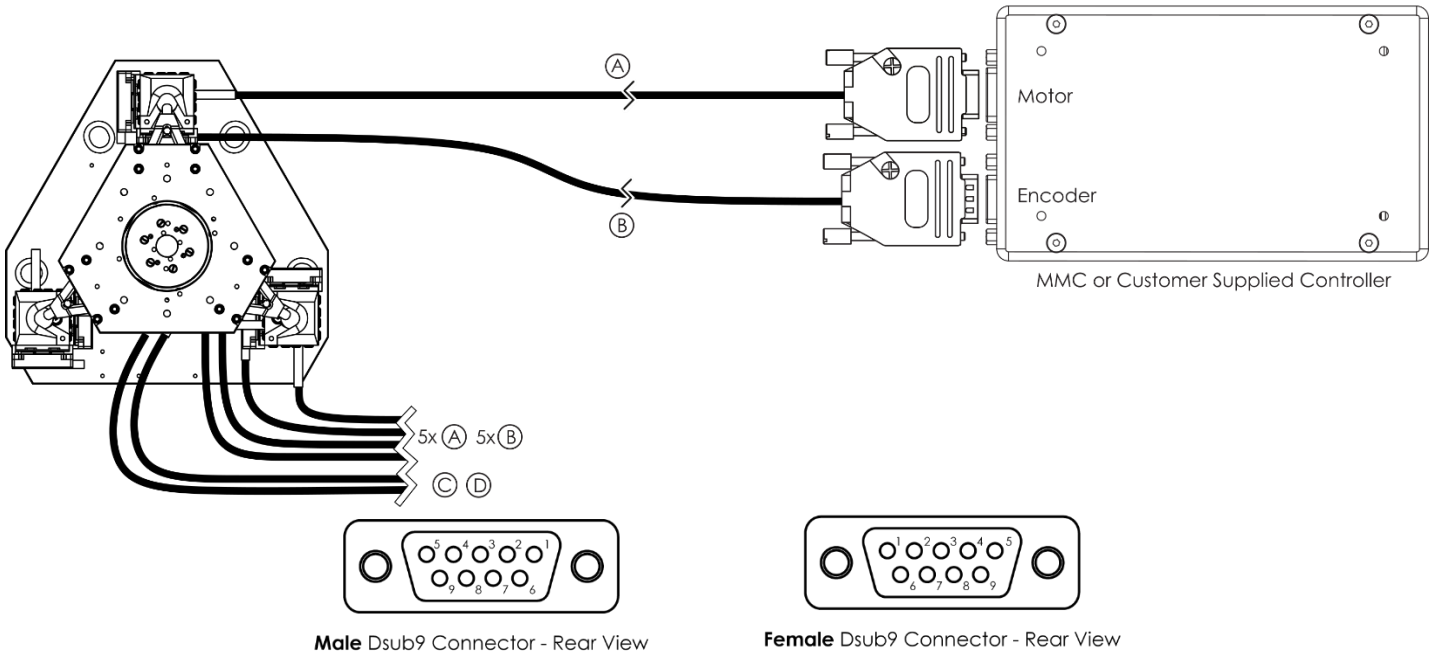
For X-BOT-120 with absolute encoder, connect the stage as shown using the supplied DSub 9 Pin cables to connect the Encoder and Motor to the Controller.

NOTE: For illustration purposes, only one axis connection is shown. Connectors for all axes are labeled Axis 1 through Axis 6. If a PR-32L is integrated, the connectors are labeled Axis 1 through Axis 7.

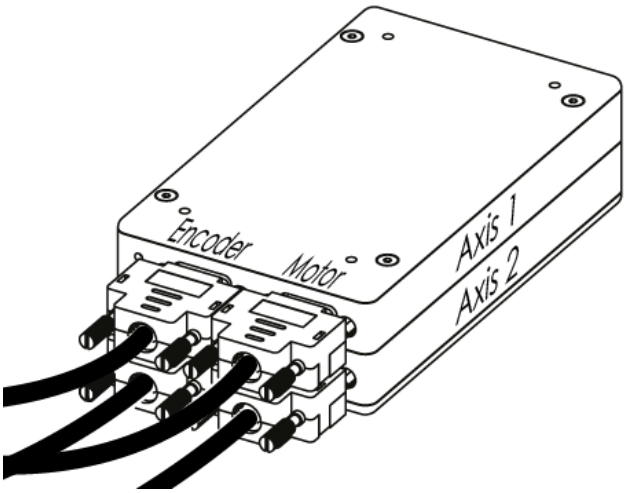
Wiring Diagram:

Cable Descriptions:

A. 6 x Linear Stage Motor Cable (Male Dsub 9 Pin Connector, 1.5m, PVC Black Cable)
B. 6 x Linear Stage Encoder Cable (Female Dsub 9 Pin Connector, 1.5m, PVC Black Cable)
C. 1 x Rotational Stage Motor Cable (Male Dsub 9 Pin Connector, 1.5m, PVC Black Cable)
D. 1 x Rotational Stage Encoder Cable (Female Dsub 9 Pin Connector, 1.5m, PVC Black Cable)



Please refer to section A.2 for the wiring pinout



For proper connection, make sure that the Dsub9 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 stage for vacuum environments, take the necessary precautions when handling the stage, 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)	Nickle-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	15 Pin Female DAP
Ultra-High Vacuum (10^{-9} mbar)	9 Pin Female PEEK	15 Pin Female PEEK

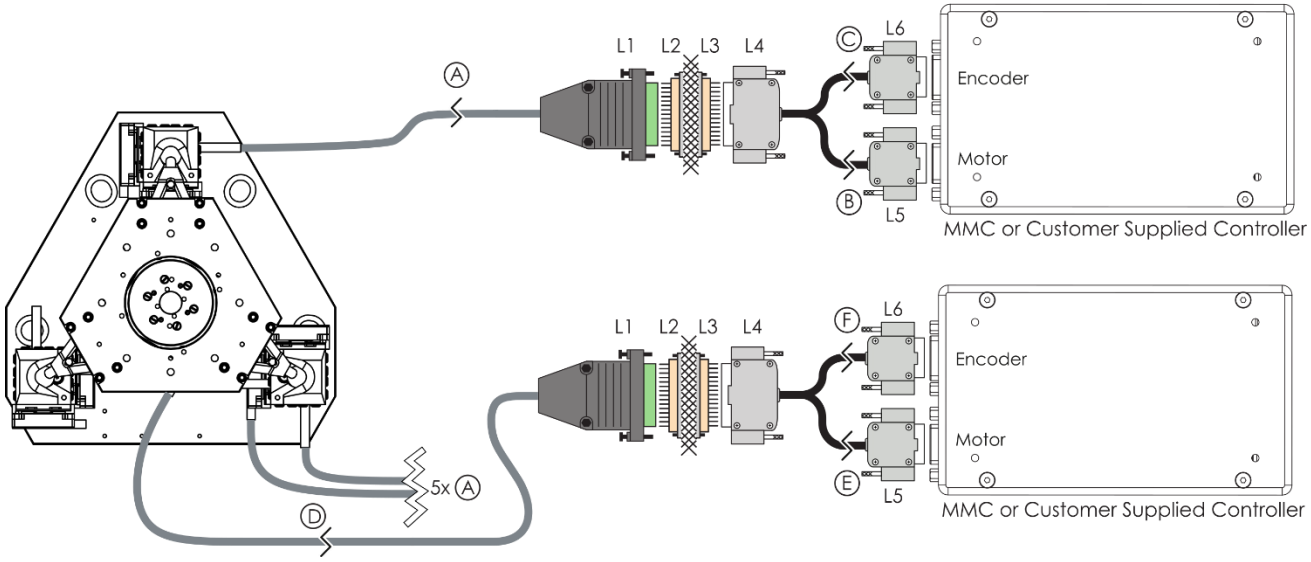
6.2.2 *Vacuum Wiring Diagram*

Connecting the X-BOT-120 in a vacuum chamber requires the use of a feed-through connector at the vacuum chamber wall. The vacuum compatible X-BOT-120 is 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 Wiring Diagram.

NOTE: For illustration purposes, only two axis connections are shown. Connectors for all axes are labeled Axis 1 through Axis 6. If a PR-32L is integrated, the connectors are labeled Axis 1 through Axis 7.

Cable Descriptions:

A. 6 x Linear Stage Vacuum Cable (Male Dsub15 PEEK or DAP, 1.5m, Silver Braided Cable)
B. 6 x Linear Stage Encoder Cable (Female Dsub 9 Pin Connector, 1.5m, PVC Black Cable)
C. 6 x Linear Stage Motor Cable (Female Dsub 9 Pin Connector, 1.5m, PVC Black Cable)
D. 1 x Rotational Stage Vacuum Cable (Female Dsub15 PEEK or DAP, 1.5m, Silver Braided Cable)
E. 1 x Rotational Stage Motor Cable (Female Dsub 9 Pin Connector, 1.5m, PVC Black Cable)
F. 1 x Rotational Stage Encoder Cable (Female Dsub 9 Pin Connector, 1.5m, PVC Black Cable)



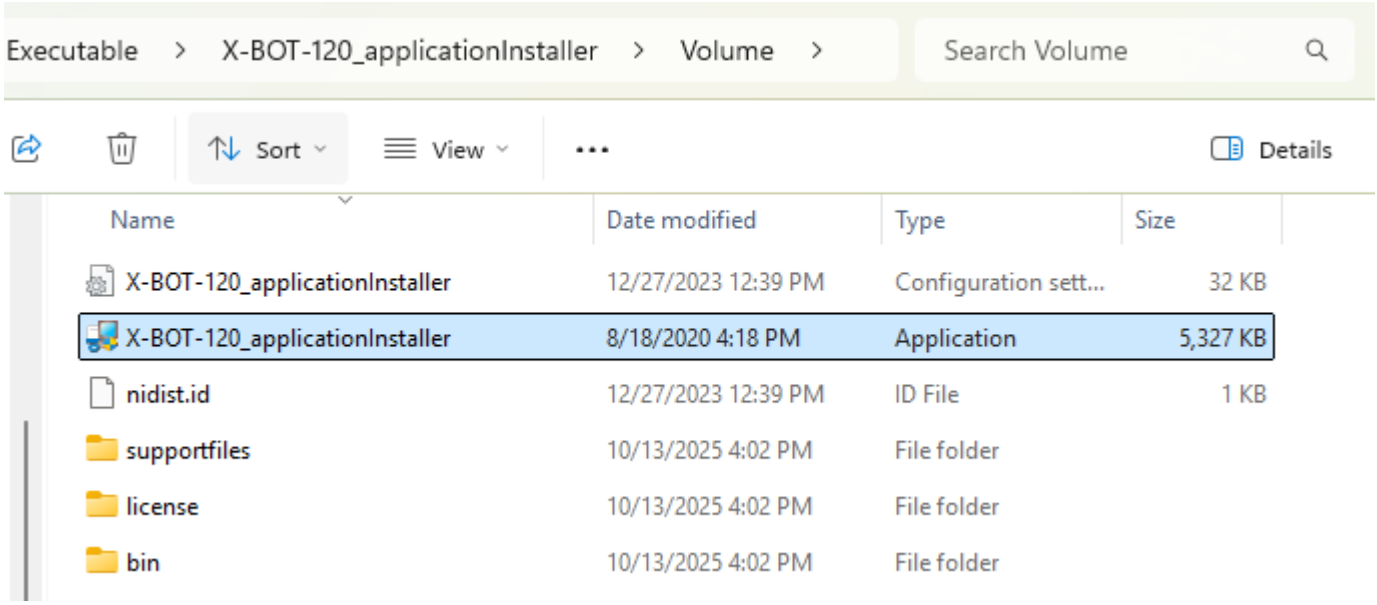
7. Software

7.1 HexaSoft™ Installation

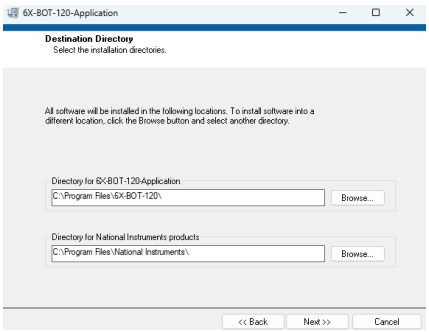
7.1.1 *X-BOT-120 Software*

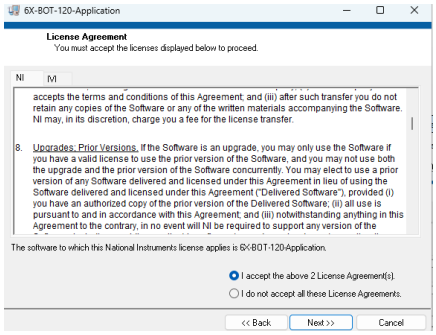
Included in the X-BOT-120 package is a USB thumb drive that contains the X-BOT-120 Installer and additional calibration file required for initialization. If a USB thumb drive is not included, then please contact MICRONIX USA for the backup software and files to be sent.

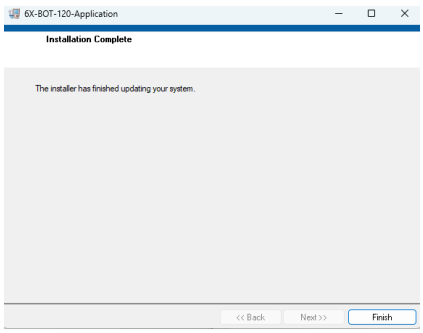
1. Locate and run the X-BOT-120 INSTALLER application executable.



2. Run through the installation process.





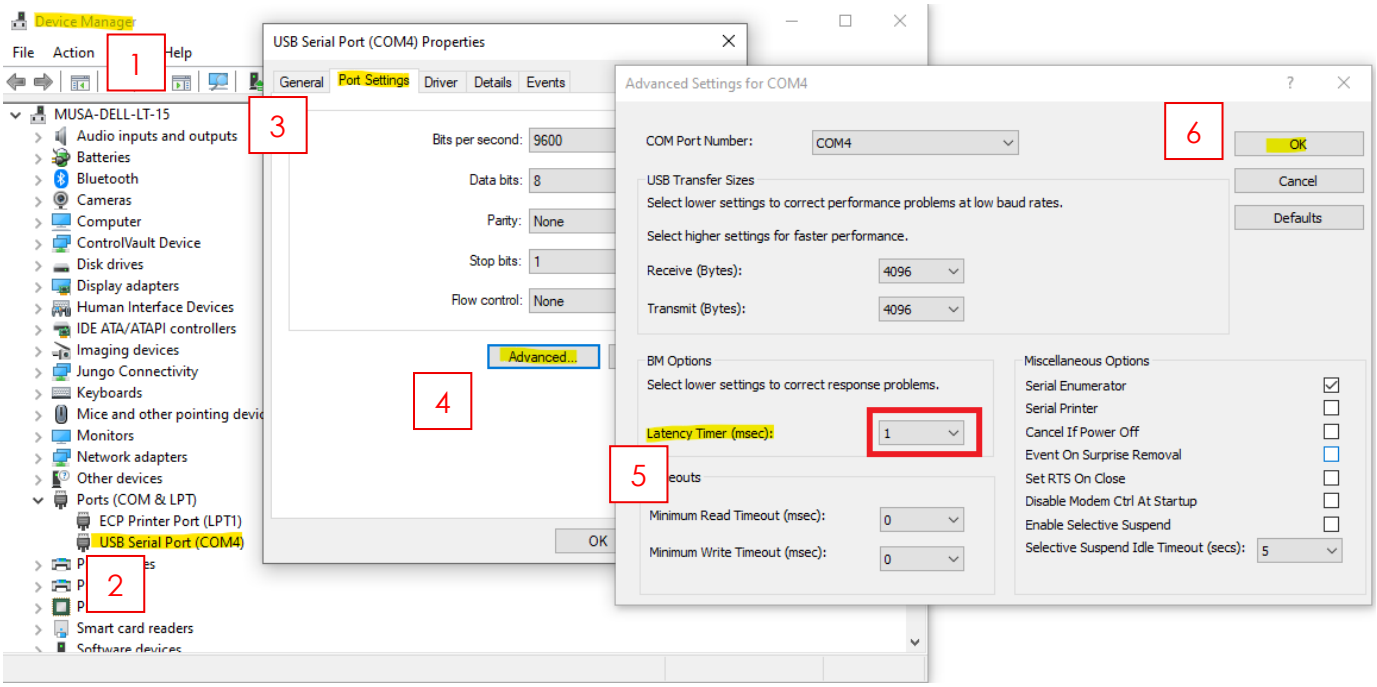


3. Once the installation is complete, restart the computer.

7.2 USB Driver Optimization

7.2.1 Configuring USB Drivers

For optimal communication and performance of the X-BOT-120, please reduce the default latency on systems with Windows OS.

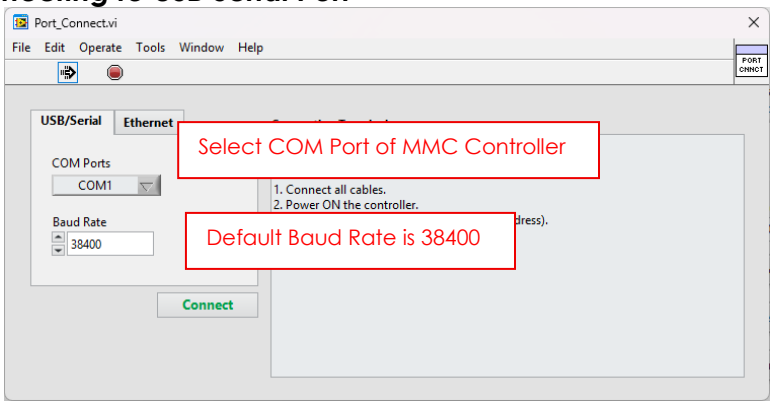


1. Navigate to Device Manager and locate the controller which is named "USB Serial Port (COMx)".
2. Right click on the USB Serial Port and select Properties.
3. Navigate to the "Port Settings" tab.
4. Click on the Advanced… button.
5. Change the default 16ms of Latency Timer to 1ms.
6. Confirm the changes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

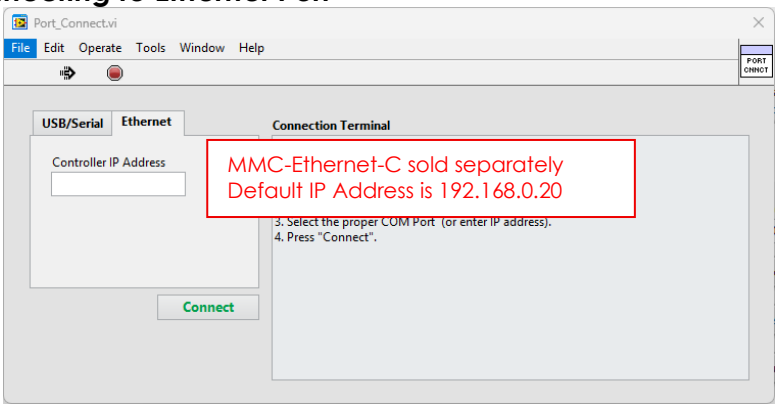
7.3 Software Overview

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

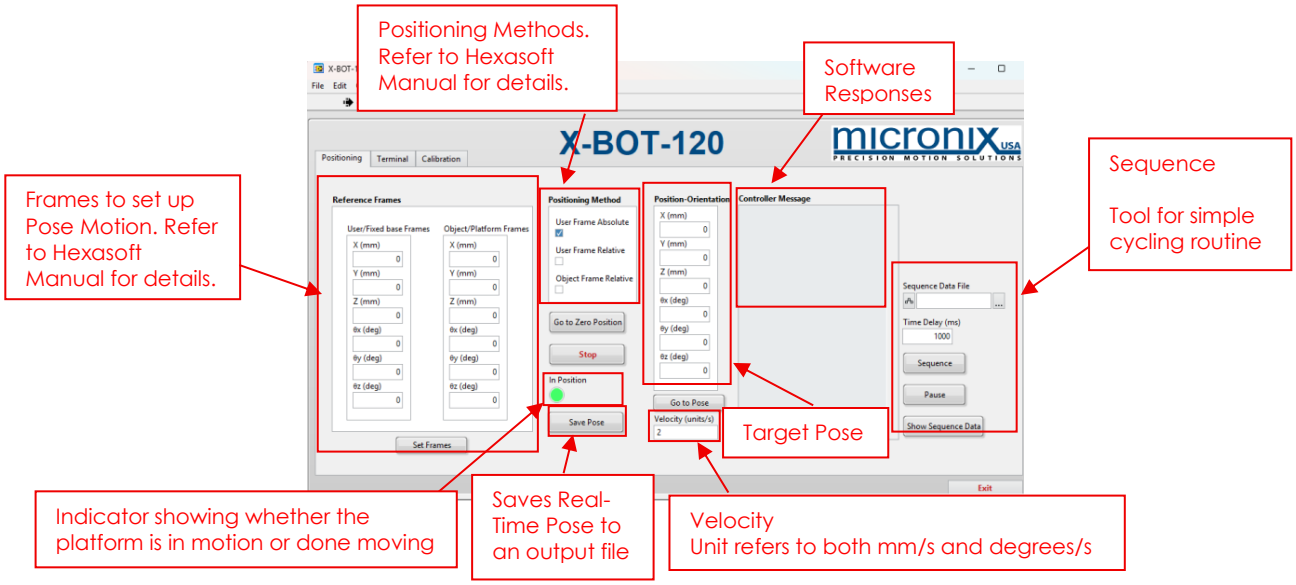
7.3.1 Connecting to USB Serial Port



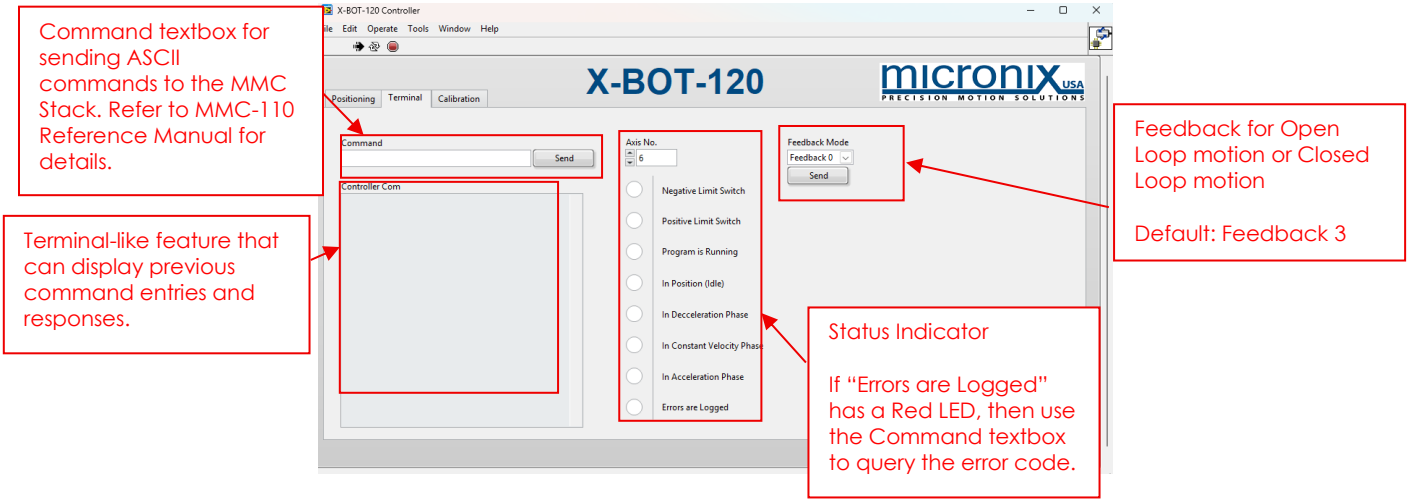
7.3.2 Connecting to Ethernet Port



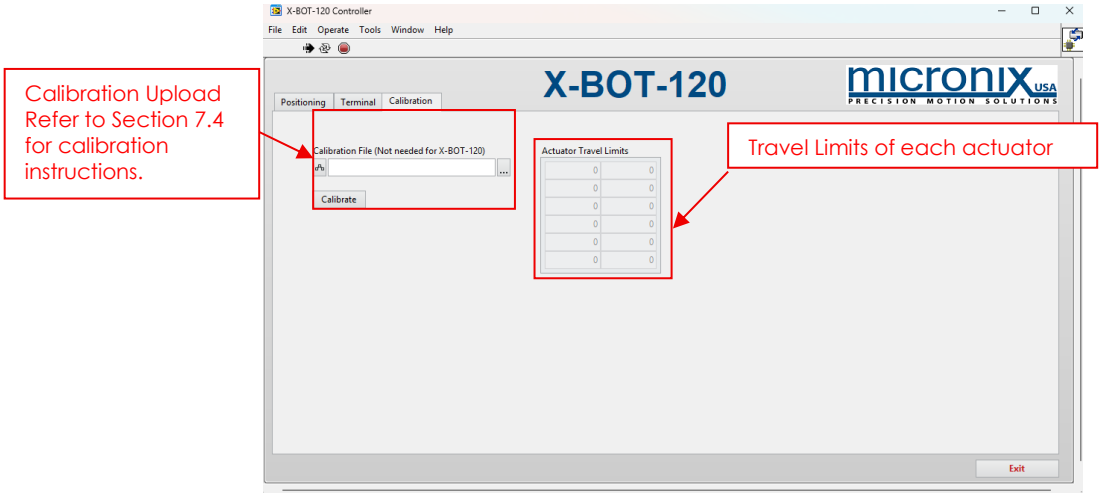
7.3.3 Positioning Tab



7.3.4 *Terminal Tab*



7.3.5 *Calibrate Tab*

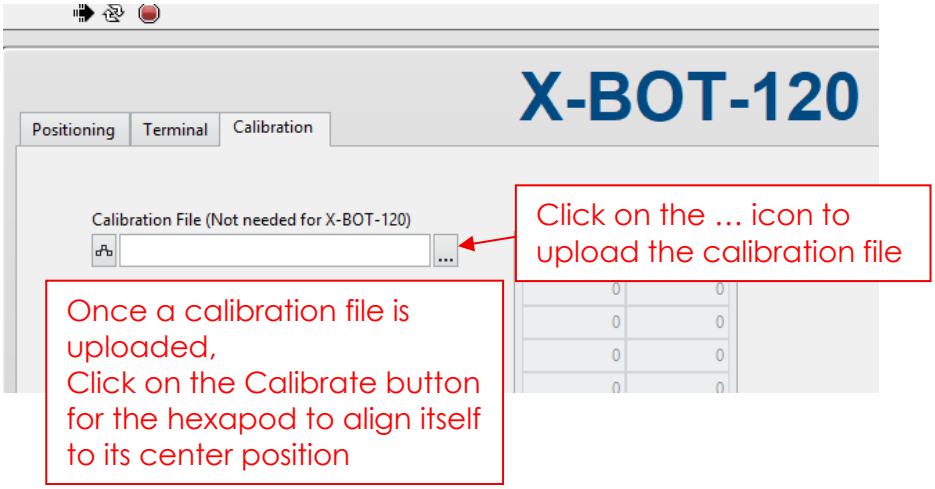


7.4 Calibration

The X-BOT-120 ships pre-calibrated from the factory. On every start-up of the X-BOT-120 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.

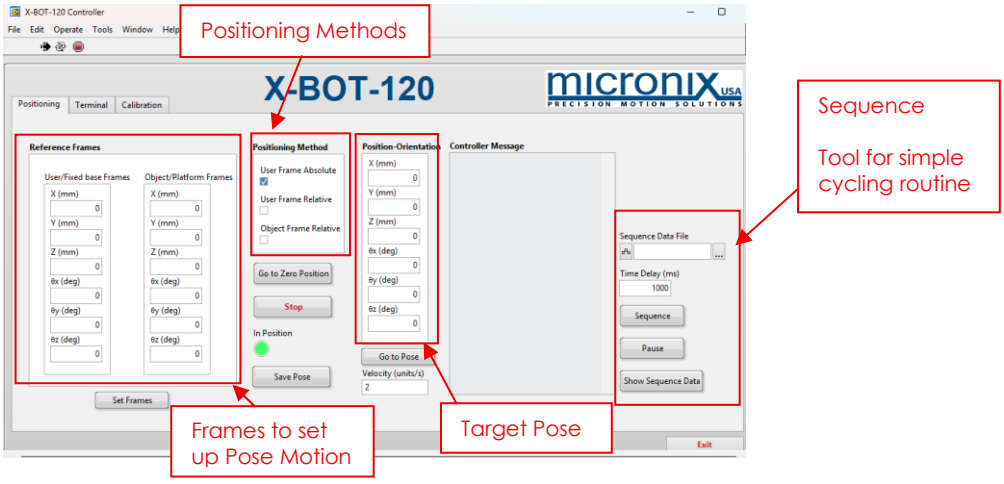
Due to tolerance and differences in manufacturing, each hexapod system will have its own calibration file to ensure that the hexapod system is calibrated to the specification as described on its datasheet.

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-120 according to the advertised datasheet specifications.



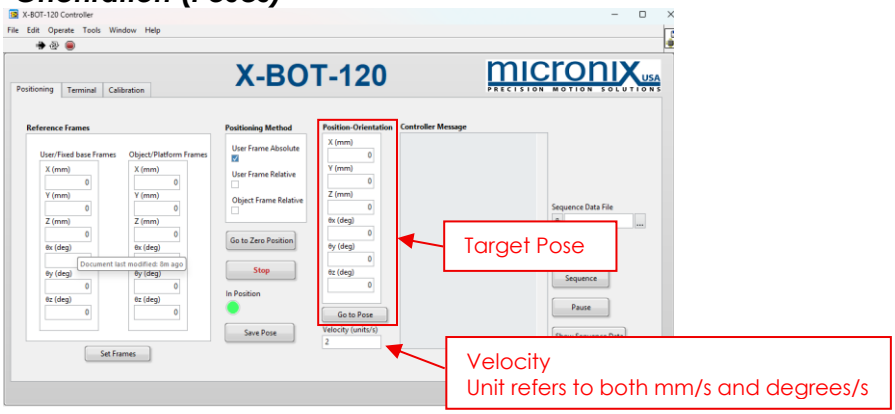
7.5 Motion

To move the X-BOT-120, navigate to the Positioning tab to start controlling the position-orientation (pose) of the X-BOT-120.



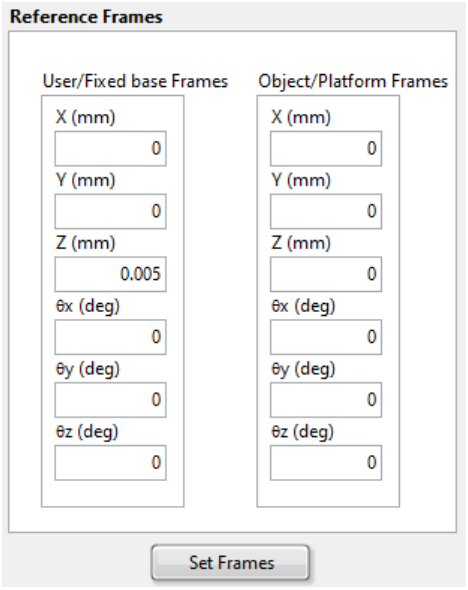
More information about coordinate frames and positioning methods can be found in the HexaSoft™ Manual.

7.5.1 *Position-Orientation (Poses)*

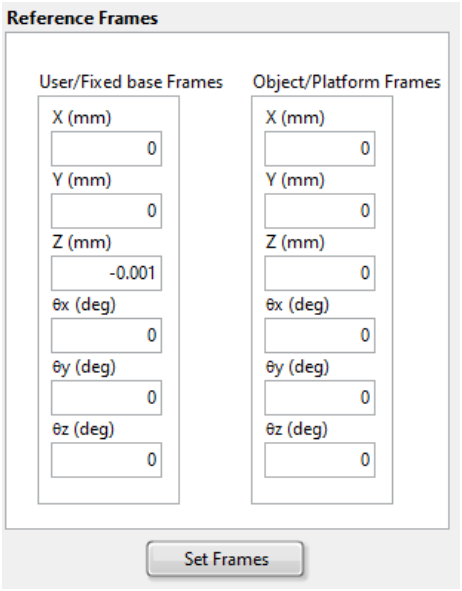


To set a target position-orientation (pose), fill in the positional values of each degree of freedom.

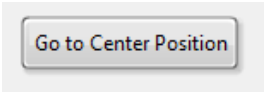
For example, if you wish to move the X-BOT-120 up in the Z-direction by 5 µm from the center position (from [0 0 0 0 0 0] to [0 0 0.005 0 0 0]), then set 0.005 to the Z(mm) textbox and leave all other boxes as 0. Then press the "Go To Pose" button.



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 X-BOT-120 datasheet for the exact travel ranges.

8. Supplementary Information

8.1 Maintenance

- The X-BOT-120 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.
- The X-BOT-120 system is a precision mechanical device and should be handled with care. Do not drop or mishandle the system.
- Do not touch the bearing slide with bare hands to avoid contaminating the motor friction surface.
- Follow the installation cautionary notes and requirements and use proper cable management to ensure a clean and safe operating environment.

8.2 Units and Conversions

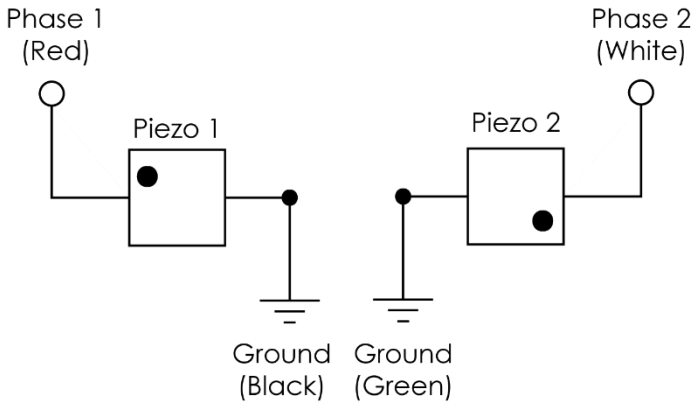
All measurements in this document are in the metric system of units.

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 ±15%

A.2. Piezo Motor Wiring Pinouts

Pinout for X-BOT-120

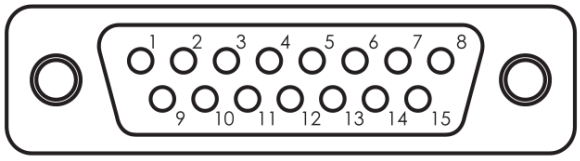
Motor (male Dsub9)

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

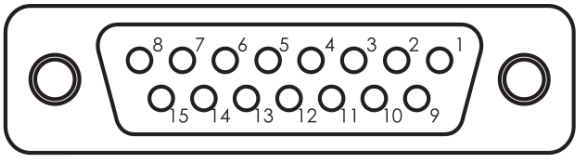
Encoder (female Dsub9)

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	-

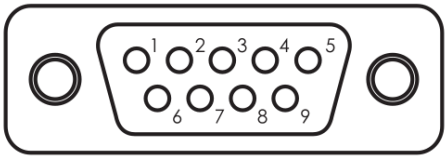
*SLI signals available upon request



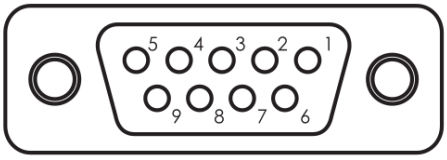
Female Dsub15 Connector - Rear View



Male Dsub15 Connector - Rear View



Female Dsub9 Connector - Rear View



Male Dsub9 Connector - Rear View

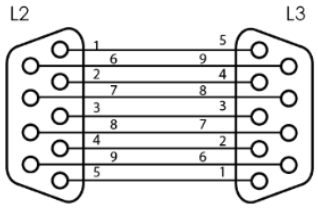
A.3. Feedthrough Pinout

	Pinout for X-BOT-120		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	Black / Green	13	4	-
	Shield	-	10	10	14	-	14	Casing	-
Incremental 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

	Pinout for X-BOT-120		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	Black / Green	13	4	-
	Shield	-	10	10	14	-	14	Casing	-
Absolute Encoder B & D	GND	Grey	8	8	1	Grey	1	-	4
	SLO+ / DATA+	Blue	7	7	2	Blue	2	-	1
	+5V	White (Grey TP)	6	6	3	White (Grey TP)	3	-	5
	SLO- / DATA-	White (Blue TP)	5	5	4	White (Blue TP)	4	-	6
	MA+ / CLK+	Brown	4	4	5	Brown	5	-	2
	MA- / CLK-	White (Brown TP)	12	12	12	White (Brown TP)	12	-	7
	SLI-	White (Violet TP)	13	13	11	White (Violet TP)	11	-	8
	SLI+	Violet	14	14	10	Violet	10	-	3
	Shield	-	15	15	9	-	9	-	Casing

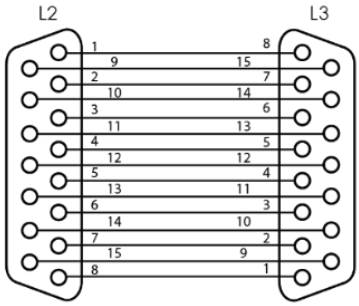
*SLI+/SLI- signals available upon request

Straight Through 9-Pin Feed-through



Male DB9 **Male DB9**

Straight Through 15-Pin Feed-through



Male DB15 **Male DB15**

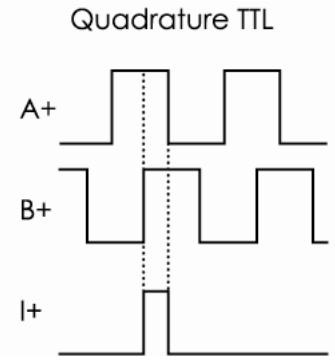
A.4. Using a Digital Encoder

The X-BOT-120 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-32L stage).

A.4.1. Operating and Electrical Specifications

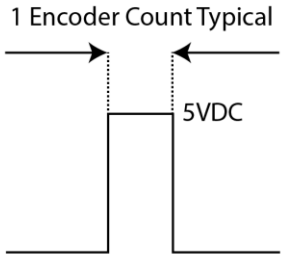
Power Supply	5VDC ±10% @ < 35mA (No outputs terminated) @ < 85mA (A, B, I, and both limits terminated); 50mA at the sensor

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

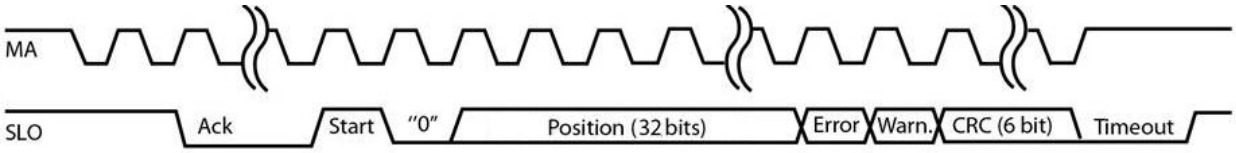
A resolution of <20 nm is achievable with a Micronix controller. The digital encoder module interpolates to a higher resolution as specified in the sales order.

A.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