

MPC-365 SERIES

MULTI MOTORIZED NARROW-FORMAT
MICROMANIPULATOR CONTROL SYSTEM

OPERATION MANUAL

REV. 3.06H (20180410)



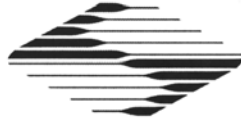
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CE EU Declaration of Conformity

Application of Council Directives:
2014/30/EU (EMC), 2014/35/EU (LVD), and 2011/65/EU (RoHS 2)

Manufacturer's Name: Sutter Instrument Company

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Equipment Tested: MPC-365 Series-Motorized Multi Micromanipulator System

Model(s): System: **MPC-365 Series**
Controller: **MPC-200**
User Control Device: **ROE-200**
Motorized Micromanipulator: **MP-265/M**
(may also include **MP-225/M** and/or **MP-285/M** manipulator, and/or **MT-800** translator)

Conforms to Standards: EMC Emissions: EN 61326-1:2013, including:
EN 55011: 2009 Class B;
EN 61000-3-2:2015, & EN 61000-3-3:2014
EMC Immunity: EN 61000-4-2:2009, EN 61000-4-3:2011,
EN 61000-4-4:2012, EN 61000-4-5:2014,
EN 61000-4-6:2014, EN 61000-4-8:2010, &
EN 61000-4-11:2004
LVD (Safety): EN 61010-1:2010

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Test Report(s): 20120511-01A-R1_MC CE RptA R4, SI_EMC_MPC-200_20160713

Sutter Instrument Company hereby declares that the equipment specified above was tested and conforms to the EU Directives and Standards listed above, and further certifies conformation to the requirements of the European Union's Restriction on Hazardous Substances in Electronic Equipment Directive 2011/65/EU (RoHS 2).

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DISCLAIMER

The MPC-365-series system consists of one or two MPC-200 controllers, an ROE-200 user control device, and one or more electromechanical micromanipulator devices. The purpose of the system is for the manipulation at the micro level of micropipettes and probes used in conjunction with a microscope. No other use is recommended.

This instrument is designed for use in a laboratory environment. It is not intended, nor should it be used in human experimentation or applied to humans in any way. This is not a medical device.


Do not open or attempt to repair the instrument. High voltages are present and inadvertent movement of the micromanipulator electromechanical could cause injury.

Do not allow unauthorized and/or untrained operative to use this device.

Any misuse will be the sole responsibility of the user/owner and Sutter Instrument Company assumes no implied or inferred liability for direct or consequential damages from this instrument if it is operated or used in any way other than for which it is designed.



SAFETY WARNINGS AND PRECAUTIONS

Electrical

- Operate the MPC-200 using 110-- 240 V AC., 50-60 Hz line voltage. This instrument is designed for use in a laboratory environment that has low electrical noise and mechanical vibration. Surge suppression is recommended at all times. If the system includes two MPC-200 controllers daisy-chained together, surge suppression is strongly recommended.
-  **Fuse Replacement:** Replace only with the same type and rating:
T2A, 250V, 5 x 20mm, Time Delay fuse (IEC 60127-2, Sheet III)
(Examples: Bussmann GDC-2A. GMC-2A or S506-2-R (RoHS); or
Littelfuse 218 200 or 218 200P (RoHS))

A spare fuse is located in the power input module. Please refer to the fuse-replacement appendix for more details on fuse ratings and for instructions on how to change the fuse.

Avoiding Electrical Shock and Fire-related Injury

-  Always use the grounded power supply cord set provided to connect the system to a grounded outlet (3-prong). This is required to protect you from injury in the event that an electrical hazard occurs.
- Do not disassemble the system. Refer servicing to qualified personnel.
-  To prevent fire or shock hazard do not expose the unit to rain or moisture.

Electromagnetic Interference

To comply with FDA and CE electromagnetic immunity and interference standards; and to reduce the electromagnetic coupling between this and other equipment in your lab always use the type and length of interconnect cables provided with the unit for the interconnection

of one or more MP-2x5/M electromechanical devices, host computer via USB interface, (see the Technical Specifications appendix for more details).








Operational

Failure to comply with any of the following precautions may damage this device.

- This instrument is designed for operation in a laboratory environment (Pollution Degree I) that is free from mechanical vibrations, electrical noise and transients.
- This unit is not designed for operation at altitudes above 2000 meters nor was it tested for safety above 2000 meters.

-  **DO NOT CONNECT OR DISCONNECT THE CABLES BETWEEN THE CONTROLLER AND THE MECHANICAL UNITS WHILE POWER IS ON.**


Please allow at least 20 seconds after turning the unit off before disconnecting the mechanical units. Failure to do this may result in damage to the electronics.

- Operate this instrument only according to the instructions included in this manual.
- Do not operate if there is any obvious damage to any part of the instrument.
-  Operate only in a location where there is a free flow of fresh air on all sides. **NEVER ALLOW THE FREE FLOW OF AIR TO BE RESTRICTED.**
-  Do not operate this instrument near flammable materials. The use of any hazardous materials with this instrument is not recommended and if undertaken is done so at the users' own risk.
-  Do not attempt to operate the instrument with the manipulator shipping screws in place - severe motor damage may result.
-  Do not operate if there is any obvious damage to any part of the instrument. Do not attempt to operate the instrument with the manipulator shipping screws in place - severe motor damage may result. When transporting the mechanical manipulator, be sure to install the shipping screws supplied in their correct locations. Failure to do this may result in damage to the motors.
-  Never touch any part of the micromanipulator electromechanical device while it is in operation and moving. Doing so can result in physical injury (e.g., fingers can be caught and pinched between the moving parts of the micromanipulator).
-  As with all microinjection devices, sharp micropipettes can fly out of their holder unexpectedly. Always take precautions to prevent this from happening. Never loosen the micropipette holder chuck when the tubing is pressurized, and never point micropipette holders at yourself or others. Always wear safety glasses when using sharp glass micropipettes with pressure microinjectors.
-  Do not handle the manipulator mechanical while the power is on, and take care to ensure no cables pass close to the mechanical manipulator.

Other

- Use this instrument only for microinjection purposes in conjunction with the procedures and guidelines in this manual.
- Retain the original packaging for future transport of the instrument.
- Some applications, such as piezo-impact microinjection call for the use of mercury in the micropipette tip. The use of any hazardous materials with any Sutter Instrument's instrument is not recommended and if undertaken is done so at the users' own risk.
- When transporting the mechanical manipulator, be sure to install the shipping screws supplied in their correct locations. Failure to do this may result in damage to the motors.
- This instrument contains no user-serviceable components — do not open the instrument casing. This instrument should be serviced and repaired only by Sutter Instrument or an authorized Sutter Instrument servicing agent.
- Sutter Instrument reserves the right to change specifications without prior notice.
- This device is intended only for research purposes.

Handling Micropipettes

 Failure to comply with any of the following precautions may result in injury to the users of this device as well as those working in the general area near the device.

- The micropipettes used with this instrument are very sharp and relatively fragile. Contact with the pulled micropipette tips, therefore, should be avoided to prevent accidentally impaling yourself.
- Always dispose of micropipettes by placing them into a well-marked, spill-proof “sharps” container.

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1. INTRODUCTION

1.1 Structure of the MPC-365 Documentation Package

The MPC-365 is a manipulator system comprised of the MPC-200 controller, the ROE-200 input device and an MP-265/M narrow format stepper motor manipulator. The MP-265/M is either right-handed or left-handed. The manual consists of two parts, "Operations" that describes the functions of the MPC-200 controller and ROE input device and "Setup" that describes how to install the MP-265/M mechanical micromanipulator.

1.2 Components of the MPC-365 Series

Carefully remove all components from the shipping container. In addition to this manual, the following are included:

1. **MPC-365** (a single manipulator system):
 - MP-265/M narrow format manipulator electromechanical (may be right or left handed)
 - MPC-200 controller
 - ROE-200 Rotary Optical Encoder manual control device
 - ROE-200-to-MPC-200 connecting cable (RJ-45 8-pin flat cable)
 - MP-265/M Mounting, connecting, and accessories kit:
 - Mounting adapter plate and hardware to attach the electromechanical to its mounting surface (X285210)
 - Rod holder assembly with Allen keys.
 - 4-inch dovetail extension for mounting headstages (X285204)
 - 2.5mm hex wrench for removing the shipping screws
 - 1.5mm hex wrench for adjusting pipette angle
 - MPC-200-to-MP-256/M connecting cable (DB25 to compact DB 26 (25-pin) cable)
 - Power cable (for the MPC-200 controller) appropriate for your location
 - USB cable for computer control of the MPC-365 series system (connects to the ROE-200)
 - Primary to secondary MPC-200 daisy chain cable for future expansion (RJ-12 6-pin flat cable)
2. **MPC-385-2** (a two-manipulator system). Same as for the MPC-385 (single manipulator system) with the following changes:
 - 2 MP-265/M narrow format manipulator electromechanicals
 - 2 MP-265/M Mounting and Accessories Kits
3. **MPC-385-3** (a three-manipulator system). Same as for the MPC-385, with the following changes:
 - 3 MP-265/M narrow format manipulator electromechanicals

- 3 MP-265/M Mounting and Accessories Kits
 - 2 MPC-200 controllers
 - 2 Power cables (for the MPC-200 controllers) appropriate for your location
4. **MPC-385-4** (a four-manipulator system). Same as for the MPC-385, with the following changes:
- 4 MP-265/M narrow format manipulator electromechanicals
 - 4 MP-265/M Mounting and Accessories Kits
 - 2 MPC-200 controllers
 - 2 Power cables (for the MPC-200 controllers) appropriate for your location
5. **MPC-385-5** (a five-manipulator system). Same as for the MPC-385, with the following changes:
- 5 MP-265/M narrow format manipulator electromechanicals
 - 5 MP-265/M Mounting and Accessories Kits
 - 3 MPC-200 controllers
 - 3 Power cables (for the MPC-200 controllers) appropriate for your location
 - 2 ROE-200 Rotary Optical Encoder manual control device
 - 2 ROE-200-to-MPC-200 connecting cable (RJ-45 8-pin flat cable)
 - 2 USB cable for computer control of the MPC-365 series system
6. **MPC-385-6** (a six-manipulator system). Same as for the MPC-385, with the following changes:
- 6 MP-265/M narrow format manipulator electromechanicals
 - 6 MP-265/M Mounting and Accessories Kits
 - 3 MPC-200 controllers
 - 3 Power cables (for the MPC-200 controllers) appropriate for your location
 - 2 ROE-200 Rotary Optical Encoder manual control device
 - 2 ROE-200-to-MPC-200 connecting cable (RJ-45 8-pin flat cable)
 - 2 USB cable for computer control of the MPC-365 series system

IMPORTANT

Once the MPC-365-series system has been unpacked, remove the two shipping screws, indicated by the red warning tags, from each MP-265/M micromanipulator mechanical. These screws must be removed before operating the manipulator. Save the screws, warning tags, and hex wrench in the event that future transport of the manipulator is needed. Once these screws have been removed, handle the micromanipulator with care. The mechanism can be damaged if the axes are moved with the screws in place.

2. MPC-200 MULTI-MANIPULATOR CONTROLLER AND ROE-200 INPUT DEVICE OPERATIONS

2.1 Electrical Connections and Initial Operating Instructions

Initially, you may want to simply connect your two manipulators, the controller, and the ROE together and try some gross movements in order to get a feel for the controls and how to make simple movements. It is perfectly acceptable to set the manipulators in the middle of a bench top, make all electrical connections and then observe each unit's movement by eye. Even if you wish to directly install the manipulators in your rig, it is useful to follow the initial setup procedure to learn how to move the units to allow easy access to the mounting screws.

1. Connect the power cord to the power entry module on the back of the MPC-200 controller.

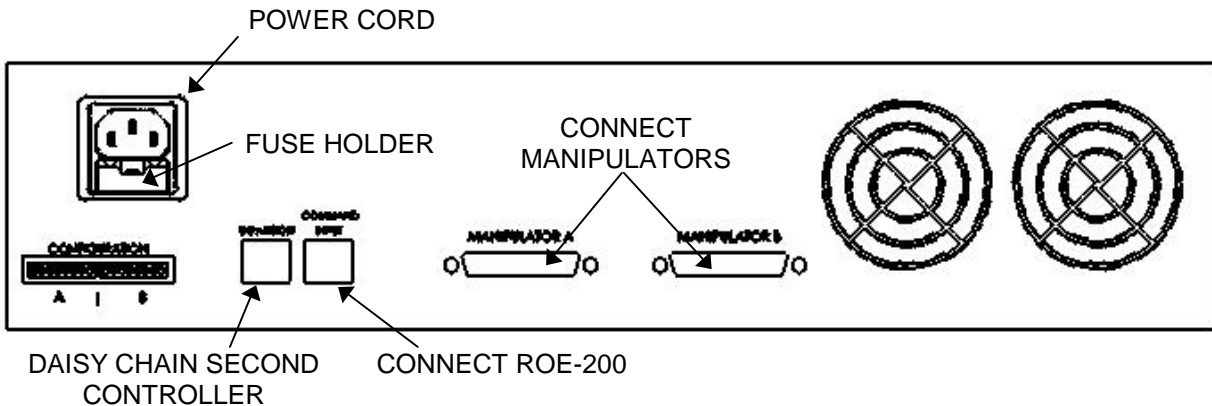


Figure 2-1. Rear of MPC-200 controller cabinet..

2. With the power OFF (front panel switch in the “0” position), connect the ROE-200 input box to the MPC-200 controller using the RJ-45 8-conductor cable. * Use the **CONTROLLER** output on the back of the ROE and the **COMMAND INPUT** on the back of the controller.
3. With the power OFF, run a DB-25-to-DB26 HD cable from each of the two MP-265/M mechanicals to the DB-25 connectors marked “**MANIPULATOR A**” and “**MANIPULATOR B**” on the back of the controller. *

***NOTE: Never connect or disconnect the ROE or the MP-265/M to and from the MPC-200 controller while the power is on!**

2.2 Initial Operating Instructions

After all electrical connections have been made, you can power up the MPC-365 using the 0/I switch on the front of the controller. As it initializes, you will see a start up screen on the ROE-200 that briefly displays the name of the device and the version of the installed firmware. As the power switch is the only control you will need to access on the MPC-200, the controller can ultimately be placed in an out of the way location (e.g., under your bench).

Once the start-up sequence has finished, you will see a display that gives the coordinates of the connected manipulator. The LED marked 1 will light if you connected the MP-265/M to

the connector marked MANIPULATOR A. Confirm that you get a coordinate display and have removed the shipping screws. If you do not get a coordinate display, go to the trouble shooting section at the back of the manual. If you have not yet removed the six shipping screws, turn the power back off and remove the six screws.

All functions necessary during normal operation are provided by four push buttons and two rocker switches on the top of the ROE-200. Other setup functions are done via buttons and DIP switches located on the back of the ROE-200 and DIP switches on the back of the MPC-200 controller.

The three ROE knobs control the three axes of the manipulator (right knob X, left knob Y, and top knob Z, see Page 15). Turn any one of the three knobs and notice that the corresponding axis moves and the coordinate for that axis changes.

The MPC-200 controller and ROE-200 have a built in Centering function. This is activated by pressing the white “CENTER” button on the back of the ROE. If the MP-265/M manipulator is sitting in a wide-open area, and the shipping screws are removed, press the CENTER button. The ROE-200 display will display the message “PLEASE WAIT MOVE IN PROGRESS”. After the CENTER operation is complete, the manipulator axes will each be at the center of travel and the display will read 12500 for X and Z, and 6250 for Y.

From this location, you can move 12500 microns in each direction on the X- and Z-axis, and 6250 on the Y-axis. The unit will stop automatically at each end of travel (00000 or 25000 microns for X and Z, and 00000 or 12500 for Y). These ends are determined by firmware. Each axis also have magnetic end of travel switches that are not activated in normal operation. If the magnetic switches are activated, you will see the message EOT (for End Of Travel) on one of the displayed axes.

When the MPC-200 controller is first turned on, the speed of movement is at its fastest, coarsest Mode. Movement mode can be finer and slower by changing the black “Mode” toggle switch. As MODE increases from 0, smaller movements are commanded by the same turn of the ROE knob. MODE 5 or 6 is probably what you will use for the final approach to a cell. MODE 0 or “Accelerated Mode” is used for fast movements to move the pipette large distances. In MODE 0, when the ROE knob is turned slowly, a relatively slow movement is achieved that is useful for final moves to place a pipette near a cell. Conversely, when you make prolonged, rapid turns of the ROE knob, the controller/ROE automatically accelerates to maximum speed to allow for prolonged, long distance movements. This would be most useful for manual pipette exchange.

The remaining functions of the ROE are explained in the next section.

2.3 Main Controls on the ROE-200

2.3.1 White Buttons:

DIAG/NORM: Pressing the DIAG/NORM button will cause the green LED near the button to light, indicating the MPC-200/ROE-200 is in Diagonal mode. In this mode, rotation of the Z-axis knob produces diagonal movement. A second press will put the manipulator back into Normal mode. When in diagonal mode, the X and Y knobs remain active, allowing you to readjust the X and Y positioning of the pipette as you approach a cell in diagonal mode. Angle of diagonal mode movement is set via DIP switches on the back of the MPC-200 controller. (See Controller DIP switch setting instructions on Pages 18 through 19). When using MODE

9 (MODE toggle set to 9), Diagonal mode produces short, quick, impulse-like movement that may be useful in sharp pipette impalements.

When you switch to Diagonal mode, the ROE-200 display is changed from absolute to relative coordinates and the current location is set to 0,0,0. This allows users to invoke relative measurements using the display as a measuring device. A fourth coordinate that gives movement along the diagonal is also added for users who wish to measure the movement of along the axis coaxial with a pipette. When you return to Normal mode, the absolute coordinate system is recovered. The relative coordinate feature can be disabled via DIP switch 2 on back of the ROE-200.

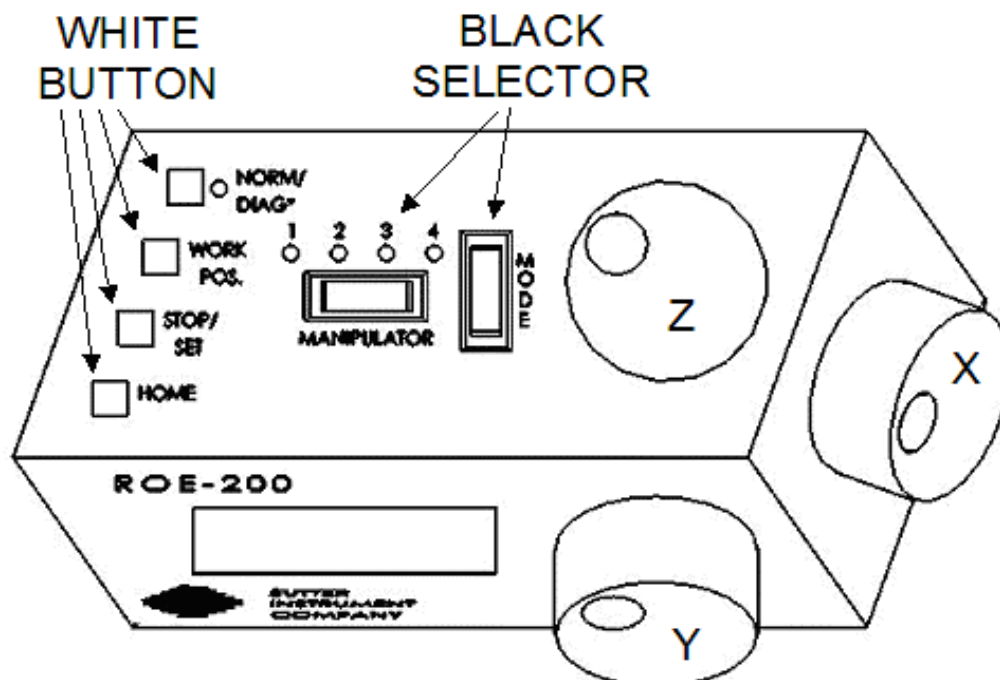


Figure 2-2. Top view of ROE-200..

HOME: When pressed, the manipulator will make a move along a stereotypic path to the location 0,0,0 or "home". Home is the location where you would most likely exchange your pipette and is maximal up on the Z-axis, maximal right on the Y-axis (maximal left on a left-handed manipulator) and maximal front on the X-axis. The stereotypic path of the movement is first along the currently set diagonal until either the X-or Z-axis reaches its origin (0). Which one of these occurs first is a function of the diagonal angle and the location at the time HOME is pressed. Once the first limit is reached, the unit will move the two remaining axes simultaneously to their origins (0). The only allowed change in this stereotyped move is that the Y-axis move can be eliminated. This is done via DIP switch 8 on the back of the MPC-200 controller (see Controller DIP switch setting instructions on Page 20).

WORK POS.: This button has three functions:

1. With the STOP/SET button is held down, a momentary press of WORK POS. makes the current location the "Work Position". A beeper will sound to indicate that the operation is complete and the location has been saved. Typically, this is a location where the pipette tip is under the microscope objective and near the cells or tissue of interest.

2. Once you have defined a Work Position, a momentary press of WORK POS. will cause the manipulator to move to the defined Work Position, providing the manipulator's last move was to Home. The move will occur along the predefined path that the manipulator moved to get to Home (described above) but in the opposite direction. This is the reason why Work Position moves **must** follow Home moves; the move to Home defines the return trip. In either case, the movement along the diagonal as you come in and out of the preparation/dish/bath should assure that the pipette tip would not hit anything on the way in or out.
3. When WORK POS. is held down for longer than 2 seconds, the current manipulator is locked so that none of the buttons or the ROE knobs will cause it to move. The lock is released by holding WORK POS. down again. A beep will indicate that the lock is enabled or disabled and the display will indicate the locked state.

Note that like HOME, the Y axis movement can be disabled when WORK POS is pressed, as set via DIP switch 8 on the back of the MPC-200 controller (see Controller DIP switch setting instructions on Page 20).

STOP/SET: This button has two functions:

1. When held down, STOP/SET" performs a "Set" function in combination with the "WORK POS." key. Think of it as a shift key when held down.
2. A momentary press of STOP/SET during a robotic move (see HOME, WORK POS. and CENTER) will immediately "Stop" the movement. **Think of this as your panic button when you see your pipette headed somewhere that you don't want it to go!**

2.3.2 Black Selector Switches:

MODE: The MODE Selector controls the speed and the relative fineness of movement of the manipulator produced by rotating the ROE knobs. As MODE increases from 0 to 9, movement gets finer and slower. As explained in "INITIAL OPERATING INSTRUCTIONS", MODE 0 is Accelerated Mode. In MODE 0, slow turns of the ROE knob produce medium course moves for moving a pipette under a microscope near a cell. Prolonged, fast turns of the ROE knobs cause the controller to accelerate to top speed for long, imprecise movements for rapid manual positioning of the pipette. The remaining MODES (1-9) produce moves of increasing sensitivity and decreasing speed. In practice, most users will find that MODE 5 or 6 will provide the necessary dexterity of movement for the final approach to a cell. The current MODE setting is displayed in the upper right of the ROE-200 display.

MANIPULATOR: The MANIPULATOR Selector toggles the active manipulator. In the MPC-365, there is only one active manipulator; therefore, the MANIPULATOR Selector has no function. You can toggle the switch, but no change will occur. With only one manipulator attached, the words "ROE-200" are displayed. If the manipulator is connected to the "MANIPULATOR A" output on the back of the MPC-200 controller LED 1 will be lit. If connected to "MANIPULATOR B", LED 2 will be lit. If you connect an additional MP-265/M manipulator in the future, the controller will automatically detect the second manipulator, the MANIPULATOR toggle will become active and the display will indicate which manipulator is active with the words "Drive A" or "Drive B"

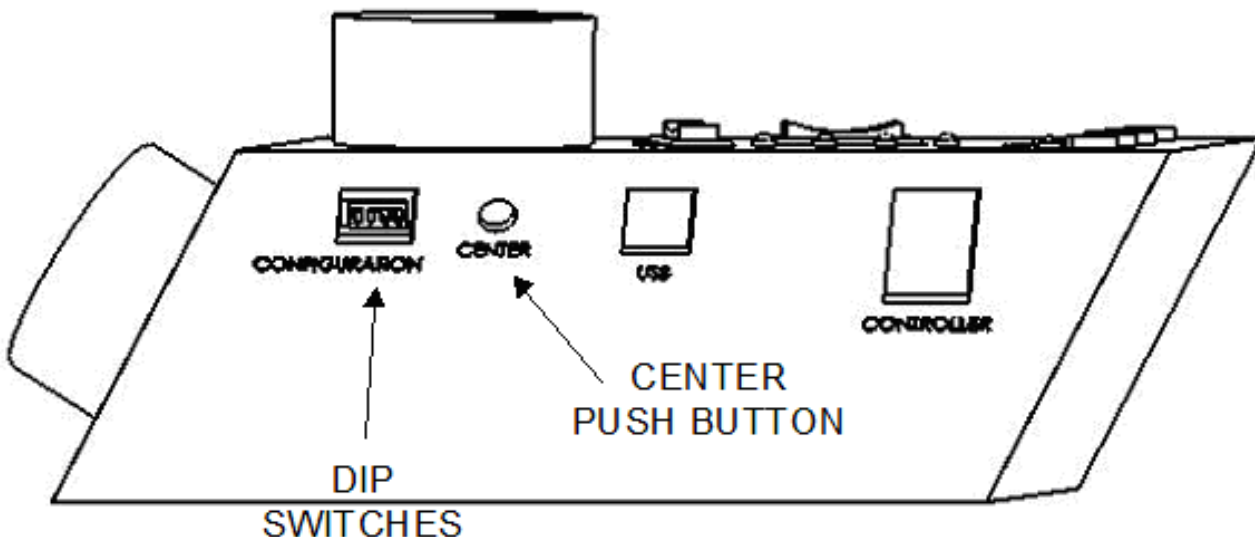


Figure 2-3. Side view of ROE-200..

2.3.3 Other Controls on the ROE-200

CENTER (round push button on the back of ROE-200): CENTER is an initialization function that is used when the unit is first set up and occasionally during normal operation. **CENTER should only be done in the absence of a pipette as the manipulator makes large robotic movements to its extreme ranges of motion.** To CENTER, press and release the white button on the back of the ROE-200. This will cause a prolonged movement in each axis to the end of travel (EOT) sensors beyond the origin (0,0,0). Once the sensors are found, a short move in the opposite direction is made and this location is defined as (0,0,0). Finally, the unit moves to the location (12500 (X), 6250 (Y), 12500 (Z)), the center of travel of each axis. If the unit is turned off, or STOP/SET is pressed during the running of CENTER, the unit will not be correctly initialized. In this case, it is necessary to cycle the power off and on and run CENTER again to its completion.

DIP Switches (on back of ROE-200): There are four DIP switches on the back of the ROE-200 which govern global and/or ROE settings.

Switch 1: When ON, all modes on the MODE selector, except Mode 0 and 5, are disabled. Some users may find that they only need Accelerated Mode and a single fine mode. This will allow them to more easily switch between the two. Factory default is OFF, enabling all modes.

Switch 2: When OFF, relative coordinates during Diagonal Mode are disabled. The factory default is ON (display of relative coordinates enabled during Diagonal Mode).

Switch 3: When OFF, the MANIPULATOR Selector functions in a cyclical fashion. After reaching the highest-numerated manipulator, a further push of MANIPULATOR cycles the user back to the lowest-numerated manipulator. When DIP switch 3 is set to ON, the selector does not cycle back to the first manipulator. Factory default is OFF, allowing cycling back.

Switch 4: Reserved for future use. **NOTE: Must be kept ON for proper functioning!**

2.4 Controls on the MPC-200

Power Switch: The power switch for the MPC-200 is located on the front panel of the controller. At power up, the microprocessor in the ROE-200 scans the attached equipment and configures the system accordingly. Among the checks/configurations that are made:

1. Determines the number and type of manipulators that are attached. The MPC-200/ROE-200 system is able determine how many and what type of manipulators (MP-285/M, MP-225/M, or MP-265/M) are connected and to what outputs they are connected. It then sets the current for each output to the correct value for the mechanicals found. If no manipulators are found, the controller will return the message "NO MANIPULATOR DETECTED, PLEASE TURN OFF CONTROLLER AND ATTACH MANIPULATOR"
2. The ROE-200 is capable of connecting to more than one MPC-200 controller. On power up the ROE makes a determination of how many controllers are attached and configures properly. If the power is off on the second controller, the ROE-200 displays a message "PLEASE TURN ON ALL CONTROLLERS, THEN PRESS SET TO START".

DIP Switches: Two banks of eight DIP switches are located on the back of the MPC-200 controller. Each bank is assigned to (and configures) one of the two manipulator outputs on the back of the controller (MANIPULATOR A or B). Users familiar with the Sutter Instrument MP-225 controller will find that they have the same function as the configuration DIP switches on the MP-225 ROE. The switches are numbered 1 through 8. In all cases, the 0 or OFF position is opposite the direction of the switch number and the 1 or ON position is in the direction of the switch number and is also indicated by an arrow and the word "ON" next to Switch 1. In order for any new switch settings to take effect, the controller must be powered off and on.

The figure below shows the two banks of switches on the back of the MPC-200 controller.

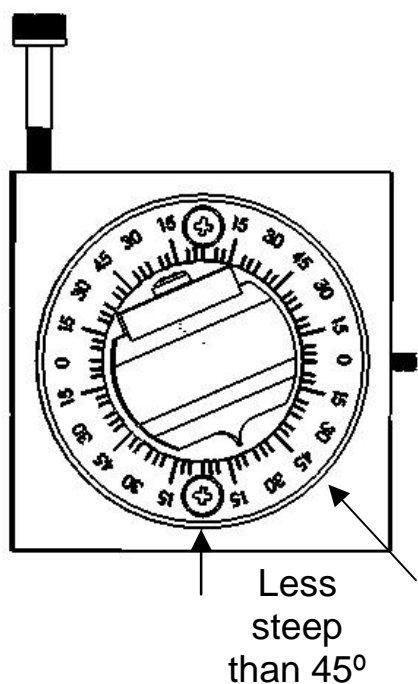


Figure 2-4. Configuration switches on rear of MPC-200 controller cabinet.

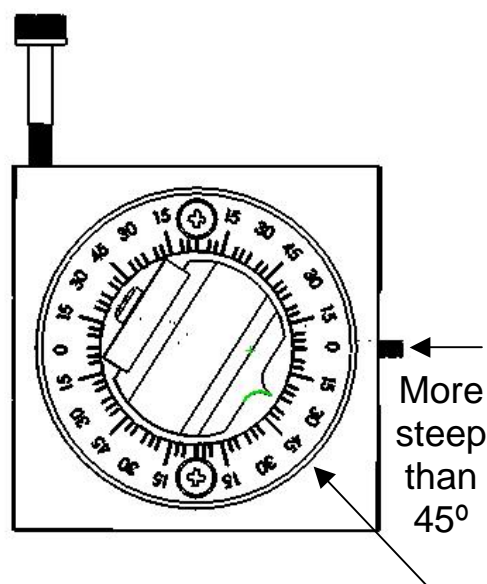
Switches 1, 2, 3 and 4 set the angle of the Diagonal mode movement.

The table on the next page gives the angles that can be used and the DIP switch settings of switches 1, 2, 3 and 4. As indicated in the inset to the left of the table, the angles fall into two different quadrants according to whether the angles are more or less steep than 45 degrees.

Table 2-1. Configuration switch settings for different angles of steepness.



Angle	DIP switch number			
	1	2	3	4
7	1	1	1	1
11	0	1	1	1
14	1	0	1	1
21	0	0	1	1
27	1	1	0	1
29 *	0	1	0	1
35	1	0	0	1
39	0	0	0	1
45	1	1	1	0



Angle	DIP switch number			
	1	2	3	4
39	0	1	1	0
35	1	0	1	0
29	0	0	1	0
27	1	1	0	0
21	0	1	0	0
14	1	0	0	0
11	0	0	0	0

*Factory default near 30 degrees

Switches 5, 6, and 7 set the direction of the movement produced by a clockwise turn (advancing right hand screw) of the ROE knob for each axis.

With the switch set to 0, a clockwise turn of the knob produces a decrement in the display; when the switch is set to 1, a clockwise turn of the knob produces an increment in the display. An increment in the display coincides with movement downward in the Z axis,

movement toward the rear of your setup in the Y axis and movement producing pipette advancement in the X axis.

The factory default is 1,1,1 for switches 5, 6, and 7.

Switch number	5	6	7
Corresponding axis	X	Y	Z

NOTE: Any channel that uses a left-side MP-265/M, Switch 6 must be changed from 1 to 0. This is because a left-handed MP-265/M has its Y-axis rotated 180° from its right-handed counterpart, and thus it is usually desirable to have the manipulator move back on its Y axis with a counterclockwise turn of the ROE's Y axis knob.

Switch 8 determines whether or not the Y-axis is included in HOME and WORK position robotic moves. If switch 8 is set to 0, the Y axis is moved to a location where the pipette is towards the user in a Home move and is moved back to whatever Y coordinate was recorded during Set-Work Pos. in the Work Pos. move. If switch 8 is set to 1, the Y axis is not moved (Y position ignored) during the HOME or WORK position moves. **In the MPC-365 system, the factory default for switch 8 is 1 (the Y axis is not moved (Y position ignored) during the HOME or WORK position moves).**

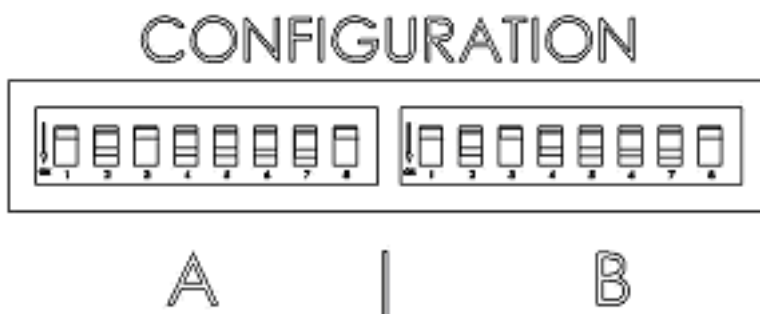


Figure 2-5. Configuration switches (rear of MPC-200 controller).

3. MP-265/M MANIPULATOR MECHANICAL MOUNTING INSTRUCTIONS

This chapter describes how to mount the MP-265/M to a stand (normally, the top plate of an MT-73 or an MT-72/LS), how to change pipettes and adjust pipette angle, and finally, the modular nature of the mechanical.

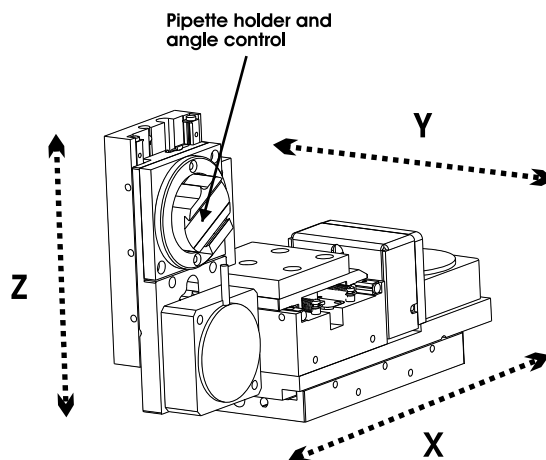


Figure 3-1. Angled view of MP-265/M showing pipette holder and angle control, and directions of all three axes.

3.1 Mounting MP-265/M to the MT-73 or MT-72 LS

The MP-265/M mounts to the top mounting plate of the MT-73 or the now discontinued MT-72 LS. Gently place the MP-265/M onto the four mounting posts that are part of the mounting plate (X265210) using four M3X0.5 hex head screws. Once placed evenly on the mounting plate, tighten the miniature hex screws (two on each side) of the MP-265/M's X-axis slide using the supplied hex wrench.

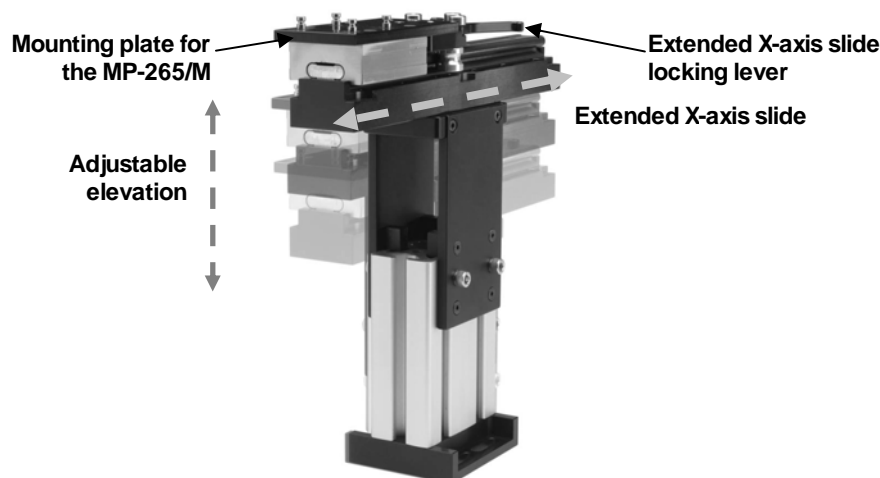


Figure 3-2. MT-73 controls and adjustments.

Only the front pair of screws is visible in this figure. **The adapter plate is normally shipped in a small plastic bag also containing the necessary hardware.**

The figure above shows the plate removed from the X-axis. Before attaching the adapter plate to the MP-265/M, you need to decide where to position the manipulator on your stand. The stand can be any flat surface carrying ¼-20 or 10-32 holes on one-inch centers (such as a Sutter Instrument's MT-series stands or MD series platforms). A good technique is to set the manipulator on top of the adapter plate and slide it around on your stand until it is in a good location. Then take the manipulator off and fix the adapter plate securely to the stand with the ¼-20 or 10-32 hardware. Finally, align the holes on the bottom corners of the manipulator with the four threaded holes on the corners of the adapter plate and attach the manipulator using the 4 supplied M3X0.5 metric cap screws.

3.2 Setting Headstage/Pipette Angle and Pipette Exchange

Mounted on the front of the Z-axis of the manipulator is the rotary dovetail. The rotary dovetail is used to hold various electrophysiological headstages and/or micro tools at defined angles.

The angle of the rotary dovetail is adjusted by loosening the hex set screw located on the hinge side of the rotary dovetail (see figure below). You can set a particular angle using the knife-edge on the dovetail and the scale on the faceplate. After choosing an angle, retighten the screw to fix the angle.

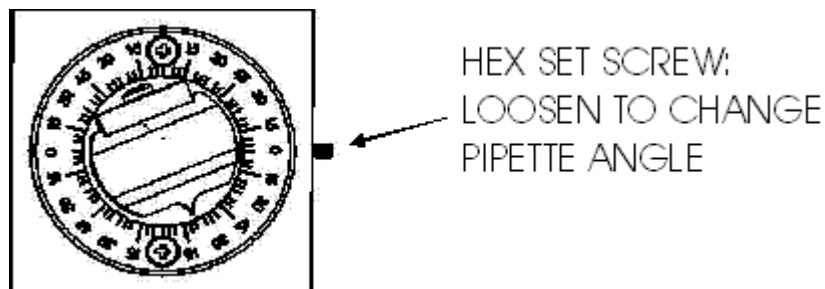


Figure 3-3. Location of screw to loosen for changing pipette angle.

To change pipettes, squeeze the linear slide cantilever and pull the MP-265M back along the slide mounted on the MT-73 (or MT-72/LS) gantry to a position that works best for removing and replacing pipettes and/or rods.

3.3 Headstage Mounting

Axon headstages 203B or CV-7 and the Heka EPC-10 headstage have an integral dovetail that slides directly into the rotary dovetail on the MP-265/M. The figure below shows an example of this type of headstage mounted in a left-handed manipulator and in profile (on the right), the location of the Phillips-head screw that secures the headstage dovetail in its mate on the manipulator.

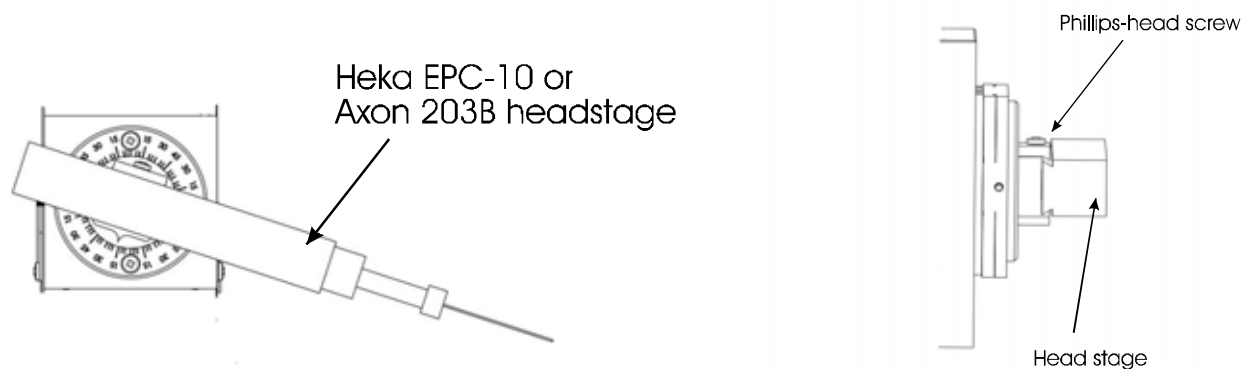
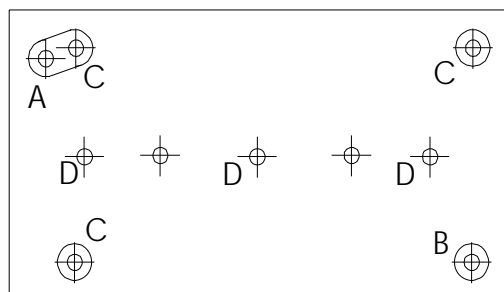


Figure 3-4. Headstage mounting.

Older Axon and Heka headstages mount using the 4-inch dovetail (X285204) and a plastic plate. A typical headstage of this type is shown mounted in a right-handed MP-265/M (right panel). The plastic plate used with the 4-inch dovetail is shown in the left panel of the figure and the holes are indicated to mount common headstages. Additional holes could be easily added to accommodate less common headstage footprints.



EPC7,8 & 9: 1-1/16" x 2-7/32"
(2 holes, A & B)

CV-4: 1-1/8" x 1-15/16"
(4 holes, B & C)

Connection to 4 inch dovetail:
(3 holes, D)

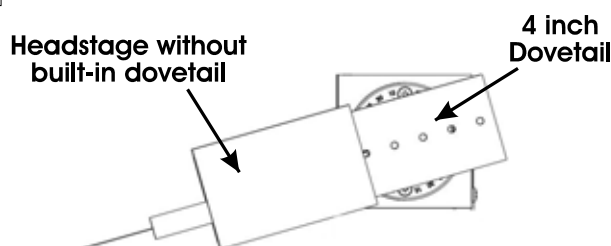


Figure 3-5. Using a dovetail for headstage mounting.

Rod mounted headstages and micro tools are accommodated by use of a rod clamp that fits into the dovetail (not shown). All the headstage adapters and mounting hardware are included with the manipulator and are shipped in a zip lock plastic bag.

3.4 Other Accessories

You may have received one or more accessories for mounting your MP-265/M and/or modifying the headstage mount to the manipulator (i.e. rotating base, microscope stage mount, gantry stand, dovetail extension). Setup of these accessories is normally covered in documentation accompanying the accessory.

If you intend to use the right angle adapter (285300) with your MP-265/M in order to rotate the manipulator 90 degrees, please see “Instructions used in Special Installations Only” below.

3.5 Minimizing Electrical Noise

We are aware of one potential noise source that users coupling their MP-365 with high-gain, high-input impedance, electrophysiological recording amplifiers may experience. Under certain circumstances, the manipulator and/or the drive cable coming from the controller may act as an antenna picking up electric field noise from nearby electrical equipment and bringing it into your setup. Grounding the manipulator will largely eliminate this noise source. Try to attach to one of the silver Phillips-head screws on the side of one or more of the axes. It should be noted that the manipulator produces negligible electrical noise when it is not moving because it is powered by a linear power supply with no AC current present.

3.6 Instructions Used in Special Installations Only

3.6.1 Installing and Using the Right-Angle Adapter (285300)

Open the swing-out gate and remove it from the front of the MP-265/M by removing the four Phillips-head screws. Next, install the right angle adapter on the front of the MP-265/M using the supplied M3-0.5 hex head screws. Finally, install the swing out gate on the right angle adapter using the four Phillips-head screws. With the right angle in place, the manipulator (right handed) can be turned 90 degrees clockwise so that its bulk faces to the right instead of the back of your microscope.

Having made the 90-degree rotation all the manual aspects of the manipulator will work normally. If you wish to use the automated features and diagonal movement mode of the MP-265/M you will need to change the configuration of the controller. To learn how to do this, please call Sutter at 415-883-0128 or email info@sutter.com.

3.6.2 Instructions for Changing Handedness

It is possible to change handedness of the MP-265 mechanical. If you wish to do this, please contact Sutter Instrument for details. If you wish, Sutter can change the handedness for you. We will charge for shipping only.

4. EXTERNAL CONTROL

4.1 General

Controlling the MPC-365 externally via computer is accomplished by sending commands to the MPC-200 controller over the USB interface between the computer and the USB connector on the rear of the ROE-200 that's connected to the MPC-200 controller. The USB device driver for Windows is downloadable from Sutter Instrument's web site (www.sutter.com). The MPC-365 (MPC-200) requires USB CDM (Combined Driver Model) Version 2.10.00 or higher. The CDM device driver for the MPC-365 (MPC-200) consists of two device drivers: 1) USB device driver, and 2) VCP (Virtual COM Port) device driver. Install the USB device driver first, followed by the VCP device driver. The VCP device driver provides a serial RS-232 I/O interface between a Windows application and the MPC-365 (MPC-200). Although the VCP device driver is optional, its installation is recommended even if it is not going to be used. Once installed, the VCP can be enabled or disabled.

The CDM device driver package provides two I/O methodologies over which communications with the controller over USB can be conducted: 1) USB Direct (D2XX mode), or 2) Serial RS-232 asynchronous via the VCP device driver (VCP mode). The first method requires that the VCP device driver not be installed, or if installed, that it be disabled. The second method requires that the VCP be installed and enabled.

Virtual COM Port (VCP) Serial Port Settings: The following table lists the required RS-232 serial settings for the COM port (COM3, COM5, etc.) generated by the installation or enabling of the VCP device driver.

Table 4-1. USB-VCP interface serial port settings.

Property	Setting
Data ("Baud") Rate (bits per second (bps))	128000
Data Bits	8
Stop Bits	1
Parity	None
Flow Control	None

The settings shown in the above table can be set in the device driver's properties (via the Device Manager if in Windows) and/or programmatically in your application.

Handshaking: Command sequences do not have terminators. All commands return an ASCII CR (Carriage Return; 13 decimal, 0D hexadecimal) to indicate that the task associated with the command has completed. When the MPC-365 (MPC-200) completes the task associated with a command, it sends ASCII CR back to the host computer indicating that it is ready to receive a new command. If a command returns data, the last byte returned is the task-completed indicator.

Commands: Each command sequence consists of at least one byte, the first of which is the "command byte". Those commands that have parameters or arguments require a sequence of bytes that follow the command byte. No delimiters are used between command sequence arguments. Every command and command sequence ends with a terminator byte containing

an ASCII CR (13 decimal, 0D hexadecimal). Although most command bytes can be expressed as ASCII displayable/printable characters, the rest of a command sequence must always be expressed as a sequence of unsigned byte values (0-255 decimal; 00 – FF hexadecimal, or 00000000 – 11111111 binary). Each byte in a command sequence being transmitted to the controller must contain an unsigned binary value. Attempting to code command sequences as “strings” is not advisable. Any command data being returned from the controller must also be received and initially treated as a sequence of unsigned byte values. Groups of contiguous bytes can later be combined to form larger values, as appropriate (e.g., 2 bytes into 16-bit “word”, or 4 bytes into a 32-bit “long” or “double word”). For the MPC-365 (MPC-200), all axis position values (number of microsteps) are stored as “unsigned long” (32-bit) values. A 32-bit value is transmitted and received to and from the controller as four contiguous bytes.

Axis Position Command Parameters: All axis positional information is exchanged between the controller and the host computer in terms of microsteps. Conversion between microsteps and microns (micrometers) is the responsibility of the software running on the host computer. The number of microsteps for any axis position is always expressed as a signed 32-bit “signed long” (I32). “Signed” means the value can be positive or negative. An I32 consists of four contiguous bytes, with a byte/bit-ordering format of Little Endian (“Intel”) (most significant byte (MSB) in the first byte and least significant (LSB) in the last byte). If the platform on which your application is running is Little Endian, then no byte order reversal of axis position values is necessary. Examples of platforms using Little Endian formatting include any system using an Intel processor (including Microsoft Windows and Apple Mac OS X).

If the platform on which your application is running is Big Endian (e.g., Motorola PowerPC CPU), then these I32 position values must have their bytes reverse-ordered after receiving from, or before sending to, the MPC-365 (MPC-200). Examples of Big Endian platforms include most all non-Intel-based systems, LabVIEW (regardless of operating system & CPU), and Java (programming language/environment). MATLAB adapts to the system on which it is running, so Little Endian may need to be enforced if running on a Big Endian system.

Microsteps and Microns (Micrometers): All coordinates sent to and received from the MPC-365 (MPC-200) are in microsteps. To convert between microsteps and microns (micrometers), use the following conversion factors (multipliers):

Table 4-2. Microns/microsteps conversion factors (multipliers).

System/Device	From/To Units	Conv. Factor
MPC-365/MPC-200 with MP-265/M micromanipulator	$\mu\text{steps} \rightarrow \mu\text{m}$	0.0625
	$\mu\text{m} \rightarrow \mu\text{steps}$	16

For accuracy in your application, these conversion factors should be typed as double precision (“double”); “float” is not recommended. If the result is in microsteps, it can be typed as a 32-bit “long” integer; otherwise, it should be typed as floating point, preferably as double precision (“double”).

Table 4-3. Travel distances and bounds.

Device	Axis	Length	Microns	Microsteps
MP-265/M	X & Z	25mm	0 – 25,000	0 – 266,667
	Y	12.5mm	0 – 12,500	0 - 133,334

4.2 Commands

4.2.1 Get Connected Devices Status ('A' or 'U') Command

This command is used to obtain information on how many devices are connected and the connected status of each one on port basis. The command sequence consists of one byte as shown in the following table, and six bytes for the returned data: 1 byte for the number of devices connected followed four bytes containing connected status for Port 1 through 4, and completion indicator (1 byte).

Table 4-4. Get Connected Devices Status ('A' or 'U') Command.

Command	Tx/- Delay/- Rx	Ver.	Total Bytes	Byte Offset (Len.)	Value			Alt- key- pad #	Ctrl- char	ASCII def./- char.	Description	
					Dec.	Hex.	Binary					
Get Connected Devices Status ('A' or 'U')	Tx	<3	1	0	65	41	0100 0001	0065		A	Returns the number of devices connected (0-4), and the connected status of Ports 1 - 2 (1 st controller) and 3 - 4 (2nd controller daisy chained to the first)	
			3+	1	0	55	37	0011 0111	0055			U
	Rx			0							Zero bytes = no devices connected. ROE displays "NO MANIPULATOR CONNECTED".	
				6	0	1 - 4	01 - 04	0000 0000 - 0000 0100		^A - ^D	<SOH> - <EOT>	Number of devices connected
												Device # Connected Status
					1	0	0	0000 0000		^@	<NUL>	1: No
						1	1	0000 0001		^A	<SOH>	1: Yes
					2	0	0	0000 0000		^@	<NUL>	2: No
						1	1	0000 0001		^A	<SOH>	2: Yes
					3	0	0	0000 0000		^@	<NUL>	3: No
						1	1	0000 0001		^A	<SOH>	3: Yes
					4	0	0	0000 0000		^@	<NUL>	4: No
						1	1	0000 0001		^A	<SOH>	4: Yes
			13	13	0D	0000 1101		^M	<CR>	Completion indicator		

4.2.2 Get Active Device & Firmware Version ('K') Command

This command is used to obtain information on which of the connected devices is currently active. The command also returns the controller's firmware version (in Firmware Ver. 3 and above). The command sequence consists of one byte as shown in the following table, and two or four bytes for the returned data: 1 byte for the active device number (1 – 4), two bytes for Firmware version number (Ver. 3 and above only), and completion indicator (1 byte).

Table 4-5. Get Active Device & Firmware Version ('K') Command.

Command	Tx/- Delay/ Rx	Ver.	Total Bytes	Byte Offset (Len.)	Value			Alt- key- pad #	Ctrl- char	ASCII def./- char.	Description
					Dec.	Hex.	Binary				
Get Active Device & Firmware Version ('K')	Tx	All	1	0	48	30	0011 0000	0048		K	Command
	Rx	<3	2	0	1 - 4	01	0000 0000		^A - ^D	<SOH> - <EOT>	Currently-active device (1 – 4).
						04	0000 0100				
				1	13	0D	0000 1101		^M	<CR>	Task-completion indicator
	Rx	3+	4	0	1 - 4	01	0000 0000		^A - ^D	<SOH> - <EOT>	Currently-active device (1 – 4).
						-	-				
						04	0000 0100				
1											
2						Major version number (e.g., if ver. = 3.10, then byte = 3)					
3	13	0D	0000 1101		^M	<CR>	Completion indicator				

4.2.3 Get Current Position ('C') Command

This command is used to obtain the current position (X, Y, & Z coordinates) of the manipulator or stage. The command sequence consists of one byte as shown in the following table, followed by 12 bytes containing currently-active device number 1 – 4 (1 byte), X, Y, & Z position values in microsteps (4 bytes each), and completion indicator (1 byte).

Table 4-6. Get Current Position ('C') command.

Command	Tx/- Delay/ Rx	Ver.	Total Bytes	Byte Offset (Len.)	Value			Alt- key- pad #	Ctrl- char	ASCII def./- char.	Description	
					Dec.	Hex.	Binary					
Get Current Position ('C')	Tx	All	1	0	67	43	0100 0011	0067		C	Command	
	Rx		14	0	1-4	01	0000 0000		^A - ^D	<SOH> - <EOT>	Drive number (1 – 4) to which the current position applies	
						04	0000 0100					
						Current positions of X, Y, & Z, in microsteps, each consisting of 4 contiguous bytes representing a single unsigned "long" (32 bit) integer value (for range, see Table 4-3).						
				1-4								X microsteps
				5-8								Y microsteps
			9-12								Z microsteps	

Command	Tx/- Delay/- Rx	Ver.	Total Bytes	Byte Offset (Len.)	Value			Alt- key- pad #	Ctrl- char	ASCII def./- char.	Description
					Dec.	Hex.	Binary				
				13	13	0D	0000 1101		^M	<CR>	Completion indicator

4.2.4 Change Active Device ('I') Command

This command is used to change which device (1- 4) is currently active. The command sequence consists of one byte as shown in the following table, and returns 1 (Ver. below 1.06) or 2 bytes: 1st byte containing specified device number if it exists or ASCII 'E' (for "error") if not, and the completion indicator (1 byte).

Table 4-7. Change Active Device ('I') command.

Command	Tx/- Delay/- Rx	Ver.	Total Bytes	Byte Offset (Len.)	Value			Alt- key- pad #	Ctrl- char	ASCII def./- char.	Description
					Dec.	Hex.	Binary				
Change Active Device (‘I’)	Tx	All	3	0	73	49	0100 1001	0073		I	Command
				1	1-4	01 - 04	0000 0001 - 0000 0100	0001 - 0004	^A - ^D	<SOH> - <EOT>	Device number to change (1 through 4)
	Rx	1- 1.05	1	0	13	0D	0000 1101		^M	<CR>	Task-completion indicator
	Rx	1.06 +	2	0	1-4 or 69	01 - 04 or 45	0000 0001 - 0000 0100 or 0010 0101		^A - ^D	<1> - <4> or 'E'	If device specified exists then device number (1-4) is returned. Else, 'E' (error) is returned.
				1	13	0D	0000 1101		^M	<CR>	Completion indicator

4.2.5 Move to Controller-Defined HOME Position ('H') Command

This command moves to the position last defined by the HOME key. Movement is equivalent to pressing the HOME key.

Table 4-8. Move to controller-defined HOME position ('H') command.

Command	Tx/- Delay/- Rx	Ver.	Total Bytes	Byte Offset (Len.)	Value			Alt- key- pad #	Ctrl- char	ASCII def./- char.	Description
					Dec.	Hex.	Binary				
Move to Home Position ¹ (‘H’)	Tx	All	1	0	72	48	0100 1000	0072		H	Command
	Rx	All	1	13	13	0D	0000 1101		^M	<CR>	Completion indicator

¹ The "Home Position" is defined manually on the ROE-200.

4.2.6 Move to Controller-Defined WORK Position ('Y') Command

This command moves to the position defined last defined for the WORK key. Movement is equivalent to pressing the WORK key.

Table 4-9. Move to controller -defined WORK position ('Y') command.

Command	Tx/ Delay/ Rx	Ver.	Total Bytes	Byte Offset (Len.)	Value			Alt- key- pad #	Ctrl- char	ASCII def./- char.	Description
					Dec.	Hex.	Binary				
Move to Work Position ² (‘Y’)	Tx	All	1	0	89	59	0101 1001	0089		Y	Command
	Rx	All	1	13	13	0D	0000 1101		^M	<CR>	Completion indicator

4.2.7 Move to Center Position ('N') Command

This command moves to the center position (mid point between beginning of travel and end of travel positions). Movement is equivalent to pressing the CENTER key.

Table 4-10. Move to Center Position ('N') command.

Command	Tx/ Delay/ Rx	Ver.	Total Bytes	Byte Offset (Len.)	Value			Alt- key- pad #	Ctrl- char	ASCII def./- char.	Description
					Dec.	Hex.	Binary				
Move to Center Position ('N')	Tx	All	1	0	78	4E	0100 1110	0078		N	Command
	Rx	All	1	13	13	0D	0000 1101		^M	<CR>	Completion indicator

4.2.8 Move to Specified Position Orthogonally at Full Speed ('M') Command

This command instructs the controller to move all three axes to the position specified, in a stereotypic or orthogonal manner, at the highest speed. The command sequence consists of thirteen bytes: Command byte followed by three sets of four bytes containing position information in microsteps for X, Y, and Z.

Table 4-11. Move to specified position ('M') command.

Command	Tx/ Delay/ Rx	Ver.	Total Bytes	Byte Offset (Len.)	Value			Alt- key- pad #	Ctrl- char	ASCII def./- char.	Description			
					Dec.	Hex.	Binary							
Move to Specified Position ('M')	Tx	All	14	0	77	4D	0100 1101	0077		M	Moves X, Y, and Z to specified position (stereotypic at fastest speed)			
				X, Y, & Z target positions, in microsteps, each consisting of 4 contiguous bytes representing a single unsigned "long" (32 bit) integer value (for range, see Table 4-3).										
				1-4									X μ steps	
				5-8									Y μ steps	
				9-12									Z μ steps	
	13	13	0D	0000 1101	0013	^M	<CR>			Command seq. term.				
=>	30ms									Time of travel (see Note 7)				


² The "Work Position" is defined manually on the ROE-200.

Command	Tx/ Delay/ Rx	Ver.	Total Bytes	Byte Offset (Len.)	Value			Alt- key- pad #	Ctrl- char	ASCII def./- char.	Description
					Dec.	Hex.	Binary				
	Rx	All	1	0	13	0D	0000 1101		^M	<CR>	Completion indicator

4.2.9 Move to Specified Position in a Straight Line at Specified Speed ('S') Command

Move to Specified Position in a Straight Line at Specified Speed ('S') Command This command instructs the controller to move all three axes to the position specified, in straight line at the specified speed (Speed Level 0 – 15). The command sequence consists of fourteen bytes.

Table 4-12. Move to Specified Position in a Straight Line at Specified Speed ('S') command.

Command	Tx/ Delay/ Rx	Ver.	Total Bytes	Byte Offset (Len.)	Value			Alt- key- pad #	Ctrl- char	ASCII def./- char.	Description	
					Dec.	Hex.	Binary					
Move to Specified Position in a Straight Line at Specified Speed ('S')	Tx	3+	14	0	83	53	0010 0011	0077		s	Command	
				1	0	00	0000 0000	0000	^@	<NUL>	Velocity (0 = slowest, 15 = fastest) (See Note 8.)	
				15	0F	0000 FFFF	0015	^O	<SI>			
	30ms									 Required delay between Velocity byte and remaining bytes		
	Tx				X, Y, & Z target positions, in microsteps, each consisting of 4 contiguous bytes representing a single unsigned "long" (32 bit) integer value (for range, see Table 4-3).							
					2-5							X μ steps
					6-9							Y μ steps
					10-13							Z μ steps
	=> 30ms									Time of travel (see Note 7)		
	Rx			1	0	13	0D	0000 1101		^M	<CR>	Completion indicator

4.2.10 Interrupt Move ('^C') Command

This command interrupts a move in progress that was originated by an external command. The command sequence consists of one byte, and returns one byte (completion indicator).

Table 4-13. Interrupt move in progress ('^C') command.

Command	Tx/ Delay/ Rx	Ver.	Total Bytes	Byte Offset (Len.)	Value			Alt- key- pad #	Ctrl- char	ASCII def./- char.	Description
					Dec.	Hex.	Binary				
Interrupt Move (^C)	Tx	All	1	0	3	03	0000 0011	0003	^C	<ETX>	Command
	Rx		1	0	13	0D	0000 1101			<CR>	Completion indicator

4.2.11 Set ROE MODE ('L') Command

Set ROE MODE ('L') Sets the ROE MODE (0 – 9). Command sequence consists of two bytes (command byte and MODE (0 – 9)), and returns one byte (completion indicator).

Table 4-14 Set ROE MODE ('L') command.

Command	Tx/- Delay/ Rx	Ver.	Total Bytes	Byte Offset (Len.)	Value			Alt- key- pad #	Ctrl- char	ASCII def./- char.	Description
					Dec.	Hex.	Binary				
Set ROE MODE ('L')	Tx	All	2	0	76	4C	0100 1100	0076		L	Command
				1	0-9	0-9	0000 0000 - 0000 1001	0000 - 0009			Mode 0 - 9 (coarsest/fastest to finest/slowest)
	Rx	All	1	0	13	0D	0000 1101		^M	<CR>	Task-completion indicator

4.2.12 Command Notes

The following list of notes apply to all the external control commands described in this chapter.

1. All positions sent to and received from the controller are in microsteps. See Table 4-2 for conversion between microns (micrometers (μm)) and microsteps (μsteps).
2. See Table 4-3 for exact minimum and maximum values for each axis of each compatible device that can be connected.
3. A short delay (usually around 2 ms) is recommended between commands (after the reception of one command and the sending of the next command).
4. All positions sent and received to and from the controller are in microsteps and consist of 32-bit signed integer values (four contiguous bytes). For C/C++, these are typed as “signed long” or just “long”. For LabVIEW, these are typed as “I32”.
5. All multibyte microstep values transmitted to, and received from, the controller consist of four bytes ordered in “Little Endian” (least significant byte last) format. The value stored in these four bytes is converted to and from 32-bit “[signed] long” (C/C++) or “I32” (LabVIEW) value storage entities. Although position values are unsigned, set the bounds for all positional storage values to appropriate range shown in Table 4-3.
6. “Little Endian” means that the least significant byte is last (last to send and last to receive). Byte-order reversal may be required on some platforms. Microsoft Windows, Intel-based Apple Macintosh systems running Mac OS X, and some Intel/AMD processor based Linux distributions handle byte storage in Little-Endian byte order so byte reordering is not necessary before converting to/from 32-bit “long” values. LabVIEW always handles “byte strings” in “Big Endian” byte order irrespective of operating system and CPU, requiring that the four bytes containing a microsteps value be reverse-ordered before/after conversion to/from a multibyte type value (I32, U32, etc.). MATLAB automatically adjusts the endianness of multibyte storage entities to that of the system on which it is running, so explicit byte reordering is generally unnecessary unless the underlying platform is Big Endian.
7. “Move” commands might have short to long distances of travel. If not polling for return data, an appropriate delay should be inserted between the sending of the command sequence and reception of return data so that the next command is sent only after the move is complete. This delay can be auto-calculated by determining the distance of travel (difference between current and target positions) and rate of travel. This delay is not needed if polling for return data. In either case, however, an appropriate timeout must be set for the reception of data so that the I/O does not time out before the move is made and/or the delay expires.

8. Full speed for the “Orthogonal Move ‘M’” command is 5000 microns/second (5 mm/second or microns/millisecond).
9. Actual speed for the “Straight-Line Move ‘S’” command can be determined with the following formula: $(5000 / 16) * (sp + 1)$, where 5000 is the maximum speed in microns/second and “sp” is the speed level 0 (slowest) through 15 (fastest). For mm/second or microns/millisecond, multiply result by 0.001.

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5. MAINTENANCE

Routine cleaning of the MPC-365-series system is required to prevent excessive dust accumulations. This is done by wiping all exterior surfaces with a dry, soft, cotton cloth.

All cables and connections should be periodically inspected to make sure that all connections are made well and that all connectors are well and evenly seated.

CAUTION: The MP-265/M electromechanical is a precision-machined part, mounted on three stepper motor shafts. As such, it DOES NOT REQUIRE LUBRICATION. Attempting to lubricate any part of the electromechanical assembly will void the warranty and may harm one or more of the motors.

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APPENDIX A. LIMITED WARRANTY

- Sutter Instrument Company, a division of Sutter Instrument Corporation, limits the warranty on this instrument to repair and replacement of defective components for two years from date of shipment, provided the instrument has been operated in accordance with the instructions outlined in this manual.
- Abuse, misuse, or unauthorized repairs will void this warranty.
- Warranty work will be performed only at the factory.
- The cost of shipment both ways is paid for by Sutter Instrument during the first three months this warranty is in effect, after which the cost is the responsibility of the customer.
- The limited warranty is as stated above and no implied or inferred liability for direct or consequential damages is intended.
- Consumables, PMTs, galvanometers, and Uniblitz^{®1} shutters are exempt from this warranty.
- An extended warranty for up to three additional years can be purchased at the time of ordering, or until the original warranty expires. For pricing and other information, please contact Sutter Instrument.

¹ Uniblitz[®] is a registered trademark of Vincent Associates.

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APPENDIX B. ACCESSORIES

MT-73	Narrow format stand with linear slide
285204	4 inch dovetail extension
265210¹	Mounting adapter plate
265RBI²	Rotating base for MP-265/M
BR-AW	Rod holding clamp for XenoWorks injectors
MP-ROD	Rod holder
M100106	Flat side panel for MPC-200 controller (for 1 side, x2 for both sides)
MP-RISER³	½-inch riser (MP-RISER-0.5) and 1-inch riser (MP-RISER-1.0)

¹ For use with MT- or MD-series stands/platforms, or any surface with 1-inch centered holes.

² Useful with MD-series stand and large platform stages such as the MT-78-FS, MP-78, and MPC-78.

³ Risers can be combined to achieve desired height.

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APPENDIX C. FUSE REPLACEMENT

In the event that the controller fails to power up when the power switch is turned on, check the line power fuses to see if either or both have blown. The fuses are located in the fuse holder on the power entry module on the back of the controller. To remove the fuse holder first unplug the power cord from the power entry module. Press down on the lever that is located just above the fuse holder and below the power receptacle, and pry the holder straight out of the power entry module.

The fuse holder holds two fuses. Both fuses are of the same type and rating. If either fuse is blown, it is recommended that both fuses be replaced.

The type and rating of both fuses are as follows:

**5 x 20 mm glass tube, Time Delay (IEC 60127-2, Sheet III)
T2A, 250V**
(Examples: Bussmann GDC-2A, GMC-2A or S506-2-R (RoHS); or
Littelfuse 218 200 or 218 200P (RoHS))

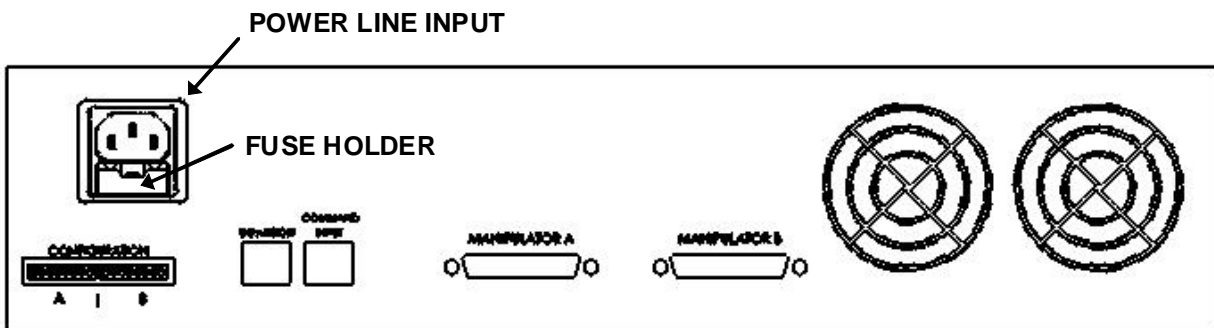


Figure C-1. Rear view of the MPC-200 controller cabinet showing the power entry module and fuse location.

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APPENDIX D. TECHNICAL SPECIFICATIONS



D.1. MP-265 Micromanipulator Mechanical

Resolution	Minimal microstep size is 62.5 nanometers per microstep. Display has single micron resolution.
Speed	3 mm/sec. maximum
Drift	< 1 micron/hr drive mechanism
Dimensions:	16 x 11 x 3.5 in (41 x 28 x 9 cm)

D.2. MPC-200 Controller

Dimensions (H x W x D):	4 x 15.94 x 11 in (10.16 x 40.49 x 27.94 cm)
Weight:	6.65 lb (6 lb., 10.4 oz.; 3.02 kg)
Electrical:	
Input voltage (Mains)	100 - 240 V, 50/60 Hz
Power consumption	170 Watts maximum per MPC-200 controller (340W max. for an MPC-365-3 or MPC-365-4 system)
Mains fuses (rear of cabinet)	refer to the FUSE REPLACEMENT appendix for details
Cables	(Refer to the following tables for a description of all possible cables.)

Table D-1. MPC-365 Controller cables and receptacles/connectors.

Controller Rear Panel Port Connector/Receptacle	Cable Connector Types	Connects to ...	Cable Type	Cable Max. Length
(Power entry) 3-pin male connector	←3-pin power standard (female) 3-pin male→ (Geographical region dependent)	Mains power source.	10A, 250V, with safety ground plug	3 meters (approx. 10 feet)
MPC-200 Controller Cabinet: MANIPULATOR A or MANIPULATOR B (each a 25-Pin DSUB female receptacle)	←DB-25 male DB-15 female→ (Straight-through)	MP-265M	Minimum of 26 awg stranded wire with 500 Volt.	3 meters (approx. 10 feet)
MPC-200: COMMAND INPUT and ROE-200 CONTROLLER	RJ45	ROE-200 User Input Device receptacle named "CONTROLLER"		
MPC-200: EXPANSION	RJ11	a second MPC-200 controller (and its EXPANSION receptacle)		
ROE-200: USB USB "A" (Device) female receptacle (full-sized)	←A connector B connector→	Host computer's USB "B" receptacle (full-sized)	Dielectric separation of circuits. Foil shielding.	3 meters (approx. 10 feet)

D.3. ROE-200:**Dimensions:**

10 x 6 x 4 in (25.4 x 15.24 x 10.16 cm)

Weight:

3.5 lbs (1.6 kg)

APPENDIX E. QUICK REFERENCE

E.1. External Control

Table E-1. USB-VCP interface serial port settings.

Property	Setting
Data ("Baud") Rate (bits per second (bps))	128000
Data Bits	8
Stop Bits	1
Parity	None
Flow Control	None

Table E-2. Microns/microsteps conversion factors (multipliers).

System/Device	From/To Units	Conv. Factor
MP-265/M micromanipulator	$\mu\text{steps} \rightarrow \mu\text{m}$	0.0625
	$\mu\text{m} \rightarrow \mu\text{steps}$	16


Table E-3. Travel distances and bounds.

Device	Axis	Length	Microns	Microsteps
MP-265/M	X & Z	25mm	0 – 25,000	0 – 266,667
	Y	12.5mm	0 – 12,500	0 – 133,334

Table E-4. Command Reference.

Command	Tx/ Delay/ Rx	Ver.	Total Bytes	Byte Offset (Len.)	Value			Alt- key- pad #	Ctrl- char	ASCII def./- char.	Description			
					Dec.	Hex.	Binary							
Get Connected Devices Status (‘A’ or ‘U’)	Tx	<3	1	0	65	41	0100 0001	0065		A	Returns the number of devices connected (0-4), and the connected status of each.			
			3+	1	0	55	37	0011 0111	0055			U		
	Rx			0								Zero bytes = no devices connected. ROE displays “NO MANIPULATOR CONNECTED”.		
				6	0	1 – 4	01 - 04	0000 0000 - 0000 0100			^A - ^D	<SOH> - <EOT>	Number of devices connected	
														Device # Connected Status
				1	0	0	0000 0000			^@	<NUL>	1: No		
					1	1	0000 0001			^A	<SOH>	1: Yes		
				2	0	0	0000 0000			^@	<NUL>	2: No		
					1	1	0000 0001			^A	<SOH>	2: Yes		
				3	0	0	0000 0000			^@	<NUL>	3: No		
					1	1	0000 0001			^A	<SOH>	3: Yes		
				4	0	0	0000 0000			^@	<NUL>	4: No		
					1	1	0000 0001			^A	<SOH>	4: Yes		
13	13	0D	0000 1101			^M	<CR>	Completion indicator						

Command	Tx/ Delay/ Rx	Ver.	Total Bytes	Byte Offset (Len.)	Value			Alt- key- pad #	Ctrl- char	ASCII def./- char.	Description									
					Dec.	Hex.	Binary													
Get Active Device & Firmware Version ('K')	Tx	All	1	0	48	30	0011 0000	0048		K	Command									
	Rx	<3	2	0	1 - 4	01 - 04	0000 0000 - 0000 0100		^A - ^D	<SOH> - <EOT>	Currently-active device (1 - 4).									
											1	13	0D	0000 1101		^M	<CR>	Task-completion indicator		
	Rx	3+	4	0	1 - 4	01 - 04	0000 0000 - 0000 0100		^A - ^D	<SOH> - <EOT>	Currently-active device (1 - 4).									
											1						Minor version number (e.g., if ver. = 3.10, then byte = 10)			
											2						Major version number (e.g., if ver. = 3.10, then byte = 3)			
											13	13	0D	0000 1101		^M	<CR>	Completion indicator		
Get Current Position ('C')	Tx	All	1	0	67	43	0100 0011	0067		C	Command									
	Rx		14	0	1-4	01 - 04	0000 0000 - 0000 0100		^A - ^D	<SOH> - <EOT>	Drive number (1 - 4) to which the current position applies									
											Current positions of X, Y, & Z, in microsteps, each consisting of 4 contiguous bytes representing a single unsigned "long" (32 bit) integer value (for range, see Table E-3).									
											1-4							X microsteps		
											5-8							Y microsteps		
											9-12							Z microsteps		
											13	13	0D	0000 1101		^M	<CR>	Completion indicator		
Change Active Device ('I')	Tx	All	3	0	73	49	0100 1001	0073		I	Command									
											1	1-4	01 - 04	0000 0001 - 0000 0100	0001 - 0004	^A - ^D	<SOH> - <EOT>	Device number to change (1 through 4)		
	Rx	1-1.05	1	0	13	0D	0000 1101		^M	<CR>	Task-completion indicator									
	Rx	1.06 +	2	0	1-4 or 69	01 - 04 or 45	0000 0001 - 0000 0100 or 0010 0101		^A - ^D	<1> - <4> or 'E'	If device specified exists then device number (1-4) is returned. Else, 'E' (error) is returned.									
											1	13	0D	0000 1101		^M	<CR>	Completion indicator		
Move to Specified Position ('M')	Tx	All	14	0	77	4D	0100 1101	0077		M	Moves X, Y, and Z to specified position (stereotypic at fastest speed)									
											X, Y, & Z target positions, in microsteps, each consisting of 4 contiguous bytes representing a single unsigned "long" (32 bit) integer value (for range, see Table E-3).									
											1-4							X μ steps		
											5-8							Y μ steps		
											9-12							Z μ steps		
											13	13	0D	0000 1101	0013	^M	<CR>	Command seq. term.		
	=> 30ms										Time of travel (see Note 7)									
Rx	All	1	0	13	0D	0000 1101		^M	<CR>	Completion indicator										

Command	Tx/- Delay/- Rx	Ver.	Total Bytes	Byte Offset (Len.)	Value			Alt- key- pad #	Ctrl- char	ASCII def./- char.	Description	
					Dec.	Hex.	Binary					
Move to Position ('S') (Straight line at specified speed)	Tx	3+	14	0	83	53	0010 0011	0077		S	Command	
				1	0	00	0000 0000	0000	^@	<NUL>	Velocity (0 = slowest, 15 = fastest) (See Note 8.)	
					15	0F	0000 FFFF	0015	^O	<SI>		
	30ms										 Required delay between Velocity byte and remaining bytes	
	Tx											X, Y, & Z target positions, in microsteps, each consisting of 4 contiguous bytes representing a single unsigned "long" (32 bit) integer value (for range, see Table E-3).
		2-5										X μ steps
		6-9										Y μ steps
10-13											Z μ steps	
=> 30ms										Time of travel (see Note 7)		
Rx			1	0	13	0D	0000 1101		^M	<CR>	Completion indicator	
Move to Home Position ⁷ (‘H’)	Tx	All	1	0	72	48	0100 1000	0072		H	Command	
	Rx	All	1	13	13	0D	0000 1101		^M	<CR>	Completion indicator	
Move to Work Position ⁸ (‘Y’)	Tx	All	1	0	89	59	0101 1001	0089		Y	Command	
	Rx	All	1	13	13	0D	0000 1101		^M	<CR>	Completion indicator	
Move to Center Position (‘N’)	Tx	All	2	0	78	4E	0100 1110	0078		N	Command	
	Rx	All	1	0	13	0D	0000 1101		^M	<CR>	Completion indicator	
Interrupt Move (^C)	Tx	All	2	0	3	03	0000 0111	0003	^C	<ETX>	Command	
	Rx		1	0	13	0D	0000 1101		^M	<CR>	Completion indicator	
Set ROE MODE (‘L’)	Tx	All	2	0	76	4C	0100 1100	0076		L	Command	
				1	0-9	0-9	0000 0000	0000			Mode 0 - 9 (coarsest/fastest to finest/slowest)	
	Rx	All	1	0	13	0D	0000 1101		^M	<CR>	Task-completion indicator	

NOTES:

1. All positions sent to and received from the controller are in microsteps. See Table E-2 for conversion between microns (micrometers (μ m)) and microsteps (μ steps).
2. See Table E-3 for exact minimum and maximum values for each axis of each compatible device that can be connected.
3. A short delay (usually around 2 ms) is recommended between commands (after the reception of one command and the sending of the next command).
4. All positions sent and received to and from the controller are in microsteps and consist of 32-bit signed integer values (four contiguous bytes). For C/C++, these are typed as "signed long" or just "long". For LabVIEW, these are typed as "I32".

⁷ The "Home Position" is defined manually on the ROE-200.

⁸ The "Work Position" is defined manually on the ROE-200.

5. All multibyte microstep values transmitted to, and received from, the controller consist of four bytes ordered in “Little Endian” (least significant byte last) format. The value stored in these four bytes is converted to and from 32-bit “[signed] long” (C/C++) or “I32” (LabVIEW) value storage entities. Although position values are unsigned, set the bounds for all positional storage values to appropriate range shown in Table E-3.
6. “Little Endian” means that the least significant byte is last (last to send and last to receive). Byte-order reversal may be required on some platforms. Microsoft Windows, Intel-based Apple Macintosh systems running Mac OS X, and some Intel/AMD processor based Linux distributions handle byte storage in Little-Endian byte order so byte reordering is not necessary before converting to/from 32-bit “long” values. LabVIEW always handles “byte strings” in “Big Endian” byte order irrespective of operating system and CPU, requiring that the four bytes containing a microsteps value be reverse-ordered before/after conversion to/from a multibyte type value (I32, U32, etc.). MATLAB automatically adjusts the endianness of multibyte storage entities to that of the system on which it is running, so explicit byte reordering is generally unnecessary unless the underlying platform is Big Endian.
7. “Move” commands might have short to long distances of travel. If not polling for return data, an appropriate delay should be inserted between the sending of the command sequence and reception of return data so that the next command is sent only after the move is complete. This delay can be auto-calculated by determining the distance of travel (difference between current and target positions) and rate of travel. This delay is not needed if polling for return data. In either case, however, an appropriate timeout must be set for the reception of data so that the I/O does not time out before the move is made and/or the delay expires.
8. Full speed for the “Orthogonal Move ‘M’” command is 5000 microns/second (5 mm/second or microns/millisecond).
9. Actual speed for the “Straight-Line Move ‘S’” command can be determined with the following formula: $(5000 / 16) * (sp + 1)$, where 5000 is the maximum speed in microns/second and “sp” is the speed level 0 (slowest) through 15 (fastest). For mm/second or microns/millisecond, multiply result by 0.001.

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ADDENDUM

To

ALL OPERATION MANUALS OF MPC-200/ROE-200-BASED MPC-SERIES SYSTEMS

REV. 1.00 – NOVEMBER 28, 2007

As of Version 3.11 (November 12, 2007) of the firmware for the MPC-200 micromanipulator controller and ROE-200 input device, the CENTER routine associated with the white button on the rear of the ROE-200 has been replaced with a CALIBRATE routine that is less likely to break a pipette. Thus, it can be used in the middle of an experiment when you see the message EOT (end of travel) displayed on the ROE-200. Please note that all references to CENTER in the current manual should be replaced with CALIBRATE. Furthermore, the detailed instructions regarding the centering routine in section 2.3.3 should be replaced with the CALIBRATE instructions below.

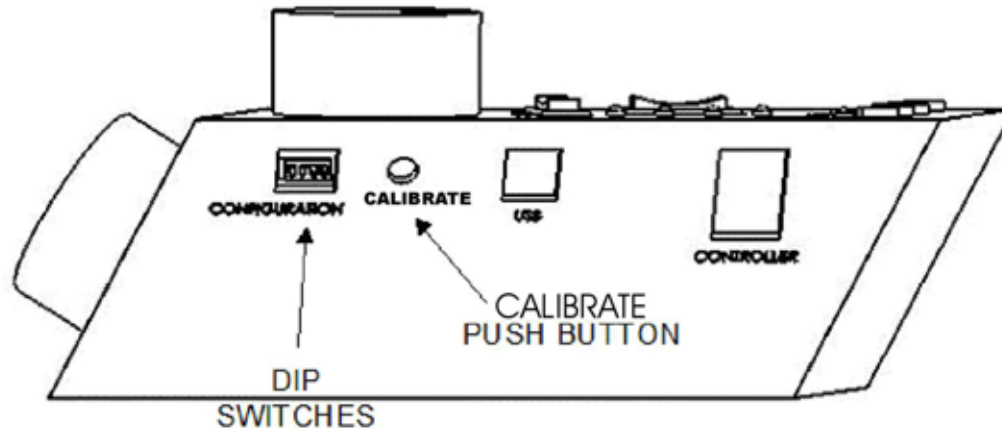


Figure 1. Location of the CALIBRATE button on the ROE-200.

CALIBRATE is used in two ways. When the unit is first set up, **CALIBRATE** is used to establish the zero location. Then, occasionally, during normal operation, **CALIBRATE** is used to reestablish the zero location. **CALIBRATE** follows a more conservative path than **CENTER**, and can generally be used in the presence of a pipette.

To **CALIBRATE**, press and release the white button on the back of the ROE-200. The manipulator will back away from the current location along the established diagonal (like a **HOME** move), and ultimately move to the end of travel (EOT) sensors, beyond the origin (0,0,0). Once the sensors are found, a short move in the opposite direction is made and this location is defined as (0,0,0). The purpose of **CALIBRATE** is to allow 0,0,0 or **HOME** to be safely reestablished during the course of an experiment without risking damage to the pipette.

If the unit is turned off, or **STOP/SET** is pressed during the running of **CALIBRATE**, the unit will not be correctly initialized. In this case, it is necessary to cycle the power off and on, and then run **CALIBRATE** again to its completion.