Millennium Series
PCI-bus Motion Controllers

User's Manual

Cito Systems

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Related Documents

Navigator Motion Processor User's Guide (MC2000UG)

How to set up and use all members of the Navigator Motion Processor family.

Navigator Motion Processor Programmer's Reference (MC2000PR)

Descriptions of all Navigator Motion Processor commands, with coding syntax and examples, listed alphabetically for quick reference.

1 Installation

In addition to the PC card the Millennium motion controller includes a diskette with the C-Motion™ software library. C-Motion is a full-featured C language library which simplifies the development of motion applications for the Navigator chipsets.

1.1 Installation Sequence

For a normal installation of the Millennium controller, you will need to configure the 3mi-0x-xx board for the PC system and motor hardware that you will connect it to. Configuration of the 3mi-0x-xx board is described in detail in the section below entitled "Preparing the board for installation"

Next you will need to connect your system's motors, encoders, amplifiers, and sensors as desired to operate your motion hardware. A description of the connections that are made for the various Navigator chipsets is found in the section "3mi-0x-xx Connections Summary".

The final step to finish the installation is to perform a functional test of the finished system. This is described in the section entitled "First time system verification".

Once all of the above has been accomplished installation is complete. You can now exercise your motion system.

1. 2 Components List

The Millennium controller set contains the following components:

1) Millennium Controller PCI Board
2) 3.5" high density floppy diskette with:
   C-Motion library (static and DLL)
   Navigator Motion Processor User's Guide (pdf format file)
   Navigator Motion Processor Programmers Reference (pdf format file)
3) 100 pin connector to dual 50-pin header converter cable
4) Documentation:
   Millennium Series Motion Controllers - User's Manual

If any of these components are missing, please contact Cito Systems directly, or your Cito Systems representative.

1. 3 Required Hardware

To install the Millennium board, you will need the following hardware:

1) PC platform: the minimum platform consists of an Intel (or compatible) processor, 80286 or better, one available PCI slot, 5MB of available disk space, 640KB of available RAM, 3.5" diskette drive. The recommended platform is an Intel (or compatible) processor, Pentium or better, one available PCI slot, 5MB of available disk space, 32MB of available RAM, and , 3.5" diskette drive. The PC operating system may be MS-DOS or Windows 9X. An asynchronous serial communications port is optional for both the minimum and recommended platforms.
2) 1 to 4 pulse and direction, PWM, or analog-input amplifiers. The type of amplifier depends on the controller's chipset type.

3) 1 to 4 step motors or servo motors. These motors may or may not provide encoder position feedback signals depending on the type of chipset being used.
4) Additional connectors as required to connect the 3mi-0x-xx PC board to the amplifiers and the servo motors. Dual male 50 pin header-type connectors will be needed to interface to the 3mi-0x-xx board's signal cable.

1.4 Preparing the board for installation

The board provides the following user-settable hardware options:

Option	Set using	Default
Host interface mode	jumper JP1	16/16 parallel

The host interface mode jumpers will not need to be changed unless it is desired that the card be operated in serial mode. If operated in serial mode, a special adapter board is required.

The following diagram shows the location of the jumper JP1:

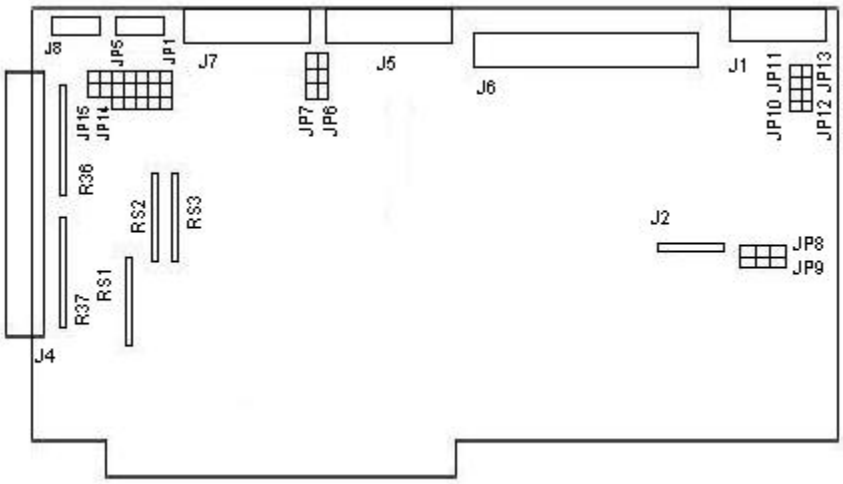


Figure 1-1. Settable jumpers and connctors

If you need to change the default setting values from the table above, or are not sure if they need to be changed, the following sections explain more about these settings.

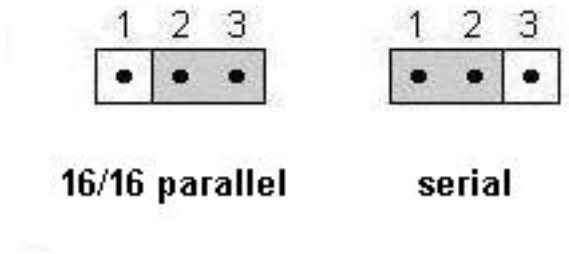
1.4.1 Setting the Host I/O mode

The PCI-bus motion controller supports two different communication modes. This is shown in the following table:

Mode	Description

16-bit mode	The motion processor accepts instructions and data as full 16-bit words, using the entire 16-bit data path
Serial port	The motion processor accepts instructions through an asynchronous serial port.

The figure below shows how the JP1 jumper should be installed to select the host mode. 16/16-bit mode is the default. Shading indicates the location of the jumper.



1.5 3mi-0x-Bx Connections summary

The following table summarizes the connections provided and expected by the Millennium PC board when a MC2140 chipset is installed. Although the MC2140 supports up to four axes any number of axis between 1 and 4 may be connected.

Chipset:	MC2100 series
Maximum # of Axes:	4
Encoder Input Type:	Incremental encoder
Encoder Input Signals: (per axis)	A quadrature channel input B quadrature channel input Index pulse channel input
# motor output channels: (per axis)	1
Amplifier Output Signals (per axis, if PWM sign, magnitude used)	PWM Direction PWM magnitude
Amplifier Output Signals (per axis, if PWM 50/50 used)	PWM magnitude
Amplifier Output Signals (per axis, if analog output used)	Differential analog out (DAC output)
Other Control Signals: (per axis)	Home signal channel input Positive limit switch input Negative limit switch input Fault input AxisOut output
Miscellaneous Signals:	GND +5 V (for encoder power)

For a complete description of the PC card connectors and interfacing requirements see Appendix A " Millennium Controller Electrical Reference".

1.6 3mi-0x-BLx Connections summary

The following table summarizes the connections provided and expected by the Millennium PC board when a MC2340 chipset is installed. Although the MC2340 supports up to four axes any number of axis between 1 and 4 may be connected.

Chipset:	MC2300 series
Maximum # of Axes:	4
Encoder Input Type:	Incremental encoder
Encoder Input Signals: (per axis)	A quadrature channel input B quadrature channel input Index pulse channel input
# motor output channels: (per axis)	2 or 3 depending on motor output selected and # phases
Amplifier Output Signals (per axis, if PWM 50/50 used)	PWM magnitude (phase A) PWM magnitude (phase B) PWM magnitude (phase C)
Amplifier Output Signals (per axis, if analog output used)	Analog out (phase A) Analog out (phase B)
Hall inputs:	Hall (phase A) Hall (phase B) Hall (phase C)
Other Control Signals: (per axis)	Home signal channel input Positive limit switch input Negative limit switch input Fault input AxisOut output
Miscellaneous Signals:	GND +5 V (for encoder power)

For a complete description of the PC card connectors and interfacing requirements see Appendix A " Millennium Controller Electrical Reference".

1.7 3mi-0x-MSx Connections summary

The following table summarizes the connections provided and expected by the Millennium PC board when a MC2440 chipset is installed. Although the MC2440 supports up to four axes any number of axis between 1 and 4 may be connected.

Chipset:	MC2400 series
Maximum # of Axes:	4
Encoder Input Type:	Incremental encoder
Encoder Input Signals: (per axis)	A quadrature channel input B quadrature channel input Index pulse channel input
# motor output channels: (per axis)	2 or 3 depending on motor output selected and # phases

Amplifier Output Signals (per axis, if PWM 50/50 used)	PWM magnitude (phase A) PWM magnitude (phase B) PWM magnitude (phase C)
Amplifier Output Signals (per axis, if analog output used)	Analog out (phase A) Analog out (phase B)
Other Control Signals: (per axis)	Home signal channel input Positive limit switch input Negative limit switch input Fault input AxisOut output
Miscellaneous Signals:	GND +5 V (for encoder power)

For a complete description of the PC card connectors and interfacing requirements see Appendix A " Millennium Controller Electrical Reference".

1.8 3mi-0x-S Connections summary

The following table summarizes the connections provided and expected by the Millennium PC board when a MC2540 chipset is installed. Although the MC2540 supports up to four axes any number of axis between 1 and 4 may be connected.

Chipset:	MC2500 series
Maximum # of Axes:	4
Encoder Input Type:	Incremental encoder
Encoder Input Signals: (per axis)	A quadrature channel input B quadrature channel input Index pulse channel input
# motor output channels: (per axis)	1
Amplifier Output Signals: (per axis)	Pulse Direction
Other Control Signals: (per axis)	Home signal channel input Positive limit switch input Negative limit switch input Fault input AxisOut output
Miscellaneous Signals:	GND +5 V (for encoder power)

For a complete description of the PC card connectors and interfacing requirements see Appendix A " Millennium Controller Electrical Reference".

1.9 Applying Power

Once you have connected the Millennium board to the desired # of external amplifiers and motor encoders, hardware installation is complete and the board is ready for operation.

Upon power up, the motion chipset will be in a reset condition. In this condition no motor output will be applied until the chipset is initialized (see next section on software for details). Therefore, the

motors should remain stationary. If the motors do move or jump power down the board and check the amplifier and encoder connections. If anomalous behavior is still observed, call Cito Systems, or your local representative for assistance.

1.10 Software Installation

On the 3.5" diskette provided with the Millennium controller there is a motion functions library called C-Motion. This library contains functions that are commands for the PMD motion processor installed in the Millennium controller. The user is responsible for writing a program to control motors motion and serving specific application. Below are samples of the functions to perform some basic moves.

1.11 First Time System Verification

To verify that the Millennium board has been properly installed, it is useful to have each axis of the system perform a short move.

For the MC2100 parts to perform this simple sequence it is necessary to specify two items; the motor amplifier type (PWM sign/mag, PWM 50/50, or analog), and the filter gains. For the MC2300 parts it is necessary to specify these two items as well as initialize the motor commutation.

The following table summarizes this. Note that the step #'s reference specific steps which are detailed in the next section.

Chipset	Step #	Operation
MC2100	1	Set amplifier type (PWM sign/mag, PWM 50/50, DAC)
	4	Set filter parameters
	5	Make a trajectory move
MC2300	1	Set amplifier type (PWM 50/50, DAC)
	2	initialize commutation
	3	Check Commutation
	4	Set filter parameters
	5	Make a trajectory move

Only perform the setup step sequences indicated above for the chipset installed on your board.

To start verification use the following Navigator commands

SetActualPosition 0

Update

SetKp 25

Refer to the Programmers Reference for a full list of commands.

It is assumed that you will check out each axis of your system one at a time. Then to check out other axes enter a new axis number and check that axis out entirely, etc...

1.11.1 Step #1 set the motor amplifier type

The chipset must be told what type of motor output mode to use, PWM sign/mag, PWM 50/50, or DAC. This can be set using the command SetOutputMode. Assuming the axis you want to exercise

is #1, you would use the command "SetOutputMode" followed by the output mode; 0 for DAC, 1 for PWM sign/mag, and 2 for PWM 50/50. For example to specifiy the output mode as PWM 50/50 the following command would be used:

SetOutputMode 2

1.11.2 step #2 initialize the commutation

--> THIS SECTION APPLIES TO THE MC2300 CHIPSETs ONLY.

For the motor to be controlled properly using the MC2300, the chipset must select and possibly initialize the commutation phasing. If you will be using Hall-based commutation then no initialization is necessary. Simply specify this to the chipset using the command:

SetCommutationMode 1

No other commands are necessary and you may proceed to step #3.

If you will be commutating using a sinusoidal technique you must initialize the commutation phasing. There are two ways this can be done. You will need to decide whether to initialize using Hall-based or algorithmic methods. See the Navigator User's Guide for more information on this.

Each of these two phase initialization methods requires a separate sequence, as follows (note that / / indicates a comment and should not be typed in):

Hall-based initialization command sequence:

```
SetPhaseInitializeMode 1        / / set phase initialize mode to 'Hall-based'
SetNumberPhases x               / / where x is 2 or 3 depending on type of motor
InitPhase
```

Algorithmic-based initialization command sequence:

```
SetPhaseInitializeMode 0        / / set phase initialize mode to 'algorithmic'
SetMotorMode 0                  / / places axis in open loop mode, required for algorithmic init.
SetNumberPhases x               / / x is 2 or 3 depending on type of motor
SetPhaseCounts yyyy             / / yyyy is # of encoder counts per elec. cycle
SetPhaseInitializeTime zzzz     / / zzzz is # of chipset cycles to initialize for
SetMotorCommand wwww            / / wwww is motor command.
InitPhase
```

To determine the values of x, yyyy, zzzz, and wwww you should refer to the Navigator User's Guide, "commutation" section.

If your system has one or more of the following conditions present then the above sequence will need to be expanded. To handle such systems you will need to use the SetSignalSense command as well as the SetPhasePrescale command. Call Cito Systems for assistance

1) One or more Hall signals must be inverted to commutate or initialize the commutation correctly

2) # of encoder counts per electrical cycle exceeds 32,767

1.11.3 Step #3 check commutation

--> THIS SECTION APPLIES TO THE MC2300 CHIPSETs ONLY.

After phase initialization has been completed it is useful to check the smoothness of the motor rotation in open loop mode to verify that the motor phasing initialization and commutation is correct. To do this use the following command sequence:

```
SetMotorMode 0              // set axis for open loop operation
SetMotorCommand xxxx        // xxxx is the motor command from 0 to 32,767 to output
Update
```

The 'xxxx' value represents the fraction of the value 32,768 of total power that will be applied to the motor. For example a value of 1,000 sends roughly 3 % of the total power to the motor.

When the motor mode is set off the motor is not under servo control. Beware that the motor may spin rapidly after a motor command value is applied. Use small values and increase slowly.

After this command sequence the motor should smoothly spin in one direction or the other. The motor command is a signed number and the sign controls the rotation direction. When a positive motor command is given the motor should rotate in the positive (increasing encoder counts) direction. If the motor spins roughly, in the wrong direction, or if it moves a short distance and then abruptly stops there may be a problem with the commutation. Check your wiring and re-test. Once the motor is spinning smoothly in both directions under open loop control re-enable closed-loop servo control by executing the following command:

```
SetMotorMode 1
```

1.11.4 Step #4 set filter parameters

For motion to occur, some amount of feedback gain must be specified. Initially use just a proportional gain with a very low value between 1 and 25. Later you can add integral or derivative gains as well as feedforward gains if desired. The following sequence shows how to set the P, I, and D terms of the filter and how to 'update' them, making them active.

```
SetKp xxxx                  // xxxx is the desired proportional gain
SetKd yyyy                  // yyyy is the desired derivative gain
SetKi zzzz                  // zzzz is the desired integral gain
Update                      // make thee values active.
```

It is not necessary to specify all 3 gains. Just Kp, followed by an Update can be specified, just a Kd, etc...

When exercising the motor use extreme caution. It is the responsibility of the user to observe safety precautions at all times.

1.11.5 Step #5 make a trajectory move

To test that the motor is being driven properly, set up and execute a small trapezoidal move. Specify a small distance of (for example) 5,000 counts, and a low velocity and acceleration of (for example) 10,000 counts/sample time, and 10 counts/sample time^2 respectively. With a cycle time of 400 uSec, these values correspond to roughly 381 counts/sec, and 954 counts/sec^2, respectively.

Whatever profile values you use, be sure that they are safe for your system.

Here is the command sequence to use:

```
SetProfileMode 0                    // Sets current profile mode to trapezoidal
SetPosition xxxx                // xxxxxxxx is the desired destination position
SetVelocity yyyyyyyy                // yyyyyyyy is the desired maximum velocity
SetAcceleration zzzzzzzz        // zzzzzzzz is the desired acceleration
SetDeceleration wwwwwwww            // wwwwwwww is the desired deceleration
Update                              // execute the move
```

After entering this sequence of commands you should see the axis smoothly move for about 15 seconds (if the suggested values are used and the cycle time of the chipset is 400 uSec)

If you do not see the axis moving, or if the axis jumps rapidly in one direction or the other, there may be a problem with the board or software settings. Re-check and review the board setup procedures, as well as the exerciser parameter settings.

If you are still having problems after re-checking your system call your Cito Systems representative.

2. Appendix A. Millennium Controller Electrical Reference

2.1 PCI-bus Millennium Controller Layout

Figure 2.1 shows the locations of the principal components of the Millennium controller board. The component side of the board is shown, with the PCI slot connector at the bottom. All component locations in this manual are referred to this orientation.

Jumper JP1 sets the Host I/O mode

Jumpers JP2 – JP5 set incremental encoder signal type

Jumpers JP6 & JP7 set high power digital output configuration

Jumpers JP10 – JP13 set analog input reference source

Jumpers JP14 & JP15 set committed I/O signals voltage supply source

Connectors J1, J2, J4, J5 and J7 are described in the second part of this manual

Resistor packs RS1 – RS3 are set according to the type of encoder used

Resistor packs R36 and R37 are set according to external power supply voltage of opto-isolated committed I/O signals used

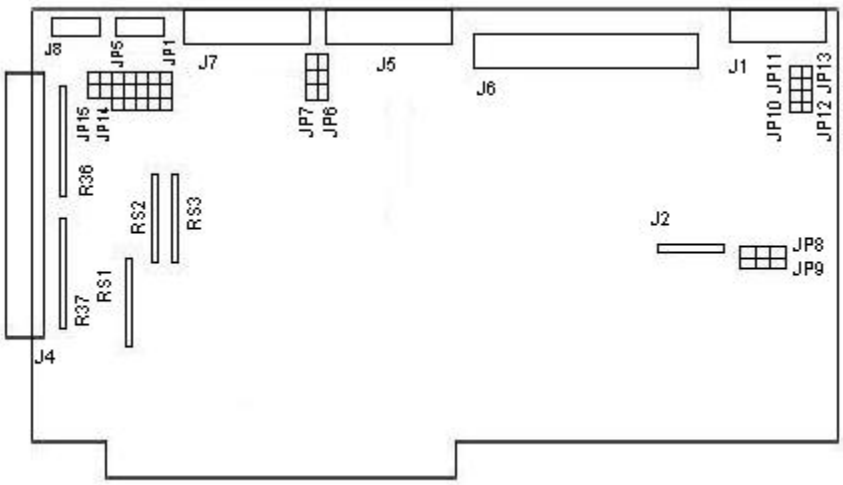


Figure 2-1. Millennium PCI-bus controller board layout

2.2 PCI-bus Millennium Controller Connectors

This section describes the pinouts for the following cable connectors on the Millennium motion control card (Figure 2-1):

J1 16-pin analog input signal connector

J2 5-pin serial diagnostic channel connector

J4 100-pin main connector containing encoder input, Hall input, Fault Input, Axis Out signals, Motor output signals, and limit switch inputs.

J5 20-pin user-defined digital I/O connector

J7 16-pin user-defined high power digital output connector

2.2.1 Analog input signal connector (J1)

Location: Along the upper edge, at the far right corner of the board.
This is a 16-pin header (2x13, 0.1” spacing).

Pin number	Signal Name	Pin number	Signal Name
1	Analog Input 1	9	AnalogRefHigh
2	Analog Input 2	10	AnalogRefLow
3	Analog Input 3	11	AnalogVcc
4	Analog Input 4	12	AnalogGND
5	Analog Input 5	13	5 Vcc
6	Analog Input 6	14	GND
7	Analog Input 7	15	Synch (internal use)
8	Analog Input 8	16	Hstint- (internal use)

2.2.2 Serial diagnostic channel connector (J2)

Location: At the right edge, in the middle, next to the JP8 & JP9
This is a 5-pin single row header (0.1” spacing).

Pin number	Signal Name
1	SrlXmt
2	SrlRcv
3	Synch
4	GND
5	V_{cc}

2.2.3 Motion peripherals connector (J4)

Location: On the left edge of the card.
This is a 100-pin high-density connector (2x50, 0.05” spacing). The accompanying cable assembly supplied with your controller board consists of two 36” flat ribbon cables terminating together at one end in the matching 100-pin connector. At the other end, each ribbon terminates in a 50-pin header (2x25, 0.1” spacing). The ribbons are labeled **Hdr1** and **Hdr2**. Pins 1-50 on Hdr1 connect to pins 1-50 of J4. Pins 1-50 of Hdr2 connect to pins 51-100 of J4.

Header 1 *(to J4 pins 1-50)*				**Header 2** *(to J4 pins 51-100)*			
First row		***Second row***		***Third row***		***Fourth row***	
Pin	**Signal Name**	**Pin**	**Signal Name**	**Pin**	**Signal Name**	**Pin**	**Signal Name**
1	QuadA1+	26	QuadA2+	1	QuadA3+	26	QuadA4+
2	QuadA1-	27	QuadA2-	2	QuadA3-	27	QuadA4-
3	QuadB1+	28	QuadB2+	3	QuadB3+	28	QuadB4+
4	QuadB1-	29	QuadB2-	4	QuadB3-	29	QuadB4-
5	Index1+	30	Index2+	5	Index3+	30	Index4+
6	Index1-	31	Index2-	6	Index3-	31	Index4-
7	V_{cc} (encoder)	32	V_{cc} (encoder)	7	V_{cc} (encoder)	32	V_{cc} (encoder)
8	GND (encoder)	33	GND (encoder)	8	GND (encoder)	33	GND (encoder)
9	Hall1A	34	Hall2A	9	Hall3A	34	Hall4A
10	Hall1B	35	Hall2B	10	Hall3B	35	Hall4B
11	Hall1C	36	Hall2C	11	Hall3C	36	Hall4C
12	GND (Hall)	37	GND (Hall)	12	GND (Hall)	37	GND (Hall)
13	PosLim1	38	PosLim2	13	PosLim3	38	PosLim4
14	NegLim1	39	NegLim2	14	NegLim3	39	NegLim4
15	Home1	40	Home2	15	Home3	40	Home4
16	Fault1	41	Fault 2	16	Fault 3	41	Fault 4
17	AxisOut1	42	AxisOut2	17	AxisOut3	42	AxisOut4
18	PWMMagA1	43	PWMMagA2	18	PWMMagA3	43	PWMMagA4
19	PWMMagB1	44	PWMMagB2	19	PWMMagB3	44	PWMMagB4
20	PWMMagC1	45	PWMMagC2	20	PWMMagC3	45	PWMMagC4
21	PWMsign1	46	PWMsign2	21	PWMsign3	46	PWMsign4
22	DACV1*	47	DACV2*	22	DACV3*	47	DACV4*
23	DACV1*	48	DACV2*	23	DACV3*	48	DACV4*
24	GND (DAC)	49	GND (DAC)	24	GND (DAC)	49	GND (DAC)
25	Opto VSS	50	Opto GND	25	Opto VSS	50	Opto GND

*DACV*n*, are mapped to two analog output signals for axis *n*. For non-phased chipset products (for example MC2401) this is an analog differential control output.

Note 1.

For MC2500 chipset series (stepper motor controllers) signals PWMMagA are used as Pulse and PWMMagC are used as Direction. The remaining motor signals are not connected.

2.2.4 User-defined digital I/O connector (J5)

Location: Along the upper edge, second from the left right angle connector.

This is a 20-pin header (2x10, 0.1" spacing).

Pin number	Signal Name	Pin number	Signal Name
1	PrlIn0	10	PrlOut4
2	PrlOut0	11	PrlIn5
3	PrlIn1	12	PrlOut5
4	PrlOut1	13	PrlIn6
5	PrlIn2	14	PrlOut6

Pin number	Signal Name	Pin number	Signal Name
6	PrlOut2	15	PrlIn7
7	PrlIn3	16	PrlOut7
8	PrlOut3	17, 19	GND
9	PrlIn4	18, 20	Vcc

Note 2.

PrlOut*n* output signals are overlapped by high power output signals of the J7 connector. They can be used when high power logic signals are not desirable to be used e.g. interfacing to CMOS or TTL logic.

2.2.5 User-defined digital I/O connector (J7)

Location: Along the upper edge, first from the left right angle connector.

This is a 16-pin header (2x10, 0.1" spacing).

Pin number	Signal Name	Pin number	Signal Name
1	PrlOut0	9	PrlOut4
2	+VS	10	Pwr GND
3	PrlOut1	11	PrlOut5
4	+VS	12	Pwr GND
5	PrlOut2	13	PrlOut6
6	+VS	14	Pwr GND
7	PrlOut3	15	PrlOut7
8	+VS	16	Pwr GND

Note 2.

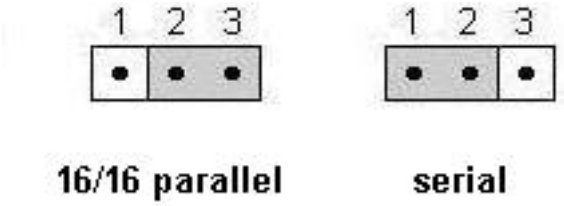
PrlOut*n* output signals overlap digital output signals of the J5 connector. They can be used to control relays, solenoids, lamps, LED, etc. +VS is a supply voltage that can range from +5 to +50 VDC and allowing do derive max. 500 mA current from each output.

2.3 PCI-bus Millennium Controller Jumpers Settings

2.3.1 Setting the Host I/O mode – JP1

The PCI-bus motion controller supports two different communication modes.

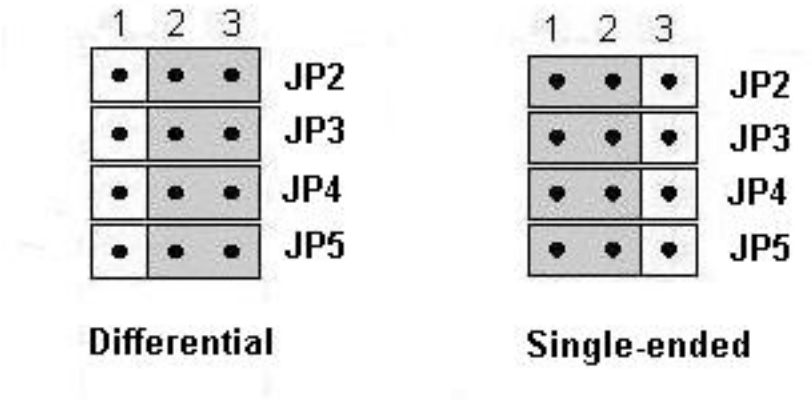
The figure below shows how the JP1 jumper should be installed to select the host mode. 16/16-bit mode is the default. Shading indicates the location of the jumper.



The default HOST I/O mode setting is "16/16 parallel"

2.3.2 Setting the incremental encoders input signal – JP2 - JP5

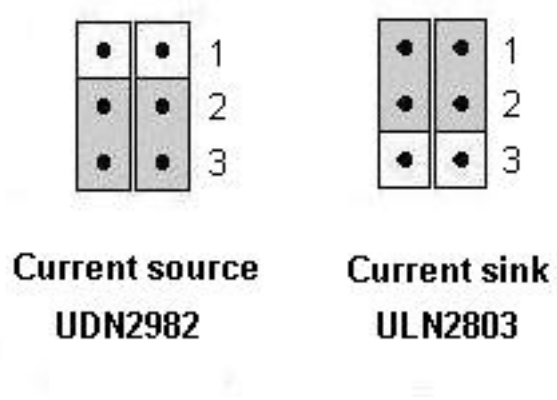
The Millennium series controllers support differential or single-end incremental encoder outputs. The figure below shows how JP2 – JP5 jumpers should be installed to select the encoder output signal.



The default incremental encoder output signal setting is "Differential"

2.3.3 Setting the high power digital output – JP6 & JP7

The PCI-bus motion board provides high voltage high current digital signals on the J7 connector. These output signals can work either as current sink with ULN2803 or current source with UDN2982. It is up to customer order, what type of output driver should be installed. The figure below shows how JP6 & JP5 jumpers should be installed to select the digital output configuration.



The default high power digital output signal setting is "current source"

2.3.4 Setting the analog input voltage reference source - JP10 - JP13

The PCI-bus motion controller supports analog input signals on the J1 connector. The reference voltage is provided internally as +5 VDC or can be supplied from an external source. If the board internal reference source is used, the jumpers JP10, JP11, JP12 & JP13 should be installed, otherwise they must be removed.

The default analog input voltage reference source setting is "Internal"

2.3.5 Setting the committed I/O signal voltage supply source – JP14 - JP15

The PCI-bus motion controllers use opto-isolation on the HOME, LIM"-", LIM"+" and FAULT dedicated input signals. For applications that do not demand opto-isolation the internal +5VDC supply voltage can be used, otherwise an external power supply voltage has to be applied. If the board internal supply voltage is used, the jumpers JP14 & JP15 should be installed, otherwise they must be removed.

The default committed I/O signal voltage supply source setting is "Internal"

Note:
Jumpers JP8 & JP9 should follow the factory setting – JP8 installed on 1&2 and JP9 removed.

2.4 Outputs to Motor Amplifiers

The controller board supports three types of output to the motor amplifiers:

DAC	Analog signals from the on-board D/A converters
PWM 50/50	Pulse-width modulated square-wave signals with a 50% duty cycle
PWM sign-magnitude	Pulse-width modulated signals with definable duty cycle and direction

These outputs should be connected from the designated J4 pins to the appropriate amplifier inputs, as shown in the following tables. The names of the inputs pins may vary among amplifiers; common names are shown.

2.4.1 DAC Outputs

Tuning potentiometers P1 – P8
These tunable pots are at the left edge of the controller board.

2.5 Brushed Servo Motors (MC2100 series)

			J4 connection (Header-pin)			
	Signal name	**Amplifier input**	**Axis 1**	**Axis 2**	**Axis 3**	**Axis 4**
DAC	DACA*n*	Ref+ or V+	Hdr1-22	Hdr1-47	Hdr2-22	Hdr2-47
	GND*n*	Ref- or Gnd	Hdr1-24	Hdr1-49	Hdr2-24	Hdr2-49
PWM sign-magnitude	PWMMagA*n*	PWM magnitude	Hdr1-18	Hdr1-43	Hdr2-18	Hdr2-43
	PWMSignA*n*	PWM direction	Hdr1-21	Hdr1-46	Hdr2-21	Hdr2-46

2.6 Brushless Servo Motors (MC2300 series)

			J4 connection (Header-pin)			
	Signal name	**Amplifier input**	**Axis 1**	**Axis 2**	**Axis 3**	**Axis 4**
DAC	DACA*n*	Ref1+ or V1+	Hdr1-22	Hdr1-47	Hdr2-22	Hdr2-47
	DACB*n*	Ref2+ or V2+	Hdr1-23	Hdr1-48	Hdr2-23	Hdr2-48
	GND*n*	Ref- or Gnd	Hdr1-24	Hdr1-49	Hdr2-24	Hdr2-49
PWM 50/50	PWMMagA*n*	PWM phase 1	Hdr1-18	Hdr1-43	Hdr2-18	Hdr2-43
	PWMMagB*n*	PWM phase 2	Hdr1-19	Hdr1-44	Hdr2-19	Hdr2-44
	PWMMagC*n*	PWM phase 3	Hdr1-20	Hdr1-45	Hdr2-20	Hdr2-45

2.7 Microstepping Motors (MC2400 series)

			J4 connection (Header-pin)			
	Signal name	**Amplifier input**	**Axis 1**	**Axis 2**	**Axis 3**	**Axis 4**
DAC	DACA*n*	Ref1+ or V1+	Hdr1-22	Hdr1-47	Hdr2-22	Hdr2-47
	DACB*n*	Ref2+ or V2+	Hdr1-23	Hdr1-48	Hdr2-23	Hdr2-48
	GND*n*	Ref- or Gnd	Hdr1-24	Hdr1-49	Hdr2-24	Hdr2-49
PWM 50/50	PWMMagA*n*	PWM phase 1	Hdr1-18	Hdr1-43	Hdr2-18	Hdr2-43
	PWMMagB*n*	PWM phase 2	Hdr1-19	Hdr1-44	Hdr2-19	Hdr2-44
	PWMMagC*n*	PWM phase 3	Hdr1-20	Hdr1-45	Hdr2-20	Hdr2-45

2.8 Stepper Motors (MC2500 series)

			J4 connection (Header-pin)			
	Signal name	**Amplifier input**	**Axis 1**	**Axis 2**	**Axis 3**	**Axis 4**
Pulse/Direction	Pulse*n* Direction*n*	Pulse train Direction signal	Hdr1-18 Hdr1-20	Hdr1-43 Hdr1-45	Hdr2-18 Hdr2-20	Hdr2-43 Hdr2-45

2.9 Encoder Inputs

Resistor packs RS1 – RS3

The three resistor packs are at the right end of the controller board, next to the 100-pin connector J4. When using differential encoders, leave these packs in place. When using open-ended encoders, remove all three packs. Encoder connections are shown in Appendix B.

J4 pin connections

	Axis 1	**Axis 2**	**Axis 3**	**Axis 4**
A	Hdr1-1	Hdr1-26	Hdr1-51	Hdr1-76
~A	Hdr1-2	Hdr1-27	Hdr1-52	Hdr1-77
B	Hdr1-3	Hdr1-28	Hdr1-53	Hdr1-78
~B	Hdr1-4	Hdr1-29	Hdr1-54	Hdr1-79
Index	Hdr1-5	Hdr1-30	Hdr1-55	Hdr1-80
~Index	Hdr1-6	Hdr1-31	Hdr1-56	Hdr1-81
V_{cc}	Hdr1-7	Hdr1-32	Hdr1-57	Hdr1-82
GND	Hdr1-8	Hdr1-33	Hdr1-58	Hdr1-83

2.10 Opto-isolated committed inputs

Resistor packs R36 & R37

The three resistor packs are at the left end of the controller board, next to the 100-pin connector J4. When using opto-isolation of committed input signals – the fault, home and limit switches powered by an external power supply appropriate values need to be installed. The table below shows the resistor packs values corresponding to different external power supply voltage levels applied.

External supply voltage (+VS)	**Resistor value**
5V	330 Ω
12-14V	1.2kΩ
24V	2.2 kΩ
48V	4.7kΩ

The default factory setting is 2.2kOhm for 24V external supply voltage.

3. PCI-bus Millennium Controller Signal Connections

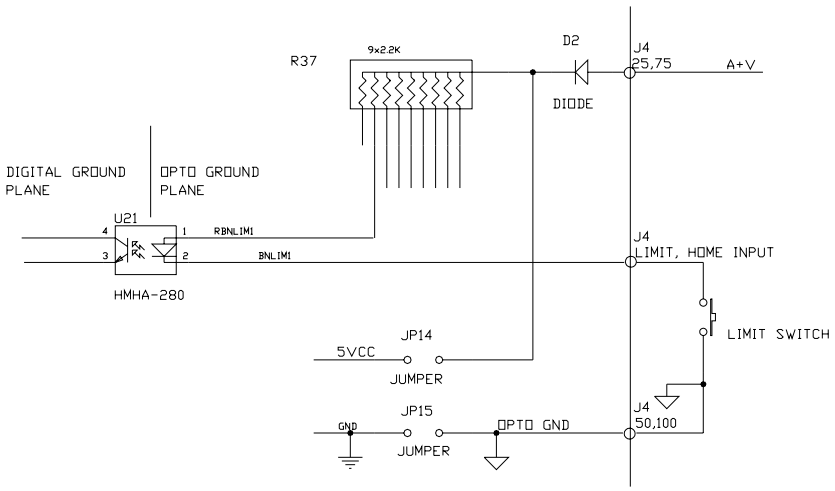


Fig. 3.1. Connecting dedicated inputs of limit and home switches to the controller.

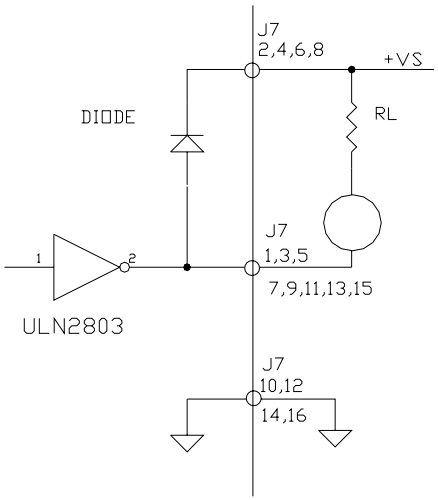


Fig 3.2. Connecting outputs in a version of ULN2803 through ULN2824 high current sinking driver – J7 connector.

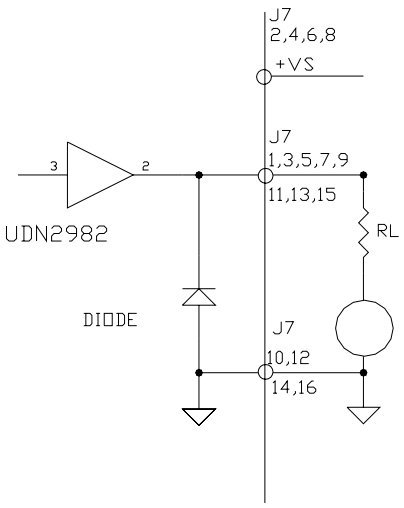


Fig 3.3. Connecting outputs in a version of UDN2981 through UDN2984 high current sourcing driver – J7 connector.

4. PCI-bus Millennium Controller Hardware Information

Environmental and Electrical Ratings

All ratings and ranges are for both the I/O and CP chips.

Dimensions	8.3” x 4.1” (210 mm x 105 mm), PCI Adapter
Storage Temperature	-40 °C to 125 °C
Operating Temperature	0 °C to 70 °C*
Power Consumption	1A @ 5V; 83mA @ 12V
Supply Voltage limits	-0.3V to +7.0V
Supply Voltage operating range	4.75V to 5.25V
High power digital output supply voltage range	5.0V to 50.0V
Max. current derived from high power digital I/O	500 mA with variable cycle, 300 mA constant
Analog Output range	-10.0V to 10.0V
Analog Input range	0.0V to 5.0V