

# Option User Manual (Pre-Release)

## The Rook™

### Fully Integrated 3-axis Cryogenic Nanopositioner

CryoAdvance 50 | CryoAdvance 100 | s200





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Specifications and product information listed in this document are accurate to the time of publishing for a standard system. Options, custom designs, and one or more modifications may cause slight differences. Future design changes to the system, including software updates, may change information.

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## Section 1 - Preface

### **WARNING**

#### **Read all instructions before using this product**

All users must read and understand this manual and all other safety instructions before using the equipment. Retain these instructions for future reference.

This manual is intended for users of the Montana Instruments products and systems described herein. Users include anyone who may physically interact with the system or peripheral equipment, including installing, setting up, or configuring the system or anyone who may operate system components via operating panels, the supplied user interface, or remote interfaces.

This manual may be used by facilities personnel for determining infrastructure requirements in the room or building where the equipment will be installed.

This manual should be referenced by authorized service personnel for important safety and hazard information and other product restrictions.

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## 1.1 Conventions Used in this Manual

The following style conventions are used in this document:

- Vertical bar ( | )
  - Indicates alternative selections. The bar may be used in place of “and” or “or”.
- Alphanumeric List (1., 2., 3...| a., b., c...)
  - Indicates instructions or actions which should be completed in a specific ordered sequence.
- Bulleted List (• | ◦ | -)
  - Indicates instructions, commands, or additional information about an action.
  - May alternatively be used for unordered lists of materials or additional reference notes.
- Courier Font
  - Indicates a label or indicator on a physical product or part.
  - Indicates a system output, such as a display reading.
  - May also be used for URLs, file paths, file names, scripting language, prompts, or syntax.

### 1.1.1 Abbreviations

The following abbreviations may be used:

- ACM: Ancillary Control Module
- CAN: Controller Area Network
- DMM: Digital Multimeter
- HDMI: High-Definition Multimedia Interface
- MI: Montana Instruments
- PCB: Printed Circuit Board
- TCM: Temperature Control Module
- UI: User Interface
- UPS: Uninterruptible Power Supply
- USB: Universal Serial Bus
- VNC: Virtual Network Computing

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## 1.1.2 Explanation of Safety Warnings

Safety and hazard information includes terms, symbols, warnings, and instructions used in this manual or on the equipment to alert users to precautions in the care, use, and handling of the system. The following hazard levels and information are considered:

 **DANGER**

**Serious personal injury**

Imminent hazards which, if not avoided, will result in serious injury or death.

 **WARNING**

**Serious personal injury**

Potential hazards which, if not avoided, could result in serious injury or death.

 **CAUTION**

**Possible personal injury**

Potential hazards which, if not avoided, could result in minor or moderate injury.

**NOTICE**

**Command or Product Safety Notice**













Potential hazards which, if not avoided, could result in product damage.

**» NOTE**

Points of particular interest for more efficient or convenient equipment operation; additional information or explanation.

### 1.1.3 Graphical Symbols

The following symbols may be used in diagrams, supporting text, and on physical parts:

	Hazard Alert: General Warning		Hazard Alert: High Voltage
	Hazard Alert: Laser Radiation		HDMI port
	CAN bus module		USB port
	Hazard Alert: Hot Surface		Hazard Alert: Magnetic Field
	Waste Electrical and Electronic Equipment (WEEE)		Conformité Européenne (CE)
	Multimeter Required		Hand Push Button



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## 1.2 General Hazard Information

The following descriptions are of general hazards and unsafe practices that may result in product damage, severe injury, or death.

- The products, parts, and components in this manual are to be serviced by authorized Montana Instruments service representatives only. Failure to do so will void the warranty and may damage the product and/or create a safety hazard.
- Only use all components provided for the intended purpose described herein.
- If the equipment or any component is used or modified in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

The following hazards may be typical for this product:

 **WARNING**

**Risk of injury when lifting or moving system components**

System components, including standalone equipment and installed assemblies, may be heavy.

- Use caution when lifting or moving equipment or assemblies. Ensure proper lifting principles are used to avoid injury.
- Equipment or assemblies >20 kg should always be lifted by two or more people or with a suitable lifting device.

 **WARNING**

**High voltage: danger of electric shock**

Electric shocks and burns from capacitor discharge or power circuits could lead to serious injury or death.

- Before turning on any power supply, the ground prong of the power cord plug must be properly connected to the ground connector of the wall outlet. The wall outlet must have a third prong or must be properly connected to an adapter that complies with these safety requirements.
- Only use replacement power cords or power plugs with the same polarity and power rating as that of the original ones. Do NOT use inadequately rated cables.

If the equipment or the wall outlet is damaged, the protective grounding could be disconnected.

- Do NOT use damaged equipment until its safety has been verified by authorized personnel.
- Do NOT disconnect or tamper with the operation of the protective earth terminal inside or outside the apparatus.

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**NOTICE****Only clean exterior surfaces with acceptable fluids**

- Only use deionized water, glass cleaner, or isopropyl alcohol to clean the exterior surfaces of any enclosure. Do NOT use any volatile chemicals other than isopropyl alcohol.
- Apply fluid to a clean, lint-free cloth and wipe the surface with a cloth. Do NOT apply fluid directly to any surfaces or enclosures.

## Section 2 - Option Overview

### 2.1 Rook Nanopositioner

Compatible Cryostation Models	Configuration
CryoAdvance 50	One positioner, open- & closed-loop
CryoAdvance 50 – CryoOptic	One positioner, open- & closed-loop
CryoAdvance 50 – MagnetoOptic	One positioner, <b>open loop only</b>
CryoAdvance 100	Up to two positioners, open- & closed-loop
CryoAdvance 100 - CryoOptic	Up to two positioners, open- & closed-loop
s200	Up to four positioners, open- & closed-loop



#### 2.1.1 Intended Use

Montana Instruments has set a new standard of positioning reliability by delivering the only nanopositioner available today with critical motion performance specified at the top of the 3-axis stack. Bi-directional repeatability and bi-directional runout are measured and specified while integrated into an operational Cryostation set to 4 K base temperature. The Rook stands up to everyday handling and operation using Montana Instruments' Galaxy software and touchscreen control architecture for ease and simplicity of use.

The Rook positioning system seamlessly integrates with other Montana Instruments equipment, allowing for a single source of control for your cryogenic environment and makes experimental automation simpler. Scripting examples are available on-board your touchscreen and in this user manual.

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## 2.1.2 Components

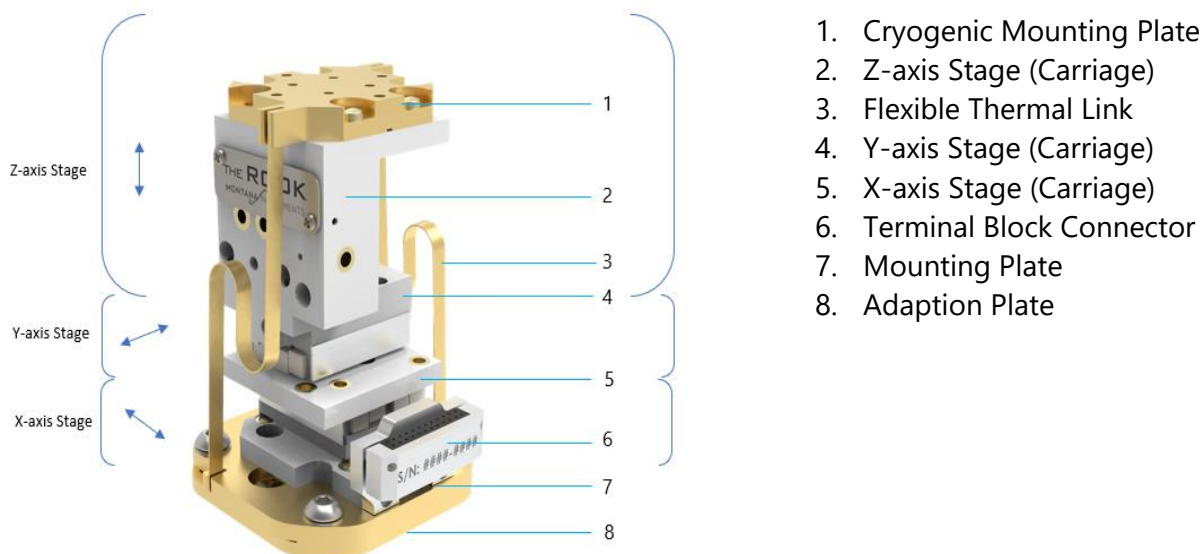
The nanopositioner module consists of a 3-axis (X-Y-Z) positioner stack, rack-mountable motion controller, and power supply. The Cryostation user interface touchscreen provides the operational control of the nanopositioner.

### The Rook Nanopositioner

Ceramic body with motion powered by piezo slip-stick mechanisms on each axis. The positioner kit includes flexible thermal links for the best possible conduction to your sample, and the whole assembly is removable from the Cryostation sample chamber for added flexibility. The Rook nanopositioner is capable of operation at cryogenic temperatures down to <3 kelvin.

#### Features:

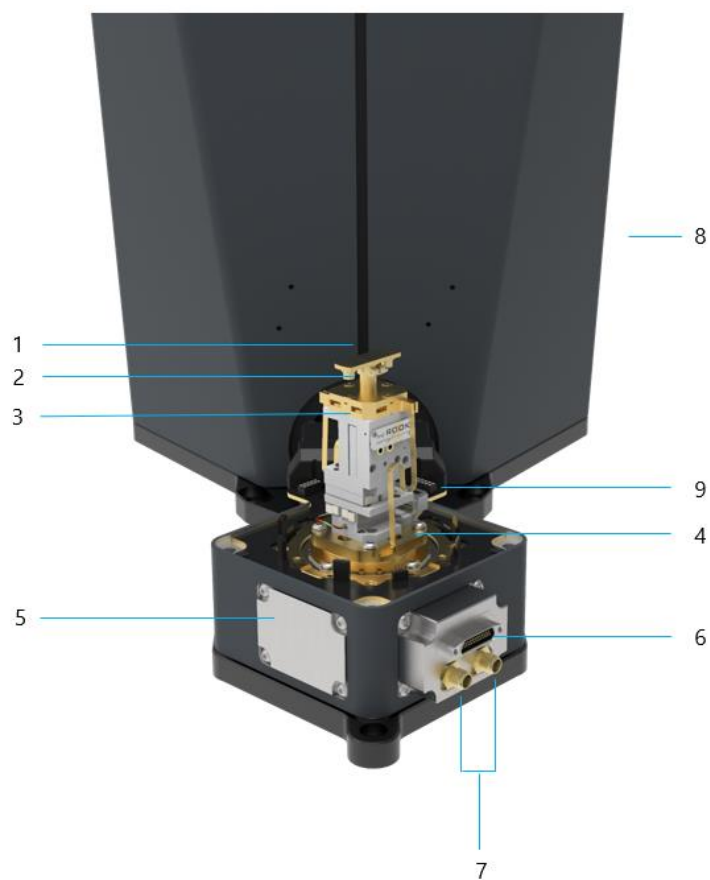
- Travel range of 5mm x 5mm x 5mm.
- 50 nm closed loop encoder resolution.
- Load capacity of up to 0.4 kg (with spring).
- Complete ceramic construction.



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### 2.1.3 Nanopositioner Mounted to Sample Chamber Base

The nanopositioner module consists of a 3-axis (X-Y-Z) positioner stack, rack-mountable motion controller, and power supply. The Cryostation user interface touchscreen provides the operational control of the nanopositioner.



1. Sample Mount
2. Adapter
3. Cryogenic Mounting Plate
4. Flexible Thermal Link
5. Side-Panel
6. Micro-D 25 Adapter
7. Coaxial Connectors
8. Foundation
9. Terminal Block Connector

## 2.1.4 Cryostation, Nanopositioner, and Housing

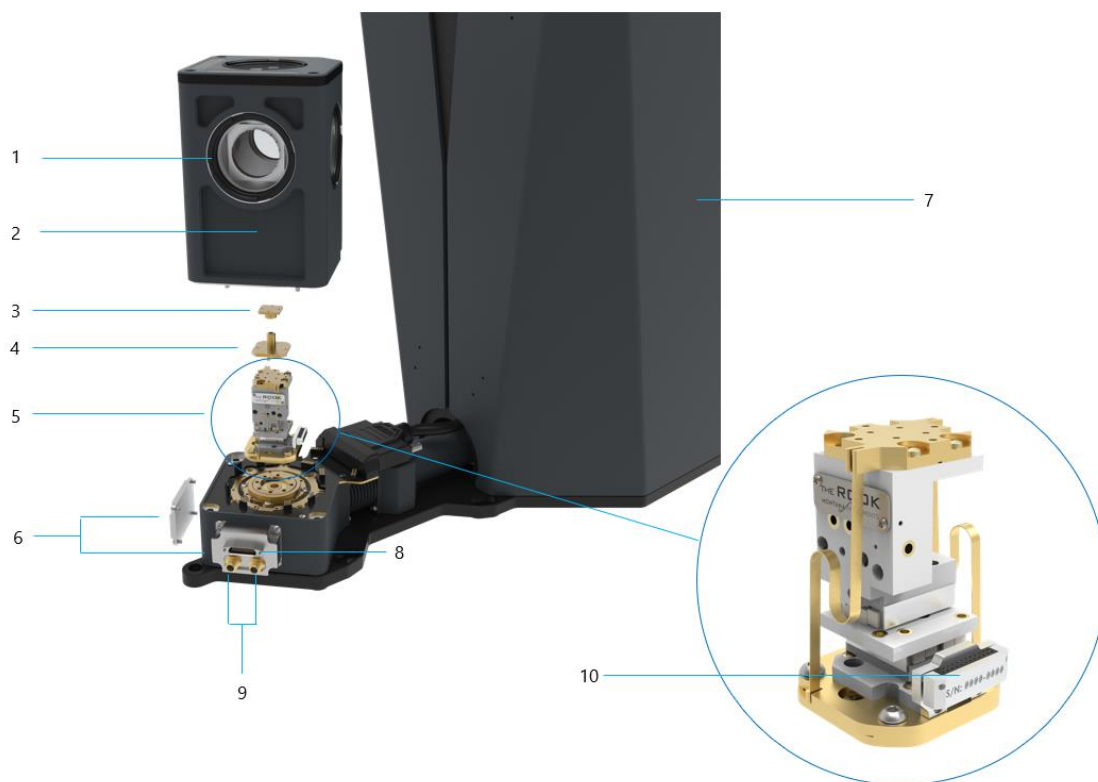
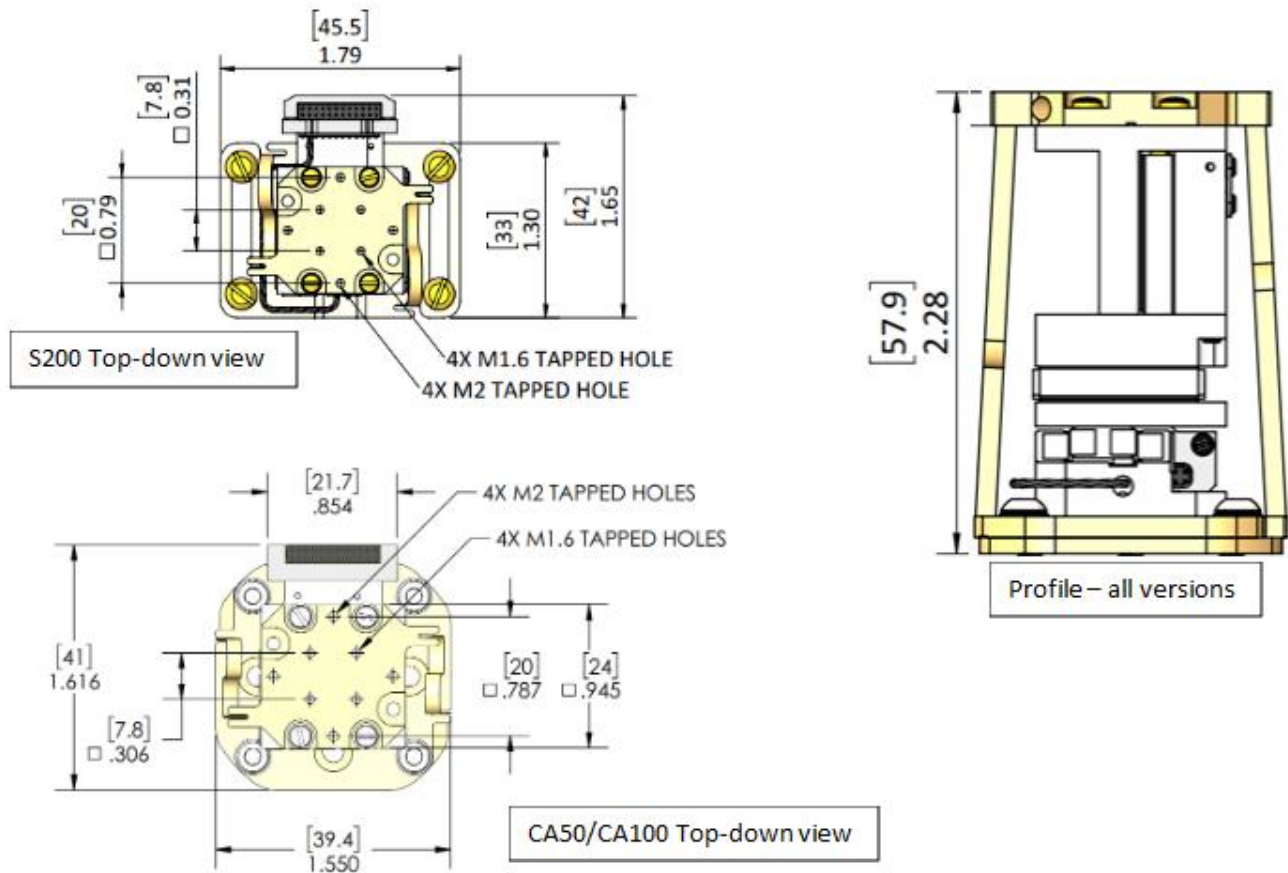


Figure 1: Cryostation, nanopositioner, and housing.

1. Window
2. Housing
3. Sample Mount
4. Adapter
5. Nanopositioner
6. Side Panels
7. Foundation
8. Micro-D 25 Feedthrough.
9. Coaxial Connectors
10. Terminal Block Connector

## 2.1.5 Nanopositioner Stage Dimensions



## 2.1.6 Technical Specifications

### Environmental Specifications

Temperature of Environment (Non-Operational)	Up to 350K
Temperature of Environment (Operational)	3.2K to 300K
Altitude	<2000 m

### Physical Dimensions

Component	L x W x H
Positioner Physical size (Not including "flex-link" or wiring connector)	24mm x 24mm x 51mm

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## 2.1.7 Safety Information

The following hazards may be typical for this product:

 **WARNING**

**Risk of injury due to sharp edges**

The interior of the enclosure contains sheet metal parts that may have sharp edges.

- When working inside the enclosure (authorized service personnel only), exercise caution to avoid getting cut by these edges.

 **WARNING**

**High voltage: danger of electric shock**

Electric shocks and burns from capacitor discharge or power circuits could lead to serious injury or death.

- Prior to accessing the enclosure or when otherwise servicing the unit (authorized service personnel only), completely power down the system and unplug the power cable.
- If power must be applied to diagnose issues or otherwise, a grounding strap must be applied to the arm interfacing internal components.



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## 2.2 Touchscreen Monitor

The Cryostation user interface touchscreen provides the operational control of the nanopositioner.

### 2.2.1 Intended Use

A 10-inch touchscreen display provides the main user interface control for the system. The software can alternatively be monitored and controlled via a VNC interface or remote scripting.

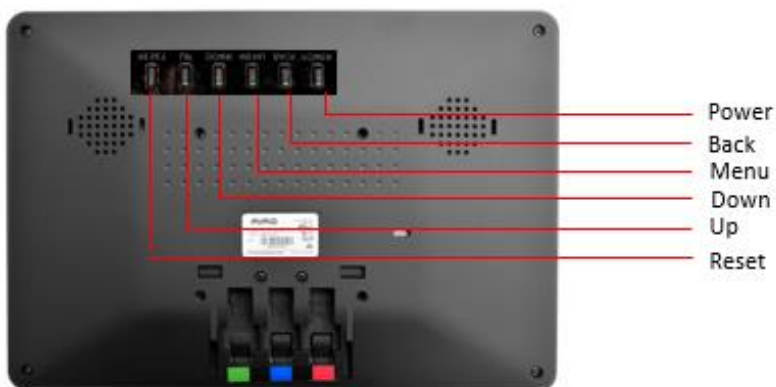
### 2.2.2 Touchscreen Monitor Inputs

The touchscreen monitor has HDMI, USB 3.0, and Power input ports located on the back near the lower center of the device.



### 2.2.3 Control Console

The console located on the back near the top-center of the device contains basic display controls.



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## 2.2.4 Safety Information

The following hazards may be typical for this product:

 **WARNING**

**High voltage: danger of electric shock**

Electric shocks and burns from capacitor discharge or power circuits could lead to serious injury or death.

- Prior to accessing the enclosure or when otherwise servicing the unit (authorized service personnel only), completely power down the system and unplug the power cable.
- If power must be applied to diagnose issues or otherwise, a grounding strap must be applied to the arm interfacing internal components.

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## 2.3 Motion Control Unit

### 2.3.1 Intended Use

The motion control unit is a device used for interfacing with and controlling of the nanopositioner. It provides both the electronics hardware and software interface for communicating with the nanopositioner and controlling the stages within the stack.

### 2.3.2 Components

The nanopositioner module consists of a 3-axis (X-Y-Z) positioner stack, rack-mountable motion controller, and power supply. The Cryostation user interface touchscreen provides the operational control for the nanopositioner.

### 2.3.3 Motion Controller Inputs/Outputs (I/O)

The Nanopositioner I/O ports are located at the back of the unit.

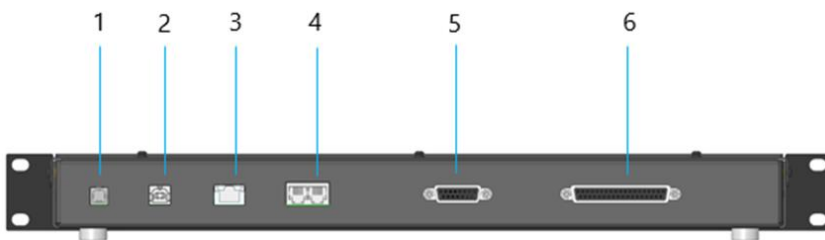


Figure 2: Motion controller (back) inputs/outputs (I/O).

1. Power Input HIROSE P/N: RP34-8R-3DL 24 VDC/50 W
2. USB 2.0 Receptacle
3. Ethernet 10/00/1000 MBPS
4. RS485 IN/OUT
5. Digital Input/Output D-SUB 25 Pin Female Connector
6. Motor and Encoder D-SUB 37 Pin Female Connector

### 2.3.4 Motion Controller Power Button

The Nanopositioner power button is located on the front panel. When the unit is powered on the button will glow.



Figure 3: Motion controller (front) power button location.

## 2.3.5 Technical Specifications

### Environmental Specifications

Temperature of Environment	5 – 25 °C
Humidity	5 – 80% non-condensing
Altitude	<2000 m

### Power Specifications


Model	Motion Controller	
Mains Power Connector on Unit	IEC 60320 C14	
Line Voltage	100 – 240 VAC	
Frequency	50 – 60 Hz	
Maximum Current Draw	1.9 A	
Maximum Power Consumption	190 W	
Wall Outlet / Receptacle	N. America & non-EU	Standard NEMA 1-15P
	CEE Europe (non-UK)	NEMA 1-15P supplied and IEC 320-C8 available for region specific adapters
	UK	NEMA 1-15P supplied and IEC 320-C8 available for region specific adapters
	Israel	NEMA 1-15P supplied and IEC 320-C8 available for region specific adapters

### Physical Dimensions

Component	L x W x H	Mass
	19" x 15" x 1.75"	7.5 lbs

## 2.3.6 Safety Information

The following hazards may be typical for this product:

 <b>WARNING</b>
<p><b>High voltage: danger of electric shock</b></p> <p>Electric shocks and burns from capacitor discharge or power circuits could lead to serious injury or death.</p> <ul style="list-style-type: none"> <li>• Prior to accessing the enclosure or when otherwise servicing the unit (authorized service personnel only), completely power down the system and unplug the power cable.</li> <li>• If power must be applied to diagnose issues or otherwise, a grounding strap must be applied to the arm interfacing internal components.</li> </ul>

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## Section 3 - Option Installation & Handling

### 3.1 Packaging Contents

The motion controller comes packed with Cryostation.

#### 3.1.1 Unpacking the Motion Controller

1. Locate the control unit boxes and remove the box wrap and cut the bands securing the box to the pallet. Carefully lift the box off the pallet and set it on the floor or a nearby surface.
2. Open the top of the box and remove the top piece of foam.
3. Reach inside and grasp the underside of the unit. Lift the unit up and out of the box. Keeping the unit in the same orientation, set onto an adjacent surface.
4. Carefully remove the plastic wrap around the enclosure.
5. Move the unit to the desired location.

**» NOTE**

The Nanopositioner is installed in the Cryostation system prior to shipping. Refer to the Cryostation system manual for additional details.

## 3.2 Connecting System Cables and Power

### NOTICE

**Only use cables and hoses provided or approved by the manufacturer**  
 Only use the cables and hoses in the manner described below.

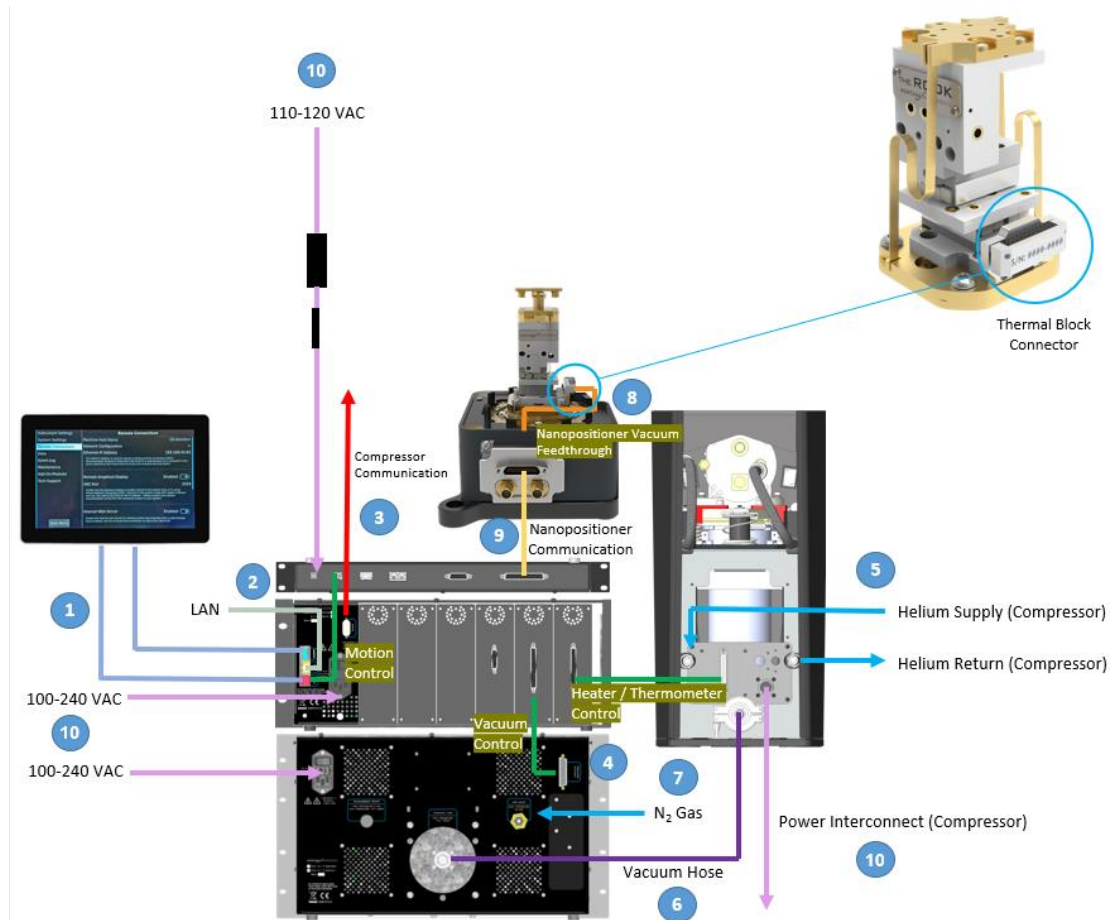


Figure 4: Cryostat interconnect diagram containing The Rook.

1. User Interface
2. LAN
3. Compressor Communication
4. System Control Cables
5. Helium Line
6. Vacuum Hose
7. Nitrogen (N<sub>2</sub> Gas)
8. Nanopositioner Vacuum Feedthrough
9. Nanopositioner Communication
10. Nanopositioner System Power / Power Interconnect

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Remove any plastic covers from the connector locations on the back of the compressor, the cryostat, the system control unit, and the vacuum control unit.

### 1. User Interface:

Locate the USB and HDMI cables. Connect these cables from the back of the system control unit to the user interface touchscreen display.

### 2. LAN:

Locate the LAN cable (if applicable). Connect LAN cables from the back of the system control unit to dedicated facility LAN socket.

### 3. Compressor Communication:

Locate the DSUB9 M-M series cable. Connect one end to the DSUB9 location on the back of the compressor. Connect the other end to the COMM PORT location on the back of the system control unit. Tighten both connections with the thumbscrews to secure.

### 4. Control Cables:

Locate the DSUB37 F – split cable. Connect the DSUB37 F end to the HEATER/THERMOMETER CONTROL location on the TCM peripheral card in the system control unit. Where the cable splits, attach the DSUB25 F end to the SAMPLE CONTROL location, the DSUB25 M end to the CORE CONTROL location, and the MDR26 to the USER INPUT locations on the back panel of the cryostat. Tighten connections with the thumbscrews to secure.

Locate the DSUB25 M-M series cable. Connect one end to the VACUUM CONTROL location on the back of the vacuum control unit. Connect the other end to the VACUUM CONTROL location on the ACM peripheral card in the system control unit.

### 5. Helium Hoses:

Helium hoses should first be tightened by hand. Use a crescent wrench to continue to tighten the fitting, stopping as soon as force is required. Do not overtighten.

- Locate the helium hose labeled SUPPLY. Connect one end to the SUPPLY location on the front of the compressor. Connect the other end to the SUPPLY location on the back panel of the cryostat.
- Locate the helium hose labeled RETURN. Connect one end to the RETURN location on the front of the compressor. Connect the other end to the RETURN location on the back panel of the cryostat.

### 6. Vacuum Hose:

Locate the vacuum hose. Connect one end to the VACUUM LINE location on the back of the vacuum control unit. Connect the other end to the VACUUM LINE location on the back panel of the cryostat. The O-ring seal only needs to be compressed, so take care not to overtighten.

### 7. Nitrogen (optional):

To keep the sample space clean, a dry clean nitrogen connection is highly recommended, especially in humid climates. Nitrogen will help rid the system of moisture and decrease the initial pump down time.

- Connect a ¼ in (6mm) tube to your nitrogen source (this tubing is not supplied).
- Start the nitrogen supply at a low flow rate.
- Verify that the nitrogen is flowing through the tube and does not contain any water vapor. Allow some nitrogen to flow through the tube to remove impurities.
- Connect this tube to the N<sub>2</sub> INLET fitting on the back of the vacuum control unit by pressing in.
- Set the nitrogen pressure to approximately 15 psi.

To disconnect the tubing, push the green circle on the fitting inwards and pull the tubing out.

» **NOTE**

The system uses nitrogen during a VENT operation or during a COOLDOWN or PULL VACUUM operation if a “dry nitrogen purge” is enabled.

### 8. Nanopositioner Vacuum feedthrough:

Nanopositioner feedthrough cable should already be connected. This connection is made during assembly of the Cryostation.

### 9. Nanopositioner Communication:

- Carefully plug the nanoposition communication cable into the back of the motion controller (A). Locate the MicroD 25 socket (female) on the sidepanel of the sample chamber base section of the cryostation foundation (B). Plug the remaining nanopositioner cable into the Micro D 25 socket on the sidepanel of the sample chamber base section of the cryostation foundation (C).

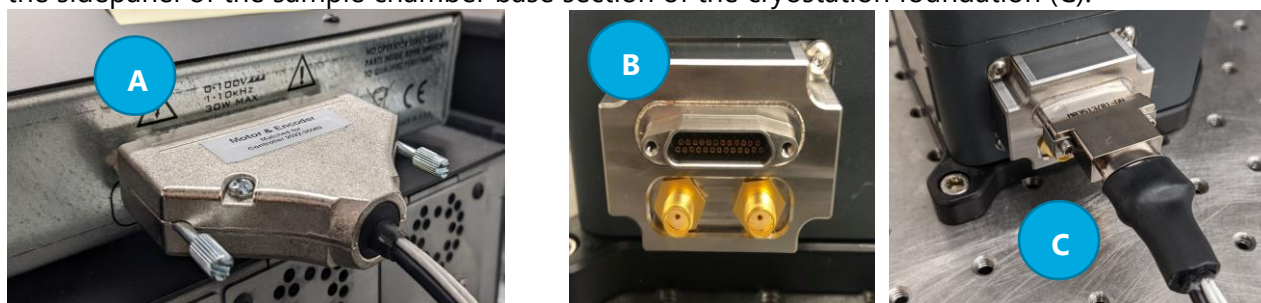


Figure 5: Side-view of nanopositioner communication connector plugged into side panel (left image) to the motion controller (right image).

### 10. Nanopositioner System Power / Power Interconnect:

Be sure to connect all other cables and hoses prior to connecting system power.

- Locate one of the C13 main power cords. Ensure the rocker switch on the back of the system control unit is off ( o ).
- Connect the main power cord to the C14 inlet located on the rear of the enclosure.
- Connect the power plug to the appropriate 100 – 240 VAC wall outlet power source.
- Locate the other C13 main power cord. Ensure the rocker switch on the back of the vacuum control unit is off ( o ).
- Connect the main power cord to the C14 inlet located on the rear of the enclosure.
- Connect the power plug to the appropriate 100 – 240 VAC wall outlet power source.
- Ensure the rocker switch on the front of the compressor is off ( o ).
- Ensure that the 50/60 Hz toggle switch is in the correct position.
- Ensure that the circuit breaker on the compressor is open (handle in the down position).
- Uncoil “output to cryocooler” cable and connect to Accessory port located on the front of the compressor.
- Connect the compressor power cable to the appropriate 208 – 240 VAC wall outlet power source.

» **NOTE**

Once all cables and hoses are connected, use the Velcro straps provided to neatly bundle the cables, but do NOT include the helium hose. The helium hoses should never be strapped down in any location.



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## Section 4 - Sample Installation

The top plate of the flex link is the same as the top plate of the attocube flex link and the MI standard sample mounts can be shared.

Do not apply a torque greater than 1.33 in-lbs. to any screw attaching a mount to the flex link or any other attachment above the flex link.

Always brace the positioner stack with one hand while torquing screws to further guarantee no damage to positioner stack.

### 4.1 Magnetic Fields

The Rook's encoders are magnetically encoded so the presence of external magnetic fields will interact with the position feedback, causing the position to be inaccurate. It is advised that positioner encoders not be relied upon when in the presence of a magnetic field.

According to the magnetic encoder manufacturer, a field of 25 mT or larger applied to the encoder may cause permanent damage. Testing done by Product Development has not been proven to cause permanent damage, so it is believed these encoders are not overly sensitive to non-direct magnetic fields.

It is still prudent for users to be mindful not to place positioners in proximity to large fields ( $>0.7$  T) or even to place small permanent magnets ( $>0.25$  T) directly on or next to encoders. Permanent magnets can still be placed on top of the positioner stack near a sample. At the time of this writing, it is unknown the exact field strength that will permanently damage encoders. Distance, angle, and duration may all play a role in the interaction between the encoder and magnetic field.

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## 4.2 Payload

The full positioner XYZ stack will operate with loads ranging from 0-100 grams without the addition of the preload spring to the Z-axis. The mass of the flex link is already accounted for, and the load listed in the table below is in addition to the flex link.

The preload spring is only added to the Z-axis since it must also overcome gravity; heavy loads of 100 g or more require an assist from this spring-loaded plunger. The X-axis and Y-axis will remain operational with all these loads and do not require any modification to translate loads up to 400 g. Please note, heavy loads may reduce the max velocity of the positioner stack, especially at base temperature. With the addition of the preload spring, we cannot guarantee that stack motion will still comply with published specifications.

For optimal performance with the spring installed, the sample center of mass should be designed to be as close to the center axis of the positioner stack as possible.

Load (g)	Spring Plunger
0-100	Do Not Install Spring Plunger
100-250	Low Force Spring Plunger
250-400	High Force Spring Plunger

**Important:** Only use the preload spring when mass is on the positioner stack (following the table above). If a spring is used with less mass than specified above, the positioner will not be able to counteract the expansion force lose travel moving down (-Z).

The spring is easily installed & removed from the Z-axis by hand – simply translate the Z-axis to the end of its positive travel, grab the spring plunger at its base, position the smaller end on the top plate of the positioner and push up to compress spring. Then insert into or remove from the bore holes in the stage

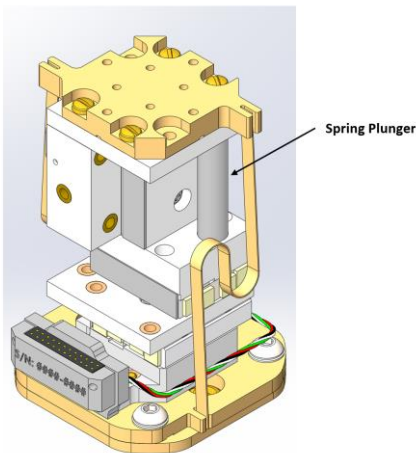


Figure 6: Rook with "Spring Plunger" installed.

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## Section 5 - Usage & Operation (Galaxy 1.18 UI)

### 5.1 System Control Options

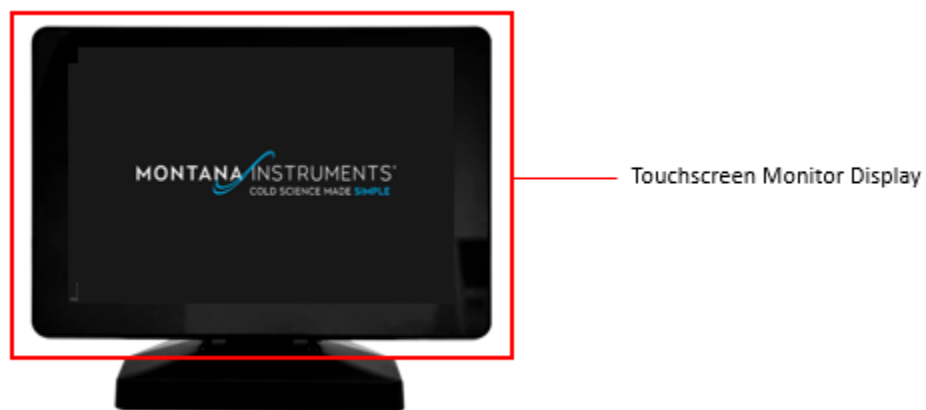
#### 5.1.1 Powering on Touchscreen Monitor

If touchscreen monitor does not power up, locate, and depress power button on the back of the unit.



#### 5.1.2 Touchscreen Monitor Display

Upon powering up touchscreen monitor the Montana Instruments splash screen will appear.



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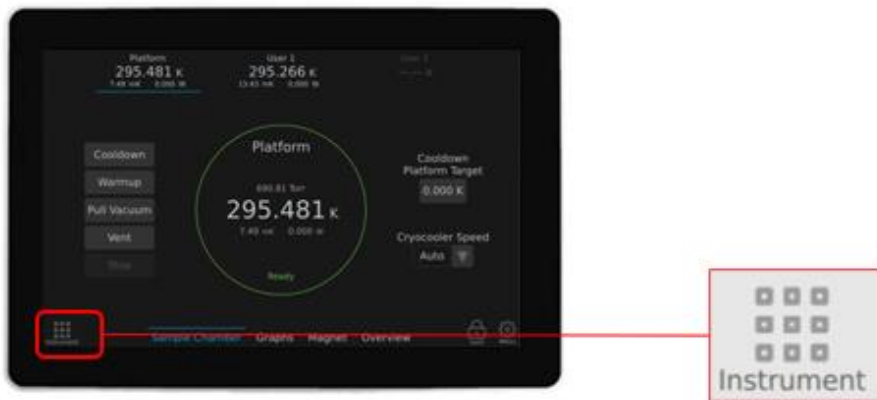
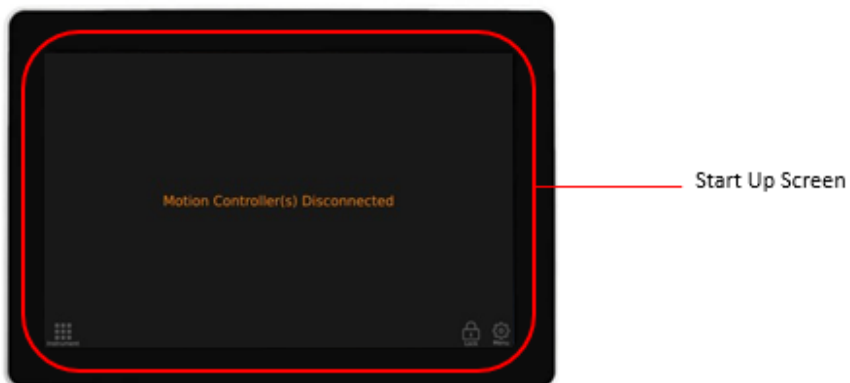
### 5.1.3 Splash Screen

Appearance of the splash screen verifies that the touch screen is powering up.



### 5.1.4 Startup Screen

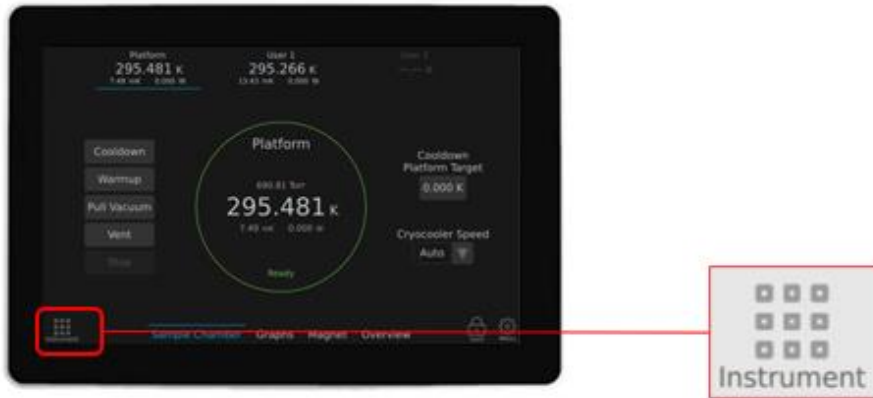
An amber-colored Indicator message will be displayed upon startup of the user interface.



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## 5.1.5 Cryostation Control Screen and Instrument Selection

Tap on "Instrument" icon on the lower left of the display screen to access connect instruments.



## 5.1.6 Closed Loop Mode

When closed loop mode is enabled the switch will turn blue and a blue indicator dot will appear next to enabled axes names.



## 5.1.7 Open Loop Mode

When open loop mode is enabled, the switch will turn white and there will be no indicator dot next to the axis names.



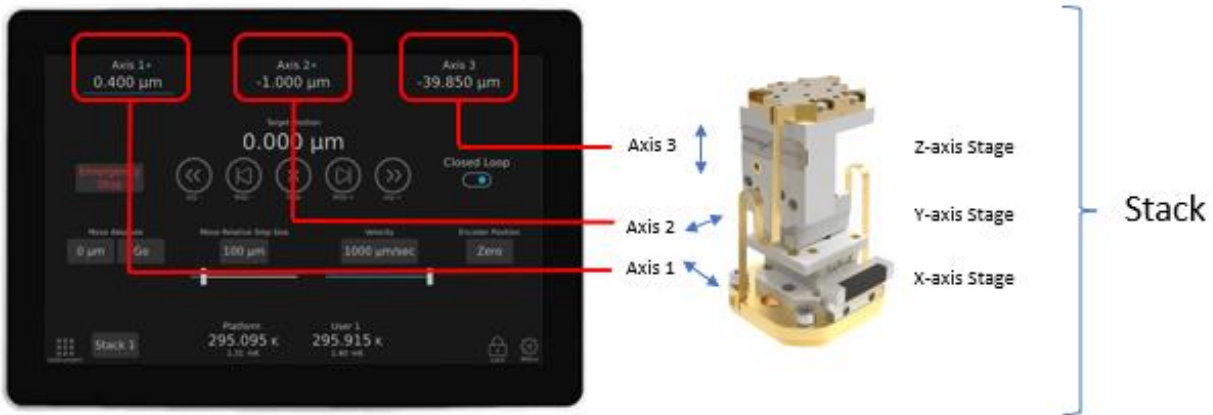
## 5.1.8 Axis Enable and Position

The selected axis is underscored with blue line. The selected axis with blue dot indicator is in "Closed Loop" mode. "Target position" value indicates the encoder position (Closed Loop).



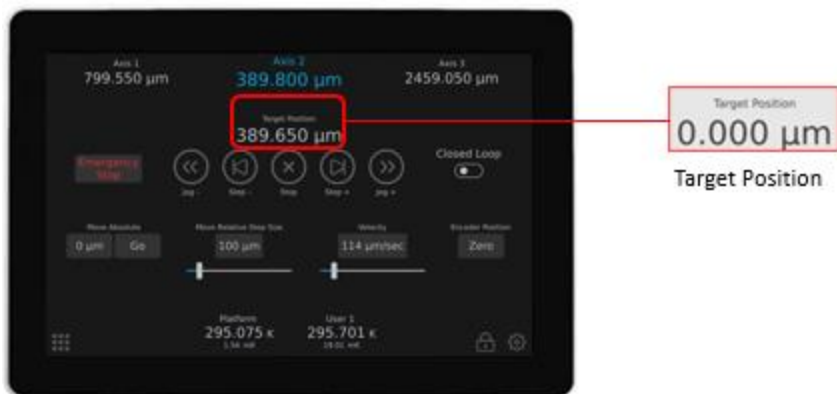
## 5.1.9 Axis Assignment

"Axis 1" is the "X-axis" (bottom stage). "Axis 2" is the "Y-axis" (middle stage). "Axis 3" is the "Z-axis" (upper stage).



## 5.1.10 Target Position

"Target Position" is the position the enabled axis that the controller is attempting to achieve.



## 5.1.11 Emergency Stop

This operation will place all axes in open loop mode. If closed loop operation is desired after initiating the emergency stop, each desired axis must be manually set to closed loop via the "Closed Loop" switch. This operation will stop all axes, which sets all axes "Target Position" to their current position.



## 5.1.12 Manual Position Controls (Jog±)

Touch and hold to move the enabled axis in the positive (Jog +) or negative (Jog -) direction.





### 5.1.13 Manual Position Controls (Step±)

Touch to step the enabled axis in the positive (Step +) or negative (Step -) direction.



### 5.1.14 Manual Position Controls (Stop)

Touch to stop the motion of the currently enabled axis.



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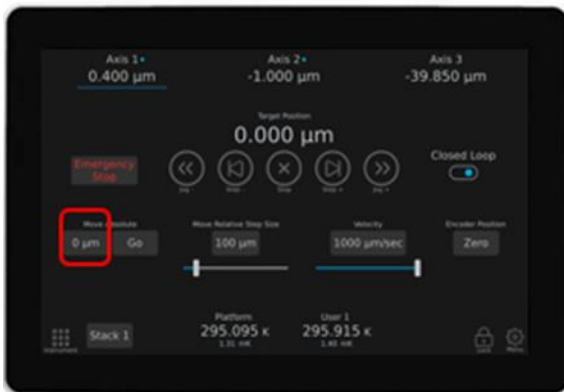
## 5.1.15 Move Absolute (Closed Loop Function)

Move Absolute is a "Closed Loop" function that returns position values.



## 5.1.16 Entering Move Absolute Value (Closed Loop Function)

Enter value and tap "Set" button.



Tap on position value box.



1000 μm

Enter Absolute Position

Set

Tap on Set

## 5.1.17 Move Absolute (Closed Loop Function)

Tap on the Go button.



Go

Tap Go.

### 5.1.18 Enter "Move Relative Step Size" Using Slider

Move slider to adjust the value.



### 5.1.19 Enter "Move Relative Step Size" Using key Entry

Touch the step size box and enter the desired step size. This value dictates the step size taken when using the "Step +" or "Step -" buttons.



### 5.1.20 Enter "Velocity" Using key Entry

Touch the velocity box and enter the desired axis movement velocity. This value dictates the velocity of "Jog" and "Step" motion.



### 5.1.21 Enter "Velocity" Using Slider

The slider can be moved to set the velocity value.



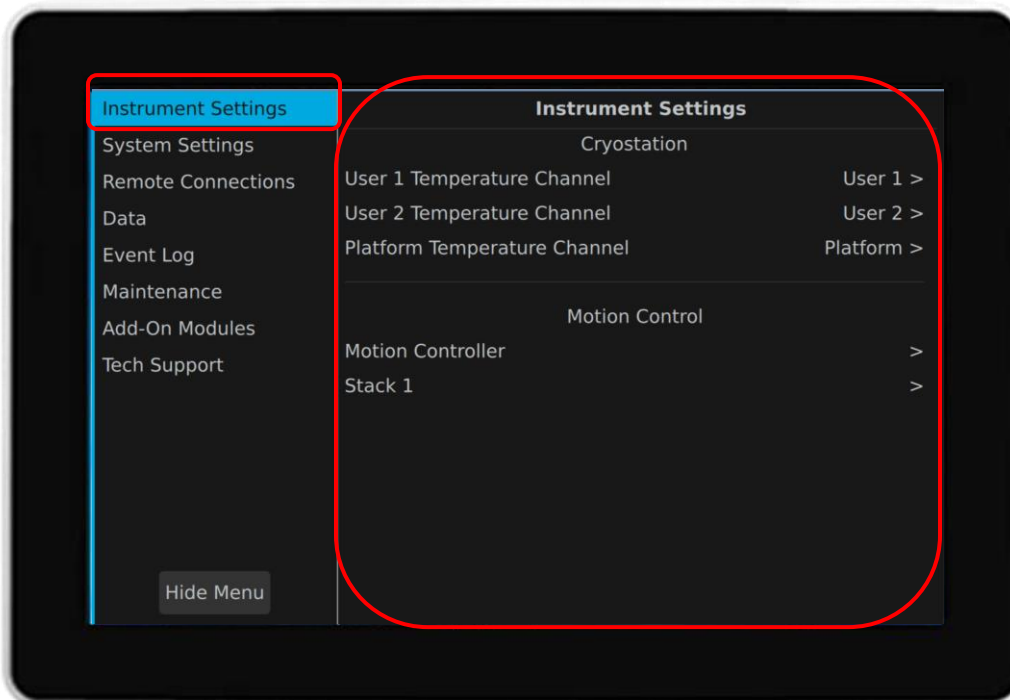
## 5.2 System Menus

Tap on the "Menu" icon to access the instruments settings.

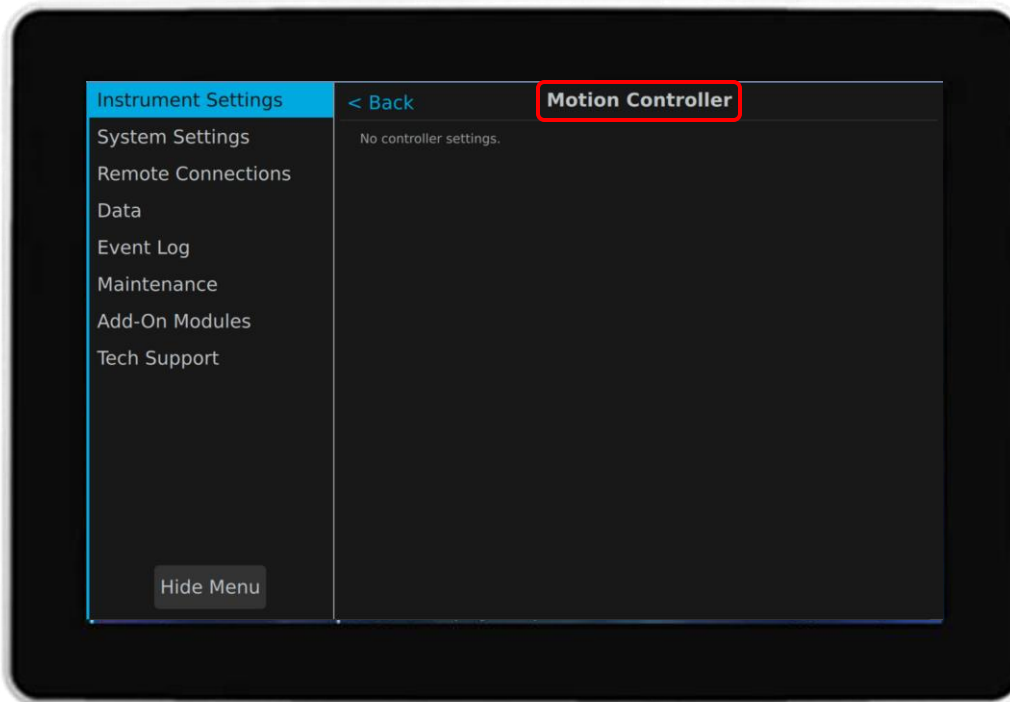


### 5.2.1 Instruments Settings

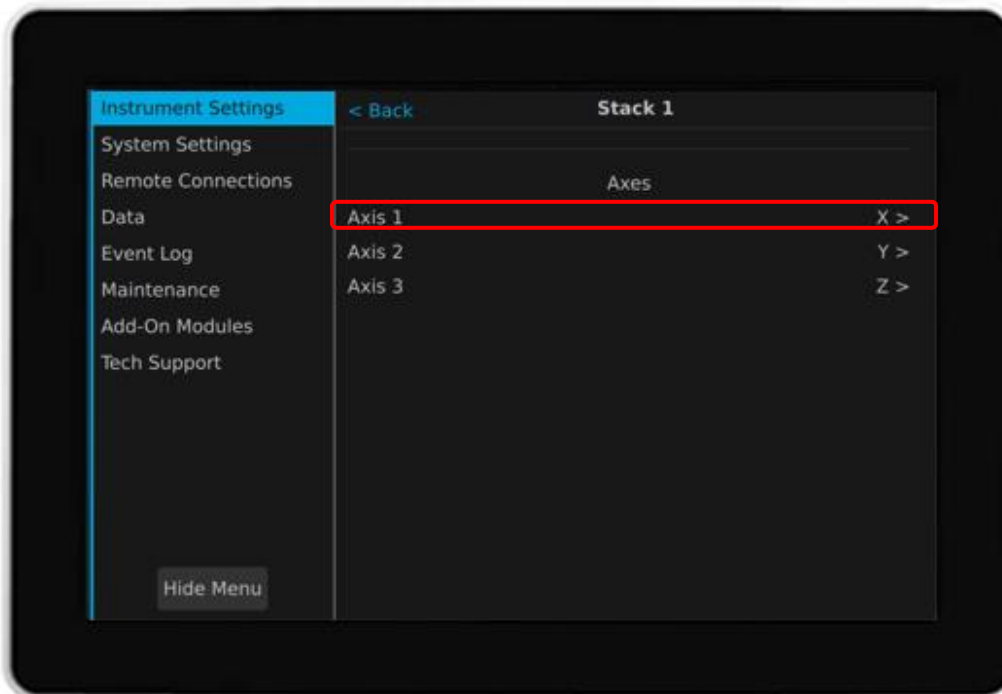
- Side menu will highlight whatever was recently accessed. In this case Instrument settings is displaying both the Cryostation and stack, i.e., connected devices.
- 



- Select "Motion Controller" to view stack settings.

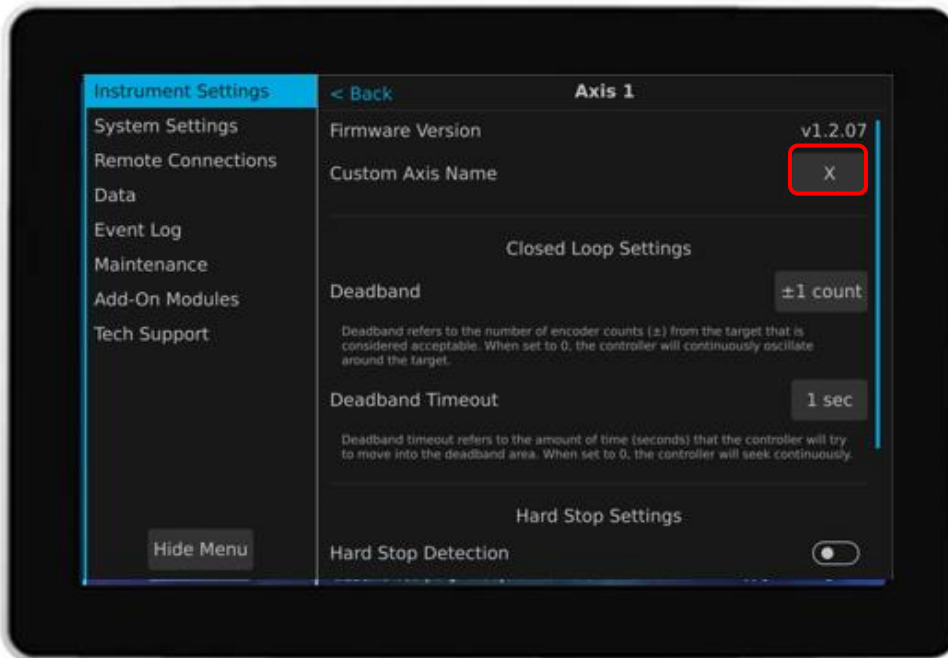


- The stack settings screen will display the axes.
- Tapping on "Axis 1" (in this case) will display Axis 1 settings.

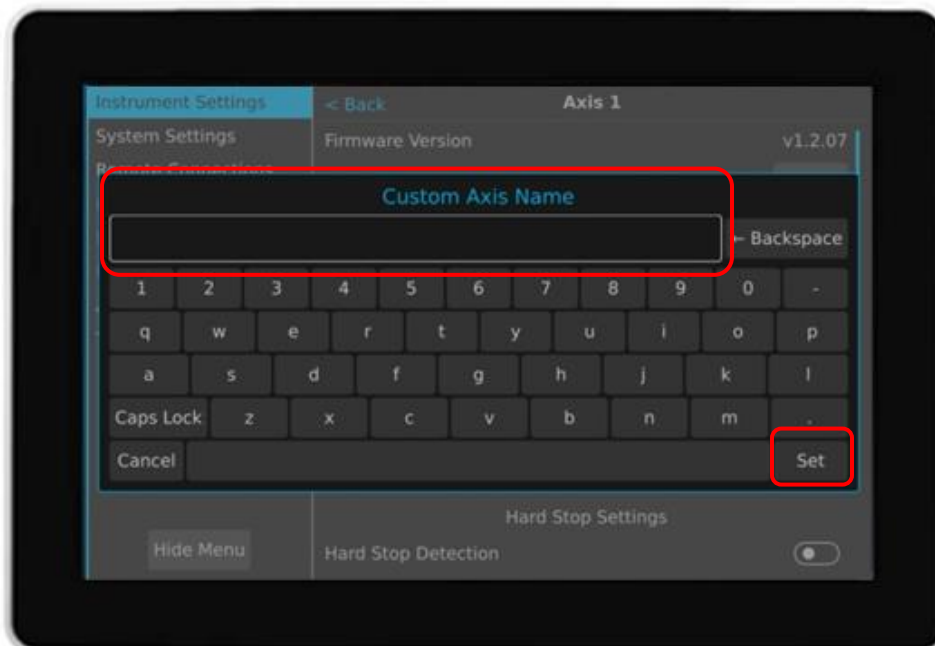


- Axis settings allows the user to customize and configure the axis.
- Tapping on the grayed boxes allows the user to provide a custom axis name (X), change the "Closed Loop Settings" and to toggle "Hard Stop Settings" on or off.

- Tap on the "X" button to customize the axis name.

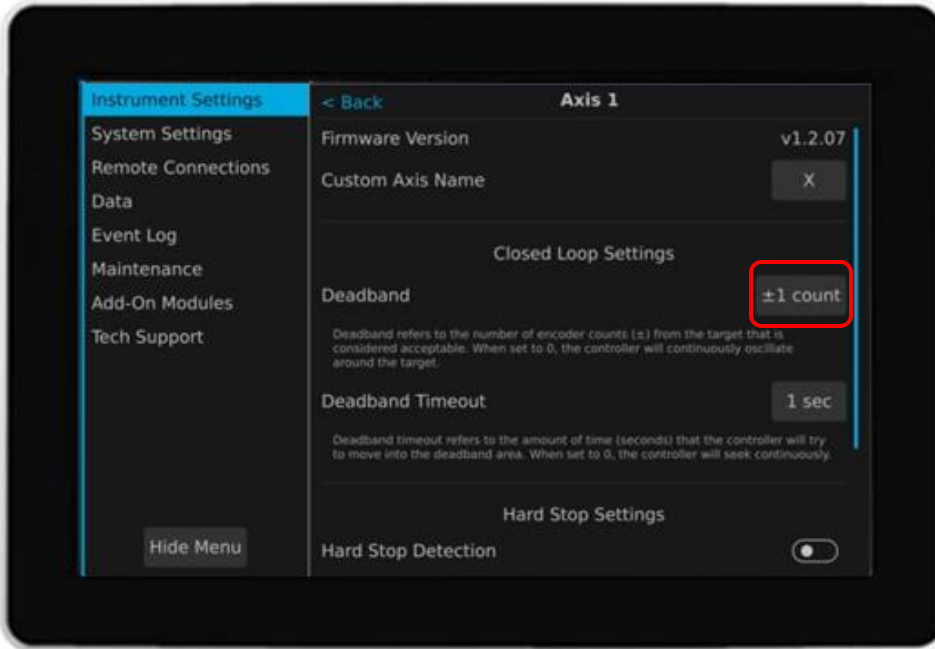


- A keyboard will display upon tapping on the "X" button. Enter "Custom Axis Name" and then tap on the "Set" button in the lower left of the keyboard display.

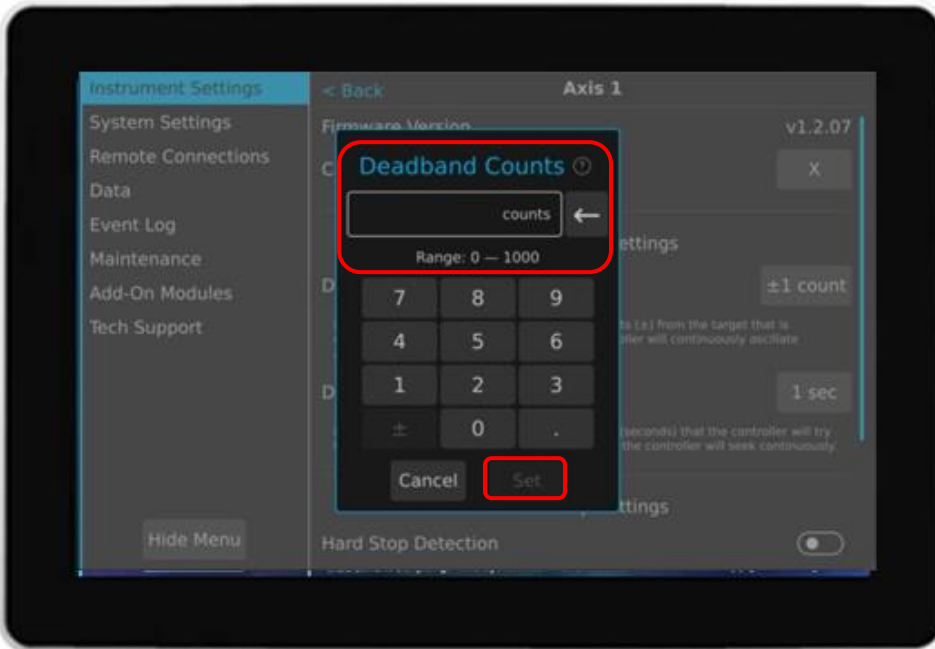


- "Closed Loop Settings" will automatically display and allow the user to enter or select a "Deadband" and "Deadband Timeout" values.
- Tap on the "Deadband" button to change "Deadband" value.

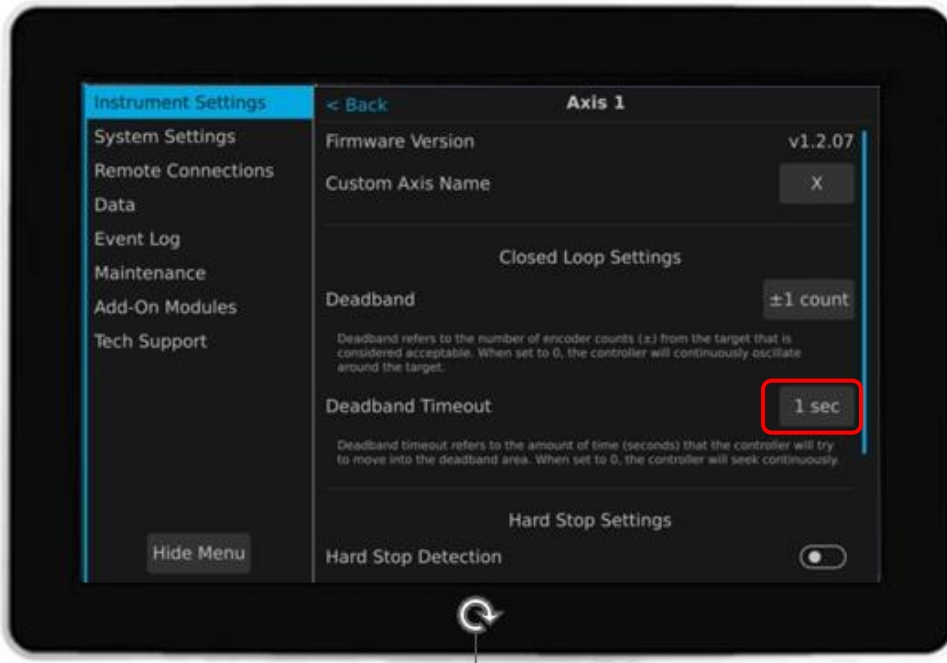




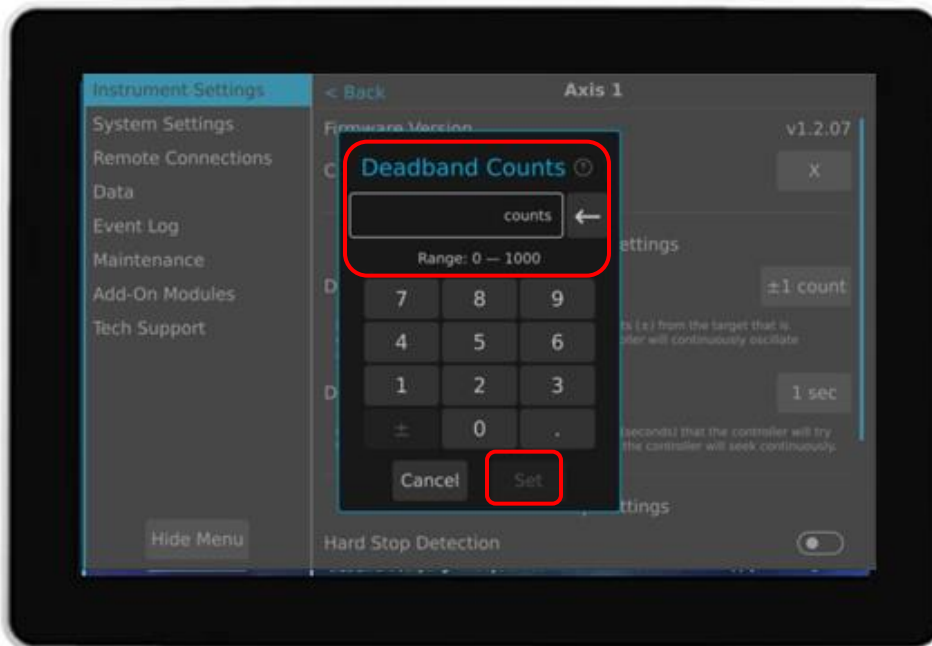
- Enter "Deadband" value (count) and then tap on "Set."



- Tap on the "Deadband Timeout" value (Sec) button to change "Deadband Timeout" value.



- Enter the "Deadband Timeout" value and then tap on "Set."

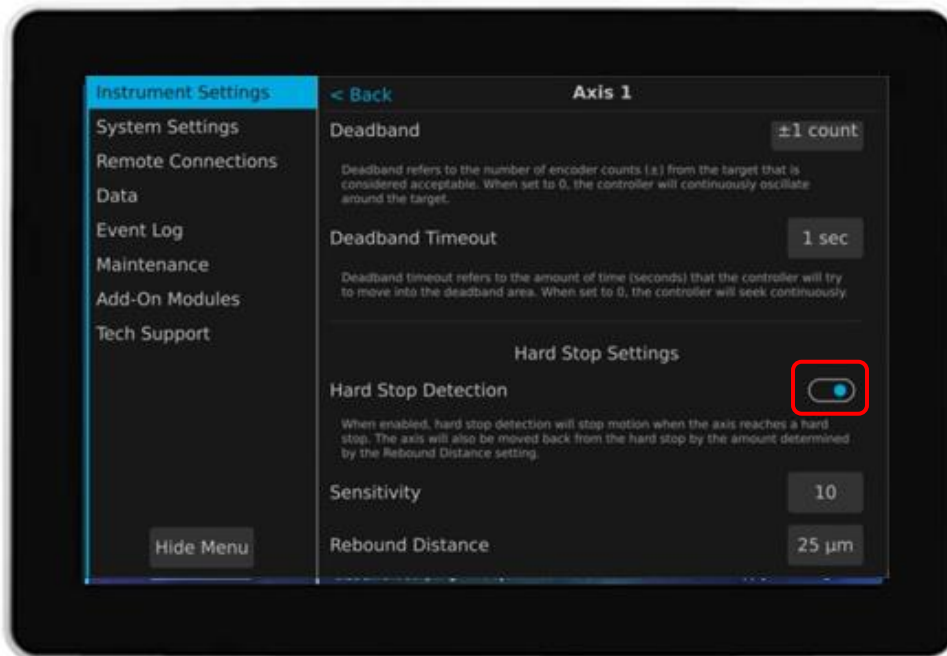


## 5.2.2 Hard Stop Settings

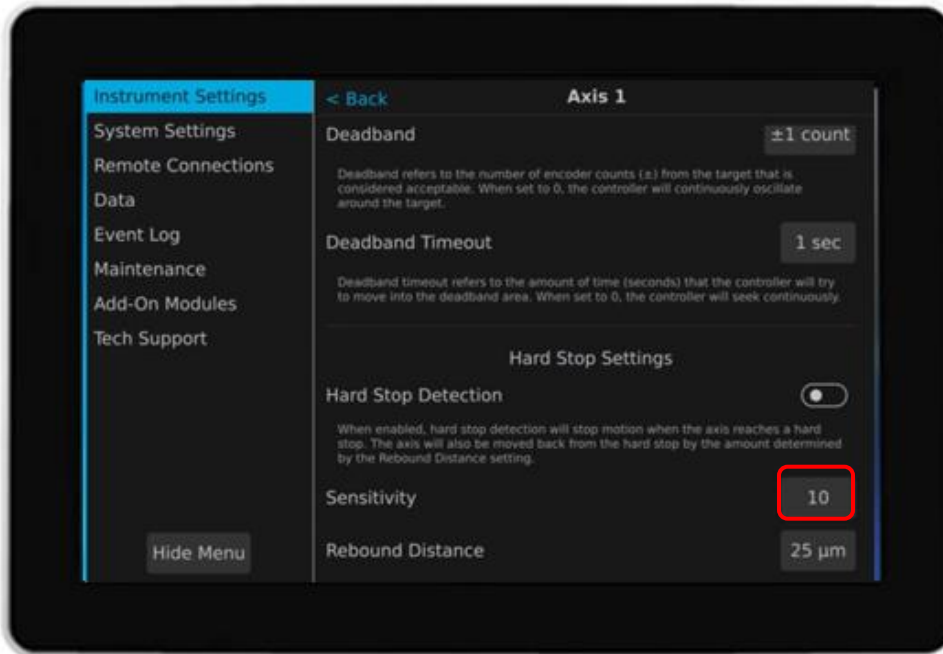
- Toggle "Hard Stop Detection" ON or OFF.
- Toggling the "Hard Stop" selection to OFF (left) will grey out toggle button.



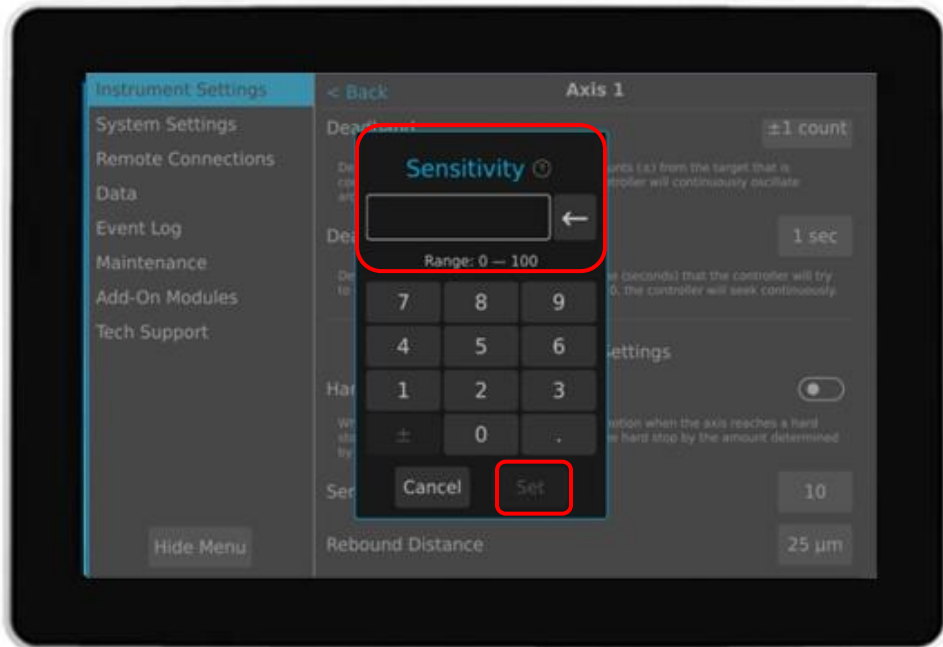
- Toggling the “Hard Stop” selection to ON (right) will illuminate the toggle button (blue). When enabled, hard stop detection will stop motion when the axis reaches a hard stop.



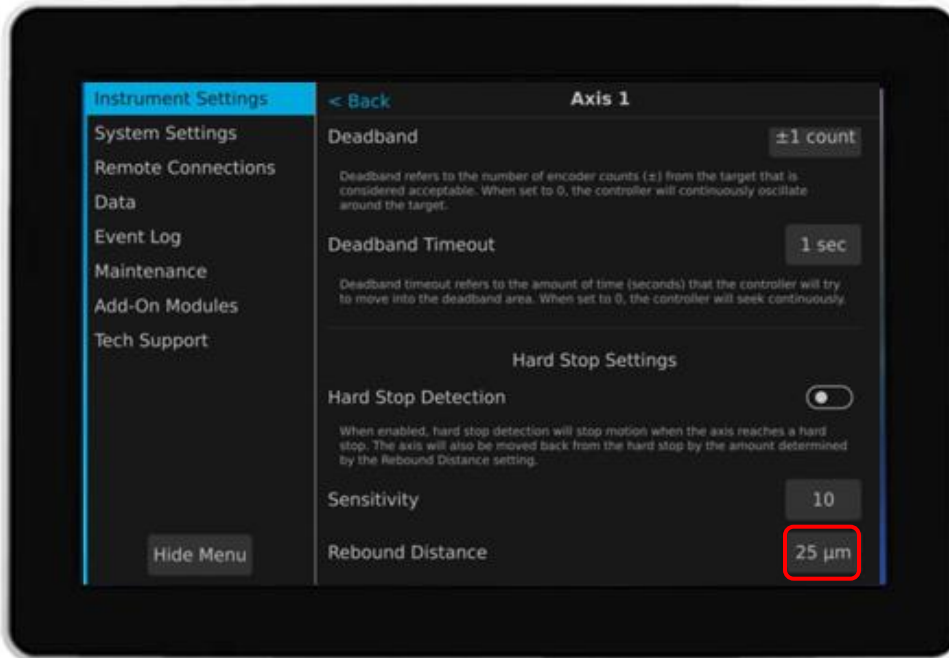
- Tap on the "Sensitivity" button to change the "Sensitivity" value.



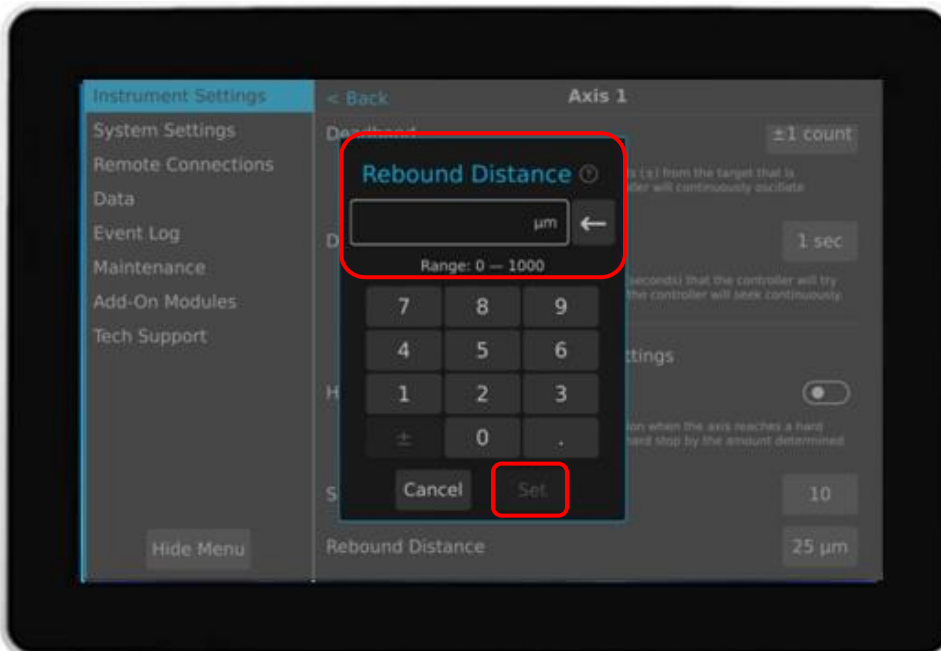
- Enter the "Sensitivity" value and then tap on "Set." Please be advised that the range is 1-100, with 100 being the most sensitive. We recommend that the sensitivity value be set to 5. Higher sensitivities can lead to "false stops."



- Tap on the "Rebound Distance" button to change the "Rebound Distance" value.



- Enter the "Rebound Distance" value and then tap "Set."



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## Section 6 - Care & Maintenance

### 6.1 System Care

Recommended system care procedures should be followed by any users of the system. For further information on any of these procedures, contact an authorized service representative for assistance. When handling the stage for cryogenic environments, take the necessary precautions when handling the stage, such as wearing clean latex gloves, clean room clothing, etc. Avoid any contaminants. Maximum cryogenic temperature is down to <4 Kelvin. Montana Instruments optionally supplies the stage with cryogenic compatible connectors, see chart below.

#### 6.1.1 Maintenance of Nanopositioner Stack

- The Rook linear stage utilizes a maintenance free design. Do not modify the stage or perform any maintenance unless specifically instructed to do so by Montana Instruments personnel. If the stage is not performing up to the original specifications, please contact Montana Instruments.
- The Rook linear stage is a precision mechanical device and should be handled with care. Do not drop or mishandle the stage.
- Follow the Installation Preparation requirements and use proper cable management to ensure a clean and safe operating environment.

#### 6.1.2 When Working in the Sample Chamber

- Keep surfaces clean. Avoid touching any surfaces inside the sample space with your fingers as oils or other foreign contaminants can easily be transferred to the surfaces, the sample, or optics. **Always wear clean gloves.**
- Use proper grease and adhesives in the sample chamber. The accessory kit includes Apiezon® L-grease, N-grease, and the adhesive GE Varnish (VGE).
- Avoid using too much grease – a thin layer (just enough so the surface is shiny) is best for metal-to-metal surfaces and O-rings. Too much grease can outgas and contaminate other surfaces in the sample chamber
- Do not apply N-grease anywhere above the positioner stack assembly e.g. flex link top plate or above: N-grease tends to run when system is baked out and can contaminate the bearings, rails, and encoders which will render the positioners non-operational at cryogenic temperatures.
- Inspect, wipe, and grease O-rings. Make sure that the O-rings are clean with a thin layer of L-grease. The exposed surface should be wiped with a dry Kimwipe or lens tissue and re-greased every 10-15 uses.

- 
- Check to ensure wires are preserved. Make sure wires do not overlap under thermal clamps and ensure the clamps are not too tight. Make sure wires do not touch the radiation shield or contact the sample mount directly after the thermal clamp.

### 6.1.3 When You are Using Your Cryostat

- Keep the lid on the sample chamber to keep it free from dust.
- Supply a slight amount of nitrogen to keep the system clean and dry.
  - Use the `VENT` command with "Vent Continuously" enabled to keep nitrogen flowing through the chamber at atmospheric conditions.
- Keep the sample chamber under vacuum. Use the `PULL VACUUM` command button to pull and keep the chamber under a medium vacuum state.

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## Section 7 - Diagnostics and Troubleshooting

This section contains information for basic system diagnostics and troubleshooting advice. Diagnostics or repairs outside of the scope of this section should be completed by an authorized service representative.

Fast Platform temperature decline seen at the end of cooldown causes large thermal gradient between Platform and stack as the stack temperature lags the Platform. i.e., When Platform first plummets to  $<10$  K, the stack is typically still  $100+$  K. This may occasionally cause the temperature compensation algorithm for the encoders to falsely shift.

Recommendation is to give stack time to thermalize and reach temperatures closer to the Platform before operation. Encoders may need to be zeroed if large shifts occur. Slight shifts in the encoder readings will occur as temperature compensation is applied to the encoders when the temperature is changing significantly (more than a few degrees).



## 7.1 Troubleshooting Guide

If a degradation in performance or other failures are experienced, check for these common issues:

Problem/Symptom	Possible Cause	Solution/Suggestion
<b>Axis not moving</b>	Physical impediment.	<ul style="list-style-type: none"> <li>• Check physical state of positioner stack for:               <ul style="list-style-type: none"> <li>○ Grease on the axis that isn't moving.</li> <li>○ Any other contamination on the axis.</li> <li>○ Wire routing impediments.</li> <li>○ Potential collisions preventing movement.</li> </ul> </li> </ul>
	Control cabling issue.	Ensure all cables and wiring are connected/plugged in and do not have any shorts or breaks. <ul style="list-style-type: none"> <li>• Check thermal clamp where In-Vacuum control cable is clamped and make sure it isn't clamped too tight:               <ul style="list-style-type: none"> <li>○ Remove clamp and check to see if axis becomes operational.</li> <li>○ Re-install clamp and do not torque screws to more than 0.5 in-lbs.</li> </ul> </li> </ul>
	Incorrect settings (open loop only).	Confirm that settings are correct.
<b>No encoder feedback (incorrect feedback)</b>	Cables are not properly connected.	Check cables and plugs to ensure everything is connected properly and do not have any shorts or breaks.
	Nanopositioner is not paired with the correct controller (multi-stack configuration).	If in a multi-stack configuration confirm that the correct controller is being paired with the nanopositioner.
<b>Z-axis not moving up</b>	Mass on top of positioner is too heavy (100g-250g)	Mass (>100g) on top of the positioner, you may have overloaded the z-axis. Reduce the mass on top of the positioner.
		Install the Low Force Spring Plunger and see if the positioner can lift the mass.

<p><b>Z-axis not moving down</b></p>	<p>Mass on top of positioner is too light (&gt;250g-400g)</p>	<ul style="list-style-type: none"> <li>• If the Low Force spring plunger is installed but the mass on top of the stage is under 100 g, it may not be able to move all the way down: <ul style="list-style-type: none"> <li>○ In this case remove the Low Force spring plunger.</li> <li>○ Then check to see if full travel is achieved.</li> </ul> </li> <li>• If the High Force spring plunger is installed but the mass on top of the stage is under 250 g, it may not be able to move all the way down: <ul style="list-style-type: none"> <li>○ Remove the High Force spring plunger.</li> <li>○ Check to see if full travel is achieved.</li> </ul> </li> </ul>
<p><b>Communication issues</b></p>	<p>There are communication issues between the MEIC and the Motion Controller.</p>	<ul style="list-style-type: none"> <li>• Confirm that the controller is powered, "ON."</li> <li>• Check USB cable and ensure it is connected.</li> <li>• If using multi-stack configuration confirm that USB and RS 485 connections are correct.</li> <li>• Try plugging the USB cable into alternate USB port on the MIEC including the front ports.</li> <li>• Check external control cable to ensure it is plugged in to the sample chamber and back of motion controller properly and is not too loose or partially plugged in.</li> </ul>
<p><b>Controller issues</b></p>	<p>The controller won't power on.</p>	<ul style="list-style-type: none"> <li>• Confirm 24V output from the power brick to the controller: <ul style="list-style-type: none"> <li>○ Confirm 24V output from the power brick to the controller.</li> </ul> </li> <li>• Verify connections.</li> <li>• If the number of stacks or axes is not as expected: <ul style="list-style-type: none"> <li>○ Power off the MIEC and motion controllers then power on the motion controllers followed by the MIEC.</li> <li>○ NOTE: When using multiple stacks, the motion controllers must be powered on simultaneously.</li> </ul> </li> </ul>
<p><b>High base temperature</b></p>	<p>Abnormal heat loads.</p>	<p>Accounting for wiring and encoder heat loads, consider the following:</p> <ul style="list-style-type: none"> <li>• The wiring going through the thermal clamp. <ul style="list-style-type: none"> <li>○ Is it well lagged?</li> <li>○ Is the clamp tight or too loose?</li> <li>○ Are the wires spread out as much as possible to allow for optimal thermalization of each wire?</li> </ul> </li> <li>• Is adaption plate secured to the cold platform and torqued to 8 in-lbs.?</li> </ul>

		<ul style="list-style-type: none"> <li>• Is the base of the flex link secured to the adaption plate and torqued to 5 in-lbs.?</li> <li>• Are there any burrs or deformities on the adaption plate or base of flex link preventing good thermal contact?</li> <li>• Are any components touching the radiation shield or other warmer surfaces?</li> </ul>
<b>Vibrations</b>	If experiencing greater than expected vibrations confirm that the following mechanical connections are within specified torque.	<ul style="list-style-type: none"> <li>• Sample mount and exchange boss to the top of the flex links: <ul style="list-style-type: none"> <li>○ Flex-link top to the nanopositioner stack.</li> <li>○ Flex-link bottom to the nanopositioner stack.</li> <li>○ Flex-link to the platform adaptor plate.</li> <li>○ Platform adaptor plate to the platform.</li> </ul> </li> </ul>
	Nanopositioner is out of tolerance.	<ul style="list-style-type: none"> <li>• Carefully manually translate each axis through its travel range to feel for abnormal mechanical motion.</li> </ul>

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# Section 8 - Getting Help and Contacting Montana Instruments

## 8.1 Technical Support Information

Any technical questions or issues with the system that cannot be resolved with the information in this manual should be referred to an authorized Montana Instruments service representative.

### 8.1.1 Technical Support Information

#### 8.1.1.1 Warranty and Repairs

If the system or parts need to be returned to the Montana Instruments factory or an authorized service center for repair or service, contact an authorized service representative for a return merchandise authorization (RMA) number and instructions on returning the unit.

For a copy of the Limited Warranty Agreement, visit: [www.montanainstruments.com/About/Warranty](http://www.montanainstruments.com/About/Warranty)

#### 8.1.1.2 Accessories and Replacement Parts

Only use cables, hoses, accessories, and parts provided or approved by the manufacturer. Follow all instructions for proper installation or replacement.

- To order spare or replacement parts, please contact your local service representative.
- To order new accessories or options, or for more information on other Montana Instruments products and technologies, please contact your local sales representative.

#### 8.1.1.3 Contact Details

For a complete list of sales and service centers visit: [www.montanainstruments.com/Contact](http://www.montanainstruments.com/Contact)

#### North American Authorized Service

- M-F 8:30am-5pm MST | Call: +1.406.551.2796
- Email: [support@montanainstruments.com](mailto:support@montanainstruments.com)

#### North American Sales

- M-F 8:30am-5pm MST | Call: +1.406.551.2796
- Email: [sales@montanainstruments.com](mailto:sales@montanainstruments.com)

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## International Sales & Authorized Service

- Visit [www.montanainstruments.com/Contact/Sales-Offices](http://www.montanainstruments.com/Contact/Sales-Offices) for contact information for your local representative.

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## Section 9 - Appendices

### 9.1 Related Documentation

For a copy of associated documentation, see below:

<b>Document Number</b>	<b>Document Title</b>	<b>Location</b>
DOC102	General Terms and Conditions of Sale	<a href="http://www.montanainstruments.com/About/Terms">www.montanainstruments.com/About/Terms</a>
DOC103	Limited Warranty Agreement	<a href="http://www.montanainstruments.com/About/Warranty">www.montanainstruments.com/About/Warranty</a>
DOC104	End User License Agreement	<a href="http://www.montanainstruments.com/about/EULA">http://www.montanainstruments.com/about/EULA</a>

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## 9.2 General Terms and Definitions

**Motion Control Coordinate System:** In free space, an object is considered to have six degrees of freedom: three linear, along the x, y, and z-axes and three rotational around those (roll, pitch, and yaw respectively). All motions described here follow the right-hand coordinate system convention. The cross-product of +X and +Y axes (pointer and middle fingers) is the +Z axis (thumb). Also, if the thumb of the right-hand points in the positive direction of an axis, the fingers will wrap around the axis in the direction of positive rotation about that axis. All movements are composed of translations along and/or rotations about the coordinate axes. Generally, the X and Y axes are on the horizontal plane, the direction of travel of the first or bottom stage is aligned with the X axis, and the Z-axis is vertical. For parallel kinematic systems, cardan angles are used.

**Linear Stage:** A linear stage or translation stage (also axis), is a component of a precise motion system used to restrict an object to a single axis of motion.

**Stack:** A nanopositioner stack refers to linear stages being stacked on top of each to provide a moving foundation that can be controlled in multiple dimensions, commonly an xyz stack that provides control over the 3 linear degrees of freedom. The sample foundation at the top of a positioner stack is not to be confused with the Platform temperature in Cryostation systems.










**Open-Loop Operation:** In open-loop control, the control of the positioners is independent of the actual location of the stage. It does not use feedback to determine if the stage has achieved the desired movement goal of the input control command. Open-loop control is often used in simple applications because of its simplicity and lower cost, especially in systems where feedback is not critical.

**Closed-Loop Operation:** The term "closed-loop" in nanopositioning indicates that a sensor is used to monitor the position of a stage in real time. The position readings are fed back to the controller and compared to the command positioner, which provides error correction for the system. Control technology is used to reach the optimum target position, for high position resolution, for uniform feed velocity, and greater dynamic velocity and acceleration ranges.





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## 9.3 Galaxy UI Screen Elements (Iconography)



### 9.3.1 Manual Controls

-  Jog -  Closed Loop
-  Jog +  Open Loop
-  Step -  Axis Enabled (Closed Loop)
-  Step +  Emergency Stop
-  Stop

### 9.3.2 Main Navigation

-  Instrument Selection
-  Instrument Lock
-  Instrument Unlock
-  Menu

### 9.3.3 Status

-  Target Acquired
-  Hard Stop Detected