Millennium Series Motion Controllers

User's Manual

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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 3m-0x-xx board for the PC system and motor hardware that you will connect it to. Configuration of the 3m-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 "3m-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 PC 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 16-bit ISA 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 16-bit ISA 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 3m-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 3m-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
ISA bus I/O Address	switch bank S1, 1-4	340 (hex)
ISA bus IRQ #	switch bank S1, 5-8	IRQ disabled
Host interface mode	jumpers JP8, JP9	16/16 parallel

In a normal installation only the ISA bus I/O address and IRQ # are changed. The host interface mode jumpers will not need to be changed unless it is desired that the card be operated in serial mode, or if one of the 8 bit parallel communication modes will be used.

The following diagram shows the location of the switch bank S1 and jumpers JP8, JP9

Figure 1-1. Settable jumpers and switch blocks

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 three sections explains more about these settings.

1.4.1 Setting the ISA bus I/O address

Most PCs use the I/O address space between 300 (hex) and 400 (hex) for general purpose peripherals such as the 3m-0x-xx motion board. Each extra peripheral typically occupies addresses within this space These addresses should be used by only one installed peripheral.

The model 3m-0x-xx occupies 16 consecutive I/O addresses on the PC bus, starting at the "base address", and ending at the base address+f (hex). For example for the default base address, which is 340 (hex), the total used range of addresses is 340 (hex) - 34f (hex).

The I/O port base address should be chosen so that it doesn't conflict with any other devices using addresses in the range 300h-3FFh. Certain of these addresses are reserved for specific peripherals, as shown in the following table (not all will be present in a given system):

Port address	Device
300-377h	*available*
378-37Fh	LPT1
380-3Afh	*usually available*
3B0-3DFh	VGA
3E0-3E7h	*available*
3E8-3Efh	COM3
3F0-3F7h	Hard disk controller
3F8-3FFh	COM1

Switch block S1, switches 1 - 4 determine the ISA bus base address. S1 is oriented horizontally on the Millennium motion board. In the table below switches which should be on (or up) are indicated as such. A blank space in the table indicates the switch should be set off (or down).

Address	S1-1	S1-2	S1-3	S1-4
300h	on	on	on	on
310h		on	on	on
320h	on		on	on

330h			on	on
340h	on	on		on
350h		on		on
360h	on			on
370h				on
380h	on	on	on	
390h		on	on	
3A0h	on		on	
3B0h			on	
3C0h	on	on		
3D0h		on		
3E0h	on			
3F0h				

The default I/O port address is 340 hex (1-4: on, on, off, on)

For more detailed info on the I/O addresses used by the motion controller board, see Appendix A, "Millennium Controller Electrical Reference".

1.4.2 Setting the IRQ number

The Millennium board allows the motion chipset's HostIntrpt signal (used by the chipset to signal special events) to generate a PC interrupt that can be processed by interrupt handling routines in the PC-based control software. The specific interrupt (IRQ) that is generated can be programmed on the Millennium board using S1, switches #5-8. The PC interrupt is generated when the chipset's HostIntrpt signal transitions from high to low.

The table below shows the IRQs that are selectable and the associated S1 switch settings. If no IRQ generation is desired than the "IRQ disabled" option should be selected. A blank space in the table indicates the switch should be off (down).

IRQ #	S1-5	S1-6	S1-7	S1-8
3	on	on	on	on
5		on	on	on
7	on		on	on
10			on	on
11	on	on		on
12		on		on
14	on			on
15				on
IRQ disabled				

The default IRQ setting is "IRQ disabled"

1.4.3 Setting the Host I/O mode

The Navigator chipsets support four different communication modes. This is shown in the table below:

Mode	**Description**
16-bit mode (16/16)	The motion processor accepts instructions and data as full 16-bit words, using the entire 16-bit data path.
1st gen compatible mode (8/8)	Only backwards compatible instructions are accepted using an 8-bit data path. This mode can be used with software written for 1st gen products such as the MC1401A but should not be used with new Navigator development projects.
8-bit mode (8/16)	The motion processor accepts instructions and data as full 16-bit words, however using an 8-bit data path.
serial port	The motion processor accepts instructions through an asynchronous serial port.

mode is the default. Shading indicates the location of the jumper.

Figure 1-2. Settings for Host interface mode
Error! No topic specified.

1.5 3m-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)	Analog out (DAC output)
Other Control Signals: (per axis)	Home signal channel input Positive limit switch input Negative limit switch input AxisIn 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 3m-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)

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 AxisIn 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 3m-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 AxisIn 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

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 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 ISA slot connector at the bottom. All component locations in this manual are referred to this orientation. In figure 2.1, the Motion Processor's CP chip and I/O chip are identified for reference. All other components of interest to the user are identified by their board label:

- Jumpers JP8 and JP9 set the Host I/O mode
- Switch block S1 sets the I/O port address and IRQ for ISA-bus operation in a PC
- Switch blocks S2 and S3 set the serial interface configuration and multi-drop address
- Connectors J4, J7, J8, J9, and J10 are described in the second part of this manual
- Resistor packs RS1 – RS3 are set according to the type of encoder used
- Tuning potentiometers P1 – P8 are used to adjust zero-voltage levels for the analog outputs
-

Figure 2-1. Millennium controller board layout

2.2 Millennium Controller Connectors

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

J4 5-pin serial diagnostic channel connector

J7 100-pin main connector containing encoder input, Hall input, Fault Input, Axis Out signals, Motor output signals, and limit switch inputs.

J8 20-pin user-defined digital I/O connector

J9 26-pin Analog/Drive chip connector

J10 3-pin 12V power connector

Figure 2-2. Millennium controller board connector locations

2.2.1 Serial diagnostic channel connector (J4)

Location: Upper right corner, next to the indicator LED.

This is a 5-pin single row header (0.1" spacing).

Pin number	Signal Name
1	SrlXmt (CP pin 44)
2	SrlRcv (CP pin 43)
3	Synch (JP1 pin 2)
4	GND
5	V_{cc}

2.2.2 Motion peripherals connector (J7)

Location: On the right 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 J7. Pins 1-50 of Hdr2 connect to pins 51-100 of J7.

Header 1 *(to J7 pins 1-50)*				**Header 2** *(to J7 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	AxisIn1	41	AxisIn2	16	AxisIn3	41	AxisIn4
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	DACA1*	47	DACA2*	22	DACA3*	47	DACA4*
23	DACB1*	48	DACB2*	23	DACB3*	48	DACB4*
24	GND (DAC)	49	GND (DAC)	24	GND (DAC)	49	GND (DAC)
25	N.C.	50	N.C.	25	N.C.	50	N.C.

*DACA*n*, DACB*n* are mapped to two analog output signals for axis *n*. For non-phased chipset products (for example MC2401) DACB1 will not be used.

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.

2.2.3 User-defined digital I/O connector (J8)

Location: Along the upper edge, directly above the I/O chip.

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

2.2.4 Analog/drive chip connector (J9)

Location: Along the upper edge, directly above the CP chip and directly to the left of J8.

This is a 26-pin header (2x13, 0.1" spacing).

Pin number	Signal Name	Pin number	Signal Name
1	Analog1 (CP pin 74)	14	AnalogRefLow (CP pin 86)
2	Analog2 (CP pin 89)	15	AnalogGND (CP pin 87)
3	Analog3 (CP pin 75)	16	AnalogGND (CP pin 87)
4	Analog4 (CP pin 88)	17	AnalogVcc (CP pin 84)
5	Analog5 (CP pin 76)	18	GND
6	Analog6 (CP pin 83)	19	GND
7	Analog7 (CP pin 77)	20	Vcc
8	Analog8 (CP pin 82)	21	AxisOut1 (CP pin 94)
9	AnalogIn1 (CP pin 78)	22	AxisOut2 (CP pin 95)
10	AnalogIn2 (CP pin 79)	23	AxisOut3 (CP pin 96)
11	AnalogIn3 (CP pin 80)	24	AxisOut4 (CP pin 97)
12	AnalogIn4 (CP pin 81)	25	Watchdog (CP pin 99)
13	AnalogRefHigh (CP pin 85)	26	~HostIntrpt (CP pin 98)

2.2.5 12V power connector (J10)

Pin	Signal
1	+12V
2	GND
3	-12V

2.3 Host I/O Mode

2.3.1 Millennium Controller Configuration Jumpers and Switch Blocks

Settable jumpers and switch blocks are shown in Figure 1.1.

All other jumpers should be left in their factory settings.

2.3.2 Configuration jumpers JP8 and JP9

Error! No topic specified.

These jumpers are used to set the host interface mode, as shown in Figure 2-3 (the shadowed area indicates the position of the jumper):

2.4 ISA Bus

2.4.1 I/O Port Address and IRQ Selection

The I/O port base address should be chosen so that it doesn't conflict with any other devices using addresses in the range 300h-3FFh. Certain of these addresses are reserved for specific peripherals, as shown in the following table (not all will be present in a given system):

Port address	Device
300-377h	*available*
378-37Fh	LPT1
380-3AFh	*usually available*
3B0-3DFh	VGA
3E0-3E7h	*available*
3E8-3EFh	COM3
3F0-3F7h	Hard disk controller
3F8-3FFh	COM1

To determine the available addresses on your system, run the utility "Fimmagewurbly.exe" on the supplied disk.

2.4.2 DIP switch block S1

Switch block S1 is oriented horizontally on the controller board; **on** is up.

S1 switches 1-4: base I/O address

Address	S1-1	S1-2	S1-3	S1-4
300h	′	′	′	′
310h	≤	′	′	′
320h	′	≤	′	′
330h	≤	≤	′	′
340h	′	′	≤	′
350h	≤	′	≤	′
360h	′	≤	≤	′
370h	≤	≤	≤	′
380h	′	′	′	≤
390h	≤	′	′	≤
3A0h	′	≤	′	≤
3B0h	≤	≤	′	≤
3C0h	′	′	≤	≤
3D0h	≤	′	≤	≤
3E0h	′	≤	≤	≤
3F0h	≤	≤	≤	≤

S1 switches 5-8: IRQ

IRQ	S1-5	S1-6	S1-7	S1-8
3	≤	≤	≤	′
5	′	≤	≤	′
7	≤	′	≤	′

10	′	′	≤	′
11	≤	≤	′	′
12	′	≤	′	′
14	≤	′	′	′
15	′	′	′	′
IRQ disabled	–	–	–	≤

2.5 Serial Port

2.5.1 DIP switch block S2 and S3

These switch blocks are oriented vertically on the controller board; **on** is to the right.

5.1.1 S2: Transmission parameters

Switch block S2 sets the transmission rate, parity, stop bits, and protocol. Switch block S3 selects the device address when using the multi-drop protocol.

	S2-1	S2-2	S2-3	S2-4	S2-5	S2-6	S2-7	S2-8
1200	≤	≤	≤	≤				
24	00	′	≤	≤		≤		
	96	00	≤	′		≤		≤
	1	92	00	′		′		≤
		5	76	00		≤		≤
			1	15	2	0	0	
≤				2	3	0	4	0
′≤						3	4	5
′	′		′		≤			
e			≤		≤			
dd			′		≤			
E v	e	n						<
			<					
′								
oint-to-poi	n	t						

≤

5.1.2 S3: Serial device address

Switch block S3 sets the device address for multi-drop protocol systems.

Multi-drop Address Selection (SW3)

Address	Pin 1	Pin 2	Pin 3	Pin 4	Pin 5
0	≤	≤	≤	≤	≤
1	′	≤	≤	≤	≤
2	≤	′	≤	≤	≤
3	′	′	≤	≤	≤
4	≤	≤	′	≤	≤
5	′	≤	′	≤	≤
6	≤	′	′	≤	≤
7	′	′	′	≤	≤
8	≤	≤	≤	′	≤
9	′	≤	≤	′	≤
10	≤	′	≤	′	≤
11	′	′	≤	′	≤
12	≤	≤	′	′	≤
13	′	≤	′	′	≤
14	≤	′	′	′	≤
15	′	′	′	′	≤
16	≤	≤	≤	≤	′
17	′	≤	≤	≤	′
18	≤	′	≤	≤	′
19	′	′	≤	≤	′
20	≤	≤	′	≤	′
21	′	≤	′	≤	′
22	≤	′	′	≤	′
23	′	′	′	≤	′
24	≤	≤	≤	′	′
25	′	≤	≤	′	′
26	≤	′	≤	′	′
27	′	′	≤	′	′
28	≤	≤	′	′	′
29	′	≤	′	′	′
30	≤	′	′	′	′
31	′	′	′	′	′

2.6 Stand Alone Operation

12V connector

5V and Serial Port connector

2.7 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 J7 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.

2.7.1 DAC Outputs

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

2.8 Brushed Servo Motors (MC2100 series)

			J7 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

2.9 Brushless Servo Motors (MC2300 series)

			J7 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

2.10 Microstepping Motors (MC2400 series)

			J7 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

2.11 Stepper Motors (MC2500 series)

			J7 connection (Header-pin)			

	J7 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

3 Millennium Controller Hardware Information

3.1 Environmental and Electrical Ratings

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

Dimensions	4.8” x 10.0”, 16-bit ISA 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
Analog Output range	-10.0V to 10.0V
Analog Input range	0.0V to 5.0V