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HARDWARE REFERENCE MANUAL

PMAC2A-PC/104 Axis Expansion Accessory-1P

PMAC2A-PC/104 ACC-1P Hardware Reference

4xx-603671-xHxx

December 6, 2010



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REVISION HISTORY				
REV.	**DESCRIPTION**	**DATE**	**CHG**	**APPVD**
1	ADDED ENCODER JUMPERS E20-E23	04/10/07	CP	S. MILICI
2	ADDED SOFTWARE SETUP INFO, P. 23	10/15/09	CP	S. MILICI
3	CORR. I-VARIABLES FOR USE WITH TURBO CPU	10/01/10	SS	S. SATTARI

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INTRODUCTION

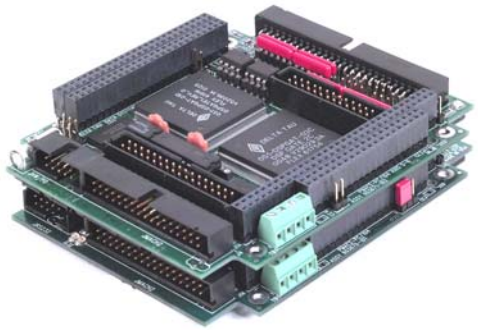
The PMAC2A PC/104 motion controller is a compact, cost-effective version of Delta Tau's PMAC2 family of controllers. The PMAC2A PC/104 can be composed of three boards in a stack configuration.

The baseboard provides four channels of either DAC ±10V or pulse and direction command outputs. The optional axis expansion board provides a set of four additional servo channels and I/O ports. The optional communications board provides extra I/O ports and either the USB or Ethernet interface for faster communications.

Acc-1P: Axis Expansion Piggyback Board

Acc-1P provides four additional channels axis interface circuitry for a total of eight servo channels, each including:

- 12-bit ±10V filtered PWM analog output
- Pulse-and-direction digital outputs
- 3-channel differential/single-ended encoder input
- Four input flags, two output flags
- Three PWM top-and-bottom pairs (unbuffered)



PMAC2A PC/104 Base Board shown stacked with the Acc-1P axes

Acc-1P Option 1: I/O Ports

Option 1 provides the following ports on the Acc-1P axes expansion board for digital I/O connections.

- Multiplexer Port: This connector provides eight input lines and eight output lines at TTL levels. When using the PMAC Acc-34x type boards these lines allow multiplexing large numbers of inputs and outputs on the port. Up to 32 of the multiplexed I/O boards may be daisy-chained on the port, in any combination.
- I/O Port: This port provides eight general-purpose digital inputs and eight general-purpose digital outputs at 5 to 24Vdc levels. This 34-pin connector was designed for easy interface to OPTO-22 or equivalent optically isolated I/O modules when different voltage levels or opto-isolation to the PMAC2A PC/104 is necessary.
- Handwheel port: this port provides two extra channels, each jumper selectable between encoder input or pulse output.

Acc-1P Option 2: Analog-to-Digital Converters

Option 2 permits the installation on the Acc-1P of two channels of analog-to-digital converters with ±10V input range and 12-bits resolution. The key component installed with this option is U20.

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HARDWARE SETUP

On the Acc-1P, there are a number of jumpers called E-points or W-points that customize the hardware features of the CPU for a given application and must be setup appropriately. The following is an overview grouped in appropriate categories. For an itemized description of the jumper setup configuration, refer to the E-Point Descriptions section.

I/O Configuration Jumpers

E1-E2: Machine Output Supply Configure – With the default sinking output driver IC (ULN2803A or equivalent) in U7 for the J7 JOPT port outputs, these jumpers must connect pins 1 and 2 to supply the IC correctly. If this IC is replaced with a sourcing output driver IC (UDN2981A or equivalent), these jumpers must be changed to connect pins 2 and 3 to supply the new IC correctly. A wrong setting of these jumpers will damage the associated output IC.

E3-E4: JHW, PD Function Select – When jumper E3 connects pins 2 and 3, a set of pulse and direction signals can be output on channel 1 (pins 2 to 5) of the JHW, PD port. If E3 connects pins 1 and 2, then channel 1 is configured as a handwheel encoder input. When jumper E4 connects pins 2 and 3, a set of pulse and direction signals can be output on channel 2 (pins 6 to 9) of the JHW, PD port. If E4 connects pins 1 and 2, then channel 2 is configured as a handwheel encoder input.

E5: Servo Gate address select – If jumper E5 connects pins 1 and 2 (default) the servo channels on the Acc-1P will be accessed at the regular addresses for motors 5 to 8. When E5 connects pins 2 and 3 the servo channels on the Acc-1P board will be accessed at the regular addresses for motors 5 to 8 plus $40, and this is useful only when two Acc-1Ps are used with the same PMAC2A PC/104 baseboard.

E6: I/O Gate address select – If jumper E6 connects pins 1 and 2 (default) the I/O features on the Acc-1P will be accessed at the regular addresses and the JTHW port can be used as a multiplexer port. When E6 connects pins 2 and 3 the I/O features on the Acc-1P board will be accessed at the regular addresses plus $40, and this is useful only when two I/O gate accessories are used with the same PMAC2A PC/104 baseboard.

E7: Machine Input Source/Sink Control – With this jumper connecting pins 1 and 2 (default) the machine input lines on the J7 JOPT port are pulled up to +5V or the externally provided supply voltage for the port. This configuration is suitable for sinking drivers. If the jumper is changes to connect pins 2 and 3, these lines are pulled down to GND – this configuration is suitable for sourcing drivers.

E16: ADC Enable Jumper – Install E16 to enable the analog-to-digital converter circuitry ordered through Option-2. Remove this jumper to disable this option, which might be necessary to control motor 5 through a digital amplifier with current feedback.

Encoder Configuration Jumpers

E20-E23: Encoder Single Ended/Differential Select – The ACC-1P has differential line receivers for each encoder channel, but can accept either single-ended (one signal line per channel) or differential (two signal lines, main and complementary, per channel). A jumper for each encoder permits customized configurations, as described below.

Single-Ended Encoders

With the jumper for an encoder set for single-ended (pin 1 to 2), the differential input lines for that encoder are tied to 2.5V; the single signal line for each channel is then compared to this reference as it changes between 0 and 5V. When using single-ended TTL-level digital encoders, the differential line input should be left open, not grounded or tied high; this is required for The PMAC differential line receivers to work properly.

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Differential Encoders

Differential encoder signals (pin 2 to 3) can enhance noise immunity by providing common-mode noise rejection. Modern design standards virtually mandate their use for industrial systems, especially in the presence of PWM power amplifiers, which generate a great deal of electromagnetic interference.

Connect pin 1 to 2 to tie differential line to +2.5V

- Tie to +2.5V when no connection
- Tie to +2.5V for single-ended encoders

Connect pin 2 to 3 to tie differential line to +5V

- Don't care for differential line driver encoders
- Tie to +5V for complementary open-collector encoders (obsolete)

Reserved Configuration Jumpers

E0: Reserved for future use

Resistor Packs Configuration (older rev boards without E20-23)

Differential or Single-Ended Encoder Selection

The differential input signal pairs to the PMAC have user-configurable pull-up/pull-down resistor networks to permit the acceptance of either single-ended or differential signals in one setting, or the detecting loss of differential signals in another setting.

The '+' inputs of each differential pair each have a hard-wired 1 kΩ pull-up resistor to +5V. This cannot be changed.

The '-' inputs of each differential pair each have a hard-wired 2.2 kΩ resistor to +5V; each also has another 2.2 kΩ resistor as part of a socketed resistor pack that can be configured as a pull-up resistor to +5V, or a pull-down resistor to GND.

If this socketed resistor is configured as a pull-down resistor (the default configuration), the combination of pull-up and pull-down resistors on this line acts as a voltage divider, holding the line at +2.5V in the absence of an external signal. This configuration is required for single-ended inputs using the '+' lines alone; it is desirable for unconnected inputs to prevent the pick-up of spurious noise; it is permissible for differential line-driver inputs.

If this socketed resistor is configured as a pull-up resistor (by reversing the SIP pack in the socket), the two parallel 2.2 kΩ resistors act as a single 1.1 kΩ pull-up resistor, holding the line at +5V in the absence of an external signal. This configuration is required if complementary open-collector drivers are used; it is permissible for differential line-driver inputs.

If Pin 1 of the resistor pack, marked by a dot on the pack, matches Pin 1 of the socket, labeled by a white square, then the pack is configured as a bank of pull-down resistors. If the pack is reversed in the socket, it is configured as a bank of pull-up resistors. The following table lists the pull-up/pull-down resistor pack for each input device:

Device	Resistor Pack	Pack Size
Encoder 1	RP30	6-pin
Encoder 2	RP31	6-pin
Encoder 3	RP36	6-pin

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Encoder 4	RP37	6-pin
Handwheel Encoder	RP55	6-pin

Handwheel Encoder Termination Resistors

The PMAC provides a socket for termination resistors on the handwheel encoder differential input pairs coming into the board. As shipped, there is no resistor pack in the RP56 socket. If these signals are brought long distances into the PMAC board and ringing at signal transitions is a problem, a SIP resistor pack may be mounted on the RP56 socket to reduce or eliminate the ringing. The 6-pin termination resistor pack is the type that has independent resistors (no common connection) with each resistor using 2 adjacent pins.

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MACHINE CONNECTIONS

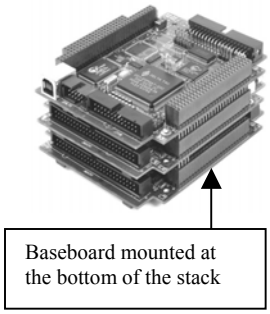
Typically, the user connections are actually made to terminal blocks that are attached to the JMACH connectors by a flat cable. The following are the terminal blocks recommended for connections:

- 34-Pin IDC header to terminal block breakouts (Phoenix part number 2281063) Delta Tau part number 100-FLKM34-000
- 50-Pin IDC header to terminal block breakouts (Phoenix part number 2281089) Delta Tau part number 100-FLKM50-000

Mounting

The PMAC2A PC/104 is always installed either using standoffs, when it is stacked to a PC/104 computer or used as a stand-alone controller. At each of the four corners of the PMAC2A PC/104 board, there are mounting holes that can be used to mount the board on standoffs.

The PMAC2A PC/104 baseboard is placed always at the bottom of the stack. The order of the Acc-1P or Acc-2P with respect to the baseboard does not matter.



Power Supplies

Digital Power Supply

3A @ +5V (±5%) (15 W)

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

The PMAC2A PC/104, the Acc-1P and the Acc-2P each require a 1A @ 5VDC power supply for operation. Therefore, a 3A @ 5VDC power supply is recommended for a PMAC2A PC/104 board stack with Acc-1P and Acc-2P boards.

- The host computer provides the 5 Volts power supply in the case PMAC is installed in the PC/104 bus. With the board stack into the bus, it will automatically pull +5V power from the bus and it cannot be disconnected. In this case, there must be no external +5V supply, or the two supplies will "fight" each other, possibly causing damage. This voltage could be measured on the TB1 terminal block or the JMACH1 connector.
- In a stand-alone configuration, when PMAC is not plugged in a computer bus, it will need an external 5V supply to power its digital circuits. The 5V power supply can be brought in either from the TB1 terminal block or from the JMACH1 connector.

DAC Outputs Power Supply

0.3A @ +12 to +15V (4.5W)
0.25A @ -12 to -15V (3.8W)
(Eight-channel configuration)

- The host computer provides the ±12 Volts power supply in the case PMAC is installed in the PC/104 bus. With the board stack into the bus, it will pull ±12V power from the bus automatically and it cannot be disconnected. In this case, there must be no external ±12V supply, or the two supplies will fight each other, possibly causing damage. This voltage could be measured on the TB1 terminal block.
- In a stand-alone configuration, when PMAC is not plugged in a computer bus, it will need an external ±12V supply only when the digital-to-analog converter (DAC) outputs are used. The ±12V lines from the supply, including the ground reference, can be brought in either from the TB1 terminal block or from the JMACH1 connector.

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Flags Power Supply

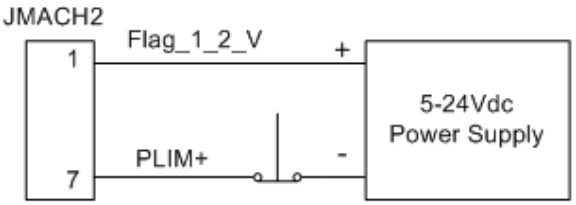
Each channel of PMAC has five dedicated digital inputs on the machine connector: PLIMn, MLIMn (overtravel limits), HOMEn (home flag), FAULTn (amplifier fault), and USERn. A power supply from 5 to 24V must be used to power the circuits related to these inputs. This power supply can be the same used to power PMAC and can be connected from the TB1 terminal block or the JMACH1 connector.

Overtravel Limits and Home Switches

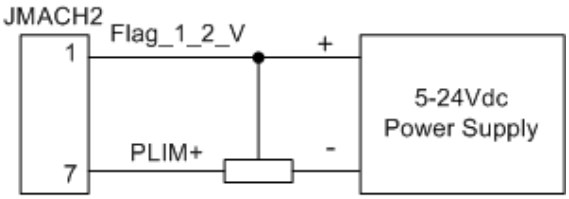
When assigned for the dedicated uses, these signals provide important safety and accuracy functions. PLIMn and MLIMn are direction-sensitive over-travel limits that must conduct current to permit motion in that direction. If no over-travel switches will be connected to a particular motor, this feature must be disabled in the software setup through the PMAC Ix25 variable.

Types of Overtravel Limits

PMAC expects a closed-to-ground connection for the limits to not be considered on fault. This arrangement provides a failsafe condition. Usually, a passive normally close switch is used. If a proximity switch is needed instead, use a 5 to 24V normally closed to ground NPN sinking type sensor.



Dry Contact



15-24V proximity

Home Switches

- While normally closed-to-ground switches are required for the overtravel limits inputs, the home switches could be either normally close or normally open types. The polarity is determined by the home sequence setup, through the I-variables I9n2. .

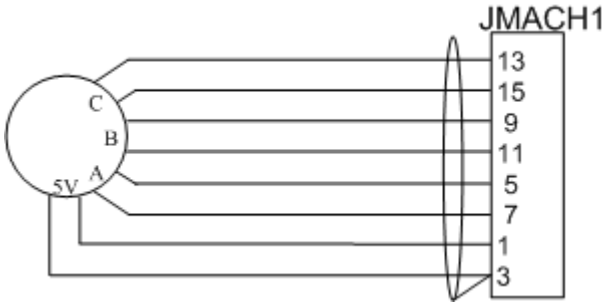
Motor Signals Connections

Incremental Encoder Connection

Each JMACH1 connector provides two +5V outputs and two logic grounds for powering encoders and other devices. The +5V outputs are on pins 1 and 2; the grounds are on pins 3 and 4. The encoder signal pins are grouped by number: all those numbered 1 (CHA1+, CHA1-, CHB1+, CHC1+, etc.) belong to encoder #1. The encoder number does not have to match the motor number, but usually does. Connect the A and B (quadrature) encoder channels to the appropriate terminal block pins. For encoder 1, the CHA1+ is pin 5 and CHB1+ is pin 9. If there is a single-ended signal, leave the complementary signal pins floating – do not ground them. However, if single-ended encoders are used, check the settings of the resistor packs (see the Hardware Setup section for details). For a differential encoder, connect the complementary signal lines – CHA1- is pin 7, and CHB1- is pin 11. The third channel (index pulse) is optional; for encoder 1, CHC1+ is pin 13, and CHC1- is pin 15.

Example: differential quadrature encoder connected to channel #1:

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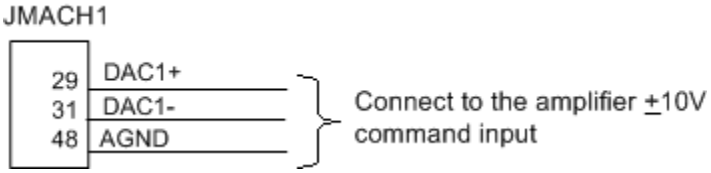
DAC Output Signals

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. For a single-ended command using PMAC channel 1, connect DAC1+ (pin 29) to the command input on the amplifier. Connect the amplifier's command signal return line to PMAC's GND line (pin 48). In this setup, leave the DAC1- pin floating; do not ground it.

For a differential command using PMAC channel 1, connect DAC1 (pin 29) to the plus-command input on the amplifier. Connect DAC1- (pin 31) to the minus-command input on the amplifier. PMAC's GND should still be connected to the amplifier common.

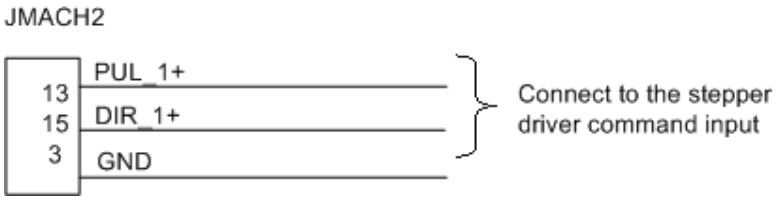
Any analog output not used for dedicated servo purposes may be utilized as a general-purpose analog output by defining an M-variable to the command register, then writing values to the M-variable. The analog outputs are intended to drive high-impedance inputs with no significant current draw. The 220Ω output resistors will keep the current draw lower than 50 mA in all cases and prevent damage to the output circuitry, but any current draw above 10 mA can result in noticeable signal distortion.

Example:



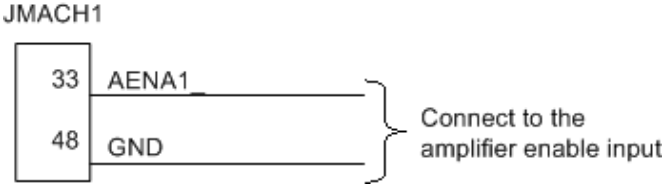
Pulse and Direction (Stepper) Drivers

The channels provided by the PMAC2A PC/104 board or the Acc-1P board can output pulse and direction signals for controlling stepper drivers or hybrid amplifiers. These signals are at TTL levels.



Amplifier Enable Signal (AENAx/DIRn)

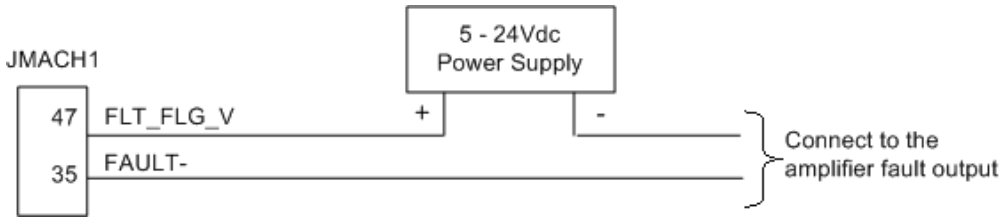
Most amplifiers have an enable/disable input that permits complete shutdown of the amplifier regardless of the voltage of the command signal. PMAC's AENA line is meant for this purpose. AENA1- is pin 33. This signal is an open-collector output and an external 3.3 kΩ pull-up resistor can be used if necessary.



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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 ground (GND). FAULT1- is pin 35. 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.



General-Purpose Digital Inputs and Outputs (J7 Port)

Acc-1P J7 connector provides eight general-purpose digital inputs and eight general-purpose digital outputs. Each input and each output has its own corresponding ground pin in the opposite row. The 34-pin connector was designed for easy interface to OPTO-22 or equivalent optically isolated I/O modules. Delta Tau's Acc-21F is a six-foot cable for this purpose. Characteristics of the JOPTO port on the PMAC:

- 16 I/O points. 100 mA per channel, up to 24V
- Hardware selectable between sinking and sourcing in groups of 8; default is all sinking (inputs can be changed simply by moving a jumper; sourcing outputs must be special-ordered or field-configured)
- Eight inputs, and eight outputs only; no changes. Parallel (fast) communications to PMAC CPU
- Not opto-isolated; easily connected to Opto-22 (PB16) or similar modules through Acc-21F cable

Jumper E7 on the Acc-1P board controls the configuration of the eight inputs. If it connects pins 1 and 2 (the default setting), the inputs are biased to +5V for the OFF state, and they must be pulled low for the ON state. If E7 connects pins 2 and 3, 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.

PMAC is shipped standard with a ULN2803A sinking (open-collector) output IC for the eight outputs. These outputs can sink up to 100 mA and have an internal 3.3 kΩ pull-up resistor to go high (RP18). Do not connect these outputs directly to the supply voltage, or damage to the PMAC will result from excessive current draw. The user can provide a high-side voltage (+5 to +24V) into Pin 33 of the J7 connector, and allow this to pull up the outputs by connecting pins 1 and 2 of Jumper E1. Jumper E2 must also connect pins 1 and 2 for a ULN2803A sinking output.

It is possible for these outputs to be sourcing drivers by substituting a UDN2981A IC for the ULN2803A. This U7 IC is socketed, and so may easily be replaced. Usually the U7 IC is offset by two pins on its socket, and so pins 1 and 2 usually remain open.

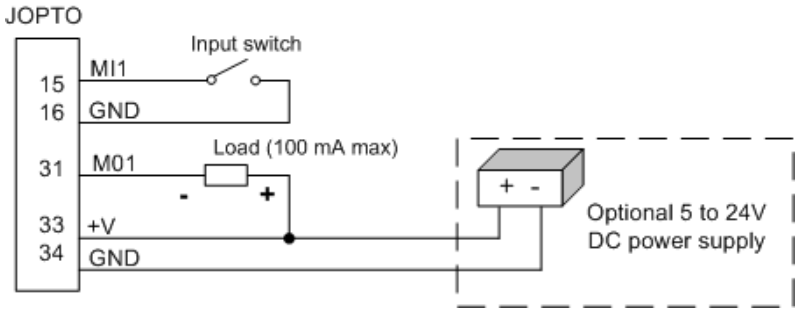
WARNING

Having Jumpers E1 and E2 set wrong can damage the IC. The +V output on this connector has a 2A fuse, F1, for excessive current protection.

For this driver, the internal resistor packs pull-down instead. With a UDN2981A driver IC, Jumper E1 must connect pins 2 and 3, and Jumper E2 must connect pins 2 and 3.

Example: Standard configuration using the ULN2803A sinking (open-collector) output IC.

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Further software settings are required to configure this port. See the Software Setup section for details.

Thumbwheel Multiplexer Port (JTHW Port)

The Thumbwheel Multiplexer Port, or Multiplexer Port, on the JTHW connector has sixteen lines. These lines can be used to multiplex large numbers of inputs and outputs on the port, and Delta Tau provides accessory boards and software structures (special M-variable definitions) to capitalize on this feature. Up to 32 of the multiplexed I/O boards may be daisy-chained on the port, in any combination. Either the Acc-1P or the Acc-2P boards, but not both, can use this connector as a multiplexing port. This is selected by jumper E6 on the Acc-1P board and jumper E5 on the Acc-2P board.

Alternatively, the inputs and outputs on this port may be used as discrete, non-multiplexed I/O. In this case, these I/O lines can be accessed through M-variables. See the Software Setup section for details on this.

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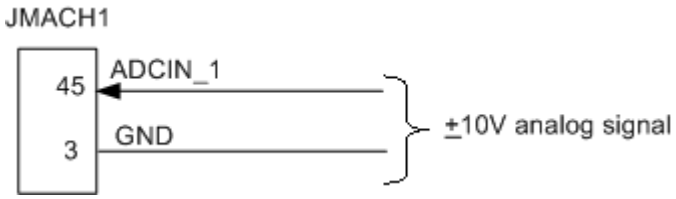
When used as non-multiplexed I/O, jumpers E7 and E8 select the I/O lines direction of the JTHW connector. This allows configuring this port as all inputs, all outputs or half inputs and half outputs. If E7 is removed or E8 is installed then the multiplexing feature if the JTHW port cannot be used.

Handwheel Port (JHW / PD Port)

This port provides an extra encoder input or a set of pulse and direction outputs. Jumpers E3 and E4 select the function of this connector between encoder input or pulse and direction outputs. The handwheel encoder input can be linked to a servomotor for manual displacement or used by a motor as a secondary encoder for dual-feedback applications. There is no C index channel input on the handwheel encoder port.

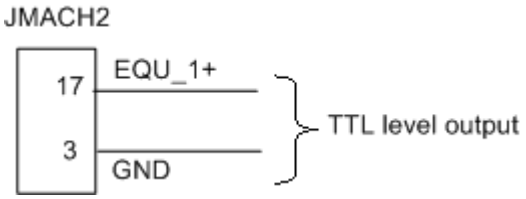
Optional Analog Inputs

The optional analog-to-digital converter inputs are ordered either through Option-12 on the baseboard or Option-2 on the axes expansion board. Each option provides two 12-bit analog inputs analog inputs with a ±10Vdc range.



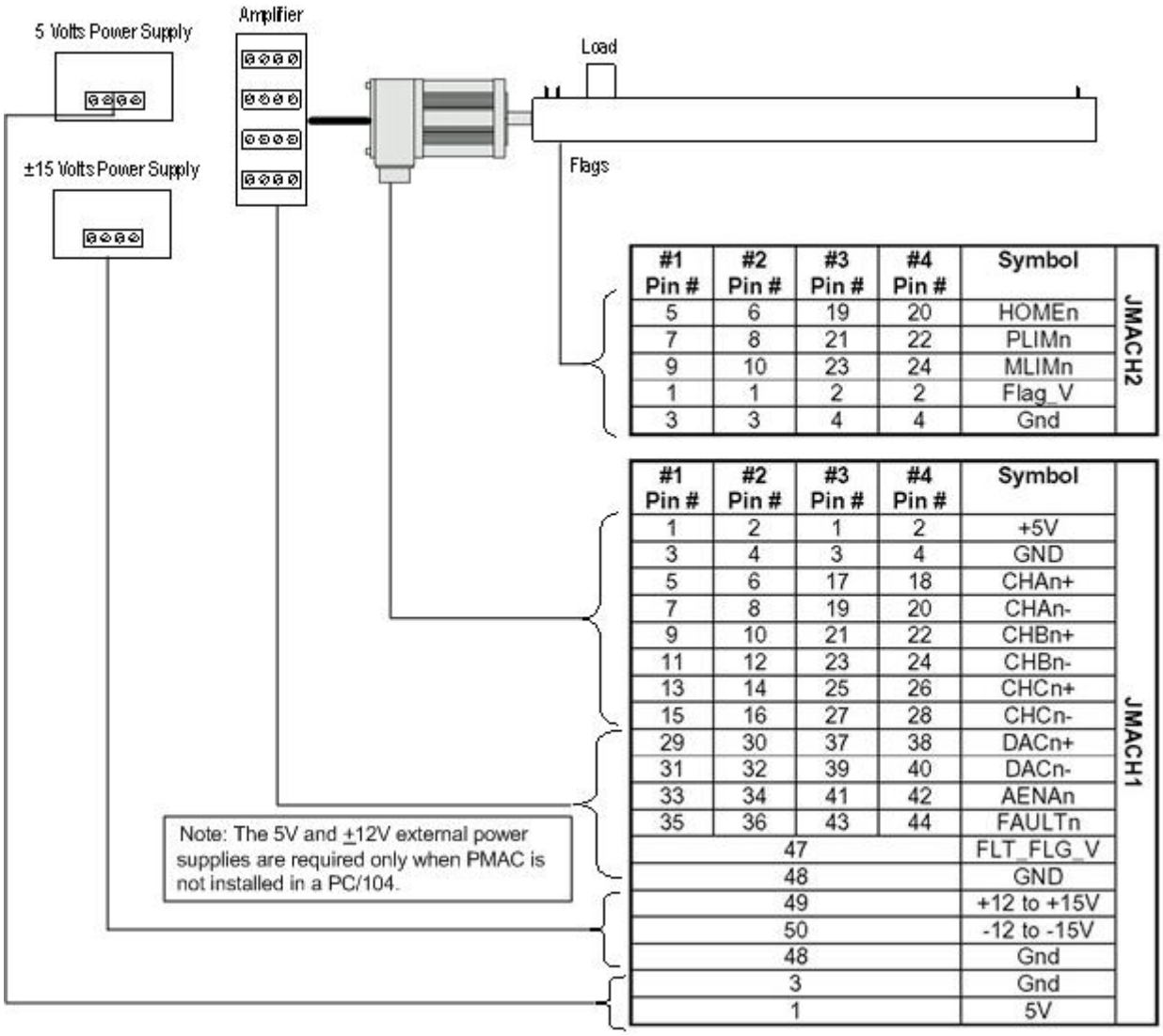
Compare Equal Outputs

The compare-equals (EQU) outputs have a dedicated use of providing a signal edge when an encoder position reaches a pre-loaded value. This is very useful for scanning and measurement applications. Instructions for use of these outputs are covered in detail in the PMAC2 User Manual.



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Machine Connections Example: Using Analog ±10V Amplifier

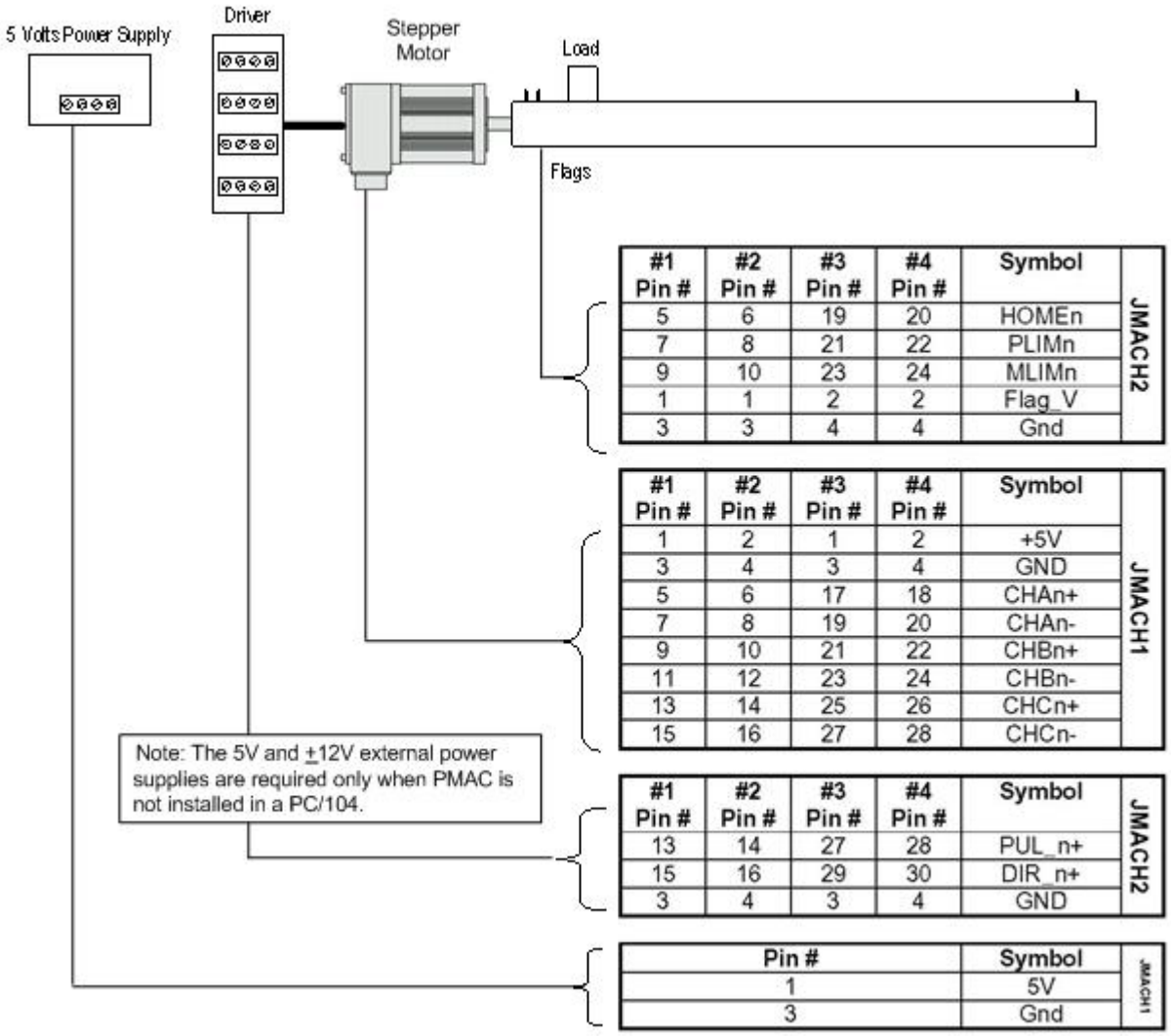


#1 Pin #	#2 Pin #	#3 Pin #	#4 Pin #	Symbol	
5	6	19	20	HOMEn	JMACH2
7	8	21	22	PLIMn	
9	10	23	24	MLIMn	
1	1	2	2	Flag_V	
3	3	4	4	Gnd	

#1 Pin #	#2 Pin #	#3 Pin #	#4 Pin #	Symbol	
1	2	1	2	+5V	JMACH1
3	4	3	4	GND	
5	6	17	18	CHAn+	
7	8	19	20	CHAn-	
9	10	21	22	CHBn+	
11	12	23	24	CHBn-	
13	14	25	26	CHCn+	
15	16	27	28	CHCn-	
29	30	37	38	DACn+	
31	32	39	40	DACn-	
33	34	41	42	AENAn	
35	36	43	44	FAULTn	
47				FLT_FLG_V	
48				GND	
49				+12 to +15V	
50				-12 to -15V	
48				Gnd	
3				Gnd	
1				5V	

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Machine Connections Example: Using Pulse and Direction Drivers



JMACH2

#1 Pin #	#2 Pin #	#3 Pin #	#4 Pin #	Symbol
5	6	19	20	HOMEn
7	8	21	22	PLIMn
9	10	23	24	MLIMn
1	1	2	2	Flag_V
3	3	4	4	Gnd

JMACH1

#1 Pin #	#2 Pin #	#3 Pin #	#4 Pin #	Symbol
1	2	1	2	+5V
3	4	3	4	GND
5	6	17	18	CHAn+
7	8	19	20	CHAn-
9	10	21	22	CHBn+
11	12	23	24	CHBn-
13	14	25	26	CHCn+
15	16	27	28	CHCn-

JMACH2

#1 Pin #	#2 Pin #	#3 Pin #	#4 Pin #	Symbol
13	14	27	28	PUL_n+
15	16	29	30	DIR_n+
3	4	3	4	GND

JMACH1

Pin #	Symbol
1	5V
3	Gnd

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SOFTWARE SETUP (non-Turbo PMAC2A-PC104)

Note:

The PMAC2A PC/104 requires the use of V1.17 or newer firmware. There are few differences between the previous V1.16H firmware and the V1.17 firmware other than the addition of internal support for the Flex CPU design.

Communications

Delta Tau provides software tools that allow communicating with of the PMAC2A PC/104 board by either its standard RS-232 port or the optional USB or Ethernet ports. PEWIN is the most important in the series of software accessories, and it allows configuring and programming the PMAC for any particular application.

PMAC I-Variables

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 non-volatile 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).

Filtered DAC Outputs Configuration

The following I-variables must be set properly to use the digital-to-analog (filtered DAC) outputs:

```
I900   =     1001              ; PWM frequency 29.4kHz, PWM 1-4
I901   =     2                 ; Phase Clock 19.6kHz
I902   =     3                 ; Servo frequency 4.9kHz
I903   =     1746              ; ADC frequency
I906   =     1001              ; PWM frequency 29.4kHz, PWM 5-8
I907   =     1746              ; ADC frequency
I9n6   =     0                 ; Output mode: PWM
Ix69   =     1001              ; DAC limit 10Vdc
I10    =     1710933           ; Servo interrupt time
```

n = channel number from 1 to 8
x = motor number from 1 to 8

Using Flag I/O as General-Purpose I/O

Either the user flags or other not assigned axes flag on the base board can be used as general-purpose I/O for up to 20 inputs and 4 outputs at 5-24Vdc levels. The indicated suggested M-variables definitions, which are defined in the PMAC2 Software reference, allows accessing each particular line according to the following table:

Flag	Type	Channel Number			
		#5	#6	#7	#8
HOME	5-24 VDC Input	M520	M620	M720	M820
PLIM	5-24 VDC Input	M521	M621	M721	M821
MLIM	5-24 VDC Input	M522	M622	M722	M822
USER	5-24 VDC Input	M515	M615	M715	M815
AENA	5-24 VDC Output	M514	M614	M714	M814

Note:

When using these lines as regular I/O points the appropriate setting of the Ix25 variable must be used to enable or disable the safety flags feature.

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General-Purpose Digital Inputs and Outputs

If one Acc-1P is present on the PMAC2A PC/104 stack configuration then its jumpers E5 and E6 should be set at the default position 1-2. In this case, the lines on its J7 general-purpose I/O connector will be mapped into PMAC's address space in register Y:$C080. Jumpers E5 and E6 should be configured on position 2-3 only when two Acc-1Ps are used. In this case, the I/O lines can be accessed at address Y:$C0C0.

If no Acc-1P is present on the PMAC2A PC/104 stack configuration, and only Acc-2P is used, then jumper E5 on the Acc-2P board should connect pins 1 and 2. In this case the lines on its JOPT general-purpose I/O connector will be mapped into PMAC's address space in register Y:$C080.

If both Acc-1P and Acc-2P are used, then jumper E5 on the Acc-2P board should connect pins 2 and 3 and its I/O lines can be accessed at address Y:$C0C0.

Typically, these I/O lines are accessed individually with M-variables. Following is a suggested set of M-variable definitions to use these data lines.

Jumper E6 on Position 1-2

```
M0->Y:$C080,0           ; Digital Output M00
M1->Y:$C080,1           ; Digital Output M01
M2->Y:$C080,2           ; Digital Output M02
M3->Y:$C080,3           ; Digital Output M03
M4->Y:$C080,4           ; Digital Output M04
M5->Y:$C080,5           ; Digital Output M05
M6->Y:$C080,6           ; Digital Output M06
M7->Y:$C080,7           ; Digital Output M07
M8->Y:$C080,8           ; Digital Input MI0
M9->Y:$C080,9           ; Digital Input MI1
M10->Y:$C080,10         ; Digital Input MI2
M11->Y:$C080,11         ; Digital Input MI3
M12->Y:$C080,12         ; Digital Input MI4
M13->Y:$C080,13         ; Digital Input MI5
M14->Y:$C080,14         ; Digital Input MI6
M15->Y:$C080,15         ; Digital Input MI7
M32->X:$C080,0,8        ; Direction Control bits 0-7  (1=output,  0 = input)
M34->X:$C080,8,8        ; Direction Control bits 8-15 (1=output,  0 = input)
M40->X:$C084,0,24       ; Inversion control (0 = 0V, 1 = 5V)
M42->Y:$C084,0,24       ; J7 port data type control (1 = I/O)
```

In order to properly setup the digital outputs an initialization PLC must be written scanning through once on power-up/reset, then disabling itself:

```
OPEN PLC1 CLEAR
M32=$FF                 ;BITS 0-8 are assigned as output
M34=$0                  ;BITS 9-16 are assigned as input
M40=$FF00               ;Define as inputs and outputs
M42=$FFFF               ;All lines are I/O type
DIS PLC1                ;Disable PLC1 (scanning through once on
                        ;power-up/reset)
CLOSE
```

Note:

After loading this program, set I5=2 or 3 and ENABLE PLC 1.

Jumper E5 in Position 2-3

```
M0->Y:$C0C0,0                ; Digital Output M00
M1->Y:$C0C0,1                ; Digital Output M01
```


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```
M2->Y:$C0C0,2                   ; Digital Output M02
M3->Y:$C0C0,3                   ; Digital Output M03
M4->Y:$C0C0,4                   ; Digital Output M04
M5->Y:$C0C0,5                   ; Digital Output M05
M6->Y:$C0C0,6                   ; Digital Output M06
M7->Y:$C0C0,7                   ; Digital Output M07
M8->Y:$C0C0,8                   ; Digital Input MI0
M9->Y:$C0C0,9                   ; Digital Input MI1
M10->Y:$C0C0,10                 ; Digital Input MI2
M11->Y:$C0C0,11                 ; Digital Input MI3
M12->Y:$C0C0,12                 ; Digital Input MI4
M13->Y:$C0C0,13                 ; Digital Input MI5
M14->Y:$C0C0,14                 ; Digital Input MI6
M15->Y:$C0C0,15                 ; Digital Input MI7
M32->X:$C0C0,0,8                ; Direction Control (1=output,  0 = input)
M34->X:$C0C0,8,8                ; Direction Control (1=output,  0 = input)
M40->X:$C0C4,0,24               ; Inversion control (0 = 0V, 1 = 5V)
M42->Y:$C0C4,0,24               ; JI/O port data type control (1 = I/O)
```

In order to properly setup the digital outputs, an initialization PLC must be written scanning through once on power-up/reset, and then disabling itself:

```
OPEN PLC1 CLEAR
M32=$FF                         ;BITS 0-8 are assigned as output
M34=$0                          ;BITS 9-16 are assigned as input
M40=$FF00                       ;Define as inputs and outputs
M42=$FFFF                       ;All lines are I/O type
DIS PLC1                        ;Disable PLC1 (scanning through once on
                                ;power-up/reset)
CLOSE
```

Note:

After loading this program, set I5=2 or 3 and ENABLE PLC 1.

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Thumbwheel Port Digital Inputs and Outputs

The inputs and outputs on the thumbwheel multiplexer port of either the Acc-1P or the Acc-2P boards may be used as discrete, non-multiplexed I/O. In this case, these I/O lines can be accessed through M-variables that are defined according to the setup of the address selection jumpers. Jumper E6 on the Acc-1P or E5 on the Acc-2P determine which set of the following M-variables are used:

Jumper E6 in Position 1-2

```
M40->Y:$C082,8,1              ; SEL0 Output
M41->Y:$C082,9,1              ; SEL1 Output
M42->Y:$C082,10,1             ; SEL2 Output
M43->Y:$C082,11,1             ; SEL3 Output
M44->Y:$C082,12,1             ; SEL4 Output
M45->Y:$C082,13,1             ; SEL5 Output
M46->Y:$C082,14,1             ; SEL6 Output
M47->Y:$C082,15,1             ; SEL7 Output
M48->Y:$C082,8,8,U            ; SEL0-7 Outputs treated as a byte
M50->Y:$C082,0,1              ; DAT0 Input
M51->Y:$C082,1,1              ; DAT1 Input
M52->Y:$C082,2,1              ; DAT2 Input
M53->Y:$C082,3,1              ; DAT3 Input
M54->Y:$C082,4,1              ; DAT4 Input
M55->Y:$C082,5,1              ; DAT5 Input
M56->Y:$C082,6,1              ; DAT6 Input
M57->Y:$C082,7,1              ; DAT7 Input
M58->Y:$C082,0,8,U            ; DAT0-7 Inputs treated as a byte
```

Jumper E6 in Position 2-3

```
M40->Y:$C0C2,8,1              ; SEL0 I/O Line
M41->Y:$C0C2,9,1              ; SEL1 I/O Line
M42->Y:$C0C2,10,1             ; SEL2 I/O Line
M43->Y:$C0C2,11,1             ; SEL3 I/O Line
M44->Y:$C0C2,12,1             ; SEL4 I/O Line
M45->Y:$C0C2,13,1             ; SEL5 I/O Line
M46->Y:$C0C2,14,1             ; SEL6 I/O Line
M47->Y:$C0C2,15,1             ; SEL7 I/O Line
M48->Y:$C0C2,8,8,U            ; SEL0-7 I/O Lines treated as a byte
M50->Y:$C0C2,0,1              ; DAT0 I/O Line
M51->Y:$C0C2,1,1              ; DAT1 I/O Line
M52->Y:$C0C2,2,1              ; DAT2 I/O Line
M53->Y:$C0C2,3,1              ; DAT3 I/O Line
M54->Y:$C0C2,4,1              ; DAT4 I/O Line
M55->Y:$C0C2,5,1              ; DAT5 I/O Line
M56->Y:$C0C2,6,1              ; DAT6 I/O Line
M57->Y:$C0C2,7,1              ; DAT7 I/O Line
M58->Y:$C0C2,0,8,U            ; DAT0-7 I/O Lines treated as a byte
```


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Analog Inputs Setup

The optional analog-to-digital converter inputs are ordered either through Option-12 on the baseboard or Option-2 on the axes expansion board. Each option provides two 12-bit analog inputs with a ±10Vdc range. The M-variables associated with these inputs provided a range of values between +2048 and –2048 for the respective ±10Vdc input range. The following is the software procedure to setup and read these ports.

Analog Inputs

```
I907 = 1746                    ;Set ADC clock frequency at 4.9152 MHz
WX:$C034, $1FFFFF              ;Clock strobe set for bipolar inputs
M305->X:$0714,12,12,S          ;ADCIN_1 on JMACH1 connector (Acc-1P) pin 45
M405->X:$0715,12,12,S          ;ADCIN_2 on JMACH1 connector (Acc-1P) pin 46
```


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SOFTWARE SETUP (Turbo PMAC2A-PC104 and Clipper)

Filtered DAC Outputs Configuration

Although the Clipper Board uses standard Turbo PMAC2 firmware certain I-variables must be set properly to use the digital-to-analog (filtered DAC) outputs. For the first ACC-1P board, the E5 jumper should be set 1-2 to enable the four channels as motors 5-8 at base address $78100. The PMAC firmware will automatically set up the encoder conversion table and basic motor I-variables for channels 5 through 8 after a "$$$***" command is issued. This will provide a total of 8 channels. The suggested M-variables as specified in the Turbo PMAC/PMAC2 Software reference for motors 5 through 8 will apply. The I-variables should be set as follows:

```
I7000  = 1001              ; PWM frequency 29.4kHz, PWM 1-4
I7001  = 5                 ; Phase Clock 9.8kHz
I7002  = 3                 ; Servo frequency 2.45kHz
I7003  = 1746              ; ADC frequency
I7100  = 1001              ; PWM frequency 29.4kHz, PWM 5-8
I7101  = 5                 ; Phase Clock 9.8kHz
I7102  = 3                 ; Servo frequency 2.45kHz
I7103  = 1746              ; ADC frequency
I7016  = 0                 ; Output mode ch#1: PWM
I7026  = 0                 ; Output mode ch#2: PWM
I7036  = 0                 ; Output mode ch#3: PWM
I7046  = 0                 ; Output mode ch#4: PWM
I7116  = 0                 ; Output mode ch#5: PWM
I7126  = 0                 ; Output mode ch#6: PWM
I7136  = 0                 ; Output mode ch#7: PWM
I7146  = 0                 ; Output mode ch#8: PWM
I169   = 1001              ; DAC limit ch#1 10Vdc
I269   = 1001              ; DAC limit ch#2 10Vdc
I369   = 1001              ; DAC limit ch#3 10Vdc
I469   = 1001              ; DAC limit ch#4 10Vdc
I569   = 1001              ; DAC limit ch#5 10Vdc
I669   = 1001              ; DAC limit ch#6 10Vdc
I769   = 1001              ; DAC limit ch#7 10Vdc
I869   = 1001              ; DAC limit ch#8 10Vdc
I10    = 3421867           ; Servo interrupt time
```

Once this has been downloaded to the Clipper board, save and reset the board ("SAVE" and "$$$" commands). The executive's tuning programs can now be used to set up the PID parameters.

For the second ACC-1P board, the E5 jumper should be set 2-3 to enable the four channels as motors 9-12 at base address $78140. This will require special set-up since there are no I-variables associated with this servo gate address, nor will the PMAC firmware set up the encoder conversion table – this must be done in a "run once startup PLC". The following M-variables will be required to access the hardware set-up registers of the 3rd servo gate:

```
M7200->X$7815C,8,16 ;MaxPhase/PWM Frequency Control (I7m00 equivalent)
M7201->X$78144,16,4 ;Phase Clock Frequency Control (I7m01 equivalent)
M7202->X$78144,20,4 ;Servo Clock Frequency Control (I7m02 equivalent)
M7203->X$78144,0,12 ; Hardware Clock Control (I7m03 equivalent)
M7204->X$7815C,0,8  ; PWM/PFM Deadtime/Width Control (I7m04 equivalent)
M7205->X$7814C,0,24 ; DAC Strobe Word (I7m05 equivalent)
M7206->X$78154,0,24 ; ADC Strobe Word (I7m06 equivalent)
```

The following I-variables will add motors 9 through 12 to the encoder conversion table:

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```
I8008=$78140;ECT Entry motor #9
I8009=$78148;ECT Entry motor #10
I8010=$78150;ECT Entry motor #11
I8011=$78158;ECT Entry motor #12
I8012=$0;ECT Entry 12
```

The following run once startup PLC will assign the correct clock values and other hardware settings for the third servo gate to properly set-up the filtered PWM DAC outputs:

```
OPEN PLC 25 CLEAR
M7200 = 1001
M7201 = 5
M7202 = 3
M7203 = 1746
M7204 = 15
M7205 = $7FFFC0
M7206 = $FFFFFE
DIS PLC 25
CLOSE
```

Motor Setup for channels 9-12

The following M-variables will be required to access the necessary registers for the set-up (with default values) and status of each motor (listed separately for each motor):

// FIRST CHANNEL OF GATE #3 - MOTOR #9

```
M901->X:$078141,0,24,S  ; ENC9 24-bit counter position
M902->Y:$078142,8,16,S  ; OUT9A command value; DAC or PWM
M903->X:$078143,0,24,S  ; ENC9 captured position
M914->X:$078145,14      ; AENA9 output status
M915->X:$078140,19      ; USER9 flag input status
M917->X:$078140,11      ; ENC9 capture flag
M918->X:$078140,8       ; ENC9 count error flag
M919->X:$078140,14      ; CHC9 input status
M920->X:$078140,16      ; HMFL9 flag input status
M921->X:$078140,17      ; PLIM9 flag input status
M922->X:$078140,18      ; MLIM9 flag input status
M923->X:$078140,15      ; FAULT9 flag input status

M7210->X:$78145,0,4  ;I7mn0 Servo IC m Channel n Encoder/Timer Decode Control
M7211->X:$78145,13,1 ;I7mn1 Servo IC m Channel n Position Compare Channel Select
M7212->X:$78145,4,4  ;I7mn2 Servo IC m Channel n Capture Control
M7213->X:$78145,8,4  ;I7mn3 Servo IC m Channel n Capture Flag Select Control
M7216->X:$78145,20,4 ;I7mn6 Servo IC m Channel n Output Mode Select

// Default values (NOT retained on a "SAVE" command)
M7210 = 3
M7211 = 0
M7212 = 1
M7213 = 0
M7216 = 0
//Motor specific I-variables (retained on a "SAVE" command)
I924 = 1
I925 = $78140
I969 = 1001
I902 = $78142
```


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```
I903 = $3509
I904 = $3509
```

The default values not retained on a “SAVE” command must be *added* to the “run once startup PLC” from the previous section that set up the main hardware clocks:

```
OPEN PLC 25 CLEAR
// Main HDW Clocks
M7200 = 1001
M7201 = 5
M7202 = 3
M7203 = 1746
M7204 = 15
M7205 = $7FFFC0
M7206 = $FFFFFE
// Motor #9 defaults
M7210 = 3
M7211 = 0
M7212 = 1
M7213 = 0
M7216 = 0
DIS PLC 25
CLOSE
```

Note:

After loading this program, set I5=2 or 3 and ENABLE PLC 1.

// SECOND CHANNEL OF GATE #3 - MOTOR #10

```
M1001->X:$078149,0,24,S ; ENC10 24-bit counter position
M1002->Y:$07814A,8,16,S ; OUT10A command value; DAC or PWM
M1003->X:$07814B,0,24,S ; ENC10 captured position
M1014->X:$07814D,14 ; AENA10 output status
M1015->X:$078148,19 ; USER10 flag input status
M1017->X:$078148,11 ; ENC10 capture flag
M1018->X:$078148,8 ; ENC10 count error flag
M1019->X:$078148,14 ; CHC10 input status
M1020->X:$078148,16 ; HMFL10 flag input status
M1021->X:$078148,17 ; PLIM10 flag input status
M1022->X:$078148,18 ; MLIM10 flag input status
M1023->X:$078148,15 ; FAULT10 flag input status


M7220->X:$7814D,0,4  ;I7mn0
M7221->X:$7814D,13,1 ;I7mn1
M7222->X:$7814D,4,4  ;I7mn2
M7223->X:$7814D,8,4  ;I7mn3
M7226->X:$7814D,20,4 ;I7mn6


// Default values (NOT retained on a "SAVE" command)
M7220 = 3
M7221 = 0
M7222 = 1
M7223 = 0
```


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```
M7226 = 0
//Motor specific I-variables (retained on a "SAVE" command)
I1024 = 1
I1025 = $78148
I1069 = 1001
I1002 = $7814A
I1003 = $350A
I1004 = $350A
```

The default values not retained on a “SAVE” command must again be added to the “run once startup PLC” from the previous section:

```
OPEN PLC 25 CLEAR
// Main HDW Clocks
M7200 = 1001
M7201 = 5
M7202 = 3
M7203 = 1746
M7204 = 15
M7205 = $7FFFC0
M7206 = $FFFFFE
// Motor #9 defaults
M7210 = 3
M7211 = 0
M7212 = 1
M7213 = 0
M7216 = 0
// Motor #10 defaults
M7220 = 3
M7221 = 0
M7222 = 1
M7223 = 0
M7226 = 0
DIS PLC 25
CLOSE
```

Note:

After loading this program, set I5=2 or 3 and ENABLE PLC 1.

// THIRD CHANNEL OF GATE #3 - MOTOR #11

```
M1101->X:$078151,0,24,S ; ENC11 24-bit counter position
M1102->Y:$078152,8,16,S ; OUT11A command value; DAC or PWM
M1103->X:$078153,0,24,S ; ENC11 captured position
M1114->X:$078155,14 ; AENA11 output status
M1115->X:$078150,19 ; USER11 flag input status
M1117->X:$078150,11 ; ENC11 capture flag
M1118->X:$078150,8 ; ENC11 count error flag
M1119->X:$078150,14 ; CHC11 input status
M1120->X:$078150,16 ; HMFL11 flag input status
M1121->X:$078150,17 ; PLIM11 flag input status
M1122->X:$078150,18 ; MLIM11 flag input status
M1123->X:$078150,15 ; FAULT11 flag input status
```


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```
M7230->X:$78155,0,4  ;I7mn0
M7231->X:$78155,13,1 ;I7mn1
M7232->X:$78155,4,4  ;I7mn2
M7233->X:$78155,8,4  ;I7mn3
M7236->X:$78155,20,4 ;I7mn6


// Default values (NOT retained on a "SAVE" command)
M7230 = 3
M7231 = 0
M7232 = 1
M7233 = 0
M7236 = 0
//Motor specific I-variables (retained on a "SAVE" command)
I1124 = 1
I1125 = $78150
I1169 = 1001
I1102 = $78152
I1103 = $350B
I1104 = $350B
```

The default values not retained on a “SAVE” command must again be added to the “run once startup PLC” from the previous section:

```
OPEN PLC 25 CLEAR
M7200 = 1001
M7201 = 5
M7202 = 3
M7203 = 1746
M7204 = 15
M7205 = $7FFFC0
M7206 = $FFFFFE
// Motor #9 defaults
M7210 = 3
M7211 = 0
M7212 = 1
M7213 = 0
M7216 = 0
// Motor #10 defaults
M7220 = 3
M7221 = 0
M7222 = 1
M7223 = 0
M7226 = 0
// Motor #11 defaults
M7230 = 3
M7231 = 0
M7232 = 1
M7233 = 0
M7236 = 0
DIS PLC 25
CLOSE
```

Note:

After loading this program, set I5=2 or 3 and ENABLE PLC 1.

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// FOURTH CHANNEL OF GATE #3 - MOTOR #12

```
M1201->X:$078159,0,24,S ; ENC12 24-bit counter position
M1202->Y:$07815A,8,16,S ; OUT12A command value; DAC or PWM
M1203->X:$07815B,0,24,S ; ENC12 captured position
M1214->X:$07815D,14 ; AENA12 output status
M1215->X:$078158,19 ; USER12 flag input status
M1217->X:$078158,11 ; ENC12 capture flag
M1218->X:$078158,8 ; ENC12 count error flag
M1219->X:$078158,14 ; CHC12 input status
M1220->X:$078158,16 ; HMFL12 flag input status
M1221->X:$078158,17 ; PLIM12 flag input status
M1222->X:$078158,18 ; MLIM12 flag input status
M1223->X:$078158,15 ; FAULT12 flag input status


M7240->X:$7815D,0,4  ;I7mn0
M7241->X:$7815D,13,1 ;I7mn1
M7242->X:$7815D,4,4  ;I7mn2
M7243->X:$7815D,8,4  ;I7mn3
M7246->X:$7815D,20,4 ;I7mn6


// Default values (NOT retained on a "SAVE" command)
M7240 = 3
M7241 = 0
M7242 = 1
M7243 = 0
M7246 = 0
//Motor specific I-variables (retained on a "SAVE" command)
I1224 = 1
I1225 = $78158
I1269 = 1001
I1202 = $7815A
I1203 = $350C
I1204 = $350C
```

The default values not retained on a “SAVE” command must again be added to the “run once startup PLC” from the previous section:

```
OPEN PLC 25 CLEAR
M7200 = 1001
M7201 = 5
M7202 = 3
M7203 = 1746
M7204 = 15
M7205 = $7FFFC0
M7206 = $FFFFFE
// Motor #9 defaults
M7210 = 3
M7211 = 0
M7212 = 1
M7213 = 0
M7216 = 0
// Motor #10 defaults
M7220 = 3
M7221 = 0
M7222 = 1
```


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```
M7223 = 0
M7226 = 0
// Motor #11 defaults
M7230 = 3
M7231 = 0
M7232 = 1
M7233 = 0
M7236 = 0
// Motor #12 defaults
M7240 = 3
M7241 = 0
M7242 = 1
M7243 = 0
M7246 = 0
DIS PLC 25
CLOSE
```

Note:

After loading this program, set I5=2 or 3 and ENABLE PLC 1.

Using Flag I/O as General-Purpose I/O

Either the user flags or other unassigned axes flag on the ACC-1P board can be used as general-purpose I/O for up to 20 inputs and 4 outputs at 5-24Vdc levels. The indicated M-variables definitions, which are the suggested definitions for motors 5 through 8 in the Turbo PMAC/PMAC2 Software reference, allows accessing each particular line according to the following table:

Flag	Type	Channel Number			
		#5	#6	#7	#8
HOME	5-24 VDC Input	M520	M620	M720	M820
PLIM	5-24 VDC Input	M521	M621	M721	M821
MLIM	5-24 VDC Input	M522	M622	M722	M822
USER	5-24 VDC Input	M515	M615	M715	M815
AENA	5-24 VDC Output	M514	M614	M714	M814

Motors 9 through 12 must use the following M-variables as defined from the previous section since the servo gate used for these motors is at a non-standard address:

Flag	Type	Channel Number			
		#9	#10	#11	#12
HOME	5-24 VDC Input	M920	M1020	M1120	M1220
PLIM	5-24 VDC Input	M921	M1021	M1121	M1221
MLIM	5-24 VDC Input	M922	M1022	M1122	M1222
USER	5-24 VDC Input	M915	M1015	M1115	M1215
AENA	5-24 VDC Output	M914	M1014	M1114	M1214

Note:

When using these lines as regular I/O points the appropriate setting of the Ixx24 variable must be used to enable or disable the safety flags feature.

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General-Purpose Digital Inputs and Outputs

If one Acc-1P is present then its jumper E6 should be set at the default position 1-2. In this case, the lines on its J7 general-purpose I/O connector will be mapped into PMAC's address space at base address Y:$78500. If a second Acc-1P is used then its E6 jumper should be configured 2-3 and its I/O lines can be accessed at base address Y:$78540.

The inputs and outputs on the thumbwheel port of the Acc-1P boards may only be used as discrete, non-multiplexed I/O. As in the case of the JOPTO port they are defined according to the setup of the address selection jumper E6.

Typically, these I/O lines are accessed individually with M-variables. Following is a suggested set of M-variable definitions to use these data lines.

JOPTO port first ACC-1P, Jumper E6 on Position 1-2

```
M4050->Y:$78500,0       ; Digital Output M00
M4051->Y:$78500,1       ; Digital Output M01
M4052->Y:$78500,2       ; Digital Output M02
M4053->Y:$78500,3       ; Digital Output M03
M4054->Y:$78500,4       ; Digital Output M04
M4055->Y:$78500,5       ; Digital Output M05
M4056->Y:$78500,6       ; Digital Output M06
M4057->Y:$78500,7       ; Digital Output M07
M4066->Y:$78500,0,8,u   ;all outputs as an 8bit word

M4058->Y:$78500,8       ; Digital Input MI0
M4059->Y:$78500,9       ; Digital Input MI1
M4060->Y:$78500,10      ; Digital Input MI2
M4061->Y:$78500,11      ; Digital Input MI3
M4062->Y:$78500,12      ; Digital Input MI4
M4063->Y:$78500,13      ; Digital Input MI5
M4064->Y:$78500,14      ; Digital Input MI6
M4065->Y:$78500,15      ; Digital Input MI7
M4067->Y:$78500,8,8,u   ; all inputs as an 8bit word

M4068->X:$78500,0,8     ; Direction Control bits 0-7  (1=output,  0 = input)
M4069->X:$78500,8,8     ; Direction Control bits 8-15 (1=output,  0 = input)
M4070->X:$78504,0,24    ; Inversion control (0 = 0V, 1 = 5V)
M4071->Y:$78504,0,24    ; port data type control (1 = I/O)
```

In order to properly setup the JOPTO digital I/O an initialization PLC must be written scanning through once on power-up/reset, and then disabling itself:

```
OPEN PLC12 CLEAR
M4068=$FF               ;BITS 0-8 are assigned as output
M4069=$0                ;BITS 9-16 are assigned as input
M4070=$FF00             ;Define inputs and outputs
M4071=$FFFF             ;All lines are I/O type
DIS PLC1                ;Disable PLC1 (scanning through once on power-
up/reset)
CLOSE
```

Note:

After loading this program, set I5=2 or 3 and ENABLE PLC 1.

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JTHW port first ACC-1P, Jumper E6 on Position 1-2

```
M4080->Y:$78502,8,1 ; SEL0 Output
M4081->Y:$78502,9,1 ; SEL1 Output
M4082->Y:$78502,10,1 ; SEL2 Output
M4083->Y:$78502,11,1 ; SEL3 Output
M4084->Y:$78502,12,1 ; SEL4 Output
M4085->Y:$78502,13,1 ; SEL5 Output
M4086->Y:$78502,14,1 ; SEL6 Output
M4087->Y:$78502,15,1 ; SEL7 Output
M4088->Y:$78502,8,8,U ; SEL0-7 Outputs treated as a byte

M4090->Y:$78502,0,1 ; DAT0 Input
M4091->Y:$78502,1,1 ; DAT1 Input
M4092->Y:$78502,2,1 ; DAT2 Input
M4093->Y:$78502,3,1 ; DAT3 Input
M4094->Y:$78502,4,1 ; DAT4 Input
M4095->Y:$78502,5,1 ; DAT5 Input
M4096->Y:$78502,6,1 ; DAT6 Input
M4097->Y:$78502,7,1 ; DAT7 Input
M4098->Y:$78502,0,8,U ; DAT0-7 Inputs treated as a byte

M4099->X:$078502,0,8 ; Direction control for DAT0 to DAT7
M4099->X:$078502,8,8 ; Direction control for SEL0 to SEL7
```

In order to properly setup the JTHW digital I/O an initialization PLC must be written scanning through once on power-up/reset, and then disabling itself:

```
OPEN PLC 13 CLEAR
M4089=0
M4099=$FF
DISPLC10
CLOSE
```

Note:

After loading this program, set I5=2 or 3 and ENABLE PLC 13.

JOPTO port second ACC-1P, Jumper E6 on Position 2-3

```
M4100->Y:$78540,0       ; Digital Output M00
M4101->Y:$78540,1       ; Digital Output M01
M4102->Y:$78540,2       ; Digital Output M02
M4103->Y:$78540,3       ; Digital Output M03
M4104->Y:$78540,4       ; Digital Output M04
M4105->Y:$78540,5       ; Digital Output M05
M4106->Y:$78540,6       ; Digital Output M06
M4107->Y:$78540,7       ; Digital Output M07
M4116->Y:$78540,0,8,u   ;all outputs as an 8bit word

M4108->Y:$78540,8       ; Digital Input MI0
M4109->Y:$78540,9       ; Digital Input MI1
M4110->Y:$78540,10      ; Digital Input MI2
M4111->Y:$78540,11      ; Digital Input MI3
M4112->Y:$78540,12      ; Digital Input MI4
M4113->Y:$78540,13      ; Digital Input MI5
```


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```
M4114->Y:$78540,14      ; Digital Input MI6
M4115->Y:$78540,15      ; Digital Input MI7
M4117->Y:$78540,8,8,u   ; all inputs as an 8bit word

M4118->X:$78540,0,8     ; Direction Control bits 0-7  (1=output,  0 = input)
M4119->X:$78540,8,8     ; Direction Control bits 8-15 (1=output,  0 = input)
M4120->X:$78544,0,24    ; Inversion control (0 = 0V, 1 = 5V)
M4121->Y:$78544,0,24    ; J9 port data type control (1 = I/O)
```

In order to properly setup the JOPTO digital I/O, an initialization PLC must be written scanning through once on power-up/reset, and then disabling itself:

```
OPEN PLC14 CLEAR
M4118=$FF               ;BITS 0-8 are assigned as output
M4119=$0                ;BITS 9-16 are assigned as input
M4120=$FF00             ;Define inputs and outputs
M4121=$FFFF             ;All lines are I/O type
DIS PLC3                ;Disable PLC1 (scanning through once on power-
up/reset)
CLOSE
```

Note:

After loading this program, set I5=2 or 3 and ENABLE PLC 1.

JTHW port second ACC-1P, Jumper E6 on Position 2-3

```
M4130->Y:$78542,8,1 ; SEL0 Output
M4131->Y:$78542,9,1 ; SEL1 Output
M4132->Y:$78542,10,1 ; SEL2 Output
M4133->Y:$78542,11,1 ; SEL3 Output
M4134->Y:$78542,12,1 ; SEL4 Output
M4135->Y:$78542,13,1 ; SEL5 Output
M4136->Y:$78542,14,1 ; SEL6 Output
M4137->Y:$78542,15,1 ; SEL7 Output
M4138->Y:$78542,8,8,U ; SEL0-7 Outputs treated as a byte

M4140->Y:$78542,0,1 ; DAT0 Input
M4141->Y:$78542,1,1 ; DAT1 Input
M4142->Y:$78542,2,1 ; DAT2 Input
M4143->Y:$78542,3,1 ; DAT3 Input
M4144->Y:$78542,4,1 ; DAT4 Input
M4145->Y:$78542,5,1 ; DAT5 Input
M4146->Y:$78542,6,1 ; DAT6 Input
M4147->Y:$78542,7,1 ; DAT7 Input
M4148->Y:$78542,0,8,U ; DAT0-7 Inputs treated as a byte

M4139->X:$078502,0,8 ; Direction control for DAT0 to DAT7
M4149->X:$078502,8,8 ; Direction control for SEL0 to SEL7
```

In order to properly setup the JTHW digital I/O an initialization PLC must be written scanning through once on power-up/reset, and then disabling itself:

```
OPEN PLC 15 CLEAR
M4139=0
M4149=$FF
DISPLC10
```


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```
CLOSE
```

Note:

After loading this program, set I5=2 or 3 and ENABLE PLC 1.

Analog Inputs Setup

The optional analog-to-digital converter inputs are ordered either through Option-2 on the axes expansion board. Each option provides two 12-bit analog inputs with a ±10Vdc range. The M-variables associated with these inputs provided a range of values between +2048 and –2048 for the respective ±10Vdc input range. The following is the software procedure to setup and read these ports on the first ACC-1P.

Analog Inputs first ACC-1P

```
I7103 = 1746                    ;Set ADC clock frequency at 4.9152 MHz
I7106 = $1FFFFF                 ;Clock strobe set for bipolar inputs
M505->Y:$78105,12,12,S          ;ADCIN_1 on JMACH1 connector (Acc-1P) pin 45
M605->Y:$7810D,12,12,S          ;ADCIN_2 on JMACH1 connector (Acc-1P) pin 46
```

Analog Inputs second ACC-1P

```
M7203 = 1746                    ;Set ADC clock frequency at 4.9152 MHz
M7206 = $1FFFFF                 ;Clock strobe set for bipolar inputs
M905->Y:$78145,12,12,S          ;ADCIN_1 on JMACH1 connector (Acc-1P) pin 45
M1005->Y:$7814D,12,12,S         ;ADCIN_2 on JMACH1 connector (Acc-1P) pin 46
```

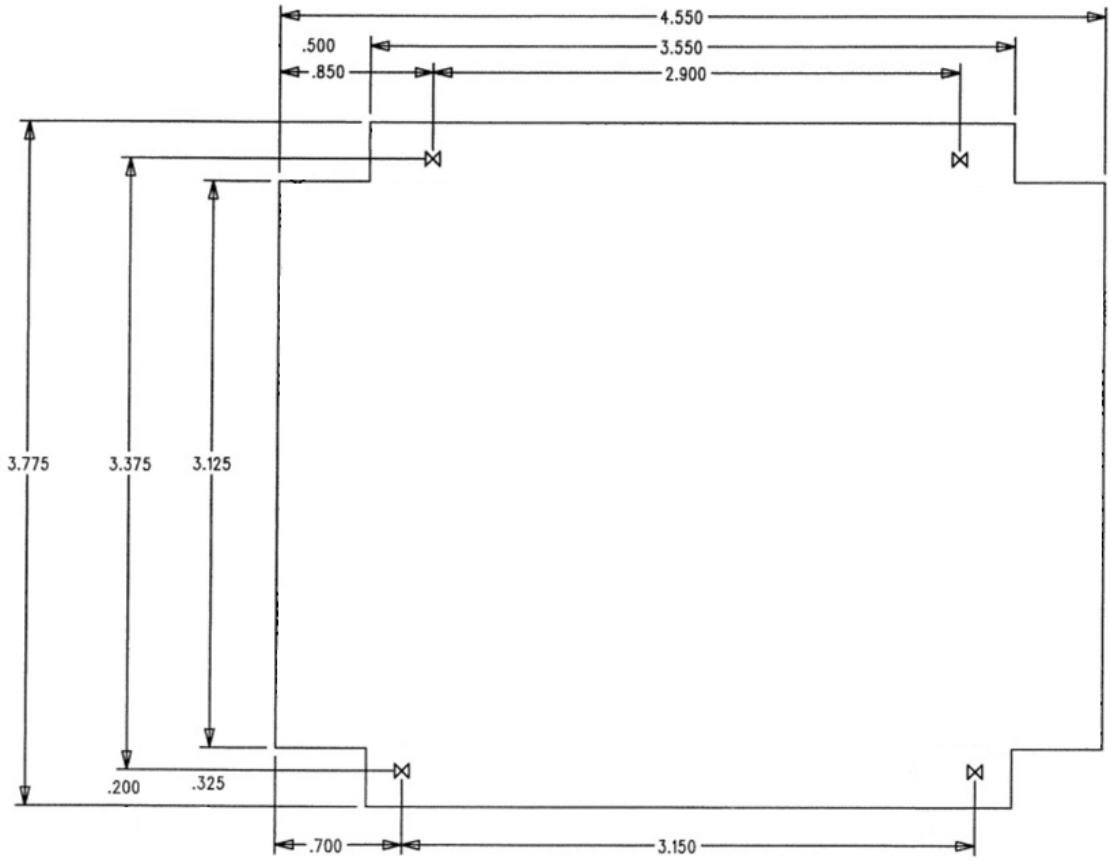

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HARDWARE REFERENCE SUMMARY

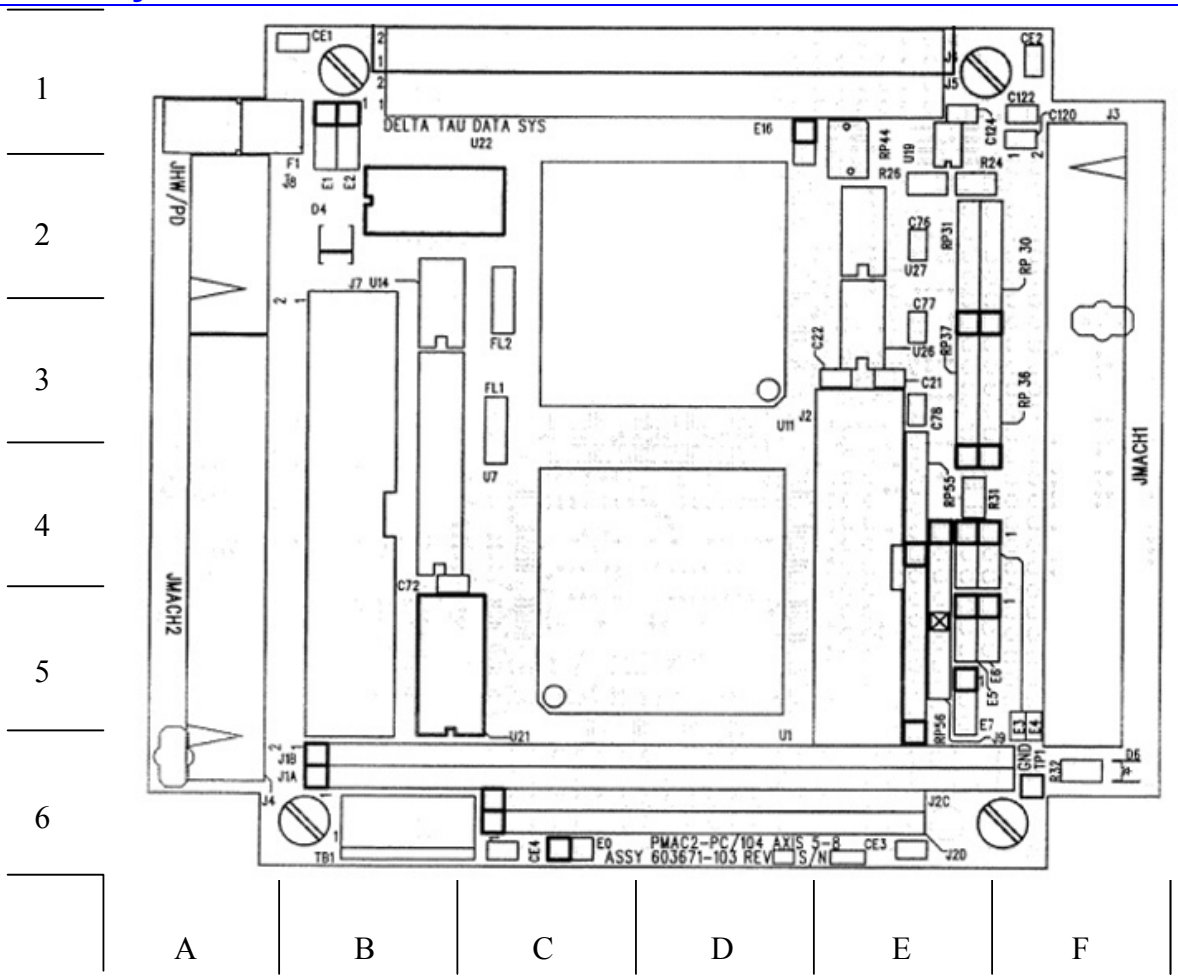
The following information is based on the Acc-1P board, part number 603671-100.

Board Dimensions



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Board Layout



Feature	Location	Feature	Location
E0	C6	**RP30**	E2
E1	B2	**RP31**	E2
E2	B2	**RP36**	E3
E3	E4	**RP37**	E3
E4	E4	**RP55**	E4
E5	E5	**RP56**	E5
E6	E5	**TB1**	B6
E7	E5	**JMACH1**	F4
E16	D1	**JMACH2**	A4
D6	F6	**JHW / PD**	A2
F1	A1	**J7**	A3
		J2	E4

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Connectors and Indicators

J2 - Thumbwheel Multiplexer Port (JTHW Port)

The Thumbwheel Multiplexer Port, or Multiplexer Port, on the JTHW connector has eight input lines and eight output lines. The output lines can be used to multiplex large numbers of inputs and outputs on the port, and Delta Tau provides accessory boards and software structures (special M-variable definitions) to capitalize on this feature. Up to 32 of the multiplexed I/O boards may be daisy-chained on the port, in any combination.

1. 26-pin female flat cable connector T&B Ansley P/N 609-2641
2. Standard flat cable stranded 26-wire T&B Ansley P/N 171.26
3. Phoenix varioface module type FLKM 26 (male pins) P/N 22 81 05 0

J3 - Machine Connector (JMACH1 Port)

The primary machine interface connector is JMACH1, labeled J3 on the PMAC. It contains the pins for four channels of machine I/O: analog outputs, incremental encoder inputs, amplifier fault and enable signals and power-supply connections.

1. 50-pin female flat cable connector T&B Ansley P/N 609-5041
2. Standard flat cable stranded 50-wire T&B Ansley P/N 171-50
3. Phoenix varioface module type FLKM 50 (male pins) P/N 22 81 08 9

J4 - Machine Connector (JMACH2 Port)

This machine interface connector is labeled JMACH2 or J4 on the PMAC. It contains the pins for four channels of machine I/O: end-of-travel input flags, home flag and pulse-and-direction output signals. In addition, the B_WDO output allows monitoring the state of the Watchdog safety feature.

1. 34-pin female flat cable connector T&B Ansley P/N 609-3441
2. Standard flat cable stranded 34-wire T&B Ansley P/N 171-34
3. Phoenix varioface module type FLKM 34 (male pins) P/N 22 81 06 3

J7 - General-Purpose Digital Inputs and Outputs (JOPT Port)

Acc-1P's JOPT connector provides eight general-purpose digital inputs and eight general-purpose digital outputs. Each input and each output has its own corresponding ground pin in the opposite row. The 34-pin connector was designed for easy interface to OPTO-22 or equivalent optically isolated I/O modules. Delta Tau's Acc-21F is a six-foot cable for this purpose.

1. 34-pin female flat cable connector T&B Ansley P/N 609-3441
2. Standard flat cable stranded 34-wire T&B Ansley P/N 171-34
3. Phoenix varioface module type FLKM 34 (male pins) P/N 22 81 06 3

J8 – Handwheel / Pulse and Direction Port (JHW / PD Port)

This port provides an extra encoder input or a set of pulse and direction outputs, and its function is selectable by jumpers.

1. 10-pin female flat cable connector T&B Ansley P/N 609-1041
2. Standard flat cable stranded 10-wire T&B Ansley P/N 171-10
3. Phoenix varioface module type FLKM 10 (male pins) P/N 22 81 01 8

TB1 – Power Supply Terminal Block (JPWR Connector)

In almost in all cases the PMAC2A PC/104 will be powered from the PC/104 bus when it is installed in a host computer's bus, or from the JMACH1 connector. This terminal block may be used as an alternative power supply connector or to easily measure the voltages applied to the board.

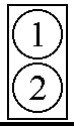
1. 4-pin terminal block, 0.150 pitch

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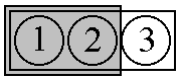
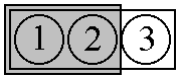
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E-POINT JUMPER DESCRIPTIONS

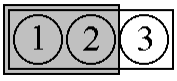
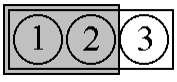
E0: Reserved for Future Use

E Point and Physical Layout	Location	Description	Default
E0 	C6	For future use.	No jumper

E1 - E2: Machine Output Supply Voltage Configure

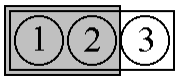
E Point and Physical Layout	Location	Description	Default
E1 	B2	Jump pin 1 to 2 to apply +V (+5V to 24V) to pin 10 of U7 (should be ULN2803A for sink output configuration) JOPTO Machine outputs M01-M08. Jump pin 2 to 3 to apply GND to pin 10 of U7 (should be UDN2981A for source output configuration). ***Warning:*** The jumper setting must match the type of driver IC, or damage to the IC will result.	1-2 Jumper installed
E2 	B2	Jump pin 1 to 2 to apply GND to pin 11 of U7 (should be ULN2803A for sink output configuration). Jump pin 2 to 3 to apply +V (+5V to 24V) to pin 10 of U7 (should be UDN2981A for source output configuration). ***Warning:*** The jumper setting must match the type of driver IC, or damage to the IC will result.	1-2 Jumper installed

E3 – E4: JHW, PD Function Select

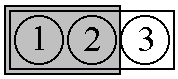
E Point and Physical Layout	Location	Description	Default
E3 	E4	Jump pin 1 to 2 to enable handwheel channel 1 inputs. Jump pin 2 to 3 to enable pulse and direction channel 1 outputs.	1-2 Jumper installed
E4 	E4	Jump pin 1 to 2 to enable handwheel channel 2 inputs. Jump pin 2 to 3 to enable pulse and direction channel 2 outputs.	1-2 Jumper installed

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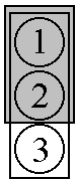
E5: Servo Gate Address Select

E Point and Physical Layout	Location	Description	Default
E5 	E5	Jump pin 1 to 2 to address Acc-1P channels at the regular addresses for channels 5 to 8. Jump pin 2 to 3 to address Acc-1P channels at the regular addresses for channels 5 to 8 plus $40.	1-2 Jumper installed

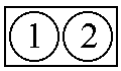
E6: I/O Gate Address Select

E Point and Physical Layout	Location	Description	Default
E6 	E5	Jump pin 1 to 2 to address Acc-1P I/O ports at the regular addresses. Jump pin 2 to 3 to address Acc-1P I/O ports at the regular addresses plus $40.	1-2 Jumper installed

E7: Machine Input Source/Sink Control

E Point and Physical Layout	Location	Description	Default
E7 	E5	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).	1-2 Jumper installed

E16: ADC Inputs Enable

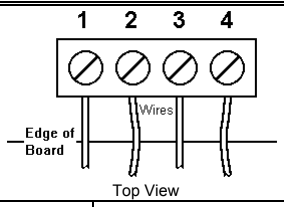
E Point and Physical Layout	Location	Description	Default
E16 	D1	Jump pin 1 to 2 to enable the Option-12 ADC inputs. Remove jumper to disable the ADC inputs, which might be necessary for reading current feedback signals from digital amplifiers.	No jumper

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CONNECTOR PINOUTS

TB1 (JPWR): Power Supply

(4-Pin Terminal Block)



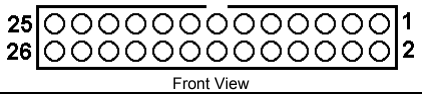
Pin#	Symbol	Function	Description	Notes
1	GND	Common	Reference Voltage	
2	+5V	Input	Positive Supply Voltage	Supplies all PMAC digital circuits
3	+12V	Input	Positive Supply Voltage	REF to digital GND
4	-12V	Input	Negative Supply Voltage	REF to digital GND

This terminal block can be used to provide the input for the power supply for the circuits on the PMAC board when it is not in a bus configuration. When the PMAC is in a bus configuration, these supplies automatically come through the bus connector from the bus power supply; in this case, this terminal block should not be used.

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J2 (JTHW): Multiplexer Port Connector

(26-Pin Connector)

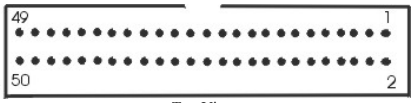


Pin#	Symbol	Function	Description	Notes
1	GND	Common	PMAC Common	
2	GND	Common	PMAC Common	
3	DAT0	Input	Data-0 Input	Data input from multiplexed accessory
4	SEL0	Output	Select-0 Output	Multiplexer select output
5	DAT1	Input	Data -1 Input	Data input from multiplexed accessory
6	SEL1	Output	Select -1 Output	Multiplexer select output
7	DAT2	Input	Data -2 Input	Data input from multiplexed accessory
8	SEL2	Output	Select -2 Output	Multiplexer select output
9	DAT3	Input	Data -3 Input	Data input from multiplexed accessory
10	SEL3	Output	Select -3 Output	Multiplexer select output
11	DAT4	Input	Data -4 Input	Data input from multiplexed accessory
12	SEL4	Output	Select -4 Output	Multiplexer select output
13	DAT5	Input	Data -5 Input	Data input from multiplexed accessory
14	SEL5	Output	Select -5 Output	Multiplexer select output
15	DAT6	Input	Data -6 Input	Data input from multiplexed accessory
16	SEL6	Output	Select -6 Output	Multiplexer select output
17	DAT7	Input	Data -7 Input	Data input from multiplexed accessory
18	SEL7	Output	Select -7 Output	Multiplexer select output
19	N.C.	N.C.	No Connection	
20	GND	Common	PMAC Common	
21	N.C.	Output	Buffer Request	Low is Buffer Request
22	GND	Common	PMAC Common	
23	N.C.	Output	In Position	Low is In Position
24	GND	Common	PMAC Common	
25	+5V	Output	+5VDC Supply	Power supply out
26	N.C.	Input	PMAC Reset	Low is Reset

The JTHW multiplexer port provides eight inputs and eight outputs at TTL levels. While these I/O can be used in unmultiplexed form for 16 discrete I/O points, most users will utilize PMAC software and accessories to use this port in multiplexed form to greatly multiply the number of I/O that can be accessed on this port. In multiplexed form, some of the SELn outputs are used to select which of the multiplexed I/O are to be accessed.

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J3 (JMACH1): Machine Port Connector (50-Pin Header)

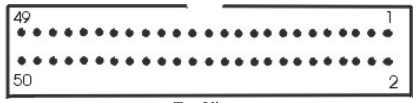


Top View

Pin#	Symbol	Function	Description	Notes
1	+5V	Output	+5V Power	For Encoders, 1
2	+5V	Output	+5V Power	For Encoders, 1
3	GND	Common	Digital Common	
4	GND	Common	Digital Common	
5	CHA5	Input	Encoder A Channel Positive	2
6	CHA6	Input	Encoder A Channel Positive	2
7	CHA5/	Input	Encoder A Channel Negative	2,3
8	CHA6/	Input	Encoder A Channel Negative	2,3
9	CHB5	Input	Encoder B Channel Positive	2
10	CHB6	Input	Encoder B Channel Positive	2
11	CHB5/	Input	Encoder B Channel Negative	2,3
12	CHB6/	Input	Encoder B Channel Negative	2,3
13	CHC5	Input	Encoder C Channel Positive	2
14	CHC6	Input	Encoder C Channel Positive	2
15	CHC5/	Input	Encoder C Channel Negative	2,3
16	CHC6/	Input	Encoder C Channel Negative	2,3
17	CHA7	Input	Encoder A Channel Positive	2
18	CHA8	Input	Encoder A Channel Positive	2
19	CHA7/	Input	Encoder A Channel Negative	2,3
20	CHA8/	Input	Encoder A Channel Negative	2,3
21	CHB7	Input	Encoder B Channel Positive	2
22	CHB8	Input	Encoder B Channel Positive	2
23	CHB7/	Input	Encoder B Channel Negative	2,3
24	CHB8/	Input	Encoder B Channel Negative	2,3
25	CHC7	Input	Encoder C Channel Positive	2
26	CHC8	Input	Encoder C Channel Positive	2
27	CHC7/	Input	Encoder C Channel Negative	2,3
28	CHC8/	Input	Encoder C Channel Negative	2,3
29	DAC5	Output	Analog Out Positive 5	4
30	DAC6	Output	Analog Out Positive 6	4
31	DAC5/	Output	Analog Out Negative 5	4,5
32	DAC6/	Output	Analog Out Negative 6	4,5
33	AENA5/	Output	Amplifier-Enable 5	
34	AENA6/	Output	Amplifier -Enable 6	
35	FAULT5/	Input	Amplifier -Fault 5	6
36	FAULT6/	Input	Amplifier -Fault 6	6
37	DAC7	Output	Analog Out Positive 7	4
38	DAC8	Output	Analog Out Positive 8	4
39	DAC7/	Output	Analog Out Negative 7	4,5

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J3 JMACH1 (50-Pin-Header) (Continued)



Top View

Pin#	Symbol	Function	Description	Notes
40	DAC8/	Output	Analog Out Negative 8	4,5
41	AENA7/	Output	Amplifier-Enable 7	
42	AENA8/	Output	Amplifier -Enable 8	
43	FAULT7/	Input	Amplifier -Fault 7	6
44	FAULT8/	Input	Amplifier -Fault 8	6
45	ADCIN_1	Input	Analog Input 1	Option-2 required
46	ADCIN_2	Input	Analog Input 2	Option-2 required
47	FLT_FLG_V	Input	Amplifier Fault pull-up V+	
48	GND	Input	Analog Common	
49	A+15V	Input	DACs +15V Supply	
50	A-15V	Input	DACs -15V Supply	

The J3 connector is used to connect PMAC to the second 4 channels (Channels 5, 6, 7, and 8) of servo amps and encoders.

Note 1: In standalone applications, these lines can be used as +5V power supply inputs to power PMAC's digital circuitry.

Note 2: Referenced to digital common (GND). Maximum of ±12V permitted between this signal and its complement.

Note 3: Leave this input floating if not used (i.e. digital single-ended encoders).

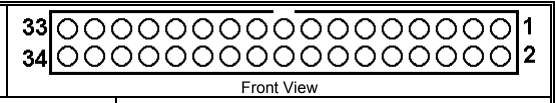
Note 4: ±10V, 10 mA max, referenced to common ground (GND).

Note 5: Leave floating if not used; do not tie to GND.

Note 6: Functional polarity controlled by variable Ix25. Must be conducting to 0V (usually GND) to produce a 0 in PMAC software. Automatic fault function can be disabled with Ix25.

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J4 (JMACH2): Machine Port Connector (34-Pin Header)



Pin#	Symbol	Function	Description	Notes
1	FLG_5_6_V	Input	Flags 5-6 Pull-Up	
2	FLG_7_8_V	Input	Flags 7-8 Pull-Up	
3	GND	Common	Digital Common	
4	GND	Common	Digital Common	
5	HOME5	Input	Home-Flag 5	10
6	HOME6	Input	Home-Flag 6	10
7	PLIM5	Input	Positive End Limit 5	8,9
8	PLIM6	Input	Positive End Limit 6	8,9
9	MLIM5	Input	Negative End Limit 5	8,9
10	MLIM6	Input	Negative End Limit 6	8,9
11	USER5	Input	User Flag 5	
12	USER6	Input	User Flag 6	
13	PUL_5	Output	Pulse Output 5	
14	PUL_6	Output	Pulse Output 6	
15	DIR_5	Output	Direction Output 5	
16	DIR_6	Output	Direction Output 6	
17	EQU5	Output	Encoder Comp-Equal 5	
18	EQU6	Output	Encoder Comp-Equal 6	
19	HOME7	Input	Home Flag 7	10
20	HOME8	Input	Home Flag 8	10
21	PLIM7	Input	Positive End Limit 7	8,9
22	PLIM8	Input	Positive End Limit 8	8,9
23	MLIM7	Input	Negative End Limit 7	8,9
24	MLIM8	Input	Negative End Limit 8	8,9
25	USER7	Input	User Flag 7	
26	USER8	Input	User Flag 8	
27	PUL_7	Output	Pulse Output 7	
28	PUL_8	Output	Pulse Output 8	
29	DIR_7	Output	Direction Output 7	
30	DIR_8	Output	Direction Output 8	
31	EQU7	Output	Encoder Comp-Equal 7	
32	EQU8	Output	Encoder Comp-Equal 8	
33	B_WDO	Output	Watchdog Out	Indicator/Driver
34	No Connect			

Note 1: Pins marked *PLIMn* should be connected to switches at the *positive* end of travel. Pins marked *MLIMn* should be connected to switches at the negative end of travel.

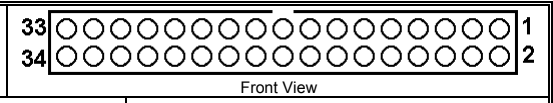
Note 2: Must be conducting to 0V (usually GND) for PMAC to consider itself not into this limit. Automatic limit function can be disabled with Ix25.

Note 3: Functional polarity for homing or other trigger use of HOMEn controlled by Encoder/Flag Variable I9n2. HMFLn selected for trigger by Encoder/Flag Variable I9n3. Must be conducting to 0V (usually GND) to produce a 0 in PMAC software.

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J7 (JOPTO): I/O Port Connector

(34-Pin Connector)



Pin#	Symbol	Function	Description	Notes
1	MI8	Input	Machine Input 8	Low is TRUE
2	GND	Common	PMAC Common	
3	MI7	Input	Machine Input 7	Low is TRUE
4	GND	Common	PMAC Common	
5	MI6	Input	Machine Input 6	Low is TRUE
6	GND	Common	PMAC Common	
7	MI5	Input	Machine Input 5	Low is TRUE
8	GND	Common	PMAC Common	
9	MI4	Input	Machine Input 4	Low is TRUE
10	GND	Common	PMAC Common	
11	MI3	Input	Machine Input 3	Low is TRUE
12	GND	Common	PMAC Common	
13	MI2	Input	Machine Input 2	Low is TRUE
14	GND	Common	PMAC Common	
15	MI1	Input	Machine Input 1	Low is TRUE
16	GND	Common	PMAC Common	
17	MO8	Output	Machine Output 8	Low-TRUE (Sinking) High-TRUE (Sourcing)
18	GND	Common	PMAC Common	
19	MO7	Output	Machine Output 7	" "
20	GND	Common	PMAC Common	
21	MO6	Output	Machine Output 6	" "
22	GND	Common	PMAC Common	
23	MO5	Output	Machine Output 5	" "
24	GND	Common	PMAC Common	
25	MO4	Output	Machine Output 4	" "
26	GND	Common	PMAC Common	
27	MO3	Output	PMAC Common	" "
28	GND	Common	PMAC COMMON	
29	MO2	Output	Machine Output 2	" "
30	GND	Common	PMAC Common	
31	MO1	Output	Machine Output 1	" "
32	GND	Common	PMAC Common	
33	+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
34	GND	Common	PMAC Common	

This connector provides means for eight general-purpose inputs and eight general-purpose outputs. Inputs and outputs may be configured to accept or provide either +5V or +24V signals. Outputs can be made sourcing with an IC (U7 to UDN2981) and jumper (E1 and E2) change. E7 controls whether the inputs are pulled up or down internally. Outputs are rated at 100mA per channel.

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J8 (JHW) Handwheel Encoder Connector

Pin#	Symbol	Function	Description
1	GND	Common	Reference voltage
2	HWA1+ / PUL1+	Input/Output	HW1 Channel A or pulse output selected by jumpers E3 and E4
3	HWA1- / PUL1-	Input/Output	HW 1 Channel A or pulse output selected by jumpers E3 and E4
4	HWB1+ / DIR1+	Input/Output	HW 1 Channel B or direction output selected by jumpers E3 and E4
5	HWB1- / DIR1-	Input/Output	HW 1 Channel B or direction output selected by jumpers E3 and E4
6	HWA2+ / PUL2+	Input/Output	HW 2 Channel A or pulse output selected by jumpers E3 and E4
7	HWA2- / PUL2-	Input/Output	HW 2 Channel A or pulse output selected by jumpers E3 and E4
8	HWB2+ / DIR2+	Input/Output	HW 2 Channel B or direction output selected by E3 and E4
9	HWB2- / DIR2-	Input/Output	HW 2 Channel B or direction output selected by E3 and E4
10	+5V	Output	Supply voltage

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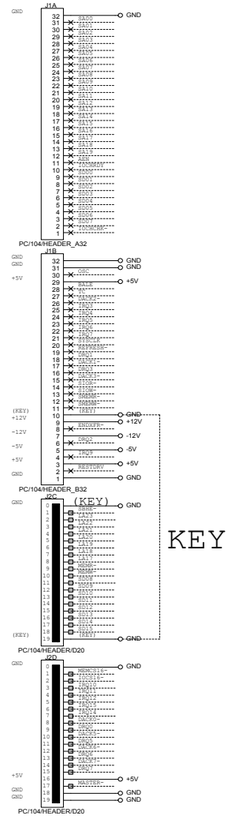
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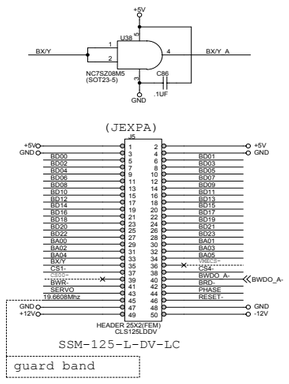
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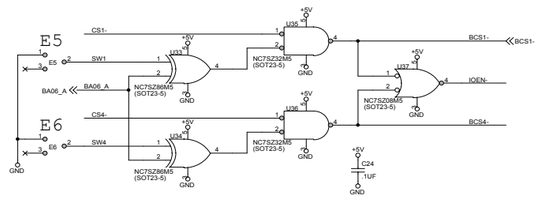
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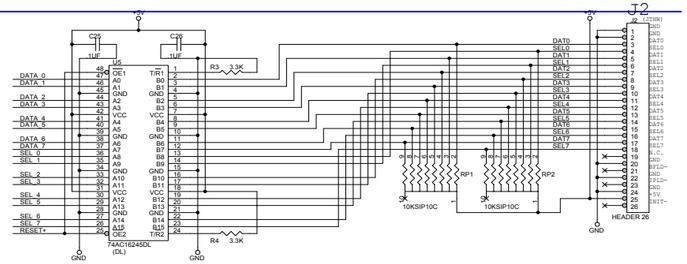
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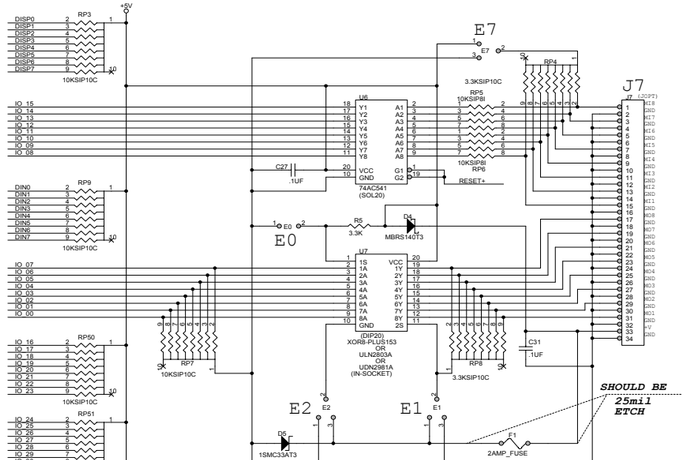
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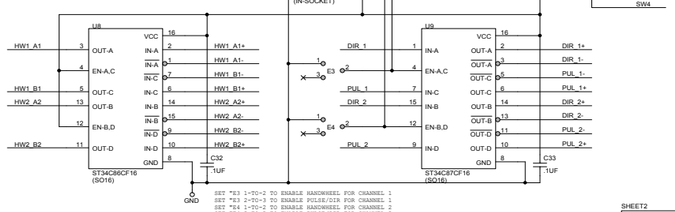


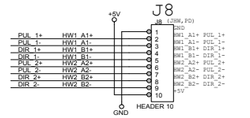


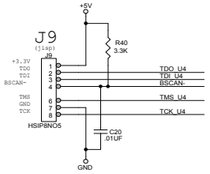


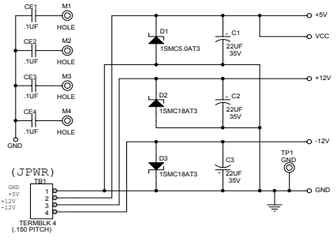




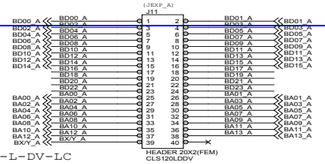




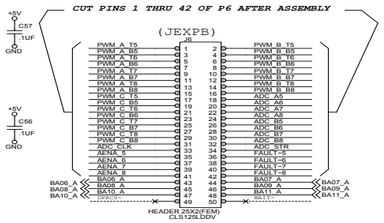




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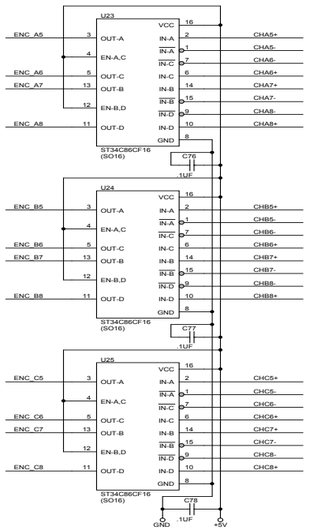


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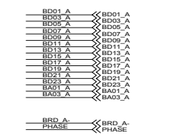


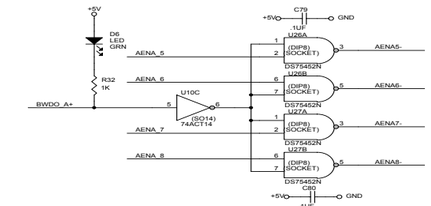
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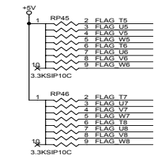


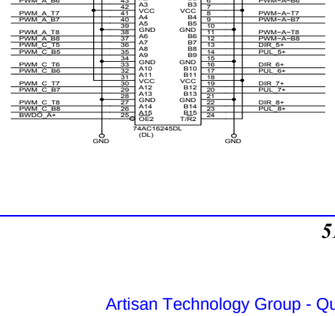


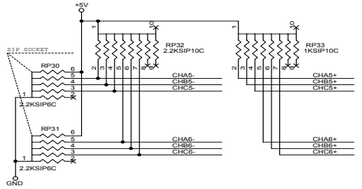
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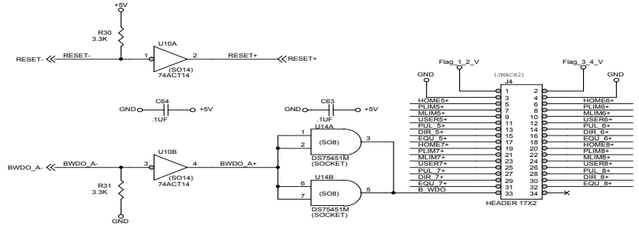


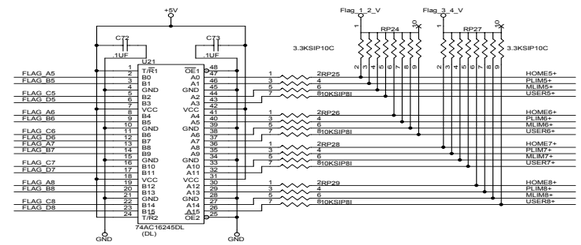


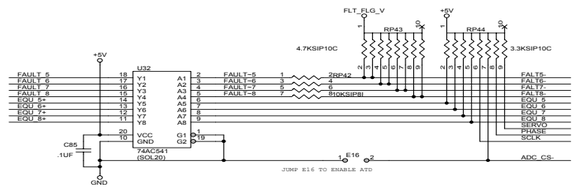












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