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DELTA TAU DATA SYSTEMS, INC.

PMAC-LITE HARDWARE REFERENCE

November, 02

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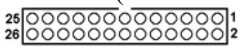
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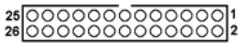
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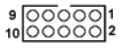
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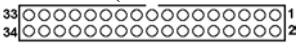
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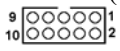
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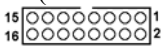
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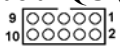
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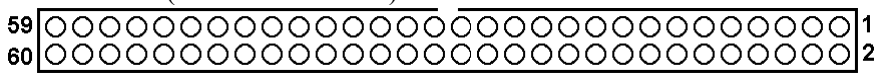
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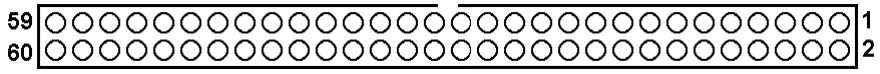
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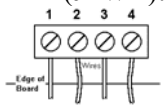
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PMAC-LITE E-POINT JUMPER DESCRIPTIONS

E POINT & PHYSICAL LAYOUT	LOCATION	DESCRIPTION	DEFAULT
E0 	D1	For future use.	No jumper

E1 - E2: MACHINE OUTPUT SUPPLY VOLTAGE CONFIGURE

E POINT & PHYSICAL LAYOUT	LOCATION	DESCRIPTION	DEFAULT
E1 	D1	Jump pin 1 to 2 to apply +V (+5V to 24V) to pin 11 of "U26" (should be ULN2803A for sink output configuration) JOPTO "MACHINE" outputs M01-M08. Jump pin 2 to 3 to apply GND to pin 11 of "U26" (should be UDN2981A for source output configuration). WARNING; *The jumper setting must match the type of driver IC, or damage to the IC will result.* also see E2.	1-2 Jumper installed
E2 	D1	Jump pin 1 to 2 to apply GND to pin 10 of "U26" (should be ULN2803A for sink output configuration). Jump pin 2 to 3 to apply +V (+5V to 24V) to pin 10 of "U26" (should be UDN2981A for source output configuration). WARNING; *The jumper setting must match the type of driver IC, or damage to the IC will result.* also see E1.	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 & PHYSICAL LAYOUT E3 E4 E5 E6  LOCATION E4 E4 E4 E4
ON	ON	ON	ON	N = DIVIDED BY 1	
OFF	ON	ON	ON	N = DIVIDED BY 2	
ON	OFF	ON	ON	N = DIVIDED BY 3	
OFF	OFF	ON	ON	N = DIVIDED BY 4	ONLY E5 and E6 ON
ON	OFF	ON	ON	N = DIVIDED BY 5	
OFF	ON	OFF	ON	N = DIVIDED BY 6	ONLY E4 and E6 ON (Opt 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	

Note: 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). If you wish a servo sample time greater than one millisecond, the sampling may be slowed in software with variable Ix60.

Frequency can be checked on J4 pin 8. 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 kHz.

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

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

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E7: MACHINE INPUT SOURCE/SINK CONTROL

E POINT & PHYSICAL LAYOUT	LOCATION	DESCRIPTION	DEFAULT
E7 	C1	Jump pin 1 to 2 to apply +5V to input reference resistor sip pack; this will bias MI1 to MI8 inputs to +5V for "OFF" state; input must then be grounded for "ON" state. Jump pin 2 to 3 to apply GND to input reference resistor sip pack; this will bias MI1 to MI8 inputs to GND for "OFF" state; input must then be pulled up for "ON" state (+5V to +24V).	1-2 Jumper installed

E9, E10, E13, E14: SERIAL INTERFACE HANDSHAKE CONTROL

These jumpers control whether the RS-232 serial port will be in DCE or DTE format. The default configuration permits straight-across connection to a PC DB-9 serial port.

E POINT & PHYSICAL LAYOUT	LOCATION	DESCRIPTION	DEFAULT
E9 E10 	E1	Jump, E9-1 to E9-2 to allow 'TXD/' to be input on J4-3; jump E10-1 to E10-2 to allow 'RXD/' to be output on J4-5. Jump E9-1 to E10-1 to allow 'TXD/' to be output on J4-3; jump E9-2 to E10-2 to allow 'RXD/' to be input on J4-5.	1-2 Jumper installed
E13 E14 	E1	D5 jump E13-1 to E13-2 to 1-2 allow 'RTS' to be input jumper on J4-4; jump E14-1 to installed E14-2 to allow 'CTS' to be output on J4-6. Jump E13-1 to E14-1 to allow 'RTS' to be output on J4-4; jump E13-2 to E14-2 to allow 'CTS' to be input on J4-6.	1-2 Jumper installed

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E17A - E17D**: AMPLIFIER-ENABLE/DIRECTION POLARITY CONTROL**

E POINT & PHYSICAL LAYOUT	LOCATION	DESCRIPTION	DEFAULT
E17A 	F1	Jump 1-2 for high TRUE AENA1. Remove jumper for low TRUE AENA1.	No jumper installed
E17B 	F1	Jump 1-2 for high TRUE AENA2. Remove jumper for low TRUE AENA2.	No jumper installed
E17C 	F1	Jump 1-2 for high TRUE AENA3. Remove jumper for low TRUE AENA3.	No jumper installed
E17D 	F1	Jump 1-2 for high TRUE AENA4. Remove jumper for low TRUE AENA4.	No jumper installed

Note: Low-true enable is the fail-safe option because of the sinking (open-collector) ULN2803A output driver IC in U54. If U54 is replaced with a UDN2981A sourcing driver IC (and E101 and E102 are changed) high-true enable is the fail-safe option.

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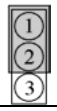
E22 - E23: CONTROL PANEL HANDWHEEL ENABLE

E POINT & PHYSICAL LAYOUT	LOCATION	DESCRIPTION	DEFAULT
E22 	E2	Jump pin 1 to 2 to obtain handwheel encoder signal from front panel at J2-16 for CHB2 (ENC2-B).	No jumper
E23 	E2	Jump pin 1 to 2 to obtain handwheel encoder signal from front panel at J2-22 for CHA2 (ENC2-A).	No jumper

Note: 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.

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E24 - E27: ENCODER SINGLE-ENDED/DIFFERENTIAL CONTROL

E POINT & PHYSICAL LAYOUT	LOCATION	DESCRIPTION	DEFAULT
E24 	F2	*ENC 4 through 1:* Jump pin 1 to 2 to tie complementary encoder inputs to 2.5V. Jump pin 2 to 3 to tie complementary encoder inputs to 5V. For no encoder connection: Jump pin 1 to 2. For single-ended encoders: Jump pin 1 to 2. For differential line-driver encoders: Don't care. For complementary open-collector encoders: Jump pin 2 to 3.	1-2 Jumper installed for E24 - E27. E24: ENC 4 E25: ENC 3 E26: ENC 2 E27: ENC 1
E25 	F2		
E26 	F3		
E27 	F3		

E28: WARNING FOLLOWING ERROR/WATCHDOG TIMER SIGNAL CONTROL

E POINT & PHYSICAL LAYOUT	LOCATION	DESCRIPTION	DEFAULT
E28 	D4	Jump pin 1 to 2 to allow warning following error (Ix12) for selected coordinate system to control "FEFCO/" on J11-57. Jump pin 2 to 3 to cause WATCHDOG timer output to control "FEFCO/". Low TRUE output in either case.	2-3 Jumper installed

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E29 - E33: PHASE CLOCK FREQUENCY CONTROL

Jumpers E29 through E33 control the speed of the phase clock, and, indirectly, the servo clock, which is divided down from the phase clock (see E3 - E6). No more than 1 of these 5 jumpers may be on at a time.

E29	E30	E31	E32	E33	PHASE CLOCK FREQUENCY		DEFAULT & 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 D3
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. This alternate configuration is common only when ACC-28 A/D converters are used.

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 A	E34	E35	E36	E37	E38	SCLK CLOCK FREQUENCY		DEFAULT & PHYSICAL LAYOUT
						19.6608 MHz MASTER CLOCK *see Note 1*	29.4912 MHz MASTER CLOCK *see Note 2*	E34A E34 E35 E36 E37 E38  LOCATION; ALL D4
ON	OFF	OFF	OFF	OFF	OFF	19.6608 MHz	29.4912 MHz	
OFF	ON	OFF	OFF	OFF	OFF	9.8304 MHz	14.7456 MHz	E34 ON
OFF	OFF	ON	OFF	OFF	OFF	4.9152 MHz	7.3728 MHz	
OFF	OFF	OFF	ON	OFF	OFF	2.4576 MHz	3.6864 MHz	
OFF	OFF	OFF	OFF	ON	OFF	1.2288 MHz	1.8432 MHz	
OFF	OFF	OFF	OFF	OFF	ON	EXTERNAL CLOCK 1 TO 30 MHz MAX. INPUT ON CHC4 & CHC4/		

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 & PHYSICAL LAYOUT	LOCATION	DESCRIPTION	DEFAULT
E39 	C4	Jump pin 1 to 2 to allow PMAC-LITE to derive its reset from the "PC" backplane. Remove jumper to allow PMAC-LITE to power up in normal way; PCbus hardware reset will not reset PMAC-LITE; must be removed for standalone operation. Only one of E39, E93, E94 should be on at once. See also E93 & E94	No jumper

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E40 - E43: SOFTWARE ADDRESS CONTROL

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

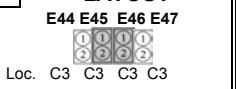
CARD ADDRESS CONTROL "E" POINTS					DEFAULT & PHYSICAL LAYOUT E40 E41 E42 E43  LOCATION C3 C3 C3 C3
E40	**E41**	**E42**	**E43**	**CARD ADDRESS**	
ON	ON	ON	ON	@0	@0
OFF	ON	ON	ON	@1	
ON	OFF	ON	ON	@2	
OFF	OFF	ON	ON	@3	
ON	ON	OFF	ON	@4	
OFF	ON	OFF	ON	@5	
ON	OFF	OFF	ON	@6	
OFF	OFF	OFF	ON	@7	
ON	ON	ON	OFF	@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	

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

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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 & PHYSICAL LAYOUT
E44	E45	E46	E47	Option 4A	Standard, Option 5A	Option 5, Option 5B	 *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	

Note: These jumpers are only used to set the baud rate at power-on/reset

* Non-standard baud rates

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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 & 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)

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 & 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)

Note: 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.

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E49: SERIAL COMMUNICATIONS PARITY CONTROL

E POINT & PHYSICAL LAYOUT	LOCATION	DESCRIPTION	DEFAULT
E49 	C2	Jump pin 1 to 2 for NO serial parity; remove jumper for ODD serial parity.	Jumper installed

E50: EAROM SAVE ENABLE/DISABLE

E POINT & PHYSICAL LAYOUT	LOCATION	DESCRIPTION	DEFAULT
E50 	C2	Jump pin 1 to 2 to enable save to EAROM; remove jumper to disable save to EAROM.	Jumper installed

E51: NORMAL/RE-INITIALIZING POWER-UP

E POINT & PHYSICAL LAYOUT	LOCATION	DESCRIPTION	DEFAULT
E51 	C2	Jump pin 1 to 2 to re-initialize ON power-up/reset; remove jumper for NORMAL power-up/reset.	No jumper installed

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E55 - E65: **HOST INTERRUPT SIGNAL SELECT**

E POINT & PHYSICAL LAYOUT	LOCATION	DESCRIPTION	DEFAULT
E55 	B4	Jump pin 1 to 2 to allow "EQU4" to interrupt host-PC at PMAC interrupt level "IR7".	No jumper installed
E57 	C4	Jump pin 1 to 2 to allow "EQU3" to interrupt host-PC at PMAC interrupt level "IR7".	No jumper installed
E58 	C4	Jump pin 1 to 2 to allow "MI2" to interrupt host-PC at PMAC interrupt level "IR6".	No jumper installed
E59 	C4	Jump pin 1 to 2 to allow "AXIS EXPANSION INT-0" to interrupt host-PC at PMAC interrupt level "IR6".	No jumper installed
E61 	C4	Jump pin 1 to 2 to allow "EQU2" to interrupt host-PC at PMAC interrupt level "IR6".	No jumper installed
E62 	C4	Jump pin 1 to 2 to allow "MI1" to interrupt host-PC at PMAC interrupt level "IR5".	No jumper installed
E63 	C4	Jump pin 1 to 2 to allow "AXIS EXPANSION INT-1" to interrupt host-PC at PMAC interrupt level "IR5".	No jumper installed
E65 	C4	Jump pin 1 to 2 to allow "EQU1" to interrupt host-PC at PMAC interrupt level "IR5".	No jumper installed

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E66 - E71: BUS BASE HARDWARE ADDRESS

These jumpers work with E91 & E92 to set the base address of PMAC-Lite on the PC bus. See PMAC-Lite PC Bus Addressing below for details on how to set these jumpers.

E POINT & PHYSICAL LAYOUT	LOCATION	DESCRIPTION	DEFAULT
E66 E67 E68 E69 E70 E71 	C4/D4	E66 - Bit 9 PC bus base address E67 - Bit 8 PC bus base address E68 - Bit 7 PC bus base address E69 - Bit 6 PC bus base address E70 - Bit 5 PC bus base address E71 - Bit 4 PC bus base address	E67-E70 installed

Note: ON = 0 and OFF = 1 for E66 - E71.

E72 - E73: PANEL ANALOG TIME BASE SIGNAL ENABLE

E POINT & PHYSICAL LAYOUT	LOCATION	DESCRIPTION	DEFAULT
E72 	D2	Jump pin 1 to 2 to allow "V to F" converter "FOUT" derived from WIPER input on J2 to connect to "CHA4".	No jumper installed
E73 	D2	Jump pin 1 to 2 to allow "V to F" converter "SIGNOUT" derived from WIPER input on J2 to connect to "CHB4".	No jumper installed

Note: With these jumpers ON, no encoder should be wired into ENC4 on JMACH. 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 EXT. INTERPOLATION

E POINT & PHYSICAL LAYOUT	LOCATION	DESCRIPTION	DEFAULT
E74 	D2	Jump pin 1 to 2 to allow "SCLK/" to output on "CHC4/".	No jumper installed
E75 	D2	Jump pin 1 to 2 to allow "SCLK" to output on "CHC4".	No jumper installed

Note: SCLK out permits synchronous latching of analog encoder interpolators such as ACC-8D Opt 8.

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E76 - E84: **HOST INTERRUPT SIGNAL SELECT**

E POINT & PHYSICAL LAYOUT	LOCATION	DESCRIPTION	DEFAULT
E76 	D4	Jump pin 1 to 2 to allow "PMAC-INTERRUPT" to host-PC on "IRQ14".	No jumper installed
E77 	D4	Jump pin 1 to 2 to allow "PMAC-INTERRUPT" to host-PC on "IRQ15".	No jumper installed
E78 	D4	Jump pin 1 to 2 to allow "PMAC-INTERRUPT" to host-PC on "IRQ12".	No jumper installed
E79 	D4	Jump pin 1 to 2 to allow "PMAC-INTERRUPT" to host-PC on "IRQ11".	No jumper installed
E80 	D4	Jump pin 1 to 2 to allow "PMAC-INTERRUPT" to host-PC on "IRQ10".	No jumper installed
E81 	E4	Jump pin 1 to 2 to allow "PMAC-INTERRUPT" to host-PC on "IRQ3".	No jumper installed
E82 	E4	Jump pin 1 to 2 to allow "PMAC-INTERRUPT" to host-PC on "IRQ4".	No jumper installed
E83 	E4	Jump pin 1 to 2 to allow "PMAC-INTERRUPT" to host-PC on "IRQ5".	No jumper installed
E84 	E4	Jump pin 1 to 2 to allow "PMAC-INTERRUPT" to host-PC on "IRQ7".	No jumper installed

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E85: HOST-SUPPLIED ANALOG POWER SOURCE ENABLE

E POINT & PHYSICAL LAYOUT	LOCATION	DESCRIPTION	DEFAULT
E85 	F4	Jump pin 1 to pin 2 to allow A+14V to come from PC bus (ties amplifier and PMAC-Lite power supply together. Defeats OPTO coupling.). Note that if E85 is changed, E88 and E87 must also be changed. Also see E90.	No jumper

E86: HOST INTERRUPT SIGNAL SELECT

E POINT & PHYSICAL LAYOUT	LOCATION	DESCRIPTION	DEFAULT
E86 	E4	Jump pin 1 to 2 to allow "PMAC-INTERRUPT" to host-PC on "IRQ2".	No jumper

E87 - E88: HOST-SUPPLIED ANALOG POWER SOURCE ENABLE

E POINT & PHYSICAL LAYOUT	LOCATION	DESCRIPTION	DEFAULT
E87 	F4	Jump pin 1 to pin 2 to allow AGND to come from PC bus (ties amplifier and PMAC-Lite GND together. Defeats OPTO coupling.). Note that if E87 is changed, E85 and E88 must also be changed. Also see E90.	No jumper
E88 	F4	Jump pin 1 to pin 2 to allow A-14V to come from PC bus (ties amplifier and PMAC-Lite 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 & PHYSICAL LAYOUT	LOCATION	DESCRIPTION	DEFAULT
E89 	F3	Jump pin 1 to 2 to use A+15V from J11 (JMACH) pin 59 as supply for input flags. Remove jumper to use A+V from J8 (JEQU) pin 9 (+12V to +24V) as supply for input flags. Note: This jumper setting is only relevant if E90 connects pin 1 to 2. Also see E85, E87, E88, E90 and PMAC-Lite Opto-Isolation diagram.	Jumper installed

E90: HOST-SUPPLIED SWITCH PULL-UP ENABLE

E POINT & PHYSICAL LAYOUT	LOCATION	DESCRIPTION	DEFAULT
E90 	F3	Jump pin 1 to 2 to use A+15V from J11 pin 59 as supply for input flags (E89 ON) {flags should be tied to AGND} or A+V from J8 pin 11 as supply for input flags (E89 OFF) {flags should be tied to separate 0V reference}. Jump pin 2 to 3 to use +12V from PC bus connector P1-pin B09 or TB1 pin 3 as supply for input flags {flags should be tied to GND}. See also E85, E87, E88 and PMAC-Lite Opto-isolation diagram.	1-2 Jumper installed

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E91 - E92: BUS BASE ADDRESS SELECT (HIGH BITS)

These jumpers work with E66 - E77 to set the base address of PMAC-Lite on the PC bus. See PMAC-Lite PC Bus Addressing below for details on how to set these jumpers.

E POINT & PHYSICAL LAYOUT	LOCATION	DESCRIPTION	DEFAULT
E91 E92 	C4	E91 - Bit 11 PC bus base address E92 - Bit 10 PC bus base address ON = 0 OFF = 1	Jumpers installed

E93 - E94: RESET FROM BUS BY SOFTWARE ENABLE

E POINT & PHYSICAL LAYOUT	LOCATION	DESCRIPTION	DEFAULT
E93 	C4	Jump 1-2 to provide a hardware RESET of PMAC-LITE under the software control of the host-PC-AT. PMAC-LITE will power up and stay in the RESET state until PC software writes 40 HEX to BASE+12. PMAC-LITE can be put in RESET state by PC-AT writing 40 HEX to BASE+10. Remove jumper to disable this function Only one of E39, E93, E94 should be ON at the same time.	No jumper
E94 	C4	Jump 1-2 to provide a hardware RESET of PMAC-LITE under the software control of the host-PC-AT. PMAC-LITE will power up in NORMAL mode. PMAC-LITE can be put in RESET state by PC-AT writing 40 HEX to BASE+12. PMAC-LITE can be released from RESET state by PC-AT writing 40 HEX to BASE+10. Remove jumper to disable this function Only one of E39, E93, E94 should be ON at the same time.	No jumper

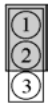
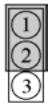
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E98: **DAC/ADC CLOCK FREQUENCY CONTROL**

E POINT & PHYSICAL LAYOUT	LOCATION	DESCRIPTION	DEFAULT
E98 	D4	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

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E101 - E102: **AMPLIFIER ENABLE/POSITION COMPARE OUTPUT CONFIGURE**

E POINT & PHYSICAL LAYOUT	LOCATION	DESCRIPTION	DEFAULT
E101 	F1	Jump pin 1 to 2 to apply +V (+5V to +15V) to pin 11 of "U54" (Should be ULN2803A for sink output configuration). Jump pin 2 to 3 to apply GND to pin 11 of "U54" (should be UDN2981A for source output configuration). WARNING; *The jumper setting must match the type of driver IC, or damage to the IC will result.*	1-2 Jumper installed
E102 	F1	Jump pin 1 to 2 to apply GND to pin 11 of "U54" (Should be ULN2803A for sink output configuration). Jump pin 2 to 3 to apply +V (+5V to +15V) to pin 11 of "U54" (Should be UDN2981A for source output configuration). WARNING; *The jumper setting must match the type of driver IC, or damage to the IC will result.*	1-2 Jumper installed

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E103 - E105**: CPU/POWER JUMPERS**

E POINT & PHYSICAL LAYOUT	LOCATION	DESCRIPTION	DEFAULT
E103 	A2	Jump pin 1 to 2 to disable WATCHDOG timer (*for test purposes only!!*). Remove jumper to enable WATCHDOG timer.	No jumper installed
E104 	A1	Jump pin 1 to 2 to BOOT from host port. Remove jumper to BOOT from PROM IC. Does not exist on PMAC-Lites with Option CPU (Opts 4A, 5A, & 5B).	No jumper installed
E105 	A1	Jump pin 1 to 2 if only battery #1 is installed (shorts battery #2 positive terminal to GND). Jump pin 2 to 3 if only battery #2 is installed (shorts battery #1 positive terminal to GND). NO jumper if both batteries are installed. Does not exist on PMAC-Lites with Option CPU (Opts 4A, 5A, & 5B).	2-3 Jumper installed

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HOST PC-AT I/O ADDRESS MAP

HEX RANGE	DEC RANGE	USAGE
000-01F	0-31	DMA Controller 1 8237A-5
020-03F	32-63	Interrupt Controller 1 8259A
040-05F	64-67	Timer 8254-2
060-06F	96-111	8042 (Keyboard)
070-07F	112-127	Real-time clock, NMI mask
080-09F	128-159	DMA Page Registers
0A0-0BF	160-191	Interrupt Controller 2 8259A
0C0-0DF	192-223	DMA Controller 2 8237A-5
0F0-0FF	240-255	Math CO processor
1F0-1F8	496-504	Fixed Disk
200-20F	512-527	Game Control
210-217	528-535	Expansion Unit (usually open)
278-27F	632-639	Parallel Printer: LPT2
2B0-2DF	688-735	Alternate EGA
2F8-2FF	760-767	Asynchronous Common: COM2
300-31F	768-799	Prototype Card (usually open)
360-36F	864-879	PC Network
378-37F	888-895	Parallel Printer: LPT1
380-38F	896-911	SDLC Communications 2
390-393	912-915	Cluster
3A0-3A9	928-937	SDLC Communications 1
3B0-3BF	944-959	IBM Monochrome Display/Printer
3C0-3CF	960-975	Enhanced Graphics Adapter
3D0-3DF	976-991	Color/Graphics
3F0-3F7	1000-1015	Diskette Controller
3F8-3FF	1016-1023	Asynchronous Common.: COM1
x2E1		GPIB Adapter
x390-x393		Cluster Adapter

Note: It is highly recommended that the addresses marked below with "" not be used by PMAC-LITE. See above chart for possible contention with existing I/O. If a contention occurs, try a new unused address.

Contention is exhibited by:

1) Total Malfunction
2) Partial Function, Input O.K., Output bad or vice versa.
3) Intermittent operation

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PMAC-Lite BUS ADDRESSING

Jumpers E91, E92, E66, E67, E68, E69, E70, and E71 on the PMAC-PC and PMAC-Lite determine the base address of the card in the I/O space of the host PC's expansion bus. Together, they form a binary number that specifies the 16 consecutive addresses on the bus where the card can be found.

The jumpers form the base address in the following fashion:

Jumper	E91	E92	E66	E67	E68	E69	E70	E71
Bit #	11	10	9	8	7	6	5	4
Dec Value	2048	1024	512	256	128	64	32	16
Hex Value	800	400	200	100	80	40	20	10

If a jumper is ON, the value it contributes to the base address is ZERO.
If a jumper is OFF, the value it contributes to the base address is given in the table above.

On both the PMAC-PC and the PMAC-Lite, the jumpers are physically arranged in the same order they are presented in the above table.

From Jumper Configuration To Address

To determine the address specified by a given jumper configuration, use the following formula:

(Decimal)
Address = 2048*E91 + 1024*E92 + 512*E66 + 256*E67 + 128*E68 + 64*E69 + 32*E70 + 16*E71

(Hexadecimal)
Address = $800*E91 + $400*E92 + $200*E66 + $100*E67 + $80*E68 + $40*E69 + $20*E70 + $10*E71

In each case, Exx = 1 if the jumper is OFF; Exx = 0 if the jumper is ON.

Example: On a PMAC card, the jumpers are in the following configuration:

E91	E92	E66	E67	E68	E69	E70	E71
ON	ON	OFF	OFF	ON	ON	ON	ON

The address can be computed as:

Decimal Address = 0 + 0 + 512 + 256 + 0 + 0 + 0 + 0 = 768
Hex Address = 0 + 0 + $200 + $100 + 0 + 0 + 0 + 0 = $300

From Address To Jumper Configuration

Once an I/O address on the PC expansion port has been selected, the following procedure can be used for setting the address jumpers.

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1.) Convert the address to a 3-digital hexadecimal value ($000 to $FFF, representing 0 to 4095). If the value does not fit in this range, you will not be able to set PMAC for this address. Make sure the last digit is 0; only addresses divisible by 16 are permitted as PMAC base addresses.

2.) Take the first hex digit and convert it to binary. The binary digits represent bits 11 through 8 of the base address. Assign each binary digit to jumpers as follows:

Bit #	11(MSB)	10	9	8(LSB)
Jumper	E91	E92	E66	E67
Digit Value	8	4	2	1
Setting for 1	OFF	OFF	OFF	OFF
Setting for 0	ON	ON	ON	ON

3.) Take the second hex digit and convert it to binary. The binary digits represent bits 7 through 4 of the base address. Assign each binary digit to jumpers as follows:

Bit #	7(MSB)	6	5	4(LSB)
Jumper	E68	E69	E70	E71
Digit Value	8	4	2	1
Setting for 1	OFF	OFF	OFF	OFF
Setting for 0	ON	ON	ON	ON

Example 1: You wish to set up the card to be at base address 992 decimal on the PC expansion bus.

1.) 992 decimal is equal to 3E0 hexadecimal
2.) The first digit of 3 is binary 0011. This sets E91 ON, E92 ON, E66 OFF, E67 OFF.
3.) The second digit of E is binary 1110. This sets E68 OFF, E69 OFF, E70 OFF, E71 ON.

Example 2: You wish to set up the card to be at base address 528 decimal on the PC expansion bus.

1.) 528 decimal is equal to 210 hexadecimal
2.) The first digit of 2 is binary 0010. This sets E91 ON, E92 ON, E66 OFF, E67 ON.
3.) The second digit of E is binary 0001. This sets E68 ON, E69 ON, E70 ON, E71 OFF.

Example 3: You wish to set up the card to be at base address 544 decimal on the PC expansion bus.

1.) 544 decimal is equal to 220 hexadecimal
2.) The first digit of 2 is binary 0010. This sets E91 ON, E92 ON, E66 OFF, E67 ON.
3.) The second digit of E is binary 0010. This sets E68 ON, E69 ON, E70 OFF, E71 ON.

PMAC-Lite MATING CONNECTORS

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

J1 (JDISP)/DISPLAY PORT

1. 14-pin female flat cable connector Delta Tau P/N 014-R00F14-0K0
   Qty. 2 - T&B Ansley P/N 609-1441

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2. 171-14 T&B Ansley stan. flat cable stranded 14-wire
3. Phoenix varioface modules type FLKM14 (male pins) P/N 22 81 02 1

J2 (JPAN)/CONTROL PANEL

1. 26-pin female flat cable connector Delta Tau P/N 014-R00F26-0K0 qty. 2 - T&B Ansley P/N 609-2641
2. 171.26.T&B Ansley stan. 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. 26-pin female flat cable connector Delta Tau P/N 014-R00F26-0K0 qty. 2 - T&B Ansley P/N 609-2641
2. 171-26 T&B Ansley stan. flat cable stranded 26-wire
3. Phoenix varioface module type FLKM 26 (male pins) P/N 22 81 05 0

J4 (JRS232)/SERIAL COMMUNICATIONS

1. 10-pin female flat cable connector Delta Tau P/N 014-R00F10-0K0 qty. 2 - T&B Ansley P/N 609-1041
2. 171-10 T&B Ansley stan. flat cable stranded 26-wire
3. Phoenix varioface module type FLKM 34 (male pins) P/N 22 81 06 3

J5 (JOPT)/OPTO I/O

1. 34 pin female flat cable connector Delta Tau P/N 014-R00F34-0K0 qty. 2 - T&B Ansley P/N 609-3441
2. 171-34 T&B Ansley stan. 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. 10 pin female flat cable connector Delta Tau P/N 014-R00F10-0K0 qty. 2 - T&B Ansley P/N 609-1041
2. 171-10 T&B Ansley stan. flat cable stranded 10 wire
3. Phoenix varioface module type FLKM 10 (male pins) P/N 22 81 01 8

J7 (JS1)/A-D INPUTS 1-4

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

J8 (JEQU)/POSITION COMPARE OUTPUTS

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

J9 (JEXP)/EXPANSION

1. 50-pin female flat cable connector Delta Tau P/N 014-R00F50-0K0 qty. 2 - T&B Ansley P/N 609-5041
2. 171-50 T&B Ansley stan. 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

J10 (JDPRAM)

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

J11 (JMACH)/MACHINE CONNECTOR

1. 60 pin female flat cable connector Delta Tau P/N 014-R00F60-0K0 qty. 2 - T&B Ansley P/N 609-6041 available as ACC 8P or 8D
2. 171-60 T&B Ansley stan. flat cable stranded 60 wire

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3. Phoenix varioface module type FLKM 60 (male pins) P/N 22 81 09 2

Note that J11is normally used with Acc 8P or 8D with Option P, which provides complete terminal strip fan-out of all connections.

TB1 (JPWR)

1. 4 pin terminal block

P1 (PC BUS)

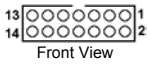
62 pin card edge connector with solder pierced eyelets Delta Tau P/N 014-000F62-SCO qty. 1
Viking P/N 3KH 31/9 JN12 card edge conn. pierced solder eyelets.

P2 (AT BUS)

36 pin card edge connector with solder pierced eyelets Delta Tau P/N 014-000 F36-SCO qty.1
Viking P/N 3KH 18/9 JN12 card edge conn. pierced solder eyelets.

PMAC-Lite CONNECTOR PINOUTS

J1 JDISP (14-PIN CONNECTOR)



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.

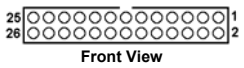
* **Note**; Controlled by potentiometer R3

See Also:

Program Commands; DISPLAY
Accessories; ACC-12, ACC16D
Memory Map; Y:$0780 - $07D1

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J2 JPAN (26-PIN CONNECTOR)



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	RET. TO PREJOG 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	-10V to +10V input Must use E72, E73 (CHA4) and ± 12v supply referenced to GND
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 PANEL
26	GND	COMMON	PMAC COMMON	

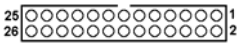
The JPAN connector can be used to connect the Accessory 16 (Control Panel), or customer-provided I/O, to the PMAC, providing manual control of PMAC functions via simple toggle switches. If the automatic control panel input functions are disabled (I2=1), the inputs become general-purpose TTL inputs, and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



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 OUTPUT	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 REQ."
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"

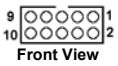
The JTHW multiplexer port provides 8 inputs and 8 outputs at TTL levels. While these I/O can be used in unmultiplexed form for 16 discrete I/O points, most users will utilize PMAC software and accessories to use this port in multiplexed form to greatly multiply the number of I/O that can be accessed on this port. In multiplexed form, some of the SELn outputs are used to select which of the multiplexed I/O are to be accessed.

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 JRS232 (10-PIN CONNECTOR)



PIN #	SYMBOL	FUNCTION	DESCRIPTION	NOTES
1	PHASE	IN OR OUT	PHASING CLOCK	OUT ON @0; ELSE IN *
2	DTR	BIDIRECT	DATA TERM RDY	TIED TO "DSR"
3	TXD/	INPUT	RECEIVE DATA	HOST TRANSMIT DATA
4	CTS	INPUT	CLEAR TO SEND	HOST READY BIT
5	RXD/	OUTPUT	SEND DATA	HOST RECEIVE DATA
6	RTS	OUTPUT	REQ. TO SEND	PMAC READY BIT
7	DSR	BIDIRECT	DATA SET READY	TIED TO "DTR"
8	SERVO	IN OR OUT	SERVO CLOCK	OUT ON @0; ELSE IN *
9	GND	COMMON	PMAC COMMON	
10	+5V	OUTPUT	+5VDC SUPPLY	POWER SUPPLY OUT

The JRS232 connector provides the PMAC-Lite with the ability to communicate serially with an RS232 port. This connector cannot be used for daisychain interconnection of multiple PMAC's. The Option 9L RS-422 interface is required for daisychaining.

* **Note**; 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.

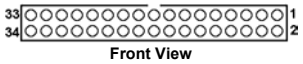
Note: When communicating to PMAC over this port using a communications package that supports modem communications (such as Microsoft Windows™ Terminal), do not connect pin 1. The clock signal from PMAC will prevent the PC from operating.

See Also:

Serial Communications
Synchronizing PMAC to Other PMACs

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J5 JOPT (34-PIN CONNECTOR)

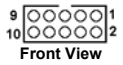


PIN #	SYMBOL	FUNCTION	DESCRIPTION	NOTES
1	MI8	INPUT	MACHINE INPUT 8	LOW IS TRUE
2	GND	COMMON	PMAC COMMON	
3	MI7	INPUT	MACHINE INPUT 7	LOW IS TRUE
4	GND	COMMON	PMAC COMMON	
5	MI6	INPUT	MACHINE INPUT 6	LOW IS TRUE
6	GND	COMMON	PMAC COMMON	
7	MI5	INPUT	MACHINE INPUT 5	LOW IS TRUE
8	GND	COMMON	PMAC COMMON	
9	MI4	INPUT	MACHINE INPUT 4	LOW IS TRUE
10	GND	COMMON	PMAC COMMON	
11	MI3	INPUT	MACHINE INPUT 3	LOW IS TRUE
12	GND	COMMON	PMAC COMMON	
13	MI2	INPUT	MACHINE INPUT 2	LOW IS TRUE
14	GND	COMMON	PMAC COMMON	
15	MI1	INPUT	MACHINE INPUT 1	LOW IS TRUE
16	GND	COMMON	PMAC COMMON	
17	MO8	OUTPUT	MACHINE OUTPUT 8	IF SINKING OUT LOW TRUE; IF SOURCE OUT HIGH 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 8 general purpose inputs and 8 general purpose outputs. Inputs and outputs may be configured to accept or provide either +5 volt or +24 volt 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. Outputs are rated to 100mA per channel.

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J6 JXIO (10-PIN CONNECTOR)

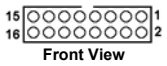


PIN #	SYMBOL	FUNCTION	DESCRIPTION	NOTES
1	CHA1	INPUT	ENC. A CH. POS.	AXIS #1 FOR RESOLVER
2	CHB1	INPUT	ENC. B CH. POS.	AXIS #1 FOR RESOLVER
3	CHC1	INPUT	ENC. C CH. POS.	AXIS #1 FOR RESOLVER
4	CHA3	INPUT	ENC. A CH. POS.	AXIS #3 FOR RESOLVER
5	CHB3	INPUT	ENC. B CH. POS.	AXIS #3 FOR RESOLVER
6	CHC3	INPUT	ENC. C CH. POS.	AXIS #3 FOR RESOLVER
7	E63	INPUT	INTERRUPT IR4	INTERRUPT FROM EXP BRD
8	E59	INPUT	INTERRUPT IR5	INTERRUPT FROM EXP BRD
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.

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J7 (16-PIN HEADER)

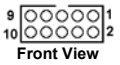


PIN #	SYMBOL	FUNCTION	DESCRIPTION	NOTES
1	DCLK	OUTPUT	D TO A, A TO D CLOCK	DAC AND ADC CLOCK FOR CHAN 1, 2, 3, 4
2	BDATA1	OUTPUT	D TO A DATA	DAC DATA FOR CHAN 1, 2, 3, 4
3	ASEL0/	OUTPUT	CHAN SELECT BIT 0	SELECT FOR CHAN 1, 2, 3, 4
4	ASEL1/	OUTPUT	CHAN SELECT BIT 1	SELECT FOR CHAN 1, 2, 3, 4
5	CNVRT01	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	

This connector is used to communicate with Accessory 23 or 28 A/D converter board. It also can be used to build a digital amplifier interface.

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J8 JEQU (10-PIN HEADER)



PIN #	SYMBOL	FUNCTION	DESCRIPTION	NOTES
1	EQU1/	OUTPUT	ENC 1 COMP EQU	1, 2
2	EQU2/	OUTPUT	ENC 2 COMP EQU	1, 2
3	EQU3/	OUTPUT	ENC 3 COMP EQU	1, 2
4	EQU4/	OUTPUT	ENC 4 COMP EQU	1, 2
5	AENA1/	OUTPUT	AMP 1 ENABLE/DIR	1, 3
6	AENA2/	OUTPUT	AMP 2 ENABLE/DIR	1, 3
7	AENA3/	OUTPUT	AMP 3 ENABLE/DIR	1, 3
8	AENA4/	OUTPUT	AMP 4 ENABLE/DIR	1, 3
9	A+V	INPUT	FLAG SUPPLY VOLT	
10	AGND	COMMON	ANALOG/FLAG COMMON	

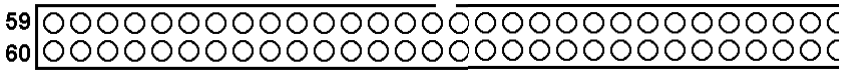
This connector brings out the 4 compare-equal and 4 Amplifier-Enable signals associated with PMAC-Lite's channels 1 to 4. In addition, the A+V supply (+12V to +24V) for motor flags 1 to 4 may be brought in through this connector (with E89 OFF, and E90 connecting pins 1 to 2).

Note:

1. Low true (ON) with the default sinking output driver ULN2803A in U54.
2. Functional polarity controlled by channel control word bit 13 (suggested M-variable Mx13).
3. Also brought out on JMACH connector. Functional polarity controlled by jumpers E17A - D.

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J11 JMACH (60-PIN HEADER)



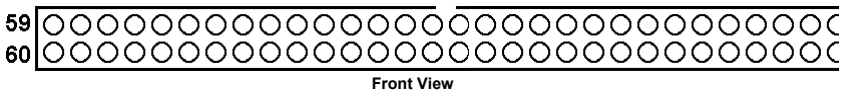
Front View

PIN #	SYMBOL	FUNCTION	DESCRIPTION	NOTES
1	+5V	OUTPUT	+5V POWER	FOR ENCODERS, 1
2	+5V	OUTPUT	+5V POWER	FOR ENCODERS, 1
3	GND	COMMON	DIGITAL COMMON	
4	GND	COMMON	DIGITAL COMMON	
5	CHC3	INPUT	ENCODER C CH. POS	2
6	CHC4	INPUT	ENCODER C CH. POS	2
7	CHC3/	INPUT	ENCODER C CH. NEG	2,3
8	CHC4/	INPUT	ENCODER C CH. NEG	2,3
9	CHB3	INPUT	ENCODER B CH. POS	2
10	CHB4	INPUT	ENCODER B CH. POS	2
11	CHB3/	INPUT	ENCODER B CH. NEG	2,3
12	CHB4/	INPUT	ENCODER B CH. NEG	2,3
13	CHA3	INPUT	ENCODER A CH. POS	2
14	CHA4	INPUT	ENCODER A CH. POS	2
15	CHA3/	INPUT	ENCODER A CH. NEG	2,3
16	CHA4/	INPUT	ENCODER A CH. NEG	2,3
17	CHC1	INPUT	ENCODER C CH. POS	2
18	CHC2	INPUT	ENCODER C CH. POS	2
19	CHC1/	INPUT	ENCODER C CH. NEG	2,3
20	CHC2/	INPUT	ENCODER C CH. NEG	2,3
21	CHB1	INPUT	ENCODER B CH. POS	2
22	CHB2	INPUT	ENCODER B CH. POS	2
23	CHB1/	INPUT	ENCODER B CH. NEG	2,3
24	CHB2/	INPUT	ENCODER B CH. NEG	2,3
25	CHA1	INPUT	ENCODER A CH. POS	2
26	CHA2	INPUT	ENCODER A CH. POS	2
27	CHA1/	INPUT	ENCODER A CH. NEG	2,3
28	CHA2/	INPUT	ENCODER A CH. NEG	2,3
29	DAC3	OUTPUT	ANA. OUT POS. 3	4
30	DAC4	OUTPUT	ANA. OUT POS. 4	4
31	DAC3/	OUTPUT	ANA. OUT NEG. 3	4,5
32	DAC4/	OUTPUT	ANA. OUT NEG. 4	4,5
33	AENA3/DIR3	OUTPUT	AMP-ENA/DIR. 3	6
34	AENA4/DIR4	OUTPUT	AMP-ENA/DIR. 4	6
35	FAULT3	INPUT	AMP-FAULT 3	7
36	FAULT4	INPUT	AMP-FAULT 4	7
37	+LIM3	INPUT	NEG END LIMIT 3	8,9
38	+LIM4	INPUT	NEG END LIMIT 4	8,9
39	-LIM3	INPUT	POS END LIMIT 3	8,9

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J11 JMACH1 (60-PIN HEADER)

Continued



Front View

PIN #	SYMBOL	FUNCTION	DESCRIPTION	NOTES
40	-LIM4	INPUT	POS END LIMIT 4	8,9
41	HMFL3	INPUT	HOME-FLAG 3	10
42	HMFL4	INPUT	HOME-FLAG 4	10
43	DAC1	OUTPUT	ANA. OUT POS. 1	4
44	DAC2	OUTPUT	ANA. OUT POS. 2	4
45	DAC1/	OUTPUT	ANA. OUT NEG. 1	4,5
46	DAC2/	OUTPUT	ANA. OUT NEG. 2	4,5
47	AENA1/DIR1	OUTPUT	AMP-ENA/DIR. 1	6
48	AENA2/DIR2	OUTPUT	AMP-ENA/DIR. 2	6
49	FAULT1	INPUT	AMP-FAULT 1	7
50	FAULT2	INPUT	AMP-FAULT 2	7
51	+LIM1	INPUT	NEG END LIMIT 1	8,9
52	+LIM2	INPUT	NEG END LIMIT 2	8,9
53	-LIM1	INPUT	POS END LIMIT 1	8,9
54	-LIM2	INPUT	POS END LIMIT 2	8,9
55	HMFL1	INPUT	HOME-FLAG 1	10
56	HMFL2	INPUT	HOME-FLAG 2	10
57	FEFCO/	OUTPUT	FE/WATCHDOG OUT	INDICATOR/DRIVER
58	AGND	INPUT	ANALOG COMMON	
59	A+15V/OPT+V	INPUT	ANALOG +15V SUPPLY	
60	A-15V	INPUT	ANALOG -15V SUPPLY	

The J11 connector is used to connect PMAC to the first 4 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.

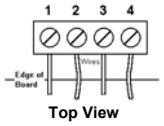
***Note 8*: Pins marked *-LIMn* should be connected to switches at the *positive* end of travel. Pins marked *+LIMn* should be connected to switches at the *negative* end of travel.**

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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TB1 (JPWR)



PIN #	SYMBOL	FUNCTION	DESCRIPTION	NOTES
1	GND	COMMON	DIGITAL GROUND	
2	+5V	INPUT	+5V SUPPLY	REF. TO DIGITAL GND
3	+12V	INPUT	+12V SUPPLY	REF. TO DIGITAL GND
4	-12V	INPUT	-12V SUPPLY	REF. TO DIGITAL GND

This terminal block may be used as an alternative power supply connector if PMAC-Lite is not installed in a PC-bus. The +5v powers the digital electronics. The +12V and -12V power the on-board V/F converter, and if jumpers E85, E87, and E88 are installed, they power the analog output stage as well (this defeats the optical isolation on PMAC).

If you desire to keep the optical isolation between the digital and analog circuits on PMAC, you *must* provide analog power (+/-12V to +/-15V & AGND) through the JMACH connector, instead of the bus connector or this terminal block.

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 PMAC's 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)
```


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```
      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
```

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.
            Autotunable 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
            Autotunable 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,
      microstepped stepping motors.
      2, 3, or 4-phase motors, Y-wound, delta-wound, or
      electrically independent phases.
```


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```
      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.
```

I/O Specifications

```
POSITION FEEDBACK:
      (JMACH1, JMACH2)
      (also ACC-24 JMACH3, JMACH4)
```


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```
      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 6 absolute parallel encoders of over 24 bits
            (limit of 6 ACC-14D cards of 48 bits each);
            straight binary; 5 volts, single-ended.

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

ANALOG OUTPUTS:
      (JMACH1, JMACH2)
      (also ACC-24 JMACH3, JMACH4)
      4 (standard) to 16 (depending on options) outputs of
      +/-10V; 16-bit resolution (300 uV/bit), optically isolated;
      Standard use is for servo output; 1 per axis if PMAC
      is not commutating axis; 2 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 under 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)
            4 dedicated digital inputs accompanying each quadrature
            encoder; optically isolated from PMAC digital circuits;
            operate from +15V voltage source.
            Inputs for each encoder are: +LIMIT, -LIMIT, HOME, FAULT.
            Uncommitted sets of inputs may be used as general-
            purpose optically isolated digital inputs.
```


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```
DEDICATED AXIS DIGITAL OUTPUTS:
      (JMACH1], JMACH2)
      (also ACC-24 JMACH3, JMACH4)

      Amplifier Enable:
            1 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:
            1 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.

GENERAL-PURPOSE DIGITAL INPUTS:
      (JOPTO)
      8 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)
      8 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, -STD)
            Single-ended +/-6-10V levels

      RS-422 serial data port (PMAC-PC, -VME, -STD, -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
      8 bits, 1 start bit, 1 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, -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.
```


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```
      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)
      8 TTL input lines; 8 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.

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

EXPANSION DIGITAL I/O:
      JEXP connector provides access to up to 6 Accessory 14
      I/O Expansion cards with 48 bits each of digital I/O,
      configurable to inputs or outputs by byte, configurable
      to high-voltage level by 24-bit word; sinking or
      sourcing available with +5 to +24V high levels, totem-
      pole +5V outputs available.
```

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 initial-
      ization 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
```


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```
      memory & 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 & 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 recirculating 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.
```

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 4 channels each of: quadrature encoders, analog (DAC) outputs, analog inputs (serial, digital data from ACC-23 or ACC-28), for a total of eight channels each on a PMAC. On PMAC-VME or PMAC-STD, this option is a piggy-back board. On PMAC-PC this option is extra ICs on the base board. This option is not available for PMAC-Lite.

OPTION 2:

8Kx16 Dual-ported RAM: for very high-speed repetitious communication of data. On PMAC-VME, this option is extra ICs on the base board. 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.

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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 on board. 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.

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 1 PMAC (3.0A rating).
ACC-1A: for 2 or 3 PMACs (6.0A rating).
ACC-1B: for 4 or 5 PMACs (9.0A rating).
ACC-1C: for 6, 7, or 8 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.

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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 1 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 1 PMAC (1.5A rating at each level).
ACC-2A: +/-15V, +5V for 1 PMAC (16W rating).
ACC-2B: +/-15V, +5V for 2 PMACs (40W rating).
ACC-2SA: 12V switching power supply for 1 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 a 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's Manual and Software Reference.
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.

ACCESSORY 8: TERMINAL BLOCK

The Accessory 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 3 ft.)

ACC-8D: 60-point terminal block with connectors for option boards.

OPT-P: 60-pin connector and cable to PMAC-PC, -STD, and -Lite.

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OPT-V: 96-pin connector and cable to PMAC-VME. (Note: a longer cable may be specified. Not to exceed 3 ft.)

OPT-1: Provides a third phase of output for two PMAC-commutated motors. Normally this function is provided in the amplifier, but if your 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 4 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, 1 16-pin and 4 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 2 10-pin 40-cm (16") cables to ACC-8D and 1 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 2 10-pin 40-cm (16") cables to ACC-8D.
OPT-B: DIN rail mount for OPT-7.

OPT-8: The analog encoder interpolator board provides 128 or 256 pulses per cycle of an analog encoder. Each Option 8 allows connection of 1 analog encoder to PMAC and

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requires 2 encoder channels on the PMAC. Up to 8 Option 8's can be connected to 1 16-channel PMAC (PMAC with Option 1 and ACC-24 with Option 1). Comes with 3 10-pin 40-cm (16") cables, 2 to ACC-8D and 1 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 4 10-pin 40-cm (16") cables to ACC-8D and 1 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 intended to be 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 their own 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-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; 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 their own 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

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Accessory 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 he wishes 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.
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 w/ 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 2 180 cm (6') 14-pin cables to ACC-12E, bezel, no filter (P/N IEE S03601-51-096).
OPT-2: 20x4 11mm high characters with 2 180 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 Accessory 14D/V provides expanded and flexible digital I/O capabilities for the controller (ACC-14D is the PCbus form; ACC-14V is the VMEbus form; there is no STDbus form). It may be configured for a wide variety of different uses by selecting different voltage levels, sinking/sourcing, and latched/nonlatched 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, PCbus compatible, requires an Option 1-4.
ACC-14V: 48 digital I/O points, VMEbus compatible, requires an Option 1-4.

OPT-1: 24 inputs and 24 outputs, TTL levels (0 - 5 volts), low true.
OPT-2: 24 inputs and 24 outputs, 0 - 24 volts, low true.
OPT-3: 48 inputs, TTL levels (0 - 5 volts), 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 Opt. 2, ACC-24P, or ACC-36P is also used.

Purchasing the Proper ACC-14D/V Configuration

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ACC-14D/V's 48 bits of I/O are grouped into two ports (A & B), each with its own connector (J7 & 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)
      (This option is typically 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)
      (This option is typically for driving I/O directly.)

Option 3:
      Port A is high-true latched TTL inputs (24)
      Port B is high-true latched TTL inputs (24)
      (This option is typically 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, if you wished 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, you would specify:

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

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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 filled out 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 Accessory 16D control panel provides all the means for using PMAC's dedicated hardware control inputs and display outputs. It has 9 toggle switches for the hardware functions, a 10-way rotary switch for motor-/coordinate-system-select (1 to 8, all, and none), a handwheel encoder, an analog potentiometer, a frequency generator, a 2x40 character alphanumeric LCD display, and 5 status LEDs. Comes with 2 180 cm (6') cables, 1 26-pin and 1 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.

ACC-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.

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 (8 max; in place of 2 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

Accessory 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.

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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. 8 switch inputs and 8 LED outputs. Comes with 1m (40") 34-pin cable.

ACCESSORY 22: EXTENDED WARRANTY

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

ACCESSORY 24: AXIS EXPANSION BOARD

The Accessory 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 4 or 8 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 8 channels of each that can be provided on the base board. This would include systems with more than 4 PMAC-commutated motors, or with more than 8 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 PCbus. Comes with 2 8 cm (3") cables, 1 50-pin and 1 10-pin.
ACC-24V: Four-Channel Expansion Board for the VMEbus. Comes with 2 8 cm (3") cables, 1 50-pin and 1 10-pin.

OPT-1: Additional four channels on the board (8 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.

ACCESSORY 25: EXTENDED SERVO ALGORITHM TUNING SOFTWARE

PMAC's Accessory 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; Site License.

ACCESSORY 26A: SERIAL COMMUNICATIONS CONVERTER

PMAC's Accessory 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 9L. IDC 26-pin 60 cm (24") serial cable provided for PMAC-PC, -VME, -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.

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ACCESSORY 27: OPTICALLY ISOLATED I/O BOARD

PMAC's Accessory 27 is a small circuit board that provides eight optically isolated inputs and eight optically isolated outputs. The I/O is rated to 24V and 100 mA. The board is designed for easy connection through a provided flat cable to PMAC'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 Accessory-28 Analog-to-Digital Conversion board has 4 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; for instance to monitor process variables such as pressure or tension, to allow analog speed control, or to monitor motor currents. The analog inputs are optically isolated from the PMAC's digital circuits.

For each ACC-28 in the system, there must be 1 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).

ACCESSORY 29: MAGNETOSTRICTIVE LINEAR DISPLACEMENT TRANSDUCER INTERFACE BOARD

This accessory is a 1/2-size IBM-PC board and is designed to handle 4, or optionally 8, 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. These transducers are generally environmentally tolerant and are used in rugged applications such as hydraulic controls.

ACC-29: 4-channel MLDT interface board.
OPT-1: Additional 4 channels (8 total).

ACCESSORY 31: PMAC DEMONSTRATION BOX UNIT

Accessory 31 is intended to be used for the purpose of demonstration of PMAC's numerous motion control features. This accessory is a very useful tool for PMAC-based program development and verifications by OEMs. Internally the unit consists of a ±15V and +5V DC power supply, four or eight DC motors with HP 500-line encoders, four or eight motor amplifiers, 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 Accessory 32. ACC-32 consists of updates for an EPROM (PMAC firmware), User's Manual, and ACC-9D PC Executive Program Diskette (if it was previously purchased). Delta Tau is happy to supply ACC-

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

ACC-32: Upgrade Kit: EPROM, User's Manual, Executive Diskette.
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 intended to be 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, Site License.

ACC-33S: PMAC-NC software for IBM PC; Windows based; source code in C; Site License.
OPT-1 - Source code upgrade, 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 3 versions of this accessory: the ACC-34, the ACC-34A, and the ACC-34B.

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 8 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 & 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 Accessory 35A and Accessory 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 enable the following PMAC accessories to communicate with PMAC via long distance cables:

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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 Accessory 36 (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.

The Accessory 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 to be used for converting signals from analog transducers via the PMAC's DSPGATE gate array IC (see the PMAC User's Manual and 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 PCbus.
ACC-36V: 16-Channel, 12-bit A/D converter board, mountable in VMEbus.

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 accessory 39 (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

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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 & B), differential line driver encoder inputs (A, A/ & 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 & 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. Please contact the factory for the latest update.

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