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*
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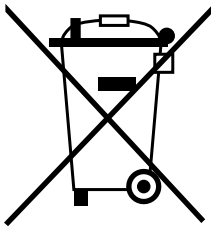
Operating Conditions

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.



EN Dispose in accordance with applicable regulations.

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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 5V and 12V 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 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 Manual further discusses PMAC motion control features and how they may be implemented.

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 packages. If any of these manuals are missing, contact Delta Tau for a replacement before attempting installation.

Manual Number	Manual Title
3A0-602204-xUxx	PMAC User Manual
3A0-602204-xSxx	PMAC/PMAC2 Software Reference
3A0-602274-xHxx	PMAC Lite Hardware Reference Manual
3A0-0PEWIN-xUxx	PMAC Executive for Windows User 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 the warranty.

Technical Support

Delta Tau is happy to respond to any questions or concerns regarding PMAC Pack. Contact the Delta Tau Technical Support Staff by the following methods:

By Telephone

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

By Fax and E-Mail

Fax or E-Mail a request or problem overnight and an attempt to reply will be made the following business day. TheFAX numbers and E-Mail addresses are listed below. Supply all pertinent equipment set-up information.

Bulletin Board Service (BBS) and Web Site

Messages can also be left on one of our Bulletin Board Services (BBSs). The BBSs are provided for the Customers, Distributors, Representatives, Integrators, et al. Download and upload files and read posted bulletins and Delta Tau newsletters from this board. Messages may be left for anyone who is a member/user of the Bulletin Board Systems. All that is needed is a modem and Procomm-Plus or similar communications program. Many Download-Upload Protocols such as Z-Modem are supported.

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

Basic Specifications

Physical Specifications

(See Figure 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”) with Expansion Pack

Weight

- 5.0 kg (11 lb) PMAC Pack (standard)
- 6.1 kg (13.4 lb) PMAC Pack (with all available options and accessories)
- 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)

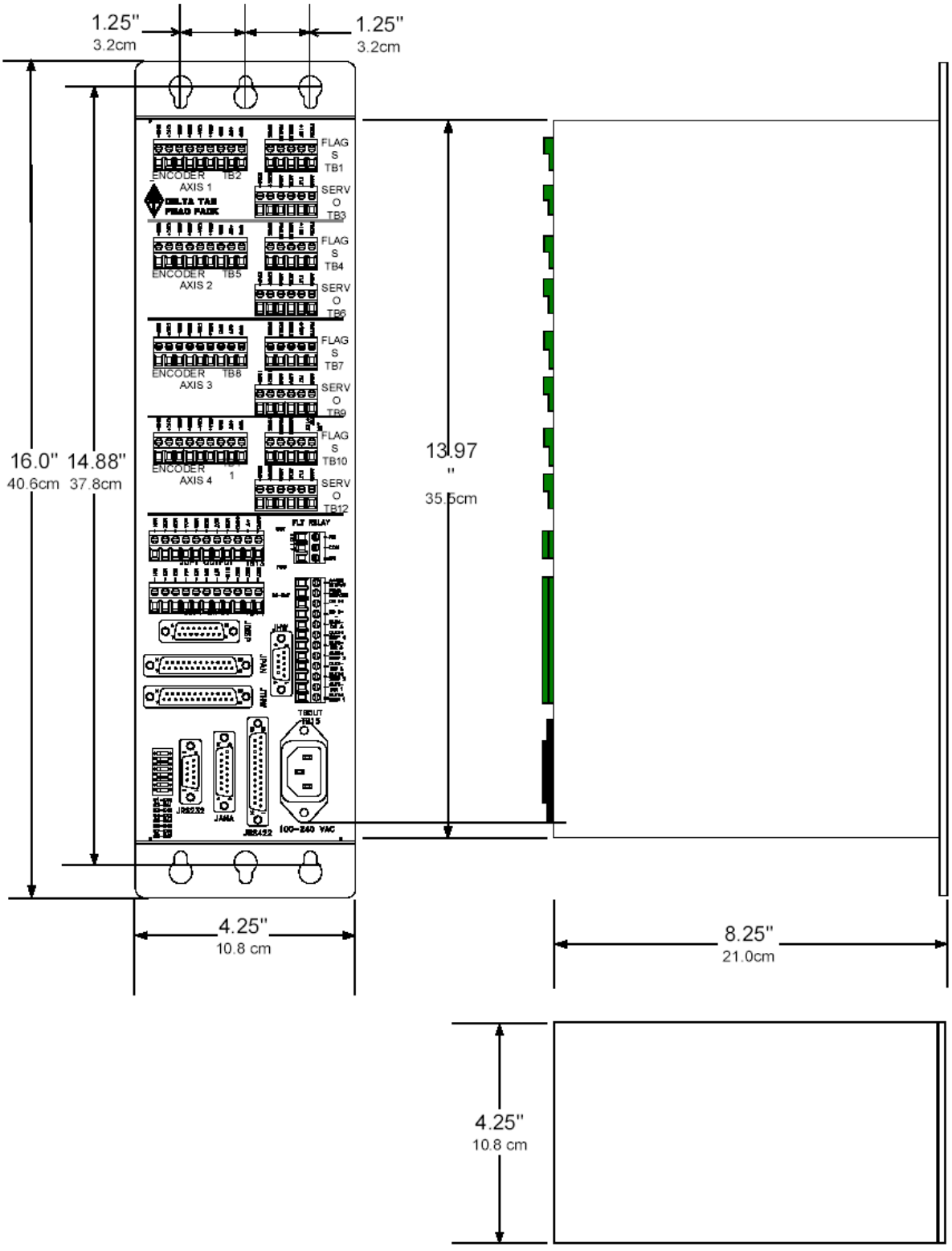


Figure 1 PMAC Pack Dimension

Internal Power Supply

- Manufacturer and 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 auto-tuning 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 (with Option 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 one servo cycle

I/O Specifications

Position Feedback

Quadrature Encoders

- Four (standard) to eight (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 Acc-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, 5V, single-ended absolute parallel encoders of over 24 bits (limit of 6 Acc-14D cards of 48 bits each)

Resolvers

- Thru Acc-8D Option 7 Resolver-to-Digital Converter card (two or four 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 one servo output per axis if PMAC is not commutating axis and two servo outputs per axis if PMAC is commutating axis
- Uncommitted analog outputs may be used for other purposes

On-Board Analog Input (JPAN)

- One input, 0 to +10V, converted to frequency at 25 kHz/V (on PMAC Lite) 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)

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

Axis Dedicated Digital Inputs

- Four 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

- One 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)

- Eight 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)

- Eight 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, one start bit, one 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 with 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
- Acc-26 is available for optically isolated conversion between RS-422 and RS-232 levels

Control-Panel Dedicated Inputs (JPAN)

- Nine dedicated manual control functions Low-true 0-5V TTL inputs: Run, Step, Abort, Hold, Home, Jog+, Jog-, Prejog, Reset
- Intended for momentary toggle switches
- Four 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)

- Eight TTL input lines; eight TTL output lines
- Designed for interface to Acc-18 Thumb wheel Multiplexer boards; up to 512 digits or 2048 discrete inputs
- Acc-34 multiplexed I/O cards 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 alphanumeric liquid crystal or vacuum fluorescent display

Expansion Digital I/O

- JEXP connector provides access to up to six Acc-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 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 and 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 re-circulating 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 non-commutated axes or two commutated axes. Figure 6, 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.

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 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.

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 Packs 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 connected to them internally.

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 Acc-12 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 Acc-27, Acc-34), 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 PMAC PACK 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 Acc-24EXP, PMAC Acc-14, 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 eight DIP-switches sets the serial communications baud rate. Additionally it controls the card address for use in addressing multiple PMAC Packs.

RE-INIT

Re-Initialization – This switch, if pressed 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 Watchdog Timer LED will illuminate when there is a serious fault within PMAC. See the section in 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 Re-initialization switch (momentary contact, only active on power-up) has been added to the front panel to allow re-initialization 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 Acc-8D Option 2 for Pulse and Direction output to stepper axes.

Acc-24 EXP Expansion Pack

If more encoder inputs or DAC outputs are required, a 4-axis expansion pack, Acc-24EXP, can be mounted alongside PMAC Pack to provide additional encoder inputs and DAC outputs. This allows one PMAC Pack to control up to eight non-commutated axes or four commutated axes. The Acc-24EXP Expansion Pack, in addition to the additional DACs and encoder channels it provides, may be ordered with the internal accessories shown in Table 3.

Note:

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

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 Manual.

Inspection

Unpack the 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 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 this manual. The vast majority of applications can be accomplished using the default settings, thereby eliminating the need to open up PMAC Pack to customize the jumper setup.

Note:

To interface to a high-true amplifier enable line, set up the appropriate jumpers before continuing. Refer to the next chapter for disassembly and jumper setup instructions.

Mounting

During the initial setup of the PMAC Pack for an 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 six mounting holes on the rear plate of the unit (see Figure 3).

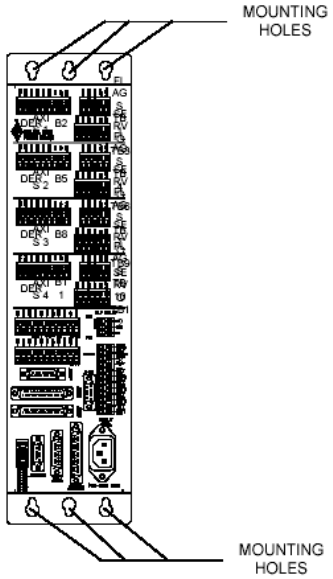


Figure 2 PMAC Pack Mounting

Power Connection

Connect the power cord provided to the power port on the front of the PMAC Pack. 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 connecting to something other than 115 VAC, or find it necessary to extend the cord, cut the plug from the power cord and proceed to connect to the AC input source. When AC power is applied to the PMAC Pack, the controller's green PWR LED should illuminate. The red WDT LED (watchdog timer) should not light. Provided this is the case, proceed to the Installing the PMAC Executive Program section below. If the WDT LED is lit, consult the Troubleshooting Guide in this manual.

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). PMAC Executive for DOS (Acc-9DA) 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.

Create a PMAC subdirectory on yotheur computer's hard drive and install the zipped files using the Install utility included on the diskette. The system's CONFIG.SYS file may need modification to provide the PMACEXEC program access to extended memory. (Refer to 3A0-PCPMAC-363 or 3A0-0PEWIN-363 for details.)

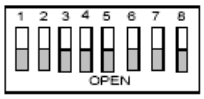
Communication SwitchBank Setup

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 for address control settings.

Note:

Unless the 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 PMAC Pack that is set up as @0, or the watchdog timer will trip (red light ON) and the control will shut down.

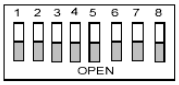
Card Address Control Switches				Card Address	Default and Physical Layout
					 Location PMAC Pack Front Panel
S1	**S2**	**S3**	**S4**		@0
ON	ON	ON	ON	@0	
OFF	ON	ON	ON	@1	
ON	OFF	ON	ON	@2	
OFF	OFF	ON	ON	@3	
ON	ON	OFF	ON	@4	
OFF	ON	OFF	ON	@5	
ON	OFF	OFF	ON	@6	
OFF	OFF	OFF	ON	@7	
ON	ON	ON	OFF	@8	
OFF	ON	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					

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 for communications control settings.

Note:

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

Baud Rate Control E Points				Baud Rate			Default and 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. Tell the program to look for PMAC on a COM port and tell it the baud rate which to communicate at (this is set up with via the Communication SwitchBank). PMAC Pack is set up at the factory to communicate at a default baud rate of 9600 baud.

Once the program knows where and how to communicate with PMAC, it will send a query command to try to establish communications with PMAC Pack by and wait for the response. If it gets the expected type of response, it will report that it has found PMAC. 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 for 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 a response is received 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, make sure that communication with the card at a basic level has been established. Type `P<CR>` (this is not case sensitive); this requests a position. PMAC should respond with a number, probably a 0. Now type a **<CONTROL-F>**. Eight numbers (one for each axis) should display since **<CONTROL-F>** requests following error from all eight motors; some or all may be 0. Note that even with encoder counts as read-out (no scaling) PMAC's position is displayed with fractional counts.

Note:

If there are difficulties establishing communications with PMAC, consult the troubleshooting tables in this manual.

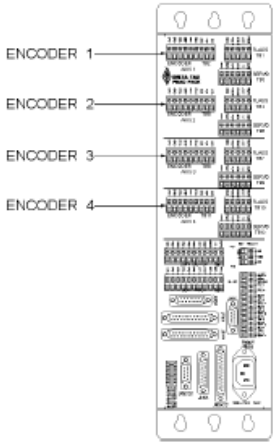
Incremental Encoder Connection

WARNING:

Remove power from the 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 using position capture features, but usually it 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 set up by default for either single-ended or differential Line-Driver encoders. If there is a single ended signal, leave the complementary signal pins floating – do not ground them. If using an encoder with complementary open collector outputs, set E24-27 on the PMAC Lite board to pins 2-3. The third channel (index pulse) is optional, although to precisely home the motor, it is recommended that an encoder with an index channel is used.



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-

Figure 3 Encoder Connection Port Pinouts

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

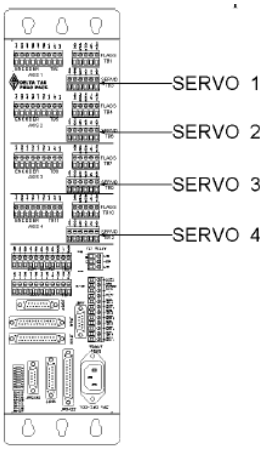
For a single-ended command using PMAC channel 1, connect DAC1 (pin 5) to the command input on the amplifier. Connect the amplifier's command signal return line to PMAC's AGND line (pin 4).

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.



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

Figure 4 PMAC Pack/Amplifier Pinouts

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, this amplifier signal may be under manual control. PMAC Lite jumper E17 controls the polarity of the signal. The default is low-true (conducting) enable, which is the safest polarity because a PMAC shutdown will disable the amplifiers automatically.

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 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 5 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 6 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. 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 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.

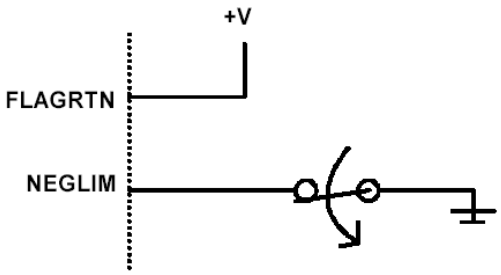


Figure 5 Flag Input in A Sinking Configuration

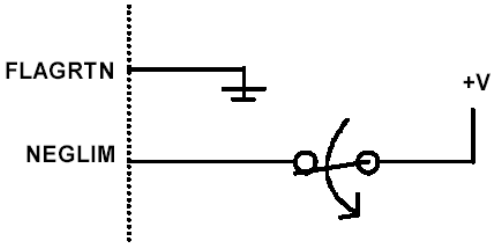


Figure 6 Flag Input in Sourcing Configuration

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.

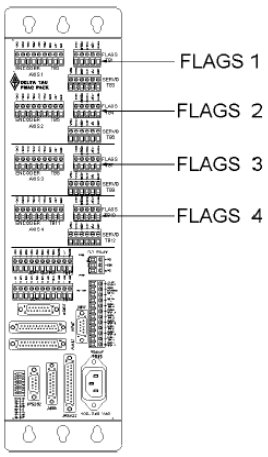
Software Setup of the Controller

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 the PMAC Pack only. (At this time, do not power the amplifiers.) Run the PMAC Executive Program on the PC. The value of an I-variable may be queried 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, the I-variable pages (under the Configuration menu) may be used to view and change these variables in a more user-friendly fashion.

Note:

If any I-variables are changed during this setup, use the **SAVE** command before powering down or resetting the card, or the changes will be lost.



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

Figure 7 Flag Connection Pinouts

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 I-variables control the encoder flags which are 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 outputs 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 there is just one feedback encoder (ENC1) for Motor #1 in the 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 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 the amplifier is expecting =)10V and the full range should be used, set I169 to 32,767. If the 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 start checking on the basic motor functions. First 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 needed to ensure that the position counting is working properly in both directions. If the position count does not change, review the Troubleshooting Guide in this manual.

Changing Position Direction

If 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 there is a polarity mismatch, refer to the Troubleshooting Guide in this manual.

Testing the Command Output and Polarity

Next, check the command outputs and whether the output polarity matches the feedback polarity. To do this, provide power to the 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, make sure that the servo feedback and output polarities match. Give 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, there is a polarity mismatch. Now type **O-10<CR>**. The position counter should count down. If it counts up, there is a polarity mismatch. If the counter does not count in opposite directions for the two tests, there is an encoder and/or amplifier problem.

Verify Overtravel Limit Polarity.

Make sure as the direction sense of the motor is verified that the hardware position limit switches are 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, the hardware limit functions will not work.

Manually trip the limit. Using the PMAC Exec, 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 things can be stopped 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, there is mismatched polarity; re-run the above polarity tests. If control is lost 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 there is some reasonable stiffness, but do not try yet to get the maximum possible stiffness. The tests described below will help.

Oscillations

If the motor has a tendency to oscillate at low to moderate frequency, there is 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), there is 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, there should be 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, it was 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 the position is holding well, but the motor will not move, the hardware limits are not 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 the ammeter in series with this circuit to confirm this). If this is not right, refer to the Encoder Connection and Amplifier Connection sections and re-check the connections. Additionally, check that Ix06 is set to zero to disable the motor's position following abilities.

If the motor dies after a jog command, the fatal following error limit has been exceeded. If this has happened, it is either because a move was requested that is more than the system can physically do (if so, reduce I122), or because it is badly tuned (if this is the case, increase proportional gain I130). To restore closed-loop control, issue the **J/** command.

Optimizing Jog Performance

If the jog speed seems slower than desired, one or more of PMAC's automatic safety limit parameters may have been activated, particularly if it is 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. It may be increased several orders of magnitude for now to get it out of the way.

Setting Velocity Feedforward Gain

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

Setting the Integral Gain

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 needed (quick restoration of commanded position without introducing oscillation). If there is oscillation, reduce the integral gain until the oscillation is eliminated. If there is 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, set I180 so that power up is done in the mode desired. 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 the position-capture I-variables (I902 and I903 in the example). Make sure they are set up to capture the position where the home position should be. With a bare motor, 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 the 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 command a homing move with the **HM** command and the motor will move as specified until the proper signal edges 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 jumpers on the PMAC card need not be changed 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, use a 2- position switch and an LED, moving on to actual I/O connection when satisfied that their logic can be controlled.

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 8.

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.

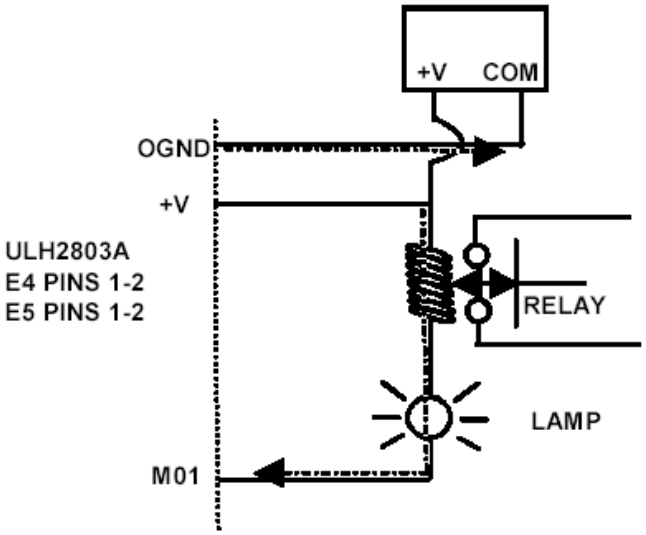


Figure 8 General Purpose Output Connected in the Default Sinking Configuration

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 be replaced easily. For this driver, internal 3.3Kohm pull-resistors keep the outputs from floating. A typical interconnection is shown in Figure 9.

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 JOPT-output connector will illuminate when power (+12 to +24V) is applied to the O+V (pin 2 of the JOPT-output port).

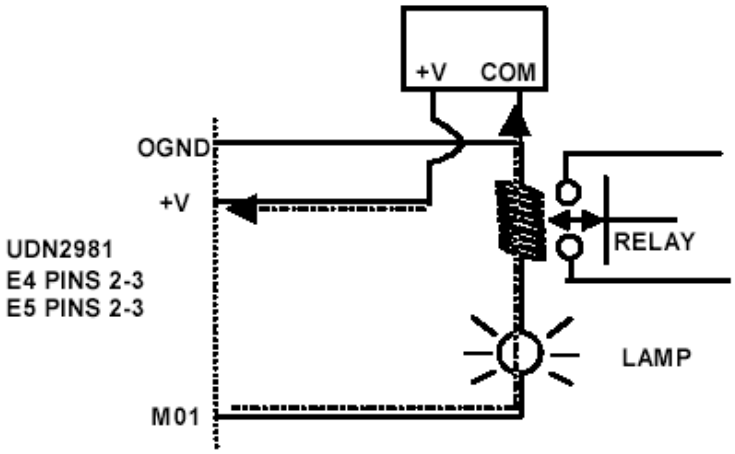


Figure 9 General Purpose Output Connected in the Optional Sourcing Configuration

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 10 illustrates connection of an input in a Sinking configuration and Figure 11 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. 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) typically, which is shared by the amplifier.

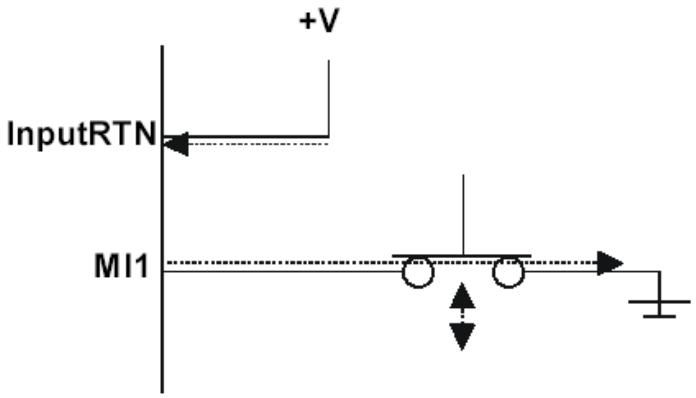


Figure 10 Connection of Input in Sinking Configuration

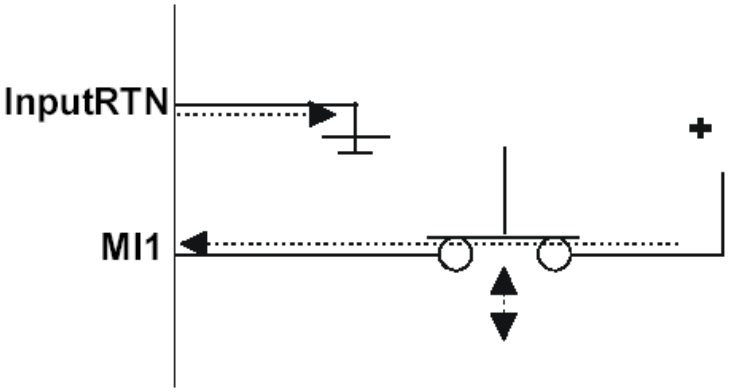


Figure 11 Connection of Input in Sourcing Configuration

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 the 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 the following table.

Testing the I/O

Testing an Output

Using the terminal window of the PMAC Exec, type **M01=0 <CR>** . Now type **M01=1 <CR>**. the LED or corresponding device should be 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. There should be the corresponding change of state in software.

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

The basic system setup is now complete. Further information on setting up Coordinate Systems and Programming the PMAC can be found in the PMAC User 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 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 7 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.

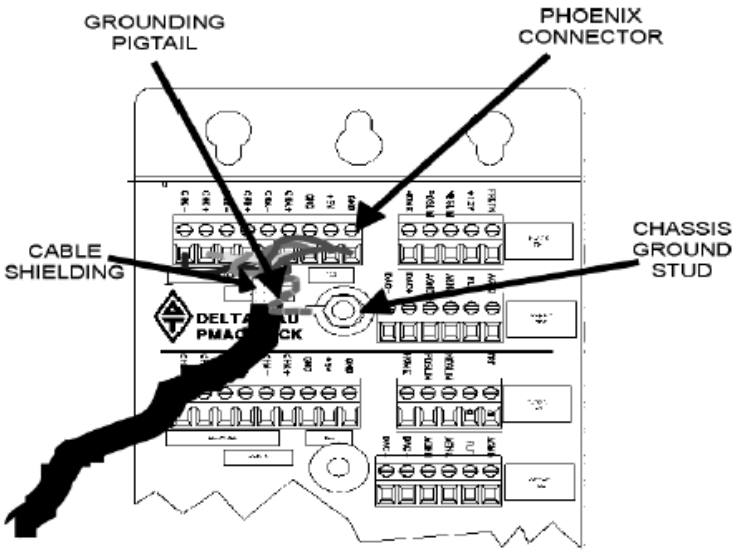


Figure 12 Grounding Procedures for Phoenix Plug-In Connectors

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 13 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.

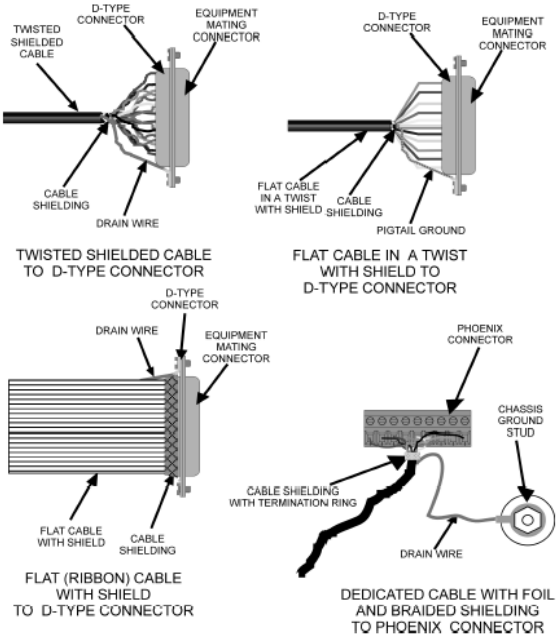


Figure 13 Typical Cable/Connector Installation

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 14).

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 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 15 shows the location of the backplane E-point jumpers, Figure 16 shows the locations of the PMAC Lite 1.5 card E-point jumpers, and the tables following the drawing provide the information required for customizing the PMAC Pack backplane and PMAC Lite 1.5 card configurations to a specific application.

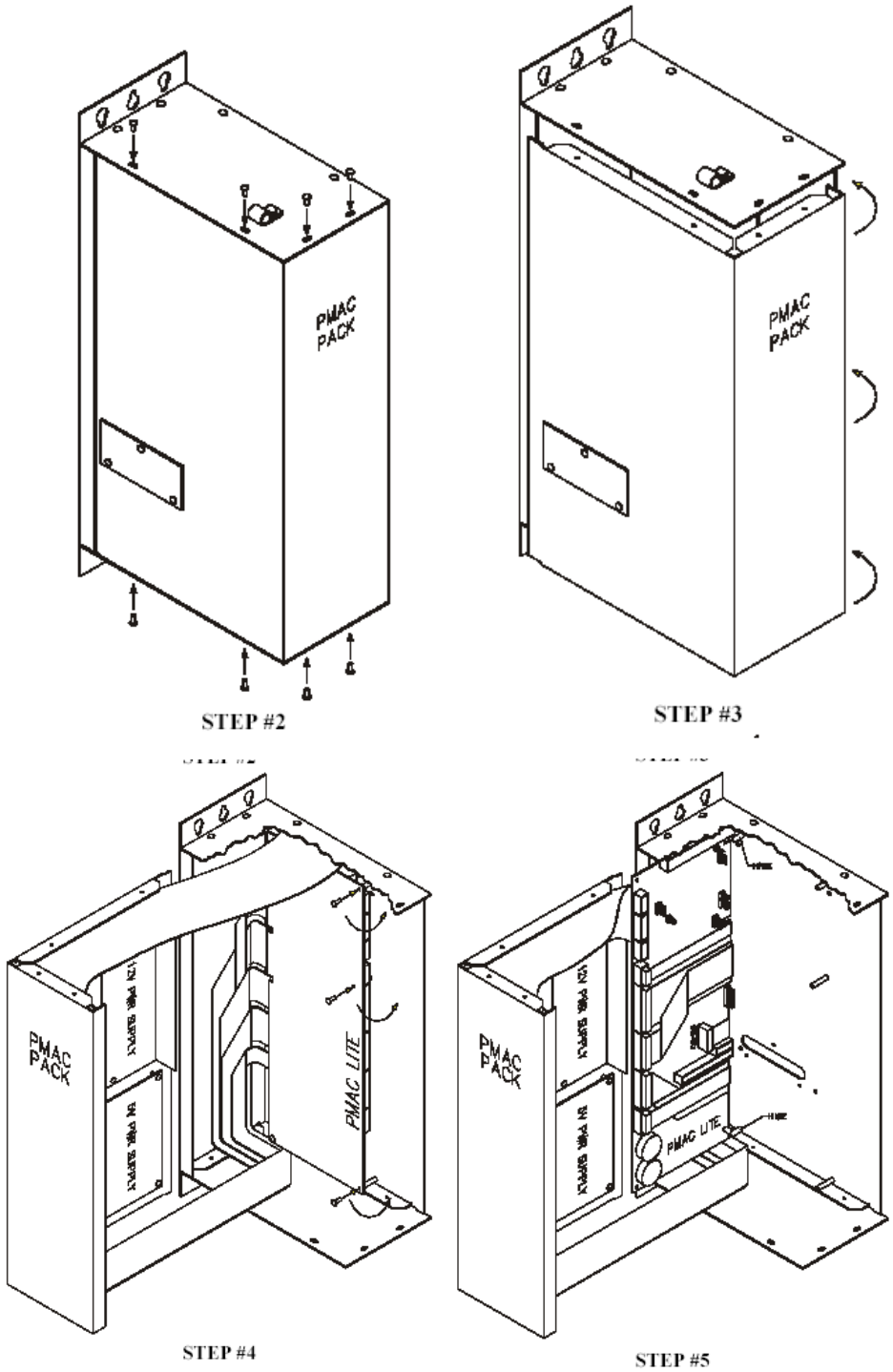
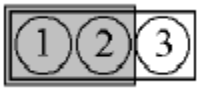
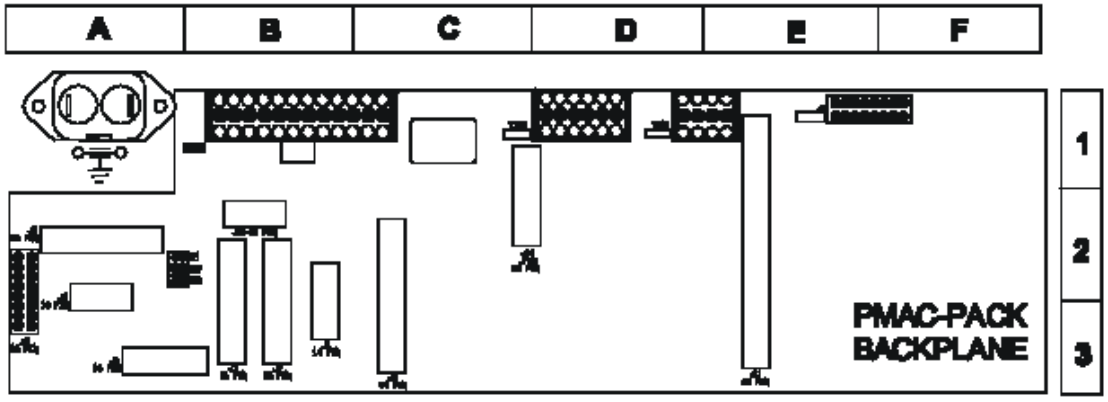


Figure 14 PMAC Pack Disassembly

PMAC Pack Backplane E-Point Jumper Descriptions

E Point and 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

E Point and 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 15 PMAC Pack Backplane E-Point Locations

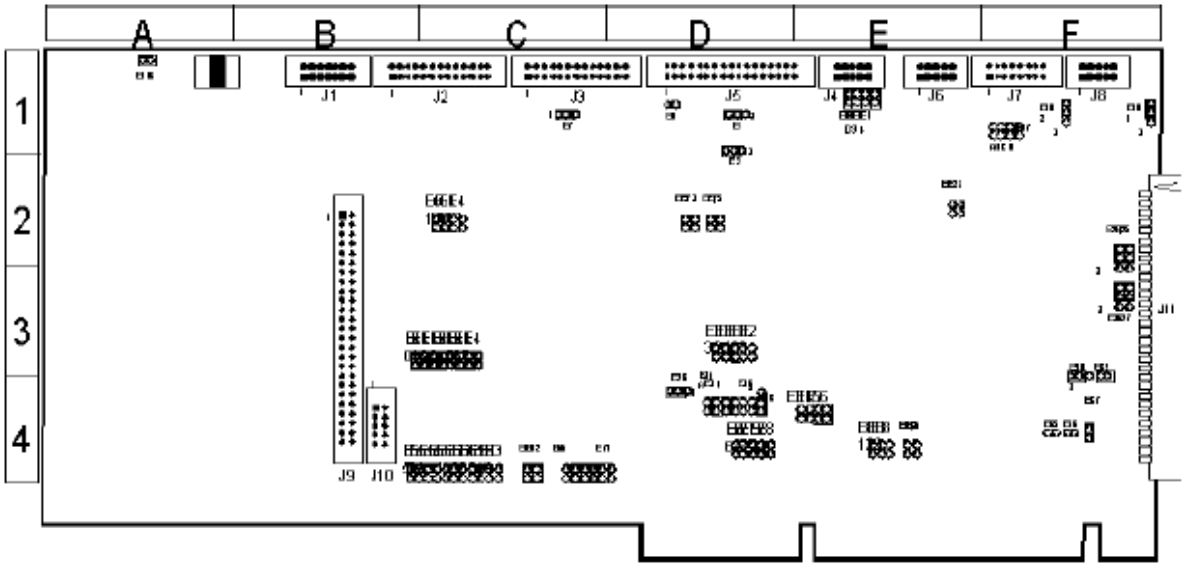


Figure 16 PMAC Lite E-Point Locations

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		

PMAC Lite E-Point Jumper Descriptions

E0: Reserved for Future Use

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

E1 and E2: Output Supply Voltage

E Point and 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

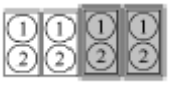
E3 - E6: Servo Clock Frequency Control

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 the basic unit of time on PMAC should be something other than a millisecond). To have 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 and 22.

Note:

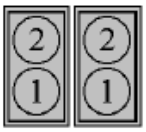
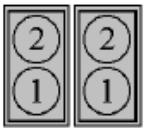
If E40-E43 are set up so that the card has a software address other than @0, the servo clock signal must be received over the serial port from card @0, so these jumpers have no effect.

E3	E4	E5	E6	Servo Clock = Phase Clock Divided By N	Default and 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	

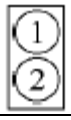
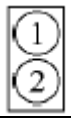
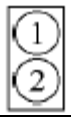
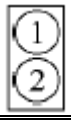
E Point and Physical Layout	Location	Description	Default
E7 	C1	Jump pin 1 to 2 to apply +5V to input reference resistor sip pack; this will bias MI1 to MI8 inputs to +5V for OFF state; input must then be grounded for ON state. Jump pin 2 to 3 to apply GND to input reference resistor sip pack; this will 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.

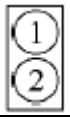
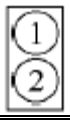
E Point and Physical Layout	Location	Description	Default
E9 E10 	E1	Jump, E9-1 to E9-2 to allow TXD/ to be input on J4-3; jump E10-1 to E10-2 to allow RXD/ to be output on J4-5. Jump E9-1 to E10-1 to allow TXD/ to be output on J4-3; jump E9-2 to E10-2 to allow RXD/ to be input on J4-5.	1-2 Jumper installed
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

E Point and 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.

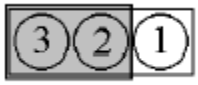
E Point and Physical Layout	Location	Description	Default
E22 	E2	Jump pin 1 to 2 to obtain handwheel encoder signal from front panel at J2-16 for CHB2 (ENC2-B).	No jumper
E23 	E2	Jump pin 1 to 2 to obtain handwheel encoder signal from front panel at J2-22 for CHA2 (ENC2-A).	No jumper

E24 - E27: Encoder Control

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

E Point and 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

E Point and 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 one of these five 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.

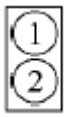
E29	E30	E31	E32	E33	Phase Clock Frequency		Default and Physical Layout E33 E32 E31 E30 E29
					19.6608MHz Master Clock	29.4912 MHz Master Clock	
ON	OFF	OFF	OFF	OFF	2.26 kHz	3.39 kHz	
OFF	ON	OFF	OFF	OFF	4.52 kHz	6.78 kHz	
OFF	OFF	ON	OFF	OFF	9.04 kHz	13.55 kHz	
OFF	OFF	OFF	ON	OFF	18.07 kHz	27.10 kHz	
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 one of these five jumpers may be on at a time.

E34A	E34	E35	E36	E37	E38	SCLK Clock Frequency	Default and 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

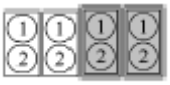
E Point and Physical Layout	Location	Description	Default
E39 	C4	Must be removed for standalone operation. Jump pin 1 to 2 to allow PMAC Lite to derive its reset from the PC backplane. Only one of E39, E93, E94 should be on at once See also E93 & E94	No jumper

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.

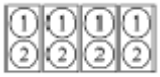
Note:

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 watchdog timer will trip (red light ON) and the card will shut down.

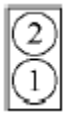
Card Address Control E Points				Card Address	Default and Physical Layout E40 E41 E42 E43  Location C3 C3 C3 C3
E40	**E41**	**E42**	**E43**		
ON	ON	ON	ON	@0	@0
OFF	ON	ON	ON	@1	
ON	OFF	ON	ON	@2	
OFF	OFF	ON	ON	@3	
ON	ON	OFF	ON	@4	
OFF	ON	OFF	ON	@5	
ON	OFF	OFF	ON	@6	
OFF	OFF	OFF	ON	@7	
ON	ON	ON	OFF	@8	
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.

Baud Rate Control E Points				**Baud Rate**			**Default and 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

E Point and 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)

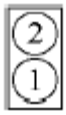
E49: Serial Communications Parity Control

E Point and 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

E Point and 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

E Point and 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.	No jumper installed
Note: In PMAC Pack, this jumper is connected to the front panel RE-INIT.			

E55 - E65: Host Interrupt Signal Select

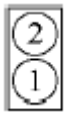
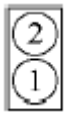
These jumpers work together with E86 and E76-E84 to set the mapping of PMAC information to host PC bus interrupt lines. (They are of no relevance to PMAC Pack operation.)

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.

E Point and 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

E Point and 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

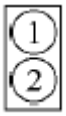
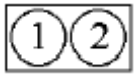
These jumpers work together with E86 and E55-E65 to set the mapping of PMAC information to host PC bus interrupt lines. (They are of no relevance to PMAC Pack operation.)

E85: Host-Supplied Analog Power Source Enable

E Point and 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

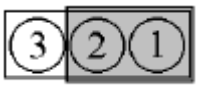
This jumper works together with E55-E65 and E76-E84 to set the mapping of PMAC information to host PC bus interrupt lines. (It is of no relevance to PMAC Pack operation.)

E Point and 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 and E87 must also be changed. Also, see E90.	No jumper

E89: Switch Pull-Up Enable

E Point and 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

E Point and 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

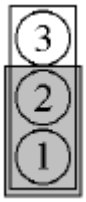
E91 - E92: Bus Base Address Select (High Bits)

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 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

E Point and 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

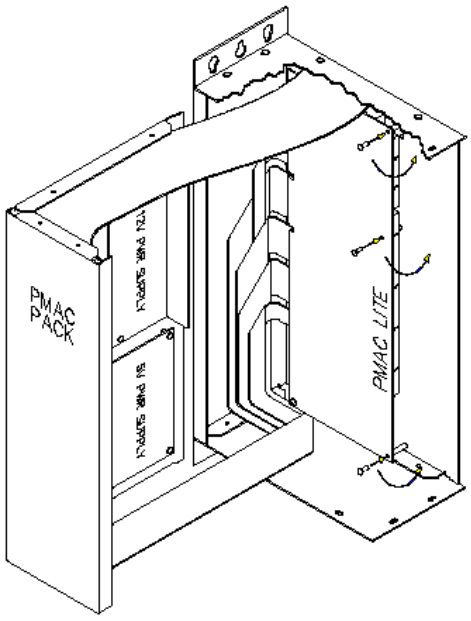
Caution:

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

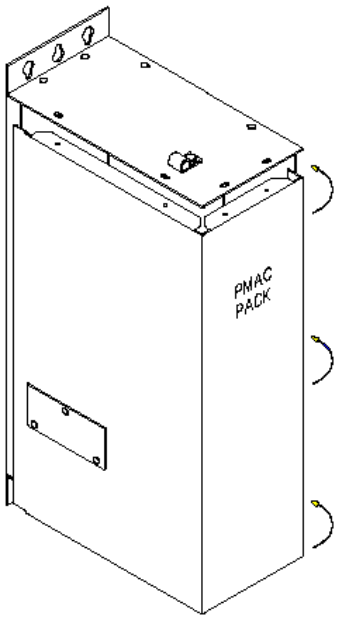
E Point and Physical Layout	Location	Description	Default
E101 	F1	Jump pin 1 to 2 to apply +V (+5V to +15V) to pin 11 of U54 (should be ULN2803A for sink output configuration). Jump pin 2 to 3 to apply GND to pin 11 of U54 (should be UDN2981A for source output configuration).	1-2 Jumper installed
E102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

E Point and 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



STEP #1



STEP #2

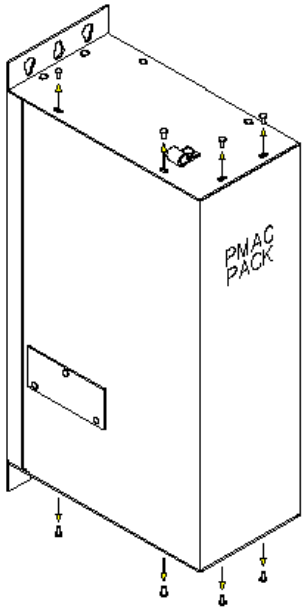


Figure 17 PMAC Pack Assembly

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 17).

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. If necessary, pull the left half slightly forward to clear the front right lip.
3. Insert eight 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

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 the section in this manual on 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 COM port connector has been cabled out of. • 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 there is action on the transmit lines from the PC while typing in the Executive program. If not, there is a problem on the PC end. • Probe the return communication line while PMAC is given a command that requires a response (e.g. <CONTROL-F>). If there is no action, change jumpers E9-E14 on PMAC to exchange the send and receive lines. If using the RS422 option and there is action, but the host program does not receive characters, RS-232 may be receiving circuitry that does not respond at all to PMAC Pack's RS-422 levels. If there is another model of PC, try using it as a test (most models accept RS-422 levels quite well). If the computer will not accept the signals, a level-conversion device may be needed, such as Acc-26. • As a last resort, check the +5V supply level inside the PMAC Pack. If the level is below 4.75V, problems can result. Contact Delta Tau before any attempts to adjust the +5V supply are made.
Cannot 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?

There is a polarity mismatch (There is a potentially dangerous runaway condition when trying 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; or exchange the motor leads.
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 the amplifier and motor connections. If the DAC voltage has not changed: • Recheck I102. The DAC output must be tied to the motor through this variable. Check ytheour limit-input configuration. • Is the 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. There should be 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 the proportional gain (Ix30) greater than zero? • Can any output be measured at the DAC pin when an O command has been given? • Is the following error limit being tripped? 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. • Is there proper supply to A+15V, A-15V, and AGND? Open the PMAC Pack and verify connection 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 the big step limit (Ix67) too low? Try increasing it to 8,000,000 -- near the maximum -- to eliminate any effect. • Is the 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: • Is there feedback? Check that position changes in both directions can be read. • Does the 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.	Is the following error limit being tripped? Disable the 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-Variable that is being toggled linked to the address of the Machine Output? Type **M01**-> <**CR**> and verify that PMAC responds with: `Y:$FFC2,8,1`. • After toggling the output's state, query the M-variable value to confirm that in software a change has occurred. If it has not, issue a **<CTRL> A** to abort any programs which may be resetting the output variable. Also set I5=0 to disable any PLC programs could be doing the same. Again, try to re-toggle the variable.
Machine input (JOPTINP) state does not change	Check the following: • Verify with a voltmeter or scope that the input voltage is indeed changing (0 to 12/24Vdc), as measured on Pin 11. • Is the PMAC M- Variable that is being toggled linked to the address of the Machine Output? Type **M11-> <CR>** and verify that PMAC responds with: `Y:$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	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	Eight General purpose outputs	016-P000011-08P	Phoenix	1777374
JOPTO INPUT	11-pin female screw terminal connector	Eight 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
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
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

Connector Name	Mating Connector Type	Connector Function	Delta Tau Part Number	Manufacturer/ Vendor	Part Number
JTHW	25-pin DB male connector w/ grounding plane	PMAC J Thumb wheel Multiplexer input. Used for interconnection of additional I/O (PMAC Acc-27, Acc-34), 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 Acc-24EXP, PMAC Acc-14, 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
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

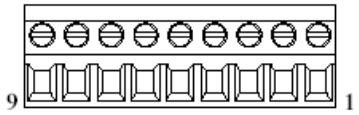
Note:

- 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.

Encoder Terminal Block

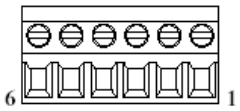


Front View

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.

Servo Terminal Block

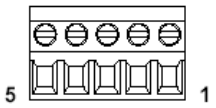


Front View

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.

Flags Terminal Block

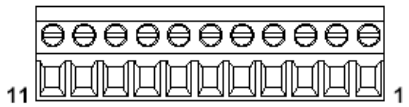


Front View

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.

JOPT Output Terminal Block

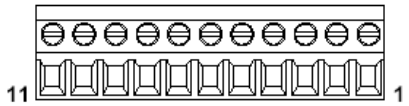


Front View

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).

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.

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.

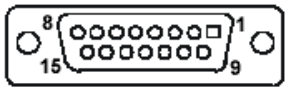
TBAMP Terminal Block

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 V ground
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 (Acc-8D OPT4PP or Acc-8D OPT4APP). Connection points are provided for motor leads, optional shunt regulator resistor, and amplifier power supply.

JDISP 14-Pin Connector



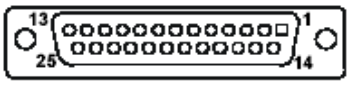
Front View

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 and OPT2) via the large display adapter and power driver (Acc-12E). The DISPLAY command may be used to send messages and values to these displays.

* Controlled by potentiometer R3

JPAN 26-Pin Connector

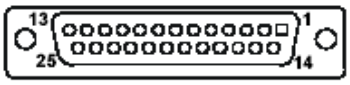


Front View

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 Acc-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.

JTHW 26-Pin Connector

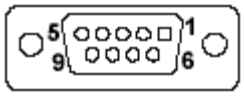


Front View

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 eight inputs and eight 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.

JRS232 DB9 Connector



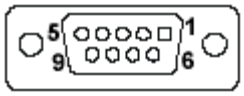
Front View

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.

JRS232 DB9 Connector

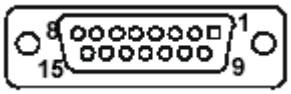


Front View

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 Supply	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.

JANA DB15 Connector

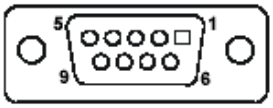


Front View

Pin#	Symbol	Function	Description	Notes
1	ADC1	Input	1st Chan. Main Input	1
2	ADC2	Input	2nd Chan. Main Input	1
3	ADC3	Input	3rd Chan. Main Input	1
4	ADC4	Input	4th Chan. Main Input	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. Input	2
10	ADC2/	Input	2nd Chan. Comp. Input	2
11	ADC3/	Input	3rd Chan. Comp. Input	2
12	ADC4/	Input	4th Chan. Comp Input	2
13	AGND	Common	Analog Ground	3
14	AGND	Common	Analog Ground	3
15	A-15V	Input/Output	Analog Negative Supply	3,4

Note: This connector is provided for use with PMAC Pack's optional 4-channel A/D converter, Acc-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.

J8 JHW 9-Pin Header

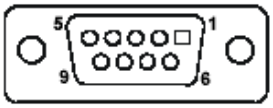


Front View

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), Acc-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.

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 four compare-equal and four 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 needed, 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

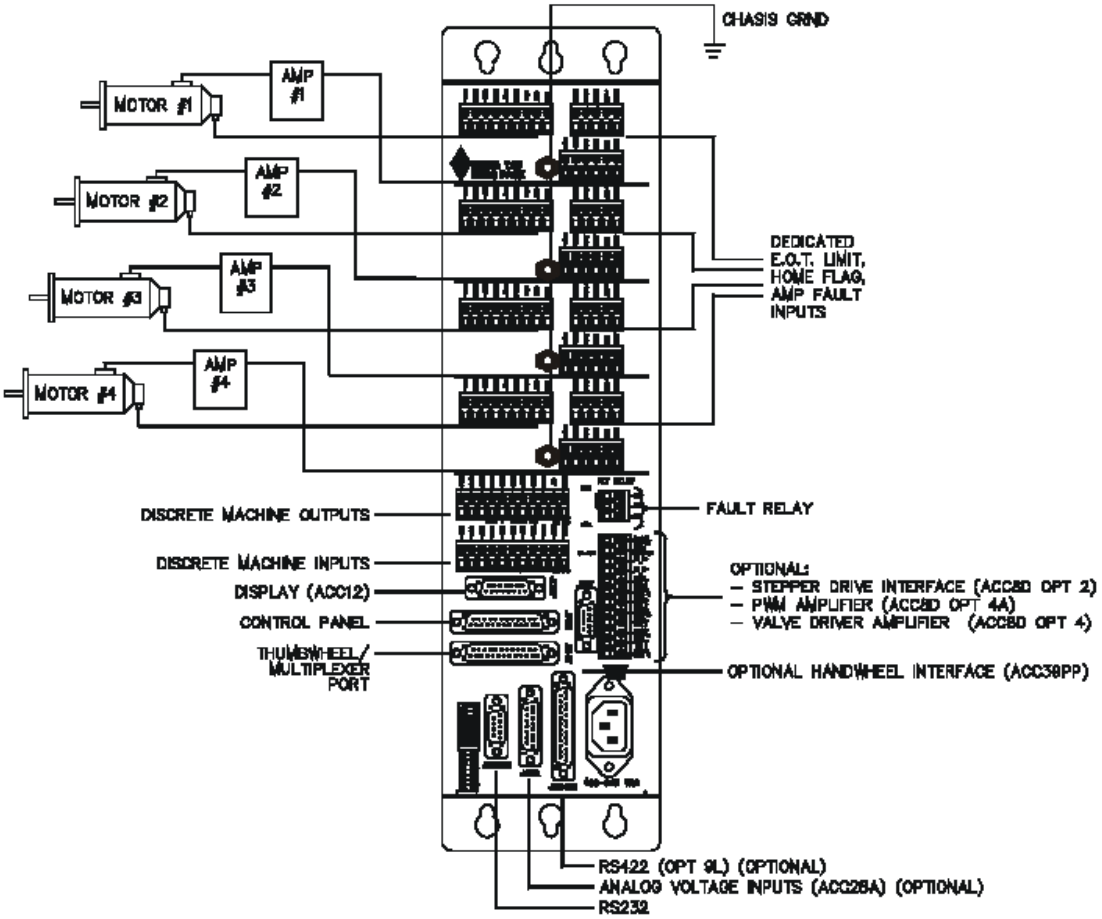


Figure 18 PMAC Pack System Connections (Basic Non-Commutated System)

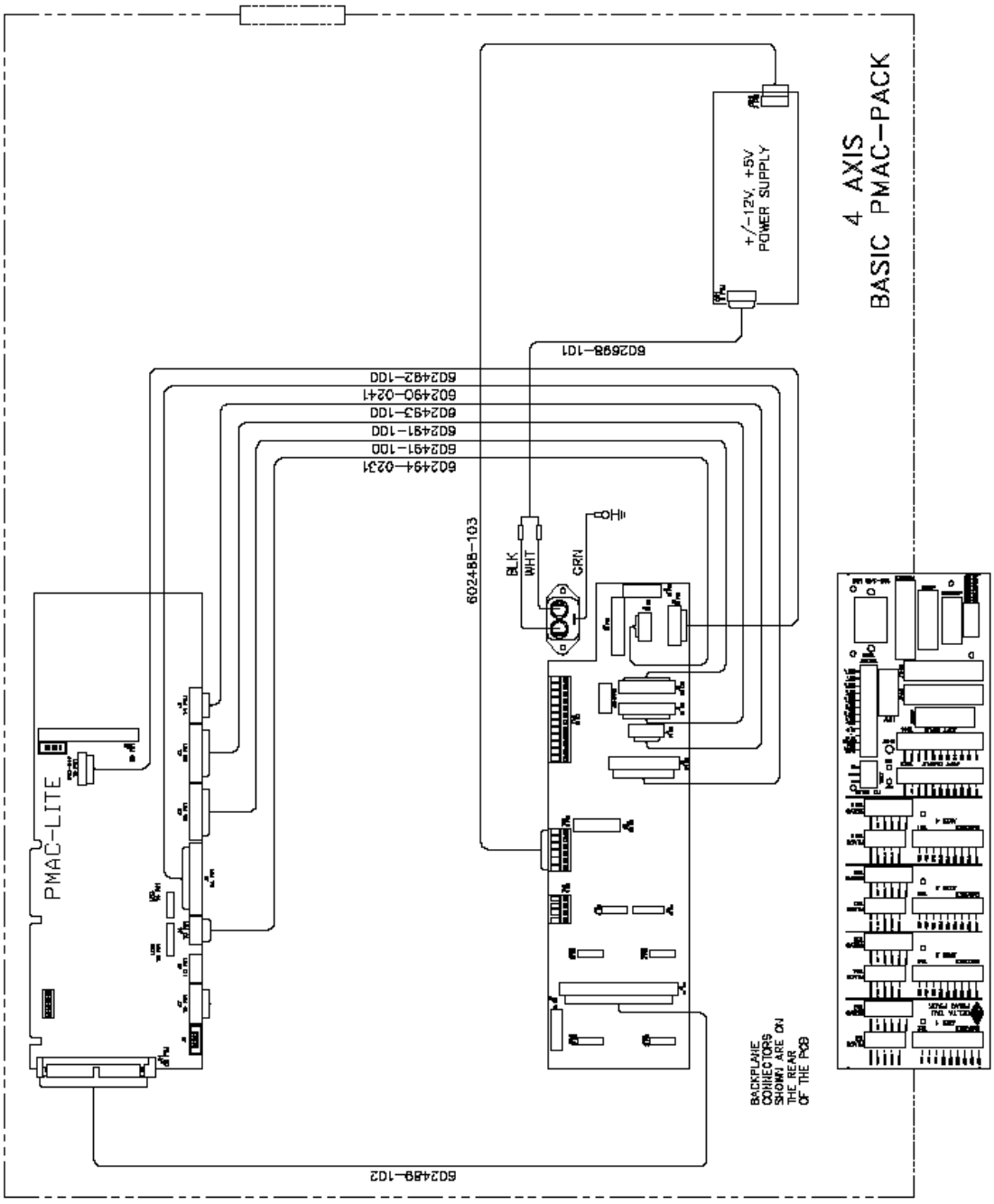


Figure 19 Basic PMAC Pack Wiring Diagram

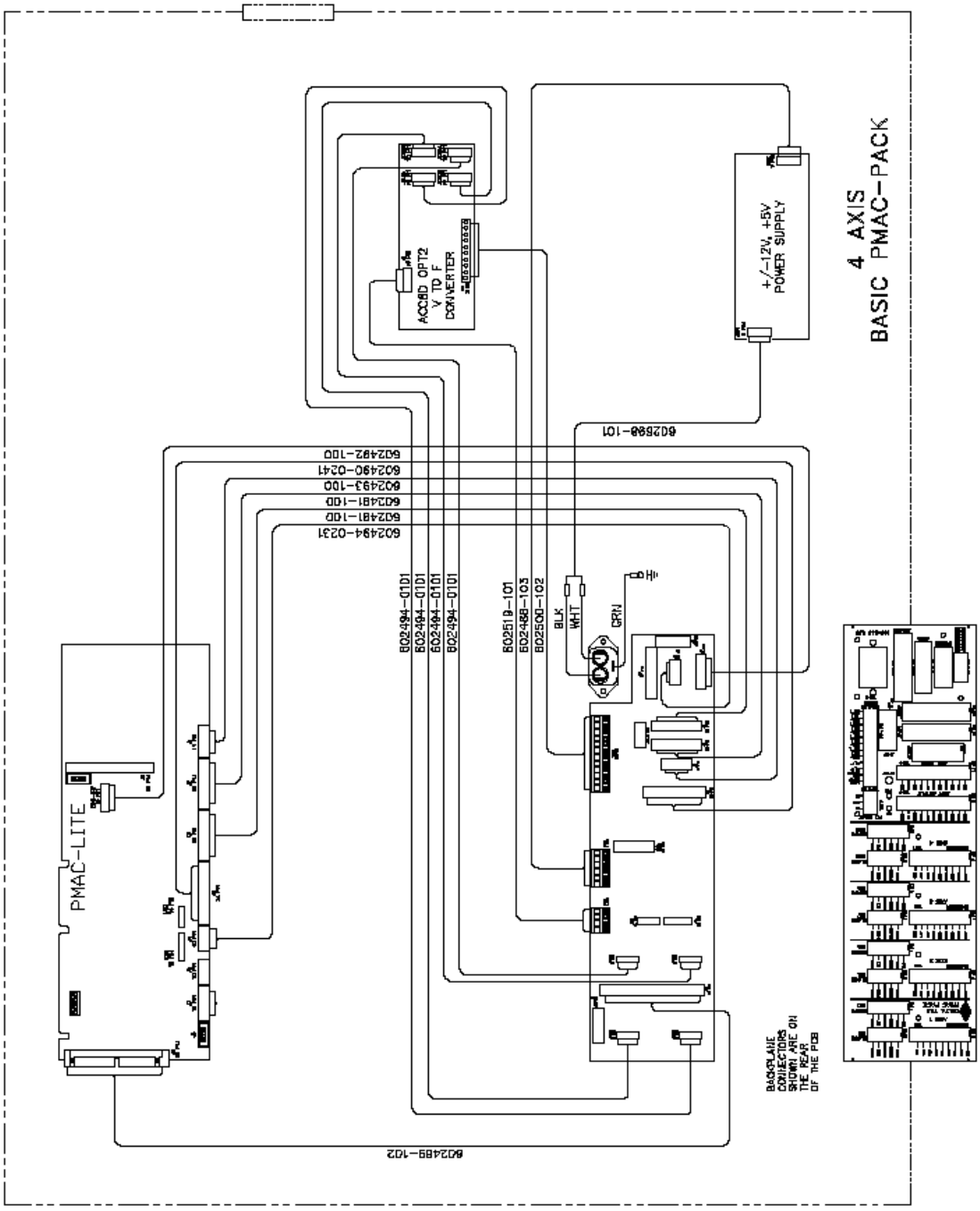


Figure 20 PMAC Pack with Accessory 8D Option 2 Wiring Diagram

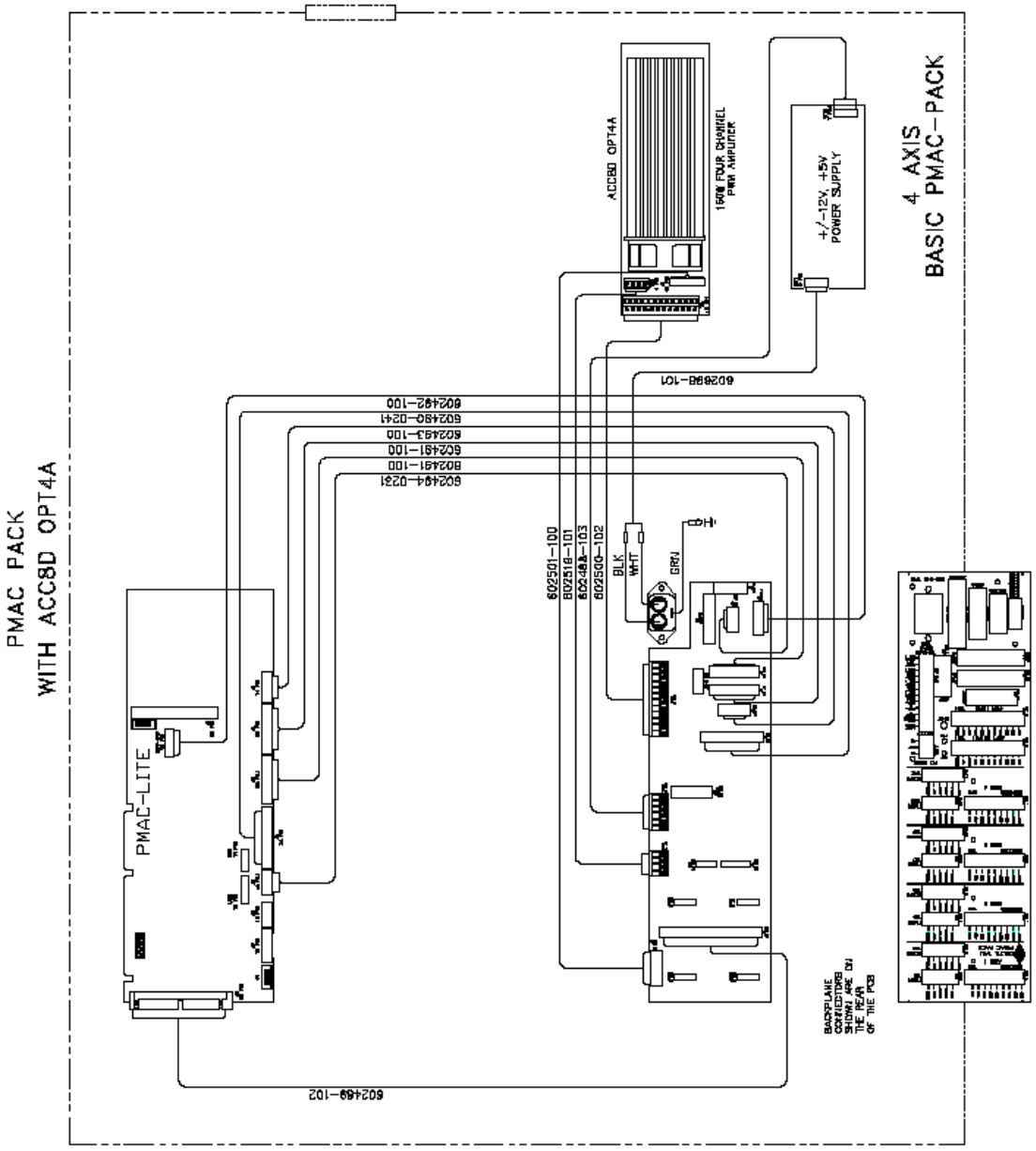


Figure 21 PMAC Pack with Acc-8D Option 4A Wiring Diagram

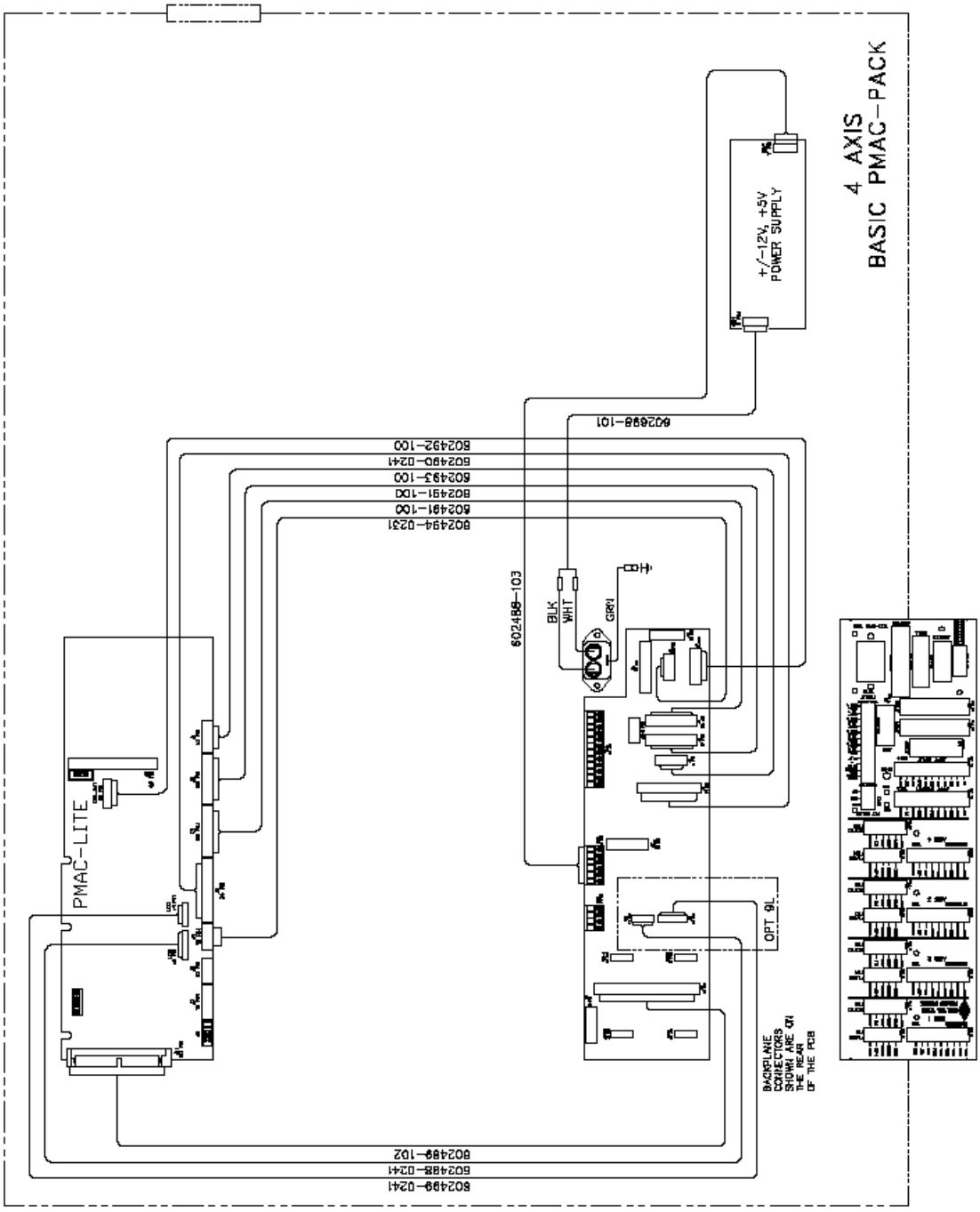


Figure 22 PMAC Pack with Option 9L Wiring Diagram

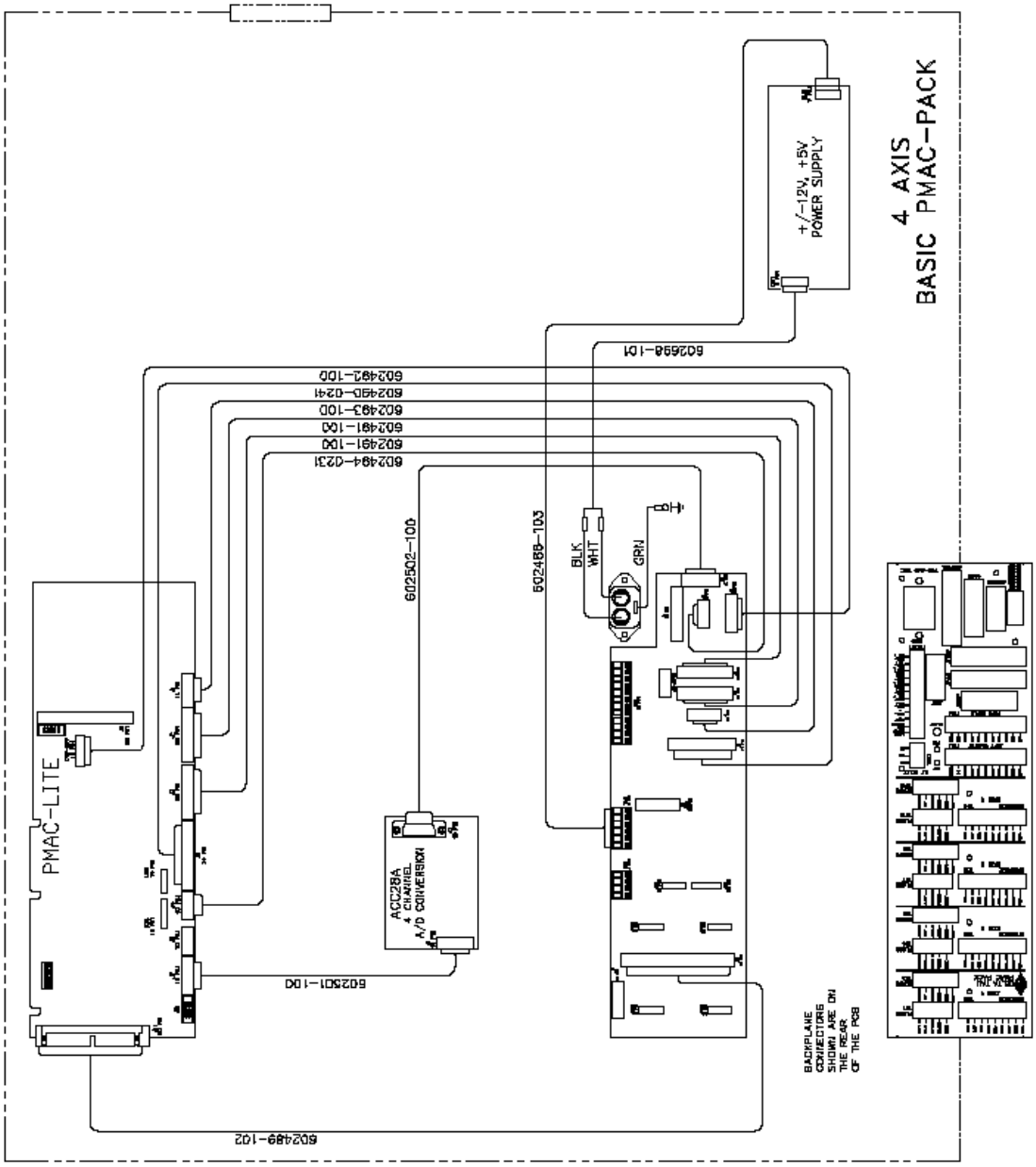


Figure 23 PMAC Pack with Acc-28A Wiring Diagram

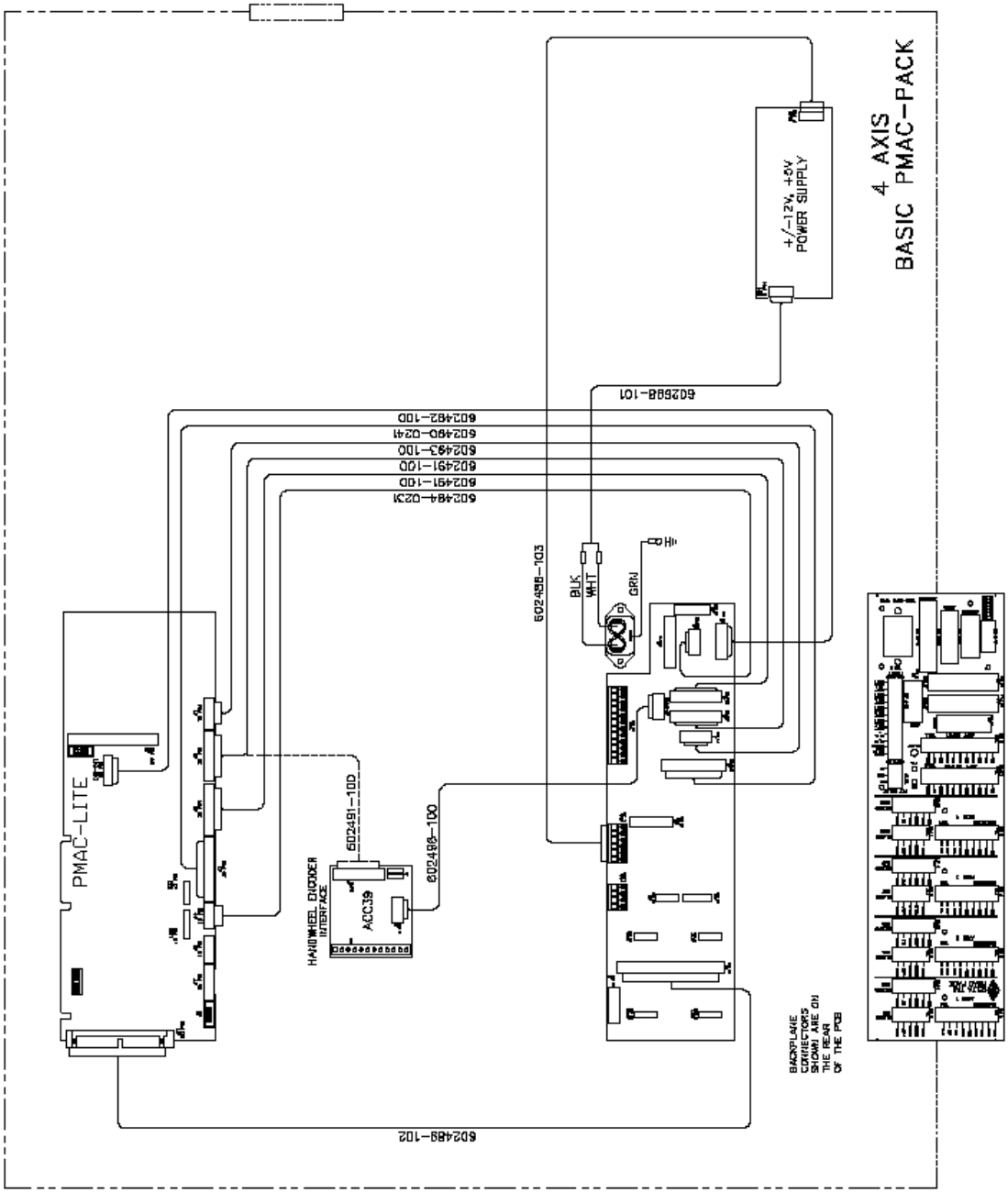


Figure 24 PMAC Pack with Acc-39 Wiring Diagram

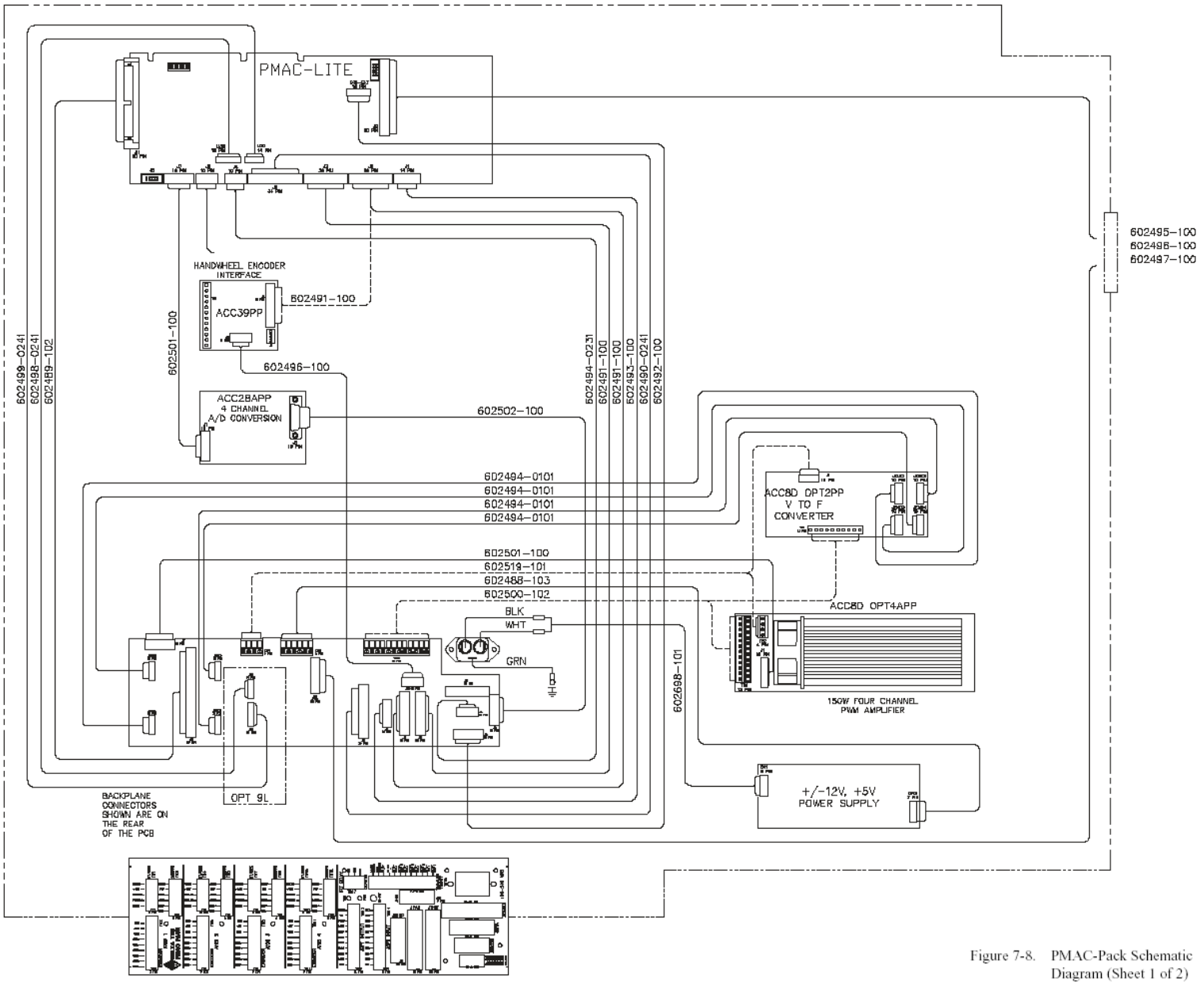


Figure 7-8. PMAC-Pack Schematic Diagram (Sheet 1 of 2)

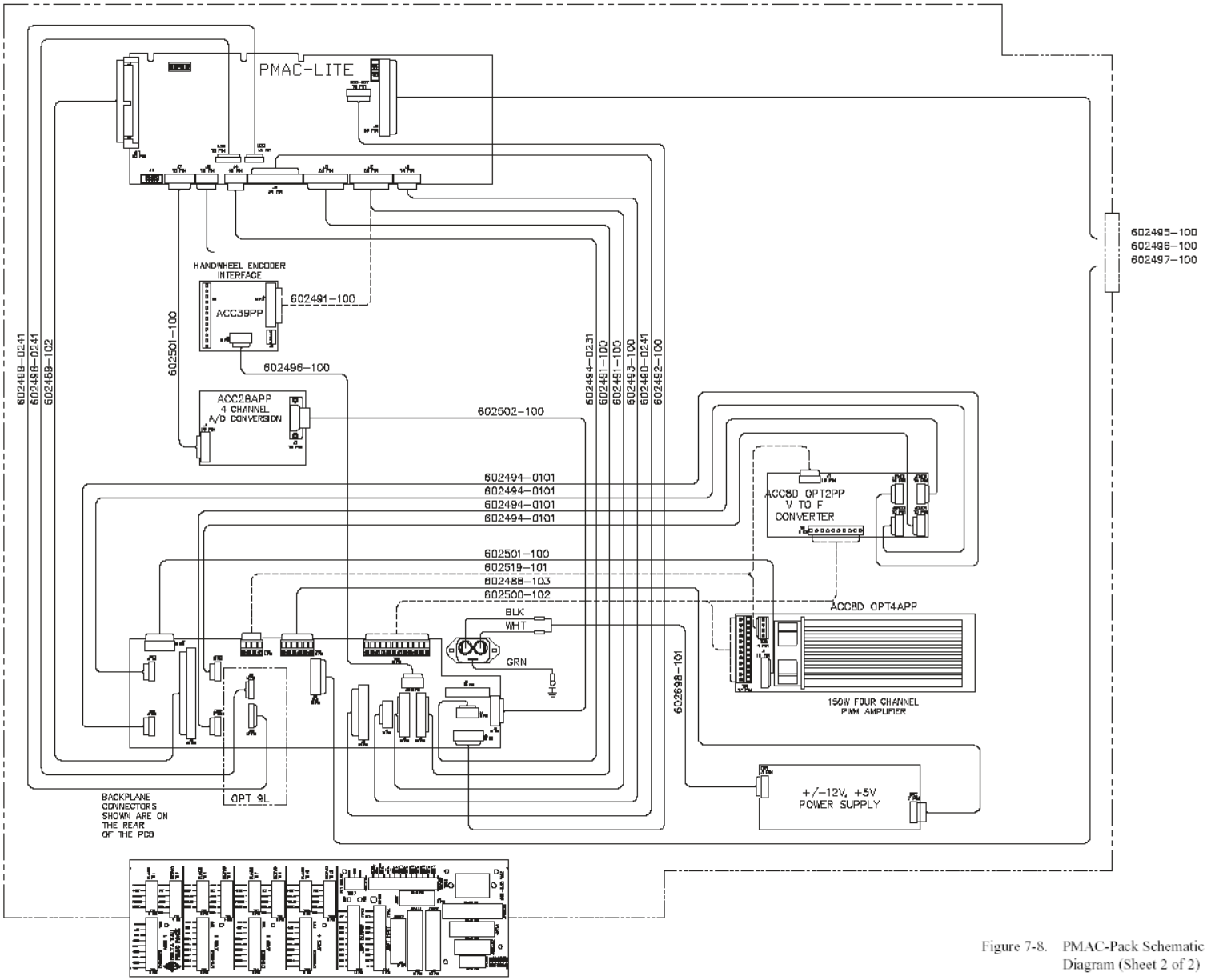


Figure 7-8. PMAC-Pack Schematic Diagram (Sheet 2 of 2)

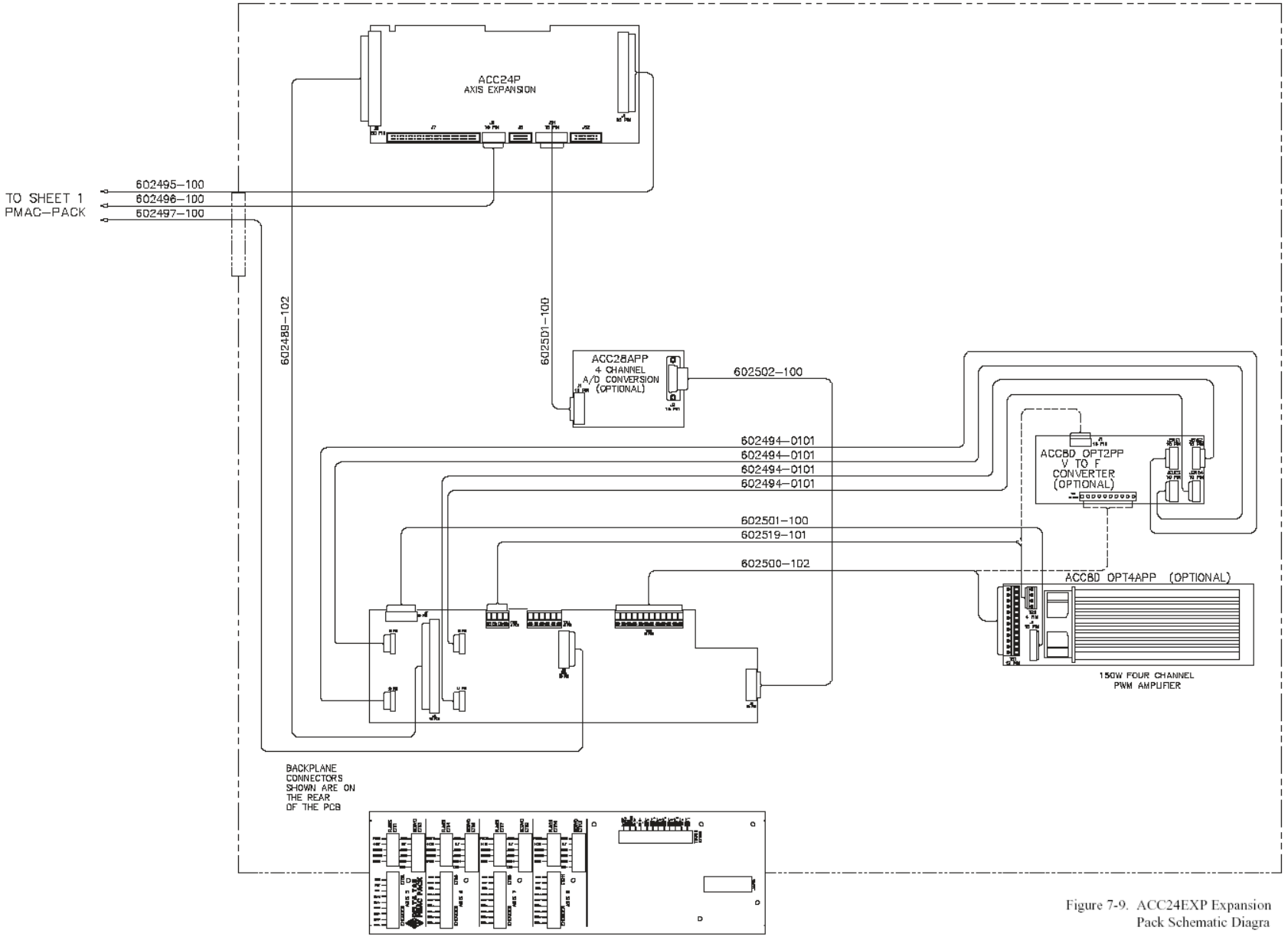


Figure 7-9. ACC24EXP Expansion Pack Schematic Diagra

ACC-24E ACC-24EXP EXPANSION XP PACK

Expansion Pack Installation

The Acc-24 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 four 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 Acc-24 PMAC Pack Expansion Pack. Therefore, it is not necessary to follow the Software Setup paragraph.

1. Remove the 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.
2. Remove the eight screws securing the two halves of the PMAC Pack sheet metal together.
3. Pull the front of the PMAC Pack case 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.

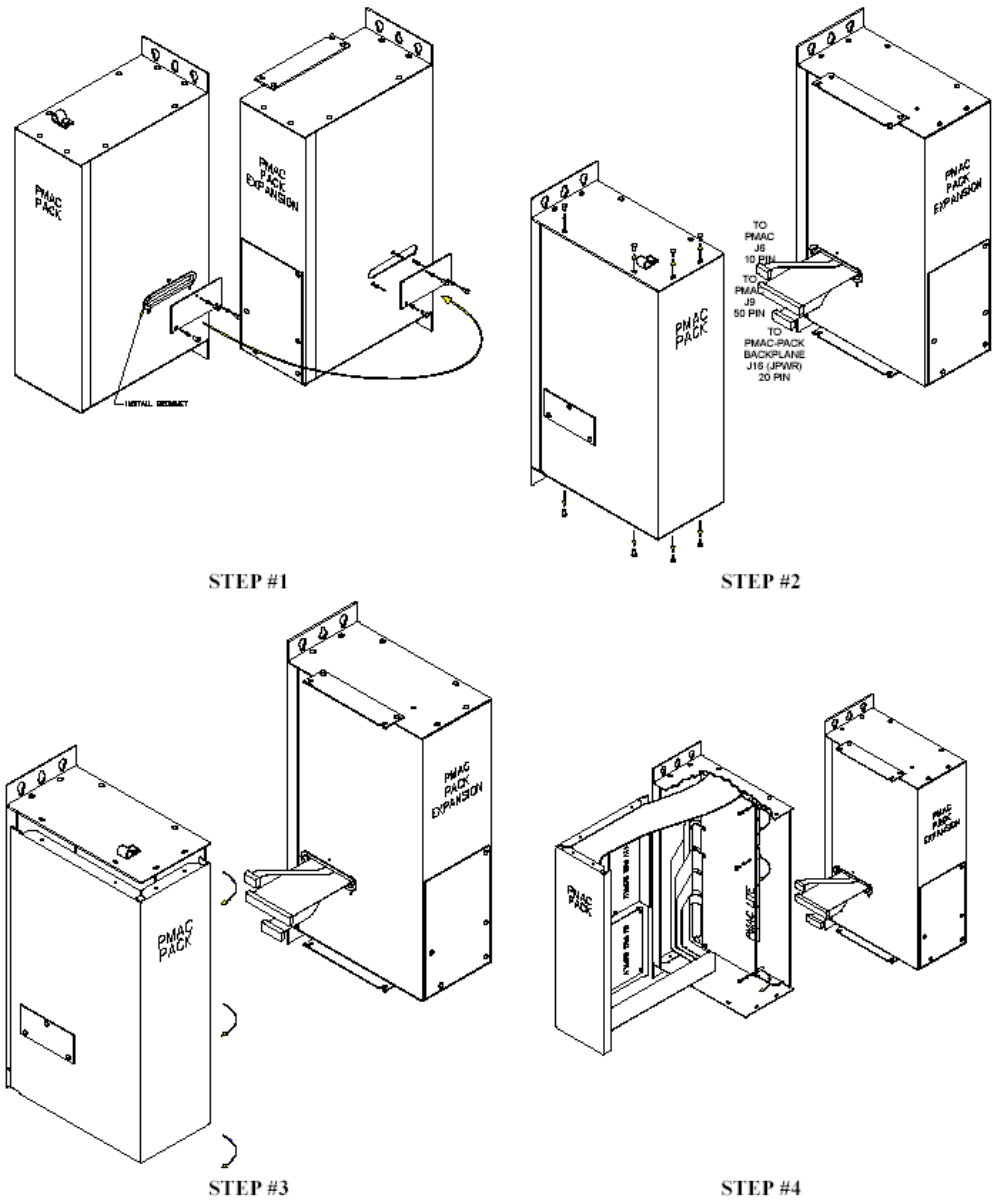


Figure 25 Expansion Pack Installation

PMAC Pack/Expansion Pack Connection

The field connection of PMAC Pack and the Acc-24EXP 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. Set up the hardware of the 8-axis PMAC Pack 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. Therefore, it is not necessary to follow the Software Setup paragraph.

The following paragraph describes how to internally connect the Expansion Pack to the PMAC Pack (see Figure 26).

1. 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.

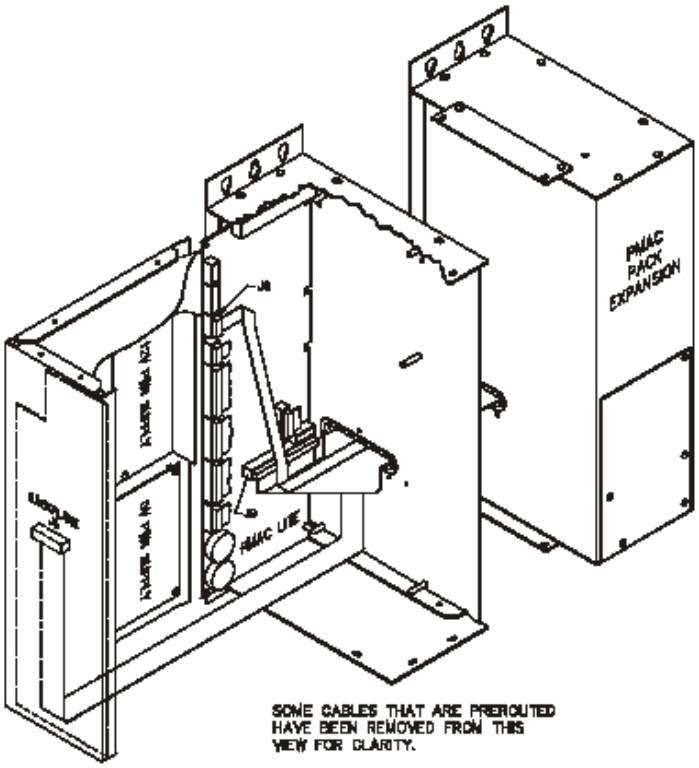


Figure 26 PMAC Pack/Expansion Pack Internal Connections

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).

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. Pull the left half slightly forward to clear the front right lip.
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.
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.

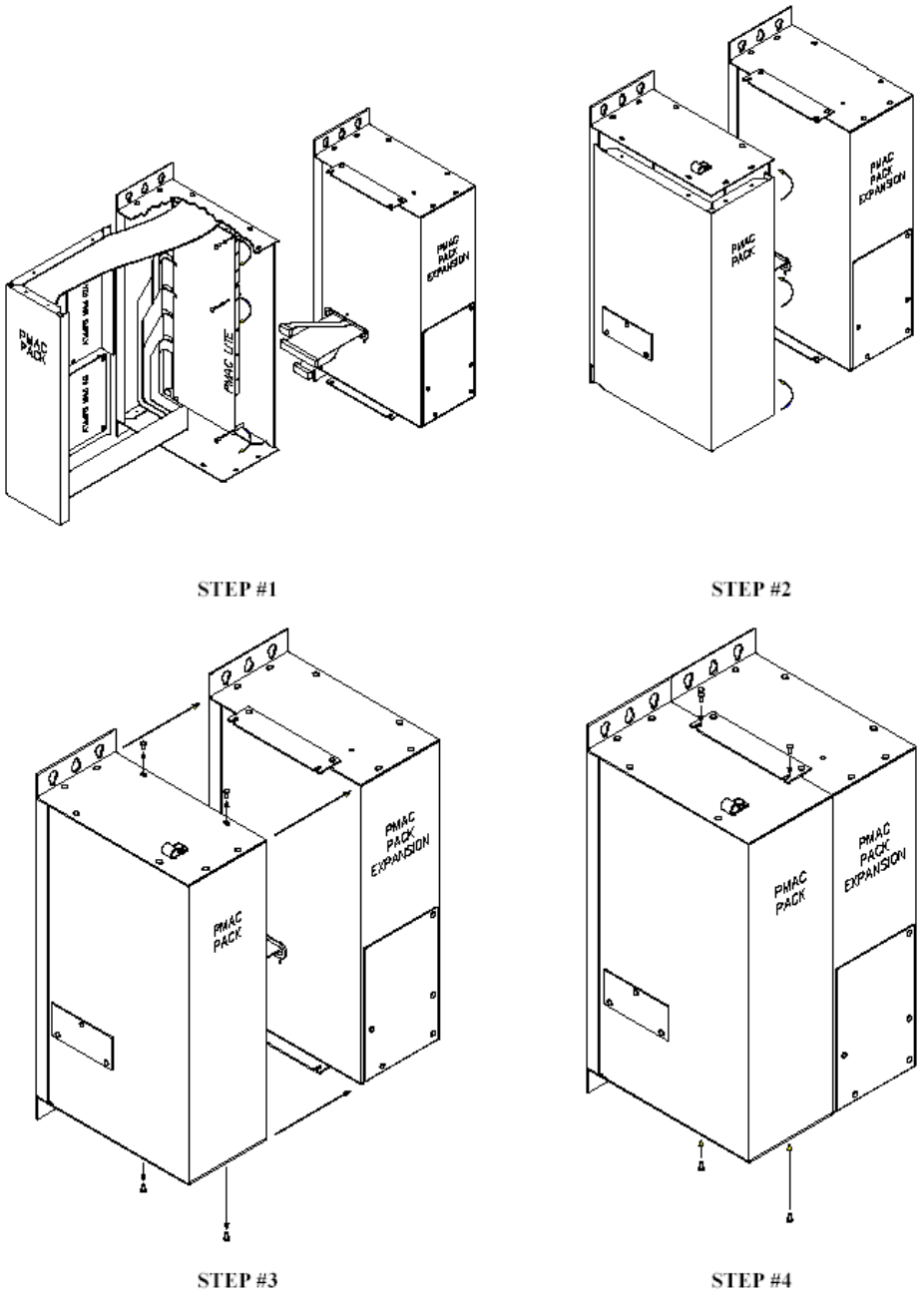


Figure 27 PMAC Pack Assembly

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, the 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 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: To use PMAC to commutate motor 5, set I583 = #C021. This will map the encoder hardware interface channel 9 ($C021) to motor 5.

PMAC PACK OPTIONS AND ACCESSORIES

PMAC Pack Internal Options and Accessories

Acc-8D Option 2PP: Stepper Drive Interface

This option provides four 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 Acc-8D Option 2PP is currently under development. At present, request the Acc-8D-Option 2 manual for further information.

Acc-8D 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 Acc-8D Option PP is under development. At present, request the Acc-8D Option 4 manual for further information.

Acc-8D 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 PMAC Pack Acc-8D Option 4APP is under development. At present, request the Acc-8D Option 4A manual for further information.

Option 9LPP: Optional RS422 Interface

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

Acc-24PP: PMAC Pack Expansion Pack

Provides four additional encoder channels and four additional DAC outputs which may be used to expand PMAC Packs control abilities to eight non-commutated axes or four commutated axes.

Acc-28APP: A/D Conversion Board

PMAC Pack Acc-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 PMAC Pack Acc-28 is under development. At present, request the Acc-28 manual for further information.

Acc-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 Acc-39 is under development. At present, request the Acc-39 manual for further information.

PMAC Pack Compatible External Accessories

Acc-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 with 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 Manual and Software Reference Manual
- Acc-4PP: PMAC Pack Hardware Reference Manual

Acc-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 Acc-39PP.

Note:

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

Acc-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 Acc-8D options can interface to PMAC Pack to facilitate connection of different servo feedback devices and motors. Terminal block options are as follows:

Acc-8D, 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 Acc-8D
Options are specified as follows:

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

Acc-9: IBM PC Executive Software Disks
The Acc-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.

Acc-12: Liquid Crystal/Vacuum Fluorescent Display
Acc-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 will 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

Acc-14: I/O Expansion Board

An Acc-14D may be mounted externally on standoffs and connected to the PMAC Pack through the JEXP port. An enclosed Acc-14 may be available in the future. Contact Delta Tau for further information.

Acc-16D: Control Panel and Display Box

The Acc-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 five status LEDs.

Note:

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

Acc-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 thumbwheel 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, eight position DIP switches may be mounted on the board for input.

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

Acc-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 six special programmable function keys; also an alphanumeric 2 x 24 LCD display.

Acc-22: Extended Warranty

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

Acc-25: Servo Evaluation Package

The Acc-25 Servo Evaluation Package (SEP) is a program for IBM PC compatible systems running under DOS for auto-tuning 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 auto-tuning (the Acc-9DA can perform the auto-tuning). Acc-25: Servo Evaluation Software for Extended Servo Algorithm on 3.5" diskette.

Acc-26: Serial Communications Converter

Acc-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 use, including PMAC Pack with Option 9LPP. 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 Option 9LPP RS-422 port, straight over the Acc-3D cable. PMAC Packs with Option 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

Acc-27: Optically Isolated I/O Board

Acc-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
- Option 2A: DB-25 I/O connector
- Option 2B: 18-point terminal block I/O connector

Acc-29: Magnetostrictive Linear Displacement Transducer Interface Board

An Acc-29 may be mounted externally on standoffs and connected to the PMAC Pack through the JEXP port. A ruggidized enclosed Acc-29 is not available at present but may be available in the future. Contact Delta Tau for further information.

Acc-31: PMAC Demonstration Box Unit

Acc-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)

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

Acc-32: PMAC Software Upgrade/Update Kit

PMAC's software for motion control is being upgraded continually. Software and documentation updates are readily available to the customer through Acc-32. Acc-32 consists of updates for an EPROM (PMAC firmware), User Manual, and Acc-9D PC Executive Program Diskette (if it was previously purchased).

Note:

Delta Tau will supply Acc-32 at least twice, 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 Manual, Executive Diskette
- Acc-32, Option 1: Additional EPROM

Acc-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

Acc-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

Acc-36: A/D Conversion Board

An Acc-36 may be mounted externally on standoffs and connected to the PMAC Pack through the JEXP port. A ruggidized enclosed Acc-36 is not available at present but may be available in the future. Contact Delta Tau for further information

Acc-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. Contact the factory for the latest update.

APPENDIX A - ELECTROSTATIC DISCHARGE CONTROL

Caution:

These procedures must be followed by anyone involved in handling PMAC Pack components. Failure to do so may void the product 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. Generally, a protected area is 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 a topical antistatic. 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 cannot 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. Normally, good general ventilation is 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. Ensure that conductive covers/caps are installed on all exposed terminals and connectors.
2. Ensure that the host unit is properly grounded.
3. Prior to disconnecting cable connectors, touch the unit's case with a 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.