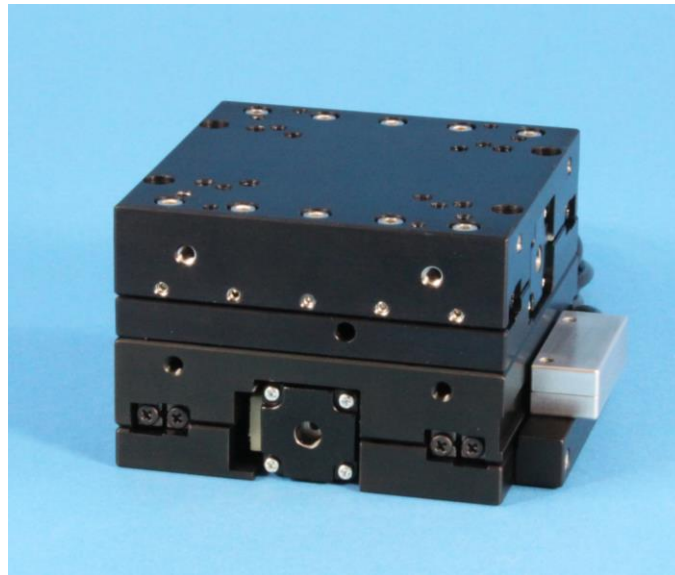
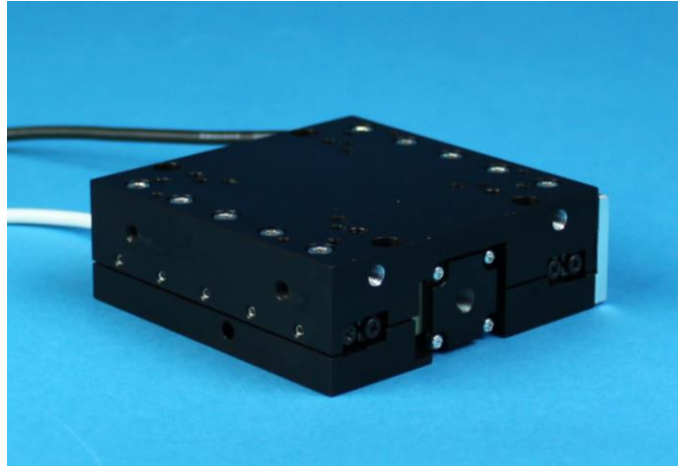


MMP micropositioning stage and Micro-Drive™ controller



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IMPORTANT

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CONTENTS

1. INTRODUCTION

2. SOFTWARE INSTALLATION

3. HARDWARE INSTALLATION

3.1 Mounting Procedures

3.2 Micro-Drive™ Controller

3.3 MMP Connections

3.3.1 Encoder Connections (option)

4. LIMIT SWITCHES

5. DEMONSTRATION PROGRAM

6. OPERATING THE MMP

7. OPTIONS: WIRELESS GAMEPAD CONTROL

7.1 Installing the Logitech Gamepad

7.2 Choosing the Correct Input Mode

7.3 Gamepad Configuration

7.4 MicroDrive Gamepad Control Configuration

INTRODUCTION

The Mad City Labs, Inc. MMP is a modular single axis micropositioner designed to for high precision automated motion. The MMP platform has a high resolution stepped linear actuator for motion control and can be equipped with an optional high resolution glass scale encoder for position measurement. The linear actuators have a step resolution of 1.524 microns and are operated in a divide by 16 microstep mode. The minimum step of the MMP is 95.25 nm.

Mad City Labs MMP stages may be enabled with the encoder option. Models with encoders are described by a –xxE suffix, where the xx describes the resolution of the encoder in nanometers (e.g. -50E suffix denotes a 50nm resolution encoder).

Each axis of the MMP has a forward and reverse limit switch that limits the range of motion. The limit switches are set up to allow for 1.0" (25mm) of motion on each axis.

For shipping purposes, each axis of the MMP has a shipping plate installed. This plate must be removed prior to installation.

The Mad City Labs, Inc. Micro-Drive™ is the control electronics for the MMP. The Micro-Drive™ consists of a divide by 16 microstep controller, limit switch circuitry, and encoder electronics (if option is installed) for each axis. The Micro-Drive™ interfaces to a computer via a USB port and the supplied LabView based software.

The MMP micropositioning stage may be fitted together to form a multi-axis configuration. The MMP is compatible with selected Mad City Labs nanopositioners. These nanopositioners can be secured directly to the top of the MMP. Using the Mad City Labs MMP with a Mad City Labs nanopositioner gives true long range motion with sub-nanometer precision.

2 SOFTWARE INSTALLATION

The USB driver must be installed on your host computer before connecting the Micro-Drive™ to the host computer. Your host computer must be using either Windows Vista, 7, 8 or 10.

The installation program is on the Manuals and Software CD shipped with your system. The installation program will automatically run when you place the CD in your CD drive. The installation program also installs the example software and manuals for your system.

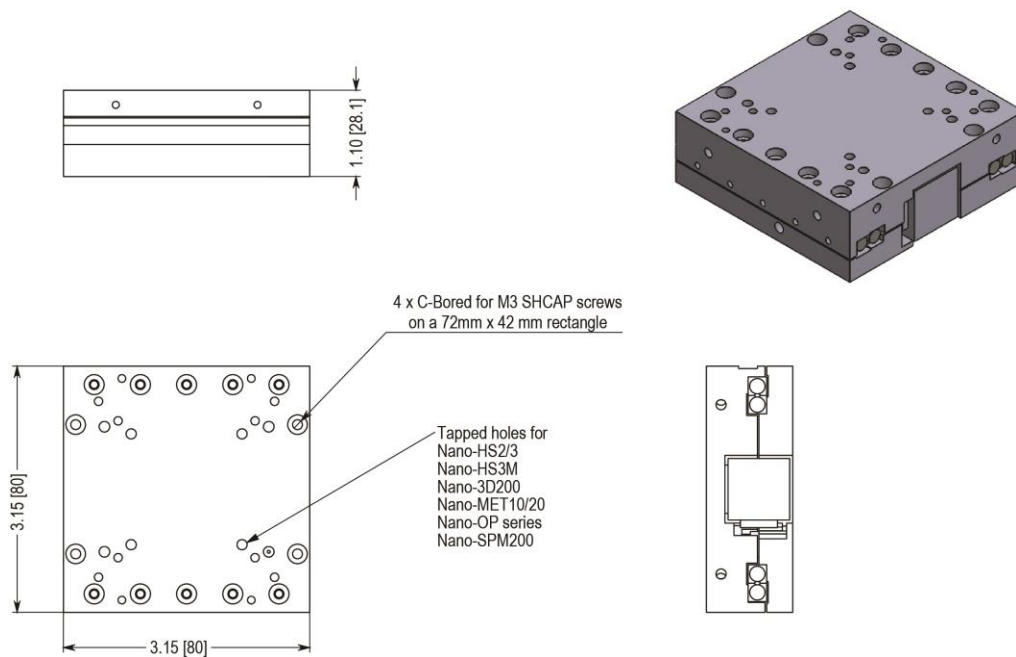
Once the software has been installed, connect the PC to the Micro-Drive™ controller. Windows will now recognize that a new USB device has been attached to your computer and install the required software. No further steps are required. The system is now ready for operation.

3 **HARDWARE INSTALLATION**

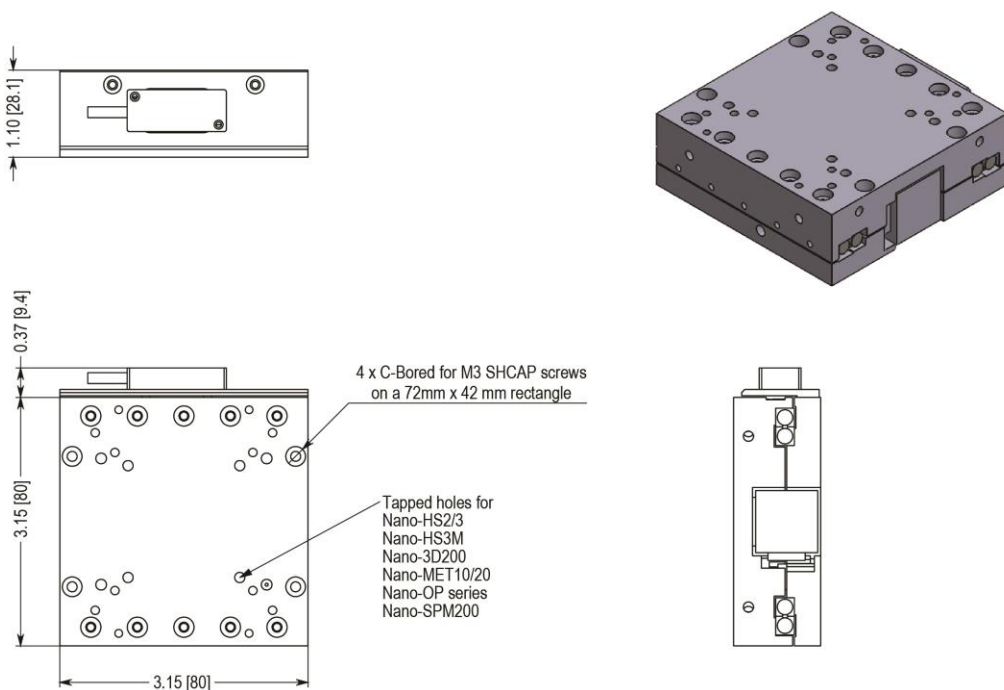
For shipping purposes, each axis of the MMP has a shipping plate installed. This plate must be removed prior to installation. Please retain the shipping plate and thumbscrews.



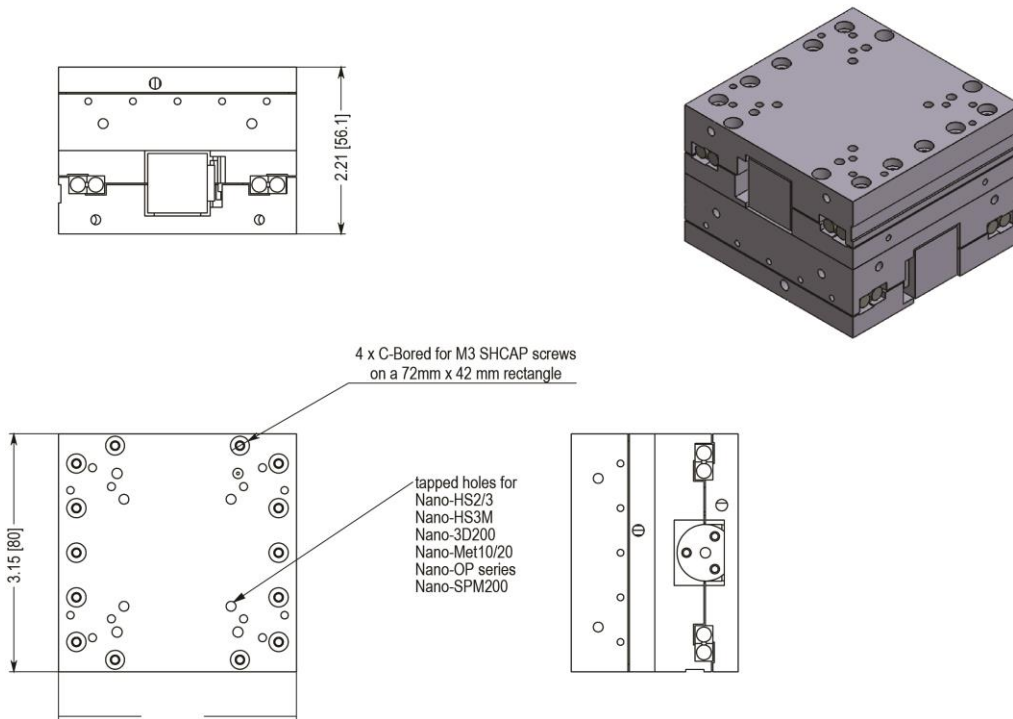
Single-axis MMP shown with shipping plate attached. Remove prior to installation.



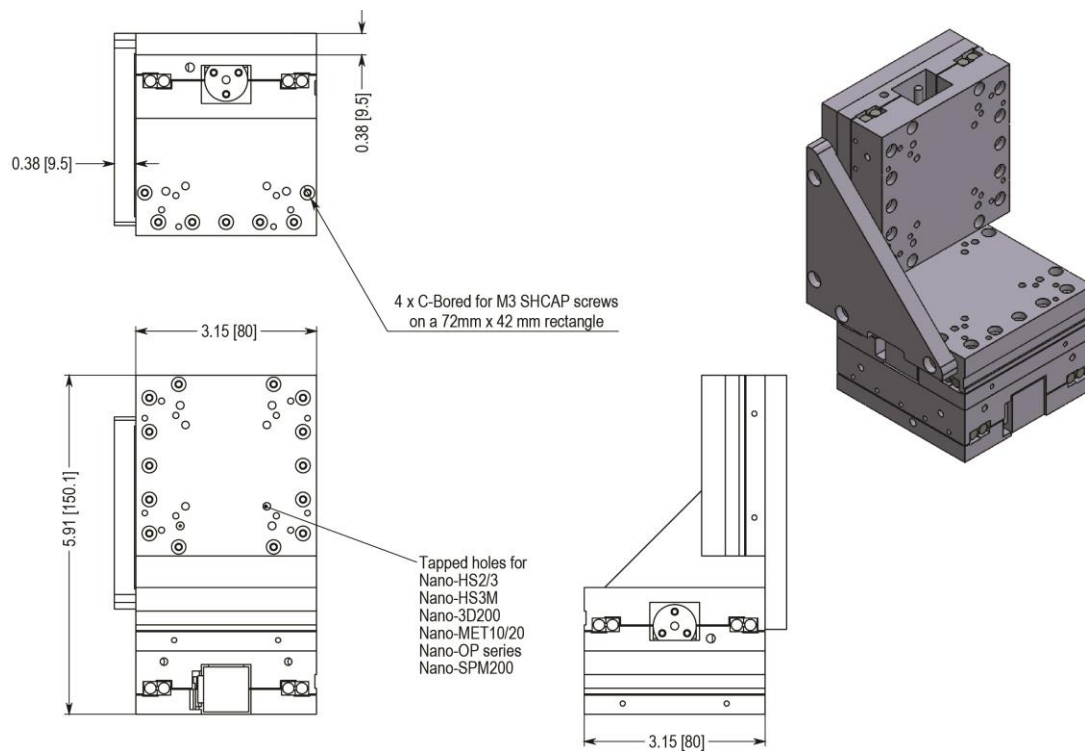
Single-axis MMP dimensions shown in inches [mm]. Note that the MMP is compatible with a wide range of Mad City Labs nanopositioning systems.



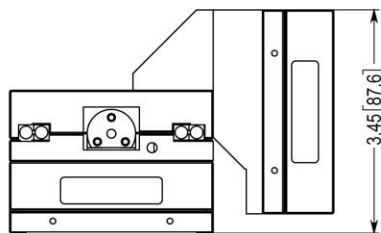
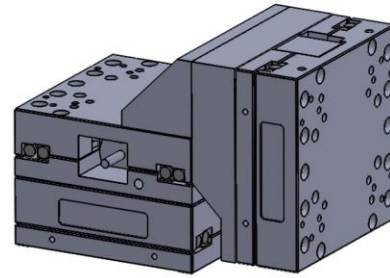
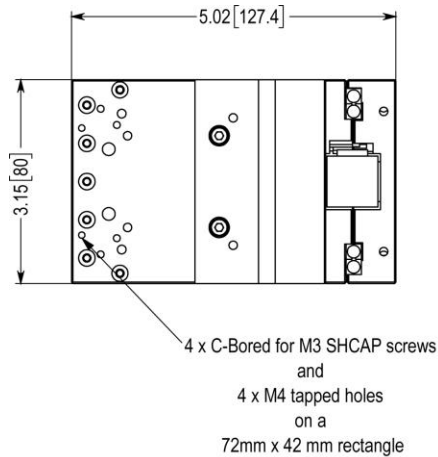
Single-axis MMP with optional encoder. Dimensions shown in inches [mm].



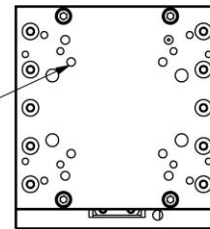
Two axis MMP (MMP2) dimensions shown in inches [mm]. Encoder connection not shown.



Three axis MMP (MMP3V) dimensions shown in inches [mm]. Encoder connection not shown.



Tapped holes for
Nano-HS2/3
Nano-HS3M
Nano-3D200
Nano-MET 10/20
Nano-OP series
Nano-SPM200



The MMP3H can be secured from the top using four M3 SHCAP screws, or from the bottom using the four M4 tapped hole.

Three axis MMP (MMP3H) dimensions shown in inches [mm]. Encoder connection not shown.

Once the software is installed on your computer, attach the MMP to your desired surface. The mounting procedure is the same irrespective of whether the MMP is shipped with the encoder option.

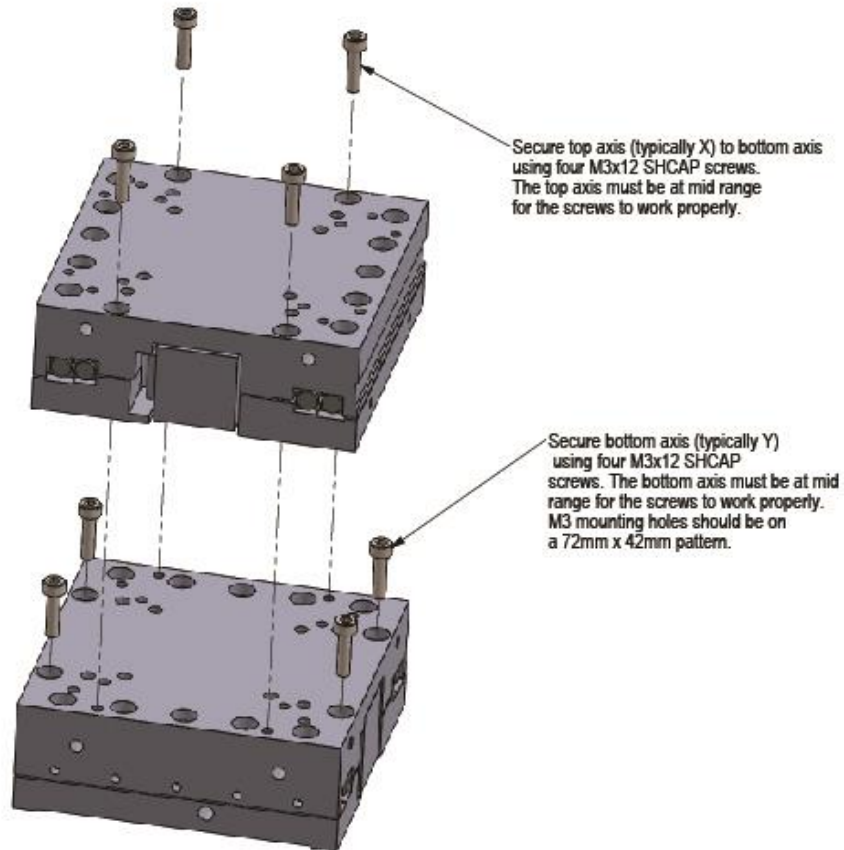
3.1 Mounting Procedures.

The MMP micropositioning stage is a modular design. If you are installing a multi-axis system the bottom stage must be fixtured first, before attaching the other axes.

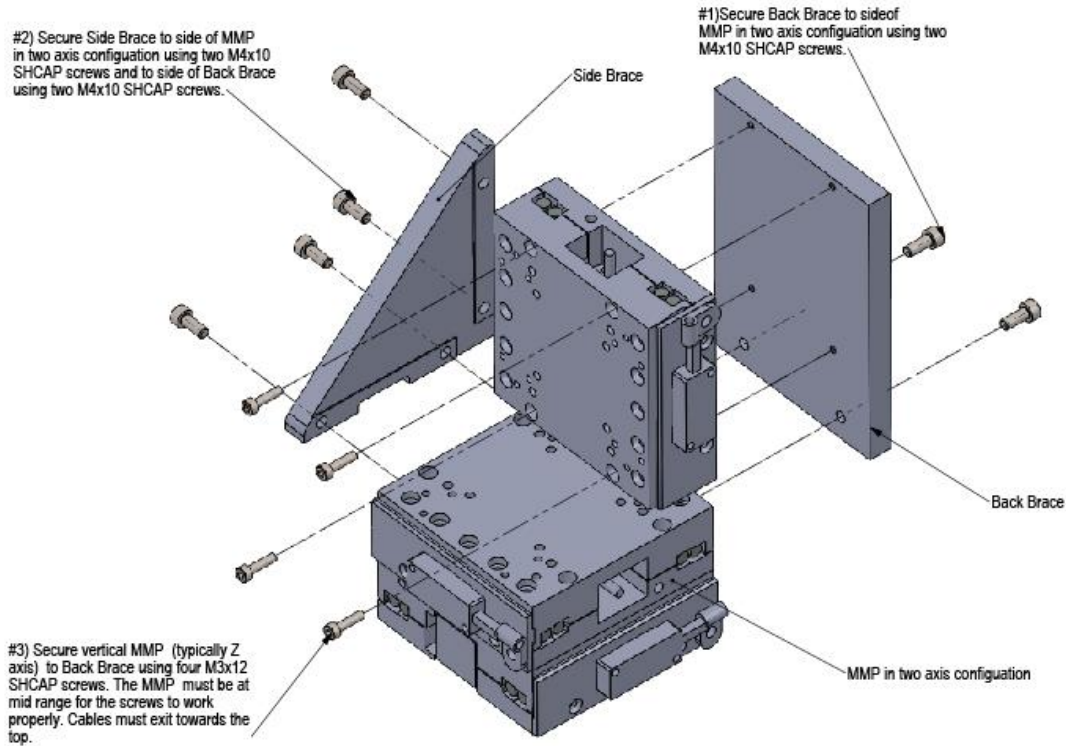
Irrespective of the number of axes installed, the MMP micropositioning stage must always be at its mid-range in order to fixture the stage to a surface.

The MMP has four C-bored holes located on a 72mm x 42mm rectangle for mounting using four M3 socket head cap screws. When tightening the M3 screws make sure the screws do not protrude above the top surface of the MMP.

A two axis configuration can be achieved by simply fastening an MMP stage orthogonal to another MMP stage. This can be achieved using the rectangular pattern mounting holes described above. Take care to ensure that the screws do not protrude and obstruct the motion of the stage.



For the three axis MMP3V a back and side brace plate (supplied) is required. It is assumed that the two axis configuration is already assembled.



- Attach the back brace to the two axis MMP configuration using two M4 x 10 SHCAP screws.
- Attach the side brace to the two axis MMP configuration using two M4 x 10 SHCAP screws.
- Secure the side brace to the back brace using two M4x10 SHCAP screws.
- Attach the third MMP stage to the back brace using four M3x12 SHCAP screws. Ensure that the cables exit towards the top.

3.2 Micro-Drive™ Controller

The Mad City Labs, Inc. Micro-Drive™ is the control electronics for the MMP. The Micro-Drive™ consists of a divide by 16 microstep controller, limit switch circuitry, and encoder electronics (if option is installed) for each axis. The Micro-

Drive™ interfaces to a computer via a USB port and the supplied LabView based software.

FRONT PANEL	
STEPPER MOTOR CONTROL (PER AXIS)	SUB-D
LIMIT SWITCH INDICATORS (PER AXIS)	LED
REAR PANEL	
ENCODER CONNECTOR TYPE	SUB-D
POWER REQUIREMENT	12V/3.0A
16 BIT DIGITAL INTERFACE	USB 2.0



Front panel of a three axis Micro-Drive™ controller.

The front panel of the Micro-Drive™ controller features the connectors for the stages and LED limit switch indicators. Each stage axis connector is clearly labelled and must be connected to the matching controller connector.

Do not connect the stage to the controller unless the power is disconnected.



Rear panel of the Micro-Drive controller. This controller has the encoder option.

The rear panel of the Micro-Drive™ controller has the USB port (with LED ready light), the encoder sub-D connectors (if ordered), and the power connector.

The DC power connector is a 12V/3.0A connection. The power to the Micro-Drive™ controller should only be connected once all stage and encoder connections have been made and fastened.

3.3 MMP Connections (all models)

Each axis of the MMP has a cable with a sub-D connector. These cables carry the motor voltages and the limit switch connections. The connectors should be screwed into the front panel of the Micro-Drive™ at the position for the corresponding axis. Before connecting these cables to the Micro-Drive™ ensure that the power to the Micro-Drive™ is disconnected at the rear panel. **Never connect or disconnect stage cables to the Micro-Drive™ with the power on.**

3.3.1 Encoder connections (encoder option only)

Encoder enabled MMP systems have black cables terminated with sub-D connectors which include the encoder interpreter (see section 4 below). Each connector is labeled for a specific axis and should be connected to the matching rear panel port on the Micro-Drive™ controller. Before connecting these cables to the Micro-Drive™ ensure that the power to the Micro-Drive™ is disconnected. **Never connect or disconnect cables to the Micro-Drive™ with the power on.**

The power cord to the rear panel of the Micro-Drive controller can be safely connected once all encoder and stage connectors have been fixed to their appropriate controller ports.

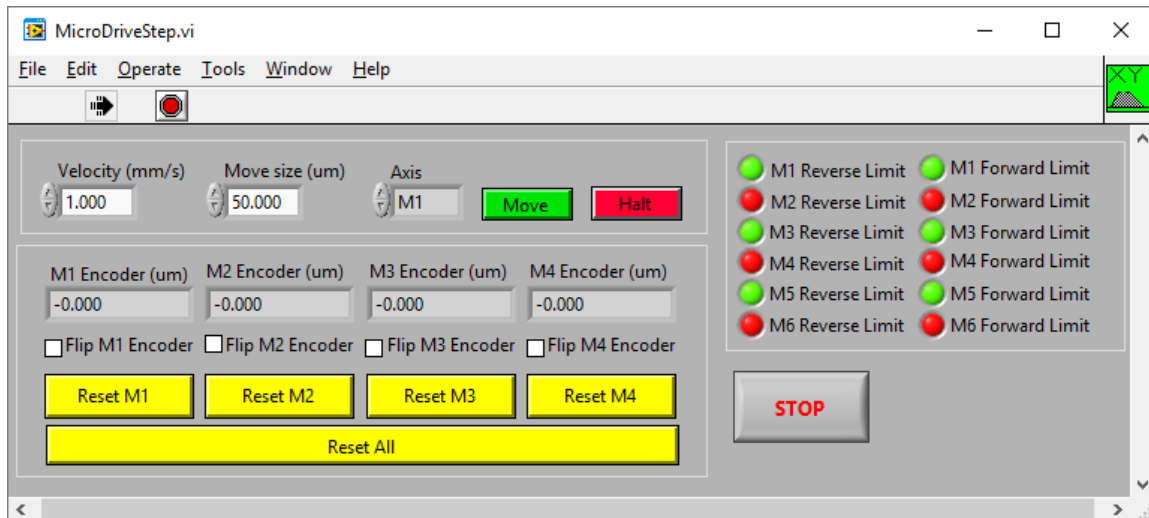
4 LIMIT SWITCHES

Each axis has a set of two limit switches that define the range of motion. The forward limit switch prevents the stage from moving too far in the direction towards the linear actuator for each axis. The reverse limit switch prevents the stage from moving too far in the direction away from the linear actuator for each axis.

When a limit switch is tripped a red LED on the front panel of the Micro-Drive™ will light. The Micro-Drive™ will not allow the MMP to move in that direction while the LED is lit. The MMP can move in the opposite direction so that the limit switch will be released and the LED will go out.

5 DEMONSTRATION PROGRAM

Mad City Labs, Inc. provides a multi-axis stepper program called **MicroDriveStep.VI** which can be used to test the MMP and as a reference design for more sophisticated control programs. **MicroDriveStep** is provided as a LabView VI and as a LabView executable. These programs can be found in installation directory (by default C:\Program Files\MicroDrive) under the "LabView Example" and "LabView Executable" subdirectories. The VI is compatible with LabView versions 2009 and higher. The executable is dependent on the LabView 2009 runtime engine which can be installed by running the executable file located in the "LabView Executable" directory.



To start running **MicroDriveStep** press the run button in the top tool bar (white arrow in upper left-hand corner). The program is designed as a loop which runs continuously until the 'STOP' button is pressed. The program should always be stopped by pressing the 'STOP' button as this ensures that control of the Micro-Drive™ is properly released.

While the program is running the MMP can be moved by setting the 'Velocity', 'Move size', and 'Axis' control inputs on the front panel and pressing the Move button. Setting the 'Move size' input to a positive value will move the selected axis toward its forward limit and to a negative value will move it toward its reverse

limit. Moves are reflected in the encoder position. Remember that the encoder reflects the actual distance traveled whereas the specified move size is only approximate. To reset the value of an encoder press either the 'Reset (M1/M2/M3/M4)' or 'Reset all' button.

The encoder values are updated once every ~100ms when the MMP is not moving. Care should be taken not to access the Micro-Drive™ while the MMP is moving for any reason other than stopping it. Doing so will adversely affect the internal timers of the Micro-Drive™ which generate the required step pulses for the specified movement.

The motor power is automatically turned off when the MMP is not in use. Turning the motors off eliminates any vibration that might be sensed by the nanopositioner.

For more information about the Micro-Drive™ API refer to MicroDrive_*.doc in the install directory.

6 OPERATING THE MMP

Often the MMP is used as a coarse positioner. In this mode the MMP is sent to a specific position and then held there while the nanopositioner is used. It is important to have the position of the MMP held accurately. To insure accurate holding of the MMP:

- 1) Always move the stage in integral multiples of 8 steps. When the Micro-Drive™ is turned on it sets the motor angle to a full step. Also, the stepper is a permanent magnet stepper. Therefore, the motor has the highest holding torque value on a full or half step.
- 2) Always operate the stage in the reverse direction before stopping. Due to the preload on the motor this gives the best holding torque.

7 OPTIONS: WIRELESS GAMEPAD CONTROL

The MMP can be controlled via a wireless gamepad as an available option. The Logitech gamepad is supplied with its own software and drivers and can be used with mad City Labs software to control the Micro-Drive™ controller. The Logitech software must be installed and the input mode set prior to running any Mad City Labs' gamepad software. Proportional control is not supported by Mad City Labs' software, however two drive speeds are supported which correspond to joystick pressure less than halfway (slow) and more than halfway (fast).

7.1 Installing the Logitech Gamepad

Ensure that your wireless gamepad has batteries installed.

It is important to run Windows update before installing Logitech software.

A quick start guide to installing the gamepad is supplied by the manufacturer.

Please follow these instructions before proceeding. The gamepad is a USB device and will not operate until the necessary drivers have been installed. The drivers are on the CD supplied with the gamepad or can be downloaded from www.logitech.com. If you download the driver from the Logitech website you may auto-detect your gamepad if it is plugged in. This will detect the device and operating system. Choose "Logitech gaming software" as the appropriate software.

If you have not already been prompted to plug in the USB connector of the gamepad to the PC, please do so now.

7.2 Choosing the correct input mode.

The supplied Logitech gamepad can operate in DirectInput or XInput mode. For use with the Mad City Labs gamepad examples, the controller must be set to DirectInput mode. The supplied gamepad has a switch at the top of the controller which switches between modes, "X" for XInput mode and "D" for DirectInput mode.

7.3 Gamepad configuration for use with the MicroDrive Software

Once the drivers are installed and the input mode is selected the gamepad must be ready for use with the supplied Mad City Labs software.

The gamepad software ships with a default configuration which maps gamepad button presses into Micro-Drive™ motion. This default configuration can be modified with the example program.

Be aware that the gamepad goes into sleep mode after 5 minutes of inactivity. To wake up the gamepad push any button on the gamepad.

7.4 MicroDrive Control Software Configuration

Once you are satisfied that you have the gamepad configured to your requirements, then open the Mad City Labs MicroDrive control software. For more information about the MicroDrive Control software please read the application note “Gamepad MicroDrive control with limits”.