PMDX-130

4-Axis Motion Control Motherboard

User's Manual

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1.0   Overview

This document describes the configuration and operation of the PMDX-130 4-Axis Motion Control Motherboard. The PMDX-130 provides an interface between a PC and up to four motor driver boards, as well as optional riser boards that provide digital inputs and outputs. Motor driver boards intended for use with the PMDX-130 provide optical isolation of the step and direction signals. I/O signals may or may not be isolated, depending on the option cards installed. This document pertains to the following versions of the PMDX-130:

> Circuit Board Revision: PCB-437B (marked on the bottom of the board)

1.1   Important Safety Information

The PMDX-130 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-130 is not guaranteed to be fail-safe. The system into which the PMDX-130 is installed should provide fail-safe protection and emergency stop capability.

The PMDX-130 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-130 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-130 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.

If you have an item requiring service, please see the support page on the PMDX web site (http://www.pmdx.com) for return instructions.

The purchaser must pay shipping to return the unit to PMDX. We 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.

1.3   Features

The PMDX-130 has the following features:

PC Parallel Port:
- Centronics cable connector uses standard PC printer cable

Motor Driver Interface:
- 4 axes of step and direction
- Driver fault sensing
- Motor drivers isolated from parallel port ground

Power Supply Input:
- 24 VAC, center tapped

Special Features:
- Regulated motor supply voltage protects motor drivers
- Support for Mach2 "charge pump"
- Two slots for accessory cards
- Wire clamp terminal strips for I/O connections from parallel port status and control signals

1.4   Updates to this Manual

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-130 page (follow the links from the main page).

2.0   Connectors

The PMDX-130 contains the following connectors. Refer to the following sections 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	Centronics 36-pin PC Parallel Port
J2	PC parallel port control output signals
J3	AC Power
J4, J5, J6, J7	Motor driver daughter board connectors
J8	PC Parallel Port status input signals
J9	Fan power and external "Power" LED

Table 1 - Summary of PMDX-130 Connectors

2.1   PC Parallel Port (J1)

The PMDX-130 provides a Centronics-style connector for connections to a PC's parallel port. This allows the use of a standard PC printer cable.

> NOTE – Some printer cables do not have good signal shielding. Some cables also omit some of the status or control signals (such as "Auto Feed" and "Select Out", 25-pin D connector pin numbers 14 and 13, respectively). We recommend using cables that are listed as IEEE-1284 compliant.

> WARNING – The PMDX-130 by itself does not provide any isolation for the status and control signals to/from the PC parallel port. The motor driver boards provide optical isolation for the step and direction signals (i.e. the parallel port's data bus). Future riser cards that plug in to the PMDX-130 may or may not provide isolation for the parallel port's status and control signals.

Pin Numbers PC (note 1)	J1 (note 3)	PC Signal Name	Direction (relative to PC)	PMDX-130 Signal	Comment
1	1	~Strobe	out	Output "A"	Non-buffered signal from PC
2	2	Data 0	out	Dir signal to driver plugged into J4	Non-buffered signals from the PC. See section 2.4, *Motor Driver Connectors*, for more information on these connectors and their signals.
3	3	Data 1	out	Step signal to driver plugged into J4	
4	4	Data 2	out	Dir signal to driver plugged into J5	
5	5	Data 3	out	Step signal to driver plugged into J5	
6	6	Data 4	out	Dir signal to driver plugged into J6	
7	7	Data 5	out	Step signal to driver plugged into J6	
8	8	Data 6	out	Dir signal to driver plugged into J7	
9	9	Data 7	out	Step signal to driver plugged into J7	
10	10	~Ack	in	E-Stop & Fault	See sections 4.0 and 2.4.3
11	11	Busy	in	Contact Closure "A"	Non-buffered signals into PC. The PC usually has an internal pull-up resistor allowing it to directly sense switch closures to ground (pin 1 of J8).
12	12	Paper End	in	Contact Closure "B"	
13	13	Select Out (note 2)	in	Contact Closure "C"	
14	14	~Auto Feed	out	Output "B"	Non-buffered signal from PC
15	32	~Error	in	Contact Closure "D"	See contact closure note above
16	31	~Init	out	Output "C"	Non-buffered signal from PC
17	36	~Select In (note 2)	out	Output "D" and charge pump signal	Non-buffered signal from PC, see section 5.0 for charge pump description.
18 – 25	19-30, 33	Ground		Ground	

Table 2- PC Parallel Port Connectors (J1)

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 "~Select In" and "Select Out" signals are named relative to the printer's point of view. That is why the "~Select In" is an *output* from the PC, and "Select Out" in an *input*.

NOTE 3 – J1 is the Centronics 36-pin connector on the PMDX-130.

NOTE 4 – The "~" character at the beginning of some of the signal names indicates a signal that is "active low" (measured at the PC's 25-pin D connector) *when connected to a printer*. The PMDX-130 *does not* necessarily use the polarity implied by the signal names.

The following web sites provide information regarding the PC's parallel port, including pin-outs, signal names and useful data for software control of the parallel port:

- IBM PC Parallel Port FAQ and tutorial
  http://www.pmdx.com/Resources/parallel-port.html
  and
  http://et.nmsu.edu/~etti/fall96/computer/printer/printer.html

- General information and lots of links
  http://www.lvr.com/parport.htm

- If the previous links do not work, go to http://www.pmdx.com (our main web page), click on the PMDX-120 link, then look for the links to parallel port information pages)

Note that these web links were accurate as of the printing date of this manual. While we expect that these two sites will remain available at these addresses, it *is* possible that they will move or disappear.

2.2   Control Output Connector (J2)

The control output connector provides wire clamp screw terminal connections for all of the PC parallel port control signals. These signals are *not* buffered by the PMDX-130, and are *not* optically isolated. If buffering or isolation is needed, check http://www.pmdx.com for option cards with these features.

This connector also provides access to the PMDX-130-generated ~CP_OK signal from the charge pump circuit. See section 5.0 for more information on the charge pump.

Pin Number	Description
1	Ground connection
2	~CP_OK (see section 5.0)
3	Control output from PC parallel port pin 1 (~Strobe)
4	Control output from PC parallel port pin 14 (~Auto Feed)
5	Control output from PC parallel port pin 16 (~Init)
6	Control output from PC parallel port pin 17 (~Select In – the signal that also feeds the PMDX-130's charge pump circuit, see section 5.0).

Table 3 – Control Output Connector Pin-Out (J2)

Outputs which do not need to be controlled by the "charge pump" can simply be connected between the relevant output connector pin and ground.

The "~CP_OK" signal is designed to be used as the return path for signals driving optically isolated devices such as Opto-22 relays or similar devices. These devices should be connected between the relevant output connector pin and the "~CP_OK" signal on pin 2. When the "charge pump" is OK, pin 2 will be driven to ground. When the "charge pump" is *not* OK, pin 2 will be allowed to "float". This will deprive the optically isolated load of its ground return path, effectively turning it off.

2.3   AC Power Connector (J3)

J3 is a 3-position wire clamp screw terminal for AC power input. It should be connected to a center-tapped 24-volt (nominal) power transformer. The center tap is needed *only* if the fan power connector is utilized. A pair of 12-volt transformers (of the same ratings) in series may be substituted for a single center-tapped transformer. The current rating required varies with the type of motors being driven. Eight amperes is sufficient for full rated current to four motors. Transformers rated at less than 3 amperes are *not* recommended because they may not be able to handle the pulse loads imposed on them.

The PMDX-130 is designed to protect the motor driver boards from minor deviations in the supply voltage. Voltages that are more than 20% high or low are not recommended.

Pin Number	Description
1	AC power input, one side of the 24-volt transformer
2	Center tap from transformer
3	AC power input , other side of the 24-volt transformer

Table 4 – AC Power Connector Pin-Out (J3)

2.4   Motor Driver Connectors (J4, J5, J6, and J7)

These connectors provide for up to four motor driver daughter boards. These four connectors can be populated in any combination. The only restriction is that the step and direction signals from the PC's parallel port are hard wired to specific connectors, as shown in Table 2 on page 5. There is no connection between the power system on the PMDX-130 and the parallel port signals.

When looking at the board from the rear side (the side with the Centronics connector), J4 is the connector on the left, and J7 is the connector on the right.

Pin Number	Description
1	Negative motor power supply (Vneg)
2	Positive motor power supply (Vpos)
3	Step & Direction Enable (section 3.2)
4	Step (from PC parallel port data pins)
5	Direction (from PC parallel port data pins)
6	~Fault (active low open-collector input)
7	"Aux A" signal
8	"Aux B" signal

Table 5 – Motor Driver Connector Pin-Out (J4, J5, J6, and J7)

2.4.1 Step & Direction Signals

The step and direction signals are hard-wired to specific motor driver connectors (see Table 2 on page 5). These signals are *not* buffered on the PMDX-130, and are *not* optically isolated by the PMDX-130. However, the motor driver boards do provide optical isolation for these signals.

2.4.2 Step & Direction Enable Signal

The "Step & Direction Enable" signal provides a way for the PMDX-130 to disable the motor driver output stages in the event of a problem (such as a charge pump failure). Jumper JP2 determines what drives this signal. See section 3.2 for more information.

2.4.3 Fault Signal

The PMDX-130 takes the "~Fault" signals from all four motor driver connectors and combines them together to generate the main fault signal. This fault signal is then combined with the E-Stop circuit. Refer to section 4.0, *E-Stop Input*, for a list of actions that take place when the "Fault" input is drive low.

2.4.4 "Aux A" and "Aux B" Signals

The "Aux A" and "Aux B" signals are for future expansion. The current PMDX stepper motor driver boards do not use these signals, and the PMDX-130 boards that are shipped with these driver cards have 6-pin connectors installed instead of the full 8-pin connectors. See also section 3.1, *Aux B Source Select*.

2.5 Status Input Connector (J8)

The status input connector provides wire clamp screw terminal connections for all of the PC parallel port status signals except the "~Ack" signal (pin 10 of the parallel port). These signals are **not** buffered by the PMDX-130, and are **not** optically isolated. If buffering or isolation is needed, check http://www.pmdx.com for option cards with these features.

The PMDX-130 does not provide direct access to the "~Ack" signal on this connector because the PMDX-130 uses this signal to indicate fault conditions to the PC. This connector provides access to the "~Ack" signal via the PMDX-130's emergency stop input, which is combined with other fault signals to generate the "~Ack" signal. See section 4.0 for more information on the emergency stop input and the "~Ack" signal.

Pin Number	Description
1	Ground connection
2	Emergency Stop (E-Stop) input (**must** be grounded for normal operation, see section 4.0 for more information)
3	Status input to PC parallel port pin 11 (Busy)
4	Status input to PC parallel port pin 12 (Paper End)
5	Status input to PC parallel port pin 13 (Select Out)
6	Status input to PC parallel port pin 15 (~Error)

Table 6 – Status Input Connector Pin-Out (J8)

2.6 Fan Power and Power LED Connector (J9)

This connector provides power to drive a 24 volt DC fan. The PMDX-130 supplies approximately 18VDC – this is enough to run a 24V DC fan, and will generate less acoustic noise than when the fan is driven by the full 24VDC.

This connector also provides a signal for an optional external "Power On" LED. The PMDX-130 provides a 2.2K ohm current limiting resistor from Vpos (positive motor voltage) to the LED terminal.

Pin Number	Description
1	Negative power lead
2	Positive power lead
3	Optional external power LED (connect the LED's annode to this terminal and the cathode to pin 1 of this connector)

Table 7 – Fan Power Connector Pin-Out (J9)

3.0 Jumpers

The PMDX-130 contains two 3-pin jumpers that determine various aspects of its behavior. Each jumper has silk screen labels that describe the function of the jumper, and each possible setting. Each jumper should have a shorting block installed either between pins 1 and 2, or between pins 2 and 3.

3.1   Aux B Source Select (JP1)

The "Aux B" signal on the four motor driver connectors can be driven by one of two sources, as shown in the table below. Note that not all types of motor driver boards use this "Aux B" signal. See section 2.4, *Motor Driver Connectors*, for more information on the "Aux B" signal.

Setting	Label	Description
1 to 2	ptr port	"Aux B" signal sourced from the PC parallel port ~Strobe signal
2 to 3	smart	"Aux B" signal sourced from the optional Smart Card connector

Table 8 – "Aux B" Source Select Jumper Settings (JP1)

3.2   Step/Direction Enable Source Select (JP2)

The "Step & Direction Enable" signal on the four motor driver connectors can be driven by one of two signals, as shown in the table below. See section 2.4, *Motor Driver Connectors*, for more information on the "Step & Direction Enable" signal.

Setting	Label	Description
1 to 2	always	Always enabled (ignores the E-Stop and charge pump circuits)
2 to 3	CP-OK	Driven by the "charge pump OK" signal (see section 5.0)

Table 9 – Step/Direction Output Enable Jumper Settings (JP2)

4.0   E-Stop Input

The status input connector (J8) provides an "emergency stop" input. The "E-Stop" signal can cause the motor drivers to disable their step inputs (depending on the setting of jumper JP2), and also tells the PC that something is wrong (via the "~Ack" status signal).

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 ground, such that the switch contacts open to indicate an emergency stop condition.

> *NOTE –* The E-Stop signal **must** be grounded in order for the motor driver's step inputs to be enabled (depending on JP2) and the "~Ack" status signal to the PC parallel port to go low (signaling "OK"). If you do not have an emergency stop circuit, connect the E-Stop terminal to ground.

The "~Ack" status signal sent to pin 10 on the PC's parallel port is driven by a combination (logical "OR") of the "E-Stop" signal and the PMDX-130's fault logic (see section 2.4.3). A logic high on this signal (~Ack) indicates an error condition and a logic low means "OK". The ~Ack signal will appear as a logic high to the PC under the any one or more of the following conditions:

- Any motor driver boards faults (thus asserting the PMDX-130's fault signal)
- The E-Stop circuit opens (E-Stop input is no longer grounded)
- Power is removed from the PMDX-130 board

When the E-Stop input is open-circuited, or the internal fault signal is asserted, the following happens:

- The ~Ack signal floats "high" (using the pull-up resistor built in to the PC parallel port)
- the ~CP_OK signal floats (see section 5.0)
- The "Step & Direction Enable" signal to the four motor driver boards floats, thereby disabling the motor drivers (this depends on the configuration of JP2, see section 3.2 for more information)

5.0   Charge Pump (watchdog)

The charge pump circuit (also called a watchdog circuit) is designed to disable the PMDX-130 (and all motor driver board inputs) when the software running on the PC stops working properly. It does this by monitoring pin 17 on the PC parallel port (the "~Select In" signal). When this signal is toggling between high and low, the charge pump is "OK" and the ~CP_OK signal is driven low. When the signal stops toggling, the ~CP_OK signal floats.

This charge pump circuit is designed to work with the Mach2 CNC software. However, any software that can toggle pin 17 on the PC parallel port can make use of this feature. If your software does not support this feature, configure jumper JP2 to disable the charge pump circuit (see section 3.2).

> *NOTE –*   The state of the charge pump signal is ***not*** reflected in the E-Stop and Fault status that is output on the "~Ack" signal to the PC (pin 10 on the parallel port). This is to prevent "lock up" of the software. Mach2 requires that the Emergency Stop signal (~Ack) ***not*** be asserted before it will start generating the "charge pump" signal.

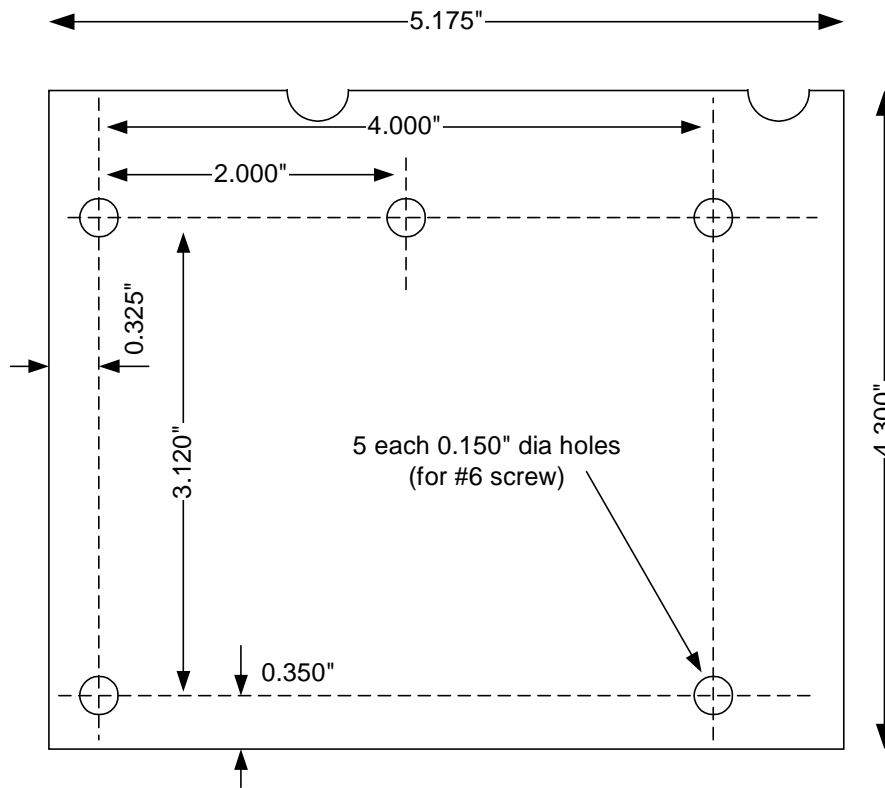## 6.0   Mechanical Specifications

Figure 1 - PMDX-130 Dimensions and Mounting Holes

WARNING: The PMDX-130 should be protected from liquids, dirt, or chips (especially metal chips which can cause shorts) coming in contact with the board.

7.0   Electrical and Environmental Specifications

Main Power: 24 VAC ±20%, center tapped, 3 to 8 Amperes as required by the motors

Voltage supplied
to motor drivers: 33 to 34 volts DC

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

Appendix A – Warranty

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.