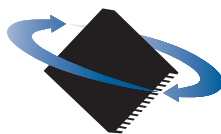


Prodigy™-PC/104 Motion Board

User Guide



**PERFORMANCE
MOTION DEVICES**

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Related Documents

Magellan Motion Control IC User Guide


Complete description of the Magellan Motion Control IC features and functions with detailed theory of its operation.

Magellan Motion Control IC Programming Reference

Descriptions of all Magellan Motion Control IC commands, with coding syntax and examples, listed alphabetically for quick reference.

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1. Installation

In This Chapter

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- ▶ Prodigy-PC/104 Developer Kit
- ▶ Accessory Products
- ▶ Installation Sequence
- ▶ Recommended Hardware
- ▶ Software Installation
- ▶ Preparing the Board for Installation
- ▶ Connection Summary for Prodigy-PC/104 Motion Boards
- ▶ Applying Power
- ▶ First-Time System Verification

1.1 Prodigy-PC/104 Motion Boards Overview

The Prodigy-PC/104 Motion Boards are high-performance PC/104-bus boards which provide motion control for DC brush, brushless DC, microstepping, and step (pulse & direction) motors. These boards are based on PMD's Magellan Motion Control ICs, which perform motion command interpretation and many other real-time functions.

The following product selector table shows the relationship between board part numbers (Prodigy-PC/104 Motion Board P/N), Magellan Motion Control IC part numbers contained on the board (Magellan P/N), the number of axes supported, and the type of motors supported. In the motor type column in the following table, "all motor types" refers to DC brush, brushless DC, microstepping, and step (pulse & direction) motors.

Prodigy-PC/104 Motion Board P/N	Magellan P/N	Number of Axes	Motor Type
PR8258120	MC58120	1	All motor types
PR8258220	MC58220	2	All motor types
PR8258320	MC58320	3	All motor types
PR8258420	MC58420	4	All motor types
PR8255120	MC55120	1	Step (pulse & direction) only
PR8255220	MC55220	2	Step (pulse & direction) only
PR8255320	MC55320	3	Step (pulse & direction) only
PR8255420	MC55420	4	Step (pulse & direction) only

1.1.1 Prodigy-PC/104 Motor Types

Here is additional information on the different motor types supported by Prodigy-PC/104 boards.

DC Brush: output is a single-phase motor command; either in PWM (pulse width modulated), or analog ($\pm 10V$) output format. They are intended to control DC brush motors, or brushless DC motors using an amplifier which performs commutation.

Brushless DC: provides multi-phase motor command signals, either in PWM (pulse width modulated), or analog ($\pm 10V$) output format, using Hall-based or sinusoidal commutation. The output is intended to interface with brushless DC amplifiers and motors.

Microstepping: output is multi-phase analog ($\pm 10V$) or PWM (pulse width modulation) waveforms. They are designed to control 2- or 3-phase step motors using amplifiers which accept this command format.

Pulse & direction: output is standard pulse & direction signals, and are intended to interface with amplifiers which accept this command format.

For complete information on motor output formats and other information, see *the Magellan Motion Control IC User Guide*.

1.2 Prodigy-PC/104 Developer Kit

To facilitate initial system development and integration, PMD offers a developer kit for Prodigy-PC/104 Motion Boards. The Prodigy-PC/104 Developer Kit includes a complete Prodigy-PC/104 board and the following software and accessory products are also included:

- Pro-Motion Windows-based exercisor software
- C-Motion SDK
- PDFs of all Prodigy documentation
- Cable-2003 50-pin ribbon cable for connecting the board to external motion components

The table below provides additional information about the Prodigy-PC/104 Developer Kit that you may find useful.

Prodigy-PC/104 Board			
DK Part Number	Included	# Axes	Motors Supported
PRK8258420	PR8258420	4	Brushless DC DC Brush Step Motor (microstepping) Step Motor (pulse & direction)

1.3 Accessory Products

The Prodigy-PC/104 Motion Boards can be enhanced with the addition of the following hardware accessory products.

Component Part Number	Description
Cable-2003	50-pin ribbon cable.
IM-1000	Breakout interconnect module that provides convenient jack-screw type terminators for the 100-pin cable. Used with cable-1003 or cable-1006.
Cable-4003	3-foot-long RS232 cable that connects to the serial connector. This cable allows serial RS232 communication to the PC/104 board. Only used if serial port communication is required.

For information on ordering these accessory products, please contact your PMD representative.

1.4 Installation Sequence

- 1 Before using the board, the software must be installed. Installation of the software is described in [Section 1.6, “Software Installation.”](#) Conventions in this manual refer to a Windows-based system with a PC/104 bus, or with an ISA to PC/104 converter device. Such converters are available from a number of vendors.
- 2 For a normal installation of a Prodigy-PC/104 Motion Board, you will need to configure the board for the specific motor hardware to which it will be connected. Configuration of the Prodigy-PC/104 Motion Boards is described in detail in [Section 1.7, “Preparing the Board for Installation.”](#)
- 3 Next, connect the system’s motors, encoders, amplifiers, and sensors to operate the motion hardware. A description of the available connections and options for the Prodigy-PC/104 Motion Board is found in [Section 1.8, “Connection Summary for Prodigy-PC/104 Motion Boards.”](#)
- 4 Once this hardware configuration is complete, the final step to finish the installation is to perform a functional test of the finished system. This procedure is described in [Section 1.10, “First-Time System Verification.”](#)

Once these steps have been accomplished, the installation is complete, and the board is ready for operation.

1.5 Recommended Hardware

To install a Prodigy-PC/104 Motion Board, the following hardware is recommended.

- 1 Intel (or compatible) processor, 1 Gbyte of available disk space, 256 MB of available RAM, and a CD ROM drive. The supported PC operating systems are Windows XP, Vista, Windows 7, and Windows 8.
- 2 One to four pulse and direction, PWM, or analog-input amplifiers. The type of amplifier depends on the type of motor being used.
- 3 One to four step motors or DC brush and brushless DC motors. These motors may or may not provide encoder position feedback signals, depending on the type of motor being used. Encoder feedback is a requirement for DC brush and brushless DC motors; for step motors, it’s an option.
- 4 Additional connectors as required to connect the Prodigy-PC/104 Motion Board to the amplifiers and the motors. Two 50-pin header-type connectors will be required, and the PR82582x0 boards will require an additional 50-pin connector. See [Section 3.3, “Connections Summary—Motor Amplifiers,”](#) for more information on setting up these connections.

1.6 Software Installation

The software distribution for the Prodigy-PC/104 board developer kit is downloaded from the PMD website at the URL: <https://www.pmdcorp.com/resources/software>.

All software applications are designed to work with Microsoft Windows.

To install the software:

- 1 Go to the Software Downloads section of PMD’s website located at <https://www.pmdcorp.com/resources/software> and select download for "Developer Kit Software"
- 2 After selecting download you will be prompted to register your DK and provide information about you and your motion application.
- 3 After selecting submit the next screen will provide a link to the software download. Select this link and downloading will begin.

- 4 Once the download is complete extract the zip file and execute the desired install programs from the list below. Every first-time installation should install Pro-Motion, and at least one of the two SDK options. However you may install both SDKs if desired. When installing the SDKs you will be given the option to download the documentation and/or the complete SDK content.

- Pro-Motion – an application for communicating to, and exercising PMD ICs, modules, or boards.
- PMD SDK – a software development kit for creating motion applications using the C/C++ programming languages. Also contains PDF versions* of all PMD product documentation.
- CME SDK – a software development kit for creating motion applications using the .NET (C#, VB) programming languages. Also contains PDF versions* of all PMD product documentation.

*Adobe Acrobat Reader is required for viewing these files. If the Adobe Acrobat Reader is not installed on your computer, it may be freely downloaded from <http://www.adobe.com>.

Here is more information on each of these software packages:

1.6.1 Pro-Motion

Pro-Motion is a sophisticated, easy-to-use exerciser program which allows all Prodigy board parameters to be set and/or viewed, and allows all features to be exercised. Pro-Motion features include:

- Motion oscilloscope graphically displays processor parameters in real-time
- AxisWizard to automate axis setup and configuration
- Position loop and current loop auto-tuning
- Project window for accessing motion resources and connections
- Ability to save and load settings
- Distance, time, and electrical units conversion
- Frequency sweep and bode plot analysis tools
- Motor-specific parameter setup
- Axis shuttle performs continuous back and forth motion between two positions

1.6.2 C-Motion

C-Motion provides a convenient set of callable routines comprising the C language code required for controlling Prodigy boards. C-Motion includes the following features:

- Magellan axis virtualization
- Ability to communicate to multiple PMD motion cards or modules
- Ability to communicate via PC/104 bus, serial, CANbus, Ethernet, SPI (Serial Peripheral Interface), or 8/16 bit parallel bus
- Provided as source code, allowing easy compilation & porting onto various run-time environments including a PC, microprocessor, embedded card, or C-Motion Engine
- Can be easily linked to any C/C++ application

C-Motion is described in the *Magellan Motion Control IC Programming Reference*.

1.6.3 .NET Language Support

A complete set of methods and properties is provided for developing applications in Visual Basic and C# using a dynamically loaded library (DLL) containing PMD library software. The DLL may also be used from any language capable of calling C language DLL procedures, such as Labview, but no special software support is provided.

Includes the following features:

- Magellan axis virtualization
- Ability to communicate to multiple PMD motion cards or modules
- Ability to communicate via PCI bus, serial, CANbus, or Ethernet
- Provided as a single DLL and Visual Basic .NET source code for easy porting onto various PC environments

VB Motion is documented in the *PMD Resource Access Protocol Programming Reference*.

1.7 Preparing the Board for Installation

Figure 1-1 shows the location of the resistor packs RS1, RS2, RS3, along with other components such as jumpers and connectors. The front or top side of the board is shown, with the main-PC/ PC/104 connectors at the bottom. Figure 1-2 shows the bottom or back side of the PC/104 board. The components and connectors for both sides of the board are detailed on page 14.

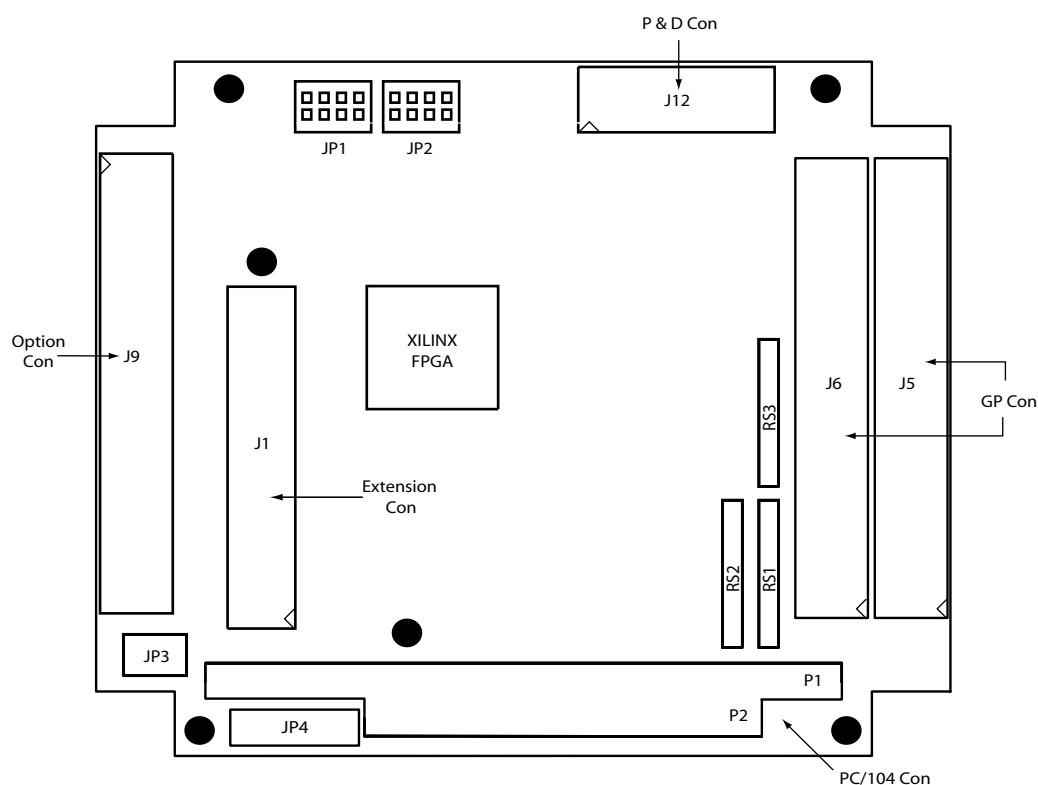
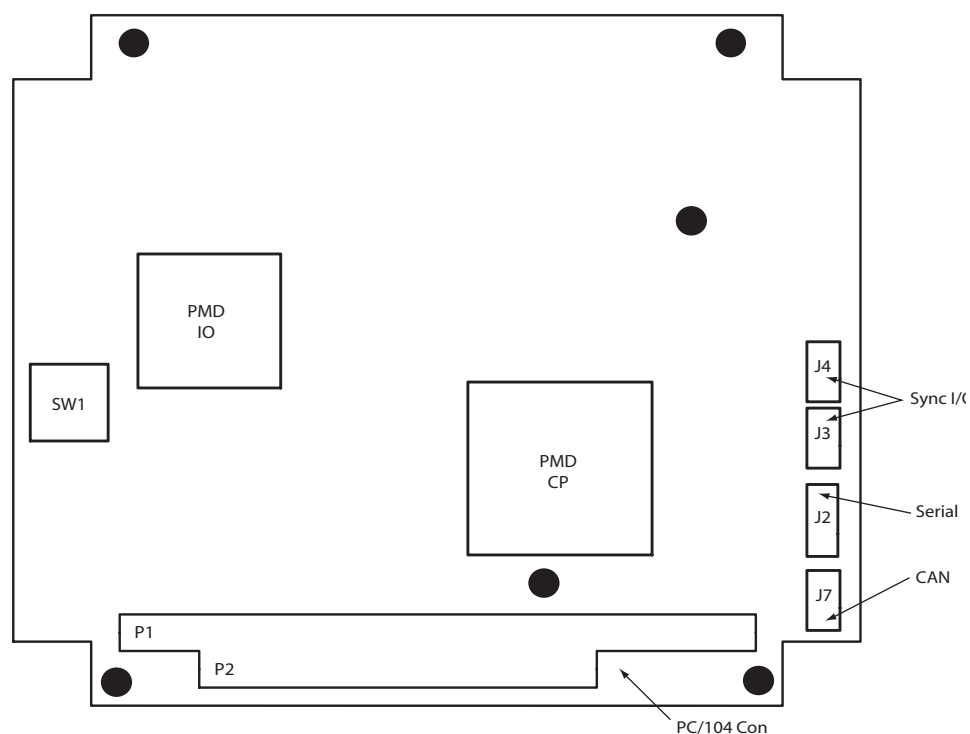


Figure 1-1:
Prodigy-PC/
104 Motion
Board, front
view

**Figure 1-2:
Prodigy-PC/
104 Motion
Board, back
view**



Front of Board Components

The following table describes the components on the front of the board (as shown in [Figure 1-1](#)) and their functionality.

Label	Description
RS1 - RS3	Resistor packs
P1, P2	PC/104 connectors
J5	Right GP Con connector
J6	Left GP Con connector
J9	Option Con connector
J12	Pulse & direction differential output connector
JP1, JP2	Motor type jumpers
JP3	Reserved
JP4	Interrupt (IRQ) selection jumpers

Back of Board Components

The following table describes the components on the back of the board (as shown in [Figure 1-2](#)) and their functionality.

Label	Description
P1, P2	PC/104 connectors
SW1	DIP switch block for base I/O address selection
J2	Serial connector
J3, J4	Sync I/O connectors
J7	CAN connector

1.7.1 Resistor Pack Settings

The Prodigy-PC/104 Motion Board has minimal jumper settings; most settings are software configurable. To prepare the board for installation, the following user-specified resistor pack options should be checked.

Item	Setting	Description
Resistor packs RS1, RS2, RS3	Installed; this is the default setting of resistor packs RS1 - RS3.	If differential connections are being used, leave these resistor packs installed.
	Removed	If single-ended encoder connections are being used, remove the resistor packs.

1.7.2 Motor Jumper Settings

Various possibilities exist for setting up the Prodigy-PC/104 Motion Board for use with either DC brush, brushless DC (with or without on-board commutation), microstepping, or step (pulse & direction) motors. The default mode at power-on is for DC brush motor on all axes.

The jumpers JP1 and JP2 consist of four jumper blocks each, relating to axis 1, 2, 3, or 4. The following table describes the correct jumper settings for each motor type. See [Figure 1-1](#) for JP1 and JP2 locations. In the following table, the individual jumpers are numbered from left to right on each jumper block with each jumper number preceded by its jumper block: JP1-1 is the jumper farthest to the left on JP1; JP1-2 is second from the left, and so on.

An example of jumper settings is shown in [Figure 1-3](#). Note that the motor type selection determines the default output mode. See the *Magellan Motion Control IC User Guide* for more information.

Axis	Pulse & Direction	DC Brush, Brushless DC
1	JP1-1 installed	JP2-1 installed
2	JP1-2 installed	JP2-2 installed
3	JP1-3 installed	JP2-3 installed
4	JP1-4 installed	JP2-4 installed

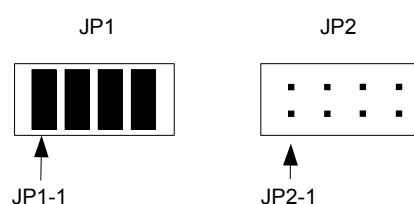


Figure 1-3:
Example of
Pulse &
Direction
Jumper Settings

NOTE: Use caution when setting motor jumpers. Be sure that the jumper settings are valid for the specified motor type.

1.7.3 DIP Switch Settings

The Prodigy-PC/104 is equipped with DIP switches (labeled SW1 in [Figure 1-2](#)) for ISA bus mode and base address settings. These switches, along with their functionality and settings, are detailed in the following table:

Item	Setting	Description
ISA bus mode (SW1)	SI-1	SI-1 on – 16 bit ISA bus mode (default) SI-1 off – 8 bit ISA bus mode When the board is in 8-bit ISA bus mode, the data transfer scheme is the same as the motion control IC's 8/16-bit mode. The motion control IC transfers instructions and data as full 16-bit words, using an 8-bit data path. Words are transferred in two successive bytes; the high-order byte of each word is transferred first in all cases.
PC/104 base address jumpers (SW1)	SI-2 10 (hex) SI-3 20 (hex) SI-4 40 (hex) SI-5 80 (hex) SI-6 100 (hex) SI-7 200 (hex) SI-8 400 (hex)	Switch SI sets the board address on the PC/104 bus. The selected board address is the additive value of the switch settings indicated in the Settings column. Moving the switch to the off position adds that value to the final base address. For example, to select a base address of 340 (hex), the following DIP switch settings would be selected. SI-2 on SI-3 on SI-4 off SI-5 on SI-6 off SI-7 off SI-8 on The user-specified board address must match the address expected by the software. In addition, this address must not be used by any other boards. From the specified base address, 16 addresses are used by the board. For example, if 300 (hex) is selected, then locations 300–30F will be used by the board, and cannot be used by other boards on the bus. NOTES: 1. The default base address is 300 (hex). 2. The recommended base address range for PCs is 200–3F0.

1.7.4 IRQ Jumper Settings

The Prodigy-PC/104 is equipped with IRQ jumpers (labeled JP4 in [Figure 1-1](#)). These jumpers, along with their functionality and settings, are detailed in the following table:

Item	Location	IRQ	Description
IRQ selection (JP4)	JP4-1 JP4-2 JP4-3 JP4-4 JP4-5 JP4-6 JP4-7 JP4-8	IRQ3 IRQ5 IRQ7 IRQ10 IRQ11 IRQ12 IRQ14 IRQ15	Selects the specific IRQ signal to be active on the PC/104 bus. The jumper block has eight positions with JP4-1 on the left, nearest the mounting hole. Only one IRQ may be selected, and that IRQ must be available on the system. If not using the IRQ functionality, leave all locations unjumped. The IRQ, if connected, is activated by the motion control IC under various host-programmable conditions.

1.8 Connection Summary for Prodigy-PC/104 Motion Boards

The following sections summarize the recommended connections for various motor types. Generally, the motor type to be installed is specified by the type of Prodigy-PC/104 Motion Board (see table on [page 9](#)). However, with the

PR8258x20 boards, DC brush, brushless DC, microstepping, and step (pulse & direction) motors may be connected to the same board.

1.8.1 DC Brush Motors

The following table summarizes connections to the Prodigy-PC/104 Motion Board when DC brush motors are used. Between one and four axes may be connected, depending on the specific Prodigy board and application requirements. All connections are made through connector GP Con, the two 50-pin connectors labeled J5 and J6 in [Figure 1-1](#). For a detailed list of connections, see [Chapter 3, Prodigy-PC/104 Electrical Reference](#).

Signal Category	Signal Description
Encoder input signals:(per axis)	A quadrature Channel input B quadrature channel input Index pulse channel input
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 DAC output used)	DAC out
Other control signals: (optional per axis)	Home signal input Limit switch inputs AxisIn input AxisOut output
Miscellaneous signals:	Digital GND, AmpEnable,+5V (for encoder power)

1.8.2 Brushless DC Motors

The following table summarizes connections to the Prodigy-PC/104 Motion Board when brushless DC motors are used. Between one and four axes may be connected, depending on the specific Prodigy board and application requirements. All connections are made through GP Con, the two 50-pin connectors labeled J5 and J6 in [Figure 1-1](#), and Option Con, which is labeled J9. For a detailed list of connections, see [Chapter 3, Prodigy-PC/104 Electrical Reference](#). For detailed information regarding the Option Con, see [Section 3.2.5, “Option Con Connector.”](#)

Signal Category	Signal Description
Encoder input signals:(per axis)	A quadrature channel input B quadrature channel input Index pulse channel input
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 DAC output used)	DAC out (phase A) DAC out (phase B)
Hall inputs: (Option Con)	Hall (phase A) Hall (phase B) Hall (phase C)
Other control signals: (optional per axis)	Home signal channel input Positive limit switch input Negative limit switch input AxisIn input AxisOut output
Miscellaneous signals:	Digital GND, AmpEnable,+5V (for encoder power)

1.8.3 Step Motors

The following table summarizes connections to the Prodigy-PC/104 Motion Board when pulse & direction interface step motors are used. Between one and four axes may be connected, depending on the specific Prodigy board and application requirements. Except for differential pulse & direction output, all connections are made through connector GP Con, the primary 50-pin connectors labeled J5 and J6 in [Figure 1-1](#). For a detailed list of connections, see [Chapter 3, Prodigy-PC/104 Electrical Reference](#).

Signal Category	Signal Description
Encoder input signals:(per axis)	A quadrature channel input B quadrature channel input Index pulse channel input
Amplifier output signals:	Pulse Direction
Other control signals: (optional per axis)	AtRest signal output Home signal channel input Positive limit switch input Negative limit switch input AxisIn input AxisOut output
Miscellaneous signals:	Digital GND, AmpEnable, +5V (for encoder power)

1.8.4 Microstepping Motors

The following table summarizes connections to the Prodigy-PC/104 Motion Board when microstepping-interface step motors are used. Between one and four axes may be connected, depending on the specific Prodigy board and application requirements. All connections are made through the connectors GP Con, the primary 50-pin connectors labeled J5 and J6 in [Figure 1-1](#), and Option Con, which is labeled J9. For a detailed list of connections, see [Chapter 3, Prodigy-PC/104 Electrical Reference](#).

Signal Category	Signal Description
Encoder input signals:(per axis)	A quadrature channel input B quadrature channel input Index pulse channel input
Amplifier output signals: (per axis, if PWM sign, magnitude used)	PWM magnitude (phase A) PWM magnitude (phase B) PWM direction (phase A) PWM direction (phase B)
Amplifier output signals: (per axis, if PWM 50/50 used)	PWM magnitude (phase A) PWM magnitude (phase B)
Amplifier output signals: (per axis, if DAC output used)	DAC out (phase A) DAC out (phase B)
Other control signals: (optional per axis)	Home signal channel input Positive limit switch inputs Negative limit switch inputs AxisIn input AxisOut output
Miscellaneous signals:	Digital GND, AmpEnable, +5V (for encoder power)

1.9 Applying Power

Once you have installed the Prodigy-PC/104 Motion Board in your PC and have made the necessary connections to your external amplifiers and motor encoders, hardware installation is complete, and the board is ready for operation. Upon power-up, the board will be in a reset condition. In this condition, no motor output will be applied. 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 PMD for application assistance. Complete PMD contact information is listed on the last page of this manual.

If the PR8258x20 is being used, there may be a situation where undesired motion may occur when the processor is powered up. In particular, if the connected amplifier is a PWM 50/50 amplifier, the motor will receive 100% power because the PR8258x20 Prodigy-PC/104 Motion Board defaults to PWM sign/magnitude on reset. To avoid this situation, use AmpEnable as an enable/disable signal for the amplifier, and set the motor type for each axis before enabling the amplifier. See [Section 2.3.2, “Amplifier Enable.”](#)



1.10 First-Time System Verification

The best way to setup and configure the Prodigy-PC/104 motion system is to run the Axis Wizard in Pro-Motion. The Axis Wizard performs a step-by-step software configuration and verification of each function for each axis. You may want to refer to the *Magellan Motion Control IC User Guide* to familiarize yourself with operation of the board's motion control IC.

The following sections are provided as a summary for users who are developing applications using C-Motion or VB-Motion. They show the minimum set of steps required to get an axis up and running. The Axis Wizard in Pro-Motion performs a more exhaustive list of software configuration steps including limit switch configuration, index capture, etc.

Since the configuration steps differ depending on motor type, the following table provides an overview listing each step by number. These steps are then detailed in subsequent sections. Perform only the setup step sequences for the board/motor type installed in your system.

Motor Type	Step #	Operation
DC brush	1	Set motor type
	2	Set output mode
	5	Set filter parameters
	6	Check encoder direction
	8	Make a trajectory move
Brushless DC	1	Set motor type
	2	Set output mode
	3	Initialize commutation
	4	Check commutation
	5	Set filter parameters
	6	Check encoder direction
Microstepping	8	Make a trajectory move
	1	Set motor type
	2	Set output mode
	7	Set the Motor Command
Step (pulse & direction)	8	Make a trajectory move
	1	Set motor type
	8	Make a trajectory move

It is assumed that each axis of your system will be verified one at a time. The Steps below are for Axis 1. To verify other axes, use a new axis number and verify each axis accordingly.

1.10.1 Step 1: Set the Motor Type

The Prodigy-PC/104 Motion Board must be told which type of motor will be driven by which axis. To do this, use the command:

SetMotorType AxisI, type// Sets the motor type for axis I

The operation sets the number of phases for commutation on the axis, as well as internally configuring the motion IC for the motor type. See the *Magellan Motion Control IC Programming Reference* for additional information.

The following table lists the number of phases to be commutated.

Motor Type	Value	Commutation
Brushless DC	0	3 phase
Brushless DC	1	2 phase
Microstepping	2	3 phase
Microstepping	3	2 phase
Step (pulse & direction)	4	None
DC brush	7	None

1.10.2 Step 2: Set the Output Mode

The Prodigy-PC/104 Motion Board must be told what type of motor output mode to use: PWM Sign Magnitude, PWM 50/50, or parallel DAC. This can be set using the command:

`SetOutputMode Axis1, mode//` Sets the output mode for axis 1

See the *Magellan Motion Control IC Programming Reference* for additional information.

1.10.3 Step 3: Initialize the Commutation

NOTE: This section applies to brushless DC motors only.

For the motor to be properly controlled, the Prodigy-PC/104 Motion Board must select and possibly initialize the commutation phasing. If Hall-based commutation will be used, then no initialization is necessary. Simply specify this to the Prodigy-PC/104 Motion Board using the command:

`SetCommutationMode Axis1, l//` Sets the commutation mode to Hall for Axis 1

No other commands are necessary, and you may proceed to step 4.

If commutating using a sinusoidal technique, the commutation phasing must be initialized. There are two ways this can be done; either by using Hall-based or by algorithmic methods. See the *Magellan Motion Control IC User Guide* for more information. Each of these two-phase initialization methods requires a separate sequence, as demonstrated in the following examples:

Hall-based initialization command sequence:

`SetPhaseCounts Axis1, yyyy//` yyyy is # of encoder counts per electrical cycle

`SetPhaseInitializeMode, Axis1, 1//` sets phase initialize mode = 1 (Hall-based) for Axis 1

`InitializePhase Axis1//` Initiates the phase initialization sequence for Axis 1

Algorithmic-based initialization command sequence:

`SetPhaseCounts Axis1, yyyy//` yyyy is # of encoder counts per electrical cycle

`SetPhaseInitializeMode Axis1, 0//` sets phase initialize mode = 0 (Algorithmic)

`SetOperatingMode, Axis1, 3//` disables the position loop, required for algorithmic initialization.

`SetPhaseInitializeTime Axis1, zzzz//` zzzz is # of motion control IC cycles to initialize for

`SetMotorCommand Axis1, wwwwww//` wwwwww is motor command

`InitializePhase Axis1//` Initiates the phase initialization sequence for Axis 1

To determine the values of yyyy, zzzz, and www, please refer to the *Magellan Motion Control IC User Guide* and the *Magellan Motion Control IC Programming Reference*.

If your system has one or more of the following conditions present:

- 1 one or more Hall signals must be inverted to commute or initialize the commutation correctly; or:
- 2 the number of encoder counts per electrical cycle exceeds 32,767

then the preceding command sequences will need to be expanded. For these systems, you will need to use the **SetSignalSense** command, along with the **SetPhasePrescaleMode** command. Refer to the commutation section of the *Magellan Motion Control IC User Guide* for more information.

When the operating mode is set to 3, the motor is not under closed-loop position control. Be aware that the motor may spin rapidly after a motor command value is applied. To begin, use small values, and then gradually increase the values.

Contact PMD for additional information on the Phase Initialization application note.



1.10.4 Step 4: Check Commutation

NOTE: This section applies to brushless DC motors only.

After phase initialization has been completed, we recommend checking the smoothness of the motor rotation in open loop mode, to verify that the motor phasing initialization and commutation is correct. For this verification, use the following command sequence:

SetOperatingMode Axis1, 3// mode = 3 disables the position loop of Axis 1

SetMotorCommand Axis1, xxxx// xxxx is the motor command

Update Axis1// updates the buffered parameters and starts the move

The motor command value represents the fraction of 32,767 (where 32,767 is equivalent to total power) which will be applied to the motor. For example, a value of 1000 sends roughly 3% (1000/32,767) of the total power to the motor. After executing this command sequence, the motor should spin smoothly in the specified direction. 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 either roughly, in the wrong direction, or if it moves a short distance and then stops abruptly, there may be a problem with the commutation. Check the wiring and re-test. Once the motor is spinning smoothly in both directions under open-loop control, re-enable closed-loop DC brush and brushless DC control by executing the command:

SetOperatingMode Axis1, 0x33// mode = 0x33 enables the trajectory generator, position loop and motor

// output

1.10.5 Step 5: Set Filter Parameters

For motion to occur, some amount of feedback gain must be specified. Initially, use a proportional gain with a very low value between 1 and 25. Later, integral or derivative gains may be added, 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, thus making them active.

SetPositionLoop Axis1, Param0, xxxx// Param0 selects Kp and xxxx is the desired proportional gain

SetPositionLoop Axis1, Param3, yyyy// Param3 selects Kd and yyyy is the desired derivative gain

SetPositionLoop Axis1, Param1, zzzz// Param1 selects Ki and zzzz is the desired integral gain

SetPositionLoop Axis1, Param2, aaaa// Param2 selects Ilimit and aaaa is the desired integration limit value

Update Axis1// make the values active

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



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

1.10.6 Step 6: Check Encoder Direction

NOTE: This Section applies to DC brush and brushless DC motors only.

The next step is to ensure that the sense of direction between the PID output and the encoder is synchronized. A positive PID output should induce a direction of torque in the motor corresponding to positive encoder incrementation. In other words, a positive motor torque (which creates motion), should cause a positive encoder displacement.

This condition can be tested immediately after completing Step 5. This is because the system will respond to a position error once the filter parameters have been set. If the motor “runs away” after setting the filter parameters, then the encoder direction does not correspond to the motor torque direction. If the motor remains stationary, manually rotate the motor to induce a position error. If the motor runs away, then the encoder direction does not correspond to the motor torque direction. The simple solution for this is to use the C-Motion command **SetSignalSense 0x0001** to invert the direction of the encoder. If the motor does not run away, but remains “servoed,” then no action is necessary.

1.10.7 Step 7: Set the Motor Command

NOTE: this section applies to microstepping motors only.

In order for motion to occur, the magnitude of the output must be set. Refer to the *Magellan Motion Control IC User Guide* for more information. A value between 0 and 32,767 represents an amplitude of 0 – 100%. As a starting point, a value of around 5000 should be satisfactory.

Here is the command sequence to use:

SetMotorCommand Axis1, xxxx// sets the motor output level for Axis 1

Update Axis1// execute the move

1.10.8 Step 8: Make a Trajectory Move

To verify that the motor is being controlled properly, set up and execute a short trapezoidal move. For example, a short distance of 5000 counts, a low velocity of 10,000, and acceleration of 10. With a cycle time of 256μsec, these values correspond to roughly 596 counts/sec, and 2.4×10^{-3} counts/sec², respectively.

The command sequence to use is as follows:

SetProfileMode Axis1, 0// sets the profile mode to trapezoidal for Axis 1

SetPosition Axis1, 5000// 5000 is the desired destination position

SetVelocity, Axis1, 10000// 10,000 is the desired maximum velocity

SetAcceleration Axis1,10// 10 is the desired acceleration

SetDeceleration Axis1,10// 10 is the desired deceleration

Update Axis1// execute the move

After entering this sequence of commands, the axis should move smoothly for about 15 seconds (if the suggested values are used and the cycle time of the Prodigy-PC/104 Motion Board is 256 μ sec). If the axis is not moving, or if the axis jumps rapidly in one direction or the other, there may be a problem with the motor connections or software settings. Re-check and review the board setup procedures, as well as the exerciser parameter settings. If problems still exist after re-checking the system, contact PMD for applications assistance. PMD contact info is located on the final page of this manual.

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



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2. Operation

In This Chapter

- ▶ Board Function Overview
- ▶ Magellan Motion Control IC Functions
- ▶ Board-Specific Functions
- ▶ Signal Processing and Hardware Functions
- ▶ ISA Bus Address Map

The Prodigy-PC/104 Motion Boards are high-performance PC/104-bus boards which provide motion control for DC brush, brushless DC, pulse & direction, and microstepping motors. These boards are based on Magellan Motion Control ICs, which perform motion command interpretation and other real-time functions. The overall board functions are divided among a number of modules, as illustrated in the following diagram.

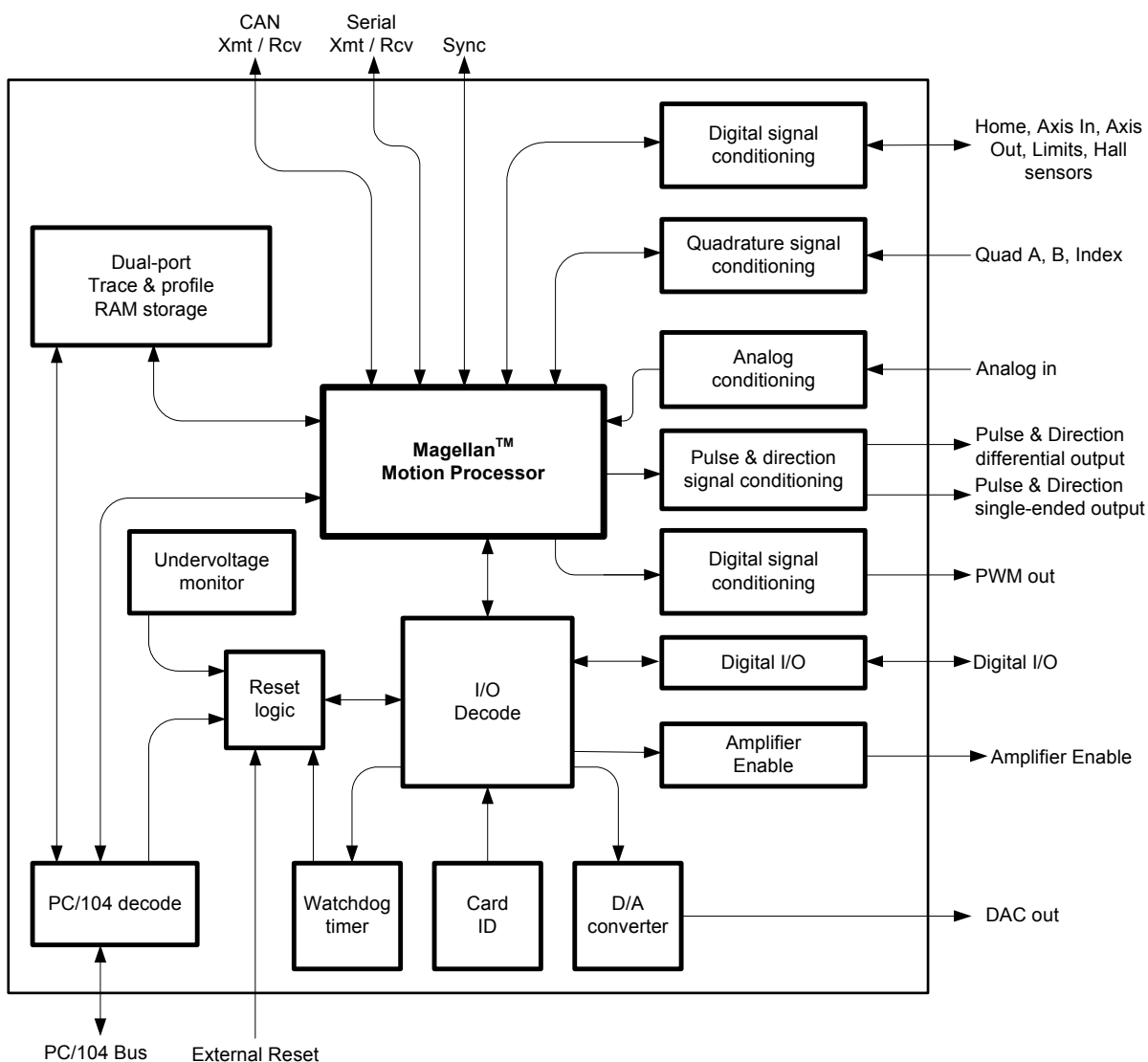


Figure 2-1:
Prodigy-PC/
104 Internal
Block Diagram

2.1 Board Function Overview

The Prodigy-PC/104 Motion Board's resources can be broken down into three overall categories:

Magellan Motion Control IC functions - These are programmable functions which reside in the Magellan Motion Control IC chipset. Included are profile generation, DC brush and brushless DC loop closure, microstep generation and much more. These functions are accessed through the Magellan API commands, which allows for sophisticated control of the board's overall behavior.

Board-specific functions - These are programmable functions which are controlled by the Magellan Motion Control IC using the **ReadIO** and **WriteIO** commands, but which reside in various portions of the board circuitry. These functions include general purpose digital I/O, and other board-specific capabilities.

Signal processing & hardware functions - A substantial portion of the board provides signal conditioning and other functions associated with non-programmable, signal-related processing.

2.2 Magellan Motion Control IC Functions

The Magellan Motion Control IC block pictured in [Figure 2.1](#) consists of two ICs: a CP (command processor) chip, and an IO (input/output) chip. A summary list of the functions provided by the Magellan Motion Control IC is as follows:

- Profile generation
- Motor output signal generation (PWM and analog)
- Quadrature encoder counting and index capture
- DC brush and brushless DC loop closure
- Breakpoint processing
- AxisIn and AxisOut signal processing
- Trace
- Motion error detection, tracking windows, and at-settled indicator
- Limit switches

Access to the Magellan Motion Control IC on the Prodigy-PC/104 Motion Board occurs through the PC/104 bus, the serial port, or the CAN port. Two manuals describe how the Magellan Motion Control IC operates and how it is programmed: the *Magellan Motion Control IC User Guide*, and the *Magellan Motion Control IC Programming Reference*.

The Magellan instruction set is very flexible and powerful. The following example, which would be used to set up and execute a simple trapezoidal profile, illustrates just a small part of the overall command set.

```
SetProfileMode AxisI, trapezoidal    // set profile mode to trapezoidal for axis I
SetPosition AxisI, 12345             // load a destination position for axis I
SetVelocity AxisI, 223344            // load a velocity for axis I
SetAcceleration AxisI, 1000          // load an acceleration for axis I
SetDeceleration AxisI, 2000          // load a deceleration for axis I
SetUpdateMask AxisI, Profile         // specify that an update of profile parameters only
                                     // is to occur
```

Update AxisI

```
// Double buffered registers are copied into
// the active registers, thereby initiating the move
```

2.3 Board-Specific Functions

Board-specific functions are those functions which are mapped through the Prodigy-PC/104 Motion Board's **ReadIO** and **WriteIO** facility, but are implemented in the board circuitry.

Board-specific functions are detailed in this document, rather than the *Magellan Motion Control IC User Guide* or the *Magellan Motion Control IC Programming Reference*.

2.3.1 General-Purpose Digital I/O

In addition to numerous special-purpose digital signals which are input or output to the board such as **AxisIn**, **AxisOut**, **Home**, **Quada**, etc., the Prodigy-PC/104 Motion Boards support eight general-purpose inputs, and eight general-purpose outputs. These signals provide a convenient way of accessing additional general-purpose digital I/O. Although access to these signals occurs through the Prodigy-PC/104 Motion Board's **ReadIO** and **WriteIO** commands, the signals present at these various connections do not directly affect the Prodigy-PC/104 Motion Board's behavior; the Prodigy-PC/104 Motion Board simply passes them through.

The general purpose digital I/O voltage range is 0-5V.



ReadIO and WriteIO commands

The eight inputs and eight outputs are read using the **ReadIO** command and **WriteIO** command, with an I/O address of 0. This is illustrated in the following table, along with the bit locations of the input and output signals.

I/O Address	Bit Location	Signals
0	0 - 7	DigitalOut0-7
	8 - 15	DigitalIn0-7

To read the eight general-purpose digital I/Os, a **ReadIO** command is performed at address offset 0. The 16-bit read word returns the current output values (set using the **WriteIO** command) in bits 0 - 7, while bits 8 - 15 hold the digital values corresponding to the signal levels at the connector for those inputs. To write new signal values to the eight digital outputs, a **WriteIO** command to address offset 0 is sent, and the values on bits 0-7 will be output to the signal connections. The value of bits 8 - 15 are ignored.

Example

To write the value 0xAA to bits 0 - 7, the command **WriteIO** is used. Assuming that the signal pattern 0x55 is present on the eight input connections, then if the command **ReadIO** is used, the value returned will be 0x55AA. The upper eight bits reflect the present value of the input signals, while the lower eight bits reflect the 8-bit value being output.

Related commands

In addition to the low-level **ReadIO** and **WriteIO** commands, the following utility commands are also supported in C-Motion and VB-Motion: **WriteDigitalOutput**, **ReadDigitalInput**, and **ReadDigitalOutput**. These utility commands provide a simpler interface by handling the high byte–low byte shifting. See the *Magellan Motion Control IC Programming Reference* for more information.

Connections & associated signals

The general-purpose I/O are direct digital inputs and outputs. There are no associated connections required for these signals to function properly, however, one or more of the digital grounds must be connected. Digital inputs are pulled up through 4.7 kOhm resistors to 5V. The power-up default value for all general-purpose digital outputs is low.

For a complete description of the pinout connections to and from the board, see [Chapter 3, Prodigy-PC/104 Electrical Reference](#).

2.3.2 Amplifier Enable

The signals **AmpEnable 1-4** provide four digital outputs which may be used as amplifier enable signals. They can also be used as general-purpose digital outputs. Similar to the general-purpose digital inputs and outputs (see [Section 2.3.1, “General-Purpose Digital I/O”](#)), these signals are not directly affected by the Prodigy-PC/104 Motion Board’s behavior. However, they can be read or written through the Prodigy-PC/104 Motion Board’s **ReadIO** and **WriteIO** commands.

ReadIO and WriteIO commands

These outputs are read using the **ReadIO** command, and written to using the **WriteIO** command, using an address of 1, as shown in the following table:

I/O Address	Bit Location	Signals
1	0-3	Amplifier enable outputs (0-3)
	4-6	Unused
	7	DAC enable status (1 = enabled; 0 = disabled)
	8-11	Change mask for bits 0-3; amplifier enable outputs (1 = change; 0 = don’t change)
	12-14	Unused
	15	Change mask for DAC enable (1 = change; 0 = don’t change)

To read the status of the amplifier enable outputs, the command **ReadIO** is used at address 1. The values currently being output will appear in bits 0 - 3. To write values to the amplifier enable output signals, the **WriteIO** command is used with an address of 1. The change mask bits corresponding to the signals which will be changed must be loaded at bits 8 - 11, and the value(s) to be loaded must be loaded in bits 0 - 3.

Examples

```
WriteIO Address1, 0x0505      // write 0x0505 to I/O Address 1 to enable Amplifiers 1 & 3
WriteIO Address1, 0x0400      // write 0x0400 to I/O Address 1 to disable Amplifier 3
WriteIO Address1, 0x0100      // write 0x0100 to I/O Address 1 to disable Amplifier 1
```

Related commands

In addition to the low-level **ReadIO** and **WriteIO** commands, the following utility commands are also supported in C-Motion and VB-Motion: **SetAmplifierEnable** and **GetAmplifierEnable**. These utility commands provide a simpler interface by handling the bit shifting. See the *Magellan Motion Control IC Programming Reference* for more information.

Connections & associated signals

AmpEnable 1-4 are direct digital outputs. There are no associated connections required for these signals to function properly, however, one or more of the digital grounds must be connected. The power-up default value for all amplifier enable signals is low (disabled). For a complete description of the pinout connections to and from the board, see [Chapter 3, Prodigy-PC/104 Electrical Reference](#).

2.3.3 DAC Output Enable

In addition to the amplifier enable outputs, there is a dedicated board function which allows the DAC output signals to be shunted to 0 volts for safety purposes (DAC disabled), or allowed to be set by the Magellan Motion Control IC (DAC enabled). This shunting occurs at a hardware level outside the motion control IC itself, and provides an additional safety layer to control the motor command.

ReadIO and WriteIO commands

The status of the DAC output enable function can be read using the **ReadIO** command, and the DAC output enable status can be set using the **WriteIO** command, with an address of, as shown in the following table:

I/O Address	Bit Location	Signals
1	0-3	Amplifier enable outputs (0-3)
	4-6	Unused
	7	DAC enable status (1 = enabled; 0 = disabled)
	8-11	Change mask for bits 0-3; amplifier enable outputs (1 = change; 0 = don't change)
	12-14	Unused
	15	Change mask for DAC enable (1 = change; 0 = don't change)

To read the status of the DAC output enable function, **ReadIO** is used. The value currently in use will appear in bit 7. A value of 1 indicates DAC output is enabled, meaning that the voltage being output by the DACs is controlled by the motion control IC. A value of 0 indicates that it is disabled, meaning that the voltage being output by the DAC is forced to 0.0 volts.

To enable or disable the DAC enable function, the **WriteIO** command is used. The change mask bit located at bit 15 must be loaded with a 1. Bit 8 must be loaded with a value of 0 to disable, or a value of 1 to enable output.

The powerup default value for DAC Output Enable is disabled. In addition, the DAC Output Enable is disabled upon a hard reset, which is a reset via the PC/104 bus, or via the external **Reset** signal. See [Section 2.3.8, "Reset"](#), for more information.

Examples

```
WriteIO Address1, 0x8080      // write 0x8080 to I/O Address 1 to enable all DACs
WriteIO Address1, 0x8000      // write 0x8000 to I/O Address 1 to disable all DACs
```

Related commands

In addition to the low-level **ReadIO** and **WriteIO** commands, the following utility commands are also supported in C-Motion and VB-Motion: **SetDACOutputEnable** and **GetDACOutputEnable**. These utility commands provide a simpler interface by handling the bit shifting. See the *Magellan Motion Control IC Programming Reference* for more information.

Connections & associated signals

DAC output enable is an internal function of the board. Thus there are no signals directly associated with this function.

2.3.4 Serial Communications

The Prodigy-PC/104 Motion Board offers an asynchronous serial communications port. All functions of the board can be commanded through this port or it can be used to monitor operations, even while the PC/104 bus is used to command motion sequences.

The serial port can be operated at various baud rates from 1,200 to 460,800 and in varying configurations of stop, start, and parity codes. In addition, two serial protocols are supported: point-to-point, and multi-drop (idle line) mode. The Magellan commands **SetSerialPortMode** and **GetSerialPortMode** are used to set and read the serial port communication parameters. A complete description of the serial port, and its usage modes are provided in the *Magellan Motion Control IC User Guide*. A complete description of Magellan commands can be found in the *Magellan Motion Control IC Programming Reference*. Also see [Section 3.2.7, “Serial Connector.”](#)

After a reset or at power-up, the board sets the communication parameters to 57,600 baud, no parity, one stop bit, and point-to-point mode. To alter these parameters, new serial port parameters should be set using the **SetSerialPortMode** command, while communicating at the default parameters, and then switch to the new communications parameters.

Connections & associated signals

A special 5-pin connector is used to connect to the serial port. A convenient cable with this connector installed may also be ordered. See [Section 1.3, “Accessory Products”](#) and [Section 3.2.7, “Serial Connector”](#) for a detailed signal description of the serial connector.

2.3.5 CAN Communications

The Prodigy-PC/104 Motion Board offers a CAN port. All functions of the board can be commanded through this port or it can be used to monitor certain operations, even while the PC/104 bus is used to command motion sequences.

The CAN port may be operated at various baud rates from 1,200 to 1,000,000. The Magellan commands **SetCANMode** and **GetCANMode** are used to set CAN communication parameters. A complete description of the CAN connector and its usage modes are provided in the *Magellan Motion Control IC User Guide*. A complete description of Magellan commands can be found in the *Magellan Motion Control IC Programming Reference*.

After a reset or at power-up, the board sets the CAN default parameters to 20,000 bps, and node ID to 0. To alter these parameters, the user may set new CAN parameters using the **SetCanMode** command, while communicating at the default parameters, and then switch to the new communications parameters.

The Prodigy-PC/104 Motion Board will integrate with a CAN 2.0B network. It will coexist, but not communicate with, other CAN 2.0B nodes on that network. The CAN functionality receives commands, sends responses, and (optional) sends asynchronous event notifications.

Connections & associated signals

A special 2-pin connector is used to connect to the CAN port. See [Section 3.2.9, “CAN Connector”](#) for a detailed signal description of the CAN connector.

2.3.6 Watchdog Timer

To enhance the overall safety of the board, a watchdog function has been included. The watchdog will automatically trigger a hard reset if communication from the host should be lost. Resetting the Prodigy-PC/104 Motion Board will have the result of setting all motor command outputs to zero, thus allowing the motors to come to a safe stop.

ReadIO and WriteIO commands

To enable the watchdog timer, the **WriteIO** command is used to send a value of 0x5562 to address 4. Once enabled, the watchdog timer will time out, causing a hard reset, if another write to address 4 with a value of 0x5562 is not received within 104 milliseconds. As long as a watchdog value is written to address 4 within the 104-millisecond interval, no reset will occur and motion operations will proceed normally.

After powerup or any hard reset, if no command is sent to the watchdog address, then the watchdog will remain disabled. The watchdog is disabled by default at power-up. When the watchdog timer times out and triggers a hard reset, it also disables itself.

Related commands

In addition to the low-level **ReadIO** and **WriteIO** commands, the following utility command is also supported by C-Motion and VB-Motion: **SetWatchDog**. This utility command provides a simpler interface by automatically sending the value 0x5562. See the *Magellan Motion Control IC Programming Reference* for more information.

Connections & associated signals

The watchdog timer is an internal function of the board. There are no signals directly associated with this function.

2.3.7 Undervoltage Monitor

To enhance reliability under a variety of electrical conditions, an undervoltage detection circuit has been included. This circuit triggers a hard reset when the voltage has dropped to an unsafe level. Resetting the Prodigy-PC/104 Motion Board will have the result of setting all motor command outputs to zero, thus allowing the motors to come to a safe stop. An undervoltage condition is detected when the 3.3V internal supply on the board drops below 95% of its rated value. To determine if a reset was caused by an undervoltage condition, see [Section 2.3.9, “Reset Monitor.”](#)

Connections & associated signals

The undervoltage detector is an internal function of the board. There are no signals directly associated with this function.

2.3.8 Reset

Although a reset occurs automatically during power-up, it is sometimes desirable to reset the Prodigy-PC/104 Motion Board explicitly through a user-initiated command or action. There are several methods by which the Prodigy-PC/104 Motion Board may be reset. The methods are summarized in the following table:

Method	Type of Reset	Description
External reset	Hard reset	When the external signal Reset on GP Con is brought low, a “hard” reset occurs, which resets all of the board’s circuitry and the Magellan Motion Control IC.
Reset through the Magellan Motion Control IC	Soft reset	Sending the Reset command to the Prodigy-PC/104 Motion Board causes a “soft” reset of the Magellan Motion Control IC only.
Reset through PC/104 bus	Hard reset	The HardReset command uses the PC/104 bus to perform a “hard” reset, which resets all of the board’s circuitry and the Magellan Motion Control IC.

After a reset occurs, the Prodigy-PC/104 Motion Board and other related output signals will be driven to known states, depending on the type of reset performed. These are summarized in the following table:

Signal Name	Soft Reset	Hard Reset
AxisOutI-4	High	High
PWMMagIA-4C	Low	Low
PWMSignIA-4B	Low	Low
DACIA-DAC4B	No change	0.0 volts
DigitalOut0-7	No change	Low
AmpEnableI-4	No change	Low
DAC On/Off	No change	Off

Signal Name	Soft Reset	Hard Reset
Watchdog Timer	No change	Disabled

Related commands

A **HardReset** utility command is provided in C-Motion and VB-Motion. This utility command uses the PC/104 interface to force a Hard reset of the entire board. See the *Magellan Motion Control IC Programming Reference* for more information on this command.

Connections & associated signals

The reset feature has an external signal input, **Reset**, associated with it. This active low signal is located on the GP Con. It is pulled up through a 4.7 kOhm resistor to 5 V.

2.3.9 Reset Monitor

In addition to resets which are explicitly requested by the user (as detailed in the previous section), some reset conditions may occur automatically. During normal operations, the Prodigy-PC/104 Motion Board is only reset during power-up. A reset serves the purpose of initializing values and bringing the Prodigy-PC/104 Motion Board to a known and consistent state. On occasion, the Prodigy-PC/104 Motion Board will be reset due to one of a few anomalous conditions.

ReadIO and WriteIO commands

To determine the cause of a board reset, special instructions to read the reset source have been provided. The command **ReadIO** with an address of 2 should be used. The following table details the encoding of this I/O address word.

I/O Address	Bit Location	Signals
2	0-11	Reserved
	12	Hard Reset: a 1 value in this bit indicates a reset commanded over the bus.
	13	Undervoltage detection: a 1 value in this bit indicates a reset caused by undervoltage detection.
	14	External signal: a 1 value in this bit indicates a reset caused by the external Reset signal.
	15	Watchdog timeout: a 1 value in this bit indicates a reset caused by watchdog timeout.

Once a reset condition has occurred, the reset status stored at address 2 (described in the preceding table) can be cleared by a **WriteIO** command to address 2 with a value of zero (0).

Example

To determine that a reset has occurred, and to determine the cause of the reset, the command **ReadIO** is used. Assuming that a watchdog timer event has occurred, the value returned would be 0x8000. To reset the reset monitor word, the command **WriteIO** is sent to address 2 with a value of zero (0).

Related commands

In addition to the low-level **ReadIO** and **WriteIO** commands, a **GetResetCause** utility command is also supported by C-Motion and VB-Motion. This utility command returns the cause and also clears the reset condition. See the *Magellan Motion Control IC Programming Reference* for more information.

Connections & associated signals

The Reset monitor is an internal function of the board. There are no signals directly associated with this function.

2.3.10 Board ID

This feature allows the user to query the board for a Board ID. This may be helpful for verifying the type of Prodigy Motion Board in situations where multiple boards of varying types are installed.

ReadIO and WriteIO Commands

To read the Board ID, the **ReadIO** command is used with an address of 0xFF. The encoding of the bits returned is detailed in the following table:

Address	Bit Location	Signals
0xFF	0-3	Major board revision: This nibble encodes the major board revision. This value can range from 0 to 15.
	4-7	Minor board revision: This nibble encodes the minor board revision. This value can range from 0 to 15.
	8-11	Board generation: This nibble encodes the board generation. This value can range from 8 to 15. (0 to 7 are reserved for older motion board families.)
	12-15	Board type: This nibble encodes the board type and has one of the following values: 0 = ISA Bus 1 = PCI Bus 2 = CompactPCI 3 = PC/104 4 = MIPS 5 = RS232 6 = CAN

Example

To read the Board ID, the command **ReadIO** is used. Assuming the value returned is 0x3805, this can be interpreted as: Prodigy-PC/104 Motion Board, board generation 8, board revision 5.0.

Related commands

In addition to the low-level **ReadIO** command, a **ReadboardID** utility command is also supported by C-Motion and VB-Motion. This utility command returns the Board ID in the format described above. See the *Magellan Motion Control IC Programming Reference* for more information.

Connections & associated signals

The Board ID is an internal function of the board. There are no signals directly associated with this function.

2.3.11 Memory Configuration

Trace capture is a powerful feature of the Prodigy-PC/104 Motion Board which allows various Magellan Motion Control IC parameters and registers to be continuously captured and stored to an external memory buffer. The captured data may later be downloaded by the host using standard memory buffer access commands. Data traces are useful for optimizing DC brush and brushless DC performance, verifying trajectory behavior, capturing sensor data, or to assist with any type of monitoring where a precise time-based record of the system's behavior is required.

Maintaining the trace buffer requires the motion control IC to perform extra work during each cycle. Most applications should disable trace capture once the motion application has been debugged. It is also possible to access the on-board memory independent of the trace function, which allows it to be used for generic storage. The remaining on-board memory available for trace must be calculated accordingly. See the "Trace Capture" section of the *Magellan Motion Control IC User Guide* for more information on these subjects.

The Prodigy-PC/104 Motion Board has 40 KBytes of on-board dual-ported memory (DPRAM) which is interfaced to the motion control IC as well as the PC/104 decode circuitry allowing two paths of communication. In many applications, the Magellan Motion Control IC can be used to store and access all trace data. This method of operation is described in the *Magellan Motion Control IC User Guide*. Alternatively, for moving large amounts of data, the host computer can directly interface to the DPRAM so that the memory can be used in a real-time circular buffer mode. In this configuration, the motion control IC stores data to the DPRAM and the host processor reads the data using the PC/104 interface instead of using motion control IC commands. The PC/104 interface offers a much higher read and write rate than is available through the motion control IC. This allows an almost unlimited amount of “virtual” trace storage space, as the host computer’s memory or hard drive is used to store the data.

For both the host computer and the Magellan Motion Control IC, the 40 KBytes of DPRAM memory is accessed from offset 0 to offset 10,240, where the offset is calculated in 4-byte (32 bit) dwords. The number of dwords read or written can be 0 to 10,240, but must never be greater than (10,240 - `offset_in_dwords`).

The following commands are used by the host to read and write directly to the DPRAM:

```
ReadDPRAM
WriteDPRAM
```

By using these commands, blocks of 32-bit data can be read or written to the DPRAM. While a trace is in progress, the location to which the motion control IC is currently writing may be determined by using the motion control IC command `GetBufferWriteIndex`. Only data behind the current write index location should be read.

These commands are documented in the *Magellan Motion Control IC Programming Reference*.

2.4 Signal Processing and Hardware Functions

These functions are implemented in hardware and are not directly user-programmable. The following sections are organized into related groups of signals, and provide information which may be helpful when connecting the motion system.

2.4.1 Home, AxisIn, AxisOut, Limits, Hall Sensors

These signals are conditioned by the board, and then input or output directly to the Magellan Motion Control IC. The *Magellan Motion Control IC User Guide* explains the functions provided in connection with these various signals. Most of the signals are optional, and are connected depending on the nature of the application.

These signals are named *HomeI-4*, *AxisInI-4*, *AxisOutI-4*, *PosLimI-4* (positive direction limit input), *NegLimI-4* (negative direction limit input), and *HallIA-4C* (12 signals in all).

Connections & associated signals

These signals are single-ended digital inputs to the board, with the exception of *AxisOut*, which is a single-ended output. There are no associated connections required for these signals to function properly, however, one or more of the digital grounds must be connected. The input signals are pulled up through 4.7 kOhm resistors to 5V. The default power-up value for all *AxisOut* signals is high.

For a complete description of the pinout connections to and from the board, see [Chapter 3, Prodigy-PC/104 Electrical Reference](#).

2.4.2 QuadA, QuadB, Index

These signals provide position feedback to the motion controller which is used to track motor position. For DC brush and brushless DC motors, they are required for proper operation. For microstepping or step (pulse & direction) motors, they are optional.

The encoder-processing circuitry provides a multi-stage digital filter of the *QuadA*, *QuadB*, and *Index* signals for each axis. This provides additional protection against erroneous noise spikes, thus improving reliability and motion integrity. These signals are named *QuadA1+* through *QuadB4-* (16 signals), and *Index1+* through *Index4-* (8 signals).

Connections & associated signals

These signals can be connected in one of two ways. Single-ended means that only one wire per signal is used, while differential means two wires encode each signal (labeled + and -). Differential transmission is generally recommended for the highest level of reliability, because it provides greater noise immunity than a single-ended connection scheme.

If single-ended connections are used, only the + signal is connected, and the - signal should be left floating. For example, in connecting to the A quadrature input, *QuadA1+* connects to the signal, and *QuadA1-* remains floating. If differential connections are used, both the + and - signals are used. Differential or single-ended termination must be selected through resistor pack installation. For details see the table in [Section 1.7, “Preparing the Board for Installation.”](#) Note that all quadrature and index connections should be in either single-ended or differential mode. It is not possible to mix on a signal-by-signal basis. When using the system with differential connections, the polarity of the differential signal can be reversed by swapping the + and - connections. This may be useful for altering the motor and/or encoder direction; however, this same function can also be accomplished through commands to the Prodigy-PC/104 Motion Board. See the *Magellan Motion Control IC User Guide* for more information. Associated connections supported by the board are the +5V output signals. These are provided as a convenience, as they are generally connected to a corresponding input on the encoder to power its internal circuitry. As was the case for the digital input signals, one or more of the digital grounds must also be connected.

For a complete description of the pinout connections to and from the board, see [Chapter 3, Prodigy-PC/104 Electrical Reference](#).

2.4.3 Analog Input

The *Analog1-8* signals provide general purpose input of up to eight analog signals. The voltages present at these various connections do not directly affect the Prodigy-PC/104 Motion Board's behavior. However, they can be read through the Prodigy-PC/104 Motion Board, thus providing a convenient way of importing analog signal levels which may be acted upon by the user's application code located on the host PC. These signals are read using the Magellan command **ReadAnalog**. For more information on reading the value of these analog inputs, see the *Magellan Motion Control IC User Guide*. The minimum allowed input voltage is 0.0V, and the maximum allowed input voltage is 3.3V. To determine the numerical value that will be read by the Prodigy-PC/104 Motion Board given a specific voltage, the following formula is used:

$$\text{ReadValue} = \text{AnalogVoltage} * 65,536 / 3.3\text{V}$$

Conversely, given a read value, the voltage at the connection is calculated as:

$$\text{AnalogVoltage} = \text{ReadValue} * 3.3\text{V} / 65,536$$

Connections & associated signals

For analog voltages to be read correctly, in addition to the analog signal itself, *AnalogGND* (analog ground) must be connected.

2.4.4 Pulse and Direction

For pulse & direction applications, these signals provide a stream of pulse and direction data, and are compatible with a wide variety of off-the-shelf step motor amplifiers. These signals are generated by the Magellan Motion Control IC and are named *Pulse I-4* and *Direction I-4*. The default value at power-up and reset for all pulse and direction output signals is: pulse signal is high; direction signal is low.

Connections & associated signals

Both single-ended and differential line driver versions of these signals are output from the Prodigy-PC/104 Board. There are no associated connections required for these signals to function properly, however, one or more of the digital grounds must be connected. For a complete description of the pinout connections to and from the board, see [Chapter 3, Prodigy-PC/104 Electrical Reference](#).

2.4.5 PWM Out

For DC brush, brushless DC or microstepping motors, these signals provide PWM (pulse width modulated) motor command signals when the motor output mode is set to **PWMSignMagnitude** or **PWM5050Magnitude**. The number of signals per axis varies, depending on factors such as the motor type, the number of phases of the motor, and the motor drive method (sign/magnitude or 50/50). See [Chapter 3, Prodigy-PC/104 Electrical Reference](#), for complete connection tables for various motor configurations.

These signals are named *PWMMagIA-4C* (12 signals) and *PWMSignIA-4B* (8 signals).

Connections & associated signals

These signals are generated by the Magellan Motion Control IC. There are no associated connections required for these signals to function properly, however, one or more of the digital grounds must be connected. For a complete description of the pinout connections to and from the board, see [Chapter 3, Prodigy-PC/104 Electrical Reference](#).

2.4.6 DAC Out

For DC brush, brushless DC or microstepping motors, this is the analog motor command when the motor output mode is set to DAC (digital-to-analog converter). These signals are named *DACIA - DAC4B* (8 signals), and vary between -10V and +10V. The number of signals per axis depends upon the motor type. See [Section 3.4, “Environmental and Electrical Ratings”](#), and the *Magellan Motion Control IC User Guide* for more information.

Connections & associated signals

For analog voltages to be output correctly, *AGND* (motor command ground) must be connected. For a complete description of the pinout connections to and from the board, see [Chapter 3, Prodigy-PC/104 Electrical Reference](#).

2.5 ISA Bus Address Map

The Prodigy-PC/104 Motion Board has a 16-bit ISA bus for parallel communications. The ISA bus can be configured as an 8-bit or 16-bit interface. The ISA bus mode is set with DIP switches as detailed in [Section 1.7.3, “DIP Switch Settings”](#).

Prodigy-PC/104 occupies a block of 16 contiguous addresses in I/O space. Memory space is not used. The base I/O address is set with DIP switches as detailed in [Section 1.7.3, “DIP Switch Settings.”](#) The following table outlines the function of each address offset within the address block:

Address Offset	Register Name	Type	Function
+0	Data	Write / Read	These two locations implement the parallel interface to the motion control IC. Refer to the Host Communications section of the Magellan Motion Control IC User Guide for more information.
+2	Command / Status	Write / Read	
+4	not used		
+6	Hard Reset	Write only	Writing to this location will cause a Hard reset of the Prodigy board.
+8	not used		
+A	DPRAM Address Pointer	Write / Read	These three locations are used to implement direct high-speed read and write of the onboard dual-port RAM over the ISA bus.
+C	DPRAM Data	Write / Read	
+E	DPRAM Config	Write / Read	

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3. Prodigy-PC/104

Electrical Reference

In This Chapter

- ▶ User-Settable Components
- ▶ Connectors
- ▶ Connections Summary—Motor Amplifiers
- ▶ Environmental and Electrical Ratings
- ▶ Certifications & Compliance
- ▶ Mechanical Dimensions
- ▶ User I/O Memory Map

3.1 User-Settable Components

Figures 3-1 and 3-2 illustrate the locations of the principal components of the Prodigy-PC/104 Motion Boards. The important user-accessible components of the board are listed in the following table:

Component	Function
Resistor packs RS1, RS2, and RS3	Sets the encoder termination.
JP1 and JP2 jumpers	Selects pulse & direction (step) or DC brush and brushless DC mode for each axis.
SW1 DIP switch	Sets base I/O address.

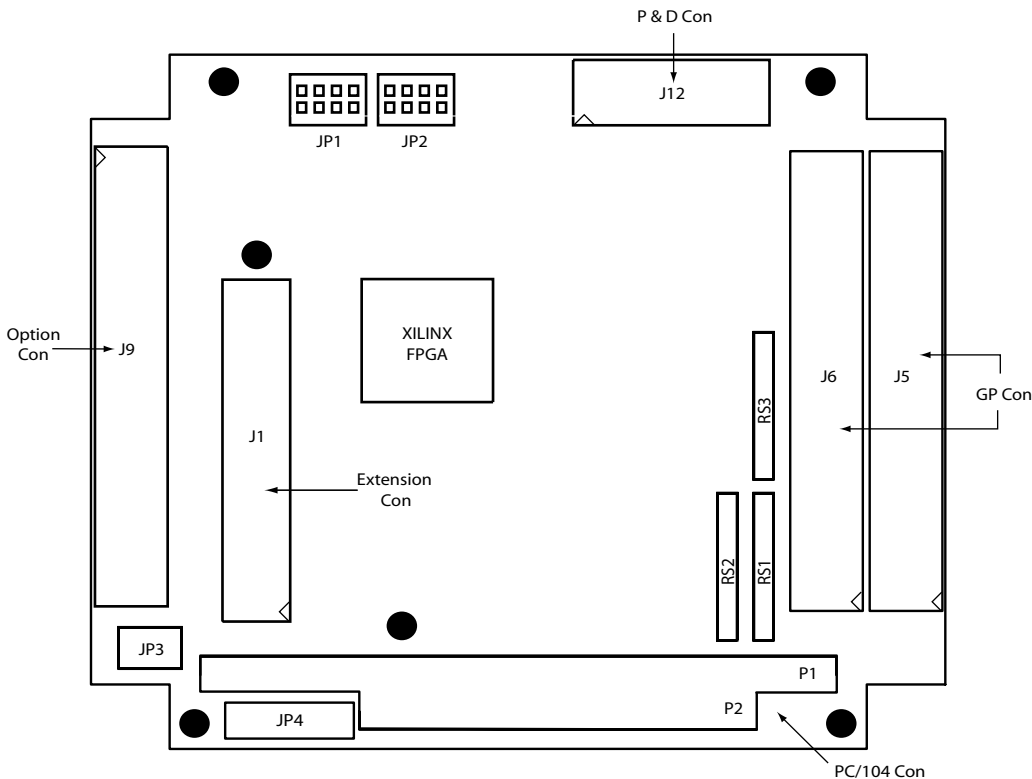
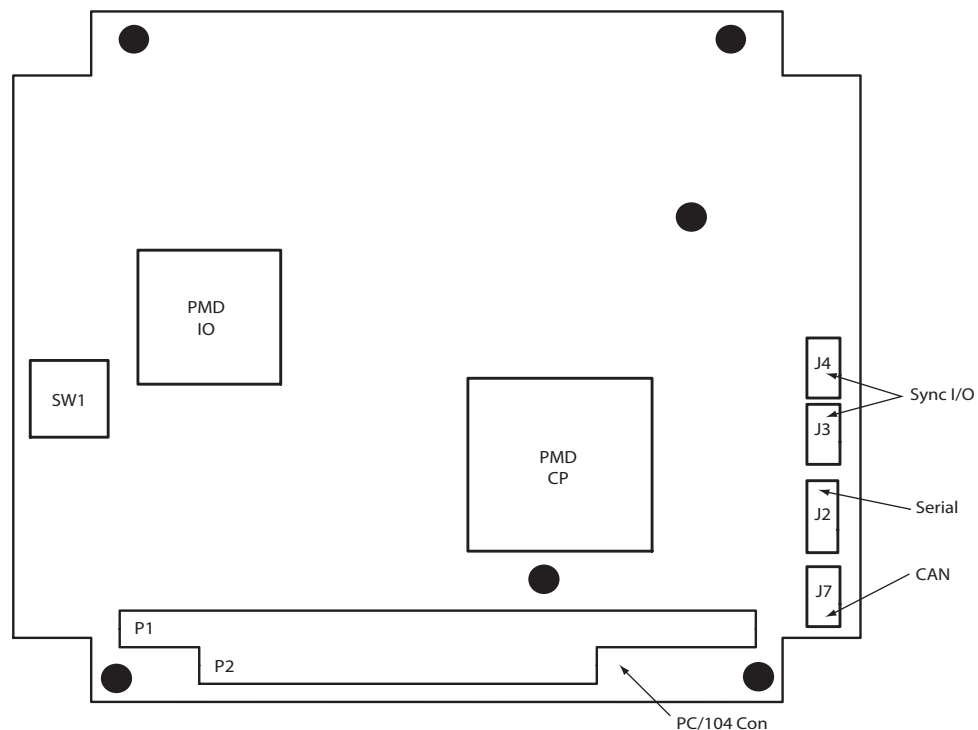


Figure 3-1:
Components
and Layout,
front of board

**Figure 3-2:
Components
and Layout,
back of board**



3.1.1 Encoder Connections and Resistor Packs

The RS1, RS2, and RS3 resistor packs (labeled RS 1 - 3 in [Figure 3-1](#)) are installed on the Prodigy-PC/104 Motion Board by default. Encoder inputs may be connected differentially, with two wires for *QuadA*, *QuadB*, and *Index* signals, or with just one wire per signal. If differential connections are being employed, resistor packs RS1, RS2, and RS3 should remain installed. If single-ended encoders are used, remove all three resistor packs, and connect encoder signals to the positive encoder input only. The negative input may remain unconnected. Encoder connections are detailed in the following tables:

Encoder connections when using differential encoder input:

Signal	J5 & J6 Pin Connections			
QuadAn+	J5-1	J5-19	J6-1	J6-19
QuadAn-	J5-2	J5-20	J6-2	J6-20
QuadBn+	J5-3	J5-21	J6-3	J6-21
QuadBn-	J5-4	J5-22	J6-4	J6-22
Indexn+	J5-5	J5-23	J6-5	J6-23
Indexn-	J5-6	J5-24	J6-6	J6-24
Vcc	J5-7	J5-25	J6-7	J6-25
GND	J5-8	J5-26	J6-8	J6-26

Encoder connections when using single-ended encoder input:

Signal	J5 & J6 Pin Connections			
QuadAn	J5-1	J5-19	J6-1	J6-19
QuadBn	J5-3	J5-21	J6-3	J6-21
Indexn	J5-5	J5-23	J6-5	J6-23
Vcc	J5-7	J5-25	J6-7	J6-25
GND	J5-8	J5-26	J6-8	J6-26

The Prodigy-PC/104 Motion Board has minimal jumper settings; most settings are software configurable. To prepare the board for installation, the following user-specified resistor pack options should be observed.

Item	Setting	Description
Resistor packs RS1, RS2, RS3	Installed; this is the default setting of resistor packs RS1 - RS3.	If differential connections are being used, leave the resistor packs installed.
	Removed.	If single-ended encoder connections are being used, remove the resistor packs.

3.1.2 Motor Jumpers

Various possibilities exist for setting up the Prodigy-PC/104 Motion Board for use with either DC brush, brushless DC (with or without on-board commutation), microstepping, or step (pulse & direction) motors. The default mode at power-on is for DC brush motor on all axes.

The jumpers JP1 and JP2 consist of four jumper blocks each, relating to axis 1, 2, 3, or 4. The following table describes the correct jumper settings for each motor type. See [Figure 3-1](#) for JP1 and JP2 locations. In the following table, the individual jumpers are numbered from left to right on each jumper block with each jumper number preceded by its jumper block: JP1-1 is the jumper farthest to the left on JP1; JP1-2 is second from the left, and so on.

An example of jumper settings is shown in [Figure 3-3](#). Note that the motor type selection determines the default output mode. See the *Magellan Motion Control IC User Guide* for more information.

Axis	Pulse & Direction	DC Brush, Brushless DC
1	JP1-1 installed	JP2-1 installed
2	JP1-2 installed	JP2-2 installed
3	JP1-3 installed	JP2-3 installed
4	JP1-4 installed	JP2-4 installed

NOTE: Use caution when setting motor jumpers. Be sure that the jumper settings are valid for the specified motor type.

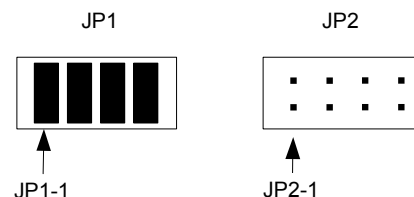


Figure 3-3:
Example of
Pulse &
Direction
Jumper
Settings

3.2 Connectors

There are nine user-accessible connectors on the Prodigy-PC/104 Motion Board. See page 14 for the specific locations of the connectors on the board. The connectors and their functions are outlined in the following table:

Connector	Functionality
GP Con (x2)	Provides connections to an external amplifier and motor elements.
Option Con	For brushless DC and microstepping motors, the Option Con connector provides additional connections to external amplifier and motor components.
Serial	The Serial connector allows the Prodigy-PC/104 Motion Board to be controlled via a serial port, or to enable monitoring over a separate serial port.
Sync I/O (x2)*	The Sync I/O connectors synchronize additional boards within the same system.
CAN	The CAN connector allows for integration with a CAN 2.0B network.
P&D Con	The pulse & direction differential output connector.

*Sync I/O is not available on the 8255xxx series motion boards.

3.2.1 GP Con

The GP Con connector (J5 and J6 in [Figure 3-1](#)) connects to various motion peripherals such as encoders, amplifiers, etc. The GP Con is comprised of two standard 50-pin ribbon cable headers. See [Section 3.2.11, “Connector Parts Reference,”](#) for more information.

3.2.2 GP Con Using DC Brush Motors

Pin	Connection	Description	Pin	Connection	Description
J5			J6		
1	QuadA1+	Quadrature A+ encoder input (axis 1)	1	QuadA3+	Quadrature A+ encoder input (axis 3)
2	QuadA1-	Quadrature A- encoder input (axis 1)	2	QuadA3-	Quadrature A- encoder input (axis 3)
3	QuadB1+	Quadrature B+ encoder input (axis 1)	3	QuadB3+	Quadrature B+ encoder input (axis 3)
4	QuadB1-	Quadrature B- encoder input (axis 1)	4	QuadB3-	Quadrature B- encoder input (axis 3)
5	Index1+	Index+ input (axis 1)	5	Index3+	Index+ input (axis 3)
6	Index1-	Index- input (axis 1)	6	Index3-	Index- input (axis 3)
7	Vcc	+5V	7	Vcc	+5V
8	GND	Ground	8	GND	Ground
9	PosLim1	Pos. direction limit switch input (axis 1)	9	PosLim3	Pos. direction limit switch input (axis 3)
10	NegLim1	Neg. direction limit switch input (axis 1)	10	NegLim3	Neg. direction limit switch input (axis 3)
11	Home1	Home input (axis 1)	11	Home3	Home input (axis 3)
12	GND	Ground	12	GND	Ground
13	AxisOut1	AxisOut output (axis 1)	13	AxisOut3	AxisOut output (axis 3)
14	PWMMag1A	PWM magnitude output (axis 1)	14	PWMMag3A	PWM magnitude output (axis 3)
15	PWMSign1A	PWM sign output (axis 1)	15	PWMSign3A	PWM sign output (axis 3)
16	AxisIn1	AxisIn input (axis 1)	16	AxisIn3	AxisIn input (axis 3)
17	DAC1A	Analog mtr cmd output (axis 1), $\pm 10V$	17	DAC3A	Analog mtr cmd output (axis 3), $\pm 10V$
18	AGND	Ground for analog motor command	18	AGND	Ground for analog motor command
19	QuadA2+	Quadrature A+ encoder input (axis 2)	19	QuadA4+	Quadrature A+ encoder input (axis 4)
20	QuadA2-	Quadrature A- encoder input (axis 2)	20	QuadA4-	Quadrature A- encoder input (axis 4)
21	QuadB2+	Quadrature B+ encoder input (axis 2)	21	QuadB4+	Quadrature B+ encoder input (axis 4)
22	QuadB2-	Quadrature B- encoder input (axis 2)	22	QuadB4-	Quadrature B- encoder input (axis 4)
23	Index2+	Index+ input (axis 2)	23	Index4+	Index+ input (axis 4)
24	Index2-	Index- input (axis 2)	24	Index4-	Index- input (axis 4)
25	Vcc	+5V	25	Vcc	+5V
26	GND	Ground	26	GND	Ground
27	PosLim2	Pos. direction limit switch input (axis 2)	27	PosLim4	Pos. direction limit switch input (axis 4)
28	NegLim2	Neg. direction limit switch input (axis 2)	28	NegLim4	Neg. direction limit switch input (axis 4)

Pin	Connection	Description	Pin	Connection	Description
29	Home2	Home input (axis 2)	29	Home4	Home input (axis 4)
30	AxisOut2	AxisOut output (axis 2)	30	AxisOut4	AxisOut output (axis 4)
31	PWMMag2A	PWM magnitude output (axis 2)	31	PWMMag4A	PWM magnitude output (axis 4)
32	PWMSign2A	PWM sign output (axis 2)	32	PWMSign4A	PWM sign output (axis 4)
33	AxisIn2	AxisIn input (axis 2)	33	AxisIn4	AxisIn input (axis 4)
34	DAC2A	Analog mtr cmd output (axis 2), $\pm 10V$	34	DAC4A	Analog mtr cmd output (axis 4), $\pm 10V$
35	AGND	Ground for analog motor command	35	AGND	Ground for analog motor command
36	DigitalIn0	General purpose digital input 0	36	DigitalIn4	General purpose digital input 4
37	DigitalIn1	General purpose digital input 1	37	DigitalIn5	General purpose digital input 5
38	DigitalIn2	General purpose digital input 2	38	DigitalIn6	General purpose digital input 6
39	DigitalIn3	General purpose digital input 3	39	DigitalIn7	General purpose digital input 7
40	AmpEnable1	Amplifier enable signal (axis 1)	40	AmpEnable3	Amplifier enable signal (axis 3)
41	DigitalOut0	General purpose digital output 0	41	DigitalOut4	General purpose digital output 4
42	DigitalOut1	General purpose digital output 1	42	DigitalOut5	General purpose digital output 5
43	DigitalOut2	General purpose digital output 2	43	DigitalOut6	General purpose digital output 6
44	DigitalOut3	General purpose digital output 3	44	DigitalOut7	General purpose digital output 7
45	AmpEnable2	Amplifier enable signal (axis 2)	45	AmpEnable4	Amplifier enable signal (axis 4)
46	Reset	Hardware reset input	46	AnalogGND	Gnd for general purpose analog inputs
47	Analog1	General purpose analog input 1	47	Analog5	General purpose analog input 5
48	Analog2	General purpose analog input 2	48	Analog6	General purpose analog input 6
49	Analog3	General purpose analog input 3	49	Analog7	General purpose analog input 7
50	Analog4	General purpose analog input 4	50	Analog8	General purpose analog input 8

3.2.3 GP Con Using Brushless DC or Microstepping Motors

Pin	Connection	Description	Pin	Connection	Description
J5			J6		
1	QuadA1+	Quadrature A+ encoder input (axis 1)	1	QuadA3+	Quadrature A+ encoder input (axis 3)
2	QuadA1-	Quadrature A- encoder input (axis 1)	2	QuadA3-	Quadrature A- encoder input (axis 3)
3	QuadB1+	Quadrature B+ encoder input (axis 1)	3	QuadB3+	Quadrature B+ encoder input (axis 3)
4	QuadB1-	Quadrature B- encoder input (axis 1)	4	QuadB3-	Quadrature B- encoder input (axis 3)
5	Index1+	Index+ input (axis 1)	5	Index3+	Index+ input (axis 3)
6	Index1-	Index- input (axis 1)	6	Index3-	Index- input (axis 3)
7	Vcc	+5V	7	Vcc	+5V
8	GND	Ground	8	GND	Ground
9	PosLim1	Pos. direction limit switch input (axis 1)	9	PosLim3	Pos. direction limit switch input (axis 3)
10	NegLim1	Neg. direction limit switch input (axis 1)	10	NegLim3	Neg. direction limit switch input (axis 3)
11	Home1	Home input (axis 1)	11	Home3	Home input (axis 3)
12	GND	Ground	12	GND	Ground
13	AxisOut1	AxisOut output (axis 1)	13	AxisOut3	AxisOut output (axis 3)
14	n.c.	No connection	14	n.c.	No connection
15	n.c.	No connection	15	n.c.	No connection
16	AxisIn1	AxisIn input (axis 1)	16	AxisIn3	AxisIn input (axis 3)
17	DAC1A	Phase A analog mtr cmd output (axis 1), $\pm 10V$	17	DAC3A	Phase A analog mtr cmd output (axis 3), $\pm 10V$
18	AGND	Ground for analog motor command	18	AGND	Ground for analog motor command
19	QuadA2+	Quadrature A+ encoder input (axis 2)	19	QuadA4+	Quadrature A+ encoder input (axis 4)
20	QuadA2-	Quadrature A- encoder input (axis 2)	20	QuadA4-	Quadrature A- encoder input (axis 4)
21	QuadB2+	Quadrature B+ encoder input (axis 2)	21	QuadB4+	Quadrature B+ encoder input (axis 4)
22	QuadB2-	Quadrature B- encoder input (axis 2)	22	QuadB4-	Quadrature B- encoder input (axis 4)
23	Index2+	Index+ input (axis 2)	23	Index4+	Index+ input (axis 4)
24	Index2-	Index- input (axis 2)	24	Index4-	Index- input (axis 4)
25	Vcc	+5V	25	Vcc	+5V
26	GND	Ground	26	GND	Ground
27	PosLim2	Pos. direction limit switch input (axis 2)	27	PosLim4	Pos. direction limit switch input (axis 4)
28	NegLim2	Neg. direction limit switch input (axis 2)	28	NegLim4	Neg. direction limit switch input (axis 4)
29	Home2	Home input (axis 2)	29	Home4	Home input (axis 4)

Pin	Connection	Description	Pin	Connection	Description
J5			J6		
30	AxisOut2	AxisOut output (axis 2)	30	AxisOut4	AxisOut output (axis 4)
31	n.c.	No connection	31	n.c.	No connection
32	n.c.	No connection	32	n.c.	No connection
33	AxisIn2	AxisIn input (axis 2)	33	AxisIn4	AxisIn input (axis 4)
34	DAC2A	Phase A analog mtr cmd output (axis 2), $\pm 10V$	34	DAC4A	Phase A analog mtr cmd output (axis 4), $\pm 10V$
35	AGND	Ground for analog motor command	35	AGND	Ground for analog motor command
36	DigitalIn0	General purpose digital input 0	36	DigitalIn4	General purpose digital input 4
37	DigitalIn1	General purpose digital input 1	37	DigitalIn5	General purpose digital input 5
38	DigitalIn2	General purpose digital input 2	38	DigitalIn6	General purpose digital input 6
39	DigitalIn3	General purpose digital input 3	39	DigitalIn7	General purpose digital input 7
40	AmpEnable1	Amplifier enable signal (axis 1)	40	AmpEnable3	Amplifier enable signal (axis 3)
41	DigitalOut0	General purpose digital output 0	41	DigitalOut4	General purpose digital output 4
42	DigitalOut1	General purpose digital output 1	42	DigitalOut5	General purpose digital output 5
43	DigitalOut2	General purpose digital output 2	43	DigitalOut6	General purpose digital output 6
44	DigitalOut3	General purpose digital output 3	44	DigitalOut7	General purpose digital output 7
45	AmpEnable2	Amplifier enable signal (axis 2)	45	AmpEnable4	Amplifier enable signal (axis 4)
46	Reset	Hardware reset input	46	AnalogGND	Gnd for general purpose analog inputs
47	Analog1	General purpose analog input 1	47	Analog5	General purpose analog input 5
48	Analog2	General purpose analog input 2	48	Analog6	General purpose analog input 6
49	Analog3	General purpose analog input 3	49	Analog7	General purpose analog input 7
50	Analog4	General purpose analog input 4	50	Analog8	General purpose analog input 8

3.2.4 GP Con Using Step (Pulse & Direction) Motors

Pin	Connection	Description	Pin	Connection	Description
J5			J6		
1	QuadA1+	Quadrature A+ encoder input (axis 1)	1	QuadA3+	Quadrature A+ encoder input (axis 3)
2	QuadA1-	Quadrature A- encoder input (axis 1)	2	QuadA3-	Quadrature A- encoder input (axis 3)
3	QuadB1+	Quadrature B+ encoder input (axis 1)	3	QuadB3+	Quadrature B+ encoder input (axis 3)
4	QuadB1-	Quadrature B- encoder input (axis 1)	4	QuadB3-	Quadrature B- encoder input (axis 3)
5	Index1+	Index+ input (axis 1)	5	Index3+	Index+ input (axis 3)
6	Index1-	Index- input (axis 1)	6	Index3-	Index- input (axis 3)
7	Vcc	+5V	7	Vcc	+5V
8	GND	Ground	8	GND	Ground
9	PosLim1	Pos. direction limit switch input (axis 1)	9	PosLim3	Pos. direction limit switch input (axis 3)
10	NegLim1	Neg. direction limit switch input (axis 1)	10	NegLim3	Neg. direction limit switch input (axis 3)
11	Home1	Home input (axis 1)	11	Home3	Home input (axis 3)
12	GND	Ground	12	GND	Ground
13	AxisOut1	AxisOut output (axis 1)	13	AxisOut3	AxisOut output (axis 3)
14	Pulse1	Pulse output (axis 1)	14	Pulse3	Pulse output (axis 3)
15	Direction1	Direction output (axis 1)	15	Direction3	Direction output (axis 3)
16	AxisIn1	AxisIn input (axis 1)	16	AxisIn3	AxisIn input (axis 3)
17	AtRest1	Atrest indicator output (axis 1)	17	AtRest3	Atrest indicator output (axis 3)
18	GND	Ground	18	GND	Ground
19	QuadA2+	Quadrature A+ encoder input (axis 2)	19	QuadA4+	Quadrature A+ encoder input (axis 4)
20	QuadA2-	Quadrature A- encoder input (axis 2)	20	QuadA4-	Quadrature A- encoder input (axis 4)
21	QuadB2+	Quadrature B+ encoder input (axis 2)	21	QuadB4+	Quadrature B+ encoder input (axis 4)
22	QuadB2-	Quadrature B- encoder input (axis 2)	22	QuadB4-	Quadrature B- encoder input (axis 4)
23	Index2+	Index+ input (axis 2)	23	Index4+	Index+ input (axis 4)
24	Index2-	Index- input (axis 2)	24	Index4-	Index- input (axis 4)
25	Vcc	+5V	25	Vcc	+5V
26	GND	Ground	26	GND	Ground
27	PosLim2	Pos. direction limit switch input (axis 2)	27	PosLim4	Pos. direction limit switch input (axis 4)
28	NegLim2	Neg. direction limit switch input (axis 2)	28	NegLim4	Neg. direction limit switch input (axis 4)
29	Home2	Home input (axis 2)	29	Home4	Home input (axis 4)
30	AxisOut2	AxisOut output (axis 2)	30	AxisOut4	AxisOut output (axis 4)
31	Pulse2	Pulse output (axis 2)	31	Pulse4	Pulse output (axis 4)

Pin	Connection	Description	Pin	Connection	Description
32	Direction2	Direction output (axis 2)	32	Direction4	Direction output (axis 4)
33	AxisIn2	AxisIn input (axis 2)	33	AxisIn4	AxisIn input (axis 4)
34	AtRest2	Atrest indicator output (axis 2)	34	AtRest4	Atrest indicator output (axis 4)
35	GND	Ground	35	GND	Ground
36	DigitalIn0	General purpose digital input 0	36	DigitalIn4	General purpose digital input 4
37	DigitalIn1	General purpose digital input 1	37	DigitalIn5	General purpose digital input 5
38	DigitalIn2	General purpose digital input 2	38	DigitalIn6	General purpose digital input 6
39	DigitalIn3	General purpose digital input 3	39	DigitalIn7	General purpose digital input 7
40	AmpEnable1	Amplifier enable signal (axis 1)	40	AmpEnable3	Amplifier enable signal (axis 3)
41	DigitalOut0	General purpose digital output 0	41	DigitalOut4	General purpose digital output 4
42	DigitalOut1	General purpose digital output 1	42	DigitalOut5	General purpose digital output 5
43	DigitalOut2	General purpose digital output 2	43	DigitalOut6	General purpose digital output 6
44	DigitalOut3	General purpose digital output 3	44	DigitalOut7	General purpose digital output 7
45	AmpEnable2	Amplifier enable signal (axis 2)	45	AmpEnable4	Amplifier enable signal (axis 4)
46	Reset	Hardware reset input	46	AnalogGND	Gnd for general purpose analog inputs
47	Analog1	General purpose analog input 1	47	Analog5	General purpose analog input 5
48	Analog2	General purpose analog input 2	48	Analog6	General purpose analog input 6
49	Analog3	General purpose analog input 3	49	Analog7	General purpose analog input 7
50	Analog4	General purpose analog input 4	50	Analog8	General purpose analog input 8

3.2.5 Option Con Connector

When the Prodigy-PC/104 Motion Board is used with either brushless DC or microstepping motors, the Option Con connector (labeled J9 in [Figure 3-1](#)) provides additional signals for multi-phase motor output and input of signals such as Hall sensors. The Option Con is a single standard 50-pin ribbon cable header. See [Section 3.2.11, “Connector Parts Reference,”](#) for more information.

3.2.6 PC/104 Option Con Using Multiple Motor Types (PR8258xxx only)

Pin	Connection	Description	Pin	Connection	Description
1	PWMMag1A	Phase A PWM magnitude output (axis 1)	26	Hall2B	Phase B Hall sensor input (axis 2)
2	PWMMag1B	Phase B PWM magnitude output (axis 1)	27	Hall2C	Phase C Hall sensor input (axis 2)
3	PWMMag1C / PWMSign1B	Phase C PWM magnitude output (axis 1) / Phase B PWM sign output (axis 1)	28	GND	Ground
4	PWMSign1A	Phase A PWM sign output (axis 1)	29	Hall3A	Phase A Hall sensor input (axis 3)
5	GND	Ground	30	Hall3B	Phase B Hall sensor input (axis 3)
6	PWMMag2A	Phase A PWM magnitude output (axis 2)	31	Hall3C	Phase C Hall sensor input (axis 3)
7	PWMMag2B	Phase B PWM magnitude output (axis 2)	32	GND	Ground
8	PWMMag2C / PWMSign2B	Phase C PWM magnitude output (axis 2) / Phase B PWM sign output (axis 2)	33	Hall4A	Phase A Hall sensor input (axis 4)
9	PWMSign2A	Phase A PWM sign output (axis 2)	34	Hall4B	Phase B Hall sensor input (axis 4)
10	GND	Ground	35	Hall4C	Phase C Hall sensor input (axis 4)
11	PWMMag3A	Phase A PWM magnitude output (axis 3)	36	GND	Ground
12	PWMMag3B	Phase B PWM magnitude output (axis 3)	37	AGND	Ground for analog motor command
13	PWMMag3C / PWMSign3B	Phase C PWM magnitude output (axis 3) / Phase B PWM sign output (axis 3)	38	DAC1A	Phase A analog mtr cmd output (axis 1), $\pm 10V$
14	PWMSign3A	Phase A PWM sign output (axis 3)	39	DAC2A	Phase A analog mtr cmd output (axis 2), $\pm 10V$
15	GND	Ground	40	DAC3A	Phase A analog mtr cmd output (axis 3), $\pm 10V$
16	PWMMag4A	Phase A PWM magnitude output (axis 4)	41	DAC4A	Phase A analog mtr cmd output (axis 4), $\pm 10V$
17	PWMMag4B	Phase B PWM magnitude output (axis 4)	42	DAC1B	Phase B analog mtr cmd output (axis 1), $\pm 10V$

Pin	Connection	Description	Pin	Connection	Description
18	PWMMag4C / PWMSign4B	Phase C PWM magnitude output (axis 4) Phase B PWM sign output (axis 4)	43	DAC2B	Phase B analog mtr cmd output (axis 2), $\pm 10V$
19	PWMSign4A	Phase A PWM sign output (axis 4)	44	DAC3B	Phase B analog mtr cmd output (axis 3), $\pm 10V$
20	GND	Ground	45	DAC4B	Phase B analog mtr cmd output (axis 4), $\pm 10V$
21	HallIA	Phase A Hall sensor input (axis 1)	46	AGND	Ground for analog motor command
22	HallIB	Phase B Hall sensor input (axis 1)	47	GND	Ground
23	HallIC	Phase C Hall sensor input (axis 1)	48	GND	Ground
24	GND	Ground	49	Vcc	+5V
25	Hall2A	Phase A Hall sensor input (axis 2)	50	Vcc	+5V

3.2.7 Serial Connector

The following table gives the pinout for the 5-position Molex 1.25 mm header used for serial communications.

Pin	Connection	Description
1	SrIEnable	Serial enable (used only for RS422/485)
2	SrIXmt	Serial transmit output
3	SrIRcv	Serial receive input
4	GND	Ground
5	Vcc	+3.3V

For more information on communicating to the Magellan Motion Control IC via the serial port, see the *Magellan Motion Control IC User Guide*.

3.2.8 Sync I/O Connector

The two *Sync I/O* connectors located on the back of the Prodigy-PC/104 Motion Board (J3 and J4 in [Figure 3-2](#)) allow for the synchronization of multiple Prodigy-PC/104 Motion Boards within a single system. This configuration enables operation within the same cycle period. If multiple boards are installed, yet not inter-connected, any additional boards would begin working after the first board (master) was initialized. However, none of the axes would be synchronized. With *Sync I/O* activated, the servo loops of all slave boards are synchronized to the servo loop of the master board. This allows for precise synchronization of all implemented axes.

To connect two or more Prodigy-PC/104 Motion Boards for synchronization, a *Sync I/O* cable (one cable for each set of two boards) is required. This cable may be connected to either of the two *Sync I/O* connectors on the boards. Both connectors function as either an input or output; the two sync connectors are wired in parallel. For more information on synchronizing multiple Prodigy-PC/104 Motion Boards, see the *Magellan Motion Control IC User Guide*, Section 8.5, “The Sync Pin—Multiple Chip Synchronization.”

The pinouts for the *Sync I/O* connectors are defined in the following table:

Pin Number	Signal
1	Sync-in or sync-out pin, depending on whether the board is master or slave.
2	GND

NOTE: Sync I/O is not available on the PR8255xx series boards. Additionally, if any axis is set for pulse & direction, the sync option cannot be used.

The following diagram shows three synchronized Prodigy-PC/104 Motion Boards. Note that the *Sync I/O* connectors are located on the back of the board.

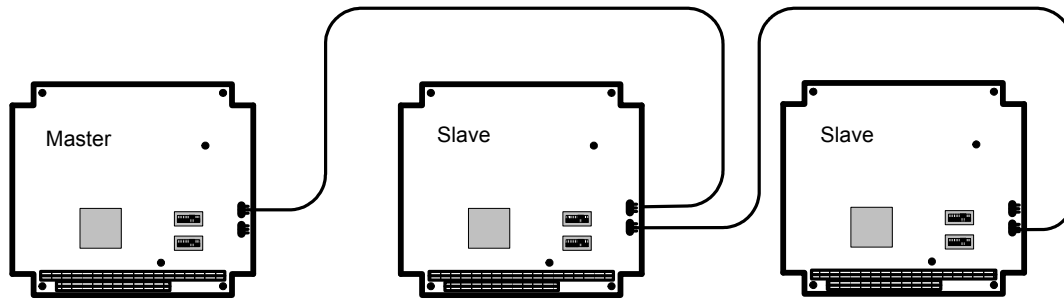


Figure 3-4:
Sync I/O
Connector to
Three Boards

3.2.9 CAN Connector

The Prodigy-PC/104 Motion Board's controller area network (CAN) transceivers are designed for use with CAN controllers, or with equivalent devices. They are intended for use in applications employing the CAN serial communication physical layer in accordance with the ISO 11898 standard. The transceiver provides differential transmit and differential receive capability to/from a CAN controller at speeds up to 1 Mbps.

The Prodigy-PC/104 Motion Board will integrate with a CAN 2.0B network. It will coexist, but not communicate with, other CAN 2.0B nodes on that network. The CAN functionality receives commands, sends responses, and (optional) sends asynchronous event notifications.

The pinouts for the CAN connector are as follows:

Pin Number	Signal
1	CANH
2	CANL

The CAN connector is located on the back of the board, and is labeled J7 in [Figure 3-2](#).

3.2.10 Pulse & Direction Differential Output Connector

This connector (labeled J12 in [Figure 3-1](#)) provides pulse and direction outputs using line drivers. Using this connector with pulse and direction step drivers will provide a higher immunity to noise, reducing the chance of mispositioning. The pins and their associated signals are described in the following table:

Pin Number	Signal	Pin Number	Signal
1	GND	11	axis 3, direction +
2	GND	12	axis 3, direction -
3	axis 4, pulse +	13	axis 1, pulse +
4	axis 4, pulse -	14	axis 1, pulse -
5	axis 1, direction +	15	axis 2, direction +
6	axis 1, direction -	16	axis 2, direction -
7	axis 4, direction +	17	axis 3, pulse +
8	axis 4, direction -	18	axis 3, pulse -
9	axis 2, pulse +	19	GND
10	axis 2, pulse -	20	GND

3.2.11 Connector Parts Reference

PMD recommends using only the PMD-supplied cable assemblies. These assemblies are guaranteed to remain below the maximum height so as to allow stacking of multiple Prodigy-PC/104 Motion Boards. Using normal IDC connec-

tors will result in exceeding the maximum height permitted by PC/104 specifications. The following table is supplied as a reference only.

Label	Description	Header Part Number	Connector Mate
J2	Serial	Molex 53261-0571	Molex 51021-0500
J3, J4	Sync I/O	Molex 53261-0271	Molex 51021-0200
J5, J6	GP Con	Samtec TSM-125-01-L-DV	Samtec IDSD-25-S
J7	CAN	Molex 53261-0271	Molex 51021-0200
J9	Option Con	Samtec TSM-125-01-L-DV	Samtec IDSD-25-S
J12	Pulse & Direction Con	Samtec TSM-110-01-L-DV	Samtec IDSD-10-S

3.3 Connections Summary—Motor Amplifiers

The Prodigy-PC/104 Motion Board supports four methods of output to motor amplifiers, as described in the following table:

Motor Output Method	Signal Output
DAC	Analog signals from the onboard D-A converters.
PWM sign-magnitude	Pulse width modulated signals with separate magnitude and sign signals per output phase.
PWM 50/50	Pulse width modulated square-wave signals with a single PWM signal per output phase.
Pulse & Direction	One signal representing stepping information, and a signal representing direction.

In addition, each motor axis may have one, two, or three output phases associated with it. For DC brush motors, the number of phases is one. For multi-phase motors such as brushless DC or microstepping motors, the number of phases can be two or three, depending on the output waveform programmed into the Prodigy-PC/104 Motion Board. For more information, see the *Magellan Motion Control IC User Guide*.

The following tables provide convenient summaries of amplifier connections for common configurations of motor output method and motor type. These outputs should be connected from the designated connector pins to the appropriate amplifier inputs. Note that the names of the pins will vary among amplifiers. Common names are shown.

3.3.1 DC Brush Motor Connections

Motor Output Method	Prodigy-PC/104 Connection Name	Amplifier Input Connection Name*	Connection			
			Axis 1	Axis 2	Axis 3	Axis 4
DAC	DAC1-4A	Ref+ or V+	J5-17	J5-34	J6-17	J6-34
	AGND	Ref- or GND	J5-18	J5-35	J6-18	J6-35
PWM sign/magnitude	PWMMag1-4A	PWM magnitude	J5-14	J5-31	J6-14	J6-31
	PWMSign1-4A	PWM direction	J5-15	J5-32	J6-15	J6-32
	GND	Ground	J5-8	J5-26	J6-8	J6-26

* Names of amplifier connections vary. Common names are shown.

3.3.2 Brushless DC Motor Connections

Motor Output Method	Prodigy-PC/104 Connection Name	Amplifier Input Connection Name*	Connection			
			Axis 1	Axis 2	Axis 3	Axis 4
DAC	DACI-4A	Ref1+ or V1+	Option-38	Option-39	Option-40	Option-41
	DACI-4B	Ref2+ or V2+	Option-42	Option-43	Option-44	Option-45
	AGND	Ref- or GND	Option-37	Option-46	Option-37	Option-46
PWM 50/50	PWMMagI-4A	PWM phase 1	Option-1	Option-6	Option-11	Option-16
	PWMMagI-4B	PWM phase 2	Option-2	Option-7	Option-12	Option-17
	PWMMagI-4C	PWM phase 3	Option-3	Option-8	Option-13	Option-18
	GND	Ground	Option-5	Option-10	Option-15	Option-20

* Names of amplifier connections vary. Common names are shown.

3.3.3 Microstepping Motor Connections

Motor Output Method	Prodigy-PC/104 Connection Name	Amplifier Input Connection Name*	Connection			
			Axis 1	Axis 2	Axis 3	Axis 4
DAC	DACI-4A	Ref1+ or V1+	Option-38	Option-39	Option-40	Option-41
	DACI-4B	Ref2+ or V2+	Option-42	Option-43	Option-44	Option-45
	AGND	Ref- or GND	Option-37	Option-46	Option-37	Option-46
PWM sign/magnitude	PWMMagI-4A	PWM magnitude	Option-1	Option-6	Option-11	Option-16
	PWMSignI-4A	PWM direction	Option-4	Option-9	Option-14	Option-19
	PWMMagI-4B	PWM magnitude	Option-2	Option-7	Option-12	Option-17
	PWMSignI-4B	PWM direction	Option-3	Option-8	Option-13	Option-18
	GND	Ground	Option-5	Option-10	Option-15	Option-20

* Names of amplifier connections vary. Common names are shown.

3.3.4 Step (Pulse & Direction) Motor Connections

Motor Output Method	Prodigy-PC/104 Connection Name	Amplifier Input Connection Name*	Connection			
			Axis 1	Axis 2	Axis 3	Axis 4
Pulse & direction (single-ended)	PulseI-4	Pulse or step	J5-14	J5-31	J6-14	J6-31
	DirectionI-4	Direction	J5-15	J5-32	J6-15	J6-32
	GND	Ground	J5-12	J5-26	J6-12	J6-26
Pulse & direction (differential)	PulseI-4+	Pulse + or step +	J12-13	J12-9	J12-17	J12-3
	PulseI-4-	Pulse - or step -	J12-14	J12-10	J12-18	J12-4
	DirectionI-4+	Direction +	J12-5	J12-15	J12-11	J12-7
	DirectionI-4-	Direction -	J12-6	J12-16	J12-12	J12-8
	GND	Ground	J12-1	J12-2	J12-19	J12-20
Pulse & direction	AtRestI-4	At Rest	J5-17	J5-34	J6-17	J6-34

* Names of amplifier connections vary. Common names are shown.

3.4 Environmental and Electrical Ratings

Storage temperature:	-40 to +125 degrees C (-40° F to +257° F)
Operating temperature:	0 to +70 degrees C (32° F to +158° F)
Power requirements:	4.8V to 5.25V operating range, 0.6A (no outputs on)
Supply voltage limits:	-0.3V to +7V
Analog (DAC) output range:	-10.0V to +10.0V, $\pm 3\text{mA}$ min/axis, short circuit protected
Analog input range:	0 to 3.3V, 1.4 KOhm input impedance
Digital I/O voltage range:	0V to 5V, TTL thresholds, inputs pulled up to 5V through 4.7 kOhm resistors
Digital outputs drive capacity:	DC output source or sink current: $\pm 50\text{mA}$
CAN communications:	2.0B compliant, non-isolated, 1 Mbps
Serial communications:	3.3V signaling, unbuffered (no transceiver)

3.5 Certifications & Compliance

Specification	Standard
CE	LVD: EN60204-1 EMC-D: EN6100-6-1, EN61000-6-3, EN55011

3.6 Mechanical Dimensions

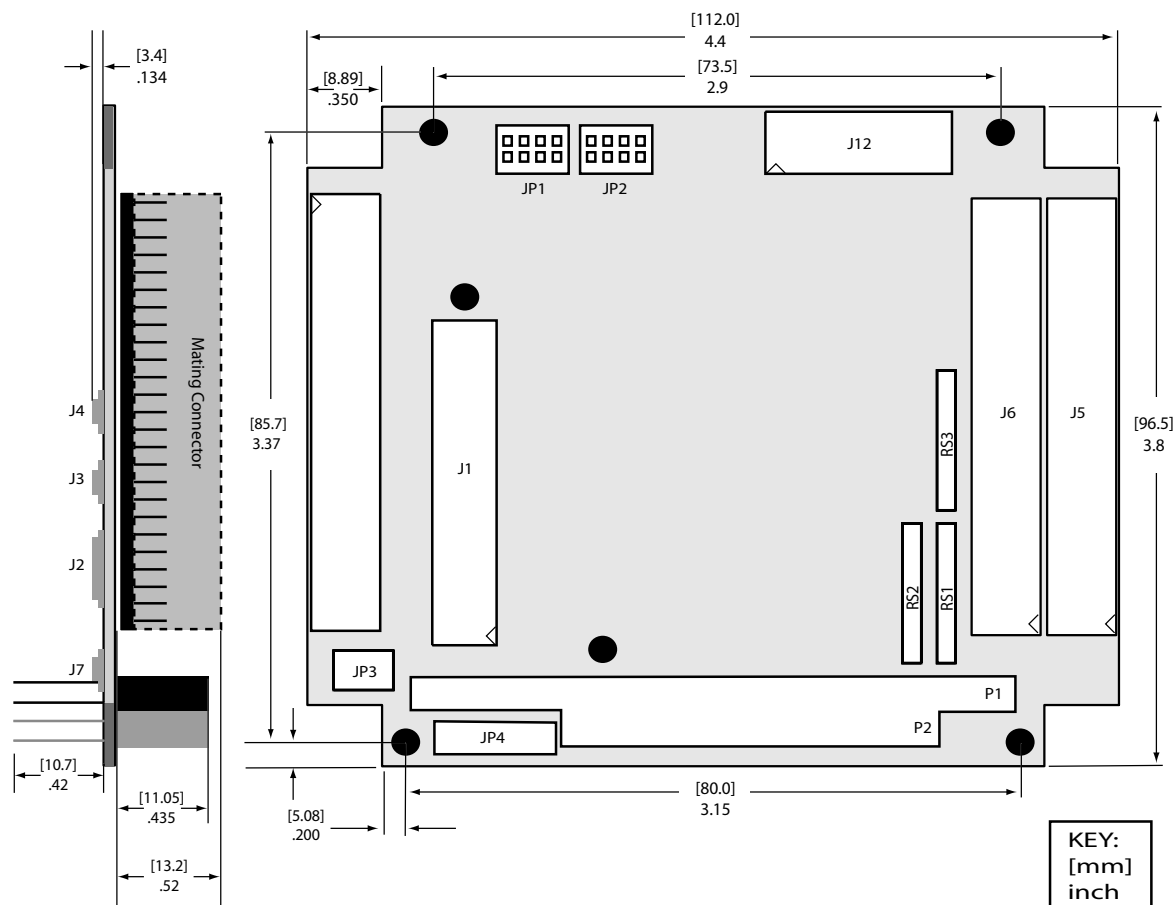


Figure 3-5:
Prodigy-PC/
104
Mechanical
Dimensions

When stacking Prodigy-PC/104 boards with 0.6" spacers, the Option Con mating connector on one board will interfere with connectors J2, J3, J4, and J7 on the other. For clearance, additional .062" or 1.5 mm shim washers are required.



3.7 User I/O Memory Map

The Magellan Motion Control IC reserves the sector from address 1000h to 10FFh in peripheral space for user-defined I/O devices. The Prodigy-PC/104 Motion Board uses this sector as shown in the following table:

Address	Device	Description
1000h	General Purpose I/O	Includes the 8 digital inputs and 8 digital outputs
1001h	Amplifier Enable register	Also includes the DAC output enable
1002h	Reset Monitor register	See Section 2.3.9
1003h	Reserved	
1004h	Watchdog register	See Section 2.3.6

Address	Device	Description
I005h	Reserved	
I006h - I00Fh	Reserved	
I020h - I0CFh	None	
I0D0h - I0DAh	Reserved	Used by Prodigy FPGA
I0DBh	Build register	Build number of Prodigy FPGA
I0DCh - I0DFh	Reserved	Used by Prodigy FPGA
I0E0h - I0EFh	None	Available for use with custom peripherals over Extension Con
I0F0h - I0FDh	Reserved	
I0FEh	Model type	For compatibility with older Magellan Motion Board family
I0FFh	Board ID	See Section 2.3.10

See the *Magellan Motion Control IC User Guide* for more information on peripheral memory space.

4. Interconnect Module

In This Chapter

- IM-1000 Interconnect Module

4.1 IM-1000 Interconnect Module

The IM-1000 is an interconnect module which assists in the set up and configuration of the Prodigy-PC/104 Motion Board, and also provides complete options for external connections. All wiring to and from the Prodigy-PC/104 Motion Board, the amplifiers, power supplies, IOs and encoder feedback may easily be connected to this central point.

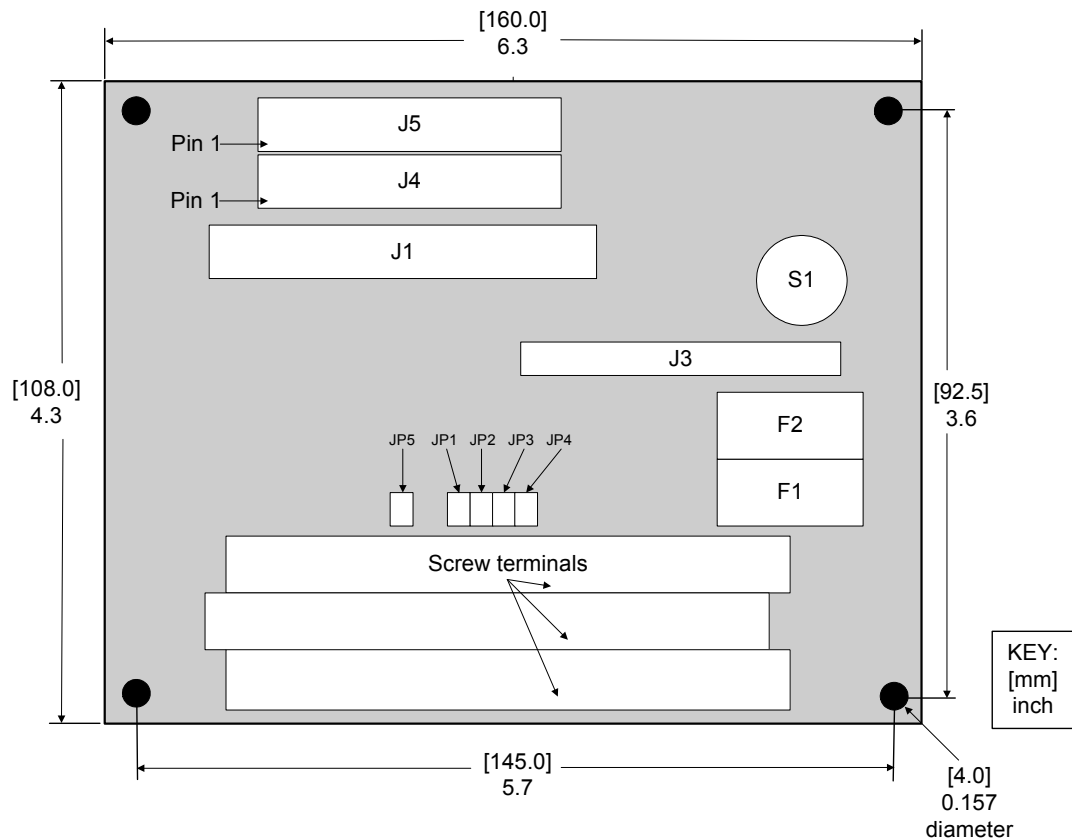


Figure 4-1:
IM-1000
Location of
Components

Connector	Description
F1	1 Amp fuse for power supply
F2	1 Amp fuse for power supply
J1	100-position connector
J3	OPTO22 connector
J4	50-position connector
J5	50-position connector
S1	External hardware reset button
Screw terminals	(3) 100-terminal connection blocks for connecting to one 100-position, or two 50-position cables.

The enclosure of the board is a standard Phoenix DIN rail mounting system. Alternatively, the enclosure may be removed, and the board mounted to other systems via the 3.5 mm mounting holes located on the corners of the board.

The pinout descriptions that follow provide a detailed illustration of the IM-1000's connections. Please observe the differences between the DC brush and brushless DC and stepping motor versions. The screw terminal numbers correspond to the pinout description for the Prodigy-PC/104 Motion Board in the following way:

PC/104	IM-1000	Screw Terminals
J5	J4	1-50
J6	J5	51-100

The following table lists the functions of the remaining screw terminals:

Screw Terminals	Function
101, 103	5V from J1 through 1 Amp fuse F2
102, 104, 105	GND
106	External power in
107	GND
108	Unused

The Prodigy-PC/104 Motion Board supplies 5V DC from the computer to pins J5-7, J5-25, J6-7, and J6-25 through a 1 Amp fuse to power encoders. When the jumpers JP1, JP2, JP3 and JP4 are installed 1-2, this 5V is passed on to screw terminals 7, 25, 57, and 75, respectively. Alternatively, it is also possible to use an external power supply in the range of 5 - 12 VDC for the encoders. To do this, install jumpers JP1, JP2, JP3 and JP4 on pins 2-3 and connect the external power to screw terminal 106 and its ground to 107. This external power will be limited to 1 Amp by fuse F1.

Connections to J3 (the OPTO 22 connector) are as follows:

J5/J6	J3	Description
	49	5V if JP5 jumper is installed
J5-36	47	DigitalIn0
J5-37	45	DigitalIn1
J5-38	43	DigitalIn2
J5-39	41	DigitalIn3
J6-36	39	DigitalIn4
J6-37	37	DigitalIn5
J6-38	35	DigitalIn6
J6-39	33	DigitalIn7
J5-41	31	DigitalOut0
J5-42	29	DigitalOut1
J5-43	27	DigitalOut2
J5-44	25	DigitalOut3
J6-41	23	DigitalOut4
J6-42	21	DigitalOut5
J6-43	19	DigitalOut6
J6-44	17	DigitalOut7
J5-40	15	AmpEnable1
J5-45	13	AmpEnable2
J6-40	11	AmpEnable3
J6-45	09	AmpEnable4
J5-13	07	AxisOut1
J5-30	05	AxisOut2
J6-13	03	AxisOut3
J6-30	01	AxisOut4
	All even-numbered pins	GND

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