Delta Tau PMAC-PACK

4-Axis Servo Drive

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HARDWARE REFERENCE MANUAL

PMAC Pack

Box PMAC-Lite PC

3xx-602476-xHxx

June 2003

DELTA TAU
Data Systems, Inc.
NEW IDEAS IN MOTION ...

Single Source Machine Control *Power // Flexibility // Ease of Use*

21314 Lassen Street Chatsworth, CA 91311 // Tel. (818) 998-2095 Fax. (818) 998-7807 // www.deltatau.com

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To report errors or inconsistencies, call or email:

Delta Tau Data Systems, Inc. Technical Support
Phone: (818) 717-5656

Fax: (818) 998-7807

Email: support@deltatau.com

Website: http://www.deltatau.com

Operating Conditions

All Delta Tau Data Systems, Inc. motion controller products, accessories, and amplifiers contain static sensitive components that can be damaged by incorrect handling. When installing or handling Delta Tau Data Systems, Inc. products, avoid contact with highly insulated materials. Only qualified personnel should be allowed to handle this equipment.

In the case of industrial applications, we expect our products to be protected from hazardous or conductive materials and/or environments that could cause harm to the controller by damaging components or causing electrical shorts. When our products are used in an industrial environment, install them into an industrial electrical cabinet or industrial PC to protect them from excessive or corrosive moisture, abnormal ambient temperatures, and conductive materials. If Delta Tau Data Systems, Inc. products are exposed to hazardous or conductive materials and/or environments, we cannot guarantee their operation.

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OVERVIEW

Introduction

The PMAC-Pack is a boxed version of the PMAC-Lite PC-based motion control card. It is designed for stand-alone operation and easy interconnection. All PMAC-Packs contain 5 volt and 12 volt power supplies, a PMAC-Lite 1.5 motion control card, and a backplane board which facilitates connection between the PMAC-Lite card and the industrialized connectors on the PMAC-Pack front panel.

Using This Manual

The PMAC-Pack Hardware Reference Manual is intended as an aid to interconnection and setup of the PMAC-Pack hardware. A Start-up section is included to quickly guide the user through the point of jogging non-commutated axes. The PMAC User's Manual and Software Reference, 3A0-602204-363 provides further instructions for establishing communication with PMAC, setup of software parameters, and programming of the control. Additionally, the PMAC User's Manual further discusses PMAC motion control features and how they may be implemented.

Organization

Chapter 1 - Overview: Introduction to the PMAC-Pack features, the layout of the manual, and equipment requirements.

Chapter 2 - Getting Started: This chapter serves as a quick-start guide to installing the PMAC-Pack and guiding the user through jogging and homing motors, toggling outputs and reading inputs.

Chapter 3 - Complying with European Community (CE) EMC Conventions: This chapter contains all data required to comply with Council Directive 89/336/EEC relating to Electromagnetic Compatibility.

Chapter 4 - PMAC-Pack Custom Configuration: This chapter describes how to disassemble the PMAC-Pack, set the E-Point jumpers on the PMAC-Pack backplane and PMAC-Lite card, and reassemble the PMAC-Pack. This Chapter also describes how to prevent electrostatic discharge (ESD) damage to the PMAC-Lite circuit card assembly.

Chapter 5 - Troubleshooting: This chapter provides procedures used to identify and resolve problems associated with the installation and operation of the PMAC-Pack.

Chapter 6 - PMAC-Pack Mating Connectors and Mating Connector Pinouts: This chapter provides a list of the mating connectors for PMAC-Pack ports, their function, the Delta Tau part numbers, and the true manufacturer's part number to facilitate customer ordering. It also includes tables describing each PMAC-Pack connector pin by number, symbol, function, and description.

Chapter 7 - Circuit Diagrams: This chapter contains all of the PMAC-Pack schematics and block diagrams.

Chapter 8 - ACC24EXP Expansion Pack: This chapter provides detailed instructions for installation of the PMAC-Pack expansion unit.

Chapter 9 - PMAC-Pack Options and Accessories: This chapter describes the internal and external options and accessories currently available for the PMAC-Pack and a brief description of their purpose and function.

Appendix A – Electrostatic Discharge Control: This Appendix describes control measures to be taken to protect against electrostatic discharge (ESD) damage.

Conventions Used in This Manual

The following conventions are used throughout the manual:

<ENTER> *<CTRL+4>*	**Italic text inside arrows denotes keyboard keys or key combinations.**
WARNING:	Information, which if not observed, may cause serious injury or death.
Caution:	Information, which if not observed, may cause damage to equipment or software.
Note:	A note concerning special functions or information of special interest.
	Electrostatic Sensitive Device. Use ESD control measures when handling, packing, and shipping (reference Appendix A).
CE	Indicates procedures or information that must be complied with to comply with European Community Interference Causing Equipment regulations.

Related Technical Documentation

The following technical manuals are required to successfully install and operate the Delta Tau PMAC-Pack. These manuals should be included in the technical documentation package you received with the PMAC-Pack, or with your software package(s). If any of these manuals are missing, please contact Delta Tau for a replacement before attempting installation.

Manual Number	Manual Title
3A0-602204-xUxx	PMAC User's Manual
3A0-602204-xSxx	PMAC/PMAC2 Software Reference
3A0-602274-xHxx	PMAC-Lite Hardware Reference Manual
3A0-0PEWIN-xUxx	PMAC Executive for Windows User's Manual (PEWIN)

Safety Summary

The following are general safety precautions not related to any specific procedures and therefore may not appear elsewhere in this publication. These are recommended precautions that personnel must understand, apply, and adhere to during the phases of installation, operation, and maintenance.

Keep Away From Live Circuits

Do not replace components or make adjustments inside the equipment with power applied. Under certain conditions, dangerous potentials may exist when power has been turned off due to charges retained by capacitors. To avoid casualties, always remove power and discharge and ground a circuit before touching it.

Live Circuit Contact Procedures

Never attempt to remove a person from a live circuit with your bare hands. To do so is to risk sure and sudden death. If a person is connected to a live circuit, the following steps should be taken:

1. Call for help immediately
2. De-energize the circuit, if possible.
3. Use a wooden hot stick to pull the person free of the circuit.
4. Apply cardiopulmonary resuscitation (CPR) if the person has stopped breathing or is in cardiac arrest.
5. Obtain immediate medical assistance.

Electrostatic Sensitive Devices

Various circuit card assemblies and electronic components may be classified as Electrostatic Discharge (ESD) sensitive devices. Equipment manufacturers recommend handling all such components in accordance with the procedures described in Appendix A. **Failure To Do So May Void Your Warranty.**

Technical Support

Delta Tau is happy to respond to any questions or concerns you have regarding PMAC-Pack. You can contact the Delta Tau Technical Support Staff by the following methods:

By Telephone

For immediate service, you can contact the Delta Tau Technical Support Staff by telephone Monday through Friday. Our support line hours and telephone numbers are listed below.

By FAX and E-Mail

You can FAX or E-Mail your request or problem to us overnight and we will attempt to reply the following business day. Our FAX numbers and E-Mail addresses are listed below. Please supply all pertinent equipment set-up information.

Bulletin Board Service (BBS) and Web Site

You can also leave messages on one of our Bulletin Board Services (BBSs). The BBSs are provided for our Customers, Distributors, Representatives, Integrators, et al. We invite you to use this service. You can download & upload files and read posted bulletins and Delta Tau newsletters. Messages may be left for anyone who is a member/user of the Bulletin Board System(s). All you need is a modem and Procomm-Plus or similar communications program. Many Download-Upload Protocols such as Z-Modem are supported.

Our BBS is also linked to the Delta Tau Internet site. It is possible to download BBS files via FTP and your Internet connection, saving log-distance phone charges. For additional information, visit our web site at www.deltatau.com.

World Headquarters
Delta Tau Data Systems, Inc.
9036 Winnetka Avenue
Northridge CA, 91324

Support Hot Line
Monday through Friday
8:30am to 4:30pm PST
Voice: (818) 998-2095
FAX: (818) 998-7807
BBS: (818) 407-4859
E-Mail: support@deltatau.com

Eastern U.S. Office
Delta Tau Data Systems, Inc.
10754 Decoursey Pike
Ryland Heights, KY 41015

Support Hot Line
Monday through Friday
8:30am to 4:30pm EST
Voice: (606) 356-0600
FAX: (606) 356-9910
BBS: (606) 356-6662
E-Mail: support@deltatau.com

BBS Settings: Baud Rates: 1200 to 19.2
8 - data bits, 1 - stop bit, No Parity

European Office
Delta Tau Data Systems International
Industrieweg 175, Suite 7
3044 AS Rotterdam, Netherlands
Support Hot Line
Monday through Friday
8:00am to 4:00pm GMT
Voice: 31-10-462-7405
FAX: 31-10-245-0945
BBS: TBD
E-Mail: bradped@xs4all.nl

PMAC-Pack Basic Specifications

Physical Specifications

(See Figure 1-1)

Size:

- 40.6cm x 10.8cm x 23cm (16" x 4.25" x 9") PMAC-Pack
- 40.6cm x 21.8cm x 23cm (16” x 9.6” x 9”) w/ Expansion Pack

Weight:

- 5.0 kg (11 lb) PMAC-Pack (standard)
- 6.1 kg (13.4 lb) PMAC-Pack (w/all available Opt. & Acc.)
- 4.2 kg (9.25 lb) PMAC-Pack Expansion Box (standard)

Temperature:

- Operating: 0oC to 60oC (32oF to 140oF)
- Storage: -12oC to 82oC (10oF to 180oF)

Humidity:

- 10% to 95%, non-condensing

Electrical Specifications

Internal Power Requirements:

(Eight-channel configuration, with a typical load of encoders)

- 1.5A @ +5V ()5%) (7.5W)
- 0.3A @ +12 to +15V (4.5W)
- 0.25A @ -12 to -15V (3.8W)

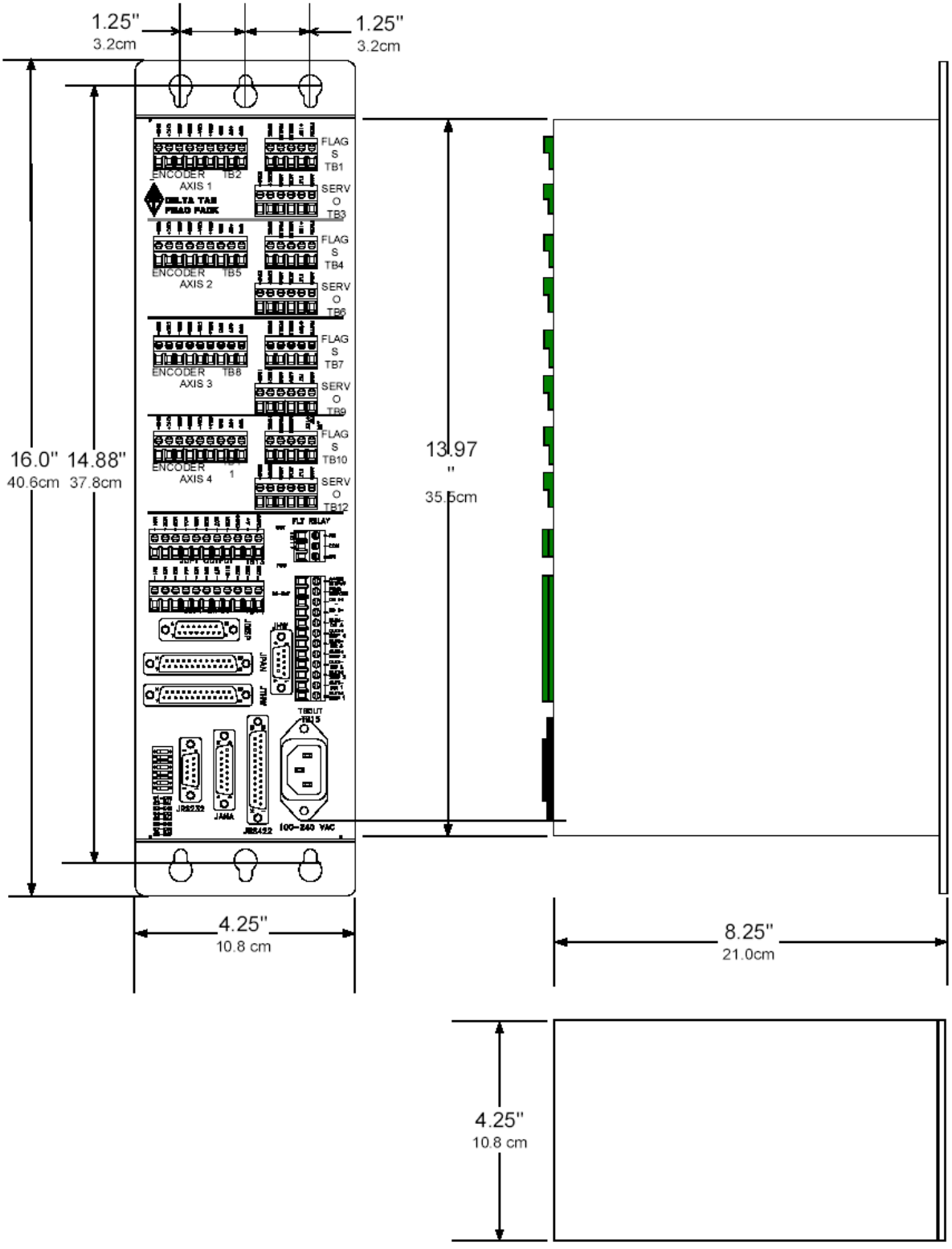


Figure 1-1. PMAC-Pack Dimension

Internal Power Supply:

- Mfg./Model - Lambda LVT-3H-322 (or equivalent)
- Input Voltage - 85 to 265 VAC
- Output (w/o options) - 5A @ + 5V (±5%)
  - @ +12V (±5%)
  - @ -12V (±5%)
- Output (with options) - 8A @ + 5V (±5%)
  - @ +12V (±5%)
  - @ -12V (±5%)
- Regulation - ±2%
- Ripple & Noise - < 150mV
- EMI - FCC Class "A" compliant
- Safety - UL/CSA/TUV approved

Battery:

(Units manufactured prior to 1995 only)

- 3.6V, 20mHz, 1000mAh, Lithium cell, 1.00" can
- Life Expectancy - 5 years (recommended replacement every 24 months)

Memory Specifications

ROM:

- 128 Kbytes Flash firmware for master control program

RAM:

- 384 Kbytes at 0 wait state static (128K 24-bit words) for active memory, battery-backed
- User Program Storage - 42K words ('X1000 Y1000' is two words) = 256KBytes.

EAROM:

- 2KBytes EEPROM non-volatile memory for setup parameter storage
- 384 Kbytes flash backup for non-volatile user parameters, programs, definitions, and tables.

CPU Specifications

Type and Clock Speed:

- Standard - 20 MHz Motorola DSP56002
- Optional - 40 MHz Motorola DSP56002 (Opt5A)
- Optional - 60 MHz Motorola DSP56002 (Opt5B)

Architecture:

- Harvard Architecture
- Dual (X and Y) internal 24-bit data buses
- Single external 24-bit data bus
- Separate 24-bit internal program bus
- 56-bit data accumulator

Performance Specifications

SERVO Cycle Time:

(Settable with hardware jumpers)

- Standard CPU - Minimum of 55 microseconds per axis controlled (110 usec for two axes; 440 usec for eight axes)
- Optional CPUs
  - Option 5A (40mHz): Minimum of 28 microseconds per axis controlled
  - Option 5B (60mHz): Minimum of 18 microseconds per axis controlled

SERVO Algorithm:

- PID with velocity and acceleration feedforward and notch filter (5 to 500 Hz).
- All gains with 24-bit resolution.
- Dual encoder (motor and load) possible.
- Optional ability to accept custom designed and installed servo algorithms for special applications.
- Advanced seventh order pole-placement algorithm, 35 terms with autotuning capability (Option 6 required).

Phasing Update Time:

(Settable with hardware jumpers)

- Minimum of 27 microseconds (1 axis)
- Minimum of 110 microseconds (8 axes)

Phasing Algorithm:

- Suitable for permanent magnet brushless motors, AC induction motors, switched reluctance servo motors, microstepped stepping motors.
- 2, 3, or 4-phase motors, Y-wound, delta-wound, or electrically independent phases.

Block Execution Rate:

- 100-500 blocks (moves) per second with full trajectory calculation, depending upon particular program conditions.
- Approximately 250-1200 blocks (moves) per second possible at 40 MHz.
- Higher rates possible with careful optimization, dependent on number of axes, servo cycle time, CPU speed, and program complexity.

Velocity Range:

- Range from 0.0001 to 20,000,000 counts/sec
- Range from 0.0001 to 30,000,000 counts/sec (w/OPT 5A or 5B)
- Digital phase-locked loop, crystal-controlled

Velocity Accuracy:

- Long-term absolute accuracy
  - Standard Crystal: 0.005%
  - High accuracy Crystal: 0.001% (Option 8)
- Short-term absolute accuracy - System-dependent; typically 0.2% to 1.0%

Position Range:

- 2 billion counts minimum (32 bits) with automatic rollover

Position Accuracy:

- 1 count. Sub-count interpolation possible with automatic 1/T decoding of incremental encoder signal, or with parallel input lines from A/D converter processing analog signal from which quadrature is derived.

Position Capture Accuracy:

- 1 count at any speed

Position Compare Accuracy:

(signal output on reaching preset position)

- 1 count at any speed
- Up to 500 Hz repetition rate

Synchronization:

- Axes in the same coordinate system on one PMAC are perfectly synchronized (to the servo cycle).
- Axes in different coordinate systems on one PMAC can be synchronized to within)2 msec.
- Coordinate systems on separate PMACs sharing same SYNC signal can be synchronized to)1 servo cycle.

I/O Specifications

Position Feedback:

Quadrature Encoders —

- 4 (standard) to 8 (depending on options) digital quadrature incremental encoders.
- 5V TTL or CMOS levels, single-ended or differential.
- Sockets provided for termination resistor packs.

Input rate —

- DC to 20mHz (count rate). X1, X2, X4 decoding, or pulse and direction.
- Digital delay filter for removing noise spikes. 3rd channel input available for position capture.
- Unused counters available as timers.

Absolute Encoders —

- Thru accessory of 14D I/O Expansion card (or other binary parallel word position data source)
- Can be up to 12 absolute parallel encoders of 24 bits or less or up to 6 straight binary, 5 volt, single-ended absolute parallel encoders of over 24 bits (limit of 6 ACC-14D cards of 48 bits each).

Resolvers —

- Thru Accessory-8D Option 7 Resolver-to-Digital Converter card (2 or 4 resolvers per accessory card). 12-bit resolution; absolute position data read on power-up or reset. Thereafter, simulated quadrature signal is read through incremental encoder input.

Analog Outputs

- 4 (standard) to 16 (depending on options) outputs of)10V; 16-bit resolution.
- Standard use is for 1 servo output per axis if PMAC is not commutating axis and 2 servo outputs per axis if PMAC is commutating axis.
- Uncommitted analog outputs may be used for other purposes.

On-Board Analog Input (JPAN)

- 1 input, 0 to +10V, converted to frequency at 25 kHz/V (On PMACLite)10V, converted to sign and frequency).
- Can be jumpered to Encoder 4 counter "time-base" conversion of counter yields 24-bit register value proportional to voltage.
- Effective A/D resolution of 10 bits.

Optional Analog Inputs (Accessory 28PP)

- 4 inputs of)10V; 16-bit resolution, single-ended or differential inputs.
- Conversion time under 50 usec, all inputs (through Accessory 28 Analog- to-Digital Converter Board).

Axis Dedicated Digital Inputs

- 4 dedicated digital inputs accompanying each quadrature encoder.
- Optically isolated from PMAC digital circuits.
- Operate from +15V voltage source.
- Inputs for each encoder are +LIMIT, -LIMIT, HOME, FAULT.
- Uncommitted sets of inputs may be used as general-purpose optically isolated digital inputs.

Axis Dedicated Digital Outputs

- 1 dedicated digital output accompanying each quadrature encoder.
- Optically isolated from PMAC digital circuits
- Operates from +15V voltage source.
- Sinking (open collector) output as shipped, socketed IC replaceable with sourcing driver
- Serves as amplifier-enable signal or direction bit.
- Polarity is settable by hardware jumper (E17).
- Uncommitted lines may be used as general-purpose optically isolated digital outputs.

General-Purpose Digital Inputs (Jopto)

- 8 general-purpose opto-isolated digital inputs, 0-24V levels.
- Sink or source (normally high or normally low) configuration determined by interconnection.
- Connector configured for easy hook-up to OPTO-22. Rated to 100 mA.

General-Purpose Digital Outputs (Jopto)

- 8 general-purpose opto-isolated digital outputs.
- +5V to +24V high level (if greater than +5V, work from external voltage).
- Sinking (standard) or sourcing (no-cost option) configurations possible.
- Rated to 100 mA. Connector configured for easy hook-up to OPTO- 22.

Serial Communications:

RS-232 Serial Data Port Single-Ended)6-10V Levels -

- Configurable for 300 to 115.2 Kbaud 8 bits, 1 start bit, 1 stop bit, no parity.
- Uses RXD1, TXD1, CTS, RTS, and GND.
- Shorts DSR to DTR.
- Up to 16 cards may be daisy-chained on a single communications line with software addressing.

Optional RS-422 Serial Data Port (PMAC-Pack w/ Opt-9LPP) -

- Differential 0-5V TTL levels. PMAC receivers accept standard RS-232 signals.
- Uses RD+, RD-, SD+, SD-, CS+, CS-, RS+, RS-, and GND lines.

- PMAC transmitters send signals recognizable by most RS-232 receivers.
- Accessory 26 is available for optically isolated conversion between RS-422 and RS-232 levels.

Control-Panel Dedicated Inputs (JPAN):

- 9 dedicated manual control functions Low-true 0-5V TTL inputs: RUN, STEP, ABORT, HOLD, HOME, JOG+, JOG-, PREJOG, RESET.
- Intended for momentary toggle switches.
- 4 motor-/coordinate-system-select lines (BCD coded, low-true TTL) that set what the above inputs affect.
- One -10V to +10V analog input for feedrate override control.
- One 2-channel handwheel encoder input (TTL levels); uses encoder channel 2 by jumpering.

Note:

Discrete inputs may be used as general-purpose inputs with I2=1.

Thumbwheel Multiplexer I/O (JTHW):

- 8 TTL input lines; 8 TTL output lines
- Designed for interface to ACC-18 Thumb wheel Multiplexer board(s); up to 512 digits or 2048 discrete inputs
- ACC-34 multiplexed I/O card(s) provide expanded I/O interface

Note:

The thumbwheel Multiplexer port may also be used as general-purpose multiplexed I/O.

Display Outputs:

Connector to standard 2x24 or 2x40 character alpha-numeric liquid crystal or vacuum fluorescent display.

Expansion Digital I/O:

- JEXP connector provides access to up to 6 Accessory 14 I/O Expansion cards with 48 bits each of digital I/O Configurable to inputs or outputs by byte
- Configurable to high-voltage level by 24-bit word
- Sinking or sourcing available with +5 to +24V high levels
- Totem-pole +5V outputs available

Note:

I/O expansion is most easily accomplished with an ACC-34 product, using JEXP for purposes other than connection of the PMAC-Pack Expansion Pack. The Expansion Pack may require modification of PMAC-Pack. Contact Delta Tau for details.

Software Specifications

Constants:

- Specifiable in hexadecimal (with '$' prefix) or decimal (without prefix)
- Range depends on use, but can be up to full range of 48-bit floating point range (36-bit mantissa, 12-bit exponent).

Variables:

- 1024 I-Variables - Pre-defined meaning for initialization and setup (gains, limits, modes, etc.)
- 1024 P-Variables -General-purpose user variables with 48-bit floating-point (36-bit mantissa, 12-bit exponent) format, global meaning
- 1024 Q-Variables - General-purpose user variables with 48-bit floating point (36-bit mantissa, 12-bit exponent) format, local to a coordinate system
- 1024 M-Variables - Pointers to locations in PMAC's memory & I/O space. User-defined address, offset, bit-width, decode

Operators

(For use in user programs):

+ (add), - (subtract), * (multiply), / (divide), % (modulo), & (bit-by-bit AND), | (bit-by-bit OR), ^ (bit-by-bit XOR).

Comparators

(For use in conditional statements in programs):

= (equal to), != (not equal to), > (greater than), !> (not greater than), <(less than), !< (not less than), ~ (approximately equal to), !~ (not approximately equal to)

Functions

(For use in user programs):

SIN, COS, TAN, ASIN, ACOS, ATAN, ATAN2, LN, EXP, ABS, SQRT, INT

Motion Program Language:

- Custom language incorporates features of BASIC-type high-level languages (computation, IF, WHILE, GOTO, GOSUB, CALL) and machine tool languages (RS-274 'G-Codes')
- User-definable G-, M-, T-, and D-codes
- 256 separate motion programs may be stored at once

PLC Program Language:

- Custom language for constantly recirculating background program; much like BASIC-type high-level languages
- 32 separate PLC programs may be stored at once

Standard PMAC-Pack

A standard PMAC-Pack provides four encoder inputs and four Digital to Analog Converter (DAC) outputs, which may be used for control of up to four noncommutated axes or two commutated axes. Figure 6-1, 4-Axis Non-Commutated System Interconnection Diagram, shows the connections necessary for a typical installation. Additional options and accessories may be built into the PMAC-Pack case as listed in Table 1-1.

Note:

Non-Commutated axes refer to axes driven motors which PMAC does not commutate. PMAC provides a differential)10V torque or velocity command per axis.

External Connections

There are many connectors on the front panel of the PMAC-Pack. Table 1-2 lists each of these connectors and their functions.

Axis Connections

Each of the four axes on the PMAC-Pack have screw terminal connectors labeled ENCODER, SERVO, and FLAGS.

Table 1-1. PMAC-Pack Internal Options and Accessories

Option/Accessory Number	Definition
OPT-5A	40mHz Flash-backed Memory CPU option
OPT-5B	60mHz Flash-backed Memory CPU option
OPT-6	Extended servo algorithm
OPT-9LPP	**Optional RS422 Interface (required for multi-drop communications to several PMACs on single serial line)**
ACC8D OPT-2PP	4-Channel Voltage to Frequency Converter for use with stepper motor pulse and direction drives
ACC8D OPT-4PP	40 W 4-Channel linear amplifier for hydraulic valves
ACC8D OPT-4APP	150 W 4-Channel PWM amplifier for small DC brush motors
ACC26APP	Serial Communications Isolator and Converter
ACC28APP	4 Channel 16 bit A/D Converter card
ACC39PP	Handwheel Encoder Interface (5th Encoder Input)

Machine Connections

In addition to the axis connections, JOPT OUTPUT, JOPT INPUT, FLT RELAY, JDISP, JPAN, JTHW, JRS232, JRS422, and 100-240 VAC connectors are provided for machine connection.

Expansion Pack Connection

All PMAC-Pack's have a portal on the right side of the casing which allows access to a 50 pin box header connector. This header is the JEXP header on the internally mounted PMAC-Lite card.

Accessory Connections

The TBAMP connector pertains only to PMAC-Packs configured with stepper motor V/F converters or 4 channel amplifier accessories. The JHW connector pertains only to PMAC-Packs configured with the handwheel encoder (5th encoder channel) accessory. The JRS422 connector pertains only to PMAC-Packs configured with the RS422 communications option. PMAC-Packs without these options retain the connector ports, however, nothing is internally connected to them.

Table 1-2. PMAC-Pack Connector Functions

Connector	Description	Function
Encoder	**9-Pin Screw Terminal**	Incremental quadrature encoder feedback input
Servo	6-Pin Screw Terminal	Amplifier command output (DAC)), amp enable output, and amp fault input
Flags	5-Pin Screw Terminal	Axis overtravel limits & home flag input
JOPT Output	11-Pin Screw Terminal	Eight general purpose outputs
JOPT Input	11-Pin Screw Terminal	Eight General purpose inputs
FLT RELAY	3-Pin Screw Terminal	PMAC Fault (Watchdog) Output (Normally closed *and* Normally open Outputs)
JDISP	15-Pin D-Sub Connector	PMAC Display Output (For use with any of the family of ACC12 Displays)
JPAN	25-Pin D-Sub Connector	PMAC Panel interface connector. (Inputs such as: Axis Select, Jog, Home, Run, Abort, Reset. Outputs such as: Following error, In position, buffer full.)
JTHW	25Pin D-Sub Connector	PMAC Multiplexer port connector. Used for interconnection of additional I/O (PMAC ACC27, ACC34), Thumb wheel inputs (PMAC ACC 18), and power on position information.
JRS232	DB9 Connector	**Standard RS232 Interface for communication to PMAC. (Non-functional when optional RRS422 interface ordered, OPT-9LPP) . This serial interface does not support multi-drop tri-state communication to multiple PMAC-Packs.**
JRS422	25-Pin D-Sub Connector	Optional RS422 Interface for communication to PMAC. Supports multi-drop tri-state communication to multiple PMAC-packs on single serial cable. (Requires PMACPACK OPT-9LPP. JRS232 port is rendered non-functional.)
JANA	15-Pin D-Sub Connector	Analog input port connector, only active when PMAC-Pack is equipped with ACC28PP. Provides interface for 4 analog inputs, isolated power.
JEXP	50-Pin Box Header	Expansion port for connection of ACC24EXP, PMAC ACC14, or other PMAC accessories which connect directly to the microprocessor bus.
TBOUT	12-Pin Screw Terminal	Four Channels of DC Motor Outputs, 48 V Amplifier DC bus input, dynamic braking resistor output
JHW	9-Pin D-Sub Connector	Inputs for one channel of incremental quadrature encoder feedback.

Switches and Indicators

PMAC-Pack is equipped with the following switches and indicators:

Communications

Switch Bank
This bank of 8 DIP-switches sets the serial communications baud rate. Additionally it controls the "card address" for use in addressing multiple PMACPacks.

RE-INIT
Re-Initialization — This switch, if depressed on power up, reinitializes PMAC's software to the factory default state. PMAC only concerns itself with the status of this switch upon power up. (The Switch is tied to PMAC's "E51" Jumper).

PWR
The Green "Power" LED should illuminate when AC power is applied to PMAC-Pack.

WDT
The Red Watch Dog Timer LED will illuminate when there is a serious fault within PMAC. Consult Chapter 4 of this manual for further detail on the conditions leading to this fault.

OPWR
The orange Opto Isolation Power LED embedded in the edge of the JOPT-OUTPUT connector will illuminate when power (+12 to +24V) is applied to the O+V (pin 2 of the JOPT-OUTPUT port).

Enhancements

PMAC-Packs produced after August 1995 are enhanced with several improvements as standard equipment. These improvements have been added:

- PMAC-Lite equipped with Flash memory and buffered JEXP port (OPT 4A), thus eliminating any battery replacement maintenance concerns over the lifetime of the controller. SwitchBank Baud Rate settings and SAVE command are effected by this change.
- Internal Power Supplies are sequenced with relay logic. On power-up +5V supply stabilizes prior to enabling)12V analog supplies.
- A "Reinitialization" switch (momentary contact, only active on power-up) has been added to the front panel to allow reinitialization without disassembly.
- Opto Isolation has been added to PMAC-Pack's JOPT machine I/O.
- JOPT IN, JOPT OUT, FLAGS, FLT. RELAY, and TBAMP connections have been improved.
- Opto Isolation has been added to PMAC-Pack’s FLAG inputs (i.e. HMFLAG, NEGLIM, POSLIM).
- CE Approval.
- Shielded DB style connectors for JTHW, JPAN, and JD1SP parts.
- Provisions have been added to accommodate ACC8D-OPT2 for Pulse and Direction output to stepper axes.

ACC-24EXP Expansion Pack

If more encoder inputs or DAC outputs are required, a 4-axis expansion pack, ACC24EXP, can be mounted alongside PMAC-Pack to provide additional encoder inputs and DAC outputs. This allows one PMAC-Pack to control up to 8 non-commutated axes or 4 commutated axes. The ACC24EXP Expansion Pack, in addition to the additional DACs and encoder channels it provides, may be ordered with the internal accessories shown in Table 1-3.

Note:

When PMAC is used to commutate Brushless or AC Induction motors, 2 DAC channels per axis are required. Refer to the PMAC User's manual for further details on PMAC motor commutation.

Table 1-3. Expansion Pack Options and Accessories

Option/Accessory Number	Definition
ACC-8D OPT2EXP	4-Channel Voltage-to-Frequency Converter For use with stepper motors
ACC-8D OPT4EXP	40 W 4-Channel amplifier for hydraulic valves
ACC-8D OPT4AEXP	150 W 4-Channel amplifier for small DC brush motors
ACC-28 AEXP	4 Channel 16 bit A/D Converter card ()10V input)

GETTING STARTED

Quick-Start Guide (Non-Commutated Motors)

This chapter serves as a quick-start guide to installing the PMAC-Pack and controlling motors and I/O. It will guide the user through the point of jogging and homing motors, toggling outputs and reading inputs. Further startup details and troubleshooting tips, including startup details for commutated motors and stepper motors can be found in the Getting Started with PMAC section of the PMAC User's Manual.

Inspection

Unpack your PMAC-Pack. Examine the controller carefully for any signs of damage. If there is any damage, contact Delta Tau immediately to arrange for repair. Do not attempt to repair the unit yourself without first consulting Delta Tau factory support. **Failure to do so may void the product warranty.**

Note:

All PMAC-Packs are shipped with mating screw terminal connectors and both standard U.S. and European format power cords.

Jumper Setup

PMAC-Pack has numerous pairs of metal prongs called E-Points. The way in which these metal prongs are either shorted together (jumpered) or left open determines the board hardware configuration. A listing of these E-points is provided in Chapter 3. The vast majority of applications can be accomplished using the default settings, thereby eliminating the need to open up PMACPack to customize the jumper setup.

Note:

If you must interface to a high-true amplifier enable line, set up the appropriate jumpers before continuing. Refer to Chapter3 for disassembly and jumper setup instructions.

Mounting

During the initial setup of the PMAC-Pack for your application, it may become necessary to open the PMAC-Pack case to reconfigure the E-point jumpers. For this reason, it is recommended that initial testing be performed with the unit on a clean workbench. Once correct operation has been verified, the PMAC-Pack should be securely mounted in a suitable cabinet or enclosure using the 6 mounting holes on the rear plate of the unit (see Figure 2-1).

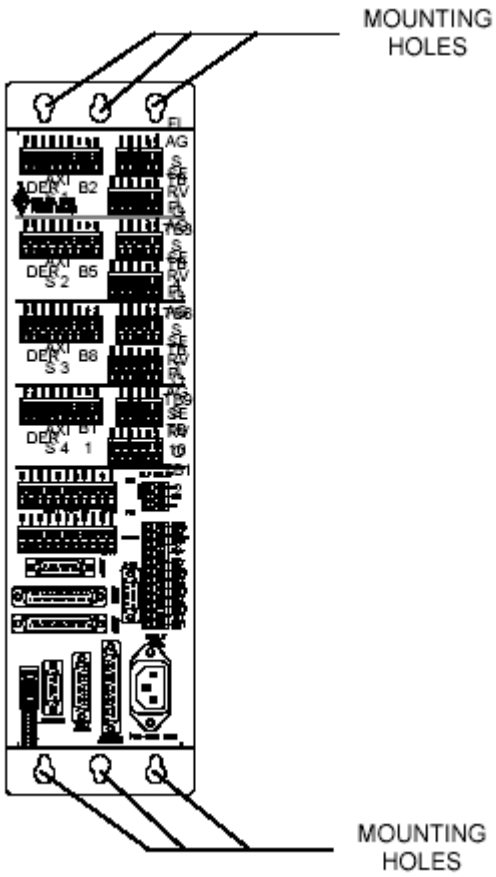


Figure 2-1. PMAC-Pack Mounting

Power Connection

Connect the power cord provided to the power port on the front of the PMACPack. A strain relief is provided underneath the power plug and should be utilized.

PMAC-Pack's auto-ranging internal power supplies can accept 85 to 265 VAC (47-63Hz). The plug on the end of the power cord is a standard 115 VAC plug. If you are connecting to other than 115 VAC, or find it necessary to extend the cord, cut the plug from the power cord and proceed to connect to your AC input source. When AC power is applied to the PMAC-Pack, the controller's green PWR LED should illuminate. The red WDT LED (watch dog timer) should not light. Provided this is the case, proceed to Installing the PMAC Executive Program below. If the WDT LED is lit, consult the Troubleshooting Guide in Chapter 4.

Caution:

Make sure the Power Cord's AC Ground connection is intact. PMAC-Pack's Chassis Ground is provided by this connection. Failure to Ground the AC Power line could result in damage to the PMAC-Pack.

CE PMAC-Pack is shipped with both a standard U.S and a European format power cord.

Installing the PMAC Executive Program

PMAC-Pack is set up and programmed serially through any IBM or 100% compatible personal computer (PC). Delta Tau's PMAC Executive for DOS (ACC9DA) or PMAC Executive for Windows (ACC-9W) software, or their accompanying PMAC Setup programs, PS or PSWIN, respectively, are recommended for use in the initial establishment of communications and software setup of PMAC.

You should create a PMAC subdirectory on your computer's hard drive and install the zipped files using the INSTALL utility included on the diskette. You may have to modify your system's CONFIG.SYS file to provide the PMACEXEC program access to extended memory. (Refer to 3A0-PCPMAC-363 or 3A0-0PEWIN-363 for details.)

Communication SwitchBank Setup

S1 - S4 Software Address Control

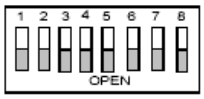
Switches S1-S4 on the front panel of the PMAC-Pack close or open PMAC-Lite jumpers E40-E43. These jumpers in turn control the software address of the card, for serial addressing and for sharing the servo clock over the serial connector. Card @0 address 0 sends the clock and cards @1-@F receive the clock. Refer to Table 2-1 for address control settings.

Note:

Unless your system contains multiple PMAC-packs daisy-chained on a single serial cable, S1-S4 should always be ON. The control must either be set up as @0 address 0, or receiving clock signals over the serial port from another PMACPack that is set up as @0, or the WATCH-DOG timer will trip (red light ON) and the control will shut down.

Table 2-1. Software Address Control Switch Settings

Card Address Control Switches				**Card Address**	**Default & Physical Layout**
S1	**S2**	**S3**	**S4**		@0
ON	ON	ON	ON	@0	
OFF	ON	ON	ON	@1	
ON	OFF	ON	ON	@2	
OFF	OFF	ON	ON	@3	
ON	ON	OFF	ON	@4	
OFF	ON	OFF	ON	@5	
ON	OFF	OFF	ON	@6	
OFF	OFF	OFF	ON	@7	
ON	ON	ON	OFF	@8	
OFF	ON	ON	OFF	@9	
ON	OFF	ON	OFF	@A	
OFF	OFF	ON	OFF	@B	
ON	ON	OFF	OFF	@C	
OFF	ON	OFF	OFF	@D	
ON	OFF	OFF	OFF	@E	
OFF	OFF	OFF	OFF	@F	
Note: OFF = OPEN **ON** = # Side of Switch					



Location PMAC-Pack Front Panel

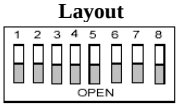
S5-S8: Communications Control

Switches S5-S8 on the front panel of the PMAC-Pack close or open jumpers E44-E47. These jumpers in turn control what baud rate to use for serial communications. If S5 - S8 are all on the serial port is disabled. Refer to Table 2-2 for communications control settings.

Note:

When PMAC-Packs ship from the factory, the switch bank settings are defaulted to 9600 baud.

Table 2-2. Communications Control Switch Settings

Baud Rate Control "E" Points				**Baud Rate**			**Default & Physical Layout**  Loc. PMAC-Pack FRONT PANEL
S5	**S6**	**S7**	**S8**	**20 MHz Flash CPU (OPT 4A)** ***Standard***	**20 MHz Battery-backed CPU** ***(standard on units produced prior to AUG 1, 1995)*** ***or*** **40 MHz Flash CPU (OPT 5A)**	**60 MHz Flash CPU (OPT 5B)**	
ON	ON	ON	ON	DISABLED	DISABLED	DISABLED	
OFF	ON	ON	ON	300	600	900	
ON	OFF	ON	ON	400	800	1200	
OFF	OFF	ON	ON	600	1200	1800	
ON	ON	OFF	ON	800	1600	2400	
OFF	ON	OFF	ON	1200	2400	3600	
ON	OFF	OFF	ON	1600	3200	4800	
OFF	OFF	OFF	ON	2400	4800	7200	
ON	ON	ON	OFF	3200	6400	9600	Default - 60MHz CPU
OFF	ON	ON	OFF	4800	9600	14400	Default - 40MHz CPU
ON	OFF	ON	OFF	6400	12800	19200	
OFF	OFF	ON	OFF	9600	19200	28800	Default - 20MHz CPU
ON	ON	OFF	OFF	12800	25600	38400	
OFF	ON	OFF	OFF	19200	38400	57600	
ON	OFF	OFF	OFF	25600	51200	76800	
OFF	OFF	OFF	OFF	38400	76800	115200	
Note: OFF = OPEN **ON** = # Side of Switch							

Serial Port Connection

PMAC-Pack communicates serially through the DB9 RS232 port located on the front panel . If OPT-9LPP is included, RS422 communications is supported through the DB25 Connector on the front panel of PMAC-Pack. (Note: If RS232 Communication is provided (default), the RS422 Com Port is rendered inoperative. If RS422 Communication has been ordered, PMAC-Pack's RS232 port is rendered inoperative.) Connect the cable that you will be using between your computer's COM port and PMAC-Pack.

Delta Tau provides serial cables as Accessories for PMAC-Pack. ACC3PP232 is a 3m (10ft) RS232 cable. ACC3PP422 is a 3m (10ft) RS422 cable. Standard DB9-25 or DB25-9 adapters may be needed for your particular setup. If you choose to manufacture your own serial port cables, refer to the Serial Port Pinouts in Chapter 6 of this manual.

Establishing Communications

Either the Executive or Setup program can be used to establish initial communications with the PMAC. Both programs have menus that allow you to tell the PC where to expect to find the PMAC and how to communicate with it. You should tell the program to look for PMAC on a COM port, and you must tell it the baud rate which you wish to communicate at (this is set up with via the Communication SwitchBank). PMAC-Pack is setup at the factory to communicate at a default baud rate of 9600 baud.

Once you have told the program where and how to communicate with PMAC, it will attempt to establish communications with PMAC-Pack by sending a query command and waiting for the response. If it gets the expected type of response, it will report that it has found PMAC, and you will be able to proceed. If it does not get the expected type of response after several attempts, it will report that it has not found PMAC.

Note:

Instructions for setting up the communications are given in detail in the manuals for the Executive and Setup programs. Refer to those manuals if you need more explanation.

Terminal Mode Communications

Once the program reports that it has found PMAC, the program should be in terminal emulation mode, so that the PC is acting as a dumb terminal to PMAC.

Check to see if you get a response by typing `I10<CR>` (`<CR>` means carriage return, the ENTER or RETURN key). PMAC should respond with a six or seven digit number. Now type `III<CR>` -- PMAC should respond with a beep, signifying an unrecognized command.

Next, satisfy yourself that you can communicate with the card at a basic level. Type a `P<CR>` (upper-case or lower-case P -- it does not matter); this requests a position. PMAC should respond with a number, probably a 0. Now type a **`<CONTROL-F>`**. You should get back eight numbers (one for each axis) since **`<CONTROL-F>`** requests following error from all eight motors; some or all may be 0. Please note that even with encoder counts as read-out (no scaling) PMAC's position is displayed with fractional counts.

Note:

If you have difficulties establishing communications with PMAC, consult the troubleshooting tables in Chapter 5.

Incremental Encoder Connection

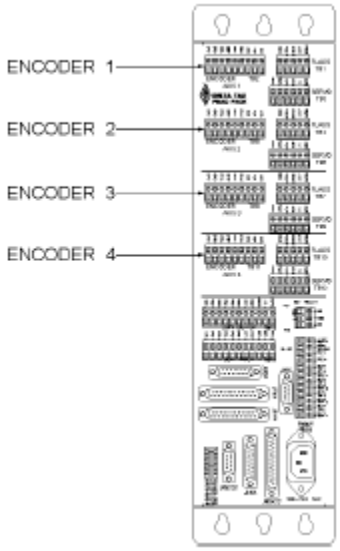
Warning:

Remove power from PMAC-Pack before connecting encoders

Each axis of the PMAC-Pack has an encoder connection port. It also provides a +5V output and logic ground for powering the encoder. Pinouts are shown in Figure 2-2.

When wiring, the encoder number does not have to match the axis number unless you want to use position capture features, but it usually does. Later in the setup, we will insure that each PMAC "Axis" is mapped to the desired Encoder. Connect the A and B (quadrature) encoder channels to the appropriate terminal block pins. The PMAC-Pack is setup by default for either single-ended or differential Line-Driver encoders. If you have a single ended signal, leave the complementary signal pins floating -- do not ground them. If you are using an encoder with complementary open collector outputs, you must set E24-27 on the PMAC-lite board to pins 2-3. The third channel (index pulse) is optional, although if you wish to precisely home your motor, it is highly recommended to use an encoder with an index channel.

Figure 2-2. Encoder Connection Port Pinouts



PIN	FUNCTION
1	GND
2	+5V
3	GND
4	CHAN A+
5	CHAN A-
6	CHAN B+
7	CHAN B-
8	CHAN C+
9	CHAN C-

Amplifier Connection (Brush DC Motor or Motor Commutated by the Amplifier)

PMAC-Pack interfaces to the system amplifiers through the "SERVO" port. Pinouts are shown in Figure 2-3. Each Axis has a SERVO port which serves to communicate amplifier command signals (Torque or Velocity), the amplifier enable signal, and amplifier fault signal. If PMAC is not performing the commutation for the motor, only one analog output channel is required to command the motor. This output channel can be either single-ended or differential, depending on what the amplifier is expecting.

Single-Ended Command Signal

For a single-ended command using PMAC channel 1, connect DAC1 (pin 5) to the command input on the amplifier. Connect the amplifier's command signal return line to PMAC's AGND line (pin 4).

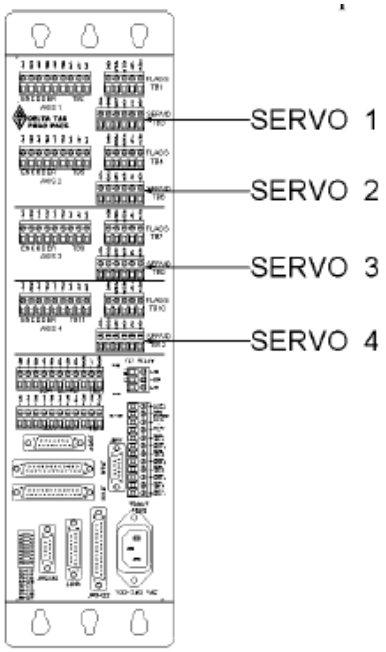
Note:

In this setup, leave the DAC1/ pin (pin 6) floating; do not ground it.

Differential Command Signal

For a differential command using PMAC channel 1, connect DAC1 (pin 5) to the plus-command input on the amplifier. Connect DAC1/ (pin 6) to the minus command input on the amplifier. PMAC's AGND (pin 4) should still be connected to the amplifier common.

Figure 2-3. PMAC-Pack/Amplifier Pinouts



PIN	FUNCTION
1	AGND
2	FLT
3	AENA
4	AGND
5	DAC +
6	DAC -

Amplifier Enable Signal (AENA/)

Most amplifiers have an enable/disable input that permits complete shutdown of the amplifier regardless of the voltage of the command signal. PMAC's AENA/line is meant for this purpose. AENA/ is pin3. This signal is an open collector output with internal 3.3K pull up resistor to 15Vdc and requires a pull up resistor. For early tests, you may wish to have this amplifier signal under manual control. The polarity of the signal is controlled by PMAC-Lite jumper(s) E17. The default is low-true (conducting) enable, which is the safest polarity because a PMAC shutdown will automatically disable the amplifiers.

Note:

If PMAC is setup for Sign and Magnitude commands for Stepper motors, the AENA line functions as the direction line. See the PMAC User's Manual and V-F Converter manuals for further information on Stepper Motor interfacing.

Amplifier Fault Signal (FAULT/)

This input can take a signal from the amplifier so PMAC knows when the amplifier is having problems, and can shut down action. The polarity is programmable with I-variable Ix25 (I125 for motor #1) and the return signal is analog ground (AGND). FAULT/ is pin 2. With the default setup, this signal must actively be pulled low for a fault condition. In this setup , if nothing is wired into this input, PMAC will consider the motor not to be in a fault condition.

Flag Connection

PMAC has two inputs for each motor intended for the hardware overtravel limit switches. These lines must actively be held low (to draw current through the LED in the optoisolator) in order for the motor to be able to move. This requires the use of normally closed (or normally conducting, if solid state) limit switches. These inputs are direction sensitive; they only stop movement in one direction.

Note:

PMAC-Pack's limits should be conventionally wired. The POSLIM input should be connected to the positive end of travel, and the NEGLIM input to the negative end of travel.

Limit Signals (NEGLIM And POSLIM)

PMAC-Pack has two inputs for each motor intended for the hardware overtravel limit switches. These lines must actively be held low (to draw current through the optoisolator) in order for the motor to be able to move. This requires the use of normally closed (or normally conducting, if solid state) limit switches. These inputs are direction sensitive; they only stop movement in one direction.

The PMAC-Packs optically isolated limits may be wired as either sinking or sourcing. Figure 2-4 illustrates connection of a limit input in a Sinking configuration. When the limit switch is normally closed, current is pulled through the opto-isolator in the PMAC-PACK to ground. Figure 2-5 illustrates the connection of a limit input in Sourcing configuration. When the limit switch is normally closed, current flows through the switch and into the PMAC-Pack’s optoisolator to the Flag Return which is tied to common. The limit inputs are capable of operation at 12 to 24 DC voltage levels. If you desire to maintain full isolation +V should be a separate voltage source. It is possible to operate using the +12V available on pin 2 of each “Flags” connector as the voltage source. However, it should be noted that this defeats the isolation circuitry causing the limit circuitry to be referenced to PMAC’s analog ground (AGND) which is typically shared by the amplifier.

Note:

If the direction input of the encoder is ever changed, the wiring of the limit switches must be changed as well. It is important to check and re-check the direction sense of your limit inputs.

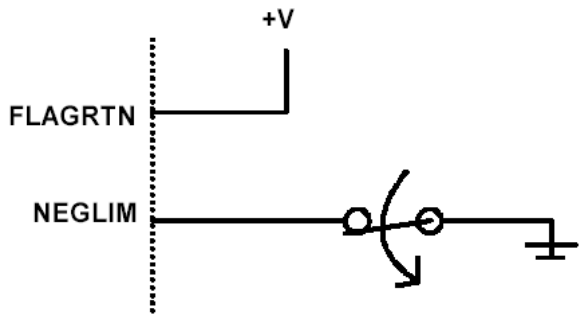


Figure 2-4. Flag Input in A Sinking Configuration

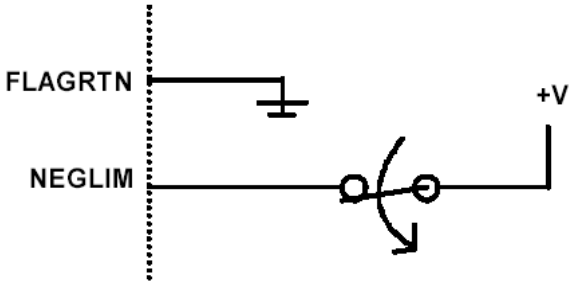


Figure 2-5. Flag Input in Sourcing Configuration

Home Flag Signal (Home)

As with the Limit inputs discussed above, a home switch can be wired between the Home Flag Input pin (HOME is pin 5 of each "Flags" port) and Fault Return (FRET). The switch may be normally open or normally closed; open is high (1), and closed is low (0). The polarity of the edge that causes the home position capture is programmable with Encoder I-Variables 2 and 3 (I902 and I903 for HOME1). PMAC-Pack's HOME inputs may be wired as sinking or sourcing and support operation at 12 or 24 V DC.

Software Setup of the Controller

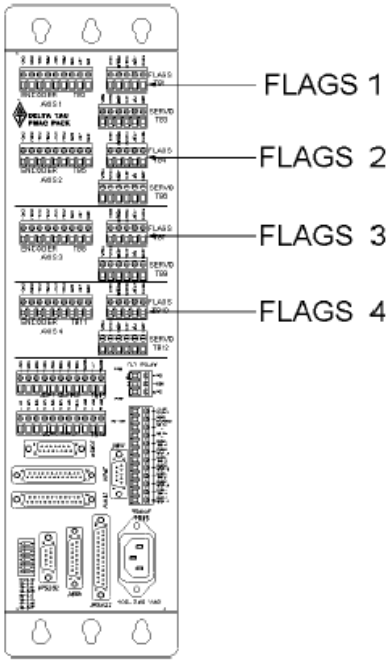
PMAC has a large set of Initialization parameters (I-variables) that determine the personality of the card for a specific application. Many of these are used to configure a motor properly. Once set up, these variables may be stored in nonvolatile EAROM memory (using the **SAVE** command) so the card is always configured properly (PMAC loads the EAROM I-variable values into RAM on power-up).

Connect power to your PMAC-Pack only. (At this time, do not power your amplifiers.) Run your PMAC Executive Program on the PC. The value of an I-variable may be queried simply by typing in the name of the I-Variable. For instance, typing *I900<CR>* causes the value of the I900 to be returned. The value may be changed by typing in the name, an equals sign, and the new value (e.g. *I900=3<CR>*). Alternatively, you may use the I-variable pages (under the *Configuration* menu) to view and change these variables in a more user-friendly fashion.

Note:

If you change any I-variables during this setup, you must use the SAVE command before you power down or reset the card, or you will lose the changes that you have made.

Figure 2-6. Flag Connection Pinouts



PIN	FUNCTION
1	FRETN
2	+12V
3	NEGLIM
4	POSLIM
5	HOME

Encoder Variable Setup

Several I-variables are linked to the encoder inputs, regardless of which motor the encoder is assigned to. These control how the encoder signal is interpreted. They are numbered in the 900s: I900-I904 belong to Encoder 1, I905-I909 belong to Encoder 2, and so on, to I975-I979 belonging to Encoder 16. Initially we will only concern ourselves with the first encoder's I-variable.

I900, I905, I910, Etc.

These control the decoding of the encoder signal into counts. Quadrature x1, x2, and x4, plus pulse and direction decode, are all possible. PMAC is shipped with counterclockwise x4 decode set up (I900, I905, ... = 7). Check this value for Encoder 1 (I900), and change it to 7 if it is different.

I901, I906, I911, Etc. Encoder Digital Filter Disable

These I-variables control whether the digital delay filter for noise spike elimination is turned on. PMAC is shipped with the filters on (I901, I906, ... = 0).

I902, I907, I912, Etc. Encoder Position Capture Control

These I-variables control which transitions of which associated encoder signals trigger a position capture for that encoder. This must be used for homing moves; it can also be used for other purposes. It specifies an edge of the encoder third channel, the edge of one of the encoder flags, or the edge of a logically combined signal from both. If it uses a flag, you must also set the next variable. The default value for this variable is 1, specifying the rising edge of the third channel.

I903, I908, I913, Etc. Encoder Flag Select Control.

Caution:

The +LIM on the PMAC-Lite board is actually wired to the NEGLIM terminal of the PMAC-Pack and the -LIM on the PMAC-Lite board is wired to the POSLIM terminal of the PMAC-Pack.

These control which of the encoder flags is used to trigger a position capture if the previous I-variable has specified that a flag is to be used. Usually this is set to 0 to specify the home flag (HMFLn).

Motor Variable Setup

A PMAC-Pack can be attached to up to eight motors (with optional expansion Pack), called #1 to #8. A motor is defined in PMAC by setting up I-variables that tell the I/O addresses of the input and output data (where to look for the feedback position, and where to send the output command).

The I-variables for motor #1 are in the 100s (I100-I184); for motor #2 in the 200s, and so on, to the 800s for motor #8. As a shorthand to refer to a particular variable independent of a particular motor, we replace the hundreds digit with the letter x. For instance, Ix20 refers to I120 for motor 1, or I220 for motor 2, and so on.

Ix00 Motor Activation

The first thing to do in the software setup of a motor is activate the software algorithms for the motor by setting Ix00 to 1. For Motor #1, set I100 to 1. (HMFLn).

Ix01 Commutation Enable/Disable

If PMAC is not performing the commutation for the motor, set Ix01 to 0 so that the commutation routines are disabled and only one analog output is used. In our example using motor 1, set I101 to 0. This is the default. If commutation is to be used, refer to the PMAC Software Manual's "Getting Started" section for setup instructions.

Establishing Servo Loop Variables

Several variable values must be established to tell PMAC where to get its servo loop information.

Ix02 DAC Output Address

Ix02 must be set to the register address of the analog output(s) used to command the amplifier. The output register address for motor #1 is defined using I102. In order to send the motor 1 output command to the DAC1 outputs we have connected, we must set I102 address $C003 (49155 decimal). This is the default value. Refer to the PMAC Software Reference Manual, 3A0-602204-363, for a complete address listing of all DACs.

Ix03 Position-Loop feedback address

Variable Ix03 defines the register to be used for the position-loop servo feedback. Typically, this reads a processed encoder value from what is known as the encoder conversion table (which you do not need to worry about yet). To have motor 1 read the processed input from Encoder 1, I103 must be set to 1824 ($720). This should be the value preset at the factory.

Ix04 Velocity-Loop (Motor) Feedback Address

It is possible to have separate motor and load feedback encoders (this can allow good control even with poor coupling). In this case, the sensor on the load is used to close the position loop; it is addressed by Ix03 (see above). The sensor on the motor is used to close the velocity loop; it is addressed by Ix04. The vast majority of users will only have one feedback encoder, whether it is on the motor, or on the load. For these users, Ix04 will be set to the same value as Ix03, addressing the same encoder. If you have just one feedback encoder (ENC1) for your Motor #1 in our example, make sure I104 is set to 1824, just as I103 is (this is the default).

Ix25 Flag Address

The +LIM1, -LIM1, and HMFL1 inputs are tied to motor #x by the setup of the Ix25 variable. By setting this variable \ the card knows where to look for its limit and home flag inputs, (remember that this is essential to command a move). To use +LIM1, -LIM1, and HMFL1, I125 should be set to ($C000) 49152. This should be the value set at the factory. If you are not using overtravel limit switches and have not wired the limit pins to ground, set I125 to $2C000. Refer to 3A0-602204-363 for further details.

Ix69 DAC Output Range

Check the voltage range of the output command by looking at I169. This is the magnitude of the maximum value that can be written to the DAC, whose full range is -32,768 to +32,767 (16 bits for)10V). The default value of I169 is 20,480, which is about) 6.25V. If your amplifier is expecting =)10V and you wish to use the full range, set I169 to 32,767. If your amplifier is expecting a differential signal with up to)10V between the lines (each line is)5V), set I169 to 16,384 or less.

Verifying Position Feedback

Now we should be able to start checking on some basic motor functions. First we will try to read motor position. With the Executive program in terminal mode, type *#1<CR>* to address motor 1. Next, type *P<CR>*, and PMAC should return a position value to the terminal screen. Turn the motor shaft by hand and type *P<CR>* again. The reported position should have changed. Alternately, use the F7 position reporting window of the PMAC Executive program, which automatically polls position repeatedly. Repeat this as often as you like to satisfy yourself that the position counting is working properly in both directions. If the position count does not change, reference the Troubleshooting Guide in Chapter 4.

Changing Position Direction

If you are getting position feedback, but want to change the positive and negative directions, use I900 (for ENC 1) to change the direction sense (or exchange the Channel A and Channel B inputs). For example, if I900 is 7, changing it to 3 will change the direction sense. If the motor does not move or if you encounter a polarity mismatch, refer to the Troubleshooting Guide in Chapter 4.

Testing the Command Output and Polarity

Next, we will check the command outputs and whether the output polarity matches the feedback polarity. To do this we will need to provide power to our amplifier. First, have PMAC disable its own outputs for the motor by typing *K<CR>* (kill). Make sure that the motor has no load at this point so that uncontrolled motion cannot damage anything. Now provide power to the amplifier.

If PMAC is not doing the commutation for a motor, we must make sure that the servo feedback and output polarities match. We do this by giving the motor an open-loop output command and seeing which way the position counts. Type *O10<CR>* (open-loop output 10%). The position counter should count up. If it counts down, you have a polarity mismatch. Now type *O-10<CR>*. The position counter should count down. If it counts up, you have a polarity mismatch. If the counter does not count in opposite directions for the two tests, you have an encoder and/or amplifier problem.

Verify Overtravel Limit Polarity.

Make sure as you verify the direction sense of the motor that you have your hardware position limit switches wired into the proper inputs. That is, the limit switch on the positive (counting up) end of travel must be wired into the POSLIM input, and the switch on the negative end must be wired into the NEGLIM input. If these are reversed, your hardware limit functions will not work.

Manually trip the limit. Using the PMAC Exec, you can monitor "Motor Status". When the +EOT Limit is tripped, the *positive* limit indicator should illuminate. When the -EOT Limit is tripped, the *negative* limit indicator should illuminate.

Setting Up the Servo Loop

WARNING

Make sure the motor is in open-loop mode before restoring the proportional gain. Otherwise, it may lurch to an old commanded position.

The polarity test is enough to see that the motor is working. Make sure the motor can run free (preferably no load attached at this point) and that you will be able to stop things quickly so that no damage is caused if problems occur. Type *K<CR>* to disable the output(s), then preset the proportional gain by setting I130 (try 2000 initially for very fine resolution systems, 50,000 for very coarse systems, or somewhere in between for medium resolution).

Closing the Loop

Now close the motor's servo loop by typing *J/<CR>* (the "jog-stop" command brings the motor into zero-velocity position control). It should hold position at this point, resisting attempts to move it away, at least gently. If it runs away, you have mismatched polarity; re-run the above polarity tests. If you lose control or the motor starts behaving wildly, type *K<CR>* to disable the motor.

Weak Loop

If the motor does not resist being turned, or does so very weakly, try increasing proportional gain (I130). Try doubling it until you get some reasonable stiffness, but do not try yet to get the maximum possible stiffness. The tests described below will help you do that.

Oscillations

If the motor has a tendency to oscillate at low to moderate frequency, you probably have inadequate derivative gain. Try doubling I131 and see if the oscillation goes away.

Buzzing

If the motor has a tendency to oscillate at high frequency (a "buzz"), you probably have too much proportional gain, or maybe too much derivative gain. Try lowering I130 (or I131) until the "buzz" disappears.

Servo Loop Tuning

The PMAC Executive Program has a large section devoted to assisting the user in optimizing the servo loop parameters for a motor. It allows the user to perform step moves and profiled moves and have the response plotted to the screen with key statistics calculated, so that the user may make easy choices about changing gains. This process is documented in detail with examples in the manual for the PMAC Executive Program. In addition, there is an *auto-tuning* feature that lets the Executive program make the decisions about what the gains should be. The program excites the system, evaluates the response, and calculates the gains necessary to achieve the desired response.

Remember that precise tuning cannot be done until the load has been connected to the motor. Our goal at this point is simply to get the motor moving reasonably well without a load.

Jogging the Motor

With these two parameters (I130 and I131) at reasonable levels, you should get good performance in moves. Try a jog move first. Before doing the move, set up the jog speed (I122, in counts/msec) acceleration time (I120, in milliseconds), and S-curve time (I121, in msec) to desired values (to be safe, use low speed and long acceleration times at first). Now type *J+<CR>* -- the motor should turn in the positive direction.

Type *J/<CR>* -- the motor should stop. If it takes a while to stop, you were falling behind during the move; either slow down the move next time, (I122), or increase I130 to reduce the error. *J-<CR>* should cause the motor to turn in the negative direction, and *J/<CR>* should stop it again. *J=<CR>* should cause the motor to jog to the last pre-jog position and stop there automatically.

If you are holding position well, but cannot move the motor, you probably do not have your hardware limits held low. Check which limits I125 is addressed to (usually)LIM1), then make sure those points are held low (to AGND), and sourcing current (unscrew the wire from the terminal block and put your ammeter in series with this circuit if you need to confirm this). If this is not right, refer to the *Encoder Connection and Amplifier Connection* sections, above, and re-check your connections. Additionally check that Ix06 is set to zero to disable the motor's position following abilities.

If your motor "dies" after you give it a jog command, you have probably exceeded your fatal following error limit. If this has happened, it is either because you have asked for a move that is more than the system can physically do (if so, reduce I122), or because you are very badly tuned (if this is the case, you will need to increase proportional gain I130). To restore closed-loop control, issue the **J/** command.

Optimizing Jog Performance

If your jog speed seems slower than you want, you may have run into one or more of PMAC's automatic safety limit parameters, particularly if you have a fine-resolution system. The first of these is I119, which is the maximum permitted motor jog acceleration, expressed in counts/msec2. The default value is quite low for most systems. You may wish to increase it several orders of magnitude for now, to get it out of the way.

Setting Velocity Feedforward Gain

When you are jogging at constant speed, you can monitor following error and increase velocity feedforward gain (I132) to minimize the following error. If you have a current-loop amplifier, you will probably set I132 equal to I131 or just slightly greater.

Setting the Integral Gain

If you want to eliminate steady-state error, bring in some integral gain. Set I133 to 10,000. This should provide weak integral action, but enough to eliminate steady-state error over a few seconds. Now try increasing I133 some more to get quicker action. It should be safe to raise it in increments of 10,000 to get the performance you want (quick restoration of commanded position without introducing oscillation). If you get oscillation, reduce the integral gain until the oscillation is eliminated. If you get no effect from adding integral gain, check the integration limit parameter I163. If this is low (100,000 or less), it will limit what integral gain can do. If this is the problem, set this parameter to its default value by typing *I163=*<CR>*.

Power-Up Mode

For future power-up/reset cycles, you will want to set I180 so you power up in the mode you desire. If I180 is zero, Motor #1 will power up "killed" (0V output, AENA signal false). It will not attempt to control until a servo command is given (usually **J/**, **A**, or **<CTRL-A>**) for a non-PMAC-commutated motor. This I-variable must be stored in non-volatile memory (with the **SAVE** command) be effective at the next power-up/reset cycle.

Setting up a Homing Search Move

To do a homing search move, first check your position-capture I-variables (I902 and I903 in our example). Make sure they are set up to capture the position where you want your home position. With a bare motor, we can probably only use the third channel of the encoder. Set I902 to 1 to force a capture on the rising edge of the third channel.

Next, set your homing speed with I123 (in units of counts/millisecond). Changing the sign of I123 changes the direction of the homing move. Homing accel/decel is controlled by I120 and I121 (which also affect jog moves). Now you can command a homing move with the **HM** command, and the motor will move as specified until the proper signal edge(s) is found, then decelerate to a stop and come back to the position of the trigger, plus or minus an offset amount determined by I126.

Connecting Machine I/O

Caution:

PMAC-Pack is designed such that you never need to change jumpers on the PMAC card to configure I/O as sinking or sourcing. Jumpers E1, E2 , and E7 on the PMAC-Lite Card should never be changed from pins 1-2.

PMAC-Pack's JOPT INPUT and JOPT OUTPUT connectors provide eight general-purpose digital inputs and eight general purpose digital outputs. Each I/O point is opto-isolated and designed for direct connection to 12 to 24V I/O.

For basic familiarization with PMAC-Pack's machine I/O, you can use a 2- position switch and an LED, moving on to actual I/O connection when satisfied that you can control their logic.

General Purpose Digital Outputs

Sinking Outputs (Standard)

Caution:

As default, E4 and E5 are both set to pins 1 and 2. Having PMAC-Pack Backplane Jumpers E4 and E5 set wrong can damage the IC!

PMAC-Pack is shipped as standard with a ULN2803A sinking (open collector) output IC for the eight outputs. These outputs can sink up to 100 mA, and utilize internal 3.3Kohm pull up resistors to go high. A typical interface is shown in Figure 2- 6.

The user can provide a high side voltage (+12 to +24V) into +V (pin 2) of the JOPTO OUT connector, and allow this to pull up the outputs by connecting pins 1 and 2 of the PMAC-Pack Backplane Jumper E4. Backplane jumper E5 must also connect pins 1 and 2 for ULN2803A sinking output.

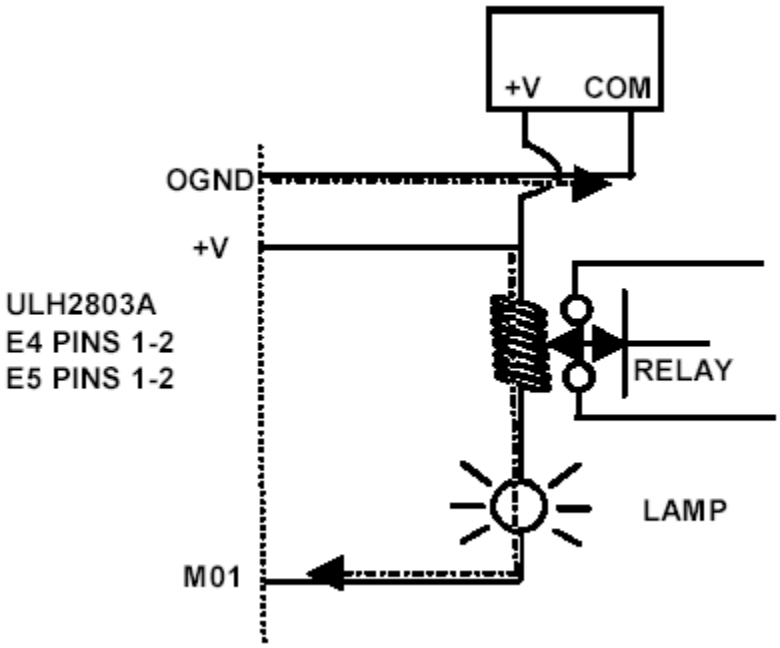


Figure 2-6. General Purpose Output Connected in the Default Sinking Configuration

Sourcing Outputs

Caution:

Having PMAC-Pack Backplane Jumpers E4 and E5 set wrong can damage the IC.

It is possible for the general purpose outputs to be sourcing drivers by substituting a UDN2981A IC for the ULN2803A. This IC (U10 on the PMAC-Pack backplane) is socketed, and so may easily be replaced. For this driver, internal 3.3Kohm pull-resistors keep the outputs from floating. A typical interconnection is shown in Figure 2-7.

With a UDN2981 driver IC, PMAC-Pack Backplane Jumper E4 must connect pins 2 and 3, and Jumper E5 must connect pins 2 and 3. Field Configurable, or order as factory Option 14APP. The orange Opto Isolation Power LED embedded in the edge of the JOPTOUTPUT connector will illuminate when power (+12 to +24V) is applied to the O+V (pin 2 of the JOPT-OUTPUT port).

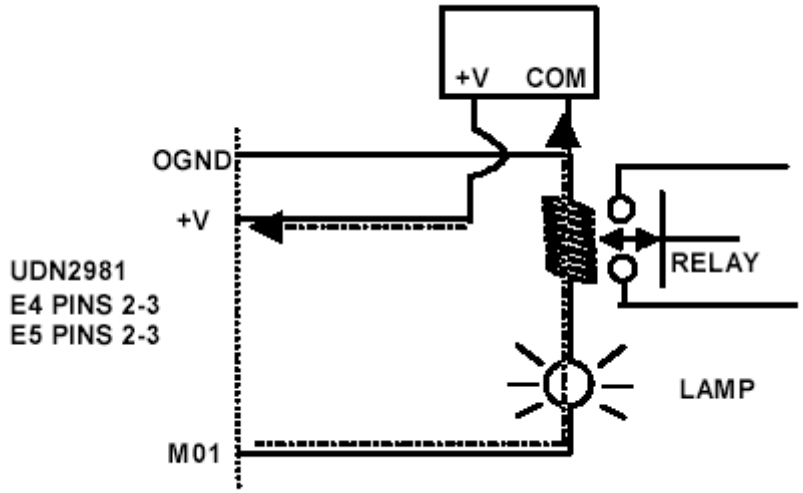


Figure 2-7. General Purpose Output Connected in the Optional Sourcing Configuration

Input Source/Sink Control

The method of interconnection to the general purpose inputs (JOPT INPUTS) determines the sinking/sourcing configuration of the eight inputs. In the sinking configuration, the inputs are biased to +V for the "OFF" state, and must be pulled low for the "ON" state. In the sourcing configuration, the inputs are biased to ground for the "OFF" state, and must be pulled high for the "ON" state. In either case, a high voltage is interpreted as a '0' by the PMAC software, and a low voltage is interpreted as a '1'.

Figure 2-8 illustrates connection of an input in a Sinking configuration and Figure 2-9 illustrates the connection of an input in sourcing configuration. When the switch is closed, current flows through the switch and into the PMAC-Pack's opto-isolator to the Limit Return which is tied to common. When the switch is closed, current is pulled through the opto-isolator in the PMAC-PACK to ground.

The general purpose inputs are capable of operation at 12 to 24 DC voltage levels. If you desire to maintain full isolation +V should be a separate voltage source. It is possible to operate using the +12V available on pin 2 of each "Flags" connector as the voltage source. However, it should be noted that this defeats the isolation circuitry causing the general input circuitry to be referenced to PMAC's analog ground (AGND) which is typically shared by the amplifier.

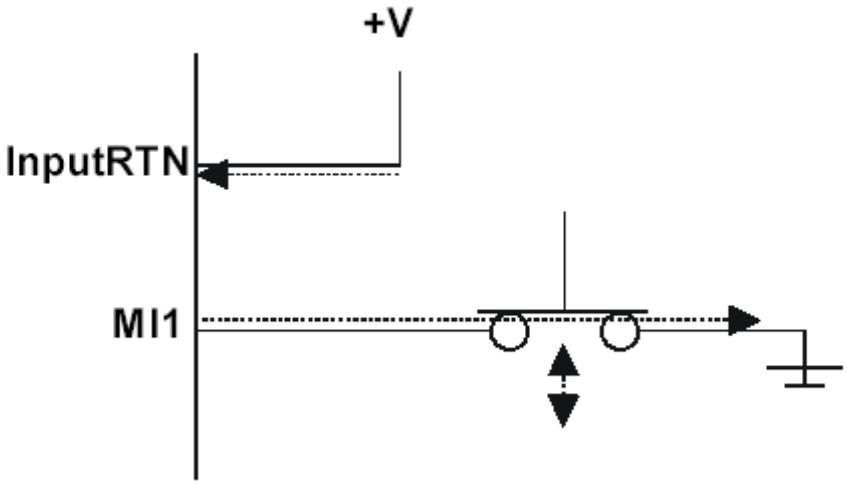


Figure 2-8. Connection of Input in Sinking Configuration

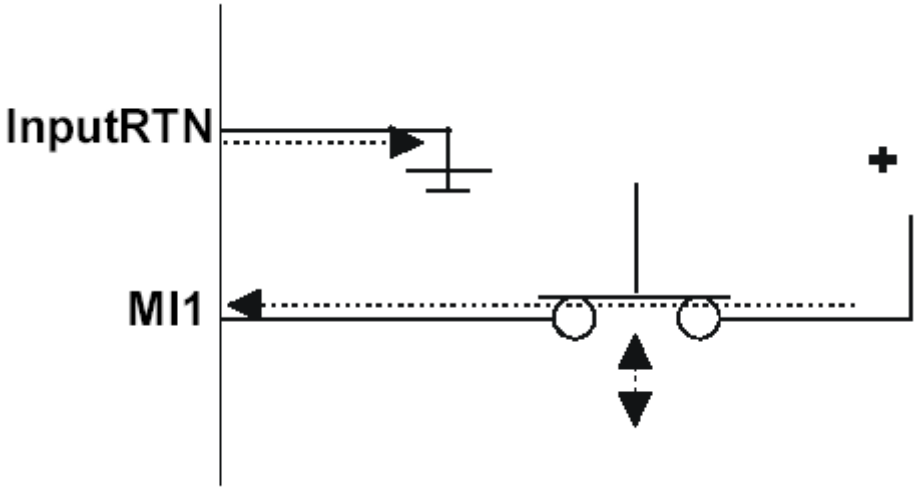


Figure 2-9. Connection of Input in Sourcing Configuration

Setting-up PMAC to Read the I/O

Machine inputs and outputs are typically accessed in software through the use of M-variables. In the suggested set of M-variable definitions (see Chapter 9 of PMAC Software manual), variables M1 through M8 are used to access outputs 1 through 8, respectively, and M11 through M18 to access inputs 1 through 8, respectively. The JOPT ports map into PMAC's memory space at Y address $FFC2. Setup M-Variables to point at the specific I/O points (bits) of Y:FFC2 as shown in Table 2-3.

Testing the I/O

Testing an Output

Using the terminal window of the PMAC Exec, type *M01=0 <CR>* . Now type *M01=1 <CR>*. You should see the LED or corresponding device interfaced to Machine Output #1 (pin 11) change state. Type *M01=0 <CR>* again. The device should return to the original state.

Testing an Input

To query the status of Machine Input #1, type M11 <CR> in the terminal window of the PMAC Exec. PMAC will respond with a 1 or 0, depending on the state of the input. Toggle the input state and again query the input value. You should see the corresponding change of state in software.

Table 2-3. M-Variable Setup

M-Variable	I/O Point
M1->Y:$FFC2,8,1	; Machine Output 1
M2->Y:$FFC2,9,1	; Machine Output 2
M3->Y:$FFC2,10,1	; Machine Output 3
M4->Y:$FFC2,11,1	; Machine Output 4
M5->Y:$FFC2,12,1	; Machine Output 5
M6->Y:$FFC2,13,1	; Machine Output 6
M7->Y:$FFC2,14,1	; Machine Output 7
M8->Y:$FFC2,15,1	; Machine Output 8
M9->Y:$FFC2,8,8,U	; Machine Outputs 1-8 treated as byte
M11->Y:$FFC2,0,1	; Machine Input 1
M12->Y:$FFC2,1,1	; Machine Input 2
M13->Y:$FFC2,2,1	; Machine Input 3
M14->Y:$FFC2,3,1	; Machine Input 4
M15->Y:$FFC2,4,1	; Machine Input 5
M16->Y:$FFC2,5,1	; Machine Input 6
M17->Y:$FFC2,6,1	; Machine Input 7
M18->Y:$FFC2,7,1	; Machine Input 8
M19->Y:$FFC2,0,8,U	; Machine Inputs 1-8 treated as byte

Coordinate Systems and Programming

Your basic system setup is now complete! Further information on setting up Coordinate Systems and Programming the PMAC can be found in the PMAC User's Guide and Software Reference, 3A0-602204-xUxx.

COMPLYING WITH EUROPEAN COMMUNITY (CE) EMC REQUIREMENTS

CE Compliance

If the PMAC-Pack is installed in accordance with the following instructions, it will comply with Council Directive 89/336/EEC relating to Electromagnetic Compatibility:

- All cables connected to the PMAC-Pack, with exception of the power supply cable, must be shielded
- All shielded cables must be terminated at both ends
- D-type mating connectors must have a metal shell and conform to the EMC Directive.

CE PMAC-Pack is shipped with both standard U.S and European format power cords. The European cord must be used to comply with electro-magnetic compatibility requirements.

Note:

Now, PMAC-Pack documentation is only available in the English language.

CE Testing and Certification

PMAC-Pack was tested and certified in accordance with the standards listed below and, if installed in accordance with the following instructions, will comply with Council Directive 89/336/EEC relating to electromagnetic compatibility.

EN50081-2	EN55011 Class A Group 1
EN50082-2	EN61000-4-2 ENV50140 ENV50204 EN61000-4-4 ENV50141

Cable Fabrication

There are several types of cables and connectors that can be used to install PMAC-Pack in accordance with CE requirements. No matter which type of cables and connectors are used, the user must ensure that each cable and connector is properly grounded in order to conform to the CE Class A emissions requirements.

Connectors

The PMAC-Pack is supplied with all the Phoenix plug-in connectors required for installation. D-type connectors of the appropriate size must be supplied by the customer.

Phoenix Plug-In Connectors

When installing the Phoenix plug-in connectors supplied with the PMAC-Pack, each individual axis connection section has a grounding (earth) stud. The exposed portion of the cable shielding must be kept as short as possible and terminated using a crimp-style termination ring at each connector. See Figure 3-1 for typical grounding (earthing) procedures for Phoenix plug-in connectors.

D-Type Connectors

D-type connectors must have a metal housing to ensure a proper ground is established between the cable connector and the PMAC-Pack connector. Drain wires and grounding pigtails must have a grommet attached. This grommet is then secured under one of the connector mounting screws to ensure a proper ground between the cable shielding and the PMAC-Pack chassis.

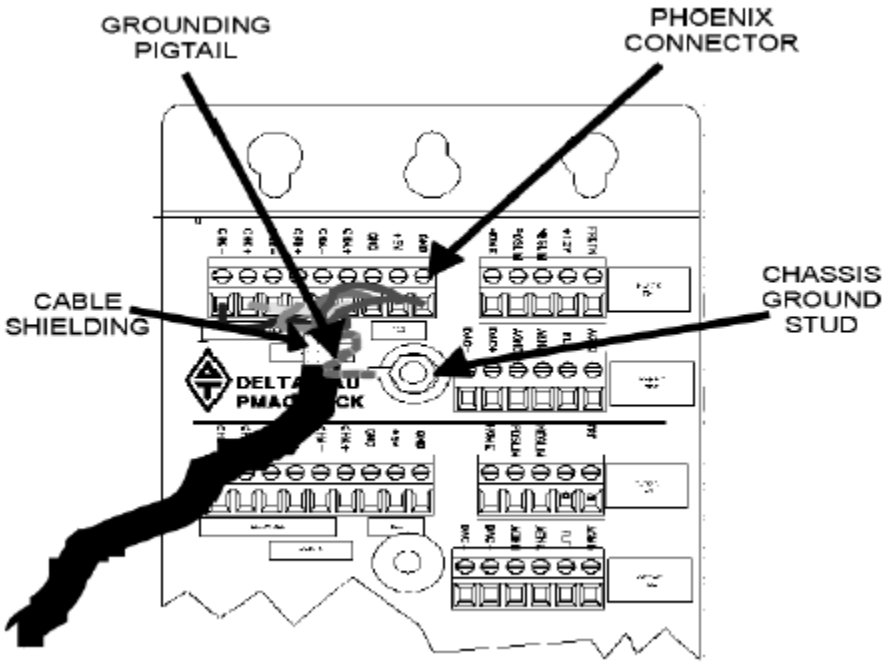


Figure 3-1. Grounding Procedures for Phoenix Plug-In Connectors

Cables

The most common types of cable used for PMAC-Pack installation are dedicated cable with foil wrap and braided shielding, twisted shielded cable, flat-shielded cable, and flat cable in a twist with shield. Figure 3-2 demonstrates the proper installation and grounding for these types of cable.

Signal Cables

The exposed portion of signal cable shielding must be kept to a minimum, nominally 10 to 12 mm. If a backshell is being used, Delta Tau recommends pulling the shielding over the outer sheath, passing it through the backshell clamp, and then clamping it.

Flat Cables

All flat (ribbon) cabling must have 360o shielding with a drain wire. Ensure the shielding is in complete contact with the metal portion of the connector and crimp it with a termination ring or tape it in place with conductive tape.

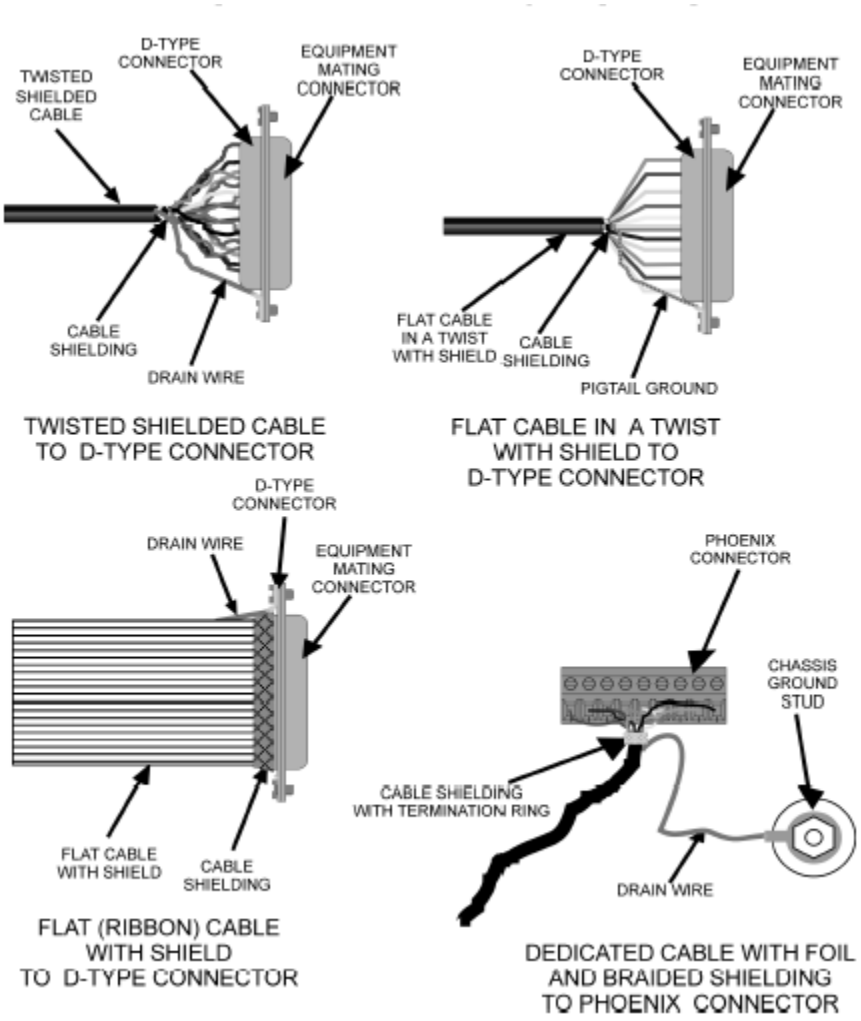


Figure 3-2. Typical Cable/Connector Installation

PMAC-PACK CUSTOM CONFIGURATION

PMAC-Pack Disassembly

Caution:

Delta Tau Data Systems, Inc. is not responsible for injuries or damage if equipment is disassembled. Do not open unit with power applied. Disconnect power cord from power source and from the PMAC-Pack before disassembly. Do not tamper with internal wiring and cabling. *Failure to heed the above instructions may void the product warranty.*

It may be necessary to disassemble the PMAC-Pack to set jumpers or diagnose a system problem. The following steps serve as a guide to the disassembly of the PMAC-Pack (see Figure 4-1).

1. Uncouple PMAC-Pack from any system connections, unbolt it from the mounting plate, and place the unit on a clean workbench or table.
2. Remove the eight (8) screws securing the two halves of the PMAC-Pack sheet metal together.
3. Pull the front of PMAC-Pack slightly forward, and rotate it to the left, exposing the interior of the unit.
4. Remove the three mounting screws securing the PMAC-Lite motion control card as shown. PMAC-Lite is then free to swivel outward, exposing the component side of the card.
5. Set jumpers as required. (Jumpers E40-47 are replaced by the communications SwitchBank on the front panel of the PMAC-Pack.)

PMAC-Pack Jumper Setup

Note:

Delta Tau Data Systems, Inc. does not recommend reconfiguring the PMAC-Pack. All units are shipped in the default configuration. If the default configuration does not meet your requirements, Delta Tau suggests ordering the PMAC-Pack factory-configured to your specifications.

Although the vast majority of applications can be accomplished using the default settings of the E-point jumpers, thereby eliminating the need to open up PMAC-Pack, the E-point jumpers may be used to "custom configure" the motion control hardware for specific tasks. Figure 4-2 shows the location of the backplane E-point jumpers, Figure 4-3 shows the locations of the PMAC-Lite 1.5 card E-point jumpers, and tables 4-1 through 4-27 provide the information required for customizing the PMAC-Pack backplane and PMAC-Lite 1.5 card configurations to your specific application.

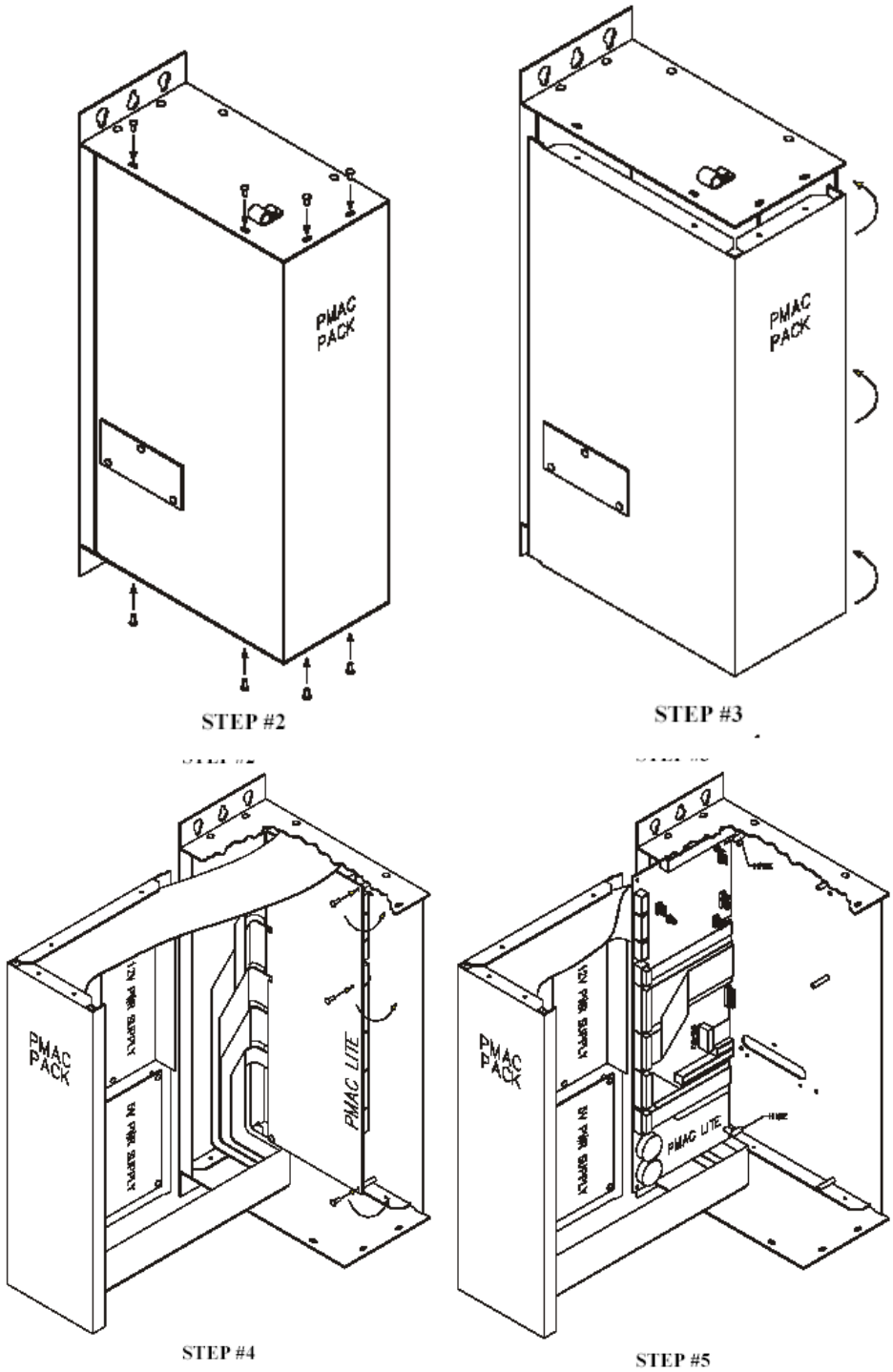


Figure 4-1. PMAC-Pack Disassembly

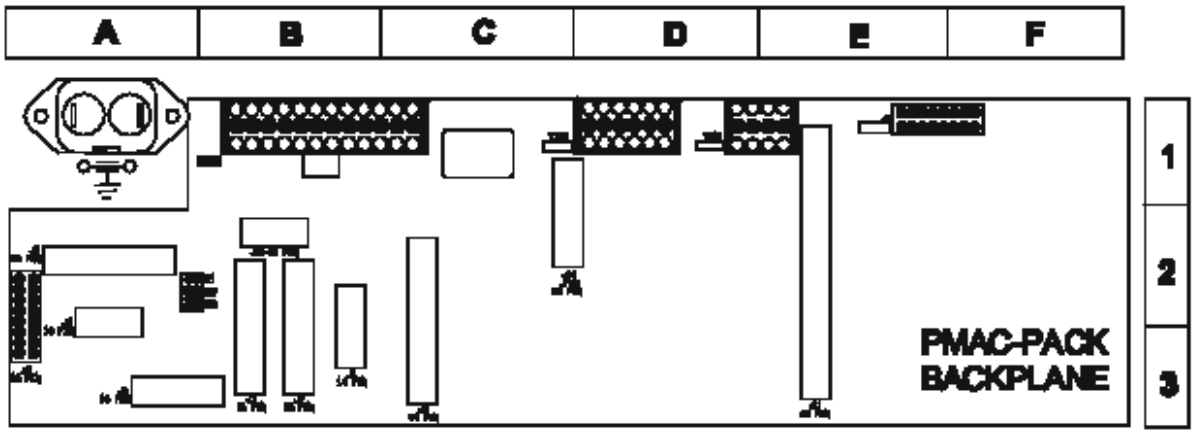
PMAC-Pack Backplane E-Point Jumper Descriptions

Table 4-1. Backplane E-Point Jumper Settings

E Point & Physical Layout	Location	Description	Default
E1 	F4	Jumps pin 1 to pin 2 to allow AGND to come from PMAC-Pack's internal supply. (Ties PMAC AGND to ground of analog inputs). Defeats isolation. **Note:** If E1 is changed, E2 and E3 must also be changed.	No jumper
E2 	F4	Jumps pin 1 to pin 2 to allow +12V to come from PMAC-Pack's internal supply. (Ties PMAC +12V supply to JANA port for power of analog inputs). Defeats isolation. **Note:** If E2 is changed, E1 and E3 must also be changed.	No jumper
E3 	F4	Jumps pin 1 to pin 2 to allow -12V to come from PMAC-Pack's internal supply. (Ties PMAC -12V supply to JANA port for power of analog inputs). Defeats isolation. **Note:** If E3 is changed, E1 and E2 must also be changed.	No jumper
E4 		**Caution:** The jumper settings must match the type of driver IC or the IC will be damaged. Jump pin 1 and 2 to apply +V (+12 to 24V) to pin 10 of U10 (should be ULN2803A) for sinking output configuration JOPTO Machine Outputs M01 to M08. Jump pins 2 and 3 to apply GND to pin 10 of U10 (should be UDN 21981) for sourcing output configuration. (Also see E2)	1-2 jumper installed

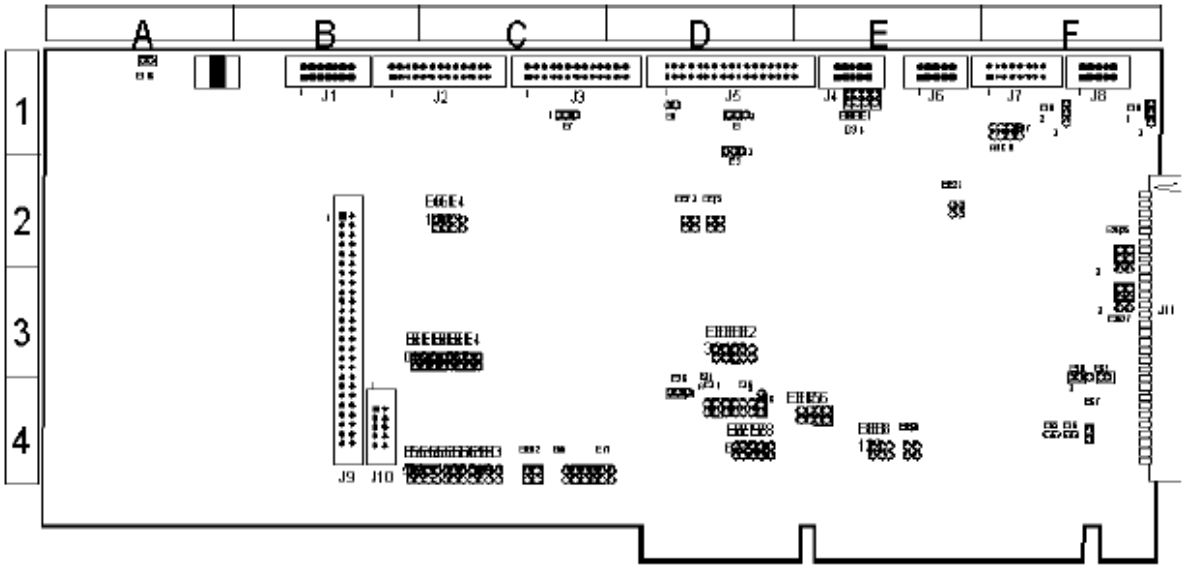
Table 4-1. Backplane E-Point Jumper Settings

E Point & Physical Layout	Location	Description	Default
E5 		**Caution:** The jumper settings must match the type of driver IC or the IC will be damaged. Jump pin 1-2 to apply GND to pin 9 of U10 (should be ULN2803A) for sinking output configuration JOPTO Machine outputs M01 to M08. Jump pins 2 and 3 to apply +V (+12 to 24V) to pin 9 of U10 (should be UDN 21981) for sourcing output configuration. (Also see E1)	1-2 jumper installed
E7 		**Note:** Jumper is only active if PMAC-Pack is configured with optional RS422 communications, OPT9LPP. Jump pins 1 and 2 for RS485 communications. Jump pins 2 and 3 for RS422 communications.	2-3 jumper installed



E-POINT	LOCATION
E1	B2
E2	B2
E3	B2

Figure 4-2. PMAC-Pack Backplane E-Point Locations



E-Point	Location	E-Point	Location	E-Point	Location	E-Point	Location	E-Point	Location
E0	D3	E23	E2	E41	C3	E65	C4	E83	E4
E1	A1	E24	F2	E42	C3	E66	C4	E84	E4
E2	D1	E25	F2	E43	C3	E67	C4	E85	F4
E3	E4	E26	F3	E44	C3	E68	V4	E86	E4
E4	E4	E27	F3	E45	C3	E69	C4	E87	F4
E5	E4	E28	D4	E46	C3	E70	C4	E88	F4
E6	E4	E29	D3	E47	C3	E71	C4	E89	F3
E7	C1	E31	D3	E48	C2	E72	D2	E90	F3
E8	E1	E32	D3	E49	C2	E73	D2	E91	C4
E9	E1	E33	D3	E50	C2	E74	D2	E92	C4
E10	E1	E34	D4	E51	C2	E75	D2	E93	C4
E13	E1	E34A	D4	E55	B4	E76	D4	E94	C4
E14	E1	E35	D4	E57	C4	E77	D4	E98	D4
E17A	F1	E36	D4	E58	C4	E78	D4	E101	F1
E17B	F1	E37	D4	E59	C4	E79	D4	E102	F2
E17C	F1	E38	D4	E61	C4	E80	D4	E103	A1
E17D	F1	E39	C4	E62	C4	E81	E4		
E22	E2	E40	C3	E63	C4	E82	E4		

Figure 4-3. PMAC-Lite E-Point Locations

PMAC- Lite E-Point Jumper Descriptions

E0: Reserved for Future Use

Table 4-2. E0: Unused

E Point & Physical Layout	Location	Description	Default
E0 	D3	For future use	No jumper

E1 & E2: Output Supply Voltage

Table 4-3. E1 - E2: Configure Machine Output Supply Voltage

E Point & Physical Layout	Location	Description	Default
E1 	D3	Jump pin 1 to 2 to apply +V (+5V to24V) to pin 11 of "U26" (should be ULN2803A for sink output configuration) JOPTO MACHINE outputs M01-M08. Jump pin 2 to 3 to apply GND to pin 11 of U26 (S/B UDN2981A for source output configuration). Also, see E2.	1-2 Jumper installed
E2 	C3	**Warning:** PMAC-Pack JOPTO Machine Output Sink/Source control is accomplished by the setting of Backplane jumpers E4 and E5. The setting of PMAC-Lite jumpers E1 and E2 should never be changed from pins 1 to 2 and U26 should always be a ULN2803A. Regardless of the sink or source configuration of the PMAC-Pack outputs, the PMAC-Lite's outputs to the Pack backplane are always sinking. Jump pin 1 to 2 to apply GND to pin 10 of "U26" (S/B ULN2803A for sink output configuration). Jump pin 2 to 3 to apply +V (+5V to 24V) to pin 10 of "U26" (S/B UDN2981A for source output configuration). Also, see E1.	1-2 Jumper installed

E3 - E6: Servo Clock Frequency Control

The servo clock (which determines how often the servo loop is closed) is derived from the phase clock (see E29 - E33) through a "divide-by-N" counter. Jumpers E3 through E6 control this dividing function.

The setting of I-Variable I10 should be adjusted to match the servo interrupt-cycle time set by E98, E3 -- E6, E29 -- E33, and the master clock frequency. I10 holds the length of a servo interrupt cycle, scaled so that 8,388,608 equals one millisecond. Since I10 has a maximum value of 8,388,607, the servo interrupt cycle time should always be less than a millisecond (unless you want to make your basic unit of time on PMAC something other than a millisecond). If you wish a servo sample time greater than one millisecond, the sampling may be slowed in software with variable Ix60. Frequency can be checked on J4 pins 21 & 22.

Note:

If E40-E43 are set up so that the card has a software address other than @0, the servo clock signal must be received over the serial port from card @0, so these jumpers have no effect.

Table 4-4. E3 - E6: Servo Clock Frequency Control

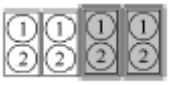
E3	E4	E5	E6	Servo Clock = Phase Clock Divided By N	Default & Physical Layout E4 E4 E4 E4 
ON	ON	ON	ON	N = divided by 1	
OFF	ON	ON	ON	N = divided by 2	
ON	OFF	ON	ON	N = divided by 3	
OFF	OFF	ON	ON	N = divided by 4	Only E5 and E6 ON
ON	OFF	ON	ON	N = divided by 5	
OFF	ON	OFF	ON	N = divided by 6	
ON	OFF	OFF	ON	N = divided by 7	
OFF	OFF	OFF	ON	N = divided by 8	
ON	ON	ON	OFF	N = divided by 9	
OFF	ON	ON	OFF	N = divided by 10	
ON	OFF	ON	OFF	N = divided by 11	
OFF	OFF	ON	OFF	N = divided by 12	
ON	ON	OFF	OFF	N = divided by 13	
OFF	ON	OFF	OFF	N = divided by 14	
ON	OFF	OFF	OFF	N = divided by 15	
OFF	OFF	OFF	OFF	N = divided by 16	

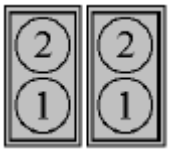
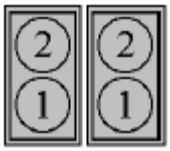
Table 4-5. E7: Machine Input Source/Sink Control

E Point & Physical Layout	Location	Description	Default
E7 	C1	Jump pin 1 to 2 to apply +5V to input reference resistor sip pack; this will bias MI1 to MI8 inputs to +5V for "OFF" state; input must then be grounded for "ON" state. Jump pin 2 to 3 to apply GND to input reference resistor sip pack; this will bias MI1 to MI8 inputs to GND for "OFF" state; input must then be pulled up for "ON" state (+5V to +24V). **Note:** When used in the PMAC-Pack with the backplane board, 2-3 jumper must be installed.	1-2 Jumper installed

E9, E10, E13, E14: Handshake Control

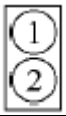
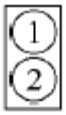
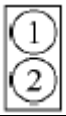
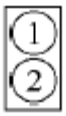
E9, E10, E13, E14 jumpers control various configurations of RS422/RS232 handshake signal setup.

Table 4-6. E9, E10, E13, E14: Serial Interface Handshake Control

E Point & Physical Layout	Location	Description	Default
E9 E10 	E1	Jump, E9-1 to E9-2 to allow 'TXD/' to be input on J4-3; jump E10-1 to E10-2 to allow 'RXD/' to be output on J4-5. Jump E9-1 to E10-1 to allow 'TXD/' to be output on J4-3; jump E9-2 to E10-2 to allow 'RXD/' to be input on J4-5.	1-2 Jumper installed
E13 E14 	E1	D5 jump E13-1 to E13-2 to 1-2 allow 'RTS' to be input jumper on J4-4; jump E14-1 to installed E14-2 to allow 'CTS' to be output on J4-6. Jump E13-1 to E14-1 to allow 'RTS' to be output on J4-4; jump E13-2 to E14-2 to allow 'CTS' to be input on J4-6.	1-2 Jumper installed

E17A - E17D: Polarity Control

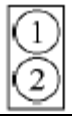
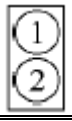
Table 4-7. E17A - E17D: Amplifier-Enable/Direction Polarity Control

E Point & Physical Layout	Location	Description	Default
E17A 	F1	Jump 1-2 for high TRUE AENA1. Remove jumper for low TRUE AENA1	No jumper installed
E17B 	F1	Jump 1-2 for high TRUE AENA2. Remove jumper for low TRUE AENA2	No jumper installed
E17C 	F1	Jump 1-2 for high TRUE AENA3. Remove jumper for low TRUE AENA3.	No jumper installed
E17D 	F1	Jump 1-2 for high TRUE AENA4. Remove jumper for low TRUE AENA4	No jumper installed

E22 - E23: Control Panel Handwheel Enable

With these jumpers ON, no encoder should be wired into ENC2 on JMACH1. Jumper E26 should connect pins 1-2.

Table 4-8. E22 - E23: Control Panel Handwheel Enable

E Point & Physical Layout	Location	Description	Default
E22 	E2	Jump pin 1 to 2 to obtain handwheel encoder signal from front panel at J2-16 for CHB2 (ENC2-B).	No jumper
E23 	E2	Jump pin 1 to 2 to obtain handwheel encoder signal from front panel at J2-22 for CHA2 (ENC2-A).	No jumper

E24 - E27: Encoder Control

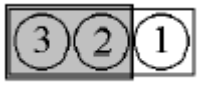
Unused encoders should be left non-differential to prevent noise pickup.

Table 4-9. E24 - E27: Encoder Single-Ended/Differential Control

E Point & Physical Layout	Location	Description	Default
E24 	F3	ENC 4 thru 1: Jump pin 1 to 2 to tie complementary encoder inputs to 2.5V. Jump pin 2 to 3 to tie complementary encoder inputs to 5V. For no encoder connection: Jump pin 1 to 2 For single ended encoders: Jump pin 1 to 2. For differential line-driver encoders: Don't care For complementary open-collector encoders: Jump pin 2 to 3.	1-2 Jumper installed for E24 – E27 E24: ENC 4 E25: ENC 3 E26: ENC 2 E27: ENC 1
E25 	F3		
E26 	F3		
E27 	F3		

E28: Error Signal Control

Table 4-10. E28: Warning Following Error/Watchdog Timer Signal Control

E Point & Physical Layout	Location	Description	Default
E28 	D4	Jump pin 1 to 2 to allow soft following error (Ix12) to control "FEFCO/" on J11-57. Jump pin 2 to 3 to cause WATCHDOG timer output to control "FEFCO/" (low TRUE output in either case).	2-3 Jumper installed

E29 - E33: Phase Clock Frequency Control

Jumpers E29 through E33 control the speed of the phase clock, and, indirectly, the servo clock, which is divided down from the phase clock (see E3 - E6). No more than 1 of these 5 jumpers may be on at a time. If jumper E98 has been changed to connect pins 2-3 (default is 1-2), the phase clock frequency is exactly 1/2 that shown in the above table.

Note:

If E40-E43 are set so that the card has a software address other than @0, the phase clock signal must be received over the serial port from card @0, so these jumpers have no effect.

Table 4-11. E29 - E33: Phase Clock Frequency Control

E29	**E30**	**E31**	**E32**	**E33**	**Phase Clock Frequency**		**Default & Physical Layout** E33 E32 E31 E30 E29 
					19.6608MHz Master Clock	**29.4912 MHz Master Clock**	
ON	OFF	OFF	OFF	OFF	2.26 kHz	3.39 kHz	
OFF	ON	OFF	OFF	OFF	4.52 kHz	6.78 kHz	
OFF	OFF	ON	OFF	OFF	9.04 kHz	13.55 kHz	
OFF	OFF	OFF	ON	OFF	18.07 kHz	27.10 kHz	
OFF	OFF	OFF	OFF	ON	36.14 kHz	54.21 kHz	

E34 - E38: SLCK Frequency Control

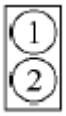
Jumpers E34 - E38 control the encoder sampling clock (SCLK) used by the gate array ICs. No more than 1 of these 5 jumpers may be on at a time.

Table 4-12. E34 - E38: Encoder Sampling Clock Frequency Control

E34A	**E34**	**E35**	**E36**	**E37**	**E38**	**SCLK Clock Frequency**	**Default & Physical Layout** E34A E34 E35 E36 E37 E38
						19.6608 MHz Master Clock	
ON	OFF	OFF	OFF	OFF	OFF	19.6608 kHz	
OFF	ON	OFF	OFF	OFF	OFF	9.8304 kHz	E34 ON
OFF	OFF	ON	OFF	OFF	OFF	4.9152 kHz	
OFF	OFF	OFF	ON	OFF	OFF	2.4576 kHz	
OFF	OFF	OFF	OFF	ON	OFF	1.2288 kHz	
OFF	OFF	OFF	OFF	OFF	ON	External clock 1 to 30 MHz maximum input on CHC4 & CHC4/	

E39: Reset-From-Bus Enable

Table 4-13. E39: Reset-From-Bus Enable

E Point & Physical Layout	Location	Description	Default
E39 	C4	Must be removed for standalone operation. Jump pin 1 to 2 to allow PMAC-LITE to derive its reset from the "PC" backplane. Only one of E39, E93, E94 should be on at once See also E93 & E94	No jumper

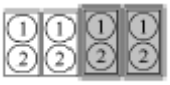
E40 - E43: Software Address Control

Switches S1-S4 on the front panel of the PMAC-Pack close or open jumpers E40-E43. These jumpers in turn control the software address of the card, for serial addressing and for sharing the servo clock over the serial connector. Card @0 sends the clock and cards @1-@F receive the clock.

Note:

The card must either be set up as @0, or receiving clock signals over the serial port from another card that is set up as @0, or the WATCH-DOG timer will trip (red light ON) and the card will shut down

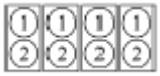
Table 4-14. E40 - E43: Software Address Control

Card Address Control E Points				Card Address	Default & Physical Layout E40 E41 E42 E43  Location C3 C3 C3 C3
E40	**E41**	**E42**	**E43**		
ON	ON	ON	ON	@0	@0
OFF	ON	ON	ON	@1	
ON	OFF	ON	ON	@2	
OFF	OFF	ON	ON	@3	
ON	ON	OFF	ON	@4	
OFF	ON	OFF	ON	@5	
ON	OFF	OFF	ON	@6	
OFF	OFF	OFF	ON	@7	
ON	ON	ON	OFF	@8	
OFF	ON	ON	OFF	@9	
ON	OFF	ON	OFF	@A	
OFF	OFF	ON	OFF	@B	
ON	ON	OFF	OFF	@C	
OFF	ON	OFF	OFF	@D	
ON	OFF	OFF	OFF	@E	
OFF	OFF	OFF	OFF	@F	

E44 - E47: Communications Control

Switches S5-S8 on the front panel of the PMAC-Pack close or open jumpers E44-E47. These jumpers in turn control what baud rate to use for serial communications. The serial port is disabled if E44-E47 are all on.

Table 4-15. E44 - E47: Communications Control

Baud Rate Control E Points				**Baud Rate**			**Default & Physical Layout E44 E45 E46 E47**  Location C3 C3 C3 C3
E44	**E45**	**E46**	**E47**	**20 MHz Flash CPU (OPT 4A) Standard**	**20 MHz Battery-backed CPU (standard on units produced prior to AUG 1, 1995) 40 MHz Flash CPU (OPT 5A)**	**60 MHz Flash CPU (OPT 5B)**	
ON	ON	ON	ON	DISABLED	DISABLED	DISABLED	
OFF	ON	ON	ON	300	600	900	
ON	OFF	ON	ON	400	800	1200	
OFF	OFF	ON	ON	600	1200	1800	
ON	ON	OFF	ON	800	1600	2400	
OFF	ON	OFF	ON	1200	2400	3600	
ON	OFF	OFF	ON	1600	3200	4800	
OFF	OFF	OFF	ON	2400	4800	7200	
ON	ON	ON	OFF	3200	6400	9600	
OFF	ON	ON	OFF	4800	9600	14400	
ON	OFF	ON	OFF	6400	12800	19200	
OFF	OFF	ON	OFF	9600	19200	28800	
ON	ON	OFF	OFF	12800	25600	38400	
OFF	ON	OFF	OFF	19200	38400	57600	
ON	OFF	OFF	OFF	25600	51200	76800	
OFF	OFF	OFF	OFF	38400	76800	115200	

E48: CPU Clock Frequency Control

Table 4-16. E48: CPU Clock Frequency Control

E Point & Physical Layout	**Location**	**Description**	**Default**
E48 	C2	Jump pin 1 to 2 to multiply crystal frequency by 3 inside CPU for 60mhz operation. Remove jumper to multiply crystal frequency by 2 inside CPU for 40mhz operation.	Jumper installed (Option 5, 5B) Jumper not installed (Standard, Option 4A, 5A)

E49: Serial Communications Parity Control

Table 4-17. E49: Serial Communications Parity Control

E Point & Physical Layout	Location	Description	Default
E49 	C2	Jump pin 1 to 2 for NO serial parity; remove jumper for ODD serial parity.	Jumper installed

E50: EAROM Save Enable/Disable

Table 4-18. E50: EAROM Save Enable/Disable

E Point & Physical Layout	Location	Description	Default
E50 	C2	Jump pin 1 to 2 to enable save to EAROM; remove jumper to disable save to EAROM.	Jumper installed

E51: Normal/Re-Initializing Power-Up

Table 4-19. E51: Normal/Re-Initializing Power-Up

E Point & Physical Layout	Location	Description	Default
E51 	C2	Jump pin 1 to 2 to re-initialize ON power-up/reset; remove jumper for NORMAL power-up/reset. **Note:** In PMAC-Pack, this jumper is connected to the front panel RE-INIT.	No jumper installed

E55 - E65: Host Interrupt Signal Select

These jumpers work together with E86 and E76-E84 to set the mapping of PMAC information to host PC bus interrupt lines. (They are of no relevance to PMAC-Pack operation.)

E66 - E71: Bus Base Hardware Address

These jumpers work with E91 & E92 to set the base address of PMAC-Lite on the PC bus. (They are of no relevance to PMAC-Pack operation).

E72 - E73: Panel Analog Time Base Signal Enable

With these jumpers ON, no encoder should be wired into ENC4 on JMACH.

Table 4-20. E72 - E73: Panel Analog Time Base Signal Enable

E Point & Physical Layout	Location	Description	Default
E72 	D2	Jump pin 1 to 2 to allow "V to F" converter "FOUT" installed to output on "CHA4"	No jumper installed
E73 	D2	Jump pin 1 to 2 to allow "V to F" converter "SIGNOUT" to output on "CHB4"	No jumper installed

E74 - E75: Clock Output Control

Table 4-21. E74 - E75: Clock Output Control for Ext. Interpolation

E Point & Physical Layout	Location	Description	Default
E74 	D2	Jump pin 1 to 2 to allow "SCLK/" to output on "CHC4/".	No jumper installed
E75 	D2	Jump pin 1 to 2 to allow "SCLK" to output on "CHC4".	No jumper installed

E76 - E84: Host Interrupt Signal Select

These jumpers work together with E86 and E55-E65 to set the mapping of PMAC information to host PC bus interrupt lines. (They are of no relevance to PMAC-Pack operation.)

E85: Host-Supplied Analog Power Source Enable

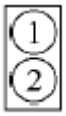
Table 4-22. E85: Host-Supplied Analog Power Source Enable

E Point & Physical Layout	Location	Description	Default
E85 	F4	E85 should be removed for normal operation of PMAC-Pack with internal opto-isolated supplies. Jump pin 1 to pin 2 to allow a+14V to come from bus or PMAC-Lite's TB1 port (ties +5 logic and)15 analog power supplies together. Defeats OPTO coupling. **Note:** If E85 is changed, E88 and E87 must also be changed. Also, see E90.	No jumper

E86: Host Interrupt Signal Select

This jumper works together with E55-E65 and E76-E84 to set the mapping of PMAC information to host PC bus interrupt lines. (It is of no relevance to PMAC-Pack operation.)

Table 4-23. E87 - E88: Host-Supplied Analog Power Source Enable

E Point & Physical Layout	Location	Description	Default
E87 	F4	E87 should be removed for normal operation of PMAC-Pack with internal opto-isolated supplies. Jump pin 1 to pin 2 to allow GND to come from bus or PMAC-Lite's TB1 port (ties +5 logic and)15 analog power supplies together. Defeats OPTO coupling. **Note:** If E87 is changed, E88 and E85 must also be changed. Also, see E90.	No jumper
E88 	F4	E88 should be removed for normal operation of PMAC-Pack with internal opto-isolated supplies. Jump pin 1 to pin 2 to allow -14V to come from bus or PMAC-Lite's TB1 port (ties +5 logic and)15 analog power supplies together. Defeats OPTO coupling. **Note:** If E88 is changed, E85 andE87 must also be changed. Also, see E90.	No jumper

E89: Switch Pull-Up Enable

Table 4-24. E89: Amplifier-Supplied Switch Pull-Up Enable

E Point & Physical Layout	Location	Description	Default
E89 	F3	Jump pin 1 to 2 to allow "A+15V/+V" on PMAC-LITE J8 (JEQU) pin 9, to tie to "A+15V" on J11 (JMACH1) pin 59. This jumper must be installed to allow "A+15V" to power the "OPTO" switch sensor inputs (including limits) from the same OPTO-power supply that powers the amplifier output stage. Also see E90.	Jumper installed

E90: Host-Supplied Switch Pull-Up Enable

Table 4-25. E90: Host-Supplied Switch Pull-Up Enable

E Point & Physical Layout	Location	Description	Default
E90 	C11	Jump pin 1-2 to allow PMAC-Pack internal supplies to power "OPTO" switch sensor inputs (including limits). Jump pin 2 to 3 to allow "+12V" from PC bus connector P1-pin B09 to power "OPTO" switch sensor inputs (including limits). Optical isolation is then lost. See also E85, E87, E88 and PMAC opto-isolation diagram.	1-2 Jumper installed

E91 - E92: Bus Base Address Select (High Bits)

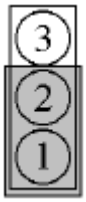
These jumpers work with E66-E71 to set the base address of PMAC-LITE on the PC bus. (They are of no relevance to PMAC-Pack operation).

E93 - E94: Reset From Bus by Software Enable

These jumpers may be used to provide a hardware RESET of PMAC-LITE under the software control of the host PC-AT. (They are of no relevance to PMAC-Pack operation).

E98: DAC/ADC Clock Frequency Control

Table 4-26. E98: DAC/ADC Clock Frequency Control

E Point & Physical Layout	Location	Description	Default
E98 	D4	Jump 1-2 to provide a 2.45 MHz DCLK signal to DACs and ADCs. Jump 2-3 to provide a 1.2 MHz DCLK signal to DACs and ADCs. Important for high accuracy A/D conversion on accessory boards. **Note:** This also divides the phase and servo clock frequencies in half. See E29-E33, E3-E6	1-2 Jumper installed

E101 - E102: Output Configure

Caution

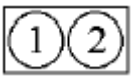
Improper setting of E101 or E102 will damage the output IC.

Table 4-27. E101 - E102: Amplifier Enable Output Configure

E Point & Physical Layout	Location	Description	Default
E101 	F1	Jump pin 1 to 2 to apply +V (+5V to +15V) to pin 11 of "U54" (Should be ULN2803A for sink output configuration). Jump pin 2 to 3 to apply GND to pin 11 of "U54" (should be UDN2981A for source output configuration).	1-2 Jumper installed
E102 	F1	Jump pin 1 to 2 to apply GND to pin 11 of "U54" (Should be ULN2803A for sink output configuration). Jump pin 2 to 3 to apply +V (+5V to +15V) to pin 11 of "U54" (Should be UDN2981A for source output configuration).	1-2 Jumper installed

E103 - E104: CPU Jumpers

Table 4-28. E103 - E104: CPU Jumpers

E Point & Physical Layout	Location	Description	Default
E103 	A2	Jump pin 1 to 2 to disable WATCHDOG timer. Remove jumper to enable WATCHDOG timer.	No jumper installed
E104 	A1	Jump pin 1 to 2 to BOOT from host port. Remove jumper to BOOT from PROM IC.	No jumper installed

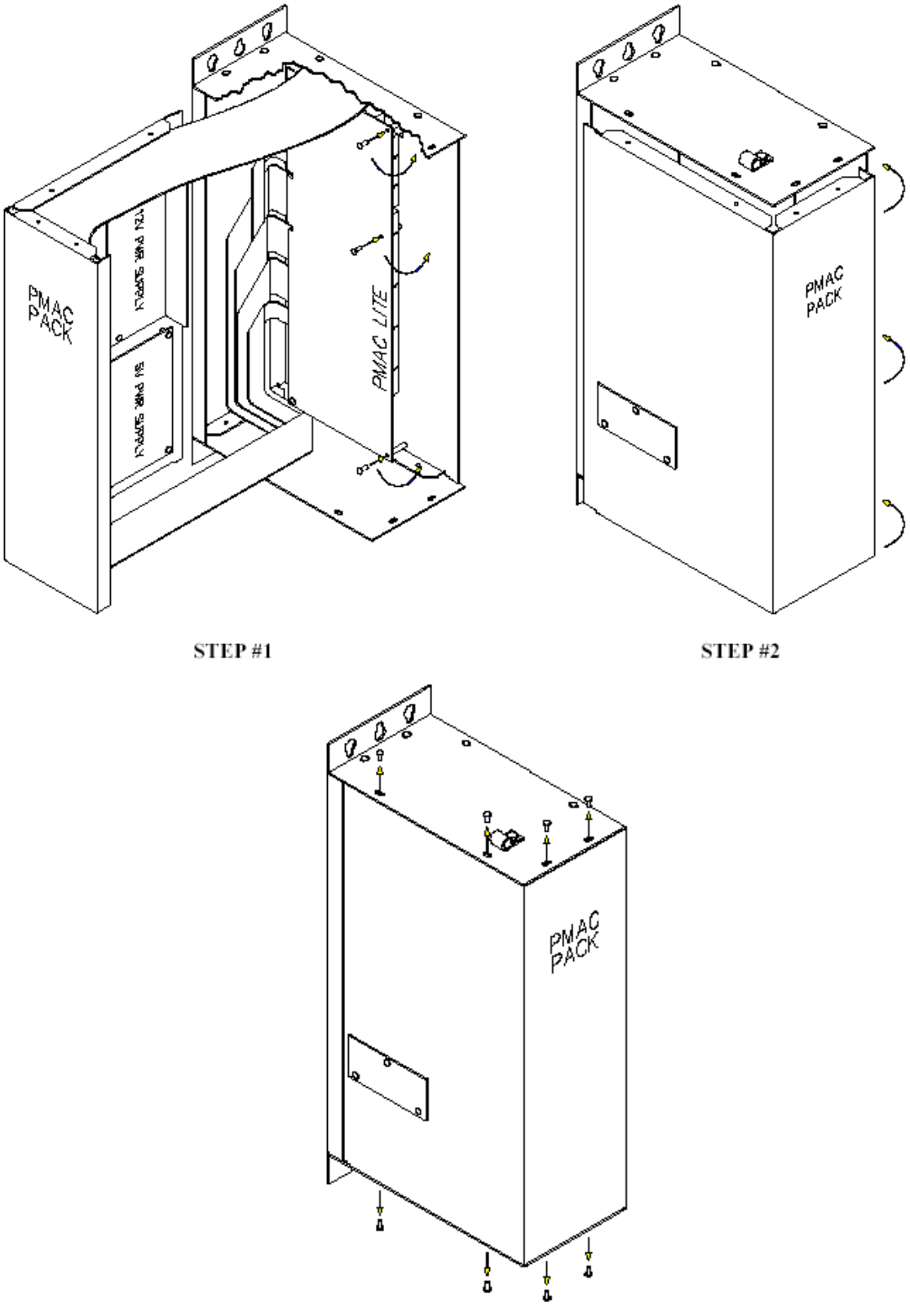


Figure 4-4. PMAC-Pack Assembly

PMAC-Pack Re-assembly

Upon completion of jumper settings, changing the PMAC-Lite lithium battery), or diagnosing a system problem, perform the following steps the re-assemble the PMAC-Pack (see Figure 4-4).

1. Rotate the PMAC-Lite card on its hinges until it is flush against the case standoffs. Insert the three mounting screws to secure PMAC-Lite to the case. Check that all internal connections are secure.
2. Fold the left half of the PMAC-Pack casing into the right. First insert the rear lip of the left half into the back of the case. Rotate the left half of the case until it is flush with the right. You may need to pull the left halve slightly forward to clear the front right lip.
3. Insert eight (8) sheet-metal screws as shown to secure the left and right halves of the casing together.
4. Bolt the PMAC-Pack to its mounting plate and make the proper system connections.

TROUBLESHOOTING

Table 5-1. PMAC-Pack Troubleshooting Procedures

Problem	Possible Solution
Neither The PWR Or WDT LEDs Illuminate When AC Power Is Applied Or Both WDT And PWR LEDs Illuminate When AC Power Is Applied.	Verify that AC Power, 100-240 VAC (47-63Hz), is being applied. Disconnect power, open PMAC-Pack case (see Chapter 3 for disassembly instructions), and check the following: • Verify AC Power connections to the internal +5V and 12V supply input plugs. • Verify +5V and 12V supply output connections to PMAC-Pack backplane TB16 connector. • Using a Voltmeter, measure for +5V between pins 1 and 2 of TB16. The voltmeter should read no less than 4.8 V DC. • Verify the connections of the 60 pin ribbon cable between PMAC-Pack backplane (J11) to PMAC-Lite Controller (JMACH1). • Verify that the Communications DIP switch bank (see 2.6) is set for card address A0 (unless multiple PMAC-Packs are daisy chained). • If problem persists, contact Delta Tau for further instructions.
Serial Communication Cannot Be Established	Check the following: • Check that the proper COM port on the PC is being used. Make sure that the Executive program is addressing the COM port and that you have cabled out of that COM port connector. • Check that the baud rate specified in the Executive program matches the baud rate setting on the PMAC-Pack communications SwitchBank. • With a breakout box or oscilloscope, make sure that you see action on the transmit lines from the PC as you type into the Executive program. If you do not, there is a problem on the PC end. • Probe the return communication line while you give PMAC a command that requires a response (e.g. **<CONTROL-F>**). If there is no action, you may have to change jumpers E9-E14 on PMAC to exchange the send and receive lines. If you are using the RS422 option and there is action, but the host program does not receive characters, you may have RS-232 receiving circuitry that does not respond at all to PMACPack's RS-422 levels. If you have another model of PC, try using it as a test (most models accept RS-422 levels quite well). If you cannot get your computer to accept the signals, you may need a level-conversion device, such as Delta Tau's Accessory-26. • As a last resort, check the +5V supply level inside the PMAC-Pack. If the level is below 4.75 V problems can result. Contact Delta Tau before any attempts to adjust the +5V supply are made.

You Do Not See The Position Changing	Check the following: • Is the encoder receiving power (+5V and GND)? • Are both quadrature channels connected properly? • If single-ended, are the complementary lines floating? • If single-ended, has E24-E27 been changed for operation with single-ended encoders? • If differential, has E24-27 set for differential encoder operation? • Is the motor activated (I100=1)? • Is I103 set to the proper encoder input? • Is I900 set for proper decode of the signal? • Can a signal be detected with a scope or voltmeter?
You Have A Polarity Mismatch (You get a potentially dangerous runaway condition when you try to close the loop.)	Change I900 (e.g. from 7 to 3, or 3 to 7) to reverse the counting sense. This will change the positive direction of the axis; if you do not wish to do this, you will need to exchange the motor leads instead.
The Motor Does Not Move	Issue an O10 command to the motor which will not move. Check the voltage on the output pin. It should be approximately 1V relative to AGND. **If the DAC voltage HAS changed:** • Recheck your amplifier and motor connections. **If the DAC voltage has not changed:** • Recheck I102. You must tie the DAC output to the motor through this variable. Check your limit-input configuration. • Is your output limit (Ix69) too low? Try increasing it to 32,767 (the maximum) to make sure PMAC can output adequate voltage. • Check the analog power supply positive voltage. Measure with a voltmeter between +12V, (pin 2 of any "FLAGS" connector) and AGND, (pin 1 of the FLAGS port). • Open PMAC-Pack and check the analog power supply voltage at the TB16 connector. You should have approximately -12 V as measured between pin 6 and AGND (pin 5).

No Movement At All (when commanding closed loop moves)	Check the following: • Are both limits held low to AGND and sourcing current out of the pins? • Is your proportional gain (Ix30) greater than zero? • Can you measure any output at the DAC pin when an O command has been given? • Are you tripping your following error limit? Disable the fatal following error limit (Ix11) by setting it to zero, and try to move again. • Ix06 is set to zero to disable the motor's position following abilities. • Feedrate override valve by typing %. If value is 0, increase to 100% by typing %100 and reissue the closed loop move command. • Do you have proper supply to A+15V, A-15V, and AGND? Open PMAC-Pack and verify connections voltages at TB16.
Movement, But Sluggish	Check the following: • Is proportional gain (Ix30) too low? Try increasing it (as long as stability is kept). • Is your "big step limit" (Ix67) too low? Try increasing it to 8,000,000 -- near the maximum -- to eliminate any effect. • Is your output limit (Ix69) too low? Try increasing it to 32,767 (the maximum) to make sure PMAC can output adequate voltage. • Can an integrator help? Try increasing integral gain (Ix33) to 10,000 or more, and the integration limit (Ix63) to 8,000,000.
Runaway Condition	Check the following: • Do you have feedback? Check that you can read position changes in both directions. • Does your feedback polarity match output polarity? Recheck the polarity match as explained above.
Brief Movement, Then Stop **Warning:** The following error limit is a safety limit. Extreme caution should be taken while the limit is disabled.	Are you tripping your following error limit? Disable fatal following error limit (Ix11) by setting it to zero, then try to move again.
Machine Output (JOPTOUT) Voltage Does Not Change	Check the following: • Verify with a voltmeter or scope that no voltage change (0-5V) occurs when the outputs state is toggled. Check Electrical connections. • Is the PMAC M-Var. that you are toggling linked to the address of the Machine Output? Type *M01->* *<CR>* and verify that PMAC responds with: **`Y:$FFC2,8,1`**. • After toggling the output's state, query the M-vas value to confirm that in software a change has occurred. If it has not, issue a *<CTRL> A* to abort any programs which may be resetting the output variable. Also set **I5=0** to disable any PLC programs could be doing the same. Again, try to re-

	toggle the variable.
Machine Input (JOPTINP) State Does Not Change	Check the following: • Verify with a voltmeter or scope that the input voltage is indeed changing (0 to 12/24Vdc), as measured on Pin 11. • Is the PMAC M-Var. that you are toggling linked to the address of the Machine Output? Type *M11*-><*CR*> and verify that PMAC responds with: **Y:$FFC2,0,1**.

PMAC-PACK MATING CONNECTORS AND PINOUTS

PMAC-Pack Mating Connectors

This section provides a list of the mating connectors for PMAC-Pack ports, their function, the Delta Tau part numbers, and manufacturer's part numbers to facilitate ordering.

Connector Name, Type, Function, and Part Numbers

Table 6-1. Screw Terminal Blocks - Mating Connectors

Connector Name	Mating Connector Type	Connector Function	Delta Tau Part Number	Manufacturer/ Vendor	Part Number
ENCODER	9-pin female screw terminal connector	Inputs for incremental quadrature encoder feedback	016-P00009-08P	Phoenix	1777358
SERVO	6-pin female screw terminal connector	Amplifier command outputs (DAC_), amp enable output, and amp fault input.	016-P00006-08P	Phoenix	1777329
FLAGS	5-pin female screw terminal connector	Axis overtravel limit & home flag inputs	016-P00005-08P	Phoenix	1777316
JOPT OUTPUT	11-pin female screw terminal connector	8 General purpose outputs	016-P000011-08P	Phoenix	1777374
JOPTO INPUT	11-pin female screw terminal connector	8 General purpose inputs	016-P000011-08P	Phoenix	1777374
FLT RELAY	3-pin female screw terminal connector	PMAC Fault Output (Normally closed *and* Normally open Outputs)	016-P00003-08P	Phoenix	1777293

Table 6-1. Screw Terminal Blocks - Mating Connectors

Connector Name	Mating Connector Type	Connector Function	Delta Tau Part Number	Manufacturer/ Vendor	Part Number
TBAMP	12-pin female screw terminal connector	Connection for either: 16) 4 channels of pulse and direction commands to stepper drives, or 16) 4 Channels of DC Motor Outputs, 48V amplifier bus input, dynamic braking resistor output.	016-P00012-08P	Phoenix	1777387

Table 6-2. PMAC-Pack Connectors - Mating Connectors

Connector Name	Mating Connector Type	Connector Function	Delta Tau Part Number	Manufacturer/ Vendor	Part Number
JDISP/ DISPLAY PORT	15-pin DB-806 male connector w/ grounding plane	PMAC J Display Output (For use with any of the family of ACC12 Displays).	014-R00M95-0DB	AMP	748308-3
JPAN/ CONTROL PANEL	25-pin DB male connector w/ grounding plane	PMAC J Panel interface connector. Inputs such as: Axis Select, Jog, Home, Run, Abort, Reset. Outputs such as: following error, In position, buffer full	014-R00M25-0DB	AMP	747306-2
JTHW	25-pin DB male connector w/ grounding plane	PMAC J Thumb wheel Multiplexer input. Used for interconnection of additional I/O (PMAC ACC27, ACC34), Thumbwheel inputs (PMAC ACC 18), and power on position information.	014-R00M25-0DB	AMP	747306-2
JEXP	50 pin box header	Expansion port for connection of ACC24EXP, PMAC ACC14, or other PMAC accessories which connect directly to the microprocessor bus.	014-R00F50-0K0	AMP	609-5041
JHW	9-pin DB male connector	Inputs for one channel of incremental quadrature encoder feedback.	014-R00M09-ODB	AMP	747306-4

Table 6-2. PMAC-Pack Connectors - Mating Connectors

Connector Name	Mating Connector Type	Connector Function	Delta Tau Part Number	Manufacturer/ Vendor	Part Number
JRS232	DB9 (9-pin) male to DB9 (9-pin) female flat cable	Standard RS232 Interface for communication to PMAC (Non-functional when optional RRS422 interface ordered OPT-9LPP.)	014-R00M09-0DB	AMP	747306-4
JRS422	DB25 (25-pin) male to DB25 (25-pin) female flat cable	Optional RS422 Interface for communication to PMAC. (Requires PMAC-Pack OPT-9LPP)	014-R00M25-0DB	AMP	747306-2
JANA	DB15 (15-pin) male to DB15 (15-pin) female flat cable		014-R00M15-0DB	AMP	747306-3
100-240 VAC	Power cord	Connection for 100-240V ac single phase, computer used by all internal power supplies	100-017601-0PC	Beldon	17601

Note:

- All DB Connectors on the PMAC-Pack are female and all mating connectors are female.
- All DB connectors used must have a grounding plane and be screwed into the PMAC-Pack when in use.
- All cables used must be shielded with drain.
- The shield and the drain wires must be connected at terminal point of the connector.
- The closest possible chassis ground terminal must be used to ground the cable.
- All exposed wires must be kept under 5/8-inch.

PMAC-Pack Mating Connector Pinouts

This section provides the pinouts for each of the mating connectors for PMAC-Pack ports to facilitate customer manufacture of cables to meet individual requirements. PMAC-Pack is shipped with mating screw terminal blocks and a power cable. Box header and DB connectors for use in making cables may be sourced through Delta Tau, the manufacturer, or a local vendor. Delta Tau can provide pre-made cables for many of these ports if required.

Table 6-3. Encoder Terminal Block

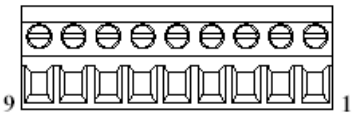
Encoder Terminal Block			Front View 	
Pin#	**Symbol**	**Function**	**Description**	**Notes**
1	GND	Common	PMAC common	
2	+5V	Output	+5V power	For encoders
3	GND	Common	Digital common	
4	CHA+	Output	Encoder A Channel positive	
5	CHA-	Output	Encoder A Channel negative	
6	CHB+	Output	Encoder B Channel positive	
7	CHB-	Output	Encoder B Channel negative	
8	CHC+	Output	Encoder C Channel positive	
9	CHC-	Output	Encoder C Channel negative	
Note: Each Axis has a 9-pin encoder terminal block. The connections for Axis 1 map to Encoder 1,Axis 2 maps to Encoder 2, etc.				

Table 6-4. Servo Terminal Block

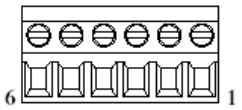
Servo Terminal Block			Front View 	
Pin#	**Symbol**	**Function**	**Description**	**Notes**
1	AGND	Common	PMAC common	
2	FLT	Input	AMP-fault	
3	AENA	Output	Amplifier enable	
4	AGND	Common	Common	
5	DAC+	Output	Analog output positive	
6	DAC-	Output	Analog output negative	
Note: Each Axis has a 6 pin SERVO terminal block. The connections for Axis 1 map to FLT1, AENA1, DAC1. Axis 2 maps to FLT2, AENA2, DAC2, etc.				

Table 6-5. Flags Terminal Block

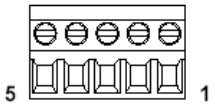
Flags Terminal Block			Front View 	
Pin#	**Symbol**	**Function**	**Description**	**Notes**
1	FRETN	Common	Flag return	
2	+12V	Output	+12V power	Only for flags
3	NEGLIM	Input	Negative end of travel limit	
4	POSLIM	Input	Positive end of travel limit	
5	HOME	Input	Home-flag	
Note: Each Axis has a 5-pin FLAGS terminal block. The connections for Axis 1 map to PMAC-Lite's +LIM1, -LIM1, HOME1, Axis 2 maps to +LIM2, -LIM2, HOME2, etc. Pins marked **NEGLIM** should be connected to switches at the **negative** end of travel. Pins marked **POSLIM** should be connected to switches at the **positive** end of travel.				

Table 6-6. JOPT Output Terminal Block

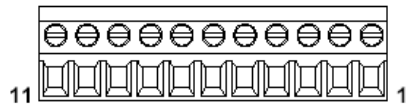
JOPT Output Terminal Block			Front View 	
Pin#	**Symbol**	**Function**	**Description**	**Notes**
1	O GND	Common	Output common	
2	+V	Input/Output	+V power I/O	+V=+5V to +24V +5V out from PMAC, +5 to +24V in from external source, Diode isolation from PMAC
3	O GND	Common	Output common	
4	MO8	Output	Machine Output 8	If sinking out, LOW=TRUE. If source out, HIGH=TRUE
5	MO7	OUTPUT	Machine Output 7	" "
6	MO6	OUTPUT	Machine Output 6	" "
7	MO5	OUTPUT	Machine Output 5	" "
8	MO4	OUTPUT	Machine Output 4	" "
9	MO3	OUTPUT	Machine Output 3	" "
10	MO2	OUTPUT	Machine Output 2	" "
11	MO1	OUTPUT	Machine Output 1	" "
Note: This connector provides means for eight general purpose outputs. Outputs may be configured to provide +5Vto +24V signals. Outputs can be made sourcing with a PMAC-Pack IC (U10 to UDN2981) and jumper (E4 & E5) change, (field configurable, or order factory OPT 14APP).				

Table 6-7. JOPT Input Terminal Block

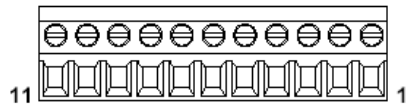
JOPT Input Terminal Block			Front View 	
Pin#	**Symbol**	**Function**	**Description**	**Notes**
1	IRET	Common	Input return	
2	IRET	Common	Input return	+V=+5V to +24V +12V to+24V in from external source when inputs sink - tie to GND for sourcing inputs.
3	IRET	Common	Input return	
4	MI8	Input	Machine input 8	If sinking out, LOW=TRUE. If source out, HIGH=TRUE.
5	MI7	Input	Machine input 7	If sinking out, LOW=TRUE. If source out, HIGH=TRUE.
6	MI6	Input	Machine input 6	If sinking out, LOW=TRUE. If source out, HIGH=TRUE.
7	MI5	Input	Machine input 5	If sinking out, LOW=TRUE. If source out, HIGH=TRUE.
8	MI4	Input	Machine input4	If sinking out, LOW=TRUE. If source out, HIGH=TRUE.
9	MI3	Input	Machine input 3	If sinking out, LOW=TRUE. If source out, HIGH=TRUE.
10	MI2	Input	Machine input 2	If sinking out, LOW=TRUE. If source out, HIGH=TRUE.
11	MI1	Input	Machine input 1	If sinking out, LOW=TRUE. If source out, HIGH=TRUE.
Note: This connector provides means for eight general purpose inputs. Inputs may be configured to accept either +12V or +24V signals. Interconnection controls whether the inputs are pulled up or down internally.				

Table 6-8. FLT Relay Terminal Block

FLT Relay Terminal Block			Front View 	
Pin#	**Symbol**	**Function**	**Description**	**Notes**
1	NC	Output	Normally closed FE/Watchdog output	See jumper E28
2	COM	Common	PMAC COMMON	
3	NO	Output	Normally open FE/Watchdog output	See jumper E28
Note: This 3 pin terminal block provides an output (either normally open, or, normally closed) for FE/Watchdog timer monitoring. Jumper E28 determines the functionality of this output.				

Table 6-9. TBAMP Terminal Block

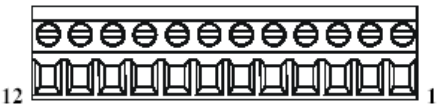
TBAMP Terminal Block				Front View 		
Pin#	**Symbol**	**Function**	**Description**	**ALT Symbol**	**ALT Function**	**ALT Description**
1	STEP 1	OUTPUT	1st Motor Pulse (ref to Step GND)	OUT1+	Output	1st motor + lead
2	DIR 1	OUTPUT	1st Motor Direction (ref to Step GND)	OUT1-	Output	1st motor - lead
3	STEP 2	OUTPUT	2nd Motor Pulse (ref to Step GND)	OUT2+	Output	2nd motor + lead
4	DIR 2	OUTPUT	2nd Motor Direction (ref to Step GND)	OUT2-	Output	2nd motor - lead
5	STEP 3	OUTPUT	3rd Motor Pulse (ref to Step GND)	OUT3+	Output	3rd motor + lead
6	DIR 3	OUTPUT	3rd Motor Direction (ref to Step GND)	OUT3-	Output	3rd motor - lead
7	STEP 4	OUTPUT	4th Motor Pulse (ref to Step GND)	OUT4+	Output	4th motor + lead
8	DIR 4	OUTPUT	4th Motor Direction (ref to Step GND)	OUT4-	Output	4th motor - lead
9	No Connect		No Connect	DB R-	Output	External shunt reg. resistor; not less than 10Ω
10	No Connect		No Connect	DB R+	Output	External shunt reg. resistor; not less than 10Ω
11	STEP GND	COMMON	Signal Return	PGND	Common	Bus Vground
12	STEP +V	INPUT	Optional Supply (+5V to +24V)	A+48V	Input	DC bus supply
Note: This terminal block provides connection of pulse and direction outputs for stepper axes or alternately for either of PMAC-Pack's internal amplifier accessories (ACC8D OPT4PP or ACC8D OPT4APP). Connection points are provided for motor leads, optional shunt regulator resistor, and amplifier power supply.						

Table 6-10. JDISP 14-Pin Connector

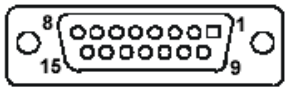
JDISP 14-Pin Connector			Front View 	
Pin#	**Symbol**	**Function**	**Description**	**Notes**
1	Vdd	OUTPUT	+5V Power	Power Supply Out
2	Rs	OUTPUT	Read Strobe	TTL Signal Out
3	E	OUTPUT	Display Enable	High is Enable
4	DB1	OUTPUT	Display Data1	TTL Signal Out
5	DB3	OUTPUT	Display Data3	TTL Signal Out
6	DB5	OUTPUT	Display Data5	TTL Signal Out
7	DB7	OUTPUT	Display Data7	TTL Signal Out
8	GND	COMMAND	PMAC Command	
9	Vss	COMMON	PMAC Common	
10	Vee	OUTPUT	Contrast Adjust Vee	0 to +5Vdc*
11	R/W	OUTPUT	Read or Write	TTL Signal Out
12	DB0	OUTPUT	Display Data0	TTL Signal Out
13	DB2	OUTPUT	Display Data2	TTL Signal Out
14	DB4	OUTPUT	Display Data4	TTL Signal Out
15	DB6	OUTPUT	Display Data6	TTL Signal Out
The JDISP connector is used to drive the 2 line x 24 character (Acc-12), 2 x 40 (Acc-12A) LCD, the 2 x 40 vacuum fluorescent (Acc 12C) display unit. It may also drive the larger 40 x 2 or 20 x 4 vacuum florescent display units (ACC12F OPT1 & OPT2) via the "large display adapter and power driver" (ACC12E). The DISPLAY command may be used to send messages and values to these displays. * *Controlled by potentiometer R3*				

Table 6-11. JPAN 26-Pin Connector

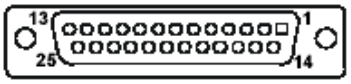
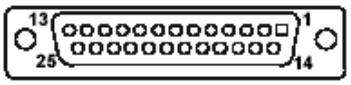
JPAN 26-Pin Connector			Front View 	
Pin#	**Symbol**	**Function**	**Description**	**Notes**
1	+5V	OUTPUT	+5V Power	For remote panel
2	FPD0/	INPUT	Motor/C.S. Select Bit 0	Low is true
3	FPD1/	INPUT	Motor/C.S. Select Bit 1	Low is true
4	PREJ/	INPUT	Return to PREJOG Position	Low is "return" Equiv to "J=" CMD
5	STEP/	INPUT	Step Through Program	Low is "step" equiv to "S" or "Q"
6	HOME/	INPUT	Home Search Command	Low is "go home" Equiv to "HM"
7	FPD2/	INPUT	Motor/C.S. Select Bit 2	Low is true
8	INIT/	INPUT	Reset PMAC	Low is "reset" equiv to "$$$"
9	IPLD/	OUTPUT	In Position Ind. (CS)	Low lights led
10	ERLD/	OUTPUT	Fatal Follow Error (CS)	Low lights led
11	(SPARE)	NC		
12	F1LD/	OUTPUT	Warn Follow Error (CS)	Low lights led
13	+5V	OUTPUT	+5V Power	For remote panel
14	GND	COMMON	PMAC Common	
15	JOG-/	INPUT	Jog IN - DIR	Low is "jog -"
16	JOG+/	INPUT	Jog IN + DIR.	Low is "jog +"
17	STRT/	INPUT	Start Program Run	Low is "start" equiv to "R CMD
18	STOP/	INPUT	Stop Program Run	Low is "stop" equiv to "A
19	HOLD/	INPUT	Hold Motion	Low is "hold" equiv to "H"
20	FPD3/	INPUT	Motor/C.S. Select Bit 3	Low is true
21	HWCA	INPUT	Handwheel Encoder A Channel	5V TTL SQ. Pulse must use E23 (CHA2)
22	BRLD/	OUTPUT	Buffer Request Ind.	Low lights LED
23	WIPER	INPUT	Feed Pot Wiper	0 TO10V input must use E72, E73 (CHA4)
24	HWCB	INPUT	Handwheel Encoder B Channel	5V TTL SQ. pulse must use E22 (CHB2)
25	F2LD/	OUTPUT	Watchdog Timer	Low lights LED
The JPAN connector can be used to connect the Accessory 16 (Control Panel), or customer-provided I/O, to the PMAC, providing manual control of PMAC functions via simple toggle switches. If the automatic control panel input functions are disabled (I2=1), the inputs become general-purpose TTL inputs, and the coordinate system (CS) specific outputs pertain to the host-addressed coordinate system.				

Table 6-12. JTHW 26-Pin Connector

JTHW 26-Pin Connector

Front View



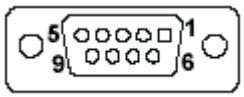
Pin#	Symbol	Function	Description	Notes
1	GND	COMMON	PMAC Common	
2	DAT0	INPUT	Data-0 Input	Data input from thumbwheel switches
3	DAT1	INPUT	Data-1 Input	Data input from thumbwheel switches
4	DAT2	INPUT	Data-2 Input	Data input from thumbwheel switches
5	DAT3	INPUT	Data-3 Input	Data input from thumbwheel switches
6	DAT4	INPUT	Data-4 Input	Data input from thumbwheel switches
7	DAT5	INPUT	Data-5 Input	Data input from thumbwheel switches
8	DAT6	INPUT	Data-6 Input	Data input from thumbwheel switches
9	DAT7	INPUT	Data-7 Input	Data input from thumbwheel switches
10	NC	NC	No Connection	
11	BRLD/	OUTPUT	Buffer Request	Low is "buffer req."
12	IPLD/	OUTPUT	In Position	Low is "in position"
13	+5V	OUTPUT	+5Vdc Supply	Power supply out
14	GND	COMMON	PMAC Common	
15	SEL0	OUTPUT	Select-0 Output	Scanner output for reading TW switches
16	SEL1	OUTPUT	Select-1 Output	Scanner output for reading TW switches
17	SEL2	OUTPUT	Select-2 Output	Scanner output for reading TW switches
18	SEL3	OUTPUT	Select-3 Output	Scanner output for reading TW switches
19	SEL4	OUTPUT	Select-4 Output	Scanner output for reading TW switches
20	SEL5	OUTPUT	Select-5 Output	Scanner output for reading TW switches
21	SEL6	OUTPUT	Select-6 Output	Scanner output for reading TW switches
22	SEL7	OUTPUT	SELECT-7 OUTPUT	Scanner output for reading TW switches
23	GND	COMMON	PMAC Common	
24	GND	COMMON	PMAC Common	
25	GND	COMMON	PMAC Common	

The JTHW connector provides 8 inputs and 8 outputs at TTL levels; these are dedicated to reading BCD thumb wheel switches. Two thumb wheels may be read by direct connection to J3, more thumb wheels, up to 512 switches, may be read using the ACC-18 (Thumb wheel Multiplexer). J3's inputs and outputs may be used as general purpose multiplexed TTL I/O, if thumb wheels are not used.

Table 6-13. JRS232 DB9 Connector

JRS232 DB9 Connector

Front View



Pin#	Symbol	Function	Description	Notes
1	PHASE	IN OR OUT	Phasing Clock	Out on @0; else in *
2	TXD/	INPUT	Receive Data	Host transmit data
3	RXD/	OUTPUT	Send Data	Host receive data
4	DSR	BIDIRECT	Data Set Ready	Tied to "DTR"
5	GND	COMMON	PMAC Common	
6	DTR	BIDIRECT	Data Term Ready	Tied to "DSR"
7	CTS	INPUT	Clear To Send	Host ready bit
8	RTS	OUTPUT	Req. To Send	PMAC ready bit
9	SERVO	IN OR OUT	Servo Clock	Out on @0; else in *

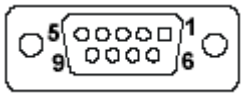
Note: The JRS232 connector provides the PMAC-Pack with the ability to communicate serially with an RS232 port. In addition, this connector is used to daisy chain interconnect multiple PMAC-Pack's for synchronized operation.

* These pins are for synchronizing multiple PMACs together by sharing their phasing and servo clocks. The PMAC designated as card 0 (@0) by its switches S1-S4, outputs its clock signals. Other PMACs designated as cards 1-15 (@1- @F) by their switches S1-S4 take these signals as inputs. If synchronization is desired, these lines should be connected even if serial communications is not used.

Table 6-14. JRS422 DB25 Connector

JRS232 DB9 Connector

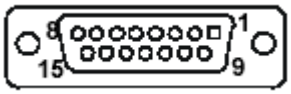
Front View



Pin#	Symbol	Function	Description	Notes
1	CHASSIS	GROUND	Chassis Ground	
2	RD-	INPUT	Receive Data	Diff. I/O low true **
3	SD-	OUTPUT	Send Data	Diff. I/O low true **
4	CS+	INPUT	Clear To Send	Diff. I/O high true **
5	RS+	OUTPUT	Req. To Send	Diff. I/O high true **
6	DTR	BIDIRECT	Data Term Read	Tied to "DSR"
7	GND	COMMON	PMAC Common	**
8	SDIO-	BIDIRECT	Special Data	Diff. I/O low true
9	SCIO-	BIDIRECT	Special Ctrl.	Diff. I/O low true
10	SCK-	BIDIRECT	Special Clock	Diff. I/O low true
11	SERVO-	BIDIRECT	Servo Clock	Diff. I/O low true ***
12	PHASE-	BIDIRECT	Phase Clock	Diff. I/O low true ***
13	GND	COMMON	PMAC Common	
14	S+5V	OUTPUT	+5Vdc Suuply	Deactivated by "E8"
15	RD+	INPUT	Receive Data	Diff. I/O high true *
16	SD+	OUTPUT	Send Data	Diff. I/O high true *
17	CS-	INPUT	Clear To Send	Diff. I/O low true *
18	RS-	OUTPUT	Req. To Send	Diff. I/O low true *
19	INIT/	INPUT	PMAC Reset	Low is "reset"
20	DSR	BIDIRECT	Data Set Ready	Tied to "DTR"
21	SDIO+	BIDIRECT	Special Data	Diff. I/O high true
22	SCIO+	BIDIRECT	Special Ctrl	Diff. I/O high true
23	SCK+	BIDIRECT	Special Clock	Diff. I/O high true
24	SERVO+	BIDIRECT	Servo Clock	Diff. I/O high true ***
25	PHASE+	BIDIRECT	Phase Clock	Diff. I/O high true ***

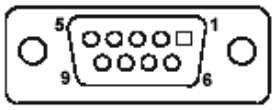
* Required for communications to an RS-422 host port
** Required for communications to an RS-422 or RS-232 host port.
*** Output on card @0; input on other cards. These pins are for synchronizing multiple PMACs together by sharing phasing and servo clocks. The PMAC designated as card 0 (@0) by jumpers E40-E43 outputs clock signals. Other PMACs designated as cards 1-15 (@1-@F) by jumpers E40-E43 take these signals as inputs. If synchronization is desired, these lines should be connected even if serial communications is not used.

Table 6-15. JANA DB15 Connector

JANA DB15 Connector			Front View 	
Pin#	**Symbol**	**Function**	**Description**	**Notes**
1	ADC1	INPUT	1st Chan. Main Inp.	1
2	ADC2	INPUT	2nd Chan. Main Inp.	1
3	ADC3	INPUT	3rd Chan. Main Inp.	1
4	ADC4	INPUT	4th Chan. Main Inp.	1
5	AGND	COMMON	Analog Ground	3
6	AGND	COMMON	Analog Ground	3
7	A+15V	INPUT/ OUTPUT	Analog Pos Supply	3,4
8	NC			
9	ADC1/	INPUT	1st Chan. Comp. Inp.	2
10	ADC2/	INPUT	2nd Chan. Comp. Inp.	2
11	ADC3/	INPUT	3rd Chan. Comp. Inp.	2
12	ADC4/	INPUT	4th Chan. Comp Inp.	2
13	AGND	COMMON	Analog Ground	3
14	AGND	COMMON	Analog Ground	3
15	A-15V	INPUT/OUPUT	Analog Neg Supply	3,4

Note: This connector is provided for use with PMAC-Pack's optional 4-channel A/D converter, Accessory 28APP. If Acc. 28APP is ordered, this connector may be used to provide the input connections for the analog signals. The connector also provides inputs for a)15 V supply which may be used for isolation of the analog inputs.
Note 1: Range is -10V to +10V if single-ended; -5V to +5V if differential.
Note 2: If using single-ended inputs, it is advisable to tie these pins to AGND for increased noise immunity. If using differential inputs, the differential return should be connected.
Note 3: As standard, an isolated supply must be connected to JANA for isolation of the analog inputs (PMAC-Pack backplane jumpers E1, E2, and E3 are not jumped). By jumping E1, E2, and E3, isolation may be bypassed and PMAC-Pack's internal 15 V supply used by the analog inputs.
Note 4: Valid power supply range is)12V to)15V.

Table 6-16. J8 JHW 9-Pin Header

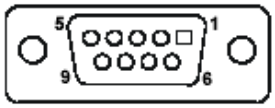
J8 JHW 9-Pin Header			Front View 	
Pin#	**Symbol**	**Function**	**Description**	**Notes**
1	HWCHA+	INPUT	Encoder A Chan. Pos.	H.P standard
2	GND	COMMON	Digital Common	H.P standard
3	HWCHB-	INPUT	Encoder B Chan. Neg.	Added
4	+5V	OUTPUT	Power Supply	H.P standard
5	+5V	OUTPUT	Power Supply	H.P standard
6	+5V	OUTPUT	Power Supply	H.P standard
7	HWCHA-	INPUT	Encoder A Chan. Neg.	Added
8	GND	COMMON	Digital Common	H.P standard
9	HWCHB+	INPUT	Encoder B Chan. Pos.	H.P standard

This connector is provided for use with PMAC-Pack's optional Handwheel Encoder Input (5th Encoder channel), Accessory 39PP. If Acc. 39PP is ordered, this connector may be used to interface the encoder inputs. This connector will be present but inoperative in PMAC-Packs ordered less ACC 39PP.

Table 6-17. J8 JEQU 10-Pin Header

J8 JEQU 10-Pin Header

Front View



Pin#	Symbol	Function	Description	Notes
1	EQU1/	OUTPUT	Enc 1 Comp EQU	Low is true
2	EQU2/	OUTPUT	Enc 2 Comp EQU	Low is true
3	EQU3/	OUTPUT	Enc 3 Comp EQU	Low is true
4	EQU4/	OUTPUT	Enc 4 Comp EQU	Low is true
5	AENA1/	OUTPUT	Amp 1 Enable/Dir	Low is true
6	AENA2/	OUTPUT	Amp 2 Enable/Dir	Low is true
7	AENA3/	OUTPUT	Amp 3 Enable/Dir	Low is true
8	AENA4/	OUTPUT	Amp 4 Enable/Dir	Low is true
9	A+V	INPUT	Flag Supply Volt	
10	AGND	COMMON	Analog/Flag Common	

This connector (found on the PMAC-LITE card) brings out the 4 compare-equal and 4 Amplifier-Enable signals associated with PMAC-Lite's channels 1 to 4. In addition, the A+V supply (+12V to +24V) for motor flags 1 to 4 may be brought in through this connector (with PMAC-Lite E89 OFF, and E90 connecting pins 1 to 2). This connector is seldom necessary, however when it is necessary to gain access to these signals, a short ribbon cable should be strung through the expansion port on the side of PMAC-PACK and connected to PMAC-Lite.

CIRCUIT DIAGRAMS

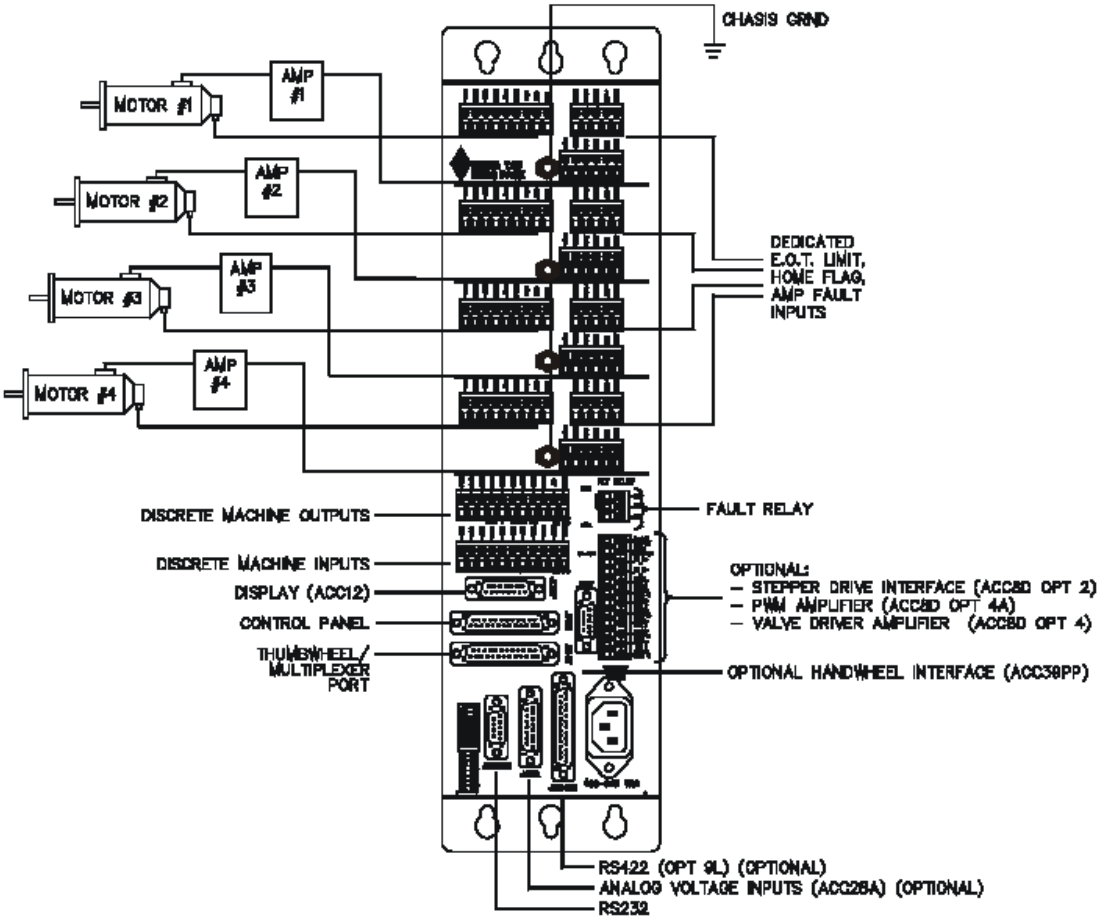


Figure 7-1. PMAC-Pack System Connections (Basic Non-Commutated System)

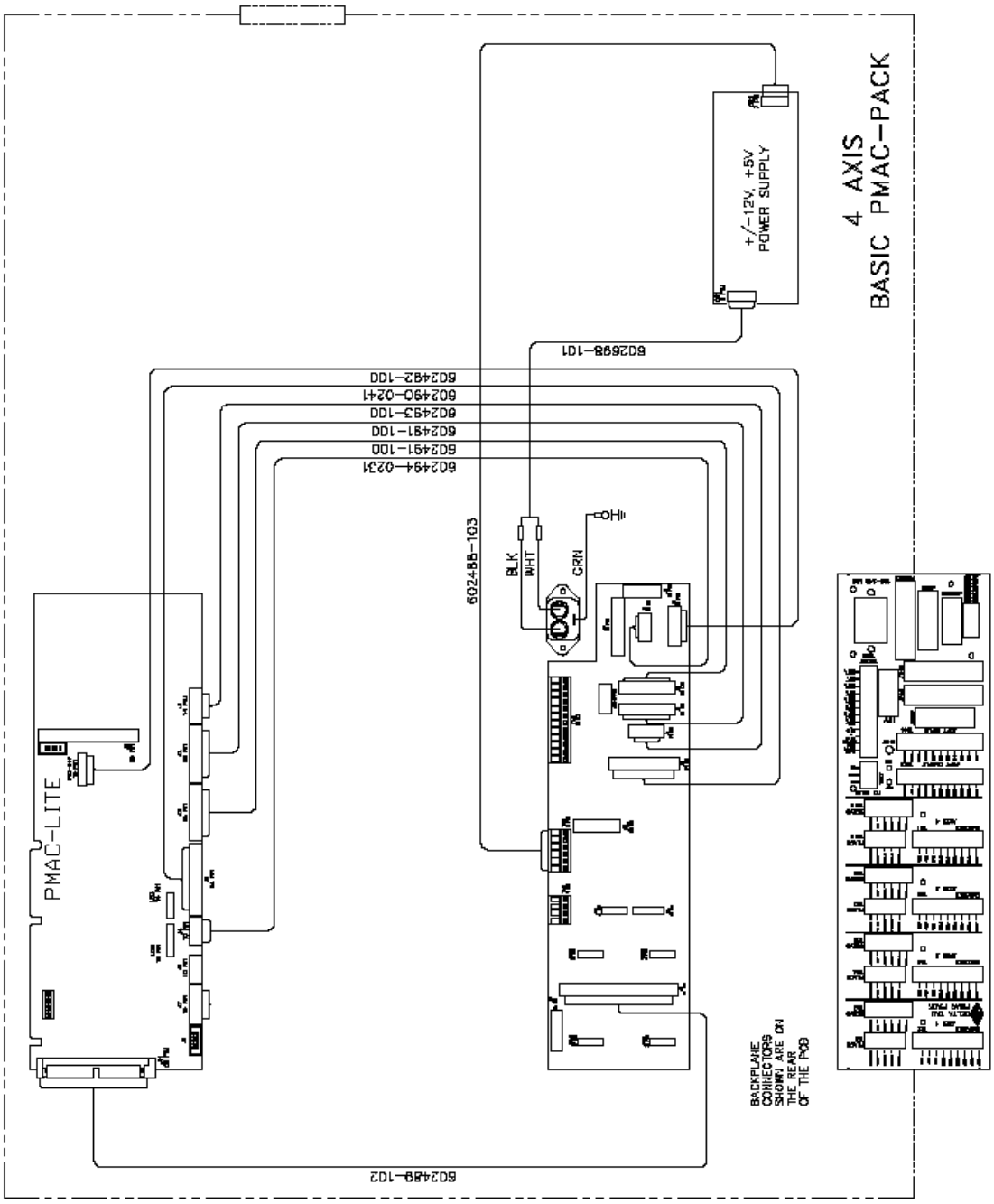


Figure 7-2. Basic PMAC-Pack Wiring Diagram

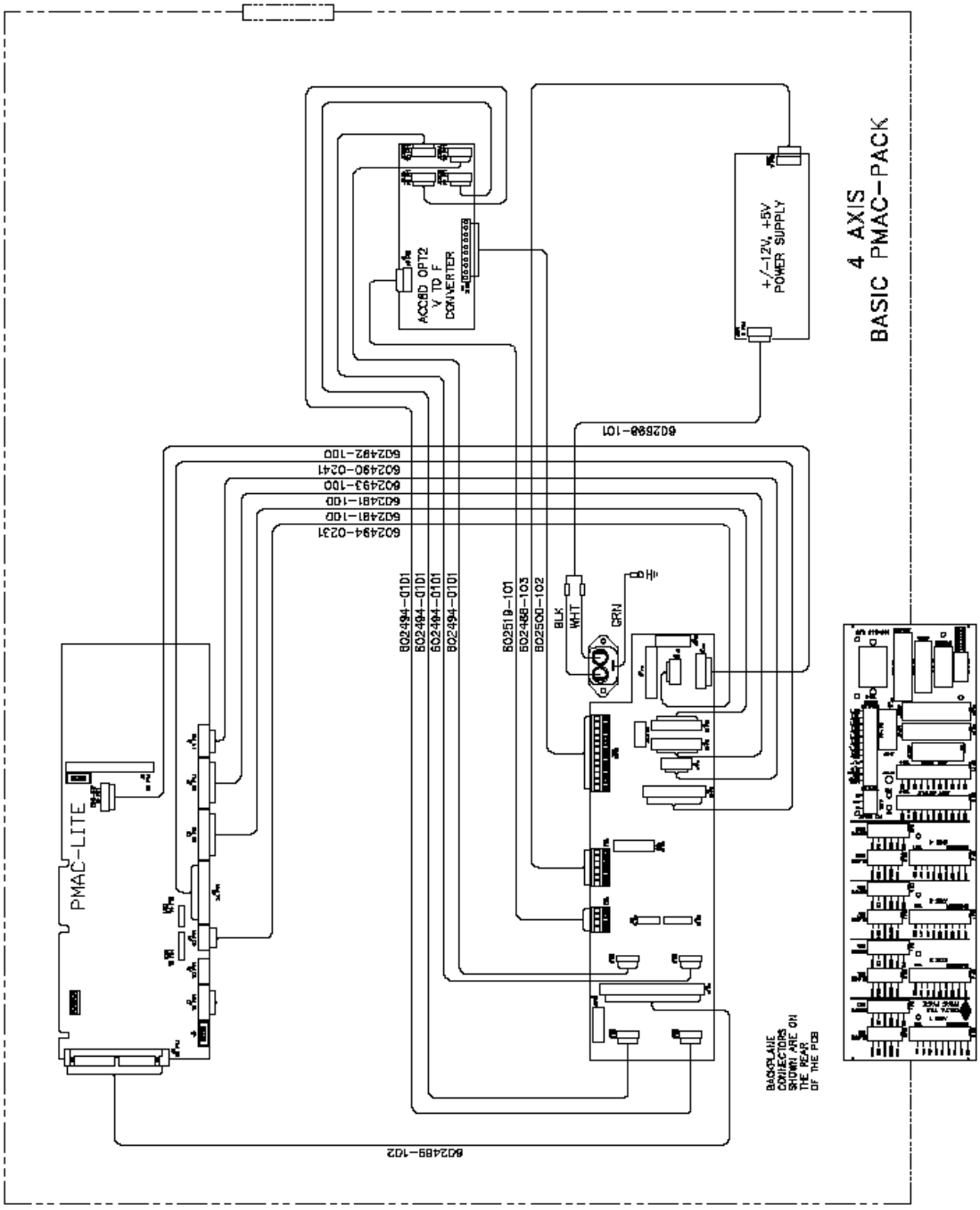


Figure 7-3. PMAC-Pack with Accessory 8D Option 2 Wiring Diagram

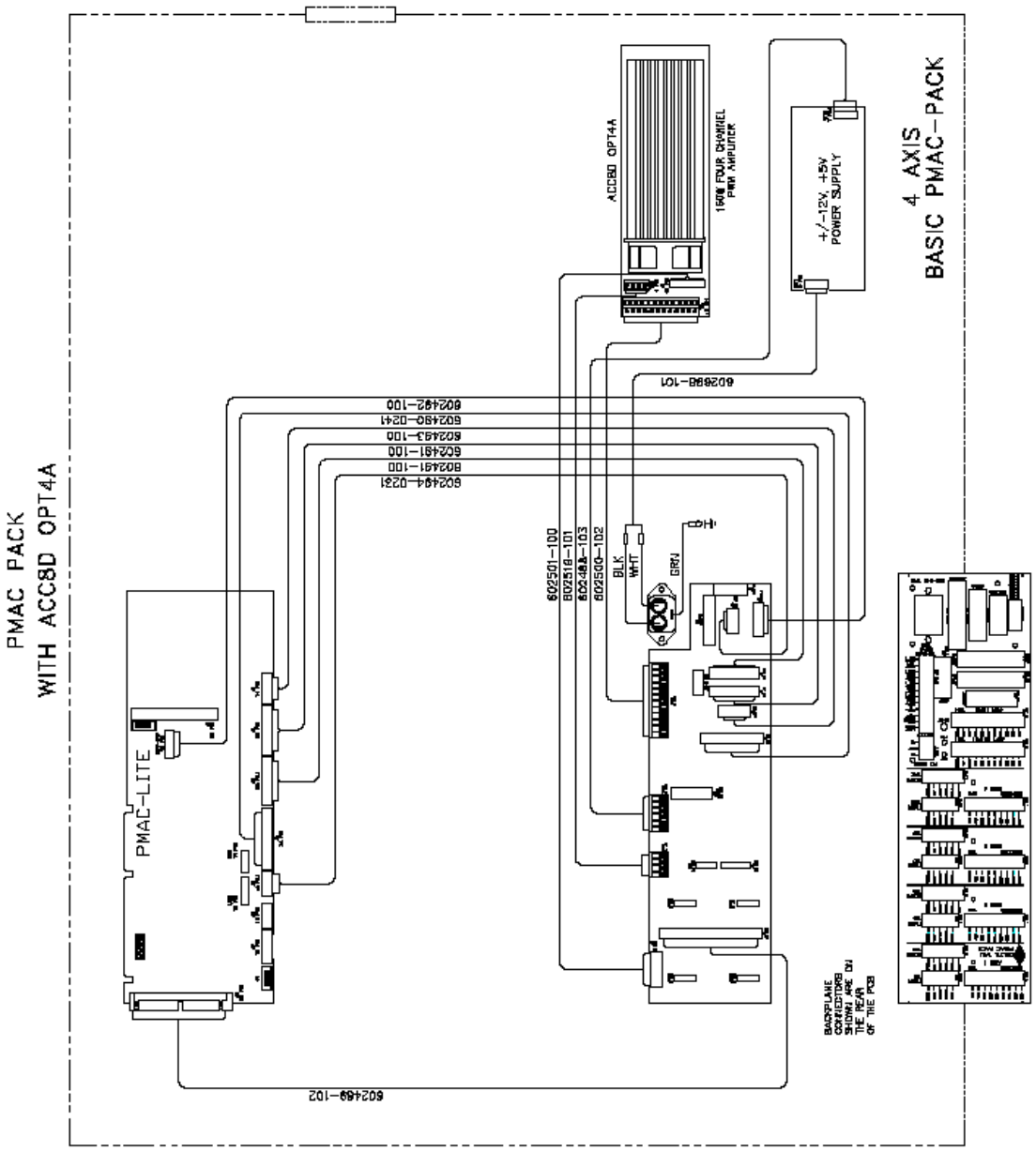


Figure 7-4. PMAC-Pack with Accessory 8D Option 4A Wiring Diagram

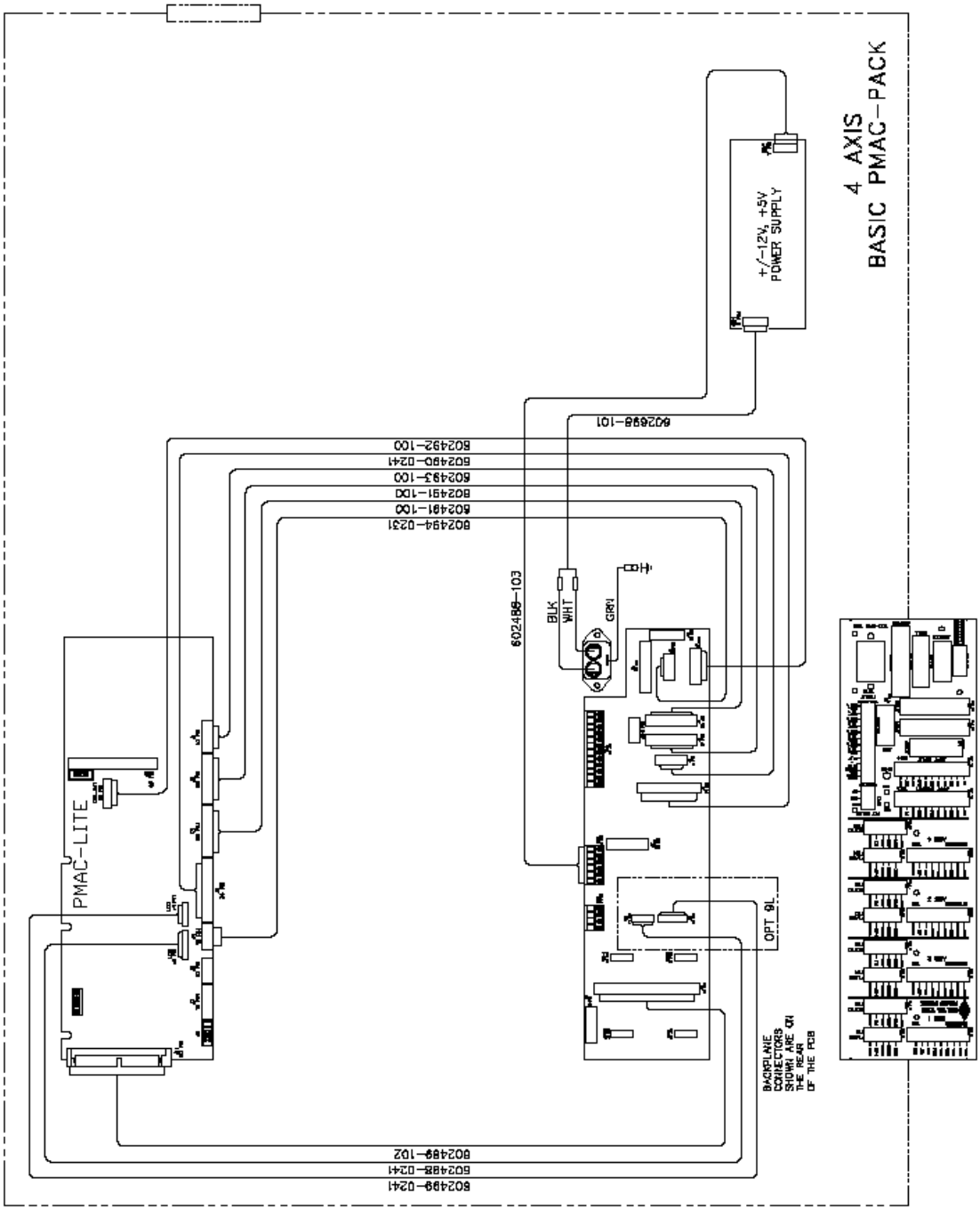


Figure 7-5. PMAC-Pack with Option 9L Wiring Diagram

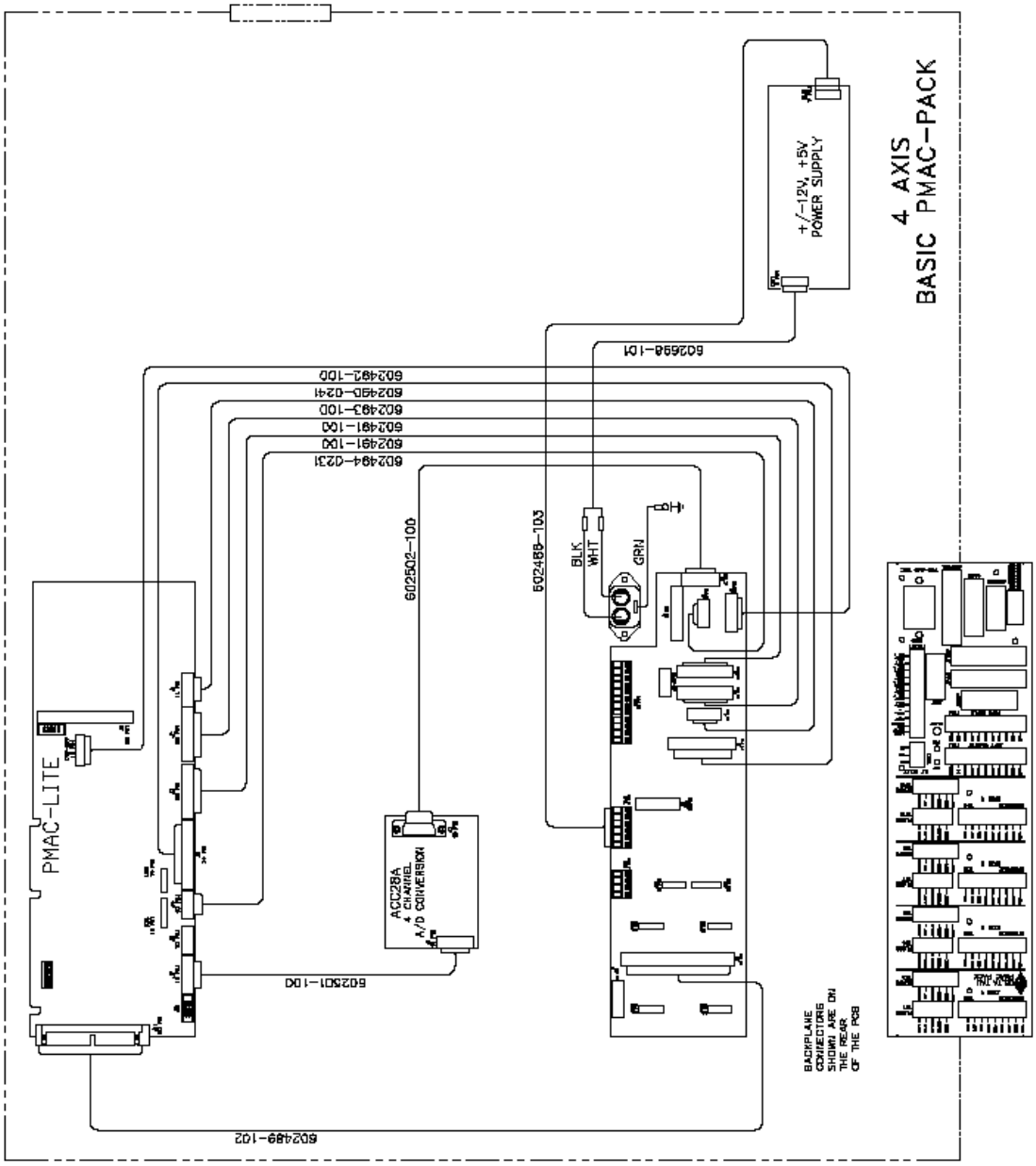


Figure 7-6. PMAC-Pack with Accessory 28A Wiring Diagram

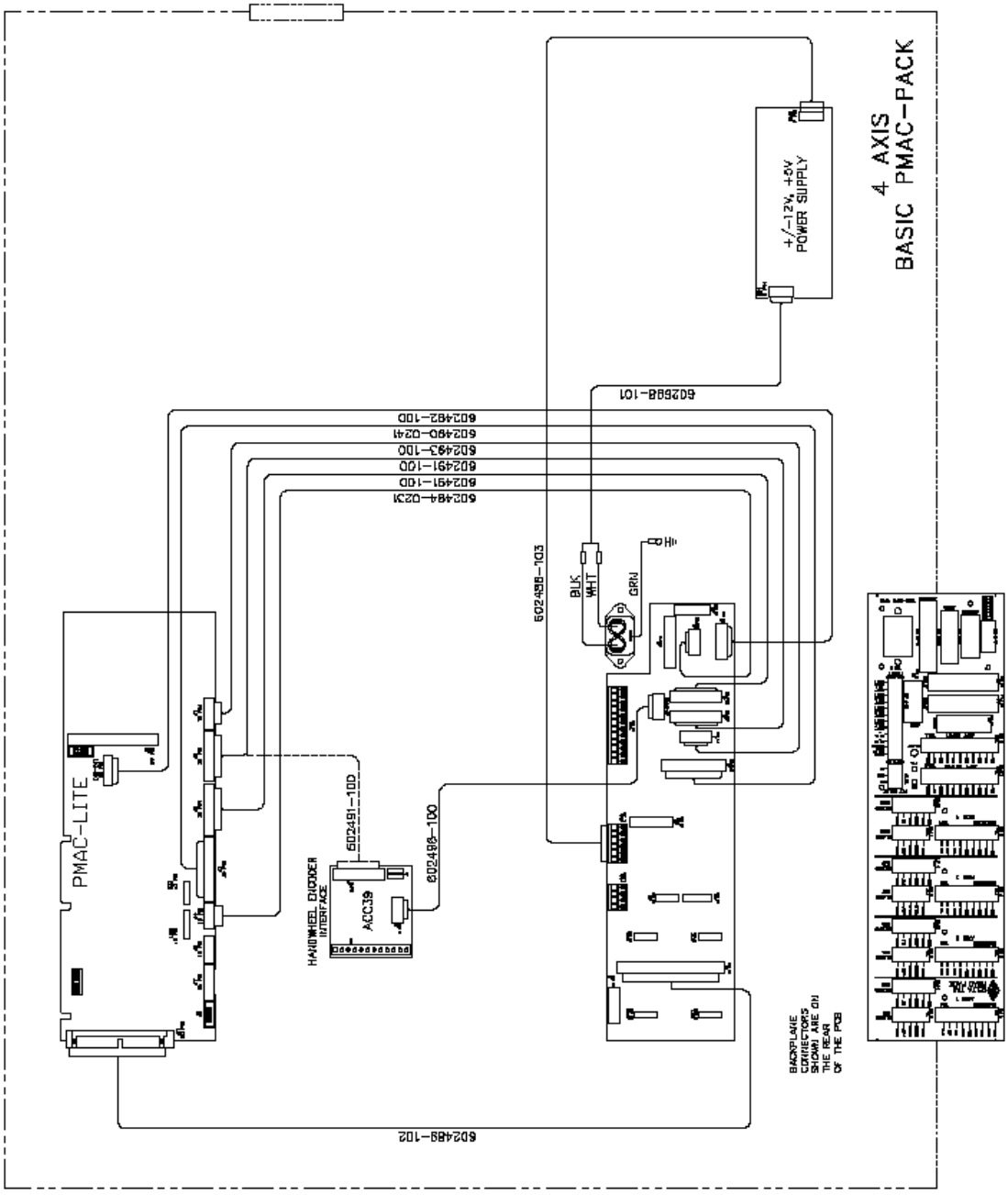


Figure 7-7. PMAC-Pack with Accessory 39 Wiring Diagram

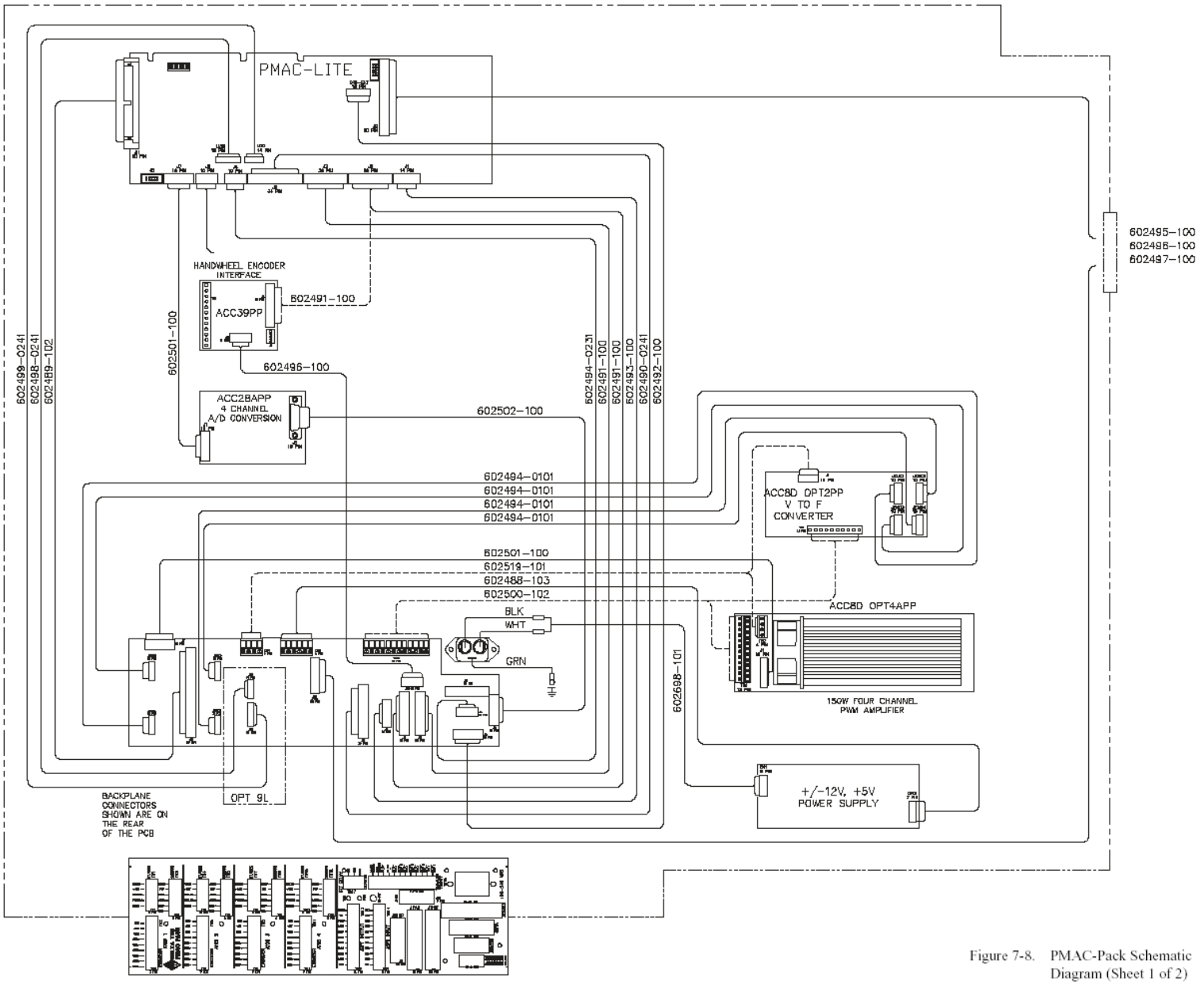


Figure 7-8. PMAC-Pack Schematic Diagram (Sheet 1 of 2)

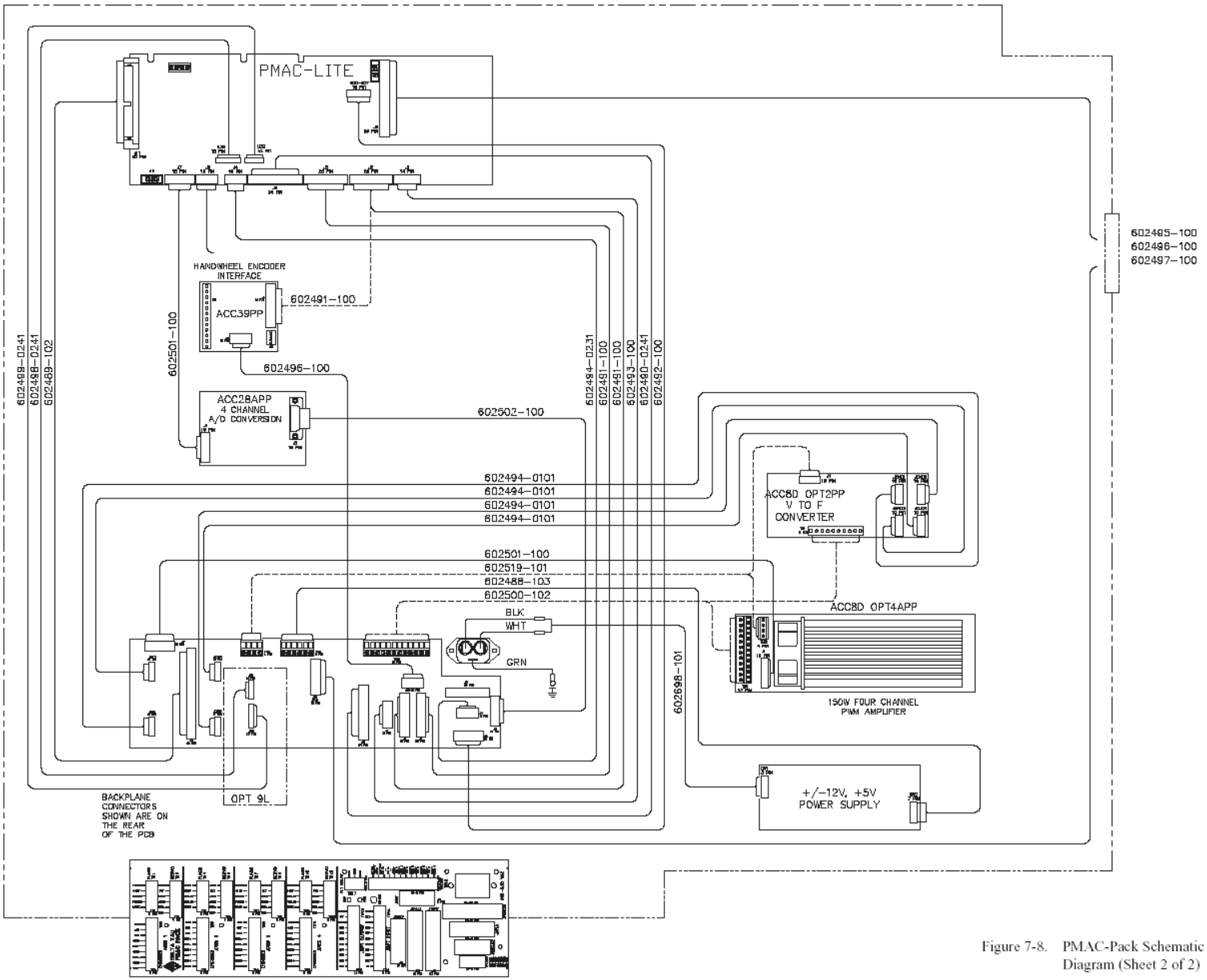


Figure 7-8. PMAC-Pack Schematic Diagram (Sheet 2 of 2)

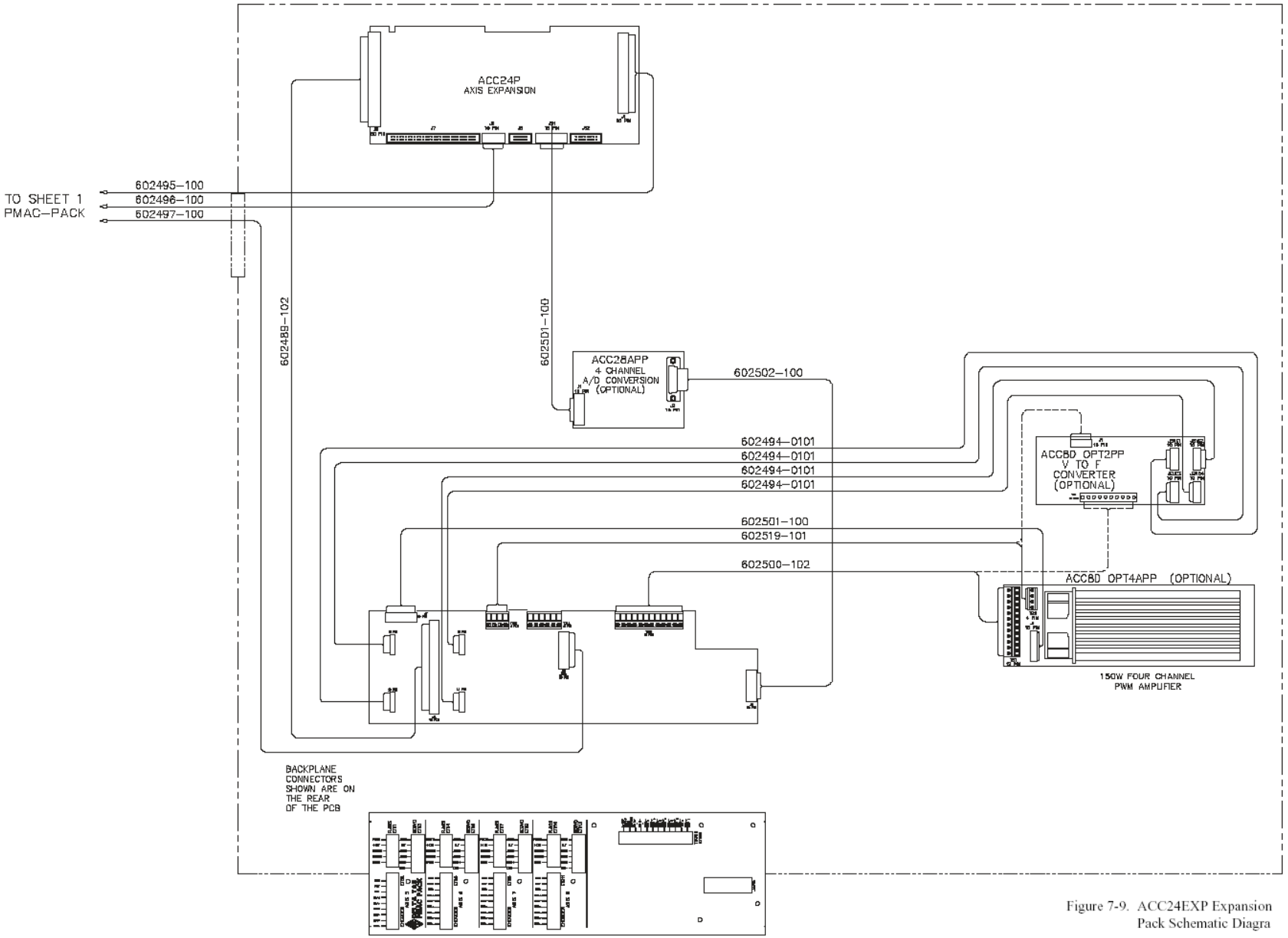


Figure 7-9. ACC24EXP Expansion Pack Schematic Diagra

ACC24E ACC24EXP EXPANSION XP PACK

Expansion Pack Installation

The ACC24 PMAC-Pack Expansion Pack provides four additional encoder channels and four additional DAC output channels, allowing the PMAC-Pack to control up to eight non-commutated axes.

PMAC-Pack Disassembly

It is necessary to disassemble the PMAC-Pack to connect the three Expansion Pack cables through the JEXP port. The following 4 steps serve as a guide to the disassembly of the PMAC-Pack (see Figure 8-1).

Note:

Eight axis PMAC-Packs are hardware configured at the Delta Tau Data Systems factory with the ACC24 PMAC-Pack Expansion Pack, allowing you to skip the Software Setup paragraph below.

STEP #1 - Remove three screws securing the metal plate to the right side of the PMAC-Pack, remove the plate, and install the plate on the right side of the expansion pack. Install the plastic grommet supplied with the Expansion Pack in the JEXP portal of the PMAC-Pack to protect the cables.

STEP #2 - Remove the eight (8) screws securing the two halves of the PMACPack sheet metal together.

STEP #3 - Pull the front of the PMAC-Pack case slightly forward, and rotate it to the left, exposing the interior of the unit.

STEP #4 - Remove the 3 mounting screws securing the PMAC-Lite motion control card as shown. PMAC-Lite is then free to swivel outward, exposing the component side of the card.

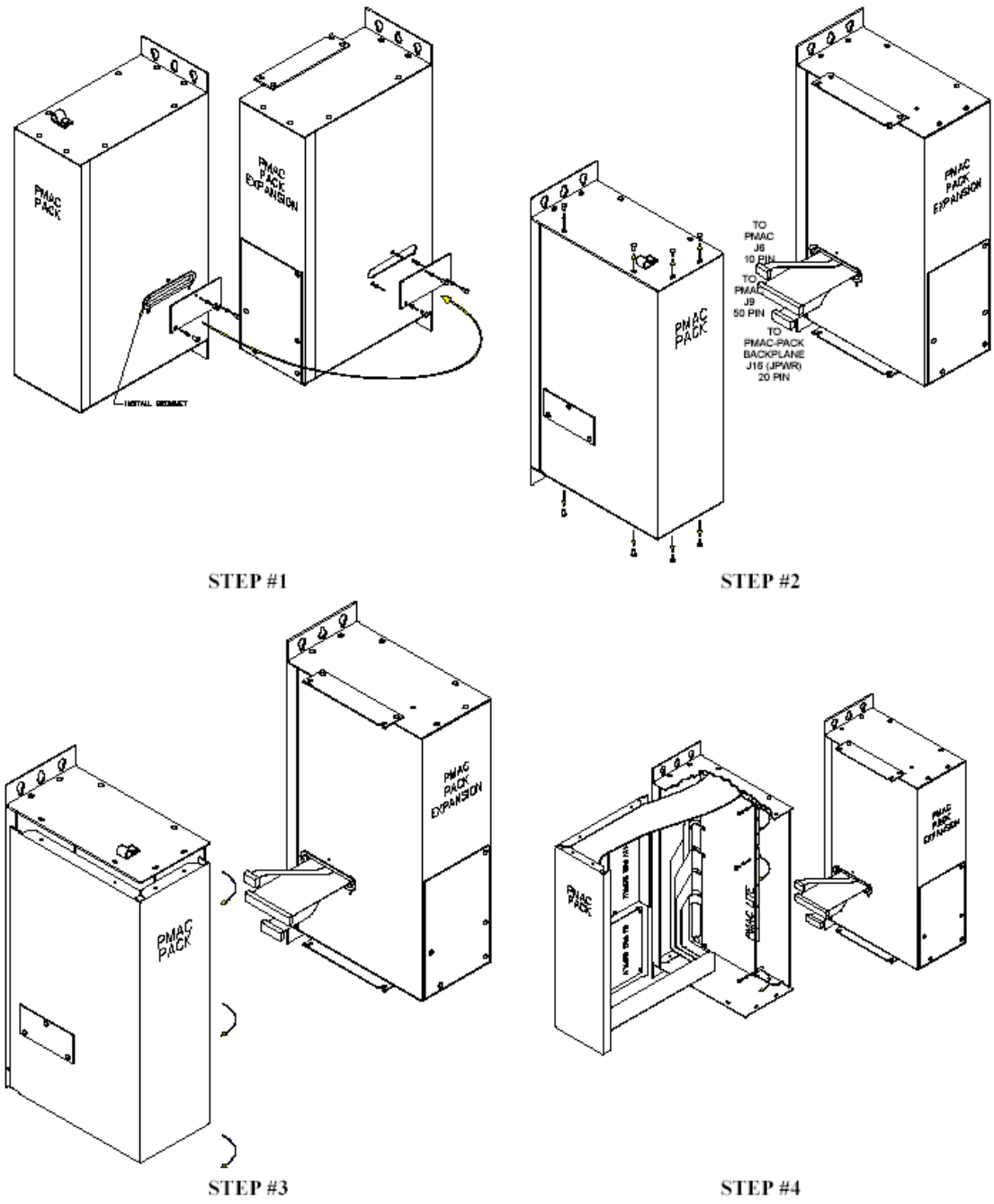


Figure 8-1. Expansion Pack Installation

PMAC-Pack/Expansion Pack Connection

The field connection of PMAC-Pack and the ACC24EXP Expansion Pack is accomplished by linking the two together through the PMAC-Pack JEXP port, located under a metal plate on the right side of the case. Hardware setup of the eight-axis PMAC-Pack is accomplished by connecting three cables through the JEXP port and securing the two cases together.

Note:

Eight axis PMAC-Packs are hardware configured at the Delta Tau Data Systems factory with the ACC24 PMAC-Pack Expansion Pack, allowing you to skip the Software Setup paragraph below.

The following paragraph describes how to internally connect the Expansion Pack to the PMAC-Pack (see Figure 8-2).

- Insert the three cables from the Expansion Pack through the PMAC-Pack JEXP portal and make the following connections:
- Connect the 10-pin ribbon cable with lines 1 through 6 removed (supplied) to the PMAC-Lite card J6 connector.
- Connect the 50-pin ribbon cable to the PMAC-Lite card J9 (JEXP) connector. This is the expansion pack/PMAC-Lite DSP microprocessor interface.
- Connect the 20-pin ribbon cable to the PMAC-Pack backplane J16 connector. This is the +5V and)12V power interface.

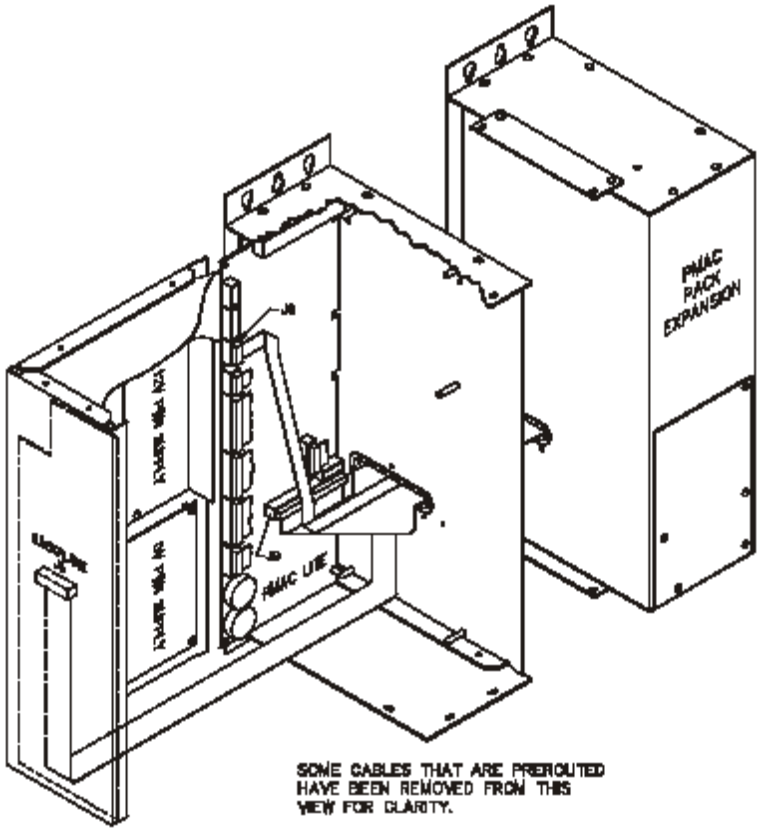


Figure 8-2. PMAC-Pack/Expansion Pack Internal Connections

PMAC-Pack/Expansion Pack Re-assembly

After connecting the cables inside the PMAC-Pack, perform steps 1 through 4 to reassemble the PMAC-Pack and Expansion Pack (see Figure 8-3).

STEP #1 - Rotate the PMAC-Lite card on its hinges until it is flush against the case standoffs. Insert the three mounting screws to secure PMAC-Lite to the case. Check that all internal connections are secure.

STEP #2 - Fold the left half of the PMAC-Pack casing into the right. First insert the rear lip of the left half into the back of the case. Rotate the left half of the case until it is flush with the right. You may need to pull the left halve slightly forward to clear the front right lip.

STEP #3 - Insert eight sheet-metal screws as shown to secure the left and right halves of the casing together. Leave the top and bottom screws on the right side of the PMAC-Pack loose.

STEP #4 - Slide the PMAC-Pack and Expansion Pack together, insuring the slots in the top and bottom brackets on the Expansion Pack slide under the PMAC-Pack screws. Any excess cable length should be carefully inserted into the expansion Pack. Tighten the four PMAC-Pack screws.

PMAC-Pack/Expansion Pack Software Setup

The following steps will configure the PMAC-Pack software to activate and utilize Expansion Pack axes 5 through 8. These steps are necessary because the Expansion Pack adds hardware interface channels (encoders, DACs, and flags) numbered 9 through 12, which must be mapped to motors 5 through 8.

Note:

As of February 1997, all PMAC-Packs are factory configured to use the expansion pack. This section should be read to gain a clearer understanding of the Expansion Pack, however, Delta Tau has preconfigured the software to control non-commutated axes connected to the Expansion pack.

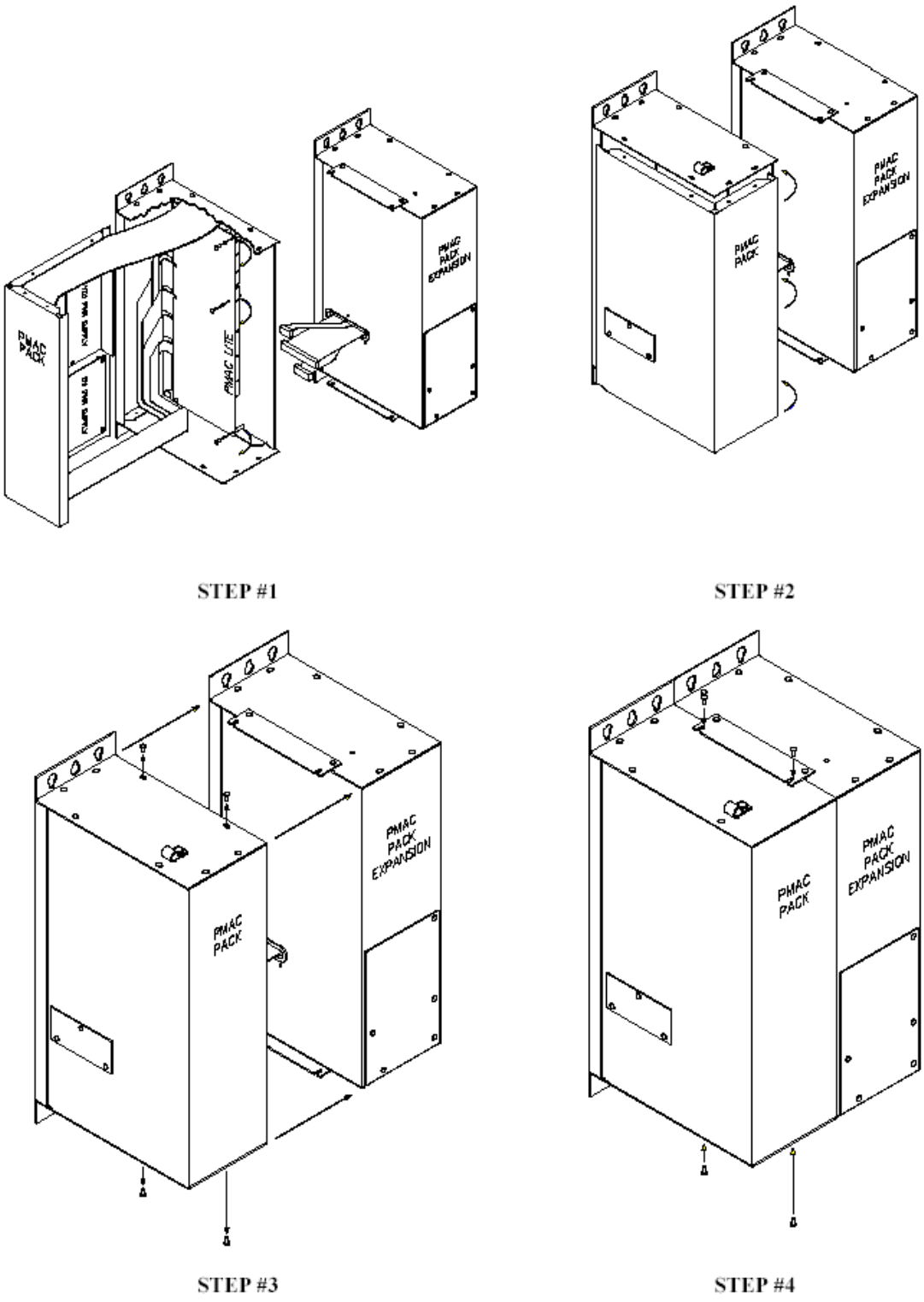


Figure 8-3. PMAC-Pack Assembly

Encoder Conversion Table Setup

To read encoders interfaced into the Expansion Pack, PMAC's encoder conversion table must be set up to read and process the encoder signals. To set up the Encoder Conversion Table, use the PMAC Executive's menu-based encoder table setup, which is accessed from the **CONFIGURE** menu. For entries 5 through 8, change the **SOURCE ADDRESS** to encoders 9 through 12. When finished, your table should look as follows:

Entry	Address	Y-Word (Source Address)	Conversion Method
1	Y:$720	$00C000	1/T extension of encoder 1 at $C000
2	Y:$721	$00C004	1/T extension of encoder 2 at $C004
3	Y:$722	$00C008	Q
4	Y:$723	$00C00C	1/T extension of encoder 4 at $C00C
5	Y:$724	$00C020	1/T extension of encoder 9 at $C020
6	Y:$725	$00C024	1/T extension of encoder 10 at $C024
7	Y:$726	$00C028	1/T extension of encoder 11 at $C028
8	Y:$727	$00C02C	1/T extension of encoder 12 at C02C

Once the encoder conversion table is set, the encoder setup for axes 5 through 8 is completed. The factory default settings for Ix03, Ix04, and Ix05 will now apply for encoder-to-axis feedback mapping.

Motor Output Command Setup

The Ix02 variable in PMAC is used to tell PMAC where (what address) to map the output command for motor x. The outputs for axes 5 through 8 must be mapped into DACs 9 through 12.

For non-commutated axes ()10V torque or velocity output commands) set:

- I502 = $C023 (DAC 9)
- I602 = $C022 (DAC 10)
- I702 = $C02B (DAC 11)
- I802 = $C02A (DAC 12)

For commutated axes (2 sinusoidal phase output commands per axis) set:

- Ix02 = $C022 (DACs 9 and 10)
- Ix02 = $02A (DACs 11 and 12)

Flag Input Command Setup

The Ix25 variable is used by PMAC to determine what set of inputs it will look to for motor x's overtravel limit switches, home flag, amplifier-fault flag, and amplifier enable output. Typically, these are the flags associated with an encoder input; specifically those of the position feedback encoder for the motor. It is necessary to reassign the Ix25 variables for motors 5 through 8 to correspond to the flag set associated with encoders 9 through 12. Flag source address settings are as follows:

- LIM9, HMFL 9,…$C020
- LIM10, HMFL 10,…$C024
- LIM11, HMFL11,…$C028
- LIM12, HMFL12,…$C02C

A typical Ix25 setup for non-commutated motors 5 through 8 is as follows:

- I525 = $C020
- I624 = $C024
- I725 = $C028
- I825 = $C02C

Phasing Position Address Setup

If you are using the PMAC Expansion Pack to interface motors commutated by PMAC, the Ix83 variable setup must be adjusted. Ix83 is the parameter which tells PMAC which register to get its commutating information from for motor x on an ongoing basis. When using the PMAC-Pack and Expansion Pack, Ix83 should be modified as follows:

Commutated Motor X	HEX	Decimal	Encoder #
Ix83	$C021	49185	Encoder 9
Ix83	$C025	49189	Encoder 10
Ix83	$C029	49193	Encoder 11
Ix83	$C02D	49197	Encoder 12

Example: If you wish to use PMAC to commutate motor **5**, set I**5**83 = #C021. This will map the encoder hardware interface channel 9 ($C021) to motor 5.

PMAC-PACK OPTIONS AND ACCESSORIES

PMAC-Pack Internal Options & Accessories

ACC8D-Option 2PP: Stepper Drive Interface

This option provides 4 voltage-to-frequency (V/F) converters for commanding stepper motor drive systems. These convert PMAC's analog output for each channel to a pulse output. The pulse output can be jumpered back to PMAC's encoder input for the motor if the system is to be run open loop, or an actual encoder can be used for true closed-loop servo control. The maximum frequency is selectable from 10KHz to 2MHz. Both servo and stepper axes can be used together allowing combinations of both motor types, up to a total of 4 motors, to be controlled.

This option is a small, separate board which is internally mounted and connected within the PMAC-Pack when the option is ordered. Interface to the stepper amp is via the] TBOUT connector. Expanded documentation for ACC8D-OPT2PP is currently under development. At present, request the ACC8D-OPT2 manual for further information.

ACC8D-Option 4PP: Hydraulic Valve Driver

Provides four low-power current-loop (transconductance) amplifier circuits for driving hydraulic valves or very small DC motors. Each of the linear amplifier circuits is rated at 40W continuous output. This option is a small, separate, internally mounted, PC Board with a built-in heat sink and fan. One of three maximum current settings can be jumper selected: 100, 200, or 2000 mA. A voltage mode provides a proportional voltage output, with a peak current of 3 amps. Expanded documentation for PMAC-Pack ACC8D-OPT4PP is under development. At present, request the ACC8D-OPT4 manual for further information.

ACC8D-Option 4APP: PWM Amplifier

Provides four low-power current-loop (transconductance) amplifier circuits for driving proportional hydraulic valve actuators or small to medium size DC motors. Each of the pulse-width modulated (PWM)amplifier circuits is rated at 150W continuous output (250W-1 second intermittent). PWM operation is at 30KHz and is short-circuit protected. Shunt-regulation provides over-voltage protection. Output can range from 15 - 48 volts at 3A continuous, and 5 amps peak per channel. This option is a small, separate, internally mounted, option board with a built-in heat sink and fan. Expanded documentation for PMACPack ACC8D-OPT4APP is under development. At present, request the ACC8D-OPT4A manual for further information.

Option 9LPP: Optional RS422 Interface

Integrated RS-422 serial interface adapter board for PMAC-Lite. Replaces standard RS-232 interface. DB25 pin connector serves as serial port link. DB9 connector is rendered inoperative. Expanded documentation for PMAC-Pack OPT 9LPP is under development. At present, request the Opt 9L manual for further information.

Accessory 24PP: PMAC-Pack Expansion Pack

Provides 4 additional encoder channels and 4 additional DAC outputs which may be used to expand PMAC-Packs control abilities to 8 non-commutated axes or 4 commutated axes. For further information, refer to Chapter 7.

Accessory 28APP: A/D Conversion Board

PMAC-Pack Accessory-28APP Analog-to-Digital Conversion board has four channels of high-speed (45 usec), high resolution (13 bit effective) analog input in the)10V range. It is a small, internally mounted option board that connects to PMAC with a provided flat cable. These inputs can be used for servo position feedback, as from an LVDT or potentiometer, or for general purpose use; for instance to monitor process variables such as pressure or tension, to allow analog speed control, or to monitor motor currents.

The analog inputs are optically isolated from the PMAC's digital circuits. Expanded documentation for PMACPack ACC28 is under development. At present, request the ACC28 manual for further information.

Accessory 39PP: Handwheel Encoder Interface Board

This accessory provides a basic interface to a single quadrature encoder. Typically, it is used for a handwheel or similar master encoder. It interfaces to PMAC through the JPAN control panel port, so the normal control panel functions must be disabled to use this accessory. Expanded documentation for PMAC-Pack ACC39 is under development. At present, request the ACC39 manual for further information.

PMAC-Pack Compatible External Accessories

Accessory 3: Serial Communications Cable

This is a three-meter (ten-foot) twisted shielded cable with a DB9/DB-25 connector on one end (for connection to the host computer) and a DB9/DB25 connector on the other end (for connection to PMAC Pack's serial port). If ACC-26 serial-communications-converter/opto-isolator card is purchased, make certain that the correct interface cables (for connection to PMAC-Pack) are ordered. Multi-drop versions of the cable are available for daisy-chained PMAC systems:

- ACC-3PP232 : Single-drop 3-meter DB9-DB9 shielded cable (PMACPack w/standard. serial port)
- ACC-3PP422 : Single-drop 3-meter DB25-DB25 shielded cable (PMAC-Pack w/ RS422 serial port)
- ACC-3PPSPC: Special Multidrop cable for connection of multiple PMAC-Packs. Contact Factory.

Accessory 4: Additional Instruction Manual

This accessory provides an additional instruction manual for the PMAC. Normally, one set of manuals is provided with every four PMACs or fewer shipped together.

- ACC-4: PMAC User's Manual and Software Reference
- ACC-4PP: PMAC-Pack Hardware Reference

Accessory 6: Handwheel Encoder

This is a Hewlett-Packard HEDS-7501 "rotary pulse generator" or "handwheel encoder"; with 256 lines per revolution. A six-foot flat cable is provided with the encoder. PMAC ACC-8D has matching sockets for this cable. This accessory can be interfaced with PMAC-Packs equipped with an internal ACC39PP.

Note:

A custom interface cable (no charge) is required for PMAC-Pack. Consult Delta Tau before ordering.

Accessory 8: Terminal Block

The ACC-8D provides connections to a family of option boards for special purposes. *The PMAC-Pack provides the user with a screw terminal interface to the PMAC, (a built-in ACC-8D so to speak).* However, many of the ACC8D options can interface to PMAC-Pack to facilitate connection of different servo feedback devices and motors. Terminal block options are as follows:

ACC8D, Option 6

Provides optically isolated connection for four incremental encoders (three channels each; A, B, and C) on a separate board.

Option 7

Provides two channels of resolver-to-digital conversion on a separate board. Two additional channels can be added to this board with sub-option a.

Option 8
Provides interpolation for an analog quadrature encoder, yielding 128 or 256 states per cycle. With sub-option a, interpolation for a second encoder is provided.

Option 9
Interfaces up to four Yaskawa absolute encoders, providing absolute power-on position serially through the thumb wheel Multiplexer port, and ongoing quadrature position information through the normal encoder ports.

PMAC-Pack Compatible ACC8D
Options are specified as follows:

- ACC8D-OPT-6: Encoder Optical isolation (4)
- ACC8D-OPT-7: Resolver-to-digital converter (2)
  - OPT A: Two additional R/D converter channels
- ACC8D-OPT-8: Analog encoder interpolator (1)
  - OPT A: One additional analog encoder interpolator
- ACC8D-OPT-9: Yaskawa absolute encoder interface (4)

Accessory 9: IBM PC Executive Software Disks
The Accessory 9 family of software products for IBM-PC and compatible computers provide development and diagnostic tools for building a PMAC application.

The ACC-9D PMAC Executive Program is a host program for the PMAC controller that is intended as a development tool in starting a PMAC application. It provides a terminal emulator, PMAC program editor with disk file functions, and special screens for viewing PMAC variables and status. The program was written in the "C" programming language.

All ACC-9 programs are sold on a site license basis. The library and function block products may be included in re-sold application software without royalties. If the Executive program is to be re-sold as part of a PMAC system, one copy must be purchased for each customer to whom it is resold.

Accessory 12: Liquid Crystal/Vacuum Fluorescent Display
Accessory 12 provides display capability for the PMAC independent of the host interface. It connects to the JDISP connector on PMAC-Pack. The user can program (through the DISPLAY command) what he wishes to show on the display. The vacuum fluorescent (VF) display is larger and brighter than the liquid crystal (LCD) display.

Note:

A custom interface cable (no charge) is required for PMAC-Pack. Consult Delta Tau before ordering.

- ACC-12: 2x24 character alphanumeric LCD display; 5mm high characters
- ACC-12A: 2x40 character alphanumeric LCD display; 5mm high characters
- ACC-12C: 2x40 character alphanumeric VF display; 5mm high characters
- ACC-12D: Long-distance display signal driver module
- ACC-12E: Adapter and power driver for ACC-12F display
- ACC-12F Opt 1: 2x40 character alphanumeric VF display; 6mm high characters
- ACC-12F Opt 2: 4x20 character alphanumeric VF display; 11mm high characters

Accessory-14: I/O Expansion Board
An ACC14D may be mounted externally on standoffs and connected to the PMAC-Pack through the JEXP port. An enclosed ACC14 may be available in the future. Contact Delta Tau for further information.

Accessory 16D: Control Panel and Display Box

The Accessory 16D control panel provides all the means for using PMAC's dedicated hardware control inputs and display outputs. It has nine toggle switches for the hardware functions, a 10-way rotary switch for motor-/coordinate-system-select (1 to 8, all, and none), a handwheel encoder, an analog potentiometer, a frequency generator, a 2x40 character alphanumeric LCD display, and 5 status LEDs.

Note:

A custom interface cable (no charge) is required for PMAC-Pack. Consult Delta Tau before ordering.

Accessory 18: Thumbwheel Multiplexer Board

This accessory is a printed circuit board that provides the needed circuitry for PMAC to interface to 16 thumb wheel switches or similar inputs. Up to 32 thumb wheel multiplexer boards can be daisy-chained together to permit the reading of up to 512 thumb wheel digits or other TTL level inputs (256 bytes). Thumb wheels may be mounted directly on the board, or can be remotely connected.

to it. Note:

A custom interface cable (no charge) is required for PMAC-Pack. Consult Delta Tau before ordering.

Alternatively, 8-position DIP switches may be mounted on the board for input.

- ACC-18: Thumb wheel Multiplexer Board (bare)
- OPT-1: Expansion Connector (for daisy-chain to next ACC-18)
- OPT-2: One 8-Position DIP Switch (16 Max; in place of digit)
- OPT-4: One Decimal Thumb wheel Digit (16 Max; specify loc.)
- OPT-5: External Power Connector
- OPT-6: Molex connectors w/ mates (16 Max; for remote digit)

An ACC-18 configuration sheet is available and can be used to define the required options and the number and location of all the thumb wheel digits.

Accessory 20: Hand-Held Terminal

This accessory provides a hand-held or panel-mountable (~5" x 8" x 3/4") terminal for simple operational communications needs. The terminal communicates with the serial port on the PMAC. It provides a numeric keypad with 6 special programmable function keys; also an alphanumeric 2 x 24 LCD display.

Accessory 22: Extended Warranty

This "accessory" extends the warranty past the 1-year standard factory warranty, for a total of two years.

Accessory 25: Servo Evaluation Package

The Accessory 25 Servo Evaluation Package (SEP) is a program for IBM-PC compatible systems running under DOS for autotuning and analysis of servo performance of PMACs with the Option 6 Extended Servo Algorithm. A onetime purchase (site license) of this accessory is required for users purchasing the

Option 6 algorithm. The ACC-25 may be used for analysis of servo performance of PMACs with the standard PID servo algorithm, but not for autotuning (the ACC-9DA can perform the autotuning). ACC-25: Servo Evaluation Software for Extended Servo Algorithm on 3.5" diskette.

Accessory 26: Serial Communications Converter

Accessory 26 is a small circuit board that converts the RS-232 serial communications of the host computer to the RS-422 serial communications format that many industrial equipment items, including PMAC-Pack with OPT-9LPP, use. This conversion is performed through an optically isolated link,

enhancing the noise immunity of the communications and separating the GND of PMAC from that of the host. An option is provided for easy connection to the PMAC-Pack. Standard serial connectors, DB-9 or DB-25, can be used to connect the ACC-26 to the host computer.

Most host computers with RS-232 can do reasonable communications directly with PMAC-Pack's RS-232 port or the OPT-9LPP RS-422 port, straight over the ACC-3D cable. PMAC-Packs with OPT-9LPP installed are equipped with receivers that take RS-232 signals robustly; most host RS-232 receivers take RS-422 signals, but with limited noise margin. Some cannot accept RS-422 at all.

ACC-26 is for those users who cannot communicate without it, or for those who want to increase their noise margins. Anyone using the PMAC-Pack's serial port in an actual industrial environment should either use an RS-422 port in their host computer, or use a level converter such as the ACC-26.

ACC-26A: Serial Communications Isolator/Converter with Rail Mount

- Option 4: Host RS-232 to PMAC-Pack RS232 format
- Option 5: Host RS-232 to PMAC-Pack RS422 format

Accessory 27: Optically Isolated I/O Board

PMAC's Accessory 27 is a small circuit board that provides eight optically isolated inputs and eight optically isolated outputs. The I/O is rated to 24V and 100 mA. The board is designed for easy connection through a provided flat cable to PMAC-Pack's JTHW port (J3). This I/O is intended for general purpose programmatic use on PMAC-Pack.

Note:

A custom interface cable (no charge) is required for PMAC-Pack. Consult Delta Tau before ordering.

ACC-27: Opto-Isolated 8-input 8-output I/O board

- Option 2: JTHW port interface with rail mount
- Opt 2A: DB-25 I/O connector
- Opt 2B: 18-point terminal block I/O connector

Accessory 29: Magnetostrictive Linear Displacement Transducer Interface Board

An ACC29 may be mounted externally on standoffs and connected to the PMAC-Pack through the JEXP port. A ruggidized enclosed ACC29 is not available at present but may be available in the future. Contact Delta Tau for further information.

Accessory 31: PMAC Demonstration Box Unit

Accessory 31 is intended to be used for the purpose of demonstration of PMAC's numerous motion control features. This accessory is a very useful tool for PMAC-based program development and verifications by OEMs. Internally the unit consists of a +15V and +5V DC power supply, four or eight DC motors with HP 500-line encoders, four or eight motor amplifiers, and the necessary wiring to external connectors. It also includes a control front panel and switches in the form of PMAC's ACC-16D to allow for input and output display independent of a host computer. An optional configuration is available, and should be specified for easy interconnection to PMAC-Pack.

ACC-31: 4-axis demo box (PMAC must be ordered separately)

- Opt 1: 4 additional axes
- Opt 4: PMAC-Pack interface option
- ACC-31L: Demo box lease (full lease-to-own credit on continuous lease)

Accessory 32: PMAC Software Upgrade/Update Kit

At Delta Tau, we are continuously upgrading PMAC's software for motion control. Software and documentation updates are readily available to the customer through Accessory 32. ACC-32 consists of updates for an EPROM (PMAC firmware), User's Manual, and ACC-9D PC Executive Program Diskette (if it was previously purchased).

Note:

Delta Tau is happy to supply ACC-32 to the customer up to two times free of charge for a period of six months from the date of purchase. If a customer has multiple PMAC cards, ACC-32 Option 1 provides extra PMAC EPROMs at a greatly reduced cost.

- ACC-32: Upgrade Kit: EPROM, User's Manual, Executive Diskette
- ACC-32, OPT-1: Additional EPROM

Accessory 34: Multiplexed I/O Expansion Board

Boards in this accessory family provide 64 points of discrete, optically isolated digital I/O connected to PMAC through the JTHW multiplexer port. Up to 16 of these accessories can be daisy-chained on a single port, for a total of 1024 I/O points. There are two versions of this accessory: the ACC-34A and the ACC-34B.

Note:

A custom interface cable (no charge) is required for PMAC-Pack. Consult Delta Tau before ordering.

The ACC-34A has 32 inputs and 32 outputs, sourcing or sinking, rated to 24V and 100 mA per point. The ACC-34B has 32 inputs and 32 outputs, totem poled, rated to 5V and 20 mA per point. It is designed to interface easily to Opto-22 or equivalent I/O modules.

- ACC-34A: 32-input, 32-output I/O module, 24V, 100mA per point
- ACC-34B: 32-input, 32-output I/O module, 5V, 20mA per point

Accessory 35: Multiplexer Port Extender Modules

The ACC-35A and 35B provide differential line drivers and receivers for long distance connections of I/O modules on PMAC's JTHW multiplexer port.

Note:

A custom interface cable (no charge) is required for PMAC-Pack. Consult Delta Tau before ordering.

- ACC-35A: Local Multiplexer Port Extender Module
- ACC-35B: Remote Multiplexer Port Extender Module

Accessory 36: A/D Conversion Board

An ACC36 may be mounted externally on standoffs and connected to the PMAC-Pack through the JEXP port. A ruggidized enclosed ACC36 is not available at present but may be available in the future. Contact Delta Tau for further information

Accessory 40: On-Site Field Service or Training

This accessory number can be used to order on-site service or training by Delta Tau personnel at an hourly rate plus travel and lodging expenses.

Future Accessories

PMAC is constantly being upgraded with new capabilities, options, and accessories. Please contact the factory for the latest update.

APPENDIX A - ELECTROSTATIC DISCHARGE CONTROL

General

Caution:

These procedures must be followed by anyone involved in handling PMAC-Pack components. Failure to do so may void your warranty.

This Appendix describes control measures to be taken to protect against electrostatic discharge (ESD) damage. Many of the PMAC-Pack components and circuit assemblies are electrostatic discharge sensitive (ESDS) and can be damaged or destroyed by ESD levels of a few hundred volts, far below the threshold of awareness. ESD can cause total failure of electronic parts, as well as intermittent failures or erroneous signals. Latent or delayed failures can also be caused by ESD. Items already partially damaged by ESD can check out electrically on the repair bench, but fail when subjected to the stresses of wide temperature ranges, mechanical shock, and high g-forces.

Whenever ESDS parts are handled outside of their protective packaging or removed from the shielding of the outside case of a piece of equipment, they must be in a protected area. A protected area is generally an ESD workstation consisting of a grounded workbench, a personnel wrist strap, a grounded floor mat, and grounded tools and equipment, all connected to a common ground. A portable ESD kit, consisting of a non-conductive tablemat, a personnel wrist strap, and a grounding cord may be adequate for field installations.

Guidelines

1. All persons handling ESDS items should be trained in ESD precautionary procedures.
2. Any electronic part received in ESD protective packaging must be considered ESDS.

Caution:

When ESDS items are handled outside their protective packaging, they should be handled by the shunting device, without Touching the ESDS parts or electrical runs.

3. ESDS items must be protected from electrostatic fields and ESD with shunts such as bars, clips, or conductive foams, or be inside conductive coverings during storage, shipping, and transporting. The ESD protective covers and shunts should be removed at a grounded workstation immediately before being installed into the assembly for which it is intended.
4. The leads or connector terminals of ESDS items should not be probed with a multimeter without first touching the probe to ground.
5. Tools and test equipment used in ESD protected areas must be properly grounded. Hand tools with insulated handles should be treated with topical antistat. Hand tools should be neutralized before and during use by contact with a grounded surface.
6. Power must not be applied to equipment or assemblies while ESDS items are being removed or installed.
7. Documents used in ESD protected areas should not be enclosed in common plastic covers.
8. Tote boxes and containers should be contacted together or grounded to a common ground before transferring ESDS parts from one to another.
9. Technical documentation should identify ESDS items and contain cautions to require that such items be removed from their protective packaging only in ESD protected areas.

10. Neutralize charges on all ESD packaged items by placing the packages on a grounded work surface prior to opening them.
11. Watch for ESD markings and symbols on packaging or parts.
12. Watch for ESD markings on equipment covers and cabinets.

Materials Receiving and Parts Storage

Personnel involved in receiving and storing of parts must observe the following procedures:

1. Watch for symbols and caution markings that identify ESDS items.
2. Perform quantity counts of ESDS items without opening final protective packaging. If counts can not be verified without opening, counts must be performed in an ESD protected area.
3. Carry ESDS items to and from storage areas in protective packaging.
4. Ensure that all packages containing ESDS items being returned to storage are properly marked with ESD symbols and caution notices.

Maintenance Of ESDS Components

Cleaning

WARNING

Ethyl Alcohol is flammable and toxic to eyes, skin, and respiratory tract. Avoid skin and eye contact. Good general ventilation is normally adequate. Keep away from open flames or other sources of ignition..

Personnel performing maintenance on ESDS components must observe the following procedures:

- Exterior surfaces of equipment containing ESD sensitive components may be cleaned in accordance with their respective technical documentation.
- Printed circuit assemblies, components, connectors, and pins will be cleaned with denatured ethyl alcohol and a camel hairbrush.

Caution:

Camel hairbrushes must be wet with ethyl alcohol when cleaning ESD devices. Do not use a dry brush.

Compressed air sources and vacuum cleaners should be used to clean ESD sensitive item enclosures only after all ESD sensitive items have been removed from the enclosure, or if the nozzle of the air source or vacuum cleaner is properly grounded.

Removal, Repair, and Installation

Electrostatic charges can build up on ESDS components while they are being transported and during maintenance. If an electrostatic charge is discharged onto the component connectors, internal circuits may be damaged. To prevent this, the following procedures must be followed:

1. Insure that conductive covers/caps are installed on all exposed terminals and connectors.
2. Insure that the host unit is properly grounded.
3. Prior to disconnecting cable connectors, touch the unit's case with your hand to equalize electrostatic potentials.
4. Disconnect and remove the component.
5. Install the replacement component.
6. Remove the conductive covers/caps and install them on the removed component.

7. Momentarily touch the outer shell of the mating connectors together to equalize electrostatic potentials prior to installing the cable connectors on the installed component.