PMDX-126

Multi-Mode Break-Out Board

User's Manual

Document Revision: 1.1
Date: 9 August 2011
PCB Revision: PCB-485A
Revision: A3
Serial Numbers: 28289 and above

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1.0 Overview

This document describes the configuration and operation of the PMDX-126 Multi-Mode Break-Out Board. The PMDX-126 provides an interface between a PC and a multi-axis step & direction controlled motor system or other user equipment. This document pertains to the following versions of the PMDX-126:

Circuit Board Revision:	PCB-485A (marked on the bottom of the board)
Revision:	A3 (marked on silk screen block above serial number)
Serial Number Range:	28289 and above

1.1 Important Safety Information

The PMDX-126 is intended for integration by the purchaser into industrial control systems. It is solely the purchaser's responsibility to assure that the system is configured in a manner consistent with applicable safety requirements. Practical Micro Design, Inc. does not control how this board is integrated into the purchaser's system and cannot be responsible for guaranteeing the safety of your system.

The PMDX-126 is not guaranteed to be fail-safe. The system into which the PMDX-126 is installed should provide fail-safe protection and emergency stop capability.

The PMDX-126 contains circuitry that may be connected to dangerous voltages. Care must be taken that user cannot come in contact with these voltages. An enclosure that allows for modest ventilation, but prevents intrusion by operator's hands and foreign objects, especially conductive byproducts of machining operations, should be utilized with this board. Interlock switches on power circuits should remove power when the enclosure is opened.

Automated machine tools, into which the PMDX-126 may be integrated, can cause injury. Precautions should be taken to assure that operators are trained in their proper operation and safety procedures, and that they are protected from moving parts that may be under remote control and may move unexpectedly.

This product may not be used in life support or other critical safety applications.

1.2 Warranty Summary

The PMDX-126 is warranted against failure due to defective parts or workmanship for 90 days from the date of sale. Refer to Appendix A for complete warranty details.

> *NOTE:* If you have an item requiring service, please see the "Warranty and Repairs" page on the PMDX web site (http://www.pmdx.com) for return instructions.

In general, the purchaser must pay shipping to send the unit to PMDX. For repairs covered under warranty and with return shipping to a USA address PMDX will ship the repaired unit back to you via ground transportation at our expense. Repairs are normally completed within 10 business days. See Appendix A for our complete warranty details. ***Please see the "Warranty and Repairs" page on our web site (http://www.pmdx.com) for full details of our repair and shipping policies.***

1.3 Trademarks

The following product names used in this manual are the trademark, tradename or registered mark of the respective companies:

Product Names	Company
EMC	Linux CNC http://www.linuxcnc.org
G201X, G203V, G320X and Geckodrive	Geckodrive, Inc. (http://www.geckodrive.com)
Mach3	ArtSoft (http://www.machsupport.com)
SmoothStepper	Warp9 Tech Design, Inc. (http://www.warp9td.com/)
PMDX-104, PMDX-106, PMDX-107, PMDX-108, PMDX-132, PMDX-133 and PMDX-134	PMDX/Practical Micro Design, Inc. (http://www.pmdx.com)

1.4 Features

The PMDX-126 has the following features:

- Provides up to 16 outputs and 9 inputs by using dual parallel ports, or a single port by using expanded mode drivers

- Integrates well with SmoothStepper by providing dual parallel ports with ribbon cable connections, mounting holes for stacking SmoothStepper onto the PMDX-126 as a daughter board, and power to run the SmoothStepper fed via ribbon cables

- Supports up to 12 outputs as step and direction signals for up to 6 motor axes using dual printer ports or Smoothstepper

- Mach software plug-in provided to support enhanced I/O features

- On board LED indicators on all signals

- Terminal strip outputs provided for external LEDs showing status of Power On, E-Stop, Charge Pump, and step signal activity

- All status inputs are optically isolated

- All parallel port signals are terminated and filtered to help resist noise problems

- All step, direction, and control output signals are buffered with 16 mA drivers

- Special isolated interface to sense ERR/RST signal used by Geckodrive servo products that can sense faults and also reset and enable Geckodrive servo products from the computer

- E-Stop, Fault, ERR/RST, and "Charge Pump timeouts" turn off all outputs without assistance from host software

- Provides one 30 ampere electromechanical relay useful for spindle control

- Provides one 10 ampere electromechanical relay for auxiliary functions

- Relays have MOV arc suppressors for longer life of contacts

- Can provide 5 axis from a single parallel port, or 6 axis with the 6 axis cloned in hardware from the first axis

- Powered directly by AC mains; 115 or 230 volts, switch selectable

- Self-resetting poly-fuse protects mains power input

- Has option card connector for directly mounting the PMDX-107 or using a ribbon cable to the PMDX-106 spindle speed controllers and also other future products

- Buffered step and direction available as screw terminal blocks, and as a ribbon header for direct connection to driver boards with ribbon header inputs for parallel port signals

- Terminal blocks also provide, +5 volts, and Ground along with Step/Dir outputs to drivers

- Screw terminal blocks for isolated status inputs also provide +5 volts and unregulated +12 volts to power sensors such as the PMDX-170, PMDX-171, and NPN proximity sensors

- Status sensor inputs work with mechanical switches, NPN sensors, 5 volt logic signals, and PNP sensors or PLC outputs that source 24 volts DC

- Pulse stretch circuit to allow a narrow pulse encoder output to be used as lathe index signal

- Built in test for generating step signals without need of a host computer

- "Charge Pump"/watchdog function has enhanced timing algorithm to avoid teasing by Windows boot process

- The 8 data bits of the second parallel port, while not connected on the PMDX-126, can be supported with the optional PMDX-108 boards which feature flow through ribbon connections

- The logic level control output connectors can be connected directly to, and power, the PMDX-104 board to provide 4 medium current isolated mechanical relay outputs

- Microprocessor and programmable logic allow for the future addition of more features

1.5 Updates to This Manual and Application Notes

Check the PMDX web site for revisions or updates to this manual (http://www.pmdx.com). The latest revision of this manual is available on the PMDX-126 page (follow the links from the main page). Older versions of this manual are available on the "User Manual Archives" web page. Also check on the "Support" web page for *application notes* related to the PMDX-126.

2.0   Quick Start Guide

2.1   Select AC Mains Voltage

The PMDX-126 can be powered from 115/120VAC or 220/230/240VAC.   There is a voltage selector switch next to the AC Mains connector (J8). Set this switch to the appropriate setting for your AC voltage. Then connect your AC power to the PMDX-126. *DO NOT APPLY POWER YET!*

2.2   Initial Power-On

Set all DIP switches to "closed" (see section 3.0) to select "Run Normal" mode (this should be the default setting when we ship the board to you). Also verify that the jumper wire is still installed on connector J13 from the "E-Stop" terminal to the "GND" terminal. Apply power to the board and observe the "Power On", "E-Stop" and "Outputs Enabled" LEDs. The "Power On" LED should turn on. The E-Stop LED should turn on for approximately 1 second and then turn off. After the E-Stop LED turns off the "Outputs Enabled" LED should turn on and stay on. *NOW POWER OFF THE BOARD.*

2.3   Connecting Motor Drivers

2.3.1   Connecting to PMDX-133 or PMDX-134

Before you connect the PMDX-133 or PMDX-134 motherboards to the PMDX-126 follow the steps in the "Quick Setup Guide" in the PMDX-133 or PMDX-134 User's Manuals. Once you have the motherboards and Geckodrives configured (and tested the motor power), then use a 26-pin female-to-female ribbon cable to connect the PMDX-126 (from connector J19) to the PMDX-133 or PMDX-134.

2.3.2   Discrete Wiring to Motor Drivers

The PMDX-126 can output step and direction signals on any of its output pins (except when in one of the "expanded" modes, see section 5.3 for details). This allows for configurations where more than 4 axis of step and direction are needed. Note that some of the "control" outputs (parallel port pins 1, 14, 16 and 17) may be used for other functions, thereby limiting their use as step and direction outputs. Each output signal connector has both a ground reference terminal and a +5V terminal. This allows the use of drivers that require either a "ground common" or "+5V common" reference for their step and direction inputs.

> *NOTE:*   When using outputs "1", "14", '16", 17", "A", "B", "C" or "D" for step and direction
>   signals, connect to the "step" signal to pins "1", "16", "A" or "C" in order for the
>   activity monitor to function correctly (see "Steps LED" in section 9.0)

2.4   Test Motor Driver Connections

Power on the board and use the PMDX-126's built-in test modes to verify that you have the step and direction signals wired correctly between the PMDX-126 and your stepper drivers. See section 5.4 for more information on the PMDX-126's test modes.

2.5   Connect E-Stop Switch(es)

If your system will use an "emergency stop" circuit, remove the jumper wire from J13 and connect your E-Stop circuit to the PMDX-126 (on connector J13 from the "E-Stop" terminal to the "GND" terminal). Verify that the red E-Stop LED on the PMDX-126 turns on when the E-Stop switch is pressed (or the E-Stop circuit is activated). Verify that the LED turns off when the E-Stop switch is released (or the E-Stop circuit is de-activated). See section 6.2 for more information about the *E-Stop* input.

2.6   Connecting Limit, & Home Switches and Other Inputs

Connect any limit or home switches, spindle sensors, etc. to the PMDX-126's input terminals. See section 6.0 for more information.

2.7   Connecting CMOS (+5V) Outputs

The output signals on connectors J5 and J6 are TTL/CMOS level digital outputs (i.e. 0V to +5V approximately). Connector J6 has signals from parallel port #1 pins 1, 14, 16 and 17 (labeled "1", "14", "16" and "17"). Connector J5 has signals from parallel port #2 pins 1, 14, 16 and 17 (labeled "A", "B", "C" and "D"), or these can be driven from the first parallel port using the PMDX-126's expanded modes (see section 5.3).

2.8   Connecting Relay Outputs

Relay K1 provides a set of "normally open" contacts on connector J9. Relay K2 provides "common", "normally open" and "normally closed" contacts as well as a MOV-protection terminal   See section 7.2 for more information.

2.9   Connecting to a PC or SmoothStepper

Connecting to a PC:
If you are using one parallel port, connect that to either J15 (using a DB25 male-to-male printer cable) or J16 (using a DB25 to 26-pin Ribbon Header cable). If your PC has two parallel ports, connect the first port as described above, and the second port to connector J17 (must use a DB25 to 26-pin Ribbon Header cable).

Connecting to a SmoothStepper:
Connect the PMDX-126 to the SmoothStepper using one or two 26-pin female-to-female ribbon cables. Determine how you will provide power to the SmoothStepper. Configure jumper JP3 on the PMDX-126 and the SmoothStepper jumpers according to the description in Table 7 in section 4.0.

2.10   Test Your Configuration in "Normal" Mode

The PMDX-126 has several different operating modes, some of which have additional requirements for proper operation. Starting to test your setup with the PMDX-126 in "Normal" mode removes most of those requirements and makes it easier to test the basic setup. This allows you to test the wiring to/from the PMDX-126 as well as the I/O settings in your motion control software (Mach3, EMC, etc.).

- Turn all of the DIP switches to the "closed" position (this should be the default setting when we ship the board to you and the configuration used in step 2.2)
- Apply power to the PMDX-126 and verify that the "Outputs Enabled" LED is on. If the "Outputs Enabled" LED is not on, all of the PMDX-126's outputs will be disabled.

Using your CNC software on the PC:
- Configure and test the E-Stop input on parallel port #1 pin 10 (also present on parallel port #2 pin 10).
- Configure your motor step and direction signals and using "jog" commands verify that your CNC software can drive each motor
- Test any other output signals (coolant pump, spindle on/off)
- Test any input signals (limit switches, spindle sensors, etc.).

2.11   Test Your Configuration with the Charge Pump

If you will be using the "charge pump" feature (see section 8.0), then enable that in your CNC software and change the PMDX-126's DIP switches to "Run Normal with Charge Pump" (see sections 3.1 and 5.2.2). Press the "Test" button or power the PMDX-126 off and back on to activate the "Run Normal with Charge Pump" mode. Verify that the ""Outputs Enabled" LED turns on when your CNC software is "enabled", and that it turns off when the CNC software is "disabled".

2.12   Test Your Configuration in Expanded Mode

If you will be using one of the PMDX-126's expanded modes (*Expanded I/O Mode*, *Expanded Output Mode* or *Exapnded Input Mode*), download the PMDX-126 Mach3 plug-in and documentation. Follow the instructions to install and configure the plug-in and Mach3. See section 5.3 for more information.

3.0   DIP Switch Settings

The PMDX-126 contains 8 DIP switches, labeled "Config 1" through "Config 8". These switches, along with the two jumpers (see section 4.0), determine the operating characteristics of the PMDX-126 as shown in the following sections.

The PMDX-126 may be assembled with either of two styles of DIP switch, as shown in Figure 1, below: rocker style switches or sliding style switches.

Rocker style switches require that you push the switch down on one end or the other. The switch is "open" if it is pressed down on the side towards the "OPEN" label on the switch body (and away from the "Config" labels on the circuit board). The switch is "closed" when it is pressed down on the side closest to the "Config" labels on the circuit board (and away from the "OPEN" label on the switch body).

Sliding style switches operate by sliding the raised part of each switch towards one side or the other. The switch is "open" when the raised part is towards the "OPEN" label on the switch body (and away from the "Config" labels on the circuit board). The switch is "closed" when the raised part is towards the "Config" label on the circuit board (and away from the "OPEN" label on the switch body).
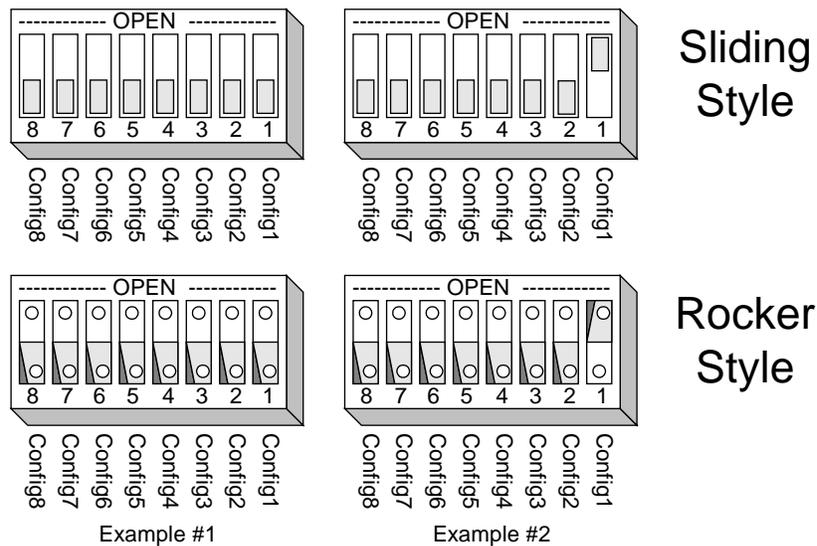
Figure 1 - Sample DIP Switch Settings

Example #1 shows the DIP switches as shipped from the factory. All switches are "closed".
Example #2 shows the DIP switches set so that "Config 1" is "open" and all other switches are "closed".

3.1   Operational Mode Switches

The Operational Mode switches are read only on power-up or when the "Test" push-button is pressed. This means that if you change the settings on these switches you must power the PMDX-126 off and back on, or press & release the "Test" push-button in order for the change to take effect.

Config 3	Config 2	Config 1	Description
Closed	Closed	Closed	Run in Normal Mode (see section 5.2)
Closed	Closed	Open	Run in Normal Mode with Charge Pump (see section 5.2)
Closed	Open	Closed	Run in Expanded I/O Mode (see section 5.3)
Closed	Open	Open	Run in Expanded Output Mode (see section 5.3)
Open	Closed	Closed	Run in Expanded Input Mode (See section 5.3)
Open	Closed	Open	Do Not Use (will keep EStop asserted and flash an error code on the Status LED, see section 9.1)
Open	Open	Closed	Test Mode – PMDX pin-outs (see section 5.4)
Open	Open	Open	Test Mode – Alternate pin-outs (see section 5.4)

Table 1 – Operational Mode DIP Switch Settings

3.2 Auxiliary Mode Switches

For all operational modes except the two test modes, DIP switches "Config6" through "Config4" determine the auxiliary (optional) functions on the PMDX-126. In test mode, the switches determine on which pair of pins the step and direction signals appear (see section 5.4 for more information). These switches are read only at power-up or when the "Test" push-button is pressed. This means that if you change the settings on these switches you must power the PMDX-126 off and back on, or press & release the "Test" push-button in order for the change to take effect.

Config 6	Config 5	Config 4	If in any "Run Mode"
Closed	Closed	Closed	No auxiliary features
Closed	Closed	Open	Touch probe merged inputs, see section 5.6.
Closed	Open	Closed	Enable pulse stretching on input pin "15" (J12 pin 9) for active low pulses. See section 5.5.
Closed	Open	Open	Enable pulse stretching on input pin "15" (J12 pin 9) for active high pulses. See section 5.5.
Open	Closed	Closed	Reserved for future option cards with feedback signals
Open	Closed	Open	Jumbo Mode (5 or 6 axis from one parallel port) with touch probe merged inputs. See section 5.7.
Open	Open	Closed	Jumbo Mode (5 or 6 axis from one parallel port) *without* touch probe merged inputs. See section 5.7.
Open	Open	Open	Do not use (will assert EStop and flash an error code)

Table 2 – Test Mode Step/Dir Select DIP Switch Settings

3.3 Relay Mode Switches

For all operational modes except the two test modes, the DIP switches labeled "Config 7" and "Config 8" determine which signals control the two relays, *when the relay jumpers are set to "multimode" (see section 4.0)*. Note that when the PMDX-126 is in one of the "test" modes (see section 5.4) the relays are forced to the "de-energized" state.

The Relay Mode switches are read continuously and any change takes effect immediately. Unlike the operational mode switches, you do not need to press the "Test" button to activate the new relay settings.

> WARNING: The corresponding relay jumper (JP1 for relay K1 and JP2 for relay K2) must be set to "multimode" in order for these DIP switch settings to have any effect. If either of the jumpers is configured to any setting other than "multimode" the corresponding DIP switch will have no effect on the relay.

Jumper JP1 Setting	DIP Switch Config 7	Relay K1 Function
"Pin 1"	Don't care	DIP Switch "Config 7" has no effect on relay K1. Relay K1 is controlled from parallel port #1 pin 1.
"multimode"	Closed	• *If the PMDX-126 is in "Expanded I/O" or "Expanded Output" mode (see section 5.3)*, then relay K1 is controlled via expanded I/O data • *If the PMDX-126 is in "Jumbo Mode" or "Jumbo Mode with Touch Probe Merged Inputs" (see section 5.7)*, then relay K1 is controlled via parallel port #1 pin 16. • Otherwise relay K1 will remain de-energized (disabled).
"multimode"	Open	Relay K1 is controlled from the option card installed in J18 (for example, from a PMDX-107 Isolated Speed Control).
No jumper installed	Don't care	Relay K1 is de-energized (disabled). DIP Switch "Config 7" has no effect on relay K1.

Table 3 – Relay K1 DIP Switch & Jumper Settings

Jumper JP2 Setting	DIP Switch Config 8	Relay K2 Function
"Pin 14"	Don't care	DIP Switch "Config 8" has no effect on relay K2. Relay K2 is controlled from parallel port #1 pin 14.
"multimode"	Closed	• *If the PMDX-126 is in "Expanded I/O" or "Expanded Output" mode (see section 5.3)*, then relay K2 is controlled via expanded I/O data. • If the PMDX-126 is in any "Test" mode (see section 5.4), then relay K2 will be de-energized. • Otherwise K2 is controlled via parallel port #2 pin 14. Note that if you do not have a 2nd parallel port connected to the PMDX-126 the relay will remain de-energized.
"multimode"	Open	Relay K2 controlled by "Outputs Enabled" signal. The relay is energized when the PMDX-126's outputs are enabled (the "Outputs Enabled" LED is on), and the relay is de-energized when the outputs are disabled (the "Outputs Enabled" LED is off). This allows the relay to be used as a "machine enable" relay.
No jumper installed	Don't care	Relay K2 is de-energized (disabled). DIP Switch "Config 8" has no effect on relay K2.

Table 4 – Relay K2 DIP Switch & Jumper Settings

4.0 Jumper Settings

The PMDX-126 contains four jumpers as described below.

Pins	Label	Function of JP1
1-2	pin"1"	Relay K1 is controlled from parallel port #1 pin 1
2-3	"multimode"	Relay K1 is controlled as determined by DIP Switch "Config 7" (see section 3.3)
No jumper installed		Relay K1 is de-energized (disabled). You can also install the jumper sideways on the center pin of the jumper.

Table 5 - Jumper JP1 Settings (Relay K1 Control)

Pins	Label	Function of JP2
1-2	Pin"14"	Relay K2 is controlled from parallel port #1 pin 14
2-3	"multimode"	Relay K2 is controlled as determined by DIP Switch "Config 8" (see section 3.3)
No jumper installed		Relay K2 is de-energized (disabled). You can also install the jumper sideways on the center pin of the jumper.

Table 6 - Jumper JP2 Settings (Relay K2 Control)

Pins	Label	Function of JP3
1-2	On	"PC+5V" (+5V relative to PC ground) is connected to J16 and J17 pins 26. Use this setting if you want to power a SmoothStepper from the PMDX-126's power supply. ***USE THIS SETTING ONLY IF YOU ARE POWERING A SMOOTHSTEPPER FROM THE PMDX-126!*** *NOTE:* You must change the SmoothStepper's power supply jumpers in order to have it powered by the PMDX-126. Remove any jumper on the SmoothStepper JP4 (this disconnects both the USB power and the "External +5V"). Then install a jumper on one or both of the two-pin jumpers next to the 26-pin "Port 1" and "Port 2" connectors. Please refer to the SmoothStepper User's Manual for more information. *NOTE:* **You cannot use this jumper to provide power <u>to</u> the PMDX-126 <u>from</u> the SmoothStepper.** The PMDX-126 must be powered from the AC mains.
2-3	Off	Nothing is connected to J16 and J17 pin 26. If a SmoothStepper is connected to the PMDX-126, the SmoothStepper must be powered from its USB connector or an external power supply. It will *NOT* be powered from the PMDX-126.

Table 7 - Jumper JP3 Settings (SmoothStepper Power)

Pins	Label	Function of JP4
1-2	On	"PC+5V" (+5V relative to PC ground) is connected to J19 pin 26.
2-3	Off	No connection to J19 pin 26

Table 8 - Jumper JP4 Settings (+5V Power to Connector J19 pin 26)

5.0   Operation Modes

5.1   Changing Modes

The PMDX-126 changes operating modes only upon power up or when the "Test" push button is pressed and released. If the Status LED is on or flashing, indicating some error or fault condition, then pressing the push button attempts to clear the error rather than changing modes. In order to change modes, the Status LED must be off (unless you are in "Test" mode), or you can power the board off and back on.

5.2   Normal Modes

In either of the two "normal" modes, the PMDX-126 may be connected to one or two parallel ports, or to a SmoothStepper. The PMDX-126 provides buffering (but not optical isolation) for all outputs signals and optical isolation for all input signals. Motor drivers and output devices often provide their own built-in isolation. There are screw terminal connectors for all signals on parallel port #1, and for the control outputs (pins 1, 14, 16 and 17) and status inputs (pins 11, 12, 13 and 15) for parallel port #2. PMDX sells option boards that can provide optically isolated inputs or outputs for the data bus on parallel port #2 (see our PMDX-108 model line). PMDX also sells isolated relay outputs for use with the signals on connectors J5 and J6, see our PMDX-104.

In either of the two "normal" modes, relay K1 can be driven from parallel port #1 pin 1, from the option card installed in J8 (a PMDX-107, for example), or disabled. Relay K2 can be driven from parallel port #1 pin 14, by the "Outputs Enabled" signal, or disabled. See jumpers JP1 and JP2 in section 4.0 and DIP switches "Config 7" and "Config 8" in section 3.3.

There are two different "normal" modes, as determined by the DIP switch settings (see Table 1 in section 3.1). These modes are described in the following sections.

5.2.1 Normal Mode without Charge Pump

In "Normal Mode without Charge Pump", the PMDX-126's outputs are enabled shortly after power-up, and remain enabled as long as the E-Stop, Fault and Gecko Error inputs are inactive.

> *WARNING:*   *In "normal" mode there is no protection against spurious movement of your machine when your motion control software is not running. Specifically when the PC is going through its start up sequence it may toggle lines on the parallel port. Therefore, if using "normal" mode, ensure that the PMDX-126 and/or your machine is powered down or otherwise disabled until your control software is running.*

5.2.2 Normal Mode with Charge Pump

In "Normal Mode with Charge Pump", the PMDX-126 looks for a "charge pump" signal on parallel port #1 pin 17 (see section 8.0 for more information). The PMDX-126 powers-up with its outputs disabled. The outputs are not enabled until a valid charge pump signal is detected, and the outputs are disabled as soon as the charge pump signal is no longer valid. Note that the *E-Stop*, *Fault* and *Gecko Error* inputs can also disable the outputs at any time.

In order to use this mode, your motion control software must be able to generate a suitable signal (see section 12.0). Both Mach3 and EMC have this capability.

5.3   Expanded Modes

A normal PC parallel port allows for 12 output signals and 5 input signals. With most breakout boards, if you need more inputs or outputs you must add a second parallel port to your PC. The PMDX-126's "expanded" modes allow you to access more input and output signals while still using a single parallel port.

Some example uses of expanded modes include:
- Allows use of both relays and still have pins 1 and 14 available as an additional step/direction pair (or as general-purpose CMOS outputs).
- Allows use of pins 16 and 17 (on connector J6) as general purpose output signals even when parallel port #1 pin 17 is used as the charge pump signal and pin 16 is used for the expanded serial data.
- Adds an additional 4 output signals
- Allows for 9 input signals instead of the usual 5

The additional output signals are labeled "A", "B", "C" and "D" on connector J5. These are normally associated with the 2nd parallel port, but in *Expanded I/O* and *Expanded Output* modes (only) they are driven by the PMDX-126 from parallel port #1. The additional input signals are labeled "E", "F", "G" and "H" on connector J11. These are normally associated with the 2nd parallel port, but in *Expanded I/O Mode* and *Expanded Input* mode, they are multiplexed onto parallel port #1.

In order to use either of the PMDX-126's expanded modes with Mach3, you must download and install the PMDX-126 Mach3 plug-in. To use the expanded modes with EMC you must provide an EMC HAL configuration that supports the expanded modes. For other controller software, contact PMDX for additional information. The sections below summarize the features and functionality available in each

expanded mode. For a full explanation please download the plug-in documentation from the Support->Downloads area of our web site.

> *NOTE:*   In either *Expanded I/O* or *Expanded Output* mode, outputs "16" and "17" on connector J6 and "A", "B", "C" and "D" on connector J5 have a slow update rate which makes them unsuitable for use as step and direction signals. They can be used for general control signals like "coolant on/off" or PLC inputs. Due to limitations in the current Mach3 implementation, these outputs are updated once every 1 to 2 seconds. See the plug-in documentation for more information.
>
> *NOTE:*   *Expanded I/O* and *Expanded Input* modes require a "charge pump" signal on parallel port #1 pin 17 (see section 8.0 for more information on the "charge pump" signal).

> *NOTE:*   *Expanded I/O* and *Expanded Output* modes require a "bit stream" signal on parallel port #1 pin 16. Please refer to the PMDX-126 plug-in documentation for more information on this signal.

> *WARNING:*   *The corresponding relay jumper (JP1 for relay K1 and JP2 for relay K2) must be set to "multimode" in order for the expanded relay functionality to be available.*

5.3.1 Expanded I/O Mode

Expanded I/O Mode provides the maximum functionality from a single parallel port. It is *not* intended for use with dual parallel ports or with a SmoothStepper. In *Expanded I/O Mode,* using the Mach3 PMDX-126 plug-in, the PMDX-126 provides the following signals via parallel port #1 (Please refer to the PMDX-126 Mach3 plug-in documentation for a full description of the available signals):

- 10 full speed output signals on J1, J2, J3, J4 and J6
- 2 slow update rate signals on J6 (see note above about update rate)
- 4 slow update rate signals on J5 (see note above about update rate)
- 2 relay control signals (with slow update rate)
- 1 E-Stop input signal on parallel port pin 10
- 8 input signals from J11 and J12 multiplexed onto parallel port pins 11, 12, 13 and 15

> *NOTE:*   Use of *Expanded I/O Mode* with Mach3 requires the PMDX-126 Mach3 plug-in, which may be downloaded from our web site at http://www.pmdx.com (see the "Support" page for the "downloads" page). Please refer to the plug-in documentation for information on how to configure Mach3 to access the additional input and output signals. Use of *Expanded I/O Mode* with EMC requires an EMC HAL configuration that supports *Expanded I/O Mode*.

> *NOTE:*   *Expanded I/O Mode* is not compatible with the PMDX-106 when the PMDX-106 is plugged into the 10-pin connector J18. This mode *is* compatible with the PMDX-107. In order to use the PMDX-106 with a PMDX-126 in *Expanded I/O Mode*, you must connect the PMDX-106 using discrete wires and configure the spindle PWM and direction signals to use pins 1 to 9 or 14.

5.3.2 Expanded Output Mode

Expanded Output Mode provides the additional 4 output signals and 2 relay control signals that Expanded I/O Mode provides without the multiplexed input signals. It is *not* intended for use with dual parallel

ports or with a SmoothStepper. In *Expanded Output Mode,* using the Mach3 PMDX-126 plug-in, the PMDX-126 provides the following signals via parallel port #1 (Please refer to the PMDX-126 Mach3 plug-in documentation for a full description of the available signals):

- 12 full speed output signals on J1, J2, J3, J4 and J6 (pin 17 must be the charge pump signal)
- 4 slow update rate signals on J5 (see note above about update rate)
- 2 relay control signals (with slow update rate)
- 1 E-Stop input signal on parallel port pin 10
- 4 input signals on parallel port pins 11, 12, 13 and 15

> *NOTE:* Use of "Expanded Output Mode" with Mach3 requires the PMDX-126 Mach3 plug-in, which may be downloaded from our web site at http://www.pmdx.com (see the "Support" page for the "downloads" page). Please refer to the plug-in documentation for information on how to configure Mach3 to access the additional output signals. Use of "Expanded Output Mode" with EMC requires an EMC HAL configuration that supports "Expanded Output Mode".

> *NOTE:* *Expanded Output Mode* is not compatible with the PMDX-106 when the PMDX-106 is plugged into the 10-pin connector J18. This mode *is* compatible with the PMDX-107. In order to use the PMDX-106 with a PMDX-126 in *Expanded Output Mode*, you must connect the PMDX-106 using discrete wires and configure the spindle PWM and direction signals to use pins 1 to 9 or 14.

5.3.3 Expanded Input Mode

Expanded Input Mode provides an additional 4 input signals like *Expanded I/O* mode, without the "slow update" output signals on connectors J5 and J6. *Expanded Input Mode* is *not* intended for use with dual parallel ports or with a SmoothStepper. In *Expanded Input Mode,* using the Mach3 PMDX-126 plug-in, the PMDX-126 provides the following signals via parallel port #1 (Please refer to the PMDX-126 Mach3 plug-in documentation for a full description of the available signals):

- 12 full speed output signals on J1, J2, J3, J4 and J6 (pin 17 must be the charge pump signal – see the plug-in documentation for more information)
- Output signals on J5 not available (except though the 2nd parallel port connector)
- 2 relays controlled either from parallel port #1 pins 1 and 14, parallel port #2 pin 14 or from the expansion connector and the "outputs enabled" signal (see section 4.0 for more information).
- 1 E-Stop input signal on parallel port pin 10
- 8 input signals from J11 and J12 multiplexed onto parallel port pins 11, 12, 13 and 15

> *NOTE:* Use of *Expanded Input Mode* with Mach3 requires the PMDX-126 Mach3 plug-in, which may be downloaded from our web site at http://www.pmdx.com (see the "Support" page for the "downloads" page). Please refer to the plug-in documentation for information on how to configure Mach3 to access the additional input signals. Use of *Expanded Input Mode* with EMC requires an EMC HAL configuration that supports this mode.

> *NOTE:* *Expanded Input Mode* is compatible with the PMDX-106 when the PMDX-106 is plugged into the 10-pin connector J18. This mode is also compatible with the PMDX-107 when the PMDX-107 is set to "normal" (non-expanded) mode.

5.4   Test Modes

The PMDX-126 provides a method for stand-alone motor testing and for adjusting the Gecko "adjust" trim pot. These test mode generate internal step and direction signals without needing a PC connected. The step pulses are generated by pressing the momentary-contact push-button switch (SW2, labeled

"Test"). The test mode will also operate when the PMDX-126 connected to a PC. If a PC is connected to the PMDX-126 while it is in test mode, the PMDX-126 will ignore all incoming signals from the PC (including the charge pump) for as long as test mode is active.

While in test mode, all PMDX-126 output signals are forced to a "low" (zero volts) and all relays are de-energized, except for the two signals that are being driven as "step" and "direction". All inputs are passed through the PMDX to the PC, but they are ignored by the PMDX-126, except for the E-Stop, Fault and Gecko Error signals, which will disable the test mode step and direction outputs as long as they are asserted.

The PMDX-126 asserts the E-Stop signal to the PC as long as it is in "Test" mode. This tells the PC that it cannot (or should not) attempt to control any signals through the PMDX-126.

> *NOTE:* Test mode only controls the currently selected step and direction pins. If your machine requires the on-board relays or other output signals to be functional while a motor is moving, then you will need to temporarily re-wire your machine to manually control those functions. For example, if you use relay K2 to control power to your stepper motor drivers, you will need to re-wire power to them so that they will be powered on when the PMDX-126 is in test mode.

> *WARNING:* ***When using test mode to generate step and direction signals on pins "1" and "14", make sure to set jumpers JP1 and JP2 to disable relays K1 and K2.***

The "Steps" LED will flicker whenever a step pulse is generated by the PMDX-126 in test mode. The output signal LED (next to connectors J1 through J6) for the step signal may glow dimly when steps are generated, depending on the step speed and polarity.

5.4.1 Test Mode DIP Switch Settings

The DIP switches provide for two different step and direction pin-outs while in test mode: "PMDX" and "Alternate". These two pin-outs are shown in the table below. Note that the pin-outs only differ for the first four pin combinations (pins 2 to 9). "PMDX" pin-out is compatible with PMDX drivers and motherboards such as the PMDX-132, PMDX-133 and PMDX-134, as well as Rutex, Hobby CNC and other products that expect the step signals on the odd numbered pins and the direction signals on the even numbered pins. The "Alternate" pin-out is compatible with Xylotex, Mechatronics and other products that expect the step signals on the even numbered pins and the direction signals on the odd numbered pins.

> *NOTE:* In order to use the PMDX-126's built-in test function you must conform to one of the two pin-out configurations shown in Table 9 below. If you do not need the test functions, any pin-out may be used for the step and direction signals.

Config6	Config5	Config4	Config3	Config2	Config1	Step	Dir	Connector
Closed	Closed	Closed	Open	Open	*Closed**	*Pin 3*	*Pin 2*	J4 (also J19)
					Open*	Pin 2	Pin 3	J4 (also J19)
Closed	Closed	Open	Open	Open	*Closed**	*Pin 5*	*Pin 4*	J3 (also J19)
					Open*	Pin 4	Pin 5	J3 (also J19)
Closed	Open	Closed	Open	Open	*Closed**	*Pin 7*	*Pin 6*	J2 (also J19)
					Open*	Pin 6	Pin 7	J2 (also J19)
Closed	Open	Open	Open	Open	*Closed**	*Pin 9*	*Pin 8*	J1 (also J19)
					Open*	Pin 8	Pin 9	J1 (also J19)
Open	Closed	Closed	Open	Open	Don't Care	Pin 1	Pin 14	J6
Open	Closed	Open	Open	Open	Don't Care	Pin 16	Pin 17	J6
Open	Open	Closed	Open	Open	Don't Care	Pin "A"	Pin "B"	J5
Open	Open	Open	Open	Open	Don't Care	Pin "C"	Pin "D"	J5

Table 9 – Test Mode Step and Direction Pin-Out Mapping

> ***NOTE:*** Config1 switch "closed" uses the PMDX-style step/dir pin out, while Config1 "open" uses the alternate step/dir pin out. These definitions matter only while in Test Mode. For normal operation, any data pin may be used for either step or direction signals.

Config 7	Closed	Test mode is "push and hold to run"
	Open	Test mode is "push to run, push to stop"

Table 10 – Test Start/Stop Mode DIP Switch Settings

5.4.2 Push and Hold to Run

When in this test mode, pressing and holding the "Test" push-button (when no fault is indicated) turns the Status LED on solid and causes the PMDX-126 to generate the following step profile:

(1) Brief pause (approx. 1/2 second)

(2) 5 steps at a rate of 2 steps per second

(3) Ramp up to 1,000 steps per second and maintain that rate until the push button is released

(4) Ramp down from 1,000 steps per second to 25 steps per second then stop

(5) Toggle the "test mode" direction so that the next push-button press will move the motor in the opposite direction (except as described below).

If the push-button is released during step (1) of the test profile no step pulse is generated but the direction signal is toggled. If the push-button is released during step (3) of the test profile, it immediately ramps down from the current step frequency and then stops (i.e. it does not wait until the ramp has reached it maximum frequency before ramping down and stopping).

Note that if the push-button is pressed while a fault is indicated, the push-button serves to attempt to clear the fault, it does not enter test mode or generate step pulses. When a fault is indicated, it takes two button presses to enter test mode – one to clear the fault and the second to enter test mode.

Each time test mode is entered the motor direction is reversed from the previous test mode. It is possible to "tap" the push-button to force a direction reversal without holding the switch long enough to generate a step pulse. In this manner, you can achieve successive runs of slow steps in the same direction.

> *WARNING:* If you press the push-button for test mode and nothing happens, a fault may have occurred while starting test mode. Release the push-button and look at the *Status* LED. If there <u>was</u> a fault, the LED will remain on or flash to indicate a fault condition. If the LED turns off (indicating no fault condition), then double-check the E-Stop LED and E-Stop wiring.

5.4.3 Push to Run, Push to Stop

When in this test mode, pressing and releasing the "Test" push-button (when no fault is indicated) causes the PMDX-126 to start generating step pulses, ramping up to 1,000 steps per second. It then continues to generate step pulses at 1,000 steps per second until the "Test" push-button is pressed again. On this 2nd press of the "Test" push-button, the PMDX-126 ramps down from 1,000 to approx. 25 steps per second and then stops generating step pulses. It also toggles the "test mode" direction so that the next time the push-button is pressed, the motor will move in the opposite direction.

This mode can be used to set the "adjust" trim pot on Gecko stepper drivers.

The Status LED will turn on solid as long as the push-button is pressed. The Status LED should turn off as soon as the push-button is released. If the LED remains on after the push-button is released, some type of fault was detected.

Note that if the push-button is pressed while a fault is indicated, the push-button serves to attempt to clear the fault, it does not enter test mode or generate step pulses. When a fault is indicated, it takes two button presses to enter test mode – one to clear the fault and the second to enter test mode.

Each time test mode is entered the motor direction is reversed from the previous test mode. It is possible to "tap" the push-button to force a direction reversal without holding the switch long enough to generate a step pulse. In this manner, you can achieve successive runs of slow steps in the same direction.

> *WARNING:* If you press the push-button for test mode and nothing happens, a fault may have occurred while starting test mode. Release the push-button and look at the *Status* LED. If there <u>was</u> a fault, the LED will remain on or flash to indicate a fault condition. If the LED turns off (indicating no fault condition), then double-check the E-Stop LED and E-Stop wiring.

5.5   Pulse Stretch Mode

Pulse stretch mode is designed for use with a sensor that may generate a pulse that is too narrow to be guaranteed to be seen by the CNC software. For example, with Mach3 running with a 25 KHz kernel rate and the PMDX-126 operating in "Expanded I/O Mode", the pulse from a spindle sensor must be at least 80 microseconds wide. Depending on the spindle sensor design and spindle speed, this may not be possible. With pulse stretching mode, the PMDX-126 extends the trailing edge of the signal to guarantee that the PC (or SmoothStepper) sees a pulse that is at least 100 microseconds wide.

5.5.1 Pulse Stretch Active Low Mode

Pulse stretch "active low" mode operates with the following constraints:
- Operates on the "Pin 15" input only (J12 pin 9)
- Assumes the signal from the sensor is active low (driven to GND when active).
- Your CNC software must be configured with the pin 15 input as active low.
- Stretches the active (low) pulse to provide a minimum 100us wide pulse to the PC.
- The active (falling) edge of the PC signal is aligned with the signal from the sensor.
- The inactive (rising) edge is delayed going to the PC

5.5.2 Pulse Stretch Active High Mode

Pulse stretch "active low" mode operates with the following constraints:

- Operates on the "Pin 15" input only (J12 pin 9).
- Assumes the signal from the sensor is active high (driven to +5V or +24V, or open/floating).
- Your CNC software must be configured with the pin 15 input as active high.
- Stretches the active (high) pulse to provide a minimum 100us wide pulse to the PC.
- The active (rising) edge of the PC signal is aligned with the signal from the sensor.
- The inactive (falling) edge is delayed going to the PC

5.6   Touch Probe Merged Inputs Mode

Touch Probe Merged Inputs mode takes two input signals and merges (combines) them into one "active high" signal going into the PC's parallel port. This mode can be used with systems that have two touch probes, or a touch plate and a digitizing probe. The PMDX-126 the outputs on parallel port #1 pin 15 the logical "OR" of the two signals as shown below:

Port #1 pin 15 into PC is high if:
       J12 pin 9 is GND or +24V (** see note below)   ***OR***   J11 pin 9 is +5V or floating

** NOTE: As described in section 6.1, the PMDX-126 interprets +24V on its input (usually from a PNP sensor) the same as having its input grounded.

For example, consider a system that has both a touch plate and a digitizing probe. Touch plates are usually configured to ground the input when the tip hits the touch plate. Therefore, the signal from the touch plate should be connected to J12 pin 9 (labeled "15"). Digitizing probes usually operate as normally-closed switches which open when the touch probe touches something. The touch probe should therefore be connected to J11 pin 9 (labeled "H"). Configure your motion control software (Mach3, EMC, etc.) to use pin 15 as an "active high" input signal (in Mach3 that means a red "X" in the "Low Active" column).

5.7   Jumbo Mode (5 or 6 axis from single parallel port)

NOTE: This section provides an overview of "Jumbo Mode." For more detailed information, see the ***PMDX-126 Jumbo Mode*** application note on our web site (http://www.pmdx.com/AppNotes).

NOTE: "Jumbo Mode" is only available on PMDX-126 boards with revision "A3" and higher.

Jumbo Mode allows for a 5 or 6 axis system to be run from a single parallel port, with the step and direction signals routed for use with two daisy-chained PMDX-133 Gecko Motherboards connected to J19, or with hand-wired connections from screw terminal connectors J1 through J5. It also allows PC control of the large on-board relay (K1). You may optionally also enable the "touch Probe Merged Inputs" functionality (see section 5.6).

Axis #	Parallel Port Pin #		Discrete wiring		PMDX-133 Connection
	DIR signal	STEP signal	DIR signal	STEP signal	
Axis #1	pin 2	pin 3	J4 pin 2 ("2")	J4 pin 3 ("3")	PMDX-133 #1 Axis #1
Axis #2	pin 4	pin 5	J3 pin 2 ("4")	J3 pin 3 ("5")	PMDX-133 #1 Axis #2
Axis #3	pin 6	pin 7	J2 pin 2 ("4")	J2 pin 3 ("5")	PMDX-133 #1 Axis #3
Axis #4	pin 8	pin 9	J1 pin 2 ("2")	J1 pin 3 ("3")	PMDX-133 #2 Axis #1
Axis #5	pin 14	pin 1	J5 pin 2 ("4")	J5 pin 3 ("5")	PMDX-133 #2 Axis #2
Axis #6	pin 2 (cloned and inverted)	pin 3 (cloned)	J5 pin 2 ("4")	J5 pin 3 ("5")	PMDX-133 #2 Axis #3

Table 11 – Step and Direction signal mapping in Jumbo Mode

The 6th axis is cloned from axis #1 in hardware on the PMDX-126 board. The 6th axis' DIR signal is inverted with respect to the axis #1 DIR signal.

Parallel port pin 16 may be used to control the K1 relay by setting jumper JP1 to "multimode" and DIP Switch "Config 7" closed. See section 3.3 for more information on controlling relay K1.

The function of parallel port pin 17 depends on the operational mode DIP switches (see section 3.1). If set for "Normal Mode", then pin 17 is a general-purpose output. If set for "Normal Mode with Charge Pump" or "Expanded Input Mode" then pin 17 must be configured as the charge pump signal.

> *Note:*   "Jumbo Mode" cannot be used when the board is configured for "Expanded I/O" or "Expanded Output" modes.

6.0   Input Signals

6.1   General Purpose Inputs

The PMDX-126 provides eight (8) optically isolated general purpose input signals, four on connector J12 (parallel port #1) and four on J11 (parallel port #2). In *Expanded I/O Mode*, all eight of these signals are available on a single parallel port (see section 5.3). Internal circuitry on the PMDX-126 pulls these inputs high when there is nothing connected to the input terminal (or when a switch circuit is open).

The PMDX-126's inputs can be driven by any of the following:
- Mechanical switches, in either "normally open" or "normally closed" configurations
- Open-collector transistor outputs
- NPN-style sensors such as the PMDX-170 Optical Interrupter and the PMDX-171 Hall Effect Sensor, and many other commercially available sensors
- +5V logic signals
- PNP-style sensors or PLC outputs that supply 24 volts

These devices can act as limit switches, home indicators or other status information. The PMDX-126's inputs should be connected to the adjacent GND terminal, left floating or driven from a +5V or +24V source. Mechanical switches can be wired directly between the input pins on J11 or J12 and adjacent GND terminals. Note that the examples below show the signals connected to a particular input pin, but the inputs may be connected to any of the input pins on the two connectors. The sensor, switch or input circuit must be capable of sinking 6 mA when pulling or driving the input signal to ground. PNP sensors and PLC outputs must be able to source 6mA at 20 to 24 volts DC.

There is an LED next to each input terminal that lights when the input is:
- connected to GND on connectors J11 or J12
- or driven to GND on connectors J11 or J12 by a switch, an NPN sensor or 5V logic signal (which has its ground reference connected to a GND terminal on connector J11 or J12)
- or driven toward +24V by a PNP sensor or PLC output (with the ground for the sensor or PLC +24V connected to a GND terminal on connector J11 or J12)

The LED is turned off when the input is:
- un-connected
- or floating
- or driven to +5V by a switch, pull-up resistor or 5V logic signal (the +5V must be referenced to a GND terminal on connector J11 or J12)

When the LED is lit the PMDX-126 will drive the corresponding PC parallel port pin low. When the LED is off the PMDX-126 drives the corresponding PC parallel port pin high.

> *NOTE:*   The PMDX-126's inputs are NOT compatible with 24V totem-pole signals (where the input is driven to +24V or driven to GND). All 24V signals must be PNP-style where the signal is either driven to 24V or left floating.

> *WARNING:*   *The PMDX-126's inputs are optically isolated from the PC-side ground. The terminals on J11 and J12 marked "GND" are* __NOT__ *the same ground as any other connector on the board. Connecting any "GND" terminal on connectors J11 or J12 to the "PCgnd" terminal on another connector will defeat this isolation.*

Normally Closed Switches

The left-hand drawing in Figure 2 shows an example of "normally closed" mechanical switches. The switches are wired in series so that the "normal" case is ground (logic low) going into pin 12 of the PC's parallel port. When one or more of the switches open, a "pull-up" circuit in the PMDX-126 provides a logic high into pin 12 on the PC's parallel port. Any number of "normally closed" mechanical switches may be connected in series to a single input terminal on the PMDX-126.

Normally Open Switches

The right-hand drawing in Figure 2 shows an example of "normally open" mechanical switches. The switches are wired in parallel so that the "normal" case is that the "pull-up" circuit in the PMDX-126 provides a logic high going into pin 12 of the PC's parallel port. When one or more of the switches close, a logic low appears on pin 12 on the PC's parallel port. Any number of "normally open" switches may be paralleled onto a single input terminal on the PMDX-126.
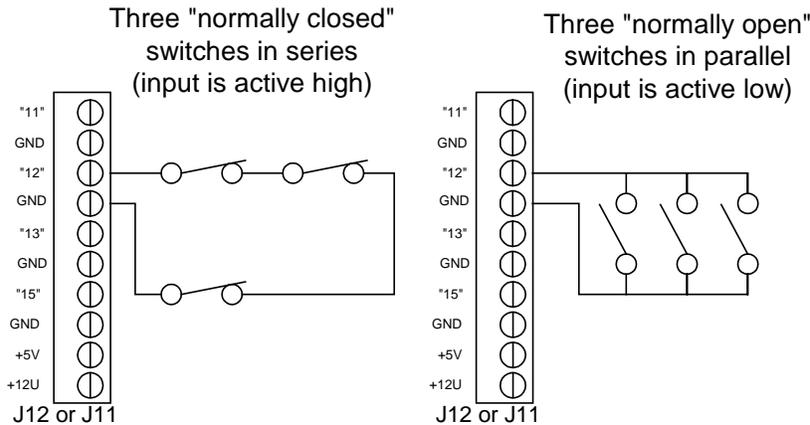
Figure 2 - Sample Mechanical Switch Input Connections

NPN-Style Sensors, Optical Interrupter or Hall Effect Sensor

Figure 3 shows an example of the PMDX-170 slotted optical sensor. This example uses the "+5V" from the PMDX-126 to power the sensor. The sensor's output signal is connected to the PMDX-126 input pin. The same connections can be used for the PMDX-171 Hall Effect sensor. Figure 4 shows an example using NPN-style sensors. Many commercial sensors will need to be powered from the unregulated +12V instead of the +5V (shown as the "alternate power connection" in Figure 4).

PMDX-170 Slotted Optical Sensor
or PMDX-171 Hall Effect Sensor
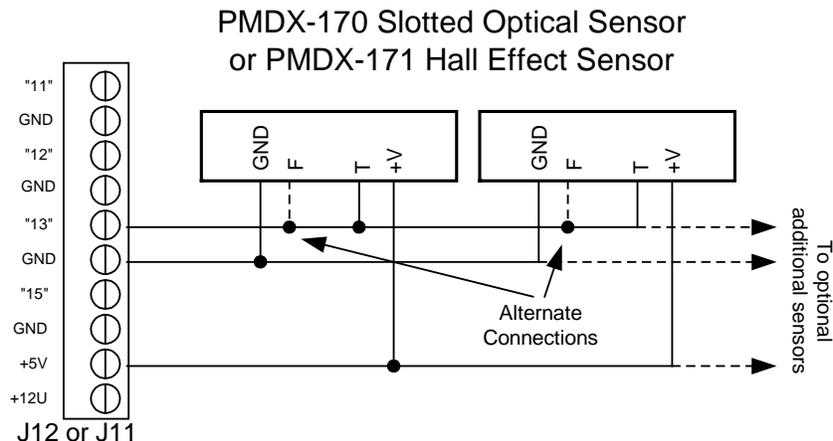
Figure 3 - Sample PMDX-170/PMDX-171 Input Connections
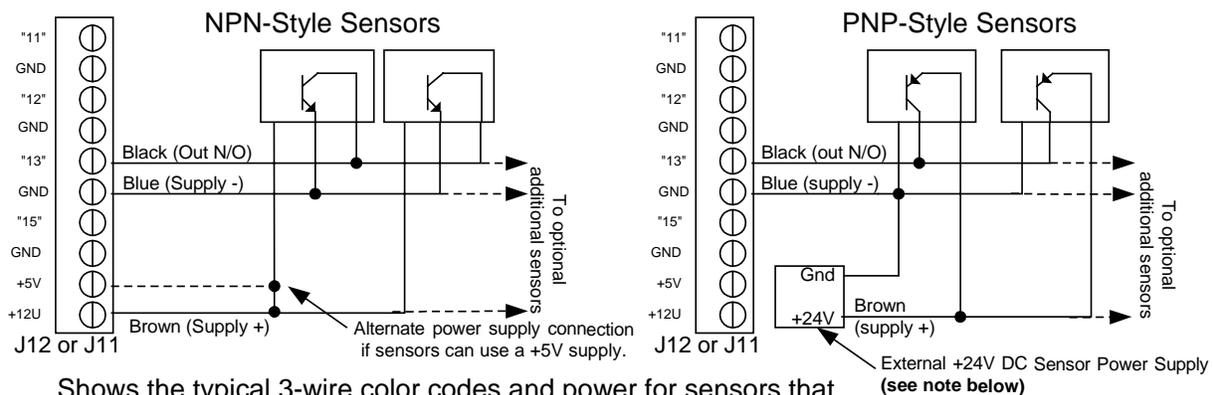
Shows the typical 3-wire color codes and power for sensors that require a +10 to +30V supply. *Verify your sensor's color code!*

Figure 4 - Sample NPN and PNP-Style Sensor Input Connections

> *NOTE:* For reliable operation with PNP sensors we recommend powering PNP sensors from an external +24V supply. While some PNP sensors may work when powered from the PMDX-126's unregulated +12V supply, we do not recommend this configuration.

6.2   E-Stop Input

The *E-Stop* input on connector J13 provides an interface for external "emergency stop" circuits. This signal is "active high", such that a logic "high" tells the system to stop, and a logic low means "all is OK". The *E-Stop* input has an internal pull-up resistor so that the default condition is "E-Stop". This also means that the external emergency stop circuit must be capable of sinking at least 6 mA of current when the switch contacts are "closed".

> *NOTE:* The *E-Stop* signal **_must_** be grounded (or driven low) in order for the PMDX-126's outputs to be enabled, and for the pin 10 status signal to the PC parallel port to go low. If you do not have an E-Stop switch or circuit then install a jumper wire between the "E-Stop" terminal and the "GND" terminal on connector J13 (the board ships with this jumper wire installed).

The *E-Stop* input should be connected to an external "normally closed" switch (or group of switches all wired in series). The external switch(es) should be wired between the *E-Stop* pin and the ground signal on connector J13, such that the switch contacts open to signal an emergency stop condition.

> **WARNING:** *Do not connect the E-Stop circuit to any "ground" or "common" signal on the PMDX-126 other than on connector J13. Doing so will defeat the optical isolation provided by the PMDX-126 and possibly damage the board or your PC's parallel port.*

The *E-Stop* and *Fault* inputs are combined to drive pin 10 on the PC's parallel port <u>**and**</u> to enable or disable all of the PMDX-126's output signals (i.e. all PMDX-126 output signals are disabled as long as either the *E-Stop* or *Fault* signals are active).

6.3 Fault Input

The *Fault* input provides an interface for external fault detection circuits. This signal is "active low", meaning that a logic "low" (or ground) indicates a fault condition, and a logic high (or floating) means "all is OK".

The *Fault* input can be connected to an external "wired-or" configuration of open-collector status signals or mechanical switches to ground (switch closed means "fault"). All of the external fault signals should be tied together and connected to the PMDX-126's *Fault* input, provided that the fault signals can share the same ground reference (the "GND" terminal on J13). The *Fault* input has an internal pull-up resistor and may be left unconnected when not used. To indicate a fault condition, drive this input to ground (via either open-collector or TTL-style drivers or mechanical switches). The fault circuit must be capable of sinking 6 mA of current when pulling or driving the *Fault* signal to ground.

The *E-Stop* and *Fault* inputs are combined to drive pin 10 on the PC's parallel port <u>**and**</u> to enable or disable all of the PMDX-126's output signals (i.e. all PMDX-126 output signals are disabled as long as either the *E-Stop* or *Fault* signals are active).

> The PMDX-126's *Fault* signal <u>**must**</u> be either driven high (+5V) or allowed to float in order for the outputs to be enabled and the E-Stop status signal to the PC parallel port (on pin 10) to go low (signaling "OK"). If you do not have any fault detection circuitry, leave the *Fault* input unconnected.

6.4 Gecko Error Input

The Gecko step servo drivers (models G320, G320X and G340) provide an error signal that is both an output from the Gecko driver and a "reset" into the driver. The PMDX-126 provides an isolated input that can connect to this signal and allow the Gecko's error signal to trigger an E-Stop condition to the PC. When the *Gecko Error Input* signal is active* the PMDX-126 will pulse the *E-Stop* signal to the PC for approximately 1 second and then flash an error code on the *Status* LED.

*   "active" means driven to zero volts with respect to +5 volts connected to the PMDX-126's *COM* terminal on connector J13

The PMDX-126 provides a *Restart Output* that works in conjunction with the Gecko error input so that the PMDX-126 can automatically pulse the Gecko's error signal to reset the drivers. See section 7.3 for more information on the *Restart Output*. Also see the *application notes* section on our web site for example configurations using the Gecko Error Input and the Restart output (http://www.pmdx.com, then look on the "Support" page).

7.0   Output Signals

7.1   General Purpose Outputs

The PMDX-126 provides up to 16 general purpose outputs, 12 from parallel port #1 and 4 from parallel port #2 (or all from parallel port #1 in *Expanded I/O* or *Expanded Output* modes, see section 5.3). These outputs are +5V digital CMOS outputs, and are buffered but *NOT* optically isolated. Motor drivers and output devices often provide their own built-in isolation.

7.2   Relay Contact Outputs

The PMDX-126 has two on-board relays. Relay K1 provides connections to its "normally open" (N.O.) set of contacts. Relay K1 always has an MOV connected across its terminals (see below for information on MOVs). Relay K2 provides connections to both its "normally closed" (N.C.) and "normally open" contacts, as well as an MOV protection terminal (see below). Depending on DIP switch and jumper settings the relays can be controlled by parallel port #1 pins 1 and 14 (for relays K1 and K2, respectively), from the expanded mode bit stream, by the "Option Connector" (J18), or by the "outputs enabled" signal. See sections 3.0 and 4.0 for more information.

The connector for relay K2 (J10) has a terminal labeled "MOV". This terminal is connected to the relay's "COM" terminal through an MOV (metal oxide varistor, see http://en.wikipedia.org/wiki/Varistor). The MOV helps absorb any inductive voltage spikes that may be generated when opening the relay contacts (for example when powering a motor or solenoid like a vacuum pump or coolant valve). This in turn helps prevent arcing on the relay contacts and extends the life of the relay. To use the MOV, connect your load to the "MOV" terminal in addition to the "N/O" or "N/C" terminal.
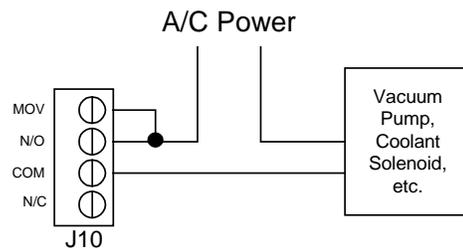
Figure 5 – Sample MOV and Relay Contacts Connections

7.3   Restart Output

The "Restart" output is a pair of solid-state relay contacts (on connector J13, labeled "RST" and "COM") that are "closed" for approximately 2 seconds every time the PMDX-126 enables its outputs. The "Restart" output can be used to reset the Gecko G320/G320X/G340 step-servo drivers, or as a momentary "machine enable" pulse. Please see the *application notes* section on our web site for example configurations using the Restart output (http://www.pmdx.com, then look on the "Support" page).

8.0   Charge Pump

The charge pump circuit (also called a watchdog circuit) is designed to disable the PMDX-126 and all motor drivers when the software running on the PC stops working properly. The charge pump also keeps the PMDX-126 disabled while the PC starts up (i.e. all outputs are disabled until the PC boots and the CNC controller application software is running). It does this by monitoring pin 17 on the first PC parallel port. When this signal is toggling between high and low, the charge pump is "OK". When pin 17 stops toggling, the charge pump is "not OK". The DIP Switch mode settings determine whether the output from the charge pump is used to enable and disable the PMDX-126 outputs (see section 3.1).

This charge pump circuit is designed to work with any software that can toggle pin 17 on the PC parallel port. If your software does not support this feature, you must use the PMDX-126 in "Normal Mode

without Charge Pump" (see section 3.1). See section 12.0, *Electrical and Environmental Specifications*, for information on minimum charge pump frequency.

> *NOTE:*   The state of the charge pump signal will **<u>not</u>** affect the **E-Stop** status that is output on pin 10 to the PC. This is to prevent "lock up" of the software. Mach3 requires that the Emergency Stop signal *not* be asserted before it will start generating the "charge pump" signal.

9.0   LEDs

Steps LED   Flickers when activity is detected on pins that *may* be used for step signals, or when "Test Mode" is generating step pulses (see section 5.4). The PMDX-126 does not know which pins are being used as "step" signals, which are used as "direction" signals or which are used for some other function. The PMDX-126 assumes that all of the signals listed in Table 12 could possibly be step signals and monitors them for activity. The PMDX-126 also does not know the polarity of the step signals, so it looks for a rising edge on any of the signals listed in the table and calls that "step activity". This has the side effect that changing a direction signal may cause the "Steps" LED to flicker. Likewise, **<u>any</u>** activity on parallel port #1 pin 1 or parallel port #2 pins 1 or 16 will cause the "Steps" LED to flicker.

Port 1 Pin 1	Can be a 5th axis (with pin 14 as the direction signal)
Port 1 Pins 2 to 9	Usual pins for up to 4 axis (X, Y, Z and A) of step and direction
Port 2 Pin 1	Can be a 5th or 6th axis (with port 2 pin 14 as the direction signal) when using 2 parallel ports into the PMDX-126
Port 2 Pin 16	• For boards marked as Revision "A2" or higher, this can be a 5th of 6th axis (with port 2 pin 17 as the direction signal) when in one of the "normal" modes and using 2 parallel ports into the PMDX-126. • For boards marked as Revision "A1", the "Steps" LED ignores this signal. It may still be used as a step signal as described above, it just won't have its activity shown on the "Steps" LED.

Table 12 – Parallel Port Pins That Affect the "Steps" LED

Status LED   This LED is off when the PMDX-126 is operating normally. The LED flashes an error code when the PMDX-126 detects an error condition (see section 9.1. The LED is on solid whenever the *Test* button is pressed.

Outputs Enabled LED   This LED is on when the PMDX-126's outputs are enabled, and is off when the outputs are disabled.

E-Stop LED   The E-Stop LED is on when the PMDX-126 is asserting the E-Stop signal to the PC on pin 10 of both parallel ports #1 and #2. Note that this is not necessarily an indicator that the E-Stop input is open. The E-Stop LED will be on when the "Fault" input is grounded, or when the PMDX-126 is in "Test" mode (see section 5.4). The E-Stop LED (and E-Stop signal to the PC) will also be asserted for approximately 1 second when the PMDX-126 detects a "Gecko Error" signal (see section 6.4).

Relay LEDs   Each relay has an LED associated with it. This LED is on when the relay is energized, and off when the relay is de-energized.

Input LEDs   Each input signal (except E-Stop, Fault and "Gecko Error") have an LED adjacent to the connector terminal. The LED is on then the input is being pulled low (to ground), and is off when the input is open or pulled to a voltage above 3.0 volts.

Output LEDs   Each output signal has an LED adjacent to the connector terminal. The LED is on when the output is driven to a logic "1" (+5V). The LED is off when the output is driven low (0V).

9.1 Status LED Error Codes

When the PMDX-126 encounters a problem, it uses the Status LED to display an error code. The error code is a repeating pattern of 3 flashes, a short pause, then some number of flashes (the error code) followed by a longer pause. Then the entire sequence repeats. Table 13 lists the possible flash patterns.

Flash Pattern	Description
Off	No error, normal operation
3 short flashes, pause, 1 short flash, long pause	Gecko Error input triggered
3 short flashes, pause, 2 short flashes, long pause	Error from option connector (J18)
3 short flashes, pause, 3 short flashes, long pause	Expanded mode bit stream error
3 short flashes, pause, 4 short flashes, long pause	Expanded mode bit stream error
3 short flashes, pause, 5 short flashes, long pause	Invalid DIP Switch setting
3 short flashes, pause, 6 short flashes, long pause	Internal error (see note below)
3 short flashes, pause, 7 short flashes, long pause	Internal error (see note below)
On solid	Push button switch pressed

Table 13 – Status LED Flash Patterns

NOTE: If you encounter an "internal error" flash code you should power off the PMDX-126 and then power it back on. Pressing the "Test" button is not sufficient. If you encounter the internal error again, contact PMDX.

9.2 External LED Connector (J7)

Connector J7 provides a "Charge Pump OK" (really "outputs enabled"), "Step Activity", "EStop" and "Power" signals that can be connected to external LEDs for remote status indicators. These signals have current limiting resistors, so all that is needed is to connect an LED from the signal to the "GND" pin on connector J7. The LED should be a "high efficiency" model that can generate sufficient light when driven by approx. 6 mA.

10.0 Connector Pin-out Summary

The PMDX-126 contains several connectors, as listed in Table 14 below. Refer to the following tables for details on the pin-outs for each connector. For all connectors, pin "1" is the pin closest to the reference designator (i.e. J1 pin 1 is the pin closest to the "J1" text on the circuit board). In addition, all connectors have square pads on pin 1 (look on the bottom of the circuit board).

Connector	Description
J1, J2, J3, J4	Parallel port #1 pins 2 through 9 (usually used for step and direction)
J5	Secondary Control Outputs (parallel port #2 pins 1, 14, 16 and 17)
J6	Primary Control Outputs (parallel port #1 pins 1, 14, 16 and 17)
J7	External LED signals
J8	AC Mains
J9	Relay K1 terminals
J10	Relay K2 terminals
J11	Secondary Status Inputs (parallel port #2 pins 11, 12, 13 and 15)
J12	Primary Status Inputs (parallel port #1 pins 11, 12, 13 and 15)
13	E-Stop, Fault, Gecko Error and Restart Output
14	Reserved for future expansion
15	Parallel port #1, 25-pin "D" connector
16	Parallel port #1, 26-pin ribbon cable connector
17	Parallel port #2, 26-pin ribbon cable connector
18	Option Card
19	Alternate Step/Direction ribbon cable connector

Table 14 – Summary of PMDX-126 Connectors

10.1 Data Bus Connectors (J1, J2, J3, and J4)

The data bus connectors are labeled to denote which pin on parallel port #1 that is associated with each connector pin. Each connector also provides a PC-referenced +5V and GND signal, either of which may be used as the "common" signal for your motor driver's step and direction inputs.

Pin Number	Label	Description
1	PC+5V	+5V power supply (referenced to the PCgnd on pin 4)
2	"8"	Buffered signal from pin 8 of the parallel port #1
3	"9"	Buffered signal from pin 9 of the parallel port #1
4	PCgnd	Ground (referenced to the ground on the PC parallel port connectors)

Table 15 – Data Bus Connector Pin-Out (J1)

Pin Number	Label	Description
1	PC+5V	+5V power supply (referenced to the PCgnd on pin 4)
2	"6"	Buffered signal from pin 6 of the parallel port #1
3	"7"	Buffered signal from pin 7 of the parallel port #1
4	PCgnd	Ground (referenced to the ground on the PC parallel port connectors)

Table 16 – Data Bus Connector Pin-Out (J2)

Pin Number	Label	Description
1	PC+5V	+5V power supply (referenced to the PCgnd on pin 4)
2	"4"	Buffered signal from pin 4 of the parallel port #1
3	"5"	Buffered signal from pin 5 of the parallel port #1
4	PCgnd	Ground (referenced to the ground on the PC parallel port connectors)

Table 17 – Data Bus Connector Pin-Out (J3)

Pin Number	Label	Description
1	PC+5V	+5V power supply (referenced to the PCgnd on pin 4)
2	"2"	Buffered signal from pin 2 of the parallel port #1
3	"3"	Buffered signal from pin 3 of the parallel port #1
4	PCgnd	Ground (referenced to the ground on the PC parallel port connectors)

Table 18 – Data Bus Connector Pin-Out (J4)

10.2 Secondary Control Output Connector (J5)

Pin Number	Label	Description
1	PC+5V	+5V power supply (referenced to the PCgnd on pin 6)
2	"A"	Output from parallel port #2 pin 1 or expanded mode bit stream
3	"B"	Output from parallel port #2 pin 14 or expanded mode bit stream
4	"C"	Output from parallel port #2 pin 16 or expanded mode bit stream
5	"D"	Output from parallel port #2 pin 17 or expanded mode bit stream
6	PCgnd	Ground (referenced to the ground on the PC parallel port connectors)

Table 19 – Secondary Control Output Connector Pin-Out (J5)

10.3   Primary Control Output Connector (J6)

Pin Number	Label	Description
1	PC+5V	+5V power supply (referenced to the PCgnd on pin 6)
2	"1"	Output from parallel port #1 pin 1
3	"14"	Output from parallel port #1 pin 14
4	"16"	Output from parallel port #1 pin 16
5	"17"	Output from parallel port #1 pin 17
6	PCgnd	Ground (referenced to the ground on the PC parallel port connectors)

Table 20 – Primary Control Output Connector Pin-Out (J6)

10.4   External LED Connector (J7)

Pin Number	Label	Description
1	"+V raw"	Unregulated +12V power supply (referenced to the PCgnd on pin 6).
2	"OE"	Connection for external "outputs enabled" LED
3	"Steps"	Connection for external "step activity" LED
4	"EStop"	Connection for external "E-Stop" LED
5	"Pwr"	Connection for external "Power On"
6	PCgnd	Ground (referenced to the ground on the PC parallel port connectors)

Table 21 – Primary Control Output Connector Pin-Out (J7)

10.5   AC Power Connector (J8)

> *WARNING:*   **Set the voltage selector switch to the appropriate voltage range BEFORE applying power to the PMDX-126.**

Pin	Description	
1	AC voltage	*NOTE:* There is no safety ground connection
2	AC voltage	required for the PMDX-126

Table 22 – Power Supply Connector Pin-Out (J8)

10.6   Relay Contact Connectors (J9 and J10)

See section 7.2 for more information on using these connectors..

Pin Number	Label	Description
1	COM	Relay common terminal
2	N/O	Normally Open relay contact (i.e. open when relay is *not* energized)

Table 23 – Relay "K1" Contact Connector Pin-Out (J9)

Pin Number	Label	Description
1	N/C	Normally Closed relay contact (i.e. closed when relay is *not* energized)
2	COM	Relay common terminal
3	N/O	Normally Open relay contacts (i.e. open when relay is *not* energized)
4	MOV	MOV protection terminal (see section 7.2 for more information)

Table 24 – Relay "K2" Contact Connector Pin-Out (J10)

10.7 Secondary Status Input Connector (J11)

Pin Number	Label	Description
1	+12U	Unregulated +12V power supply (referenced to the GND pins on this connector).
2	+5V	Regulated +5V power supply (referenced to the GND terminals on this connector).
3	"E"	Optically-isolated input for parallel port #2 pin 11 (or multiplexed onto port #1 pin 11)
4	GND	Isolated ground reference
5	"F"	Optically-isolated input for parallel port #2 pin 12 (or multiplexed onto port #1 pin 12)
6	GND	Isolated ground reference
7	"G"	Optically-isolated input for parallel port #2 pin 13 (or multiplexed onto port #1 pin 13)
8	GND	Isolated ground reference
9	"H"	Optically-isolated input for parallel port #2 pin 15 (or multiplexed onto port #1 pin 15)
10	GND	Isolated ground reference

Table 25 – Secondary Status Input Connector Pin-Out (J11)

10.8 Primary Status Input Connector (J12)

Pin Number	Label	Description
1	+12U	Unregulated +12V power supply (referenced to the GND pins on this connector).
2	+5V	Regulated +5V power supply (referenced to the GND terminals on this connector).
3	"11"	Optically-isolated input for parallel port #1 pin 11
4	GND	Isolated ground reference
5	"12"	Optically-isolated input for parallel port #1 pin 12
6	GND	Isolated ground reference
7	"13"	Optically-isolated input for parallel port #1 pin 13
8	GND	Isolated ground reference
9	"15"	Optically-isolated input for parallel port #1 pin 15
10	GND	Isolated ground reference

Table 26 – Secondary Status Input Connector Pin-Out (J11)

10.9 E-Stop, Fault, Gekco Error and Restart Connector (J13)

Pin Number	Label	Description
1	E-Stop	Emergency Stop input (active high, i.e. "open" to signal E-Stop). You **must** provide a ground via the E-Stop switch chain or a direct jumper in order to prevent an "E-Stop" condition, which will disable the outputs and relays on the PMDX-126 board.
2	GND	Ground connection
3	Fault	Fault input (active low)
4	ERR	Gecko Error Input
5	RST	Restart Output
6	COM	Common terminal for *Gecko Error Input* and *Restart Output*

Table 27 – E-Stop, Fault, Gecko Error and Restart Connector Pin-Out (J13)

10.10 Reserved Connector (J14)

> WARNING: DO NOT CONNECT ANYTHING TO J14.
> THIS CONNECTOR IS FOR FACTORY USE ONLY.

10.11 Parallel Port #1 Connectors (J15 & J16)

The PMDX-126 provides a 25-pin "D" connector and a 26-pin ribbon cable header for the parallel port #1. The pin-out of the 26-pin ribbon cable header (J16) matches the industry standard for DB-25 signals on a ribbon cable, and is not shown in the table below.

> NOTE: Some printer cables do not have good signal shielding. In addition, some cables omit some of the status or control signals (such as pin numbers 13 and 14). We recommend using cables that are listed as IEEE-1284 compliant.

Pin Numbers PC (note 1)	J15 (note 2)	PMDX-126 Signal	Comment
1	1	Relay control and connector J6	See sections 3.3 and 4.0 for relay information
2	2	Output signals to connectors J1 through J4 and J19	Normally used for step and direction signals, but may be used as generic outputs.
3	3		
4	4		
5	5		
6	6		
7	7		
8	8		
9	9		
10	10	E-Stop input to PC	Driven high when *E-Stop* or *Fault* is active, or on *Gecko Error*
11	11	Status Input from J12	
12	12	Status Input from J12	
13	13	Status Input from J12	
14	14	Relay control and connector J6	See sections 3.3 and 4.0 for relay information
15	15	Status Input from J12	
16	16	Control Output to connector J6	
17	17	Control Output to connector J6	Can act as charge pump
18 – 25	18-25	PC Ground	

Table 28- PC Parallel Port Connectors (J15 and J16)

NOTE 1 – The PC Pin number column lists the pin numbers as they would appear on the PC's 25-pin "D" connector when using a standard printer cable.

NOTE 2 – J15 is the 25-pin "D" connector on the PMDX-126. J16 (not shown in this table) is the 26-pin ribbon cable header on the PMDX-126. The pin-out on J16 matches the industry standard for DB-25 signals on a ribbon cable.

10.12 Parallel Port #2 Connector (J17)

The PMDX-126 provides a 26-pin ribbon cable header for the parallel port #2.

Pin Numbers PC (note 1)	J17 (note 2)	PMDX-126 Signal	Comment
1	1	Control Output to connector J5 "A"	
2	3	No connection on the PMDX-126	Can use the PMDX-108-In or PMDX-108-Out to access these signals
3	5		
4	7		
5	9		
6	11		
7	13		
8	15		
9	17		
10	19	E-Stop input to PC	Driven high when *E-Stop* or *Fault* is active, or on *Gecko Error*
11	21	Status Input from J11 "E"	
12	23	Status Input from J11 "F"	
13	25	Status Input from J11 "G"	
14	2	Control Output to connector J5 "B"	
15	4	Status Input from J11 "H"	
16	6	Control Output to connector J5 "C"	
17	8	Control Output to connector J5 "D"	
18 – 25	10-24 even	PC Ground	

Table 29- PC Parallel Port Connectors (J17)

> **NOTE 1 –** The PC Pin number column lists the pin numbers as they would appear on the PC's 25-pin "D" connector when using a standard printer cable.

> **NOTE 2 –** The pin-out on J17 matches the industry standard for DB-25 signals on a ribbon cable.

10.13 Option Card Connector (J18)

The option card connector is used for PMDX option boards such as the PMDX-107. The pin-out is proprietary.

10.14 Alternate Step/Direction Connector (J19)

This connector provides a method to access parallel port #1 pins 2 through 9, and parallel port #2 pins 1, 14, 16 and 17 other than by using discrete wires on connectors J1, J2, J3, J4 and J5. J19 is a 26-pin ribbon cable header and allows the use of a 26-pin ribbon cable to connect the PMDX-126 to any multi-axis motor driver that has a 26-pin header on it. Specifically, this connector can be used to connect the PMDX-126 to a PMDX-134 (4-axis Gecko Motherboard) or two one or two PMDX-133 boards (3-axis Daisy-Chainable Gecko Motherboard).

Table 30 shows the pin-out of this connector. Note that all signals on this connector are buffered by the PMDX-126.

Additionally, there is an option to connect "PC+5V" to J19 pin 26. See jumper JP4 in section 4.0 for more information.

J19 Pin Numbers	DB25 Equivalent Pin Numbers	PMDX-126 Signal	Comment
1	1	Parallel Port #2 pin 1	Possible 5th axis step signal
3	2	Parallel Port #1 pin 2	Usually X-axis step and direction
5	3	Parallel Port #1 pin 3	
7	4	Parallel Port #1 pin 4	Usually Y-axis step and direction
9	5	Parallel Port #1 pin 5	
11	6	Parallel Port #1 pin 6	Usually Z-axis step and direction
13	7	Parallel Port #1 pin 7	
15	8	Parallel Port #1 pin 8	Usually A-axis step and direction
17	9	Parallel Port #1 pin 9	
19	10	No Connection	
21	11	No Connection	
23	12	Special Function	Reserved, do not connect
25	13	Special Function	Reserved, do not connect
2	14	Parallel Port #2 pin 14	Possible 5th axis direction signal
4	15	No Connection	
6	16	Parallel Port #2 pin 16	Possible 6th axis step signal
8	17	Parallel Port #2 pin 17	Possible 6th axis direction signal
10, 12, 14, 16, 18, 20, 22, 24	18, 19, 20, 21, 22, 23, 24, 25	PC Ground	
26	None	Optional PC +5V	Depends on jumper JP4 setting, see section 4.0 for more information.

Table 30- Alternate Step/Direction Connector (J19)

NOTE 1 – The pins on J19 are numbered with the odd pins in one row and the even pins in the other row, which is the standard for ribbon cable connectors.
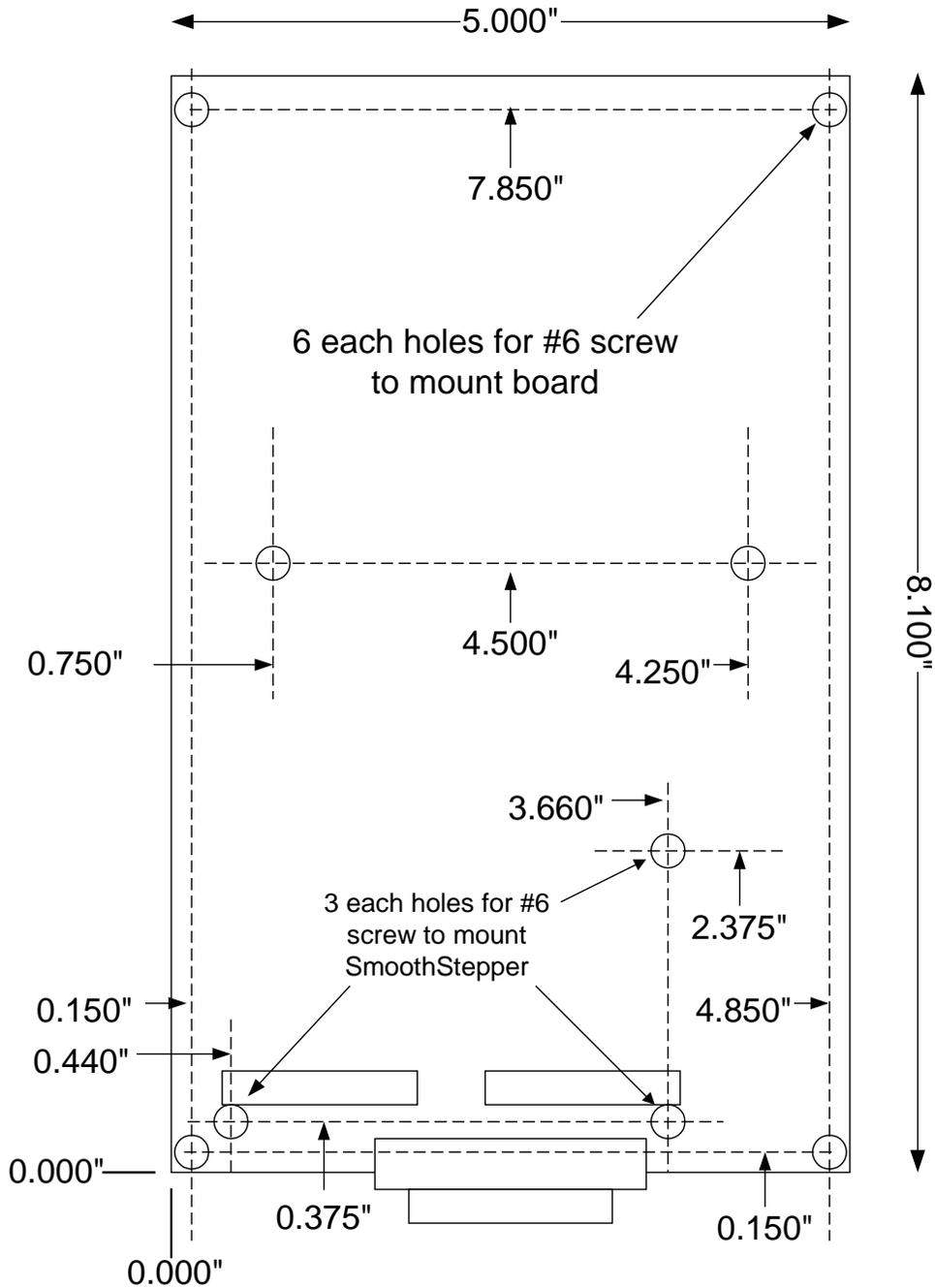
11.0 Mechanical Specifications

Figure 6 - PMDX-126 Dimensions and Mounting Holes

> **WARNING:** The PMDX-126 should be protected from liquids, dirt, or chips (especially metal chips which can cause shorts) coming in contact with the board.

12.0 Electrical and Environmental Specifications

Main Power: 115VAC (110 to 125VAC) or 230VAC (220 to 240VAC), switch selectable
0.150 Amperes maximum.

<u>External Loads from Primary Power Supply:</u>

PC+5V: Regulated +5V supply (referenced to PC ground) on connectors J1, J2, J3, J4, J5 and J6. "PC+5V" is also present on connectors J16 and J17 (depending on jumper JP3, see section 4.0), J18, and J19 (depending on jumper JP4, see section 4.0).
Maximum total current drawn from **all** "PC+5V" pins is **350 mA** (see note 1 below)

+V Raw: Unregulated +12V supply on connector J7.
Maximum current **300 mA** (see note 1 below)

NOTE 1: Total current supplied to external loads from both "PC+5V" and "+V Raw", including a SmoothStepper (if any) on J16 and J17 and a PMDX accessory board (if any) on J18 and/or J19 is **500 mA**

PMDX's experiments with a sample SmoothStepper shows that it draws approx. 120 mA when powered by a PMDX-126

<u>External Loads from Isolated Power Supply:</u>

+5V: Regulated +5V supply on connectors J11 and J12:
Maximum current **250 mA** (see note 2 below)

+12U: Unregulated +12V supply on connectors J11 and J12:
Maximum current **250 mA** (see note 2 below)

NOTE 2: Total current supplied to external loads from both +5V and +12U on J11 and J12 is **250 mA**

<u>Inputs (**_E-Stop_** and **_Fault_**):</u>

Low must be able to sink 6 mA at less than 0.8V
High must be open circuit or greater than 3.0 volts (and no greater than 25VDC)
Response time is 20 μs

<u>Inputs (all except **_E-Stop_** and **_Fault_**):</u>

Low must be able to sink 6 mA at less than 0.8V
High must be open circuit or greater than 3.0 volts and no greater than 6VDC (except PNP signals)
Active PNP signals must be able to source 20 to 24V DC at 6mA minimum. Inactive PNP signals must be open-circuit or have less than 0.1mA of leakage current.
Response time is 20 μs

<u>Outputs:</u> High: at least 3.8V driving a 16mA load
Low: at most 0.8V sinking 16mA
Maximum data rate 500 KHz

<u>Relay K1 Contact Ratings:</u>
30 amperes at 120 VAC,
30 amperes at 240 VAC,
10 amperes max at 24 VDC

<u>Relay K2 Contact Ratings:</u>
10 amperes at 120 VAC,
10 amperes at 240 VAC,
5 amperes at 24 VDC

<u>Charge Pump:</u>
Min. Frequency: 150 Hz minimum square wave appearing on parallel port #1 (J15 or J16) pin 17.

<u>Environmental:</u>
Temperature: 0° to +55° C
Relative Humidity: 20% to 80% relative humidity, non-condensing

Appendix A – Warrant y

Statement

Practical Micro Design, Inc. (PMD) warrants that this hardware product is in good working condition, according to its specifications at the time of shipment, for a period of 90 days from the date it was shipped from PMD. Should the product, in PMD's opinion, malfunction within the warranty period, PMD will repair or replace the product without charge. Any replaced parts become the property of PMD. This warranty does not apply to the software component of a product or to a product which has been damaged due to accident, misuse, abuse, improper installation, usage not in accordance with product specifications and instructions, natural or personal disaster or unauthorized alterations, repairs or modifications.

Limitations

All warranties for this product, expressed or implied, are limited to 90 days from the date of purchase and no warranties, expressed or implied, will apply after that period.

All warranties for this product, expressed or implied, shall extend only to the original purchaser.

The liability of Practical Micro Design, Inc. in respect of any defective product will be limited to the repair or replacement of such product. Practical Micro Design, Inc. may use new or equivalent to new replacement parts.

Practical Micro Design, Inc. makes no other representations or warranties as to fitness for purpose, merchantability or otherwise in respect of the product. No other representations, warranties or conditions, shall be implied by statute or otherwise.

In no event shall Practical Micro Design, Inc. be responsible or liable for any damages arising
  (a) from the use of the product;
  (b) from the loss of use of the product;
  (c) from the loss of revenue or profit resulting from the use of the product; or
  (d) as a result of any event, circumstance, action or abuse beyond the control of Practical Micro Design, Inc.
whether such damages be direct, indirect, consequential, special or otherwise and whether such damages are incurred by the person to whom this warranty extends or a third party.