



USER MANUAL

MC-5CD

Motion Controller



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Using this Manual

The MC-5CD Motion Controller is a linear motor controller designed to drive National Aperture MM series stages and other systems utilizing DC brush type motors with single ended quadrature AB encoders. The MC-5CD incorporates a Galil DMC-4143 motor controller and provides connectivity and packaging suitable for ease of use and rapid deployment in desk top, bench top and industrial automation applications.

This manual provides information necessary to set up and configure the MC-5CD controller and is intended to be used in conjunction with the user manual for the Galil DMC-4143 controller. The MC-5CD controller provides the connectivity required for USB and Ethernet based control of National Aperture, Inc. motion equipment.

What your MC-5CD Purchase Includes

Your MC-5CD Motion Controller purchase includes the following:

- MC-5CD Motion Controller
- Power Cord
- Extension Ribbon Cable – 10 Conductor

USB Flash Drive Including

- National Aperture MC-5CD User Manual (this manual)
- GalilTools Application
- Galil DMC-41x3 Motion Controller Instruction Manual
- Galil DMC-41x3 Motion Controller Command Reference

Introduction to the MC-5CD Motion Controller

The MC-5CD motion controller provides closed loop control for DC brush type motors incorporating AB quadrature encoders. This linear motion controller is designed to be controlled via USB, RS-232 , or Ethernet. Each axis of the MC-5CD includes a 10 pin motor interface, labeled “Mot/Enc/Lim”, supporting motor drive, AB quadrature encoder and limit switch connectivity and a 9 pin mini-DIN motor interface. National Aperture MM series stages may be plugged directly into either connector. The MC-5CD also includes a front panel power switch.



Getting Started

Making Hardware Connections

Power

The MC-5CD operates on line voltage. Connect the AC power cord to the rear panel power receptacle. Plug the AC power cord into an outlet and switch the MC-5CD controller on.

USB Interface

Using the USB A-B cable provided, connect the motion controller to one of the USB ports of the host computer. Your computer will detect the controller as a serial port and will install the driver. Allow three minutes of progress boxes being displayed before the installation is complete. The controller will show up in the Device Manager as “USB Serial Port” followed by a COM number in parentheses. Make a note of this for when you start GalilTools.

Do not connect any stages to the controller until controller configuration has been verified.

Configuration and Operation with Galil Tools Software Application

GalilTools is a software application for configuration and basic operation of Galil motion controllers including the DMC-4143 controller utilized in the National Aperture MC-5CD.

Installing GalilTools:

GalilTools is provided on the USB Flash drive included with your controller and may be installed with one of the setup utilities on the Flash drive root folder. If not already installed on your computer, it should be installed now by running the GalilTools-1.6.2.496-Win-x86.exe file for a 32-bit system or GalilTools-1.6.2.496-Win-x64.exe for a 64-bit system.

Establishing Communication:

Start the GalilTools application. The first window to appear will be the Connections box. In the Address column find the COM number noted from the Device Manager. It should appear twice, once with a baud rate of 19200 and again with 115200. Select the 115200 baud entry and click the Connect pushbutton in the lower right of the Connections box. A



sign-on window titled “Message from Galil” will appear next. Once you dismiss this window, the main GalilTools window will appear.

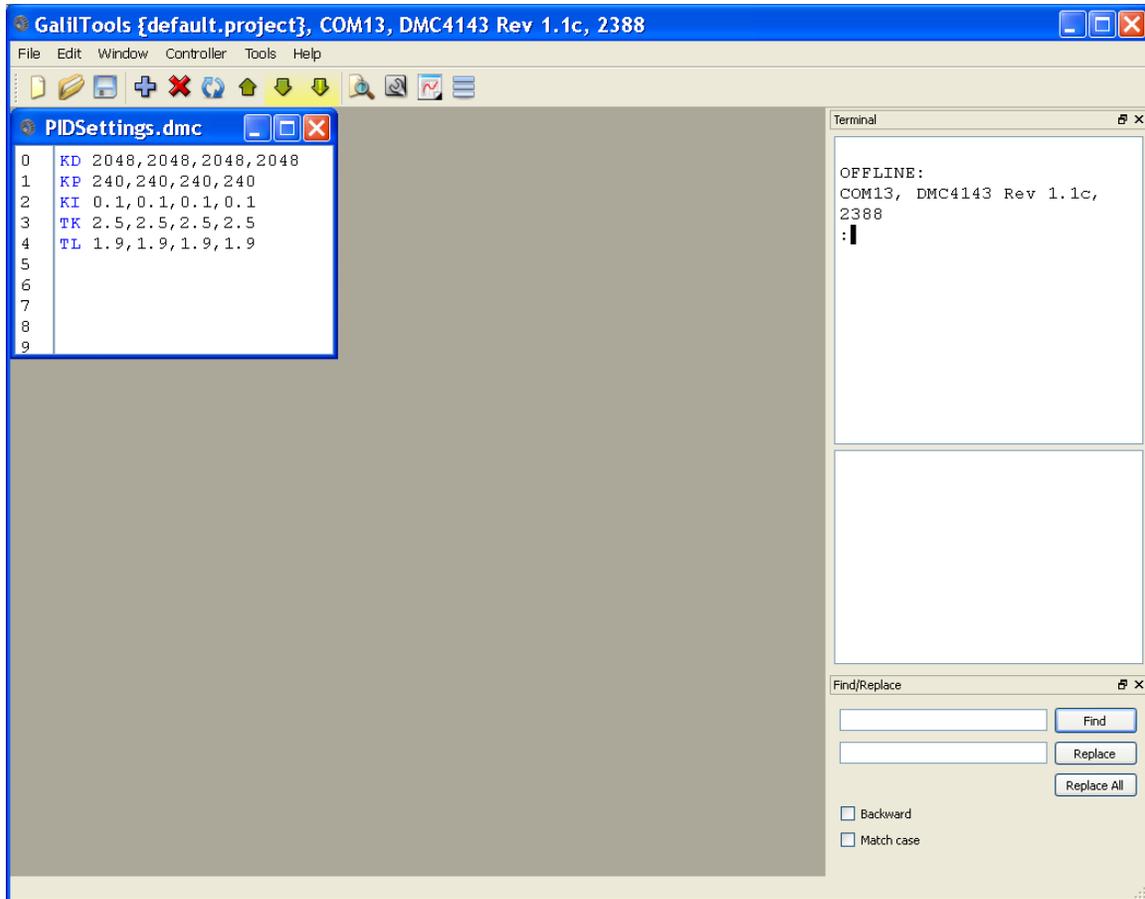


Figure 1 – GalilTools User Interface

Configuring the MC-5CD Motion Controller (continued)

GalilTools is shown with the script for making the default settings. The controller’s feedback loop gains determine the controller’s ability to accurately and responsively produce commanded motion in a stable manner. KD, KP, KI are the digital filter settings for Derivative, Proportional, and Integral. TK and TL are the peak and continuous torque limit settings to protect the stage motors from excessive current and protect gears and machinery from excessive forces. To execute this script you may use the menu item File->Execute or click the second downward arrow tool on the toolbar. If you simply want to transfer the script to your MC-5CD memory without executing it, use menu item File->Download or click the first downward arrow tool on the toolbar. Software position limits



may be set using the FL and BL commands. To set a forward software limit on axis A, send “FLA=” followed by the desired forward limit value, and to set a reverse software limit, send “BLA=” followed by the value.

The Acceleration and Deceleration parameters, AC and DC, may be set as desired, keeping in mind that extremely abrupt acceleration can result in premature stage wear. To set the acceleration on axis A, send “ACA=” followed by the value.

When using rotary stages, you may choose to disable the limit switches to allow motion past the limit (homing) switch. To disable the limit switches on axis A, you would send “LDA=3”. **This is not recommended for linear stages.** After settings have been made send “BN” to store all of the new settings to non-volatile memory so that they are retained after power is removed.

The stage should now be connected to the motion controller.

Recommended Setup Parameters for Various NAI Stages

For NAI MM-3M stages with standard torque motors and standard 10 line, 40 count per revolution encoders:

Peak Current Limit (TKn):	2.5 (250 mA)
Continuous Current Limit (TLn):	1.9 (190 mA)
Acceleration (ACn):	40000 counts/s ² typical
Maximum Speed (SPn):	<= 12,095 counts/s

For NAI MM-3M stages with high torque motors and standard 10 line, 40 count per revolution encoders:

Peak Current Limit (TKn):	3.7 (370 mA)
Continuous Current Limit (TLn):	2.8 (280 mA)
Acceleration (AC):	40000 counts/s ² typical
Maximum Speed (SP):	<= 12,095 counts/s

For NAI MM-3M stages with high torque motors and 12 line, 48 count per revolution encoders:

Peak Current Limit (TKn):	3.7 (370 mA)
Continuous Current Limit (TLn):	2.8 (280 mA)
Acceleration (AC):	40000 counts/s ² typical



Maximum Speed (SP): $\leq 12,095$ counts/s

Recommended Setup Parameters for Various NAI Stages (continued)

For NAI MM-4M stages with standard torque 10mm motors and standard 10 line, 40 count per revolution encoders:

Peak Current Limit (TKn): 2.5 (250 mA)
Continuous Current Limit (TLn): 1.9 (190 mA)
Acceleration (ACn): 40000 counts/s² typical
Maximum Speed (SPn): $\leq 12,095$ counts/s

For NAI MM-4M stages with high torque 10mm motors and standard 10 line, 40 count per revolution encoders:

Peak Current Limit (TKn): 3.7 (370 mA)
Continuous Current Limit (TLn): 2.8 (280 mA)
Acceleration (ACn): 40000 counts/s² typical
Maximum Speed (SPn): $\leq 12,095$ counts/s

For NAI MM-4M stages with high torque 10mm motors and 12 line, 48 count per revolution encoders:

Peak Current Limit (TKn): 3.7 (370 mA)
Continuous Current Limit (TLn): 2.8 (280 mA)
Acceleration (ACn): 40000 counts/s² typical
Maximum Speed (SP): $\leq 12,095$ counts/s

For NAI MM-4M stages with 13mm motors and standard 16 line, 64 count per revolution encoders:

Peak Current Limit (TKn): 7.9 (790 mA)
Continuous Current Limit (TLn): 5.9 (590 mA)
Acceleration (ACn): 40000 counts/s² typical
Maximum Speed (SP): $\leq 12,095$ counts/s



Basic Motion Commands and Examples

Some commonly used commands are provided below. A complete list of commands is available in the MCDC3006 Instruction Manual and should only be utilized after reviewing the section of this document entitled “Using the Galil DMC-41x3 Controller Documentation”

Command	Function	Description	Example
DPn	Define Home Position	Sets actual position to given value	DPA=0 DPA=12500
SHn	Enable Axis	Activates the power stage for axis	SHA
MOn	Disable Axis	Deactivates the power stage for axis	MOA
TPn	Get Actual Position	Returns the current position	TPA->500
SPn	Load Max Speed	Loads a new maximum velocity Argument in counts/sec. Range 0-30,000	SPA=14000
PAn	Load Absolute Position	Loads new absolute position. Argument:Encoder Counts	PAA=10000
PRn	Load Relative Position	Loads new relative position Argument:Encoder Counts	PRA=-2500
BGn	Move	Starts motion in position or jog mode	BGA
ACn	Load Acceleration	Load new acceleration. Argument in counts/s ² (0-30,000)	ACA=1000
JGn	Move at Specified Velocity	Activates jog mode and sets velocity in counts/s	JGA=10000
KIn	Load Integral Term	Load controller integral gain	KIA=0.1
KPn	Load Proportional Term	Load controller proportional gain	KPA=240
KDn	Load Derivative Term	Load controller pos. derivative gain	KDA=2048
STn	Stop motion	Stops motion on specified axis, or all axes	STA

The commands include the axis number at the end, using a syntax that allows the user to specify a single axis or a group of axes. The DMC-41x3 Command Reference pp 10 and 11 explain this syntax in detail.

Example – Commanding Motion with Text Commands



After powering up the motion system, starting GalilTools and configuring the controller, the user may send motion commands to the motion controller by typing them into GalilTools's "Enter Command" box. This is a small text box on the upper left portion of the main GalilTools interface. Assume the user wants to enable the controller's power stage, execute the homing sequence to establish a known position, set the position following the homing sequence to 25000 counts, move to the absolute position of 0 counts, make three relative moves of 5600 counts, the first at 5,000 rpm, the second at 10,000 rpm and the third at 15,000 rpm, display the current position of 16,800 counts, return to the zero position and disable the controller power stage. These operations may be achieved by typing the following sequence of commands into the "Enter Command" box.

```
SHA
DPA=25000
PAA=0
BGA
SPA=5000
PRA=5600
BGA
SPA=10000
PRA=5600
BGA
SPA=15000
PRA=5600
BGA
TPA
PAA=0
BGA
MOA
```

GalilTools provides a program editor whereby sequences like the one above can be downloaded to the controller and executed as programs. Some example programs are included in a folder on the Flash drive. Further instructions for commanding and controlling motion are available in the DMC-41x3 controller User Manual and the DMC41x3 Command Reference (which should be used in conjunction with this document) as well as the GalilTools help section.

Using the Galil DMC-41X3 Controller Documentation

The NAI MC-5CD motion controller incorporates a Galil DMC-4143 controller and has been implemented with a packaging and connectivity approach that allows for rapid and user friendly deployment in desktop, benchtop and industrial automation applications with no wiring required. The MC-5CD is designed to be



controlled using USB serial commands from a host computer and supports the DMC-41x3 command based functionality. Analog and digital I/O is brought out for such purposes as joystick control of speed and other external control interface.

Specifications

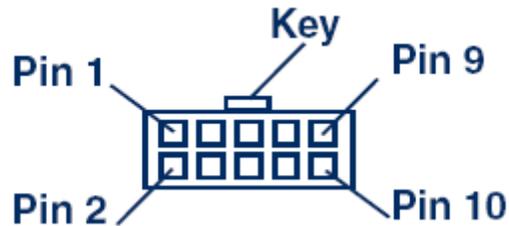
Supply Voltage	120-240 V AC
Max. Continuous Motor Current	1 A
Max. Peak Motor Current	1 A
5 V Outputs – Max Combined Load	1.1A (from Encoder Vcc and Limit Vcc)
Limit Switch Configuration	Switches to ground expected (controller incorporates 2.2k pullup resistors to 5V)
Limit Switch Logic Levels	low 0-0.5 V @ >1.5mA, high 4.0-5.0 V @ <0.5 mA
Encoder Input Logic Levels	TTL but can accept up to +/- volts
Encoder Input Max Frequency	15 mHz
Maximum Motor Velocity	30,000 rpm (do not exceed stage speed rating)
Baud Rate	19200, 115200
Operating Temperature	0 to 70 °C
Storage Temperature	-25 to +85 °C



Mating Connectors

For motor, encoder and limits:

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



Motion Controller End of Stage or Motor Cable
(ITW Pancon 050-010-415A or equivalent)

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Support

For technical support, contact National Aperture at 603 893-7393 and ask for technical support for the MC-5CD motion controller.



