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HARDWARE REFERENCE MANUAL

PMAC VME

Programmable Multi-Axis Controller

4Ax-602203-xHxx

November 4, 2004

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Table of Contents

PMAC VME E-POINT DESCRIPTIONS 1
PMAC VME Bottom Board 1
E1 - E2: Machine Output Supply Voltage Configure 1
E3 - E6: Servo Clock Frequency Control 2
E7: Machine Input Source/Sink Control 2
E8: RS232 Converter Power Supply Control 3
E9 - E16: Serial Interface Handshake Control 3
E17A-E17D: Amplifier-Enable/Direction Polarity Control 4
E22 - E23: Control Panel Handwheel Enable 4
E24 - E27: Encoder Single-Ended/Differential Control 4
E28: Warning Following Error/Watchdog Timer Signal Control 5
E29 - E33: Phase Clock Frequency Control 5
E34 - E38: Encoder Sampling Clock Frequency Control 5
E39: Reset-From-Bus Enable 6
E40 - E43: Software Address Control 6
E44 - E47: Communications Control 7
E48: RAM Wait State Control (Standard CPU Section) 7
E48: CPU Clock Frequency Control (Option CPU Section) 8
E49: Serial Communications Parity Control 8
E50: EAROM Save Enable/Disable 8
E51: Normal/Re-Initializing Power-Up 8
E52 - E53: DSP Interrupt Signal Select 8
E72 - E73: Panel Analog Time Base Signal Enable 9
E74 - E75: Clock Output Control for External Interpolation 9
E85, E87, E88: Host-Supplied Analog Power Source Enable 9
E89: Amplifier-Supplied Switch Pull-Up Enable 10
E90: Host-Supplied Switch Pull-Up Enable 10
E93 - E94: Compare-Equal Output Voltage Configure 10
E96 - E97: Analog Source Isolate from Option 1V 11
E98: DAC/ADC Clock Frequency Control 11
E99: Analog Source Isolate from Option 1V 11
PMAC VME Option 1A Jumpers 12
E17E - E17H: Amplifier Enable Polarity Control 12
E18 - E21: Encoder Single-Ended/Differential Control 12
E185, E187, E188: Host-Supplied Analog Power Source Enable 13
E189: Amplifier-Supplied Switch Pull-Up Enable 13
E190: Host-Supplied Switch Pull-Up Enable 13
E196, E197, E199: Analog Source Isolate from Main Board 14

PMAC VME CPU BOARDS 15
Legacy PMAC Universal CPU (602705-10x) 15
E1: Watchdog Disable Jumper 15
E2-E3: Expansion Port Configure 15
E4: Power-Up/Reset Load Source 15
E8: Expansion Port Configure 15
Legacy PMAC VME Standard CPU Board (602398, 602271) 16
Legacy PMAC VME Option CPU Board 16

PMAC VME MATING CONNECTORS 17
Base Board Connectors 17
J1 (JDISP)/Display 17
J2 (JPAN)/Control Panel 17
J3 (JTHW)/Multiplexer Port 17
J4 (JRS422)/RS232 or 422/Serial Communications 17

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J5 (JOPT)/OPTO I/O *17*
J6 (JXIO)/Expansion Board *17*
J7 (JEQU)/Position Compare *17*
J8 (JS1)/A-D Inputs 1-4 ..... *17*
P1 (JVME)/Standard VME Connector *17*
P2 (JMACH1)/1st Machine Connector *17*
Axis-Expansion Piggyback Board Connectors 18
P2A (JMACH2)/2nd Machine Connector *18*
J1 (JS2)/A-D Inputs 5-8 (J9 on Option 3 Front Panel) *18*
CPU Board Connectors 18
J2 (JEXP)/Expansion (J10 on Option 3 Front Panel) *18*
J4 (JDPRAM)/Dual-Ported RAM *18*

PMAC VME CONNECTOR PINOUTS 19
J1 JDISP (14-Pin Connector) *19*
J2 JPAN (26-Pin Connector) *20*
J3 JTHW Connector (26-Pin Connector) *21*
J4 JRS422 (26-Pin Connector) *22*
J5 JOPT (34-Pin Connector) *23*
J6 JXI0 (10-Pin Connector) *24*
J7 JEQU (10-Pin Connector) *24*
J8 JS1 (16-Pin Header) *24*
P1 JVME (96-Pin Header) *25*
P2 JMACH1 (96-Pin Header) *26*
P2 JMACH1 (96-Pin Header) Continued *27*
J1 JS2 (16-Pin Header on Option 1A) *28*
P2A JMACH2 (96-Pin Header on Option 1A) *28*
P2A JMACH2 (96-Pin Header on Option 1A) Continued *29*
P2A JMACH2 (96-Pin Header on Option 1A) *29*
P2A JMACH2 (96-Pin Header on Option 1A) *30*

PMAC BASIC SPECIFICATIONS 31
Physical Specifications 31
Electrical Specifications 31
Memory Specifications 31
CPU Specifications 31
Performance Specifications 32
I/O Specifications 33
Software Specifications 35
Options 36
Accessories 37
Accessory 1: +5V Power Supplies and Batteries *37*
Accessory 2: +/-15V Power Supplies *37*
Accessory 3: Serial Communications Cable *37*
Accessory 4: Additional Instruction Manual *37*
Accessory 6: Handwheel Encoder *37*
Accessory 8: Terminal Block *38*
Accessory 9: IBM PC Software *39*
Accessory 12: Liquid Crystal/Vacuum Fluorescent Display *39*
Accessory-14: I/O Expansion Board *40*
Accessory 16D: Control Panel And Display Box *41*
Accessory 17: PMACAD Cad Conversion Software *41*
Accessory-17DA: *41*
Accessory 18: Thumbwheel Multiplexer Board *41*
Accessory 20: Hand-Held Terminal *42*
Accessory 21: I/O Simulators and Cables *42*
Accessory 22: Extended Warranty *42*

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Accessory 24: Axis Expansion Board *42*
Accessory 25: Extended Servo Algorithm Tuning Software *43*
Accessory 26A: Serial Communications Converter *43*
Accessory 27: Optically Isolated I/O Board *43*
Accessory 28: A/D Conversion Board *43*
Accessory 29: Magnetostrictive Linear Displacement Transducer Interface Board *44*
Accessory 31: PMAC Demonstration Box Unit *44*
Accessory 32: PMAC Software Upgrade/Update Kit *44*
Accessory 33: PMAC NC Software Library *44*
Accessory 34: Multiplexed I/O Expansion Board *44*
Accessory 35: Multiplexer Port Line Driver and Receiver *45*
Accessory 36: Analog to Digital Converter Board *45*
Accessory 39: Handwheel Encoder Converter Board *46*
Accessory 40: On-Site Field Service and Training *46*
Accessory 41: Servo Training Systems *46*
Future Accessories *46*

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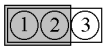
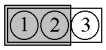
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PMAC VME E-POINT DESCRIPTIONS

PMAC VME Bottom Board

E Point and Physical Layout	Location	Description	Default
E0 	B5	For future use.	No jumper

E1 - E2: Machine Output Supply Voltage Configure

E Point and Physical Layout	Location	Description	Default
CAUTION: The jumper settings for both E1 and E2 must match the type of driver IC, or damage to the IC will result.			
E1 	A5	Jump pin 1 to 2 to apply +V (+5V to 24V) to pin 11 of U33 (should be ULN2803A for sink output configuration) JOPTO Machine outputs M01-M08. Jump pin 2 to 3 to apply GND to pin 11 of U33 (should be UDN2981A for source output configuration).	1-2 Jumper installed
E2 	A5	Jump pin 1 to 2 to apply GND to pin 10 of U33 (should be ULN2803A for sink output configuration). Jump pin 2 to 3 to apply +V (+5V to 24V) to pin 10 of U33 (should be UDN2981A for source output configuration).	1-2 Jumper installed

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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.

E3	E4	E5	E6	Servo Clock = Phase Clock Divided by N	Default and Physical Layout E3 E4 E5 E6  Location: B4 B4 B5 B5
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	Only E4 and E6 ON (option 5 only)
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	

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 crystal clock frequency. I10 holds the length of a servo interrupt cycle, scaled so that 8,388,608 equals one millisecond. Since I10 has a maximum value of 8,388,607, the servo interrupt cycle time should always be less than a millisecond (unless you want to make your basic unit of time on PMAC something other than a millisecond). To have a servo sample time greater than one millisecond, the sampling may be slowed in software with variable Ix60.

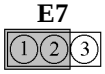
Frequency can be checked on J4 pins 21 and 22. It can also be checked from software by typing

RX:0 in the PMAC terminal at 10-second intervals and dividing the difference of successive responses by 10000. The resulting number is the approximate servo clock frequency in kHz.

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.

All versions of the PMAC except Option 5 (30MHz), have a 19.6608MHz ("20MHz) clock crystal, even the 40 and 60 MHz CPU versions.

E7: Machine Input Source/Sink Control

E Point and Physical Layout	Location	Description	Default
E7 	A4	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

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E8: RS232 Converter Power Supply Control

E Point and Physical Layout	Location	Description	Default
E8 	A4	Jump pin 1 to 2 to apply +5V to J4 pin 2 (JRS422); this can be used to power optional RS422 to RS232 converter module which requires +5V for operation.	Jumper installed

E9 - E16: Serial Interface Handshake Control

E9 to E16 jumpers control whether the RS-422 serial port will be in DCE or DTE format. The default configuration permits straight-across connection to a PC DB-25 serial port.

E Point and Physical Layout	Location	Description	Default
E9 E10 	A3	Jump, E9-1 to E9-2 to allow RD- to be input on J4-3; jump E10-1 to E10-2 to allow SD- to be output on J4-5. Jump E9-1 to E10-1 to allow RD- to be output on J4-3; jump E9-2 to E10-2 to allow SD- to be input on J4-5.	1-2 Jumper installed
E11 E12 	A3	Jump E11-1 to E11-2 to allow RD+ to be input on J4-4; jump E12-1 to E12-2 to allow SD+ to be output on J4-6. Jump E11-1 to E12-1 to allow RD+ to be output on J4-4; jump E11-2 to E12-2 to allow SD+ to be input on J4-6.	1-2 Jumper installed
E13 E14 	A4	D5 jump E13-1 to E13-2 to 1-2 allow CS+ to be input jumper on J4-7; jump E14-1 to installed E14-2 to allow RS+ to be output on J4-9. Jump E13-1 to E14-1 to allow CS+ to be output on J4-7; jump E13-2 to E14-2 to allow RS+ to be input on J4-9.	1-2 Jumper installed
E15 E16 	A4	D5 jump E15-1 to E15-2 to allow CS- to be input on J4-8. Jump E16-1 to E16-2 to allow RS- to be output on J4-10. Jump E15-1 to E16-1 to allow CS- to be output on J4-8; jump E15-2 to E16-2 to allow RS- to be input on J4-10.	1-2 Jumper installed

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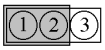
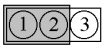
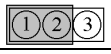
E17A-E17D: Amplifier-Enable/Direction Polarity Control

E Point and Physical Layout	Location	Description	Default
E17A 	B2	Jump 1-2 for high TRUE AENA (1-4). Remove jumper for low TRUE AENA (1-4).	No jumper installed
E17B 	C2	Jump 1-2 for high TRUE AENA (1-4). Remove jumper for low TRUE AENA (1-4).	No jumper installed
E17C 	C2	Jump 1-2 for high TRUE AENA (1-4). Remove jumper for low TRUE AENA (1-4).	No jumper installed
E17D 	C2	Jump 1-2 for high TRUE AENA (1-4). Remove jumper for low TRUE AENA (1-4).	No jumper installed
Low-true enable is the fail-safe option because of the sinking (open-collector) ULN2803A output driver IC.			

E22 - E23: Control Panel Handwheel Enable

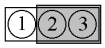
E Point and Physical Layout	Location	Description	Default
E22 	C2	Jump pin 1 to 2 to obtain handwheel encoder signal from front panel at J2-16 for CHB2 (ENC2-B).	No jumper
E23 	C2	Jump pin 1 to 2 to obtain handwheel encoder signal from front panel at J2-22 for CHA2 (ENC2-A).	No jumper
With these jumpers ON, no encoder should be wired into ENC2 on JMACH1. Jumper E26 must connect pins 1-2, because these are single-ended inputs. This function is unrelated to the encoder brought in through Acc-39 on J2.			

E24 - E27: Encoder Single-Ended/Differential Control

E Point and Physical Layout	Location	Description	Default
E24 	D2	ENC 4 through 1: Jump pin 1 to 2 to tie complementary encoder inputs to 2.5V.	1-2 Jumper installed for E24 - E27.
E25 	D2	Jump pin 2 to 3 to tie complementary encoder inputs to 5V. For no encoder connection: Jump pin 1 to 2.	E24: ENC 4 E25: ENC 3 E26: ENC 2 E27: ENC 1
E26 	D2	For single-ended encoders: Jump pin 1 to 2. For differential line-driver encoders: Do not care.	
E27 	D2	For complementary open-collector encoders: Jump pin 2 to 3.	

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E28: Warning Following Error/Watchdog Timer Signal Control

E Point and Physical Layout	Location	Description	Default
E28 	B3	Jump pin 1 to 2 to allow warning following error (Ix12) for the selected coordinate system to control FEFCO/ on J8-57. 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.

E29	E30	E31	E32	E33	Phase Clock Frequency		Default and Physical Layout
					19.6608 MHz Master Clock See Note 1	**29.4912 MHz Master Clock** See Note 2	**E33 E32 E31 E30 E29**  Location: All B4
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	
1. True for standard 20 MHz PMAC and those with Options 4A, 5A, and 5B 2. True only for PMACs with Option 5							

Note:

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.

E34 - E38: Encoder Sampling Clock Frequency Control

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

E34	E35	E36	E37	E38	SCLK Clock Frequency		Default and Physical Layout
					19.6608 MHz Master Clock See Note 1	**29.4912 Mhz Master Clock** See Note 1	
ON	OFF	OFF	OFF	OFF	9.8304 MHz	14.7456 MHz	 **E34**
OFF	ON	OFF	OFF	OFF	4.9152 MHz	7.3728 MHz	 **E35**
OFF	OFF	ON	OFF	OFF	2.4576 MHz	3.6864 MHz	 **E36**
OFF	OFF	OFF	ON	OFF	1.2288 MHz	1.8432 MHz	 **E37**
OFF	OFF	OFF	OFF	ON	External clock 1 to 30 mhz maximum input on CHC4 & CHC4/		**E38** Location: All B4
1. True for standard 20 MHz PMAC and those with Options 4A, 5A, and 5B 2. True only for PMACs with Option 5.							

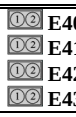
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E39: Reset-From-Bus Enable

E Point and Physical Layout	Location	Description	Default
E39 	B5	Jump pin 1 to 2 to permit VME bus reset line to reset PMAC VME. Remove jumper so that the VME bus reset line does not reset PMAC VME.	1-2 jumper installed

E40 - E43: Software Address Control

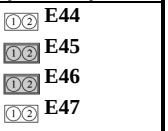
Jumpers E40-E43 control the software address of the card, for serial addressing and for sharing the servo clock over the serial connector. Card @0 sends the clock and cards @1-@F receive the clock.

Card Address Control E-Points				Default and Physical Layout	 **E40** **E41** **E42** **E43**
E40	**E41**	**E42**	**E43**	**Card Address**	**Location; All D3**
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	
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.					

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E44 - E47: Communications Control

Jumpers E44 - E47 control what baud rate to use for serial communications. Any character received over the bus causes PMAC to use the bus for its standard 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**	**Option 4A**	**Standard, Option 5A**	**Option 5, Option 5B**	 **E44** **E45** **E46** **E47** Location: All D3 Picture is for a PMAC with a Standard or Option 5A CPU
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	Options 5, 5B
OFF	ON	ON	OFF	4800	9600	14400	Std., Opt. 5A
ON	OFF	ON	OFF	6400*	12800*	19200	
OFF	OFF	ON	OFF	9600	19200	28800	Option 4A
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	

These jumpers are used only to set the baud rate at power-on/reset.
* Non-standard baud rates

E48: RAM Wait State Control (Standard CPU Section)

E48 controls the memory wait states only on PMACs with a standard CPU section using battery backup. This CPU section is used on PMACs ordered with no CPU or memory options and Option 5 (not Opt 4A, 5A, or 5B).

E Point and Physical Layout	Location	Description	Default
E48 	C2	Jump pin 1 to 2 for zero wait state operation; remove jumper for one wait state operation.	No jumper installed (standard configuration) Jumper installed (Option 5)

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E48: CPU Clock Frequency Control (Option CPU Section)

E48 controls the CPU clock frequency only on PMAC with an option CPU section using flash memory backup (no battery). This CPU section is used on PMACs ordered with Opt 4A, 5A, or 5B (not Option 5).

E Point and Physical Layout	Location	Description	Default
E48 	C2	Jump pins 1 and 2 to multiply crystal frequency by 3 inside CPU for 60 MHz operation. Remove jumper to multiply crystal frequency by 2 inside CPU for 40 MHz operation.	Jumper installed (Option 5, 5B) Jumper not installed (Standard, Option 4A, 5A)
It may be possible to operate a board with 40 MHz components (Option 5A) at 60 MHz under some conditions by changing the setting of jumper E48. However, this operates the components outside of their specified operating range, and proper execution of PMAC under these conditions is not guaranteed. PMAC software failure is possible, even probable, under these conditions, and this can lead to very dangerous machine failure. Operation in this mode is done completely at the user's own risk; Delta Tau can accept no responsibility for the operation of PMAC or the machine under these conditions.			

E49: Serial Communications Parity Control

E Point and Physical Layout	Location	Description	Default
E49 	D3	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 	D3	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 	D3	Jump pin 1 to 2 to re-initialize ON power-up/reset. Remove jumper for NORMAL power-up/reset.	No jumper installed

E52 - E53: DSP Interrupt Signal Select

E Point and Physical Layout	Location	Description	Default
E52 	B5	Jump pin 1 to 2 to allow LIRQ0 to interrupt local DSP-CPU at IRQB.	Jumper installed
E53 	B5	Jump pin 1 to 2 to allow MI3 to interrupt local DSP-CPU at IRQB.	No jumper installed

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E72 - E73: Panel Analog Time Base Signal Enable

E Point and Physical Layout	Location	Description	Default
E72 	C3	Jump pin 1 to 2 to allow V to F converter FOUT derived from wiper input on J2 to connect to CHA4.	No jumper installed
E73 	C3	Jump pin 1 to 2 to allow V to F converter FOUT/ derived from wiper input on J2 to connect to CHA4/.	No jumper installed
With these jumpers ON, no encoder should be wired into ENC4 on JMACH1. E27 must connect pins 1 to 2 because these are single-ended inputs. Variable I915 should be set to 4 to create a positive voltage (frequency) number in PMAC.			

E74 - E75: Clock Output Control for External Interpolation

E Point and Physical Layout	Location	Description	Default
E74 	C3	Jump pin 1 to 2 to allow SCLK/ to output on CHC4/.	No jumper installed
E75 	C3	Jump pin 1 to 2 to allow SCLK to output on CHC4.	No jumper installed
SCLK out permits synchronous latching of analog encoder interpolators such as Acc-8D Opt 8.			

E85, E87, E88: Host-Supplied Analog Power Source Enable

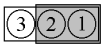
E Point and Physical Layout	Location	Description	Default
E85 	B2	Jump pin 1 to pin 2 to allow A+14V to come from P1 (ties amplifier and PMAC VME power supply together. Defeats OPTO coupling.) Note that if E85 is changed, E88 and E87 must also be changed. Also, see E90.	No jumper
E87 	D1	Jump pin 1 to pin 2 to allow analog GND to come from P1 (ties amplifier and PMAC VME GND together. Defeats OPTO coupling.) Note that if E87 is changed, E85 and E88 must also be changed. Also, see E90.	No jumper
E88 	A2	Jump pin 1 to pin 2 to allow A-14V to come from P1 (ties amplifier and PMAC VME power supply together. Defeats OPTO coupling.) Note that if E88 is changed; E87 and E85 must also be changed. Also, see E90.	No jumper

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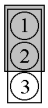
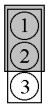
E89: Amplifier-Supplied Switch Pull-Up Enable

E Point and Physical Layout	Location	Description	Default
E89 	A2	Jump pin 1 to 2 to supply flags from A+15V input (P2 pin C30). E90 must jump pins 1 to 2 to bring power to flags. Jump pin 2 to 3 to supply flags from A+V input on option 1V (P2 pin C30). E90 must jump pins 1 to 2 to bring power to flags. See also E85, E87, E88, E89 and PMAC VME power supply connection diagram.	1-2 Jumper installed

E90: Host-Supplied Switch Pull-Up Enable

E Point and Physical Layout	Location	Description	Default
E90 	D1	Jump pin 1 to 2 to allow A+15V/OPT+V on P2 or P2A (JMACH) pin C30, (also see E89) to supply flags. Jump pin 2 to 3 to allow +12V from VME bus connector to supply flags. Optical isolation is then lost. See also E85, E87, E88, E89 and PMAC VME power supply connection diagram.	1-2 Jumper installed

E93 - E94: Compare-Equal Output Voltage Configure

E Point and Physical Layout	Location	Description	Default
E93 	A3	Jump pin 1 to 2 to apply +V (+5V to +24V) to pin 11 of U28 (should be ULN2803A for sink output configuration). Jump pin 2 to 3 to apply GND to pin 11 of U28 (should be UDN2981A for source output configuration). Also, see E2	1-2 Jumper installed
E94 	B3	Jump pin 1 to 2 to apply GND to pin 10 of U28 (Should be ULN2803A for sink output configuration). Jump pin 2 to 3 to apply +V (+5V to +24V) to pin 10 of U28 (Should be UDN2981A for source output configuration). Also, see E1	1-2 Jumper installed
E95 	A3	Reserved for future use.	No jumper

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E96 - E97: Analog Source Isolate from Option 1V

E Point and Physical Layout	Location	Description	Default
E96 1 2	A2	Jump 1 to 2 to connect A+15V on main PMAC VME board to A+15V on option 1V piggyback board. Remove jumper to keep A+15V isolated between option 1V board and main board.	No jumper installed
E97 1 2	A2	Jump 1 to 2 to connect A-15V on main PMAC VME board to A-15V on option 1V piggyback board. Remove jumper to keep A-15V isolated between option 1V board and main board.	No jumper installed

E98: DAC/ADC Clock Frequency Control

E Point and Physical Layout	Location	Description	Default
E98 1 2 3	B4	Jump 1-2 to provide a 2.45 MHz (3.67 MHz for Option 5) DCLK signal to DACs and ADCs. Jump 2-3 to provide a 1.22 MHz (1.83 MHz for Option 5) DCLK signal to DACs and ADCs. Important for high accuracy A/D conversion on Acc-28. Note: This also divides the phase and servo clock frequencies in half. See E29-E33, E3-E6, I10	1-2 Jumper installed

E99: Analog Source Isolate from Option 1V

E Point and Physical Layout	Location	Description	Default
E99 1 2	A2	Jump 1 to 2 to connect AGND on main PMAC VME board to AGND on option 1V piggyback board. Remove jumper to keep AGND isolated between option 1V board and main board.	No jumper installed

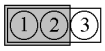
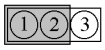
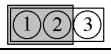
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PMAC VME Option 1A Jumpers

E17E - E17H: Amplifier Enable Polarity Control

E Point and Physical Layout	Location	Description	Default
E17E 	B1	Jump 1-2 for high TRUE AENA (5-8). Remove jumper for low TRUE AENA (5-8).	No jumper installed
E17F 	C1	Jump 1-2 for high TRUE AENA (5-8). Remove jumper for low TRUE AENA (5-8).	No jumper installed
E17G 	C1	Jump 1-2 for high TRUE AENA (5-8). Remove jumper for low TRUE AENA (5-8).	No jumper installed
E17H 	C1	Jump 1-2 for high TRUE AENA (5-8). Remove jumper for low TRUE AENA (5-8).	No jumper installed
Low-true enable is the fail-safe option because of the sinking (open-collector) ULN2803A output driver IC.			

E18 - E21: Encoder Single-Ended/Differential Control

E Point and Physical Layout	Location	Description	Default
E18 	D2	ENC 5 through 8: Jump pin 1 to 2 to tie complementary encoder inputs to 2.5V.	1-2 Jumper installed for E18 - E21.
E19 	D2	Jump pin 2 to 3 to tie complementary encoder inputs to 5V. For no encoder connection: Jump pin 1 to 2.	E18: ENC 5 E19: ENC 6 E20: ENC 7 E21: ENC 8
E20 	D2	For single-ended encoders: Jump pin 1 to 2. For differential line-driver encoders: Do not care.	
E21 	D2	For complementary open-collector encoders: Jump pin 2 to 3.	

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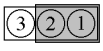
E185, E187, E188: Host-Supplied Analog Power Source Enable

E Point and Physical Layout	Location	Description	Default
E185 	B2	Jump pin 1 to pin 2 to allow A+14V to come from P1 (ties amplifier and PMAC VME power supply together. Defeats OPTO coupling.) Note that if E185 is changed, E188 and E187 must also be changed. Also see E190.	No jumper installed
E187 	A1	Jump pin 1 to pin 2 to allow analog GND to come from P1 (ties amplifier and PMAC VME GND together. Defeats OPTO coupling.) Note that if E187 is changed, E185 and E188 must also be changed. Also, see E190.	No jumper
E188 	A2	Jump pin 1 to pin 2 to allow A-14V to come from P1 (ties amplifier and PMAC VME power supply together. Defeats OPTO coupling.) Note that if E188 is changed; E187 and E185 must also be changed. Also, see E190.	No jumper

E189: Amplifier-Supplied Switch Pull-Up Enable

E Point and Physical Layout	Location	Description	Default
E189 	A2	Jump pin 1 to 2 to allow A+15V/+V on P2A (JMACH2) pin 59, to tie to A+15V on P2 (JMACH1) pin C30. 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 E190	1-2 Jumper installed

E190: Host-Supplied Switch Pull-Up Enable

E Point and Physical Layout	Location	Description	Default
E190 	D1	Jump pin 1 to 2 to allow A+15V/OPT+V on P2A (JMACH2) pin C30, (also see E189) to power OPTO switch sensor inputs (including limits). Jump pin 2 to 3 to allow +12V from VME bus connector to power OPTO switch sensor inputs (including limits). Optical isolation is then lost. See also E185, E187, E188, and figure on PMAC OPTO isolation	1-2 Jumper installed

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E196, E197, E199: Analog Source Isolate from Main Board

E Point and Physical Layout	Location	Description	Default
E196 	A2	Jump 1 to 2 to connect A+15V on option 1V piggyback board to main PMAC VME board. Remove jumper to keep A+15V isolated between main board and option 1V board.	No jumper installed
E197 	A2	Jump 1 to 2 to connect A-15V on option 1V piggyback board to main PMAC VME board. Remove jumper to keep A-15V isolated between main board and option 1V board.	No jumper installed
E199 	A2	Jump 1 to 2 to connect AGND on option 1V piggyback board to main PMAC VME board. Remove jumper to keep AGND isolated between main board and option 1V board.	No jumper installed

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PMAC VME CPU BOARDS

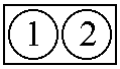
Current PMAC1 VME cards use the Flex CPU. For information regarding the Flex CPU, refer to the Flex CPU User manual.

For convenience, two other versions of the CPU have been included in this manual.

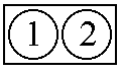
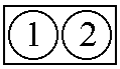
Legacy PMAC Universal CPU (602705-10x)

The following jumper descriptions are for the PMAC CPU, part number 602705-107.

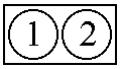
E1: Watchdog Disable Jumper

E Point and Physical Layout	Location	Description	Default
E1 		Jump pin 1 to 2 to disable watchdog timer (for test purposes only). Remove jumper to enable Watchdog timer.	No jumper

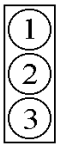
E2-E3: Expansion Port Configure

E Point and Physical Layout	Location	Description
E2 	No longer used	No Jumper
E3 	No longer used	No Jumper

E4: Power-Up/Reset Load Source

E Point and Physical Layout	Location	Description	Default
E4 		Jump pin 1 to 2 to reload firmware through serial or bus port. Must also install E51 jumper on baseboard. Remove jumper for normal operation.	No jumper

E8: Expansion Port Configure

E Point and Physical Layout	Location	Description	Default
E8 		Jump pin 1 to 2 for using the Acc-24P2 expansion board. Remove jumper for normal operation.	No jumper

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Legacy PMAC VME Standard CPU Board (602398, 602271)

This table shows the jumper settings for the standard PMAC CPU boards with batteries. These boards are used when the PMAC is ordered without any memory or CPU options, or with Option 5 (not 4A, 5A, or 5B).

E Point and Physical Layout	Description	Default
E1 	Jump pin 1 to 2 to disable watchdog timer (for test purposes only). Remove jumper to enable watchdog timer. **Note:** On old CPU boards with white CPU IC, E1 function is opposite.	No jumper installed
E2 	Jump pin 1 to 2 to boot from host port. Remove jumper to boot from IC.	No jumper installed
E3 	Jump pin 1 to 2 to use BAT1 battery (shorts BAT2 positive terminal to GND). Jump pin 2 to 3 to use BAT2 battery (shorts BAT1 positive terminal to GND). Remove jumper to use both batteries.	2-3 jumper installed (20 MHz) No jumper installed (30 MHz).

Legacy PMAC VME Option CPU Board

This table shows the jumper setting for the option PMAC CPU boards with flash memory backup (no battery). These boards are used only when the PMAC is ordered with Option 4A, 5A, or 5B (not standard or Option 5).

E Point and Physical Layout	Description	Default
E1 	Jump pin 1 to 2 to disable watchdog timer (for test purposes only). Remove jumper to enable watchdog timer.	No jumper installed
E2 	Remove jumper for use on first generation PMAC. Jump pin 1 to 2 for use on second generation PMAC (PMAC2).	No jumper installed *
E3 	Remove jumper for use on first generation PMAC. Jump pin 1 to 2 for use on second generation PMAC (PMAC2).	No jumper installed *
***** Pins for jumpers E2 and E3 may not be installed on Option CPU boards for 1st generation PMACs.		

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PMAC VME MATING CONNECTORS

This section lists several options for each connector. Choose an appropriate one for the application. (See attached PMAC mating connector sketch for typical connection.)

Base Board Connectors

J1 (JDISP)/Display

1. Two 14-pin female flat cable connector Delta Tau P/N 014-R00F14-0K0 T&B Ansley P/N 609-1441
2. 171-14 T&B Ansley standard flat cable stranded 14-wire
3. Phoenix varioface modules type FLKM14 (male pins) P/N 22 81 02 1

J2 (JPAN)/Control Panel

1. Two 26-pin female flat cable connector Delta Tau P/N 014-R00F26-0K0 T&B Ansley P/N 609-2641
2. 171.26.T&B Ansley standard flat cable stranded 26-wire
3. Phoenix varioface module type FLKM 26 (male pins) P/N 22 81 05 0

J3 (JTHW)/Multiplexer Port

1. Two 26-pin female flat cable connector Delta Tau P/N 014-R00F26-0K0 T&B Ansley P/N 609-2641
2. 171-26 T&B Ansley standard flat cable stranded 26-wire
3. Phoenix varioface module type FLKM 26 (male pins) P/N 22 81 05 0

J4 (JRS422)/RS232 or 422/Serial Communications

1. Two 26-pin female flat cable connector Delta Tau P/N 014-R00F26-0K0 T&B Ansley P/N 609-2641
2. 171-26 T&B Ansley standard flat cable stranded 26-wire
3. Phoenix varioface module type FLKM 26 (male pins) P/N 22 81 05 0

J5 (JOPT)/OPTO I/O

1. Two 60-pin female flat cable connector Delta Tau P/N 014-R00F34-0k0 T&B Ansley P/N 609-3441
2. 171-34 T&B Ansley standard flat cable stranded 34-wire
3. Phoenix varioface module type FLKM 34 (male pins) P/N 22 81 06 3

J6 (JXIO)/Expansion Board

1. Two 10 pin female flat cable connector Delta Tau P/N 014-R00F10-0K0 T&B Ansley P/N 609-1041
2. 171-10 T&B Ansley standard flat cable stranded 10 wire
3. Phoenix varioface module type FLKM 10 (male pins) P/N 22 81 01 8

J7 (JEQU)/Position Compare

1. Two 10 pin female flat cable connector Delta Tau P/N 014-R00F10-0K0 T&B Ansley P/N 609-1041
2. 171-10 T&B Ansley standard flat cable stranded 10 wire
3. Phoenix varioface module type FLKM 10 (male pins) P/N 22 81 01 8

J8 (JS1)/A-D Inputs 1-4

1. Two 16-pin female flat cable connector Delta Tau P/N 014-R00F16-0K0 T&B Ansley P/N 609-1641
2. 171-16 T&B Ansley standard flat cable stranded 16-wire
3. Phoenix varioface module type FLKM 16 (male pins) P/N 22 81 03 4

P1 (JVME)/Standard VME Connector

1. 96 pin VME connector AMLAN P/N C96F3LA+B+C

P2 (JMACH1)/1st Machine Connector

96 pin VME connector. AMLAN P/N C96F3LA+B+C

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Note:

Normally, P2 and P2A are used with Acc-8P or Acc-8D with Option V which provides complete terminal strip fan-out of all connections.

Axis-Expansion Piggyback Board Connectors

P2A (JMACH2)/2nd Machine Connector

1. 96 pin VME connector. AMLAN P/N C96F3LA+B+C

Note:

Normally, P2 and P2A are used with Acc-8P or 8D with Option V which provides complete terminal strip fan-out of all connections.

J1 (JS2)/A-D Inputs 5-8 (J9 on Option 3 Front Panel)

1. Two 16 pin female flat cable connector Delta Tau P/N 014-R00F16-0K0 T&B Ansley P/N 609-1641
2. 171-16 T&B Ansley standard flat cable stranded 16 wire
3. Phoenix varioface module type FLKM 16 (male pins) P/N 22 81 03 4

CPU Board Connectors

J2 (JEXP)/Expansion (J10 on Option 3 Front Panel)

1. Two 50-pin female flat cable connector Delta Tau P/N 014-R00F50-0K0 T&B Ansley P/N 609-5041
2. 171-50 T&B Ansley standard flat cable stranded 50-wire
3. Phoenix varioface module type FLKM 50 (male pins) P/N 22 81 08 9 used for daisy chaining Acc-14 I/0, -23 A and D connectors -24 expansion

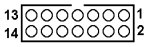
J4 (JDPRAM)/Dual-Ported RAM

1. Two 10 pin female flat cable connector Delta Tau P/N 014-ROOF10-0K0 T&B Ansley P/N 609-1041
2. 171-10 T&B Ansley standard flat cable stranded 10 wire
3. Phoenix varioface module type FLKM 10 (male pins) P/N 22 81 01 8

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PMAC VME CONNECTOR PINOUTS

J1 JDISP (14-Pin Connector)



Front View

Pin #	Symbol	Function	Description	Notes
1	VDD	Output	+5V Power	Power supply out
2	VSS	Common	PMAC Common	
3	RS	Output	Read Strobe	TTL signal out
4	VEE	Output	Contrast Adjust Vee	0 TO +5 VDC *
5	E	Output	Display Enable	High is enable
6	R/W	Output	Read or Write	TTL signal out
7	DB1	Output	Display DATA1	
8	DB0	Output	Display DATA0	
9	DB3	Output	Display DATA3	
10	DB2	Output	Display DATA2	
11	DB5	Output	Display DATA5	
12	DB4	Output	Display DATA4	
13	DB7	Output	Display DATA7	
14	DB6	Output	Display DATA6	

The JDISP connector is used to drive the 2-line x 24-character (Acc-12), 2 x 40 (Acc-12A) LCD, or the 2 x 40 vacuum fluorescent (Acc-12C) display unit. The **DISPLAY** command may be used to send messages and values to the display.

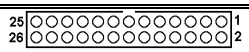
* **Note:** Controlled by potentiometer R2.

See Also:

Program Commands: **DISPLAY**
Accessories; Acc-12, 12A, 12C, Acc-16D
Memory Map: Y:$0780 - $07D1

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J2 JPAN (26-Pin Connector)



Front View

Pin #	Symbol	Function	Description	Notes
1	+5V	Output	+5V Power	For remote panel
2	GND	Common	PMAC Common	
3	FPD0/	Input	Motor/C.S. Select Bit 0	Low is True
4	JOG-/	Input	Jog In - DIR.	Low is JOG -
5	FPD1/	Input	Motor/C.S. Select Bit 1	Low is True
6	JOG+/	Input	Jog In + DIR.	Low is JOG +
7	PREJ/	Input	Return to Pre-Jog Position	Low is Return, Equiv to J= CMD
8	STRT/	Input	Start Program Run	Low is Start, Equiv to R CMD
9	STEP/	Input	Step Through Program	Low is Step, Equiv to S or Q
10	STOP/	Input	Stop Program Run	Low is Stop, Equiv to A
11	HOME/	Input	Home Search Command	Low is Go Home, Equiv to HM
12	HOLD/	Input	Hold Motion	Low is Hold, Equiv to H
13	FPD2/	Input	Motor/C.S. Select Bit 2	Low is True
14	FPD3/	Input	Motor/C.S. Select Bit 3	Low is True
15	INIT/	Input	Reset PMAC	Low is Reset, Equiv to $$$
16	HWCA	Input	Handwheel Enc. A Channel	5V TTL SQ. pulse must use E23 (CHA2)
17	IPLD/	Output	In Position Ind. (C.S.)	Low lights LED
18	BRLD/	Output	Buffer Request Ind.	Low lights LED
19	ERLD/	Output	Fatal Follow Err (C.S.)	Low lights LED
20	WIPER	Input	Feed Pot Wiper	0 to +10V input must use E72, E73 (CHA4)
21	(SPARE)	N.C.		
22	HWCB	Input	Handwheel Enc. B Channel	5V TTL SQ. pulse must use E22 (CHB2)
23	F1LD/	Output	Warn Follow Err (C.S.)	Low lights LED
24	F2LD/	Output	Watchdog Timer	Low lights LED
25	+5V	Output	+5V Power	For remote travel
26	GND	Common	PMAC Common	

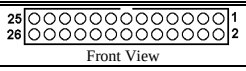
The JPAN connector can be used to connect the Accessory 16 (Control Panel), or customer-provided I/O, to the PMAC, providing manual control of PMAC functions via simple toggle switches. If the automatic control panel input functions are disabled (I2=1), the inputs become general-purpose TTL inputs, and the coordinate system (C.S.) specific outputs pertain to the host-addressed coordinate system.

See Also:

Control panel inputs
Accessories: Acc-16, Acc-39
I-variables: I2, Ix06
I/O and Memory Map Y:$FFC0
Suggested M-variables M20 - M32

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J3 JTHW Connector (26-Pin Connector)



Front View

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

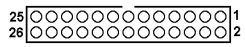
The JTHW multiplexer port provides eight inputs and eight outputs at TTL levels. While these I/O can be used in un-multiplexed form for 16 discrete I/O points, most users will utilize PMAC software and accessories to use this port in multiplexed form to greatly multiply the number of I/O that can be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

See also:

I/O and Memory Map Y:$FFC1
Suggested M-variables M40 - M58
M-variable formats TWB, TWD, TWR, TWS
Acc-8D Opt 7, Acc-8D Opt 9, Acc-18, Acc-34x, NC Control Panel

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J4 JRS422 (26-Pin Connector)



Front View

Pin #	Symbol	Function	Description	Notes
1	CHASSI	Common	PMAC Common	
2	S+5V	Output	+5VDC Supply	Deactivated by E8
3	RD-	Input	Receive Data	Diff. I/O low true **
4	RD+	Input	Receive Data	Diff. I/O high true *
5	SD-	Output	Send Data	Diff. I/O low true **
6	SD+	Output	Send Data	Diff. I/O high true *
7	CS+	Input	Clear to Send	Diff. I/O high true **
8	CS-	Input	Clear to Send	Diff. I/O low true *
9	RS+	Output	Request to Send	Diff. I/O high true **
10	RS-	Output	Request to Send	Diff. I/O low true *
11	DTR	Bidirectional	Data Terminal Ready	Tied to DSR
12	INIT/	Input	PMAC Reset	Low is Reset
13	GND	Common	PMAC Common	Low is Reset
14	DSR	Bidirectional	Data Set Ready	Tied to DSR
15	SDIO-	Bidirectional	Special DATA	Diff. I/O low true
16	SDIO+	Bidirectional	Special Data	Diff. I/O high true
17	SCIO-	Bidirectional	Special CTRL.	Diff. I/O low true
18	SCIO+	Bidirectional	Special CTRL.	Diff. I/O high true
19	SCK-	Bidirectional	Special Clock	Diff. I/O low true
20	SCK+	Bidirectional	Special Clock	Diff. I/O high true
21	SERVO-	Bidirectional	Servo Clock	Diff. I/O low true ***
22	SERVO+	Bidirectional	Servo Clock	Diff. I/O high true ***
23	PHASE-	Bidirectional	Phase Clock	Diff. I/O low true ***
24	PHASE+	Bidirectional	Phase Clock	Diff. I/O high true ***
25	GND	Common	PMAC Common	
26	+5V	Output	+5VDC Supply	Power supply out

The JRS422 connector provides the PMAC with the ability to communicate both in RS422 and RS232. In addition, this connector is used to daisy chain interconnect multiple PMACs for synchronized operation.

* **Note:** Required for communications to an RS-422 host port

** **Note:** Required for communications to an RS-422 or RS-232 host port

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

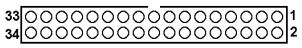
See Also:

Serial Communications

Synchronizing PMAC to other PMACs

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J5 JOPT (34-Pin Connector)



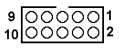
Front View

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	If sinking output, low is true. If source output, high is true.
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	Machine Output 3	" "
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 (U11 to UDN2981) and jumper (E1 & E2) change. E7 controls whether the inputs are pulled up or down internally.

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J6 JXI0 (10-Pin Connector)

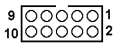


Front View

Pin #	Symbol	Function	Description	Notes
1	CHA1	Input	Enc. A Ch. Pos.	Axis #1 for resolver
2	CHB1	Input	Enc. B Ch. Pos.	Axis #1 for resolver
3	CHC1	Input	Enc. C Ch. Pos.	Axis #1 for resolver
4	CHA3	Input	Enc. A Ch. Pos.	Axis #3 for resolver
5	CHB3	Input	Enc. B Ch. Pos.	Axis #3 for resolver
6	CHC3	Input	Enc. C Ch. Pos.	Axis #3 for resolver
7	E63	Input	Interrupt IR4	Interrupt from expansion board
8	E59	Input	Interrupt IR5	Interrupt from expansion board
9	SCLK	Output	Encoder Clock	Encoder sample rate
10	DCLK	Output	D to A, A to D Clock	DAC and ADC clock for all channels

This connector is used for miscellaneous I/O functions related to expansion cards which are used with PMAC.

J7 JEQU (10-Pin Connector)

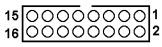


Front View

Pin #	Symbol	Function	Description	Notes
1	EQU1	Output	Enc. 1 Compare-Equ	Low is true
2	EQU2	Output	Enc. 2 Compare-Equ	Low is true
3	EQU3	Output	Enc. 3 Compare-Equ	Low is true
4	EQU4	Output	Enc. 4 Compare-Equ	Low is true
5	EQU5	Output	Enc. 5 Compare-Equ	Low is true
6	EQU6	Output	Enc. 6 Compare-Equ	Low is true
7	EQU7	Output	Enc. 7 Compare-Equ	Low is true
8	EQU8	Output	Enc. 8 Compare-Equ	Low is true
9	+V	Supply	Positive Supply	+5V to +24V
10	GND	Common	Digital Ground	

This connector provides the positive compare outputs for the eight encoder channels. Refer to jumpers E93 and E94 for proper configuration of this Output (for sourcing or sinking type outputs).

J8 JS1 (16-Pin Header)



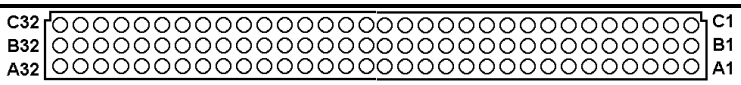
Front View

Pin #	Symbol	Function	Description	Notes
1	DCLK	Output	D to A, A to D Clock	DAC and ADC Clock for Chan 1, 2, 3, 4
2	BDATA1	Output	D to A Data	DAC data for Chan 1, 2, 3, 4
3	ASEL0/	Output	Channel Select Bit 0	Select for Chan 1, 2, 3, 4
4	ASEL1/	Output	Channel Select Bit 1	Select for Chan 1, 2, 3, 4
5	CNVRT01	Output	A to D Convert	ADC convert sig chan 1, 2, 3, 4
6	ADCIN1	Input	A to D Data	ADC data for Chan 1, 2, 3, 4
7	OUT1/	Output	Amp Enable/Dir	Amp Enable/Dir. for Chan 1
8	OUT2/	Output	Amp Enable/Dir	Amp Enable/Dir. for Chan 2
9	OUT3/	Output	Amp Enable/Dir	Amp Enable/Dir. for Chan 3
10	OUT4/	Output	Amp Enable/Dir	Amp Enable/Dir. for Chan 4
11	HF41	Input	Amp Fault	Amp fault input for Chan 1
12	HF42	Input	Amp Fault	Amp fault input for Chan 2
13	HF43	Input	Amp Fault	Amp fault input for Chan 3
14	HF44	Input	Amp Fault	Amp fault input for Chan 4
15	+5V	Output	+5V Supply	Power supply out
16	GND	Common	PMAC Common	

Miscellaneous I/O

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P1 JVME (96-Pin Header)



Front View

Pin #	Row A Signal Mnemonic	Row B Signal Mnemonic	Row A Signal Mnemonic
01	D00	BBSY/	D08
02	D01	BCLR/	D09
03	D02	ACFAIL/	D10
04	D03	B0IN/	D11
05	D04	BG0OUT/	D12
06	D05	BG1IN/	D13
07	D06	BG1OUT/	D14
08	D07	BG2IN/	D15
09	GND	BG2OUT/	GND
10	SYSCLK	BG3IN/	SYSFAIL/
11	GND	BG3OUT/	BERR/
12	DS1/	BR0/	SYSRESET/
13	DS0/	BR1/	LWORD/
14	WRITE/	BR2/	AM5
15	GND	BR3/	A23
16	DTACK/	AM0	A22
17	GND	AM1	A21
18	AS/	AM2	A20
19	GND	AM3	A19
20	IACK/	GND	A18
21	IACKIN/	SERCLK	A17
22	IACKOUT/	SERDAT/	A16
23	AM4	GND	A15
24	A07	IRQ7/	A14
25	A06	IRQ6/	A13
26	A05	IRQ5/	A12
27	A04	IRQ4/	A11
28	A03	IRQ3/	A10
29	A02	IRQ2/	A09
30	A01	IRQ1/	A08
31	-12V	+5V STDBY	+12V
32	+5V	+5V	+5V

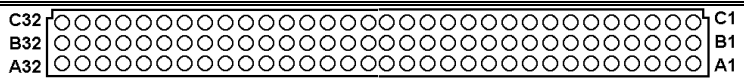
This is the standard VME connector. It is sufficient for 16-bit or 24-bit addressing, and for 8-bit or 16-bit data. For 32-bit addressing the B-row of P2 must be used as well. PMAC does not support 32-bit data transfers over the bus, even with the B-row of P2.

If P1 is connected to the VME backplane, PMAC is connected to the +5V supply and GND automatically. In this case, no other +5V supply should be connected.

If desired, the +12V and -12V power supplies of the VME bus could be used to provide power to the Opto-isolated outputs of PMAC VME using jumpers E85, E87, and E88, with the resultant loss of optical isolation between the PMAC VME and the Amplifier/Power section.

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P2 JMACH1 (96-Pin Header)

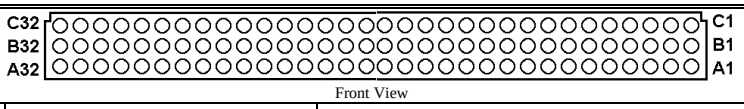


Front View

Pin #	Symbol	Function	Description	Notes
A01	+5V	Output	+5V Power	1
A02	GND	Common	Digital Common	
A03	CHC4	Input	Encoder C CH. Pos.	2
A04	CHC4/	Input	Encoder C CH. Neg.	2,3
A05	CHB4	Input	Encoder B CH. Pos.	2
A06	CHB4/	Input	Encoder B CH. Neg.	2, 3
A07	CHA4	Input	Encoder A CH. Pos.	2
A08	CHA4/	Input	Encoder A CH. Neg.	2, 3
A09	CHC2	Input	Encoder C CH. Pos.	2
A10	CHC2/	Input	Encoder C CH. Neg.	2, 3
A11	CHB2	Input	Encoder B CH. Pos.	2
A12	CHB2/	Input	Encoder B CH. Neg.	2, 3
A13	CHA2	Input	Encoder A CH. Pos.	2
A14	CHA2/	Input	Encoder A CH. Neg.	2, 3
A15	DAC4	Output	Analog Out Pos. 4	4
A16	DAC4/	Output	Analog Out Neg. 4	4, 5
A17	AENA4/DIR4	Output	Amp-Ena/Dir 4	6
A18	FAULT4	Input	Amp-Fault 4	7
A19	+LIM4	Input	Neg. End Limit 4	8, 9
A20	-LIM4	Input	Pos. End Limit 4	8, 9
A21	HMFL4	Input	HOME-FLAG 4	10
A22	DAC2	Output	Analog Out Pos. 2	4
A23	DAC2/	Output	Analog Out Neg. 2	4, 5
A24	AENA2/DIR2	Output	Amp-Ena/Dir 2	6
A25	FAULT2	Input	Amp-Fault 2	7
A26	+LIM2	Input	Neg. End Limit 2	8, 9
A27	-LIM2	Input	Pos. End Limit 2	8, 9
A28	HMFL2	Input	Home Flag 2	10
A29	AGND	Common	Analog Common	
A30	A-15V	Input	Analog -15V Supply	
A31	GND	Common	Digital Common	
A32	+5V	Output	+5V Power	1
C01	+5V	Output	+5V Power	1
C02	GND	Common	Digital Common	
C03	CHC3	Input	Encoder C Ch. Pos.	2
C04	CHC3/	Input	Encoder C Ch. Neg.	2,3
C05	CHB3	Input	Encoder B Ch. Pos.	2
C06	CHB3/	Input	Encoder B Ch. Neg.	2, 3
C07	CHA3	Input	Encoder A Ch. Pos.	2
C08	CHA3/	Input	Encoder A Ch. Neg.	2, 3
C09	CHC1	Input	Encoder C Ch. Pos.	2
C10	CHC1/	Input	Encoder C Ch. Neg.	2, 3

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P2 JMACH1 (96-Pin Header) Continued



Pin #	Symbol	Function	Description	Notes
C11	CHB1	Input	Encoder B Ch. Pos.	2
C12	CHB1/	Input	Encoder B Ch. Neg.	2, 3
C13	CHA1	Input	Encoder A Ch. Pos.	2
C14	CHA1/	Input	Encoder A Ch. Neg.	2, 3
C15	DAC3	Output	Analog out Pos. 3	4
C16	DAC3/	Output	Analog out Neg. 3	4, 5
C17	AENA3/DIR3	Output	Amp-Ena/Dir. 3	6
C18	FAULT3	Input	Amp-Fault 3	7
C19	+LIM3	Input	Neg. End Limit 3	8, 9
C20	-LIM3	Input	Pos. End Limit 3	8, 9
C21	HMFL3	Input	Home-Flag 3	10
C22	DAC1	Output	Analog out Pos. 1	4
C23	DAC1/	Output	Analog out Neg. 1	4, 5
C24	AENA1/DIR1	Output	Amp-Ena/Dir. 1	6
C25	FAULT1	Input	Amp-Fault 1	7
C26	+LIM1	Input	Neg. End Limit 1	8, 9
C27	-LIM1	Input	Pos. End Limit 1	8, 9
C28	HMFL1	Input	Home-Flag 1	10
C29	FEFCO/	Output	FE/Watchdog Output	
C30	A+15V	Input	Analog +15V Supply	
C31	GND	Common	Digital Common	
C32	+5V	Output	+5V Power	1

The P2 connector is used to connect the PMAC to the first four channels (Channels 1, 2, 3, and 4) of servo amps, flags, and encoders.

Note 1: In standalone applications, these lines can be used as +5V power supply inputs to power PMAC's digital circuitry. However, if a terminal block is available on your version of PMAC, it is preferable to bring the +5V power in through the terminal block.

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). In this case, jumper (E18 - 21, E24 - 27) for channel should hold input at 2.5V.

Note 4: ± 10V, 10mA max, referenced to analog common (AGND).

Note 5: Leave floating if not used; do not tie to AGND. In this case, AGND is the return line.

Note 6: Functional polarity controlled by jumper(s) E17. Choice between AENA and DIR use controlled by Ix02 and Ix25.

Note 7: Functional polarity controlled by variable Ix25. Must be conducting to 0V (usually AGND) to produce a '0' in PMAC software. Automatic fault function can be disabled with Ix25.

Note 8: Pins marked -LIMn should be connected to switches at the positive end of travel. Pins marked +LIMn should be connected to switches at the negative end of travel.

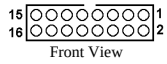
Note 9: Must be conducting to 0V (usually AGND) for PMAC to consider itself not into this limit. Automatic limit function can be disabled with Ix25.

Note 10: Functional polarity for homing or other trigger use of HMFLn controlled by Encoder/Flag Variable 2 (I902, I907, etc.) HMFLn selected for trigger by Encoder/Flag Variable 3 (I903, I908, etc.). Must be conducting to 0V (usually AGND) to produce a 0 in PMAC software.

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J1 JS2 (16-Pin Header on Option 1A)

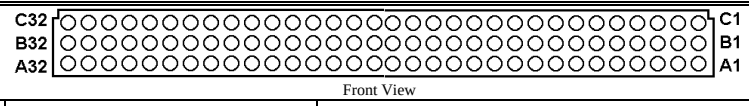
(Labeled J9 of OPT-3 front panel)



Pin #	Symbol	Function	Description	Notes
1	DCLK	Output	D to A, A to D Clock	DAC and ADC Clock for Chan. 5, 6, 7, 8
2	BDATA2	Output	D to A Data	DAC Data for Chan. 5, 6, 7, 8
3	ASEL2/	Output	Chan. Select Bit 2	Select for Chan. 5, 6, 7, 8
4	ASEL3/	Output	Chan. Select Bit 3	Select for Chan. 5, 6, 7, 8
5	CNVRT23	Output	A to D Convert	ADC Convert Sig. Chan. 5, 6, 7, 8
6	ADCIN2	Input	A to D Data	ADC data for Chan. 5, 6, 7, 8
7	OUT5/	Output	Amp. Enable/Dir	Amp/Enable/Dir for Chan. 5
8	OUT6/	Output	Amp. Enable/Dir	Amp/Enable/Dir for Chan. 5
9	OUT7/	Output	Amp. Enable/Dir	Amp/Enable/Dir for Chan. 5
10	OUT8/	Output	Amp. Enable/Dir	Amp/Enable/Dir for Chan. 5
11	HF45	Input	Amp. Fault	Amp fault input for Chan. 5
12	HF46	Input	Amp. Fault	Amp fault input for Chan. 6
13	HF47	Input	Amp. Fault	Amp fault input for Chan. 7
14	HF48	Input	Amp. Fault	Amp fault input for Chan. 8
15	+5V	Output	+5V Supply	Power supply out
16	GND	Common	PMAC Common	

Miscellaneous I/O.

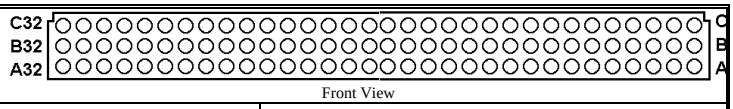
P2A JMACH2 (96-Pin Header on Option 1A)



Pin #	Symbol	Function	Description	Notes
A01	+5V	Output	+5V Power	1
A02	GND	Common	PMAC Common	
A03	CHC8	Input	Encoder C Chan. Pos.	2
A04	CHC8/	Input	Encoder C Chan. Neg.	2,3
A05	CHB8	Input	Encoder B Chan. Pos.	2
A06	CHB8/	Input	Encoder B Chan. Neg.	2, 3
A07	CHA8	Input	Encoder A Chan. Pos.	2
A08	CHA8/	Input	Encoder A Chan. Neg.	2, 3
A09	CHC6	Input	Encoder C Chan. Pos.	2
A10	CHC6/	Input	Encoder C Chan. Neg.	2, 3
A11	CHB6	Input	Encoder B Chan. Pos.	2
A12	CHB6/	Input	Encoder B Chan. Neg.	2, 3
A13	CHA6	Input	Encoder A Chan. Pos.	2
A14	CHA6/	Input	Encoder A Chan. Neg.	2, 3
A15	DAC8	Output	Analog Out Pos. 8	4
A16	DAC8/	Output	Analog Out Neg. 8	4, 5
A17	AENA8/DIR8	Output	Amp-Ena/Dir. 8	6
A18	FAULT8	Input	Amp-Fault 8	7
A19	+LIM8	Input	Neg. End Limit 8	8, 9
A20	-LIM8	Input	Pos. End limit 8	8, 9
A21	HMFL8	Input	Home-Flag 8	10
A22	DAC6	Output	Analog Out Pos. 6	4
A23	DAC6/	Output	Analog Out Neg. 6	4, 5
A24	AENA6/DIR6	Output	Amp-Ena/Dir. 6	6
A25	FAULT6	Input	Amp-Fault 6	7

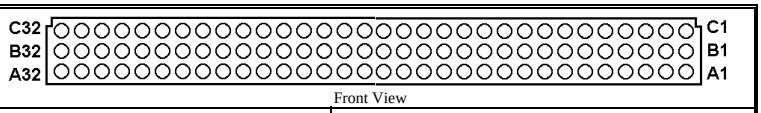
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P2A JMACH2 (96-Pin Header on Option 1A) Continued



A26	+LIM6	Input	Neg. End Limit 6	8, 9
A27	-LIM6	Input	Pos. End Limit 6	8, 9
A28	HMFL6	Input	Home-Flag 6	10
A29	AGND	Common	Analog Common	
A30	A-15V	Input	Analog -15V Supply	
A31	GND	Common	Digital Common	
A32	+5V	Output	+5V Power	1

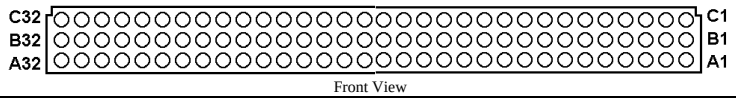
P2A JMACH2 (96-Pin Header on Option 1A)



Pin #	Symbol	Function	Description	Notes
C01	+5V	Output	+5V Power	1
C02	GND	Common	Digital Common	
C03	CHC7	Input	Encoder C Channel Positive	2
C04	CHC7/	Input	Encoder C Channel Negative	2,3
C05	CHB7	Input	Encoder B Channel Positive	2
C06	CHB7/	Input	Encoder B Channel Negative	2, 3
C07	CHA7	Input	Encoder A Channel Positive	2
C08	CHA7/	Input	Encoder Channel Negative	2, 3
C09	CHC5	Input	Encoder C Channel Positive	2
C10	CHC5/	Input	Encoder C Channel Negative	2, 3
C11	CHB5	Input	Encoder B Channel Positive	2
C12	CHB5/	Input	Encoder B Channel Negative	2, 3
C13	CHA5	Input	Encoder A Channel Positive	2
C14	CHA5/	Input	Encoder A Channel Negative	2, 3
C15	DAC7	Output	Analog Out Positive 7	4
C16	DAC7/	Output	Analog Out Negative 7	4, 5
C17	AENA7/DIR7	Output	Amp-Ena/Dir. 7	6
C18	FAULT7	Input	Amp-Fault 7	7
C19	+LIM7	Input	Neg. End Limit 7	8, 9
C20	-LIM7	Input	Pos. End Limit 7	8, 9
C21	HMFL7	Input	Home-Flag 7	10
C22	DAC5	Output	Analog Out Positive 5	4
C23	DAC5/	Output	Analog Out Negative 5	4, 5
C24	AENA5/DIR5	Output	Amp-Ena/Dir. 5	6
C25	FAULT5	Input	Amp-Fault 5	7
C26	+LIM5	Input	Neg. End Limit 5	8, 9
C27	-LIM5	Input	Pos. End Limit 5	8, 9
C28	HMFL5	Input	Home-Flag 5	10
C29	ORST/	Output	Reset Output	
C30	A+15V	Input	Analog +15V Supply	
C31	GND	Common	Digital Common	
C32	+5V	Output	+5V Power	1

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P2A JMACH2 (96-Pin Header on Option 1A)



The P2A connector is used to connect PMAC to the first four channels (Channels 1, 2, 3, and 4) of servo amps, flags, and encoders.

Note 1: In standalone applications, these lines can be used as +5V power supply inputs to power PMAC's digital circuitry. However, if a terminal block is available on your version of PMAC, it is preferable to bring the +5V power in through the terminal block.

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). In this case, jumper (E18 - 21, E24 - 27) for channel should hold input at 2.5V.

Note 4: ± 10V, 10mA max, referenced to analog common (AGND).

Note 5: Leave floating if not used; do not tie to AGND. In this case, AGND is the return line.

Note 6: Functional polarity controlled by jumper(s) E17. Choice between AENA and DIR use controlled by Ix02 and Ix25.

Note 7: Functional polarity controlled by variable Ix25. Must be conducting to 0V (usually AGND) to produce a 0 in PMAC software. Automatic fault function can be disabled with Ix25.

Note 8: Pins marked -LIMn should be connected to switches at the positive end of travel. Pins marked +LIMn should be connected to switches at the negative end of travel.

Note 9: Must be conducting to 0V (usually AGND) for PMAC to consider itself not into this limit. Automatic limit function can be disabled with Ix25.

Note 10: Functional polarity for homing or other trigger use of HMFLn controlled by Encoder/Flag Variable 2 (I902, I907, etc.) HMFLn selected for trigger by Encoder/Flag Variable 3 (I903, I908, etc.). Must be conducting to 0V (usually AGND) to produce a '0' in PMAC software.

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PMAC BASIC SPECIFICATIONS

Physical Specifications

Size	33.5cm x 9.9cm x 3.8cm (13.2" x 3.9" x 1.4") PMAC PC 33.5cm x 12.0cm x 1.3cm (13.2" x 4.7" x 0.5") PMAC Lite 23.4cm x 16.0cm x 3.8cm (9.2" x 6.3" x 1.4") PMAC VME 15.6cm x 11.4cm x 3.2/4.8cm (6.1" x 4.4" x 1.2/1.8") PMAC STD
Weight	0.5-0.7 kg (1.1-1.5 lb)
Temperature	Operating: 0°C to 60°C (32°F to 140°F) Storage: -12°C to 82°C (10°F to 180°F)
Humidity	10% to 95%, non-condensing

Electrical Specifications

Power	1.5A @ +5V (+/-5%) (7.5W) 0.3A @ +12 to +15V (4.5W) 0.25A @ -12 to -15V (3.8W) (Eight-channel configuration, with a typical load of encoders)
Battery	Not applicable to PMACs with Options 4A, 5A, or 5B 3.6V Lithium Cell, 1000 mAh, Can Stack Or 3.0V Lithium Cell, 1200 mAh, 2/3A-size, no tabs (old style) Expected battery life: 10 years (standard), 9 months (Opt 5) Recommended replacement: 24 months (standard), 3-6 months (Opt 5)

Memory Specifications

ROM	(Standard, Option 5 only) 128 KBytes EPROM firmware for master control program
Flash	(Option 4A, 5A, 5B only): 512 KBytes segmented flash memory for both firmware and user program/parameter storage.
RAM	384 KBytes Static (128K 24-bit words) for active memory; Battery-backed (standard, Option 5) Savable to flash memory (Option 4A, 5A, 5B) One wait state (standard); zero wait states (Option 4A, 5, 5A, 5B) User program storage: 42K 48-bit words = 252KBytes; ('X1000 Y1000' is 2 words)
EAROM	2KBytes EEPROM non-volatile memory for setup parameter storage (used only with battery-backed RAM boards; not used even if present on flash-memory boards)

CPU Specifications

Type	Motorola DSP56002 (Option 4A, 5A, 5B) Motorola DSP56001
Clock Speed	19.6608 MHz ("20 MHz": Standard, Option 4A) 39.3216 MHz ("40 MHz": Option 5A) 58.9824 MHz ("60 MHz": Option 5B)
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

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Performance Specifications

Servo Cycle Time	Minimum of 55 microseconds per axis controlled (110 usec for two axes; 440 usec for eight axes) for 20 MHz CPU; proportionally less with faster CPUs. Actual time can be set with hardware jumpers.
Servo Algorithm	
Standard	PID with velocity and acceleration feedforward plus 2nd-order notch filter; all gains with 24-bit resolution. Auto-tunable through PMAC Executive program. Capability to accept custom servo algorithms written in DSP56000 assembly language.
Optional (OPT 6)	Advanced 7th-order pole-placement algorithm; 35 terms Auto-tunable through Servo Evaluation Package software for IBM-PC and compatibles.
Phasing Update Time	Minimum of 27 microseconds (1 axis); Minimum of 110 microseconds (8 axes) for 20 MHz CPU; proportionally less with faster CPUs. Actual time can be set with hardware jumpers.
Phasing Algorithm	Suitable for permanent magnet brushless motors, AC induction motors, switched reluctance servo motors, micro-stepped stepping motors. 2, 3, or 4-phase motors, Y-wound, delta-wound, or electrically independent phases. Capability to accept custom phase algorithms written in DSP56000 assembly language.
Block Execution Rate	Up to 200 to 800 blocks (moves) per second (dependent on number of axes, servo cycle time, CPU speed, and program complexity) for 20 MHz CPU; proportionally greater with faster CPUs. Higher rates possible with careful optimization.
Velocity Range	
Commanded Velocity	0, +/-0.0001 to 256M (268,435,456) counts/second
Measured Velocity	Dependent on type of feedback used. **Quadrature Feedback:** 0 to 19,660, 800-encoder counts/second (edge rate) (slight hardware modification required on PMAC PC to exceed 9,830,400 encoder counts/second). 0 to 30,000,000 encoder counts per second with externally provided encoder sample clock. **Parallel Feedback:** For N-bit feedback word, 2^(N-1)-1 counts/servo cycle
Velocity Accuracy	
Long-term	0.005% absolute accuracy with standard crystal; 0.001% absolute accuracy with optional crystal (OPT 8)
Short-term	System-dependent; typically 0.2% to 1.0%
Position Range	+/-128 trillion counts maximum (no sub-count interpolation, minimum position scale factor) +/-32 billion counts typical (sub-count interpolation, default position scale factor)
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 1000 Hz repetition rate
Synchronization	Axes in the same coordinate system on one PMAC are perfectly synchronized (to the servo cycle); Axes in different coordinate systems on one PMAC can be synchronized to within +/-2 msec; Coordinate systems on separate PMACs sharing same SYNC signal can be synchronized to +/-1 servo cycle.

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I/O Specifications

Position Feedback	(JMACH1, JMACH2) (Also Acc-24 JMACH3, JMACH4)
Quadrature Encoders	4 (standard) to 16 (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 19.66 MHz (count rate). X1, X2, X4 decoding, or pulse and direction. Digital delay filter for removing noise spikes. 3rd channel input available for position capture. Unused counters available as timers.
Absolute Encoders	(Thru Accessory-14D I/O Expansion card) (Or other binary parallel-word position data source) Up to 12 absolute parallel encoders of 24 bits or less or up to six absolute parallel encoders of over 24 bits (limit of 6 Acc-14D cards of 48 bits each); straight binary; 5V, single-ended.
Resolvers	(Thru Accessory-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	(JMACH1, JMACH2) (Also Acc-24 JMACH3, JMACH4) four (standard) to 16 (depending on options) outputs of +/-10V; 16-bit resolution (300 uV/bit), optically isolated; Standard use is for servo output; one per axis if PMAC is not commutating axis; two per axis if PMAC is commutating axis; uncommitted analog outputs may be used for other purposes.
On-Board Analog Input	(JPAN - requires Option 15) 1 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.
Accessory Analog Inputs	
(Thru Accessory 28 Analog-to-Digital Converter Board)	4 to 16 (depending on number) inputs of +/-10V; 16-bit resolution; single-ended or differential inputs. Conversion time less than 50 usec, all inputs.
(Thru Accessory 36 Analog-to-Digital Converter Board)	8 or 16 inputs of 0 to 10V or +/-5V 12-bit resolution per board; single-ended or differential inputs. Effective conversion time 1 phasing cycle per channel.
Dedicated Axis Digital Inputs	(JMACH1, JMACH2) (Also Acc-24 JMACH3, JMACH4) 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.
Dedicated Axis Digital Outputs	(JMACH1], JMACH2) (Also Acc-24 JMACH3, JMACH4)
Amplifier Enable	One dedicated digital output accompanying each quadrature encoder; optically isolated from PMAC digital circuits, operates from +15V voltage source. Serves as amplifier-enable signal or direction bit; polarity is can be set by hardware jumper (E17). Uncommitted lines may be used as general-purpose optically isolated digital outputs.
Position Compare	One dedicated digital output accompanying each quadrature encoder; serves as position compare output providing pulse exactly when preset count value is reached. Uncommitted compare outputs may be used as general-purpose outputs by using polarity control.

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General-Purpose Digital Inputs	(JOPTO) Eight general-purpose digital inputs; 0-24V levels; Hardware jumper sets as normally high or normally low; Connector configured for easy hook-up to OPTO-22. Rated to 100 mA.
General-Purpose Digital Outputs	(JOPTO) Eight general-purpose 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 (PMAC Lite or STD) Single-ended +/-6-10V levels RS-422 serial data port (PMAC PC, VME, STD, or Lite with Opt-9L); Differential 0-5V TTL levels. PMAC receivers accept standard RS-232 signals. PMAC transmitters send signals recognizable by most RS-232 receivers. (Acc-26 available for optically isolated conversion between RS-422 and RS-232 levels.)
	Configurable for 300 to 76,800 baud Eight bits, one start bit, one stop bit, no parity. Uses RD+, RD- (RXD/), SD+, SD- (TXD/), CS+, CS-, (CTS), RS+, RS- (RTS), and GND lines. Shorts DSR to DTR. Up to 16 cards may be daisy-chained on a single communications line with software addressing.
Bus (Parallel) Communications	Bus communications (8-bit wide data); type of bus determined by version of card. For PMAC PC, Lite, or STD, on-board Programmable Interrupt Controller permits interrupting of host on excess following error, in-position, buffer request, character request, position-compare-equals, or programmatically. For PMAC VME, 16 8-bit mailbox registers for bi-directional transmission of commands and data. A16, A24, and A32 addressing modes possible. D08 data transmission used.
Dual-Ported RAM	(Option 2 Required) 8K x 16 bits of dual-ported RAM for PMAC PC, Lite, or VME Usable for binary data transmission in either direction
Control-Panel Dedicated Inputs	(JPAN) 9 dedicated manual control functions on low-true 0-5V TTL inputs: RUN, STEP, ABORT, HOLD, HOME, JOG+, JOG-, PREJOG, RESET; intended for momentary toggle switches. 4 motor-/coordinate-system-select lines (BCD coded; low-true TTL) that set what the above inputs affect. 1 0-10V analog input for feedrate override control (requires Option 15). 1 2-channel handwheel encoder input (TTL levels). Discrete inputs may be used as general-purpose inputs with I2=1 or with select lines at 0. Discrete outputs may be used as general-purpose outputs with select lines at 0.
Thumbwheel Multiplexer I/O	(JTHW) Eight TTL input lines; eight TTL output lines; Automatic firmware support for multiplexed I/O accessories: Acc-8D Opt 7 R/D converters (absolute serial data) Acc-8D Opt 9 Yaskawa encoder interface (absolute serial) Acc-18 Thumbwheel Board Acc-34 Family of I/O Boards Up to 16 of these boards may be multiplexed on the port. Port may also be used as non-multiplexed general-purpose I/O.

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Display Outputs	Connector to standard 2x24 or 2x40 character alpha-numeric liquid-crystal or vacuum fluorescent display.
Expansion Digital I/O	JEXP connector provides access to up to six Accessory 14 I/O Expansion cards with 48 bits each of digital I/O, configurable to inputs or outputs by byte, configurable to high-voltage level by 24-bit word; sinking or sourcing available with +5 to +24V high levels, totem-pole +5V outputs available.

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 of pre-defined meaning for initialization and setup (gains, limits, modes, etc.). 1024 P-Variables: general-purpose user variables; 48-bit floating-point (36-bit mantissa, 12-bit exponent) format, global meaning. 1024 Q-Variables: general-purpose user variables; 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. 1-48 bit, fixed and floating point. For compiled PLC programs only: 1024 L-Variables pointers to locations in PMAC's memory and I/O space, 1-24 bit integer values only.
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 interpreted PLC programs and 32 separate compiled PLC programs may be stored at once.

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Options

Option 0	For PMAC VME only, reduces cost for standalone applications by removing the special interface chip used to communicate with the VMEbus.
Option 1	Additional four channels each of: quadrature encoders, analog (DAC) outputs, analog inputs (serial digital data from Acc-23 or Acc-28) for eight channels each on a PMAC. On PMAC VME or PMAC STD, this option is a piggyback board. On PMAC PC, this option is extra ICs on the baseboard. This option is not available for PMAC Lite.
Option 2	8Kx16 Dual-ported RAM: for high-speed repetitious communication of data. On PMAC VME, this option is extra ICs on the baseboard. On PMAC PC and Lite, this option is a separate half-size board. This option is not available for PMAC STD.
Option 3	For PMAC VME, enhanced front plate that provides more connectors for auxiliary I/O on the front plate.
Option 4A	Optional CPU section with 20 MHz CPU, 128K x 24 bit zero-wait-state Static RAM, 4 Mbit flash ROM for firmware and user program storage (no battery), on-board buffers for expansion port. Provides approximately 25% computational speed increase over base version. Standard on all PMAC Packs purchased after July 1, 1995.
Option 5A	Optional CPU section with 40 MHz CPU, 128K x 24 bit zero-wait-state Static RAM, 4 Mbit flash ROM for firmware and user program storage (no battery), on-board buffers for expansion port. Provides approximately 125% computational speed increase over base version.
Option 5B	Optional CPU section with 60 MHz CPU, 128K x 24 bit zero-wait-state Static RAM, 4 Mbit flash ROM for firmware and user program storage (no battery), on-board buffers for expansion port. Provides approximately 250% computational speed increase over base version.
Option 5C	Optional CPU section with 80 MHz CPU, 128K x 24 bit zero-wait-state Static RAM, 4 Mbit flash ROM for firmware and user program storage (no battery), on-board buffers for expansion port. Provides approximately 375% computational speed increase over base version.
Option 6	Extended (Pole-Placement) Servo Algorithm: Firmware option for servo filter more sophisticated than standard PID; to be used with difficult-to-control systems (resonances, backlash, friction, disturbances, changing dynamics). Requires one-time purchase of Acc-25A or Acc-25B.
Option 7	Mounting plate for PMAC PC (Opt-7) or PMAC VME (Opt-7V) to provide support in standalone applications.
Option 8	Super-high accuracy clock crystal (<10 ppm) for long-term velocity accuracy. Available for all CPU Options (standard, 4A, 5A, 5B, and 5C) with Opt-8A.
Option 9L	RS-422 serial interface for PMAC Lite. Replaces standard RS-232 interface.
Option 10	PROM Version Specification: Permits customer to specify version of firmware to be installed onboard. If this option is not selected, newest firmware version is installed.
Option 14	Replacement of flag input opto-isolators with socketed shunts. This permits parallel sub-count interpolation from Acc-8D Option 8 or equivalent, or 5V-level flag inputs from Opto-22 or equivalent modules.
Option 15	Voltage to frequency converter chip for Wiper analog input on JPAN connector.

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Accessories

Accessory 1: +5V Power Supplies and Batteries

These power supplies are needed only for stand-alone applications of the PMAC, when the cards are not getting their +5V supply from the bus. The version of this accessory is selected by capacity:

Acc-1:	for one PMAC (3.0A rating).
Acc-1A:	for two or three PMACs (6.0A rating).
Acc-1B:	for four or five PMACs (9.0A rating).
Acc-1C:	for six, seven, or eight PMACs (12.0A rating).
Acc-1L:	is a replacement battery for the RAM on older PMAC PC or PMAC VME CPU boards. It is a 3V lithium battery, 1200 mAh, 2/3A-size, no tabs.
Acc-1LS:	is a replacement battery for the RAM on PMAC STD, PMAC Lite and newer PMAC PC and PMAC VME boards. It is a 3.6V lithium battery, 1000 mAh, 1.15" diameter can.
Acc-1SA:	5V-switching power supply for one PMAC (1.2A rating). Gives better transient suppression.

Accessory 2: +/-15V Power Supplies

These power supplies provide +/- 15V to the analog output stage of PMAC, which is optically isolated from the digital 5V circuitry. This accessory has the following versions:

Acc-2: +/-15V only for one PMAC (1.5A rating at each level).

Acc-2A:	+/-15V, +5V for one PMAC (16W rating).
Acc-2B:	+/-15V, +5V for two PMACs (40W rating).
Acc-2SA:	12V-switching power supply for one PMAC (1.2A rating). Gives better transient suppression.

Accessory 3: Serial Communications Cable

This is a three-meter (ten-foot) 26-strand flat cable with a DB-25 connector on one end (for connection to the host computer) and an IDC 26-pin connector on the other end (for connection to PMAC's serial port). It is not to be purchased if Acc-26 serial-communications-converter card is purchased. Multi-drop versions of the cable are available for daisy-chained PMAC systems:

Acc-3D:	Single-drop 3-meter DB-25 to IDC-26 flat cable (PC/VME).
Acc-3E:	One additional PMAC drop on Acc-3D.
Acc-3L:	Single-drop 3-meter DB-9 to IDC-10 flat cable (Lite).
Acc-3S:	Single-drop 3-meter DB-25 to SIP-5 cable (STD).

Accessory 4: Additional Instruction Manual

This accessory provides an additional instruction manual for the PMAC. Normally, one manual is provided with every four PMACs or fraction thereof shipped together.

Acc-4:	PMAC Family User Manual and Software Reference Manual
Acc-4P:	PMAC PC Hardware Reference Manual
Acc-4S1:	PMAC STD Hardware Reference Manual
Acc-4V:	PMAC VME Hardware Reference Manual
Acc-4L:	PMAC Lite Hardware Reference Manual
Acc-4AG:	GE Fanuc 90/70 PLC Interface Manual

Accessory 6: Handwheel Encoder

This is a Hewlett-Packard HEDS-7501 rotary pulse generator or handwheel encoder with 256 lines per revolution. A six-foot flat cable is provided with the encoder. PMAC Acc-8D has matching sockets for this cable.

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Accessory 8: Terminal Block

The Acc-8 family of terminal blocks provides an easy means of connecting the lines from the control system to PMAC's machine connector. One Acc-8 provides all the pinouts from a single JMACH connector on PMAC. The screw-down terminal points on the board give a quick yet reliable connection.

Acc-8P: 60-point terminal block. No connectors for option boards.
OPT-P: 60-pin connector and cable to PMAC PC, STD, and Lite.
OPT-V: 96-pin connector and cable to PMAC VME. (Note: a longer cable may be specified. Not to exceed three feet.)

Acc-8D: 60-point terminal block with connectors for option boards.
OPT-P: 60-pin connector and cable to PMAC PC, STD, and Lite.
OPT-V: 96-pin connector and cable to PMAC VME. (Note: a longer cable may be specified. Not to exceed three feet.)
OPT-1: Provides a third phase of output for two PMAC-commutated motors. Normally this function is provided in the amplifier, but if the amplifier is expecting commands for all three phases, this option generates a third phase as the negative sum of the two phases provided by PMAC. This option is located on the main Acc-8D board.
OPT-2: Provides four voltage-to-frequency (V/F) converters for commanding stepper motor driver 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. The maximum frequency is selectable from 10 kHz (2A) to 2MHz (2F). This option is on a small, separate board and comes with 5 40-cm (16") cables to Acc-8D, one 16-pin and four 10-pin. Must be ordered as one of the following (2A - 2F) depending on the frequency requirements.

- OPT-2A: V-to-F converters (4); 10 kHz max.
- OPT-2B: V-to-F converters (4); 50 kHz max.
- OPT-2C: V-to-F converters (4); 100 kHz max.
- OPT-2D: V-to-F converters (4); 500 kHz max.
- OPT-2E: V-to-F converters (4); 1 MHz max.
- OPT-2F: V-to-F converters (4); 2 MHz max.
- OPT-2G: DIN rail mount for OPT-2.

OPT-4: Family of four low-power current-loop (transconductance) amplifier circuits for driving hydraulic valves or very small DC motors. This option is a small, separate board with a built-in heat sink and fan. A voltage mode provides a proportional voltage output. This option must be ordered as either 4 or 4A. Comes with 1 40-cm (16") cable to Acc-8D.

- OPT-4: Quad hydraulic valve driver; 20W/channel, 30V max, 1.0A cont, 2.0A peak.
- OPT-4A: Quad motor driver; 150W/channel, 48V max, 3.0A cont, 5.0A peak.
- OPT-4B: DIN rail mount for OPT-4 and 4A.

OPT-5: Provides a DIN rail mount for the Acc-8D board.
OPT-6: Provides optically isolated connection for four incremental encoders (three channels each) on a separate board. Comes with 4 40-cm (16") cables to Acc-8D.
OPT-A: DIN rail mount for OPT-6.
OPT-7: Provides two channels of 12-bit fixed resolution resolver-to-digital conversion on a separate board. Two additional channels can be added to this board with sub-option A. Comes with two 10-pin 40-cm (16") cables to Acc-8D and one 26-pin 1 meter (3') cable to PMAC.

- OPT A: Provides two additional channels of resolver-to-digital conversion on the same board as OPT-7. Comes with two 10-pin 40-cm (16") cables to Acc-8D.
- OPT-B: In rail mount for OPT-7.

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OPT-8: The analog encoder interpolator board provides 128 or 256 pulses per cycle of an analog encoder. Each Option 8 allows connection of one analog encoder to PMAC and requires two encoder channels on the PMAC. Up to eight Option 8s can be connected to one 16-channel PMAC (PMAC with Option 1 and Acc-24 with Option 1). Comes with three 10-pin 40-cm (16") cables, two to Acc-8D and one to PMAC's JxIO connector.

OPT-A: DIN rail mount for OPT-8

OPT-9: Provides connection for four Sigma series type S and W Yaskawa absolute encoders. Comes with four 10-pin 40-cm (16") cables to Acc-8D and one 26-pin 60-cm (24") cable to PMAC's multiplexer port.

OPT-B: DIN rail mount for OPT-9.

Accessory 9: IBM PC Software

The software for the IBM-PC and compatibles includes development tools used in setting up the PMAC controller and developing a host computer interface for a PMAC application. Acc-9 is a once-per-customer purchase. OEMs wishing to re-sell the program to their customers must purchase one copy for each customer. Such OEMs should contact the factory for volume purchase agreements.

Acc-9C: COMLIB (COMmunications LIBrary) written in C provides a set of basic (low level) communications drivers callable from DOS or Windows ™ based programs. This software is recommended for any user who intends on developing MMI (Man Machine Interface) for PMAC. Comes on one 3.5" diskette and is purchased as a Site License.

OPT-1: Executable code upgrade and Site License.

Acc-9L: LIPS (Library Interface for PMAC Systems) Provides a set of high level communication functions (functions such as Set Up Master Slave and Why Is My Motor Not Moving) callable from DOS or Windows ™ (DLL) based programs. This software requires Acc-9C. Comes on one 3.5" diskette and is purchased as a Site License.

OPT-1: Executable code upgrade and Site License.

The PMAC Executive Program for the IBM PC and compatibles is a DOS/Windows ™ based host computer 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, status, and tuning. The program was written in the "C" programming language. The program is not copy-protected and comes on a 3.5" diskette.

Acc-9DA: PMAC Executive PC Program for DOS on 3.5" diskette

OPT-1: PMAC Executive Program upgrade, site license

Acc-9W: PMAC Executive PC Program for Windows ™ on 3.5" diskette

OPT-1: Executable code upgrade, site license

Acc-9P: PCOMM (PMAC COMmunications) written in C/C++ provides a set of basic (low level) communications drivers linkable from DOS or Windows ™ (DLL) based programs. This software is recommended for any user who intends on developing custom MMI (Man Machine Interface) for PMAC. Comes on one 3.5" diskette and is purchased as a Site License.

OPT-1: Executable code upgrade, site license

Acc-9DG: PLC Program for GE Fanuc 90/70 interface to PMAC VME.

Accessory 12: Liquid Crystal/Vacuum Fluorescent Display

Acc-12 provides display capability for the PMAC independent of the host interface. It connects to the J1 (JDISP) connector on PMAC. The user can program (through the **DISPLAY** command) what is needed to show on the display. The vacuum fluorescent (VF) display is larger and brighter than the liquid crystal (LCD) display.

Acc-12: 2x24 character alphanumeric LCD display.

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Acc-12A: 2x40 character alphanumeric LCD display.
Acc-12C: 2x40 character alphanumeric VF display.
Acc-12C1: Acc-12C with filter, bezel, standoffs, and screws. Includes differential line receivers that are latched and buffered. Acc-12D compatible.
Acc-12CA: 180 cm (6') 14-pin cable and mounting PCB for separately purchased display.
Acc-12D: Long distance display signal driver module (to 180 m (600') for Acc-12F). Includes 180 cm (6') 14-pin cable to PMAC. Requires Acc-12E with Option 1.
OPT-1: DIN rail mount for Acc-12D.
Acc-12E: Adapter and power driver for Acc-12F (large vacuum fluorescent displays). Includes 180 cm (6') 14-pin cable to PMAC.
OPT-1: DB-25 connector (no cable) to Acc-12D. No cable to PMAC.
OPT-2: DIN rail mount for Acc-12E.
Acc-12F: Display purchased separately.
OPT-1: 40x2 5mm high characters with two 180 cm (6') 14-pin cables to Acc-12E, bezel, no filter (P/N IEE S03601-51-096).
OPT-2: 20x4 11mm high characters with two 180 cm (6') 14-pin cables to Acc-12E, bezel, no filter (P/N IEE S03601-24-080).
OPT-3: IEE large screen display.

Accessory-14: I/O Expansion Board

PMAC's Acc-14D/V provides expanded and flexible digital I/O capabilities for the controller (Acc-14D is the PC bus form; Acc-14V is the VME bus form; there is no STD bus form). It may be configured for a wide variety of different uses by selecting different voltage levels, sinking/sourcing, and latched/non-latched I/O to serve many diverse applications. It is commonly used for discrete I/O and for parallel feedback (absolute encoders, laser interferometers, and resolvers). In order to provide this flexibility, the customer must take care in ordering a configuration.

Acc-14D: 48 digital I/O points, PC bus compatible, requires an Option 1-4.
Acc-14V: 48 digital I/O points, VME bus compatible, requires an Option 1-4.
OPT-1: 24 inputs and 24 outputs, TTL levels (0 - 5V), low true.
OPT-2: 24 inputs and 24 outputs, 0 - 24V, low true.
OPT-3: 48 inputs, TTL levels (0 - 5V), latching for parallel binary feedback.
OPT-4: Custom configuration to be specified by the user. Fill out specification sheet.
OPT-6: Dual parallel to quadrature converter. Required if PMAC is to commutate a motor using a parallel feedback device.
OPT-7: 20cm (8") 50-Pin 3-drop connector cable. For use with Acc-14D/V when PMAC Option 2, Acc-24P, or Acc-36P is also used.

Purchasing the Proper Acc-14D/V Configuration

Acc-14D/V's 48 bits of I/O are grouped into two ports (A and B), each with its own connector (J7 and J15, respectively). Each port has a single high supply voltage and a single strobe source (or lack of one). Each port contains three bytes: Port A has bytes 1, 2, and 3; Port B has bytes 4, 5, and 6. The I/O can be specified by port (standard) or by byte (custom), as explained below.

Standard Configurations: Three standard configurations of the Acc-14D/V can be ordered. These are specified as Options 1 to 3:

Option 1:
Port A is low-true TTL inputs (24)
Port B is low-true TTL outputs (24) (Typically this option is for use with OPTO-22.)

Option 2:
Port A is low-true 24V 100mA inputs (24)
Port B is low-true 24V 100mA outputs (24) (Typically this option is for driving I/O directly.)

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Option 3:

Port A is high-true latched TTL inputs (24)
Port B is high-true latched TTL inputs (24) (Typically this option is for parallel feedback.)

Option 4 - Custom Configurations: If one of the above configurations is not suitable, a customized configuration is possible under Option 4.

In selecting Option 4, each byte should be specified as to input option or output option. These options are detailed as follows (the IC used for each option is provided for reference):

Input Options:

I1: 14-25V inverting unlatched inputs (ULN2802A) (external voltage source required)
I2: 6-15V inverting unlatched inputs (ULN2804A) (external voltage source required)
I3: 5V non-inverting unlatched inputs (74AC573)
I4: 5V inverting unlatched inputs (74AC563) (for input from OPTO-22)
I5: 5V non-inverting edge-triggered inputs (74AC574) (for absolute encoders)

Output Options:

O1: 5-24V inverting open-collector (sinking) outputs (ULN2803A) (external source may be required)
O2: 5-24V non-inverting sourcing outputs (UDN2981A) (external source may be required)
O3: 5V non-inverting sinking/sourcing outputs (74AC573)
O4: 5V inverting sinking/sourcing outputs (74AC563) (for output to OPTO-22)

For example, to use Port A for an absolute encoder input and Port B for 16 bits of OPTO-22 output and 8 bits of OPTO-22 input, specify:

Acc-14D with Option 4: Bytes 1:I5, 2:I5, 3:I5, 4:O4, 5:O4, 6:I4.

Of course, it is possible to set up incompatible configurations; for example, I1 and O3 could not work on the same port together because of voltage differences.

A configuration sheet is available and should be completed by the customer when ordering a custom configuration, in order to create a permanent configuration record as well as to avoid misunderstandings.

Accessory 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. Comes with two 180 cm (6') cables, one 26-pin and one 16-pin.

Accessory 17: PMACAD Cad Conversion Software

This accessory is a program for IBM PC and compatible computers that converts a CAD file to the PMAC motion language. No PMAC need be attached for this conversion program to run.

The Acc-17 is a once-per-customer purchase. OEMs wishing to re-sell the program to their customers must purchase one copy for each customer. Such OEMs should contact the factory for volume purchase agreements.

Accessory-17DA:

PMACAD Conversion Program on 3.5" diskette.

Accessory 18: Thumbwheel Multiplexer Board

This accessory is a printed circuit board that provides the needed circuitry for PMAC to interface to 16 thumbwheel switches or similar inputs. Up to 32 thumbwheel multiplexer boards can be daisy-chained together to permit the reading of up to 512 thumbwheel digits or other TTL level inputs (256 bytes). Thumbwheels may be mounted directly on the board, or can be remotely connected to it. Alternatively, 8-position dip switches may be mounted on the board for input.

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Acc-18: Thumbwheel Multiplexer Board (bare). Comes with 1 180 cm (6') 26-pin cable.

OPT-1:	Expansion Connector (for daisy-chain to next Acc-18).
OPT-2:	One 8-Position DIP Switch (eight max; in place of two thumbwheel digits).
OPT-4:	One decimal thumbwheel digit (16 max; specify location).
OPT-5:	External Power Connector.
OPT-6:	Molex connectors w/ mates (16 max; for remote digit).

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

Accessory 20: Hand-Held Terminal

This accessory provides a TM200G-001 hand-held or panel-mountable (~5" x 8" x 3/4") terminal for simple operational communications needs. The terminal communicates with the serial port on the PMAC. It provides a numeric keypad with 6 special programmable function keys; also an alphanumeric 2 x 24 LCD display. Comes with a 24" 26-pin cable.

Accessory 21: I/O Simulators and Cables

Acc-21 is a family of I/O simulators and cables for connection to the J5 (JOPT) connector on PMAC. Many users will purchase OPTO-22 boards and connect it to PMAC with an Acc-21 cable from Delta Tau.

Acc-21F:	180 cm (6') 50-pin card edge to 34-pin IDC header cable, for connecting PMAC JOPTO connector to PB8/16/24 or equivalent boards.
Acc-21FH:	180 cm (6') 50-pin IDC header to 34-pin IDC header cable, for connecting PMAC JOPTO connector to PB8/16/24H or equivalent boards.
Acc-21G:	180 cm (6') 50-pin card edge to 50-pin IDC header cable, for connecting Acc-14D/V and Acc-34B to PB8/16/24 or equivalent boards.
Acc-21GH:	180 cm (6') 50-pin IDC header to 50-pin IDC header cable, for connecting Acc-14D/V and Acc-34B to PB8/16/24H or equivalent boards.
Acc-21S:	I/O simulator for PMAC JOPT port with eight switch inputs and eight LED outputs. Comes with 1m (40") 34-pin cable.

Accessory 22: Extended Warranty

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

Accessory 24: Axis Expansion Board

The Acc-24 Axis Expansion board (Acc-24P is for the PMAC PC; Acc-24V is for the PMAC VME; there is no Acc-24 for the PMAC STD) provides four or eight additional channels each of quadrature encoders, analog outputs, and data lines from analog inputs (for a total of 12 or 16 each for the PMAC). This accessory is for those systems that require more than the eight channels of each that can be provided on the baseboard. This would include systems with more than four PMAC-commutated motors, or with more than eight quadrature encoders and handwheels. The board fits in the next open bus slot, and communicates to PMAC via a provided 50-pin flat cable.

Acc-24P:	Four-Channel Expansion Board for the PC bus. Comes with two 8 cm (3") cables, one 50-pin and one 10-pin.
Acc-24V:	Four-Channel Expansion Board for the VME bus. Comes with two 8 cm (3") cables, one 50-pin and one 10-pin.
OPT-1:	Additional four channels on the board (eight total).
OPT-2:	20 cm (8") 50-pin 3-drop connector cable. When Acc-24 is used with PMAC OPT-2, Acc-14D/V, or Acc-36P.

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Accessory 25: Extended Servo Algorithm Tuning Software

PMAC's Acc-25 is software for the IBM PC to be used with PMAC OPT-6, the Extended Servo Algorithm. This software allows the user to setup and tune a PMAC that has the Extended Servo Algorithm. Comes on one 3.5" diskette and is purchased as a Site License.

OPT-1: Executable code upgrade and site license

Accessory 26A: Serial Communications Converter

PMAC's Acc-26A is a small circuit board that converts the RS-232 serial communications of the host computer to the RS-422 serial communications format that PMAC uses. 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. A cable is provided for easy connection to PMAC. 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's RS-422 port, straight over the Acc-3D cable. PMAC's receivers 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 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.

OPT-1: Host RS-232 to PMAC RS422. For PMAC PC, VME, STD, and Lite with Option 9. IDC 26-pin 60 cm (24") serial cable provided for PMAC PC, VME, and Lite. No cable provided for PMAC STD.

OPT-2: Host RS-232 to PMAC RS232. For PMAC STD and Lite. IDC 10-pin 60 cm (24") serial cable provided for PMAC Lite. No cable provided for PMAC STD.

OPT-3: Host RS-232 to PMAC RS422. For PMAC VME to GE 90/70. User specifies 10 or 15-pin 60 cm (24") serial cable provided.

Accessory 27: Optically Isolated I/O Board

PMAC's 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's JTHW port (J3). This I/O is intended for general-purpose programmatic use on PMAC. When Acc-27 is used, no other JTHW port accessories may be used (Acc-8D Opt 7, Acc-8D Opt 9, Acc-18, Acc-34).

OPT-2A: DB-25 input connection
OPT-2B: 18-pin input terminal block (default)

Accessory 28: A/D Conversion Board

PMAC's Acc-28 Analog-to-Digital Conversion board has four channels of high-speed (60 usec), high-resolution analog input in the +/-10V range. It is a small, DIN-rail-mountable 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 (e.g., 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.

For each Acc-28 in the system, there must be one DSP-GATE IC on PMAC or its Acc-24 to process the converted digital signal from the A/D.

OPT-2A: DB-15 input connection
OPT-2B: 12-pin input terminal block (default)

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Accessory 29: Magnetostrictive Linear Displacement Transducer Interface Board

This accessory is a 1/2-size IBM-PC board and is designed to handle four, or optionally eight, channels of magnetostrictive linear displacement transducers (MLDTs) for PMAC. These transducers operate on a principle that measures the time between an excitation pulse applied to the transducer and the reception of an echo generated by a magnet's position along the transducer's length. Generally, these transducers are environmentally tolerant and are used in rugged applications such as hydraulic controls.

Acc-29:	4-channel MLDT interface board
OPT-1:	Additional four channels (eight total)

Accessory 31: PMAC Demonstration Box Unit

Acc-31 is 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, an optional PMAC board, 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. In addition, an optional configuration using the demo unit with the VME-based GE-Fanuc 90/70 PLC system is available.

Acc-31A:	4-axis demo unit (PMAC must be ordered separately).
OPT-3:	PMAC Lite/PC (purchased separately) mounted internally.
Acc-31L:	4-axis demo unit/carrying case lease. 2-week minimum, customer pays shipping both directions. Full lease-to-own credit on continuous rental period.

Accessory 32: PMAC Software Upgrade/Update Kit

At Delta Tau, we are continuously upgrading PMAC's software for motion control. Software and documentation updates are readily available to the customer through 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). Delta Tau will supply Acc-32 to the customer up to two times free of charge for a period of six months from the date of purchase. If a customer has multiple PMAC cards, Acc-32 Option 1 provides extra PMAC EPROMs at a greatly reduced cost.

Acc-32:	Upgrade Kit: EPROM, User Manual, Executive Diskette
OPT-1:	Additional EPROM

Accessory 33: PMAC NC Software Library

This accessory is Windows ™ based software written for the IBM-PC and compatible computers. The software is used with a PMAC and a PC to give a high quality open-architecture machine tool controller. Source code is available to allow the user to customize these modules as needed.

Acc-33:	PMAC NC software for IBM PC; Window based; Executable code per machine
OPT-1	Executable code upgrade per machine
Acc-33L:	PMAC NC software for IBM PC; Windows based; linkable DLL libraries; Site License.
OPT-1	Library upgrade and Site License
Acc-33S:	PMAC NC software for IBM PC; Windows based; source code in C; Site License.
OPT-1	Source code upgrade and Site License

Accessory 34: Multiplexed I/O Expansion Board

This accessory provides 64 points of discrete, optically isolated digital I/O connected to PMAC through the JTHW multiplexer port. Up to 32 of these accessories can be daisy-chained on a single port, for a total of 2048 I/O points. There are three versions of this accessory: the Acc-34, the Acc-34A, and the Acc-34B.

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Acc-34:	Optically isolated I/O board, 64-bits total, definable as inputs or outputs in blocks of 32 by software command. All I/O is sinking only, 5V to 24V, 400 mA. Provided with 24" long, 26-pin cable (for 20MHz PMAC only).
OPT-1:	DIN Rail mount
Acc-34A:	Optically isolated I/O board, 64-bits total, sourcing or sinking inputs and outputs rated to 100 mA per point, 15V to 24V. The points can be selected for input or output by software command, sourcing or sinking, in groups of eight by hardware configuration (when ordering). The default configuration for Acc-34A is 32 inputs and 32 outputs, all sourcing. Comes with 1 60-cm (24") cable to PMAC.
OPT-1:	Custom configuration, sinking/sourcing in/out (Contact factory for form)
OPT-2:	DIN Rail mount
OPT-3:	All sinking configuration, 32 in, 32 out
Acc-34B:	Optically isolated I/O board, 64-bits total, designed for easy connection to Opto-22 and compatible boards (e.g. Opto-22 Models G4PB24 and G4PB16H) via standard 50-pin flat cables (see Acc-21 cables). Both the inputs and the outputs are TTL compatible negative logic (low true) types.
OPT-1:	DIN Rail mount

Accessory 35: Multiplexer Port Line Driver and Receiver

PMAC's Acc-35A and Acc-35B are two complementary printed circuit boards. These boards are designed to provide differential signal transmission capability between PMAC and most of its accessories that communicate via its JTHW connector. Currently, this accessory pair enables the following PMAC accessories to communicate with PMAC via long distance cables:

Acc-8D Opt 7 (Resolver-to-Digital converter board)
Acc-8D Opt 9 (Yaskawa Encoder interface board)
Acc-18 (the Thumbwheel Multiplexer Board)
Acc-34 (the Opto 64 Bit input/output Board)
Acc-34A (the Opto 32-Bit Input/32-Bit Output board)

Acc-35A is the local JTHW buffer board. This board should be attached to PMAC's JTHW connector via the supplied 26-pin flat cable. Acc-35B is the remote JTHW buffer board. One Acc-35B is required per each cluster of the remotely positioned I/O accessory boards. Note that the recommended cable length for the direct connection of PMAC to any of the above accessories is less than 3 meters (10 feet). However by buffering the signals through the Acc-35 pair, and by using twisted pair wires with proper shielding, cable lengths in excess on 100 meters may be used.

Acc-35A:	Thumbwheel port differential line driver w/1, 26-pin, 24" cable (Requires OPT 1 or 2)
Acc-35B:	Thumbwheel port buffer differential line receiver with 1, 26-pin, 24" cable (Requires Option 1 or 2)
OPT-1:	DB37 connector for communication between the local and the remote buffers
OPT-2:	38-pin Phoenix terminal block connector for communication between the local and the remote buffers (this is the default option)
OPT-3:	A 6 ft daisy-chain JTHW cable with four headers. This provides for the connection of up to four I/O accessory boards to a single Acc-35.

Accessory 36: Analog to Digital Converter Board

PMAC's Acc-36 is an analog data acquisition board capable of converting up to 16 analog input signals. The Analog-to-Digital Converter (ADC) units used in Acc-36 are the MAX180 monolithic devices manufactured by Maxim Integrated Products. These devices have 12-bit resolution with +/- 1/2 LSB linearity specification.

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The Acc-36P's design features make it an ideal analog data acquisition board for monitoring and collection of signals from a variety of sensors and transducers. Up to 24 Acc-36Ps may be connected to PMAC providing up to 384 possible analog input channels.

This accessory's intended use differs from that of the PMAC's other ADC board (Acc-28A). Acc-28A has been designed for use in converting signals from analog transducers via the PMAC's DSPGATE gate array IC (see the PMAC User Manual and the Acc-28A Manual). As a result, one PMAC Gate Array IC is required for each Acc-28A. In contrast, Acc-36P does not have this requirement and up to 24 Acc-36Ps may be connected to PMAC providing up to 384 possible analog input channels.

Acc-36P:	16-Channel, 12-bit A/D converter board, mountable in PC bus
Acc-36V:	16-Channel, 12-bit A/D converter board, mountable in VME bus
OPT-2:	20-cm (8") 50-pin 3-connector cable when Acc-36P is used with PMAC OPT-2, Acc-14D, or Acc-24P

Accessory 39: Handwheel Encoder Converter Board

PMAC's Acc-39 is a small printed circuit board designed for the purpose of interfacing the PMAC controller with a handwheel or a slow time base encoder. Acc-39 provides a cost effective solution for PMAC applications in which the four or the eight standard high speed encoder decode circuits on the PMAC's DSPGATES are used already and yet there is an additional need for just one handwheel encoder input. This accessory accepts one pair of A QUAD B encoder signals. Both single-ended (A and B), differential line driver encoder inputs (A, A/ and B, B/), and complementary open collector encoder signals can be accepted. The maximum rate is approximately 31 A/B square waves per servo cycle. With PMAC's default servo frequency of 2.26 kHz this translates to a maximum encoder line rate of 62.5 kHz. The x4 circuitry provides a maximum of 250,000 counts per second at this servo frequency.

Acc-39 interfaces to PMAC through PMAC's front panel port (JPAN) via the supplied 26-pin flat cable. When this accessory is installed then the normal PMAC panel functions cannot be used at the same time (I2 should be set to 1 or 3).

Acc-39:	Handwheel encoder converter board, w/60-cm (24") cable to JPAN
OPT-1:	Rail mount

Accessory 40: On-Site Field Service and Training

Acc-40:	On-site field service/training; 2-day (16 hr) minimum, plus lodging, travel cost and time

Accessory 41: Servo Training Systems

Acc-41A:	Servo training system, torsional bar/diskette mechanism, PMAC not included
Acc-41B:	Servo training system mass/spring/damper mechanism, PMAC not included

Future Accessories

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

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