Micro-Precision Apertures • Miniature Positioners • Controllers • Software

National Aperture, Inc.

MC-5B
Users Manual

version 1.2

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Section 1

Overview

The MC-5B Micro-Positioning Controller from National Aperture, Inc. was designed for ease of use and effortless integration into any application. The MC-5B is a low-cost, quick-setup solution for those applications requiring precise position control of motorized stages. Incorporated into this all-in-one controller is a keypad/display interface, a 750mA 12V linear DC motor amplifier, single ended (TTL) A/B quadrature encoder inputs, 5 volt limit switch inputs and a serial communication interface. The MC-5B functions seamlessly as a single axis, stand-alone system or as a multi-axis networked system, either with or without a PC. The peer to peer network architecture makes it possible for every MC-5B in a multi-axis system to control every axis in the motion system. No software development or complex wiring is required. The controllers themselves may be programmed to store and recall positions and to sequence through stored positions with looping, pausing and user/program interaction. Automation may also be driven serially from a PC or host processor.

Benefits:

- Instant "Out-of-the-Box" Motion Control
- A Low Cost, Integrated Motion Solution
- No Need to Write Additional Motion Commands
- Perfect for:
  - Rapid Development
  - Prototyping
  - Proof-of-Concept
  - Small OEM Lots Where Delivery is Critical
  - Lab Development

Features:

- Control all nodes from any node on the motion network
- Broadcast Single or Multiple Motion Commands to one node or all nodes at the same time
- Configure each unit as a node on the network with a unique node number
- Original settings are retained
- Up to 99 MC-5B controllers can be configured on a single motion system
- Communicate to any node on the system through your PC's Serial Port

Section

2

Setup

What You'll Need:

The MC-5B Controller comes with a 15 Volt power supply, and a User's Manual. Optional multi-axis equipment is a null modem cable (ends labeled PC and IN), a straight thru serial cable (ends labeled OUT and IN), two loopbacks (labeled LB), one 9 pin gender changer and motor extension cables.

You'll also need a stage with a 6-12 volt DC motor (750 mA max) and single ended 5 Volt A/B quadrature incremental encoder. National Aperture, Inc. offers a broad selection of such stages. Remote joystick and dial encoder input devices are also available from National Aperture, Inc. as options.

Connections – Single Axis System:

Plug the 15V power supply in and connect it to the MC-5B's 15V power input. Plug the stage into the MTR/ENC/LIM input appropriate for the connector type. (Use one stage only per controller.) If you have joystick and/or dial encoder input devices, they may be plugged into the jacks labeled JOYSTK and ENCWHL.

Power Up and Configuration:

The controller(s) may be switched on with the on/off switch located on the back of the unit(s). Node ID's (addresses) may be set, starting at one, for all nodes in a networked system by holding down the shift key and pressing the ASGN NDS (assign nodes) key.

Default Setting:

The MC-5B comes with factory default settings so that you may start testing your stage and controller immediately. Please check these settings by referencing Section 3 for Basic Menu Selections and examples beginning on page 7 to ensure you are aware of the many options available on your MC-5B. Also refer to MC-5B Factory Settings, Appendix C on page 29.

Factory default settings can be reset from the keypad of the MC-5B by holding down the shift and reset buttons simultaneously and pressing the enter button twice.

Section

3

Basic Menu Selections

Various operating parameters and configuration options may be set in the MC-5B's menu. The menu is entered by pressing any key in the menu box, and may be scrolled through **(with wrap-around)** using the up/down arrows in the menu box. The menu consists of a single column of 29 items, each item consisting of a two option selection and/or a single numeric parameter. You may select between one of two options for a menu item by pressing the SEL key. The ' > ' symbol marks the selected option. Numeric input should be followed by a menu scroll (menu arrow) input if you wish to remain in the menu. The ENTER key is used to exit the menu.
(Most National Aperture MM-3M linear stages may be operated without modifications to menu items.)

Menu Selection	Definition
Single Node Mode	**W**hen idle, numeric entries access positions stored in the corresponding memory location. Use jog keys to scroll through memory if desired. Press ENTER/GOTO to move.
Multi-Node Mode	**W**hen idle, numeric entries establish control of the axis with the entered node ID. Key commands and display information pertain to this Node. Enter another node number to change node or press ENTER to return to (default) local node.
Step Jog	**J**ogs in steps of size defined by "Step Base Increment" (in menu) and JOG RATE arrows. (HIGH SPEED JOG operates in velocity mode.)
VMode Jog	**J**ogs continuously with velocity defined by "JOG RATE" arrows and "Jog Vel Multplr" (in menu).
(Fwd Limit Value)	**P**osition for forward software limit (in encoder counts). Select to enable.
Fwd Limit Off	**D**isables forward software limit.
(Rev Limit Value)	**P**osition for reverse software limit (in encoder counts). Select to enable.
Rev Limit Off	**D**isables reverse software limit.
Store By Entry	**S**TORE operation, prompts user for memory location (separate memory from sequence).
Sequential	**S**TORE operation stores position in next memory location.
Rotary Motion	**C**onfigures controller for rotary motion. Units are angular. Reverse limit switch is not recognized.
Linear Motion	**C**onfigures controller for linear motion. Units are linear. Forward and reverse limit switches are recognized.
Locked Jog	**S**tage is held In position following JOG - Remains in servo.
Free Jog	**S**tage not held in position following JOG - Out of servo. Still in servo after MOVE, RECALL, etc
Home to Rev End	**S**tage is homed to reverse end (typically the end with no motor or gear).
Home to Fwd End	**S**tage is homed to forward end (typically the end with motor or gear).
Homing Offset	**S**tage is moved the specified distance from the limit before setting position to zero.
Final Homing Velocity	**W**hen homing, stage moves to limit at Base velocity (set with "SET VEL" key or in menu), moves back a short distance, then approaches the limit again (typically slowly for precision) at the final homing velocity. Default = 400 cts/s.
Reverse Display	**T**he Displayed Position is Reversed in Sign.
Normal Display	**T**he Displayed Position is not Reversed in Sign.
Reverse Encoder	**C**ontroller is configured for an encoder that produces negative counts (B leads A) for a positive motor voltage. (CHECK!!!)
Normal	**C**ontroller is configured for an encoder that produces positive counts (A leads B) for a positive motor voltage.

Menu Selection	Definition
Rev Backlash	**D**estination Position is Approached in the Negative Direction.
Normal	**D**estination Position is Approached in the Positive Direction. (see Backlash section bottom of page, and Backlash Comp menu item)
Reverse Dir Key	**J**OG Key Direction is Reversed.
Normal	**J**OG Key Direction is not Reversed.
Jog Vel Multplr (for "VMode Jog") OR **Step Base Increment** (for "Step Jog")	**J**og velocity is determined by the "JOG RATE" arrows and is scaled by the Jog Velocity Multiplier. (HIGHS SPEED not affected.) **J**og step size is determined by the "JOG RATE" arrows and is scaled by the "Step Base Increment."
Dial Step	**S**pecifies the number of encoder counts the stage will be stepped for a single click of the dial encoder input device.
Dial Step = Jog Step (Step Jog Mode Only)	**D**ial Encoder step determined by Jog Step (from "Step Base Increment" (in menu) and JOG RATE arrows).
Base velocity	**S**ets velocity for move commands (MOVE, REL) and homing. When the "STORE" key is used, the Base velocity (and accel) are stored in the specified memory location. The Base velocity can also be changed using the "SET VEL" key.
Base accel	**S**ets acceleration for move commands (MOVE, REL) and homing. When the STORE key is used, the Base acceleration (and velocity) are stored in the specified memory location. The Base acceleration can also be changed using the "SET ACC" key.
Jog Step Accel	**S**ets the acceleration used for step jogging.
Backlash Comp	**W**hen moving opposite the backlash direction, stage moves past the destination by the Backlash Compensation distance then returns to the destination. (see Backlash section and Rev Backlash menu item.)
Counts per Inch, cm or rev:	**S**ets the number of encoder counts per unit distance or angle. See Appendix D Stage Resolution.
Following Error	**M**otion is interrupted when the actual stage position differs from the commanded position by more than the specified following error (in encoder counts).
Enc Lns per Rev	**S**ets the number of lines on the encoder per motor revolution (not per rotary stage revolution). Encoder lines per revolution = (1/4)*Encoder counts per Revolution..
PID Kp	**P**roportional gain for the PID (proportional, integral, derivative) feedback controller. In most instances this need not be changed from the default value of 600.
PID Ki	**I**ntegral gain for the PID feedback controller. In most instances this need not be changed from the default value of 400.
PID Kd	**D**erivative gain for the PID feedback controller. In most instances this need not be changed from the default value of 1000.
PID iLimit	**L**imit applied to the integration sum in the PID Controller. Prevents the buildup of an excessive integral term and control signal when motion departs from the commanded velocity profile. In most instances this need not be changed from the default value of 1000.
PID Deriv tSamp	**S**ets the derivative sample period to the controller sample period times (1 + (PID Deriv tSamp)). In most instances this need not be changed from the default value of 0.
Node	**S**ets the controller's node ID (address) to a value from 1 to 99. The ID is used for communicating remotely, either from another MC-5B controller or from a host PC or processor. (Node ID 99 is typically reserved for a host PC node.) The "ASGN NDS" key may be used to automatically assign node ID's to all of the controllers in a (properly connected) networked system. (See Setup Section.)

Backlash

For many systems, mechanical play in gears, lead screws, nuts or other components can result in backlash, which can be defined as the actuated displacement that occurs without motion of the carriage after a change in the direction of motion. The backlash compensation distance is set to a value that is higher than the system's physical backlash. When moving in one direction, movement will be directly to the target position. When moving in the other direction, the target position will be "overshot" by the backlash compensation distance, so that the physical system backlash will be taken up in the final approach. With backlash compensation, target positions are always approached from the same direction, and from a distance that exceeds the physical backlash in the system. The final approach direction is selectable with the reverse backlash menu item. The amount of backlash compensation must be determined by an external measuring device.

1. To Set Single Node Mode

SEL To Enter Menu

SEL To toggle between selections – select Single Node Mode

Enter To Exit menu

** The ">" symbol marks the selected option**

2. To Set Multi Node Mode

SEL To Enter Menu

SEL To toggle between selections – select Multi Node Mode

Enter To Exit menu

3 To Set Forward Limit Value

SEL To Enter Menu

↓ To scroll through menu selections (select ...)

SEL To toggle between selections

Enter value

SEL To exit menu

4 To Set Forward Limit Off

SEL To Enter Menu

↓ To scroll through menu selections (select ...)

SEL To toggle between selections

Enter To exit Menu

-OR-

Another "shortcut" method to set Forward Limit Off is to press the following keys

SHIFT 8 To turn limit off/on

5. To set backlash compensation

SEL To Enter Menu

↓ To scroll through menu selections (select backlash comp)

Enter value

Enter To Exit menu

Section 4

KEY FUNCTIONS

Normal and Shift Functions:
Key functions marked in white (or black on white) are accessed by pressing the key. Key functions marked in red are accessed by pressing the key while holding down the SHIFT key.

Key	Function
STOP	Stop Motion, Cancel Entry
JOG	Move/Jog Stage (while pressed)
JOG HS	High Speed Jog (Press SHIFT & JOG)
JOG RATE	Adjust Jog Rate
HIGH RATE	Adjust High Speed Jog Rate
MOVE	Move to Absolute Position
REL	Relative Move of Specified Distance
STORE *	Store Position in Memory Location
RECALL **	Move to Position Stored in Memory Location
DELETE	Delete Position in Memory Location(s)
RUN ***	Run Stored Program
STEP ***	Single Step through Stored Program
SET 0	Set Current Position to Zero
SPECIFIED	Set Current Position to Specified Value
HOME	Home Stage (Stops when Released)
AUTO-HOME	Home Stage (Runs when Released)
HOT KEYS	Move All to Position Stored in Memory Location
STANDBY	Disable Amp and Enter Sleep Mode
ON/ID	Exit Sleep Mode and Show Node ID
UNITS	Change Units of Measure
SET VEL	Set Velocity (for MOVE, REL & STORE)
SET ACC	Set Accel (for Jog, MOVE, REL, STORE)
MEAS	Measure Distance from Start Position
MEAS REF	Set Start Position for Measurement
REV LMT	Rev Software Limit = Current Position
FWD LMT	Fwd Software Limit = Current Position
RLmtOnOff	Toggle Rev Software Limit On/Off
FLmtOnOff	Toggle Fwd Software Limit On/Off
ASGN NDS	Assign Node ID's to Networked Nodes
RESET	Reset Controller to Default Configuration
DATA OUT	Send Program Data to PC (address 99)

*To store a position, enter desired memory location at prompt. Valid locations are 0 (or 00) - 99. Current base velocity and acceleration are also stored.

**To recall a stored position with the RECALL key, enter desired memory location at prompt. A two digit entry (' 01' for location 1) displays the stored position. Jog keys may be used to subsequently scroll through stored positions if desired. Press ENTER/GOTO to move the stage to the selected position.

***By default, runs through all consecutively programmed memory locations. See memory locations and program flow section for program sequence options.

Key Function Examples

1. To Reset Controller:

SHIFT **RESET** (Hold for a few seconds and release the Reset key to generate "reset Node ## ?" prompt.)

ENTER (To accept first question prompt)

ENTER (To accept "Cancel if not sure" second prompt)

2. To home:

SHIFT

AUTO-HOME

* Note, prior to performing an "auto-home", ensure menu selections (See section 3) are correct for stage being controlled.

3. To change the displayed units:

SHIFT

UNITS

4. To move to -0.50 inches (units set to inches):

MOVE

-

.

5

ENTER

5. To set current position to zero:

SET 0

ENTER

6. To move 0.1 inch relative to current position:

REL

.

1

ENTER

7. To store the current position in memory location 1:

STORE

1

ENTER

8. To jog stage forward at jog rate:

JOG>

9. To jog stage backward at jog rate:

JOG<

10. To jog stage forward at high speed jog rate:

SHIFT | **JOG>**

11. To jog stage backward at high speed jog rate:

SHIFT | **JOG<**

12. To increase the jog rate:

JOG RATE ^

13. To increase the high speed jog rate:

SHIFT | **JOG RATE ^**

14. To stop motion:

STOP

Section

5

MEMORY LOCATIONS AND PROGRAM FLOW

Editing of the 100 program memory locations (00-99) is initiated by pressing any key in the "Edit Memory Location" box.

Navigation of memory locations is similar to Menu navigation with the added feature that memory locations may be scrolled through horizontally using the green jog keys.

Each memory location consists of the following parameters:

Parameter	Description
Location to Edit	Memory Location (0-99)
Execute/Skip Point	(as stated)
Coordinate	(as stated)
Velocity	(as stated)
Accel	(as stated)
Move Relative/Absolute	(as stated)
Pause/Wait	Pause for specified duration (0 for no pause) or wait for ENTER keystroke
Loop Count	Marks start of loop if <> 0. Loop code is executed Loopcount + 1 times.
End Loop	Marks end of loop
End Program	Marks end of program

Program Execution — Use the RUN key to run or the STEP key to single step through programs. Execution progresses sequentially after the most recently accessed memory location and ends at the first End Program encountered.

Looping — Loops start at memory locations with Loop count <> 0 and execution jumps to the start of the loop when an end loop is encountered. Loops are executed Loop count +1 times. Nesting is not supported.

End Program — Program execution ceases when an End Program is encountered.

General Programming Steps

1. To edit memory locations and Program flow:
   Press any key in the Edit Memory Location box.

2. To run the stored program following the defined program flow:

   SHIFT

   RUN

   (Execution starts after the last accessed memory location. Looping applies only when the start of loop location is >=the last accessed location.)

3. To single step through stored program following the defined program flow:

   STEP

   (Execution starts after the last accessed memory location. Looping applies only when the start of loop location is >=the first executed location.)

4. To stop motion:

   STOP

Programming Memory Locations
(Coordinates in Counts)

Memory Location 00:

EXECUTE POINT	SKIP POINT
COORDINATE	-420
VELOCITY	13333
ACCEL	25600
MOVE RELATIVE	MOVE ABSOLUTE
PAUSE 0 SEC	WAIT
LOOP COUNT	0
END LOOP OFF	END LOOP ON
END PROGRAM OFF	END PROGRAM ON

Memory Location 01:

EXECUTE POINT	SKIP POINT
COORDINATE	-600
VELOCITY	13333
ACCEL	25600
MOVE RELATIVE	MOVE ABSOLUTE
PAUSE 0 SEC	WAIT
LOOP COUNT	0
END LOOP OFF	END LOOP ON
END PROGRAM OFF	END PROGRAM ON

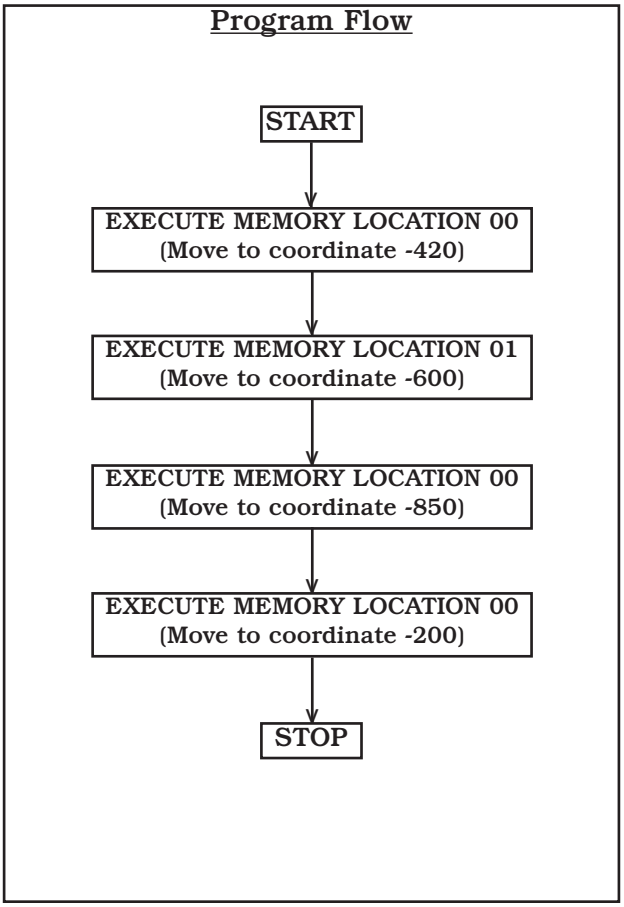
Memory Location 02:

EXECUTE POINT	SKIP POINT
COORDINATE	-850
VELOCITY	13333
ACCEL	25600
MOVE RELATIVE	MOVE ABSOLUTE
PAUSE 0 SEC	WAIT
LOOP COUNT	0
END LOOP OFF	END LOOP ON
END PROGRAM OFF	END PROGRAM ON

Memory Location 03:

EXECUTE POINT	SKIP POINT
COORDINATE	-200
VELOCITY	13333
ACCEL	25600
MOVE RELATIVE	MOVE ABSOLUTE
PAUSE 0 SEC	WAIT
LOOP COUNT	0
END LOOP OFF	END LOOP ON
END PROGRAM OFF	END PROGRAM ON

Program Flow



Programming Memory Locations with a loop
(Coordinates in Counts)

Memory Location 00:

EXECUTE POINT	SKIP POINT
COORDINATE	-420
VELOCITY	13333
ACCEL	25600
MOVE RELATIVE	MOVE ABSOLUTE
PAUSE 0 SEC	WAIT
LOOP COUNT	0
END LOOP OFF	END LOOP ON
END PROGRAM OFF	END PROGRAM ON

Memory Location 01:

EXECUTE POINT	SKIP POINT
COORDINATE	-600
VELOCITY	13333
ACCEL	25600
MOVE RELATIVE	MOVE ABSOLUTE
PAUSE 0 SEC	WAIT
LOOP COUNT	2
END LOOP OFF	END LOOP ON
END PROGRAM OFF	END PROGRAM ON

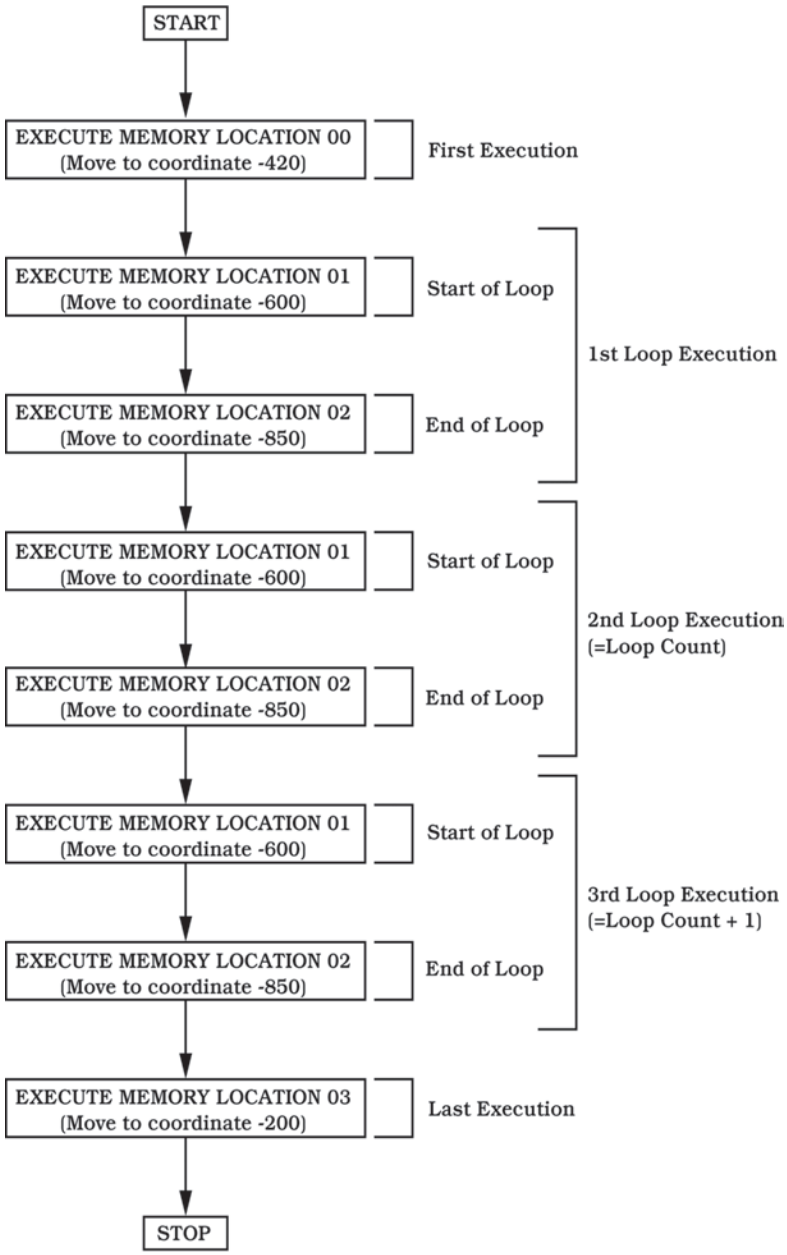
Memory Location 02:

EXECUTE POINT	SKIP POINT
COORDINATE	-850
VELOCITY	13333
ACCEL	25600
MOVE RELATIVE	MOVE ABSOLUTE
PAUSE 0 SEC	WAIT
LOOP COUNT	0
END LOOP OFF	END LOOP ON
END PROGRAM OFF	END PROGRAM ON

Memory Location 03:

EXECUTE POINT	SKIP POINT
COORDINATE	-200
VELOCITY	13333
ACCEL	25600
MOVE RELATIVE	MOVE ABSOLUTE
PAUSE 0 SEC	WAIT
LOOP COUNT	0
END LOOP OFF	END LOOP ON
END PROGRAM OFF	END PROGRAM ON

Program Flow

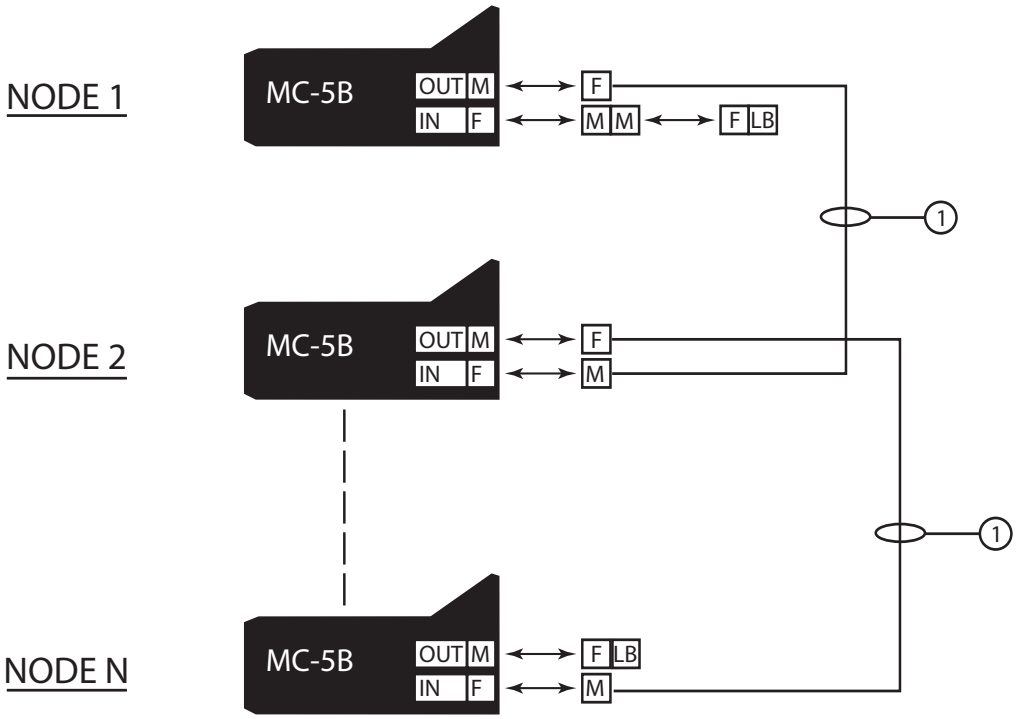


Section 6

Multi-Axis System

The MC-5B has the ability to be interconnected with multiple MC-5B's to form a multi-axis system. When more than one MC-5Bs' are connected, the user must make the "MultiNode Mode" menu selection on all the respective controllers and assign a unique node address from 1-99 (also a menu selection). Once the communication ports of the MC-5B's are physically connected (see illustration) and network addresses have been assigned, programming and control of any "node" may be performed from any one of the connected controllers.

Connections - Multi-Axis System



SYMBOL LEGEND

- M — Male DB-9 Port
- F — Female DB-9 Port
- M M — Male to Male DB-9 Genger Changer
- LB — RS-232 "LOOPBACK"
- 1 — RS-232 "STRAIGHT-THRU" Cable

Operating a Controller from the Keypad of Another Node
(Set to MultiNode Mode in Menu – see Menu section)

1. To assign node ID's to all nodes in the networked system, starting at 1:

   SHIFT

   ASGN NDS

2. To establish control of node 2 from a controller other than node 2 (node 1 for example):

   2

   Node 2's functionality will now be accessible from node 1.
   ("Node 2" will be displayed on the top line of node 1. If communication is successfully established, the current position of node 2 will be displayed on the second line of node 1. Node 2 will also display the text "C1" to signify that it is under the control of node 1. If node 2's current position is not displayed on the second line of node 1, review Setup section and connections.)
   0 is the broadcast address, and most commands may be sent to all nodes using the 0 node broadcast address. Once control of a given node has been established, it is not necessary to use the node ID as a prefix to subsequent commands.

3. To relinquish remote control of node 2 and re-establish control of the local node:

   ENTER

4. To jog node 2 remotely from node 1:

   2 **JOG**

5. To change the units on node 2 to inches (from node 1):

   2 **SHIFT**

   UNITS

(repeat until inches are displayed)

6. To move node 3 to 0.3 inches, node 2 to 0.2 inches and node 1 to 0.1 inches (from node 1):
   Change units of all nodes to inches, then

   3

   MOVE

   .

   3

   ENTER

   2

   MOVE

   .

   2

   ENTER

   1

   MOVE

   .

   1

   ENTER

7. To store the current positions of all nodes at each one's respective memory location 25:

   0

   STORE

   2

   5

   ENTER

8. To jog node 2 remotely from node 1, store the final position in node 2's memory location 6 and reestablish control of the local node 1:

   2

   JOG

   STORE

   6

   ENTER

   ENTER

9. To change node 2's mode from VMode Jog to Step Jog from node 1:

   2

   MENU SEL

   MENU V (down)

   MENU SEL

   ENTER

10. To edit node 2's memory location 4 velocity and end program parameters:

    2

    EDIT

    Then press

    JOG> or **JOG<** until 4 is displayed, or enter **4** at the Location to Edit prompt. (Do not press ENTER now.)

    Next press

    EDIT V (down) 3 times to scroll to the velocity parameter. Key in the desired velocity in the units displayed, then press

    EDIT V (down) 6 times to scroll to the end program parameter. Press

    EDIT SEL to set the end program parameter to ON, then press

    ENTER to conclude the editing process for node 2.

    ENTER relinquishes remote control of node 2

11. To home:

    SHIFT

    AUTO-HOME

12. To change the displayed units:

    SHIFT

    UNITS

Section 7

PC Control

The MC-5B also has the ability to be interconnected with multiple MC-5B's and to be controlled from a PC. When part of a multi-controller configuration, a PC would simply be another node on the "peer-to-peer ring" network. The PC would then be required to mimic the communication protocol of an MC-5B in order to maintain the "peer-to-peer communication ring".

The communication requirements for a PC to be part of an MC-5B network are slightly different in that a "Null Modem" cable is required from the PC to the first MC-5B (see connection illustration page 23).

The RS-232 serial port settings of a PC in the MC-5B network are as follows:

-4800 Baud
-8 Data Bits
-No Parity
-2 Stop Bits
-No Flow Control

The node ID of the PC in an MC-5B network is typically: 99

The communication protocol for the MC-5B "peer-to-peer ring" must be carefully adhered to and is as follows:

Sending Messages:
The message protocol from a PC to an MC-5B is an ASCII string consisting of four concatenated elements. These elements are as follows (delineated with brackets for clarity):

1.) [ascii equivalent of: 128+Sender Address (99 in this case)]
<concatenated with>
2.) [ascii equivalent of: 128+Destination Address]
<concatenated with>
3.) [Command Text]
<concatenated with>
4.) [Carriage Return (ascii 13)]

See also "Appendix G"

Message Confirmation:
The PC may also send a completion token which will be returned to the PC when all controllers have completed execution of all their serial commands transmitted before token transmission. The token message is another ASCII string consisting of three concatenated elements. These elements are as follows (delineated with brackets for clarity):

1.) [Token Character (ascii 6)]
<concatenated with>
2.) [ascii equivalent of: 128+Sender Address (99 in this case)]
<concatenated with>
3.) [Carriage Return (ascii 13)

Receiving Messages:

When Receiving data from an MC-5B controller such as "Current Position", the message will be an ASCII string consisting of four concatenated elements. These elements are as follows (delineated with brackets for clarity):

1.) [ascii equivalent of: 128+Sender Address (an MC-5B node address)]
<concatenated with>
2.) [ascii equivalent of: 128+Destination Address (99 in this case)]
<concatenated with>
3.) [Response Text]
<concatenated with>
4.) [Carriage Return (ascii 13)]

The desired data (i.e. response text), must then be parsed from the string. Note, data to be received is only intended for the receiving device (MC-5B or PC) as long as the second byte containing the destination address is a match to that assigned to the respective receiving node.

Message "Relaying":

To preserve direct communication capability between MC-5B controllers and the PC itself, the PC must relay all incoming data that it did not originate itself. In other words, when an MC-5B network is established that includes a PC, the "peer-to-peer RS-232 serial ring" protocol requirement is to re-transmit any message that was not intended for a given node whether it is an MC-5B or a PC. The PC serial input interrupt routine must relay (send out) all incoming serial data unless:

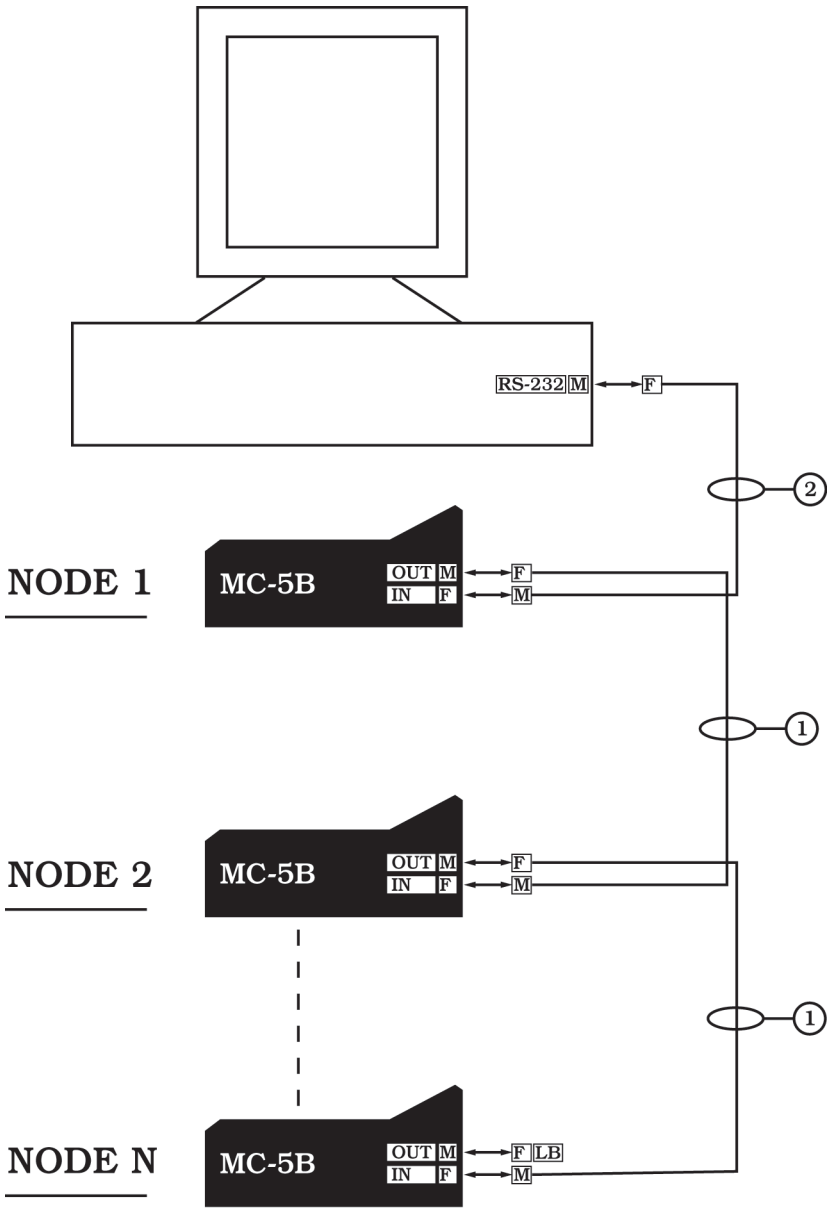
1.) The first byte of the message is its own address
<or>
2.) The message is a completion token message and the second byte of the message is its own address.

The PC must also avoid transmitting its own messages when an incoming message has been partially but not completely relayed. This is typically accomplished by waiting until an incoming message is completely relayed, masking input interrupt processing, transmitting the PC originated message and re-enabling input interrupt processing.

PC Commands Available:

Serial Cmd	Function
an	Move to absolute position n (counts)
sn	Relative Move of distance n (counts)
!vn	Set Base Velocity to n (counts/s)
!an	Set Base Acceleration to n (counts/s2)
!hn	Set Homing Offset to n (counts)
S	Single Step Node's Stored Program
B	Run Node's Stored Program
Uarg	Set Display Units (arg=N, IN, MIL, MM, UM, SEC, MS, DMS, DD, RAD, MRAD)
INN	Recall Memory Location NN
MNN	Store Current Position at Mem Loc. NN
R	Reset Current Position to Zero
H	Execute Homing Routine
N	Reset MC-5B to Default State
?x	Query Current Position (counts)
?v	Query Current Base Velocity (counts/s)
?a	Query Current Base Accel (counts/s2)
?j	Query Current Jog Step Accel (cts/s2)
hNN	Set a Single Node's Node ID
gNN	Assign All Node ID's starting at NN. Use broadcast address (Node 0) as destination node.

Connections



Symbol Ledgend

- F — Female 9 pin D-Sub Port
- M — Male 9 pin D-Sub Port
- LB — RS-232 "LOOPBACK"
- (1) — RS-232 "STRAIGHT-THRU" cable
- (2) — RS-232 "NULL MODEM" cable

APPENDIX

APPENDIX

A

Specifications

MC-5B Controller

Display:	Two-line, 20 character alphanumeric LCD
Control:	Keypad or PC
Optional Accessories:	Communication Kit Remote Dial Encoder Wheel, Remote Joystick
Motor Load:	Any 6-12 VDC brush type motor (750mA max.)
Encoder Interface:	Single ended, 5VDC TTL compatible A/B Quadrature Encoder Input
Remote Communication:	RS232
Dimensions:	5.2 x 7.5 x 2.5 inches.
Weight:	2.75 lbs.
Operating Temp:	20° C (Ambient)
Fuse:	2 Amp Bussman model ABC-2 (or equivalent)

MC-5B Power Supply

Input Voltage:	100~240Vac
Input Frequency	47 to 63Hz
Input Current:	0.6A max.
Output Voltage:	15 VDC
Output Current:	1.4 A
Operating Temp:	20°C (Ambient)
Dimension:	4.35 x 1.95 x 1.2 inches
Weight:	0.5 Pounds

Troubleshooting and Set-Up Assistance

APPENDIX B

Problem	Possible Cause and remedy
Stage runs at full speed out of control to one end.	Encoder direction (menu item) reversed: either because of menu control accident or use with motor of convention other than NAI stages.
Memory Locations do not store where you want to put them	"Sequential" storage mode engaged; use "Store By Entry" mode
Sluggish takeoff and landing	Low base acceleration setting
Sluggish jog steps	Low Jog Step Acceleration setting
Erratic jog steps	Jog Step Acceleration set too high for the jog step size.
Stops abruptly	Excessive base acceleration
Stage stops before move is completed, re-starts when GoTo is pressed	Following error related: a) Possible obstruction to motion, including lubrication problems. b) Acceleration and/or velocity too high for current gear-load combination or following error allowance. c) Following error set too low; stall threshold may vary "day-to-day"
Limits don't stop the stage	Wires to stage limits disconnected or reversed. Conductor # 10 (if ribbon), or black conductor (if round cable) should have continuity to fwd (motor) end of stage by way of connecting stage rail.
Stage overshoots destination before arriving	PID parameters need to be adjusted. Integral (I term) possibly set too high.
Grinding Noise	Check the PID tuning parameters.
Not Homing	Acceleration value set too high.

Examples, Servo Settings

APPENDIX C

Suggested for MC-5B with typical NAI stage configurations.

	Menu Settings										
	Rotary or Linear	**Homing Offset**	**VMode Jog x 1,4**	**Base Velocity**	**Base Accel.**	**Backlash Comp.**	**Counts per inch**	**Counts per rev.**	**Following Error**	**PID Kp**	**PID Ki**
MM-3M-F, EX 1 inch travel 10 mm motor 16:1 gear	Linear	25,600	1	13,333	25,600	20	51,200		1,000	600	400
MM-3M-F, EX 1 inch travel 10 mm motor 64:1 gear	Linear	102,400	4	13,333	25,600	35	204,800		1,000	600	400
MM-3M-F, EX, AB 1 inch travel 10 mm motor 64:1 gear Anti-Backlash, High Linearity	Linear						204,800				
MM-3M-R Rotary 16:1 gear	Rotary							51,200			
MM-3M-R Rotary 64:1 gear	Rotary							204,800			
MM-3M-R Rotary Ultra-low Wobble 16:1 gear	Rotary							51,200			
MM-3M-R Rotary Ultra-low Wobble 64:1 gear	Rotary							204,800			
MM-4M-F, 25 mm travel 10 mm motor 16:1 gear	Linear						51,200				
MM-4M-EX 1 inch travel 13 mm motor ~14:1 gear	Linear						70,634				
MM-4M-R Rotary 13 mm motor ~14:1 gear	Rotary							79,464			

Note: The table shows encoder count units, but the data on the MC-5B display will be in the units chosen.

Please request updates for more data.

APPENDIX

D

Stage Resolution

Linear Stages

Counts per Inch = 4 * (Encoder Lines/Motor Rev) * Motor Gear Ratio * (Lead Screw Turns/Inch)

Stage	Enc. Gear	Enc. Lines	turns/in	Counts/In
MM3M	16:1	10	80	51,200
MM3M	64:1	10	80	204,800
MM3M	256:1	10	80	819,200
MM3M	1024:1	10	80	3,276,800
MM4M	3.71:1	16	80	19,017
MM4M	14:1	16	80	70,635
MM4M	43:1	16	80	219,754
MM4M	66:1	16	80	339,048
MM4M	134:1	16	80	683,678

Rotary Stages

Counts per Rev = 4 * (Encoder Lines/Motor Rev) * Motor Gear Ratio * Stage Gear Teeth

Stage	Motor Gear	Enc. Lines	Stg. Gr. Teeth	Counts/Rev
MM3MR	16:1	10	80	51,200
MM3MR	64:1	10	80	204,800
MM3MR	256:1	10	80	819,200
MM3MR	1024:1	10	80	3,276,800
MM4MR	3.71:1	16	90	21,394
MM4MR	14:1	16	90	79,464
MM4MR	43:1	16	90	247,223
MM4MR	66:1	16	90	381,430
MM4MR	134:1	16	90	769,138

APPENDIX

E

Settings for Standard Stage Product

Linear Stages:

MM-3M-EX, MM-3M-F, MM-3M-ST and MM-4M-F
(10mm Motor, 10 Position Encoder and 80 TPI Lead Screw)

Gear Head	Counts Per Inch	Counts Per Centimeter
16:1	51,200	20,157
64:1	204,800	80,630
256:1	819,200	322,520
1,024:1	3,276,800	1,290,079

Maxon Motor - 10mm
12 position encoder x 4 (quadrature) = 48 counts/mtr Rev.
Gearhead = 16:1

$$\left(\frac{48 \text{ counts}}{1 \text{ mtr Rev}}\right) \cdot \left(\frac{16 \text{ mtr Rev}}{1 \text{ GH Rev}}\right) \cdot \left(\frac{1 \text{ GH Rev}}{0.0125 \text{ in.}}\right) = 61,440 \text{ counts/inch}$$

Micro Mo - 10mm
10 position encoder x 4 (quadrature) = 40 counts/mtr Rev
Gearhead = 16:1

$$\left(\frac{40 \text{ counts}}{1 \text{ mtr Rev}}\right) \cdot \left(\frac{16 \text{ mtr Rev}}{1 \text{ GH Rev}}\right) \cdot \left(\frac{1 \text{ GH Rev}}{0.0125 \text{ in.}}\right) = 51,200 \text{ counts/inch}$$

MM-4M-EX
(13mm Motor, 16 Position Encoder and 80TPI Lead Screw)

Gear Head Nominal	Gear Head Actual	Counts Per Inch	Counts Per Centimeter
14:1	13.795918367:1	70,635	27,809

Rotary Stages:

MM-3M-R
(10mm Motor, 10 Position Encoder and 80:1 Table)

Gear Head	Counts Per 360 Degrees
64:1	204,800
256:1	819,200
1,024:1	3,276,800

MM-4M-R
(13mm Motor, 16 Position Encoder and 90:1 Table)

Gear Head Nominal	Gear Head Actual	Counts Per 360 Degrees
14:1	13.795918367:1	79,465

Motor Connector Pin Assignments:

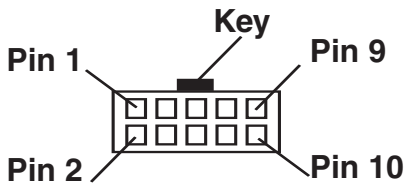
APPENDIX F

Motor Type: DC, Brush Type
Connector Type: 10 pin IDC (female) or 9 pin mini DIN (male)

10 pin IDC Connector Pin Assignments

Pin #	Name	Pin #	Name
1	Motor (-)	6	Motor (+)
2	Encoder Supply	7	Limit ground
3	Encoder Ch A	8	Limit VCC + 5V
4	Encoder Ch B	9	Reverse limit
5	Case Ground	10	Forward limit

10 Pin IDC Connector

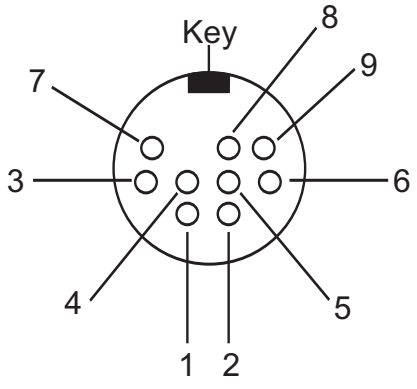


10 pin motor connector (front view)

9 Pin Mini DIN Pin Assignments

Pin#	Name	Pin #	Name
1	Motor (-)	6	Motor (+)
2	Encoder Supply	7	Limit Ground
3	Encoder Ch A	8	Forward Limit
4	Encoder Ch B	9	Reverse limit
5	Encoder/Case Ground		

9 Pin Mini DIN Connector



9 pin Mini-Din Motor connector (front view)

APPENDIX

G

PC Control - Sending Messages:

To use the MC5B with a PC we have found that some versions of Microsoft Windows may alter the characters sent.

(Note: check Windows, Help, Characters, input characters that are not on your keyboard.)

For example;

to send a position query (?x) it is necessary to add a leading zero(0) to the ASCII code so that the following;

[ASCII (128+99), ASCII(128+1), ?x, ASCII (13)
becomes [Alt 0227, Alt 0129, ?x, Alt 013].

When using Hilgraeve Hyperterminal software on a Windows 2000 OS platform the procedure is;

1. press and hold Alt key
2. type 0227 with numeric keypad
3. release Alt key
4. press and hold Alt key
5. type 0129 with numeric keypad
6. release Alt key
7. type ?x,
8. press and hold Alt key
9. type 013 with numeric keypad
10. release Alt key

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