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USER MANUAL

Accessory 24E2S

Axis Expansion Board

3Ax-603441-xUxx

February 18, 2010

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REVISION HISTORY				
REV.	**DESCRIPTION**	**DATE**	**CHG**	**APPVD**
1	ADDED CE DECLARATION	06/07/06	CP	S. FIERO
2	UPDATED TERMINAL BLOCK DESC., PP. 37-41	04-17-09	CP	A. OHMORI
3	UPDATED JUMPERS & RESISTOR PACK DESCR.	07/22/09	CP	S. SATTARI
4	ADDED UL SEAL TO MANUAL COVER UPDATED AGENCY APPROVAL/SAFETY SECTION	09/30/09	CP	S.FIERRO
5	CORRECTED RESISTOR PACK INFO, P.9	02/18/10	CP	M. YAHYAEI
6	UPDATED POWER REQUIREMENTS	07/21/15	RN	RN

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INTRODUCTION

The Acc-24E2S Axis Expansion Board provides four channels of PMAC2-style stepper interface and/or encoder/MLDT circuitry for UMAC and Ultralite/MACRO Station controllers. The Acc-24E2S is part of the UMAC or MACRO Pack family of expansion cards and these accessory cards are designed to plug into an industrial 3U rack system. The information from these accessories is passed directly to either the UMAC or MACRO Station CPU via the high speed UBUS. Other axis or feedback interface accessories include the following:

Acc-14E	Parallel Feedback Inputs (absolute enc. or interferometers)
Acc-24E2	Digital Amplifier Breakout w/ TTL encoder inputs
Acc-24E2A	Analog Amplifier Breakout w/ TTL encoder inputs
Acc-24E2S	Stepper Amplifier Breakout w/ TTL encoder inputs
Acc-28E	16-bit A/D Converter Inputs (up to four per card)
Acc-51E	4096 times interpolator for 1Vpp sinusoidal encoders
Acc-53E	SSI encoder interface (up to 8 channels)

The step and direction outputs are RS422 compatible and are capable of being connected in either differential mode or single ended configurations for 5V input drivers. Flag input terminals are provided to allow connection of 12V-24V sensors or limit switches.

Up to eight Acc-24E2S boards can be connected to one UMAC providing up to 32 additional channels of stepper interface circuitry. Because each MACRO Station CPU can service only eight channels of servo data, only two Acc-24E2S boards can be connected to the MACRO Station for stepper motor connection.

The Acc-24E2S is also an ideal board to use for dual feedback systems because it can process four encoders with one single board on the 3U rack.

The Acc-24E2S board contains no processor; it has one highly integrated 4-channel PMAC2-style Servo IC with the buffering circuitry and connectors around them. The four-axis Acc-24E2S plugs into the backplane and uses one slot in the Rack.

Features

The Acc-24E2S board can be used with any UMAC or MACRO Station CPU, interfacing through the Expansion port.

The Acc-24E2S can only support pulse and direction commands from the controller.

Board Configuration

An Acc-24E2S comes standard with one Servo IC providing four servo interface channels, which are brought out on terminal blocks. Each channel of servo interface circuitry includes the following:

- Four output command signal sets, configurable as pulse and direction outputs only:
- Four 3-channel differential/single-ended encoder input
- Four sets of five input flags and one compare output flag

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SPECIFICATIONS

Environmental Specifications

Description	Specification	Notes
Operating Temperature	0°C to 45°C,	
Storage Temperature	-25°C to 70°C	
Humidity	10% to 95 % non-condensing	

Physical Specifications

Description	Specification	Notes
Dimensions	Length: 16.256 cm (6.4 in.) Height: 10 cm (3.94 in.) Width: 2.03 cm (0.8 in.)	
Weight	210 g	Front, top, and bottom plates included
Terminal Block Connectors	FRONT-MC1,5/12-ST3,81 FRONT-MC1,5/5-ST3,81 FRONT-MC1,5/3-ST3,81	Terminal Blocks from Phoenix Contact. UL-94V0
DB Option Connectors	DB15 Female	UL-94V0
The width is the width of the front plate. The length and height are the dimensions of the PCB.		

Electrical Specifications

Description	Specification	Notes
ACC-24E2S Power Requirements	5V @ 0.9 A (±10%)	

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Agency Approval and Safety

Item	Description
CE Mark	Full Compliance
EMC	EN55011 Class A Group 1 EN61000-3-2 Class A EN61000-3-3 EN61000-4-2 EN61000-4-3 EN61000-4-4 EN61000-4-5 EN61000-4-6 EN61000-4-11
Safety	EN 61010-1
UL	UL 61010-1 File E314517
cUL	CAN/CSA C22.2 No. 1010.1-92 File E314517
Flammability Class	UL 94V-0

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E-POINT JUMPER SETTINGS

Acc-24E2S Jumpers*

Jumper	Config.	Description	Default
E1	1-2-3	1-2 send PWM/PFM output regardless of AENA1 status 2-3 send PWM/PFM only when AENA1 if true. No Jumper for Channel 1 TUVW inputs.	Jump 1-2
E2	1-2-3	1-2 send PWM/PFM output regardless of AENA2 status 2-3 send PWM/PFM only when AENA2 if true. No Jumper for Channel 2 TUVW inputs.	Jump 1-2
E3	1-2-3	1-2 send PWM/PFM output regardless of AENA3 status 2-3 send PWM/PFM only when AENA3 if true. No Jumper for Channel 3 TUVW inputs.	Jump 1-2
E4	1-2-3	1-2 send PWM/PFM output regardless of AENA4 status 2-3 send PWM/PFM only when AENA4 if true. No Jumper for Channel 4 TUVW inputs.	Jump 1-2
E5	1-2-3	Jump 1-2 for Turbo 3U CPU and MACRO CPU ** Jump 2-3 for legacy MACRO CPU (before 6/00)	Jump 1-2
E11	1-2	Jump 1-2 to enable AENA1 No Jumper to disable AENA1	Jump 1-2
E12	1-2	Jump 1-2 to enable AENA2 No Jumper to disable AENA2	Jump 1-2
E13	1-2	Jump 1-2 to enable AENA3 No Jumper to disable AENA3	Jump 1-2
E14	1-2	Jump 1-2 to enable AENA4 No Jumper to disable AENA4	Jump 1-2
E16	1-2-3	Jump 1-2 to receive phase and servo clocks Jump 2-3 to transmit phase and servo clocks	Factory set
OPT1	1-2	For factory use only (No jumper on JP1-JP9)	Factory set
OPT2	1-2	For factory use only (Jumper JP1-JP9)	Factory set
OPT3	1-2	For factory use only (jumper JP1-JP9)	Factory set

*The channels refer to the Servo IC associated with the individual Acc-24E2S board. For example, in an eight-axis application, there would be two Acc-24E2S boards. The first Acc-24E2S would have axes 1-4 and the second Acc-24E2S would contain axes 5-8.
** For legacy MACRO Stations (part number 602804-100 through 602804-104)

Note:

Delta Tau added the amplifier enable outputs with the release of the 603441-101 revision of the Acc-24E2S card and jumpers E11, E12, E13, and E14 were added for this feature. The first revision of this accessory (603441-100) does not have amplifier enable outputs or jumpers E11, E12, E13, or E14.

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HARDWARE SETUP

Switch Configuration

UMAC Address DIP Switch S1

S1-1	S1-3	S1-4	Board No.	IC No.	I-Variable Range	Base Address
ON	ON	ON	1	2	I7200	$078200
OFF	ON	ON	2	3	I7300	$078300
ON	OFF	ON	3	4	I7400	$079200
OFF	OFF	ON	4	5	I7500	$079300
ON	ON	OFF	5	6	I7600	$07A200
OFF	ON	OFF	6	7	I7700	$07A300
ON	OFF	OFF	7	8	I7800	$07B200
OFF	OFF	OFF	8	9	I7900	$07B300
S1, S1-3, S1-4 are used to address the Acc-24E2S as shown in this table.						

S1-2	S1-5	S1-6	Function
ON	ON	ON	3U Turbo PMAC Use
S1-2, S1-5, and S1-6 are used to determine whether the Acc-24E2S is communicating to a Turbo 3U PMAC or a MACRO Station CPU.			

MACRO Station Address DIP Switch S1

S1-1, S1-2, S1-3, S1-4 are used to address the Acc-24E2 as shown in the table below.

S1-1	S1-2*	S1-3	S1-4	Board No.	IC No.	Base Address
ON	ON	OFF	OFF	1	2	$00C040
OFF	OFF	OFF	OFF	2	3	$00C060
* Always set to OFF for legacy MACRO Stations (part number 602804-100 thru 602804-104)						

S1-5 and S1-6 are used to determine whether the Acc-24E2 is communicating to a Turbo 3U PMAC or a MACRO Station CPU.

S1-5	S1-6	Function
OFF	OFF	3U MACRO Station use

Acc-24E2 Clock Settings

The Phase Clock and Servo Clock must be configured on each Acc-24E2S. Each system can have only one source for the servo and phase clocks and jumpers must be set appropriately to avoid a timing conflict or a watchdog condition.

Starting in UMAC-Turbo firmware version 1.937, the firmware will set the clock settings automatically for the Acc-24E2 cards in the UBUS. To enable this feature, set jumper E16 from 2 to 3 for all of the Acc-24E2Ss plugged into the UMAC. At re-initialization (either **$$$***** command or power up with E3 jumpered on UMAC), the firmware will know that all of the cards are in the auto configuration setup and will assign the card with the lowest base address setting (usually $78200) the task of sourcing the clocks by setting variable I19 to the appropriate register. The clocks will be set initially to the factory default servo update cycle and phase clock cycle. For a better understanding of this feature, refer to the description of I19 in the Turbo Software Reference Manual.

For UMAC Turbo systems with firmware older than version 1.937, set one of the Acc-24E2s to transmit (E16 set 2-3) the phase and servo clock (usually the card at the lowest base address setting) and set the rest of the Acc-24E2s to receive (E16 set 1-2) the phase and servo clocks.

For MACRO systems, the clock select jumper should be set to receive servo and phase clocks. For the Acc-24E2S, E16 should be set 1-2.

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Resistor Pack Configuration

Differential or Single-Ended Encoder Selection

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

- The '+' inputs of each differential pair each have a hard-wired 1 kΩ pull-up resistor to +5V. This cannot be changed.
- The '-' inputs of each differential pair each have a hard-wired 2.2 kΩ resistor to +5V; also each has another 2.2 kΩ resistor as part of a socketed resistor pack that can be configured as a pull-up resistor to +5V, or a pull-down resistor to GND.

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

If this socketed resistor is configured as a pull-up resistor (by reversing the SIP pack in the socket), the two parallel 2.2 kΩ resistors act as a single 1.1 kΩ pull-up resistor, holding the line at +5V in the absence of an external signal. This configuration is required if encoder-loss detection is desired; it is required if complementary open-collector drivers are used; it is permissible for differential line-driver inputs even without encoder loss detection.

If Pin 1 of the resistor pack (marked by a dot on the pack) matches Pin 1 of the socket (marked by a wide white square solder pin on the front side of the board), then the pack is configured as a bank of pull-down resistors. If the pack is reversed in the socket, it is configured as a bank of pull-up resistors.

The following table lists the pull-up/pull-down resistor pack for each input device:

Device	Resistor Pack	Pack Size
Encoder 1	RP19	6-pin
Encoder 2	RP21	6-pin
Encoder 3	RP27	6-pin
Encoder 4	RP29	6-pin

Termination Resistors

The Acc-24E2S provides sockets for termination resistors on differential input pairs coming into the board. As shipped, there are no resistor packs in these sockets. If these signals are brought long distances into the Acc-24E2A board and ringing at signal transitions is a problem, SIP resistor packs may be mounted in these sockets to reduce or eliminate the ringing.

All termination resistor packs have independent resistors (no common connection) with each resistor using two adjacent pins.

Channel Specific Resistor Packs

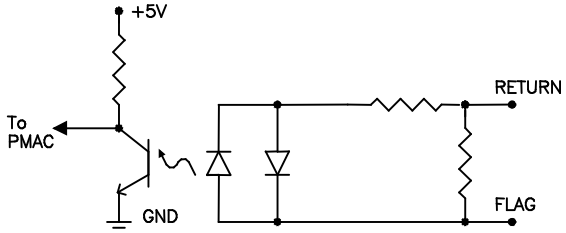
Channel 1	Channel 2	Channel 3	Channel 4	SIP	Description
RP19	RP21	RP27	RP29	2.2KΩ	Reverse for encoder loss feature
RP20	RP22	RP28	RP30	220Ω	Termination resistor to reduce ringing (Installed by default).
RP38	RP42	RP47	RP51	1KΩ	Install for 5V limits

Resistor Pack	SIP	Description
RP5	220Ω	Terminator (not installed, only used for non-UBUS) (Rev 103 and older)
RP6	220Ω	Pull Down for Old MACRO CPU; Pull Up for UMAC Turbo and MACRO (Rev 103 and older only)

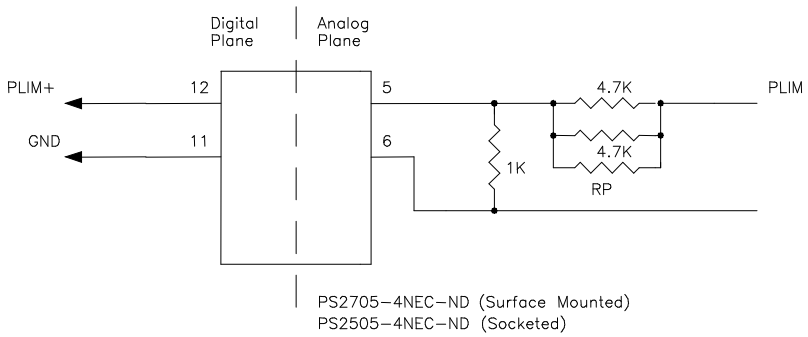
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Acc-24E2 Limit and Flag Wiring

The Acc-8F allows the use of sinking or sourcing position limits and flags to the PMAC2. The opto-isolator IC used is a PS2705-4NEC-ND quad photo-transistor output type. This IC allows the current to flow from return to flag (sinking) or from flag to return (sourcing).

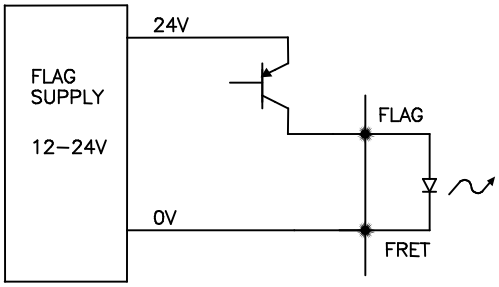


A sample of the positive limit circuit is shown below. The 4.7K resistor packs used will allow 12-24V flag inputs. If 0-5V flags are used, then a 1kΩ resistor pack (RP) can be placed in either RP38, RP42, RP47, or RP51 (refer to the Resistor Pack Configuration section of this manual).

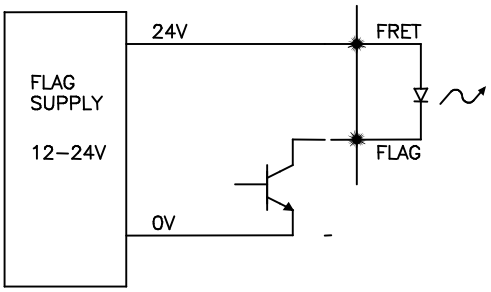


Connecting Limits/Flags to the Acc-24E2

The following diagram illustrates the sinking and sourcing connections to an Acc-24E2. This example uses 12-24V flags.



Sinking, Separate Supply



Sourcing, Separate Supply

Loss of Encoder Circuit

The encoder-loss detection circuitry works for differential incremental encoders only. In proper operation, the digital states of the complementary inputs for a channel (e.g. A and A/) always should be

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opposite: when one is high, the other is low. If for some reason, such as a cable connection coming undone, one or more of the signal lines is no longer driven, pull-up resistors on the input line pull and hold the signal high.

The encoder-loss detection circuitry uses exclusive-or (XOR) gates on each complementary pair to detect whether the signals are in the same or opposite states. These results are combined to produce a single encoder-loss status bit that the processor can read.

In order to enable this function, the socketed resistor packs for the encoder must be reversed from their factory default setting so that the complementary encoder lines A/, B/, and C/ are pulled up to 5V instead of pulled to 2.5V. The resistor packs to be reversed are RP19, RP21, RP27, and RP29.

Acc-24E2S Discrete On-board Logic with UMAC Turbo CPU

Channel	Resistor Pack	Status Bit Address (Even-Numbered Servo IC)*	Status Bit Address (Odd-Numbered Servo IC)*	Status Bit Name	Bit Error State
1	RP19	Y:$07xF08,5	Y:$07xF0C,5	QL_1-	0
2	RP21	Y:$07xF09,5	Y:$07xF0D,5	QL_2-	0
3	RP27	Y:$07xF0A,5	Y:$07xF0E,5	QL_3-	0
4	RP29	Y:$07xF0B,5	Y:$07xF0F,5	QL_4-	0
The x digit in this hex address matches the value (8, 9, A, or B) in the fourth digit from the right in the board's own base address (e.g. $079200). If alternate addressing of Servo ICs is used (e.g. Servo IC 2), add $20 to these addresses.					

Acc-24E2S Discrete On-board Logic with UMAC MACRO CPU

Channel	Resistor Pack	Status Bit Address (First-Servo IC)*	Status Bit Address (Second Servo IC)*	Status Bit Name	Bit Error State
1	RP19	Y:$B8C8,5	Y:$B8EC,5	QL_1-	0
2	RP21	Y:$B8C9,5	Y:$B8ED,5	QL_2-	0
3	RP27	Y:$B8CA,5	Y:$B8EE,5	QL_3-	0
4	RP29	Y:$B8CB,5	Y:$B8EF,5	QL_4-	0
*First Servo IC has base address $C040; second Servo IC has base address $C060.					

Position Compare Port Driver IC

As with the other PMAC controllers, the UMAC has the high speed compare outputs allowing the firing of an output based on position. This circuit will fire within 100 nsec of reaching the desired position. The position compare output ports on Acc-24E2S have driver IC at components U29 and U30. This IC gives a fast CMOS driver.

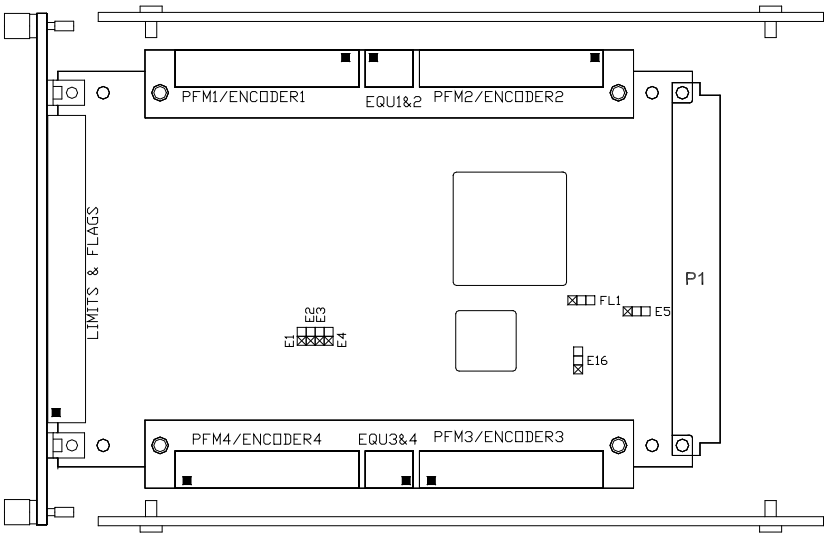
The following table lists the properties of each driver IC:

Part	# of Pins	Max Voltage and Current	Output Type	Max Frequency
DS75451N	8	5V, 10 mA	Totem-Pole (CMOS)	5 MHz

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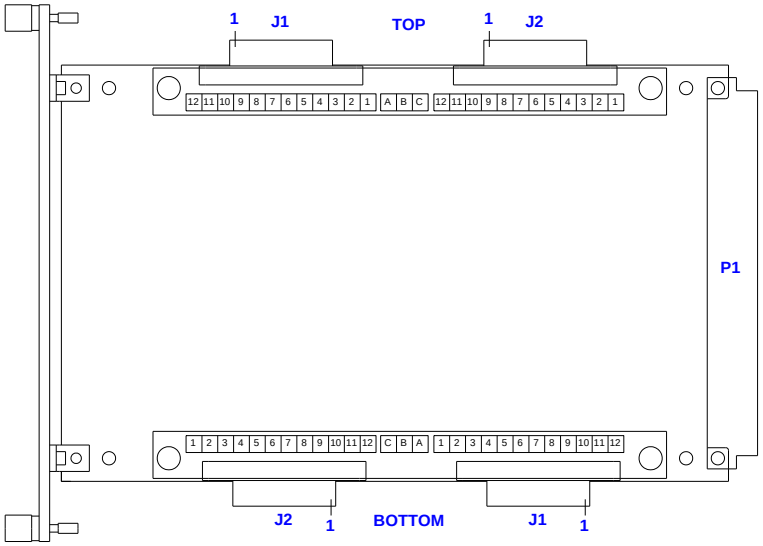
CONNECTIONS

Acc-24E2S Terminal Block Layout Diagram



Designates Pin 1

Acc-24E2S DB15 Option Layout Diagram



Mating Connectors

Terminal Block Connectors

Name	Manufacturer	Pins	Type	Details
TB1- Top	Phoenix Contact	12	FRONT-MC1,5/12-ST3,81	Encoder 1 Inputs
TB2- Top	Phoenix Contact	12	FRONT-MC1,5/12-ST3,81	Encoder 2 Inputs
TB3- Top	Phoenix Contact	3	FRONT-MC1,5/3-ST3,81	Compare Outputs
TB1- Bottom	Phoenix Contact	12	FRONT-MC1,5/12-ST3,81	Encoder 3 Inputs
TB2- Bottom	Phoenix Contact	12	FRONT-MC1,5/12-ST3,81	Encoder 4 Inputs
TB3- Bottom	Phoenix Contact	3	FRONT-MC1,5/3-ST3,81	Compare Outputs
TB1- Front	Phoenix Contact	20	FRONT-MC1,5/20-ST3,81	Flags

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5 Connector Option

Name	Manufacturer	Pins	Type	Details
J1- Top	AMP	15	AMP 745072-2	Encoder 1 Inputs and Compare Outputs
J2- Top	AMP	15	AMP 745072-2	Encoder 2 Inputs and Compare Outputs
J1- Bottom	AMP	15	AMP 745072-2	Encoder 3 Inputs and Compare Outputs
J2- Bottom	AMP	15	AMP 745072-2	Encoder 4 Inputs and Compare Outputs

Indicators

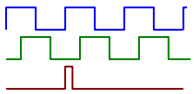
LED	Color	Description
D11	Green	Encoder 1 and 2 Power OK
D12	Green	Encoder 3 and 4 Power OK

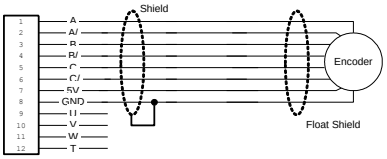
Sample Wiring Diagrams

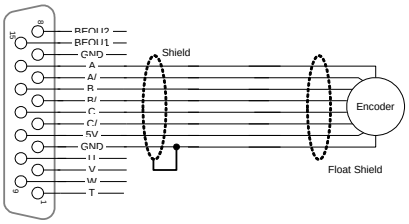
This section has typical wiring diagrams for the TTL level inputs, flags and limits, PFM outputs.

TTL Level Inputs and Outputs

Quadrature Encoders

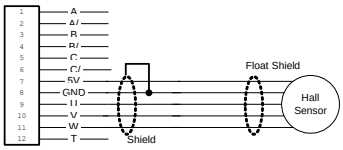


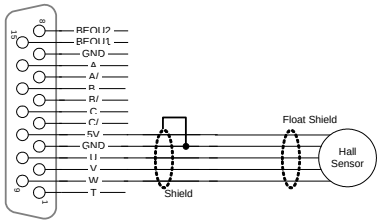




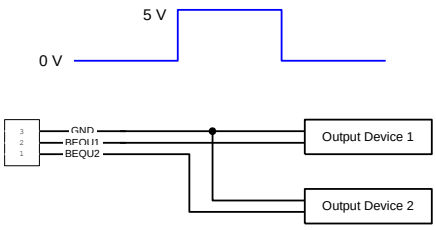
TTL Hall Effect Sensors

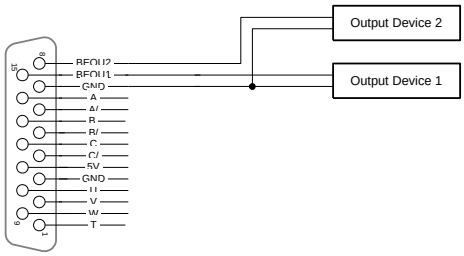






Position Compare Outputs

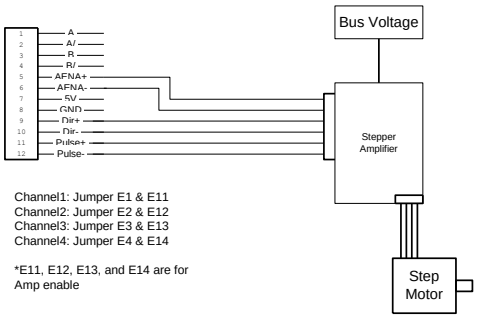




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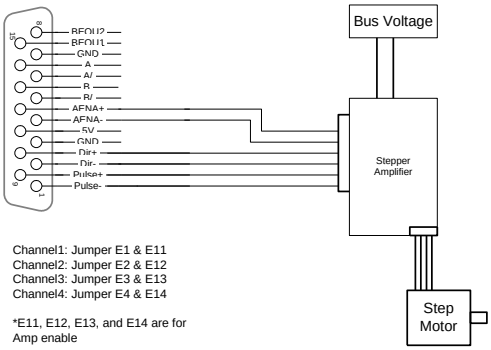
Acc-24E2S Stepper Motor Outputs (TTL level)

ACC-24E2S PFM -Stepper Output



Channel1: Jumper E1 & E11
Channel2: Jumper E2 & E12
Channel3: Jumper E3 & E13
Channel4: Jumper E4 & E14

*E11, E12, E13, and E14 are for Amp enable

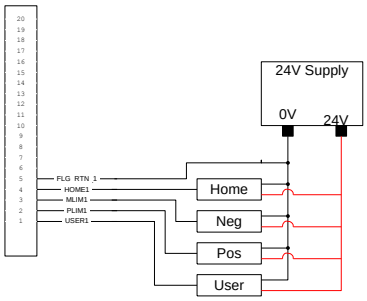


Channel1: Jumper E1 & E11
Channel2: Jumper E2 & E12
Channel3: Jumper E3 & E13
Channel4: Jumper E4 & E14

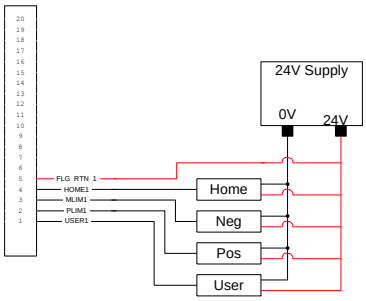
*E11, E12, E13, and E14 are for Amp enable

Position Limits, Home Flag, and User Flag

ACC-24E2S Sourcing Flags



ACC-24E2S Sinking Flags



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UMAC SOFTWARE SETUP

System Configuration I-Variables

Starting in Turbo PMAC firmware version V1.934, the Turbo PMAC determines automatically which Servo and MACRO ICs are present on power-up/reset and enables the I-variables for these ICs.

In previous versions, I65 had to be set manually to tell the Turbo PMAC which ICs were present so that the proper I-variables could be enabled. In V1.934 and newer versions, Turbo PMAC reports which ICs are present in read-only variable I4900. If using a Turbo PMAC with firmware 1.933 and below, refer to the Turbo PMAC Software Reference Manual for a detailed description of these system configuration I-variables.

Servo IC Configuration I-Variables

Turbo PMAC I-variables in the range I7000 – I7999 control the configuration of the Servo ICs. The hundreds digit represents the number of the Servo IC (0 to 9) in the system. Servo ICs 0 and 1 are (or can be) on board the Turbo PMAC board itself. Servo ICs 2 through 9 are (or can be) on external devices such as the Acc-24E2.

Servo IC Numbering

The number m of the Servo IC on the Acc-24E2 board is dependent on the addressing of the board with DIP switches S1-1, S1-3, and S1-4, which place the board as the first through eighth external devices:

- First Acc-24E2 with option 1: Servo IC 2 (channels 1-4)
- Second Acc-24E2 with option 1 Servo IC 3 (channels 5-8)
- Third Acc-24E2 with option 1: Servo IC 4 (channels 9-12)
- Fourth Acc-24E2 with option 1 Servo IC 5 (channels 13-16)
- Fifth Acc-24E2 with option 1: Servo IC 6 (channels 17-20)
- Sixth Acc-24E2 with option 1 Servo IC 7 (channels 21-24)
- Seventh Acc-24E2 with option 1: Servo IC 8 (channels 25-28)
- Eighth Acc-24E2 with option 1 Servo IC 9 (channels 29-32)

The Standard Servo IC on an Acc-24E2 occupies Channels 1 through 4 on the board.

Example: The Standard Servo IC on the first Acc-24E2 is Servo IC 2 to Turbo PMAC and is configured by variables I7200 – I7299.

Servo Channel Numbering

Each Servo IC has four channels of servo interface circuitry. The tens digit n of the I-variable configuring the IC represents the channel number on the IC (n = 1 to 4). For example, Channel 1 of the Standard Servo IC on the first Acc-24E2 is configured by variables I7210 – I7219. These channel-specific I-variables are represented generically as I7mn0 – I7mn9, where m represents the Servo IC number (0 – 9) and n represents the IC channel number (1 – 4).

The Channels 1 – 4 on the Standard Servo IC of an Acc-24E2 correspond to Channels 1 – 4, respectively, on the Acc-24E2 board itself. The Channels 1 – 4 on the Option 1 Servo IC on an Acc-24E2 correspond to Channels 5 – 8, respectively, on the Acc-24E2 board.

I-variables in the I7000s for which the tens digit is 0 (Channel 0) affect all four channels of the PMAC2-style Servo IC on the Acc-24E2. These multi-channel I-variables are represented generically as I7m00 – I7m09.

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Multi-Channel I-Variables

There are several multi-channel I-variables that must be set up properly for proper operation of the Acc-24E2 in a Turbo PMAC system. The most important are:

I7m07: Servo IC m Phase/Servo Clock Direction
This variable should be set to 3 for any Servo IC on an Acc-24E2 so it inputs its phase and servo clocks from signals generated on the Turbo PMAC itself.

I7m00: Servo IC m MaxPhase/PWM Frequency Control
Typically, this will be set to the same value as the variable that controls the system clocks: I7000 on a non-Ultralite Turbo PMAC2, or I6800 on a Turbo PMAC2 Ultralite. If a different PWM frequency is desired, or the Acc-24E2 is used with a Turbo PMAC in which the system clock frequencies are set by jumpers, then the following constraint should be observed in setting this variable:

$$\frac{2 * PWMFreq(kHz)}{PhaseFreq} = \{ Integer \}$$

I7m01: Servo IC m Phase Clock Frequency Control
Even though the IC is receiving an external phase clock (see I7m07, above), usually it is best to create the same internal phase clock frequency in the Servo IC. This yields the following constraint:

$$I7m00 * (I7m01 + 1) = I7000 * (I7001 + 1) \qquad \{\text{Non-Ultralite Turbo PMAC2}\}$$

$$I7m00 * (I7m01 + 1) = I6800 * (I6801 + 1) \qquad \{\text{Turbo PMAC2 Ultralite}\}$$

Solving for I7m01, the result is:

$$I7m01 = \frac{I7000 * (I7001 + 1)}{I7m00} - 1 \qquad \{\text{Non-Ultralite PMAC2}\}$$

$$I7m01 = \frac{I6800 * (I6801 + 1)}{I7m00} - 1 \qquad \{\text{Turbo PMAC2 Ultralite}\}$$

If I7m00 is the same as I7000 or I6800, I7m01 will be the same as I7001 or I6801. If the Acc-24E2 is interfaced to a Turbo PMAC board, it should be set by calculation to obtain the same phase clock frequency as that set by the jumpers on the Turbo PMAC.

I7m02: Servo IC m Servo Clock Frequency Control
Even though the IC is receiving an external servo clock (see I7m07, above), usually it is best to create the same internal servo clock frequency in the Servo IC. This means that I7m02 for the IC should be set the same as I7002 on a non-Ultralite Turbo PMAC2, or the same as I6802 on a Turbo PMAC2 Ultralite. When connected to a Turbo PMAC, I7m02 should create the same division from the phase clock as jumpers E3 – E6 do on the Turbo PMAC.

I7m03: Servo IC m Hardware Clock Frequency Control
The hardware clock frequencies for the Servo IC should be set according to the devices attached to it. There is no reason that these frequencies have to be the same between ICs. There is seldom a reason to change this value from the default.

Single-Channel I-Variables

The single-channel setup I-variables for Channel n of Servo IC m work the same on an Acc-24E2 as they do on a Turbo PMAC2 itself. Each Servo IC has four channels n, numbered 1 to 4. For the first (standard) Servo IC on the Acc-24E2, the channel numbers 1 – 4 on the Servo IC are the same as the channel numbers 1 – 4 on the board. For the second (optional) Servo IC on the Acc-24E2, the channel numbers 1 – 4 on the Servo IC correspond to board channel numbers 5 – 8. The most important variables are:

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I7mn0: Servo IC m Channel n Encoder Decode Control
Typically, I7mn0 is set to 3 or 7 for x4 quadrature decode, depending on which way is up. If the channel is used for open-loop stepper drive, I7mn0 is set to 8 to accept internal pulse-and-direction, or to 0 to accept external pulse-and-direction (e.g. from an Acc-8S). It is set to 12 if the channel is used for MLDT feedback.

I7mn2: Servo IC m Channel n Capture Control
I7mn2 determines whether the encoder index channel, an input flag, or both, are used for the capture of the encoder position.

I7mn3: Servo IC m Channel n Capture Flag Select
I7mn3 determines which input flag is used for encoder capture, if one is used.

I7mn6: Servo IC m Channel n Output Mode Select
I7mn6 determines whether the A and B outputs are DAC or PWM, and whether the C output is PFM (pulse-and-direction) or PWM. Typically, it is set to 0, either for 3-phase PWM, or to 3 for DACs and PFM.

Encoder Conversion Table I-Variables

To use feedback or master position data from an Acc-24E2, entries must be added to the encoder conversion table (ECT) using I-variables I8000 – I8191 to address and process this data. The default conversion table in the Turbo PMAC does not contain these entries; it only contains entries for the eight channels on board the Turbo PMAC.

Usually, the position data obtained through an Acc-24E2 board is an incremental encoder feedback, and occasionally an A/D converter feedback from an Acc-28B board connected through the Acc-24E2.

The ECT entries for Acc-24E2 incremental encoder channels are shown in the following table:

Servo IC #	Chan. 1	Chan. 2	Chan. 3	Chan. 4	Notes
2	$m78200	$m78208	$m78210	$m78218	First Acc-24E2x Channel n Encoder Set
3	$m78300	$m78308	$m78310	$m78318	Second Acc-24E2x Channel n Encoder Set
4	$m79200	$m79208	$m79210	$m79218	Third Acc-24E2x Channel n Encoder Set
5	$m79300	$m79308	$m79310	$m79318	Fourth Acc-24E2x Channel n Encoder Set
6	$m7A200	$m7A208	$m7A210	$m7A218	Fifth Acc-24E2x Channel n Encoder Set
7	$m7A300	$m7A308	$m7A310	$m7A318	Sixth Acc-24E2x Channel n Encoder Set
8	$m7B200	$m7B208	$m7B210	$m7B218	Seventh Acc-24E2x Channel n Encoder Set
9	$m7B300	$m7B308	$m7B310	$m7B318	Eight Acc-24E2x Channel n Encoder Set
The first hexadecimal digit in the entry, represented by m in the table, is a 0 for the most common 1/T timer-based extension of digital incremental encoders; it is an 8 for the parallel-data extension of analog incremental encoders; it is a C for no extension of an incremental encoder.					

Motor Addressing I-Variables

For a Turbo PMAC motor to use the servo interface circuitry of the Acc-24E2, several of the addressing I-variables for the motor must contain the addresses of registers in the Acc-24E2, or the addresses of encoder conversion table registers containing data processed from the Acc-24E2. These I-variables can include:

Ixx02: Motor xx Command Output Address
Ixx02 tells Turbo PMAC where to write its command outputs for Motor xx. If Acc-24E2 is to create the command signals, Ixx02 must contain the address of the register.

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The following table shows the address of the C output register for each channel of each Acc-24E2S. These addresses can be used for single analog outputs, double analog outputs, or direct PWM outputs.

Servo IC #	Chan. 1	Chan. 2	Chan. 3	Chan. 4	Notes
2	$078204	$07820C	$078214	$07821C	1st Acc-24E2x Channel n PFM/PWMnA
3	$078304	$07830C	$078314	$07831C	2nd Acc-24E2x Channel n PFM/PWMnA
4	$079204	$07920C	$079214	$07921C	3rd Acc-24E2x Channel n PFM/PWMnA
5	$079304	$07930C	$079314	$07931C	4th Acc-24E2x Channel n PFM/PWMnA
6	$07A204	$07A20C	$07A214	$07A21C	5th Acc-24E2x Channel n PFM/PWMnA
7	$07A304	$07A30C	$07A314	$07A31C	6th Acc-24E2x Channel n PFM/PWMnA
8	$07B204	$07B20C	$07B214	$07B21C	7th Acc-24E2x Channel n PFM/PWMnA
9	$07B304	$07B30C	$07B314	$07B31C	8th Acc-24E2x Channel n PFM/PWMnA

Ixx03: Motor xx Position-Loop Feedback Address

Ixx04: Motor xx Velocity-Loop Feedback Address

Ixx05: Motor xx Master Position Address

Usually, the Ixx03, Ixx04, and Ixx05 variables contain the address of a processed position value in the encoder conversion table, even when the raw data comes from the Acc-24E2. The first line of the encoder conversion table is at address $003501; the last line is at address $0035C0.

Ixx10: Motor xx Power-On Position Address

Ixx10 tells the Turbo PMAC where to read absolute power-on position, if any. Typically, the only times Ixx10 will contain the address of an Acc-24E2 register is if the position is obtained from an A/D converter on an Acc-28B connected through the Acc-24E2, or if it is obtained from an MLDT (e.g. Temposonics™) sensor excited directly from an Acc-24E2.

The following table shows the possible values of Ixx10 for MLDT timer registers:

Ixx10 for Acc-24E2 MLDT Timer Registers (Ixx95=$170000)

Servo IC #	Chan. 1	Chan. 2	Chan. 3	Chan. 4	Notes
2	$078200	$078208	$078210	$078218	1st Acc-24E2x Channel n Timer
3	$078300	$078308	$078310	$078318	2nd Acc-24E2x Channel n Timer
4	$079200	$079208	$079210	$079218	3rd Acc-24E2x Channel n Timer
5	$079300	$079308	$079310	$079318	4th Acc-24E2x Channel n Timer
6	$07A200	$07A208	$07A210	$07A218	5th Acc-24E2x Channel n Timer
7	$07A300	$07A308	$07A310	$07A318	6th Acc-24E2x Channel n Timer
8	$07B200	$07B208	$07B210	$07B218	7th Acc-24E2x Channel n Timer
9	$07B300	$07B308	$07B310	$07B318	8th Acc-24E2x Channel n Timer

Ixx24: Motor xx Flag Mode

Ixx24 defines how to read and use the flags for Motor xx that are in the register specified by Ixx25. Ixx24 is a set of independent control bits. There are two bits that must be set correctly to use a flag set on an Acc-24E2.

Bit 0 of Ixx24 must be set to 1 to tell the Turbo PMAC that this flag set is in a Type 1 PMAC2-style Servo IC. Bit 18 of Ixx24 must be set to 0 to tell the Turbo PMAC that this flag set is not transmitted over a MACRO ring. Other bits of Ixx24 may be set as desired for a particular application.

Ixx25: Motor xx Flag Address

Ixx25 tells Turbo PMAC where to access its flag data for Motor xx. If Acc-24E2 is interface to the flags, Ixx25 must contain the address of the flag register in Acc-24E2.

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The following table shows the address of the flag register for each channel of each Acc-24E2.

Servo IC #	Chan. 1	Chan. 2	Chan. 3	Chan. 4	Notes
2	$078200	$078208	$078210	$078218	1st Acc-24E2x Channel n Flag Set
3	$078300	$078308	$078310	$078318	2nd Acc-24E2x Channel n Flag Set
4	$079200	$079208	$079210	$079218	3rd Acc-24E2x Channel n Flag Set
5	$079300	$079308	$079310	$079318	4th Acc-24E2x Channel n Flag Set
6	$07A200	$07A208	$07A210	$07A218	5th Acc-24E2x Channel n Flag Set
7	$07A300	$07A308	$07A310	$07A318	6th Acc-24E2x Channel n Flag Set
8	$07B200	$07B208	$07B210	$07B218	7th Acc-24E2x Channel n Flag Set
9	$07B300	$07B308	$07B310	$07B318	8th Acc-24E2x Channel n Flag Set

Ixx81: Motor xx Power-On Phase Position Address

Ixx81 tells Turbo PMAC2 where to read absolute power-on position for motor phase commutation, if any. Typically, it will contain the address of an Acc-24E2 register for only two types of absolute phasing sensors: hall-effect commutation sensors (or their optical equivalents) connected to the U, V, and W input flags on an Acc-24E2 channel, or the encoder counter filled by simulated quadrature from a Yaskawa absolute encoder connected to the Acc-24E2 through an Acc-57E board.

The following table contains the possible settings of Ixx81 to read the encoder counters for Yaskawa absolute encoders:

Turbo PMAC Ixx81 Acc-24E2 Encoder Register Settings (Ix91=$480000 - $580000)

Servo IC #	Chan. 1	Chan. 2	Chan. 3	Chan. 4	Notes
2	$078201	$078209	$078211	$078219	1st Acc-24E2x Channel n Encoder Reg.
3	$078301	$078309	$078311	$078319	2nd Acc-24E2x Channel n Encoder Reg.
4	$079201	$079209	$079211	$079219	3rd Acc-24E2x Channel n Encoder Reg.
5	$079301	$079309	$079311	$079319	4th Acc-24E2x Channel n Encoder Reg.
6	$07A201	$07A209	$07A211	$07A219	5th Acc-24E2x Channel n Encoder Reg.
7	$07A301	$07A309	$07A311	$07A319	6th Acc-24E2x Channel n Encoder Reg.
8	$07B201	$07B209	$07B211	$07B219	7th Acc-24E2x Channel n Encoder Reg.
9	$07B301	$07B309	$07B311	$07B319	8th Acc-24E2x Channel n Encoder Reg.

Ixx83: Motor xx Phase Position Address

Ixx83 tells Turbo PMAC where to get its commutation position feedback every phase update cycle. Usually, this contains the address of an encoder phase position register.

The following table shows the possible values of Ixx83 for Acc-24E2 encoder phase position registers:

Turbo PMAC Ixx83 Acc-24E2 Encoder Register Settings

Servo IC #	Chan. 1	Chan. 2	Chan. 3	Chan. 4	Notes
2	$078201	$078209	$078211	$078219	1st Acc-24E2x Channel n Encoder Reg.
3	$078301	$078309	$078311	$078319	2nd Acc-24E2x Channel n Encoder Reg.
4	$079201	$079209	$079211	$079219	3rd Acc-24E2x Channel n Encoder Reg.
5	$079301	$079309	$079311	$079319	4th Acc-24E2x Channel n Encoder Reg.
6	$07A201	$07A209	$07A211	$07A219	5th Acc-24E2x Channel n Encoder Reg.
7	$07A301	$07A309	$07A311	$07A319	6th Acc-24E2x Channel n Encoder Reg.
8	$07B201	$07B209	$07B211	$07B219	7th Acc-24E2x Channel n Encoder Reg.
9	$07B301	$07B309	$07B311	$07B319	8th Acc-24E2x Channel n Encoder Reg.

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UMAC Turbo Example Setups

The following section shows how to quickly setup the key variables for a stepper motor (PFM) system.

The Acc-24E2S has three modes of outputs which are setup by either the Turbo UMAC or the MACRO CPU. The output modes available for the Acc-24E2S are Direct PWM, DAC, or PFM, but only use the PFM output because of the hardware limitations.

To setup the output mode for the UMAC Turbo, set I7mn6 to the proper value. The Gate Array on the Acc-24E2S has three outputs per channel as shown below:

I7mn6 Setting	A Output	B Output	C Output
I7mn6=0	PWM	PWM	PWM
I7mn6=1	DAC	DAC	PWM
I7mn6=2	PWM	PWM	PFM
I7mn6=3	DAC	DAC	PFM

For this example, the factory defaults for the other variables will allow the PFM outputs to be commanded with a low true Amplifier Fault and ±Limits plugged in. If this is not the case, modify Ixx24.

Example: 4-axis PFM from base address $078200 (servo IC2). Jumpers E1 through E4 must be set to 1-2 on Acc-24E2S for PFM outputs and E11 through E14 must be jumpered for amplifier enable outputs. Assume that not all stepper motors have encoders for feedback.

For this type of system, make sure I7mn6 is set for DAC and PFM output mode.

```
I7216=3     ;CH1A and CH1B ouputs will be DAC and CH1C output will be PFM
I7226=3     ;CH2A and CH2B ouputs will be DAC and CH2C output will be PFM
I7236=3     ;CH3A and CH3B ouputs will be DAC and CH3C output will be PFM
I7246=3     ;CH4A and CH4B ouputs will be DAC and CH4C output will be PFM

I7210 = 8          ;Simulated feedback for channel 1
I7220 = 8          ;Simulated feedback for channel 2
I7230 = 8          ;Simulated feedback for channel 3
I7240 = 8          ;Simulated feedback for channel 4

I102=$078204      ;Command output  to CH1A address (default address + 2) for
                  ;Stepper
I202=$07820C      ;Command output  to CH2A address (default address + 2)
                  ;for Stepper
I302=$078214      ;Command output  to CH3C address (default address + 2)
                  ;for Stepper
I402=$07821C      ;Command output  to CH4C address (default address +2)
                  ;for Stepper
```


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ULTRALITE/MACRO STATION SETUP

The Acc-24E2 family of JEXP accessories also can be used with MACRO Station to breakout the standard amplifier, flag, and encoder signals. The gate arrays on the Acc-24E2 family of accessories are located in the traditional channel 9-16 locations of the PMAC2 memory map.

Note:

In order for the MACRO Station to setup its output and input channels automatically, MACRO Station firmware 1.114 or greater must be used.

Currently there are three types of Acc-24Es to be used with the MACRO Station:

Acc-24E2	Direct PWM commutation outputs
Acc-24E2A	±10V Outputs for torque, velocity and sinusoidal input amplifiers
Acc-24E2S	Dedicated 4-channel stepper interface card

MACRO Station Gate Array Locations for Acc-24E2

Chan #	9	10	11	12	13	14	15	16
Hex	[$C040]	[$C048]	[$C050]	[$C058]	[$C060]	[$C068]	[$C070]	[$C078]

Hardware Setup for MACRO Station Use

A few hardware selections must be set in order to use this accessory with the MACRO Station:

E5	Jumper 1-2 for MACRO or Turbo communications (603804-105 and above)
E16	Jumper 1-2 for Clock Settings
SW1	SW1-1 and SW1-2 both on for $C040, both off for $C060 SW1-3 through SW1-6 set to off

Node-Specific Gate Array MI-variables

MI-variables MI910 through MI919 on the MACRO station control the hardware setup of the hardware interface channel on the station associated a MACRO node. The matching of hardware interface channels to MACRO nodes is determined by the setting of the SW1 rotary switch on the CPU/Interface Board of the MACRO station.

These variables are accessed using the MS station auxiliary read and write commands. The number immediately after the MS specifies the node number, and therefore the channel number mapped to that node by the SW1 setting.

Encoder/Timer n Decode Control (MSn,MI910)

MI910 controls how the input signal for the encoder mapped to the specified node is decoded into counts. As such, this defines the sign and magnitude of a count. The following settings may be used to decode an input signal.

0: Pulse and direction CW
1: x1 quadrature decode CW
2: x2 quadrature decode CW
3: x4 quadrature decode CW
4: Pulse and direction CCW
5: x1 quadrature decode CCW
6: x2 quadrature decode CCW
7: x4 quadrature decode CCW
8: Internal pulse and direction
9: Not used
10: Not used

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11: Not used
12: MLDT pulse timer control
(Internal pulse resets timer; external pulse latches timer)
13: Not used
14: Not used
15: Not used

In any of the quadrature decode modes, PMAC is expecting two input waveforms on CHAn and CHBn, each with approximately 50% duty cycle, and approximately one-quarter of a cycle out of phase with each other. Times-one (x1) decode provides one count per cycle; x2 provides two counts per cycle; and x4 provides four counts per cycle. Select x4 decode to get maximum resolution.

The clockwise (CW) and counterclockwise (CCW) options simply control which direction counts up. If it is the wrong direction sense, simply change to the other option (e.g. from 7 to 3 or vice versa).

Warning:

If the direction sense of an encoder with a properly working servo is changed without also changing the direction sense of the output, destabilizing positive feedback to the servo and a dangerous runaway condition will result.

In the pulse-and-direction decode modes, PMAC is expecting the pulse train on CHAn, and the direction (sign) signal on CHBn. If the signal is unidirectional, the CHBn line can be allowed to pull up to a high state, or it can be hardwired to a high or low state.

If MI910 is set to 8, the decoder inputs the pulse and direction signal generated by Channel n's pulse frequency modulator (PFM) output circuitry. This permits the Compact MACRO Station to create a phantom closed loop when driving an open-loop stepper system. No jumpers or cables are needed to do this; the connection is entirely within the ASIC. The counter polarity matches the PFM output polarity automatically.

If MI910 is set to 12, the timer circuitry is set up to read magnetostrictive linear displacement transducers (MLDTs) such as Temposonics™. In this mode, the timer is cleared when the PFM circuitry sends out the excitation pulse to the sensor on PULSEn, and it is latched into the memory-mapped register when the excitation pulse is received on CHAn.

Flag Capture Control (MSn,MI911-MI913)

The flag capture registers must also be setup at the MACRO Station to for proper homing, encoder capturing, and setting compare outputs.

MI911 determines which encoder input the position compare circuitry for the machine interface channel mapped to the specified node uses.

`MSn,MI911=0`	Use channel n encoder counter for position compare function
`MSn,MI911=1`	Use first encoder counter on IC (encoder 1 for channels 1 to 4; encoder 5 for channels 5 to 8) for position compare function

When MI911 is set to 0, the channel's position compare register is tied to the channel's own encoder counter, and the position compare signal appears only on the EQUn output.

When MI911 is set to 1, the channel's position compare register is tied to the first encoder counter on the ASIC (Encoder 1 for channels 1-4, Encoder 5 for channels 5-8, or Encoder 9 for channels 9-10) and the position compare signal appears both on EQUn, and combined into the EQU output for the first channel on the IC (EQU1 or EQU5); executed as a logical OR.

MI911 for the first channel on an ASIC performs no effective function, so is always 1. It cannot be set to 0.

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MI912 determines which signal or combination of signals, and which polarity, triggers a position capture of the counter for the encoder mapped to the specified node. If a flag input (home, limit, or user) is used, MI913 for the node determines which flag. Proper setup of this variable is essential for a successful home search, which depends on the position-capture function. The following settings may be used:

0: Capture under software control (armed)
1: Capture on Index (CHCn) high
2: Capture on Flag high
3: Capture on (Index high AND Flag high)
4: Capture under software control (latched)
5: Capture on Index (CHCn) low
6: Capture on Flag high
7: Capture on (Index low AND Flag high)
8: Capture under software control (armed)
9: Capture on Index (CHCn) high
10: Capture on Flag low
11: Capture on (Index high AND Flag low)
12: Capture under software control (latched)
13: Capture on Index (CHCn) low
14: Capture on Flag low
15: Capture on (Index low AND Flag low)

The trigger is armed when the position capture register is read. After this, as soon as the Compact MACRO Station sees that the specified input lines are in the specified states, the trigger will occur — it is level-trigger, not edge-triggered.

MI913 parameter determines which of the Flag inputs will be used for position capture (if one is used — see MI912):

0: HMFLn (Home Flag n)
1: PLIMn (Positive End Limit Flag n)
2: MLIMn (Negative End Limit Flag n)
3: USERn (User Flag n)

Typically, this parameter is set to 0 or 3, because in actual use, the LIMn flags create other effects that usually interfere with what is trying to be accomplished by the position capture. To capture on the LIMn flags, disable their normal functions with Ix25, or use a channel n where none of the flags is used for the normal axis functions.

Output Mode Select (MSn,MI916)

The Acc-24E2 family of boards can be used for multiple mode outputs. At the MACRO Station, the output mode must be set up on MACRO Station variable MSn,MI916. The table below shows the output modes available for each of the Acc-24E2 boards. The output mode select will be set up automatically if using either the P2Setup or the Turbo Setup programs.

Board	Direct PWM Mode	DAC Mode	Pulse and Direction
Acc-24E2	Yes	No	Yes
Acc-24E2A	No	Yes	Yes
Acc-24E2S	No	No	Yes

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The PMAC2 Style outputs allow the PMAC to control up to three individual output channels based on the mode. These outputs are described as output A, output B, and output C.

MSn, MI916	Output Description	Typical Use
0	A, B, and C are PWM	Direct PWM Mode only
1	A and B are DAC, C is PWM	±10V Outputs for torque, velocity and sinusoidal input amplifiers
2	A and B are PWM, C is PFM	Stepper Systems
3	A and B are DAC, C is PFM	±10V Outputs with MLDT Feedback
The default output at the MACRO Station is PWM (MSn,I916=0).		

MACRO Station Encoder Conversion Table (MSn,MI120-MI151)

At power-up, the MACRO Station will set up all of the key memory locations and MI-Variables automatically based on the SW1 connector and firmware of the MACRO Station. The key variables setup at power-up are the encoder conversion table, servo output registers, and flag input registers.

Encoder Conversion Table for Acc-24E2 at MACRO Station

```
MS0,MI120=$00C040       ;output at X:$0010 at MACRO Station (encoder 1)
MS0,MI121=$00C048       ;output at X:$0011 at MACRO Station (encoder 2)
MS0,MI122=$00C050       ;output at X:$0012 at MACRO Station (encoder 3)
MS0,MI123=$00C058       ;output at X:$0013 at MACRO Station (encoder 4)
MS0,MI120=$00C060       ;output at X:$0014 at MACRO Station (encoder 5)
MS0,MI121=$00C068       ;output at X:$0015 at MACRO Station (encoder 6)
MS0,MI122=$00C070       ;output at X:$0016 at MACRO Station (encoder 7)
MS0,MI123=$00C078       ;output at X:$0017 at MACRO Station (encoder 8)
```

Using Acc-24E2S with the MACRO Station/Ultralite or Turbo Ultralite Change Output Mode to PFM on the Third Channel

`MSn, MI916 = 2 or 3`

1. Change Encoder decode to read Pulse and Direction (if using simulated feedback): **`MSn, MI910 = 8`**
2. Change PID gains as specified in the Acc-24E2S Manual.
3. Change Motor Command Output Address at the Ultralite (Ix02) or Turbo Ultralite (Ixx02) to pulse and direction output.

PMAC2 Ultralite

Motor	Node	Address	Motor	Node	Address
1	0	$C0A2	5	8	$C0B2
2	1	$C0A6	6	9	$C0B6
3	4	$C0AA	7	12	$C0BA
4	5	$C0AE	8	13	$C0BE

PMAC2 Turbo Ultralite MACRO IC0

Motor	Node	Address	Motor	Node	Address
1	0	$078422	5	8	$078432
2	1	$078426	6	9	$078436
3	4	$07842A	7	12	$07843A
4	5	$07842E	8	13	$07843E

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PMAC2 Turbo Ultralite MACRO IC1

Motor	Node	Address	Motor	Node	Address
9	16	$079422	13	24	$079432
10	17	$079426	14	25	$079436
11	20	$07942A	15	28	$07943A
12	21	$07942E	16	29	$07943E

PMAC2 Turbo Ultralite MACRO IC2

Motor	Node	Address	Motor	Node	Address
17	32	$07A422	21	40	$07A432
18	33	$07A426	22	41	$07A436
19	36	$07A42A	23	44	$07A43A
20	37	$07A42E	24	45	$07A43E

PMAC2 Turbo Ultralite MACRO IC3

Motor	Node	Address	Motor	Node	Address
25	48	$07B422	29	56	$07B432
26	49	$07B426	30	57	$07B436
27	52	$07B42A	31	60	$07B43A
28	53	$07B42E	32	61	$07B43E

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MOTOR PARAMETER SETUP FOR UMAC AND MACRO

The motor parameter setup is identical for both the Turbo PMAC and the Ultralite/MACRO Station systems. The key motor parameters to setup are the maximum pulse frequency output and the PID gains.

Ix69 is the motor x output command limit for motor number x. For stepper motor systems, this parameter defines the magnitude of the largest number that may be placed into the PFM register for output pulse frequency. If the PMAC2 calculates a larger number than Ix69's value, the number will be clipped to the limiting value and the result of a limited output value will be a larger following error.

The default value appears to exceed most requirements for stepper motor applications, but the maximum pulse rate should be limited near the end of the setup process.

The formula for setting Ix69 is:

$$Ix69 = \frac{MasFrequency(KHz, MHz)}{PFMClock(KHz, MHz} x65536$$

The default setting for Ix69 is 20480 and the default PFM clock setting is set to approximately 9.8304 MHz. Using the default values and solving for Max Frequency, a maximum frequency output would be 3.0719 MHz. Putting a cap on the pulse output rate may keep the stepper system from exceeding its maximum step rate, which will help keep the motor from losing sync with the PMAC2.

PMAC2 Motor Servo Gain I-Variables for Stepper Motors

The PMAC2 applies its gain formulas for stepper motor systems the same way it does for a classic servo system. The basic difference with a stepper system is that the typical encoder feedback interface is handled using electronic circuitry rather than a physical encoder.

The PMAC2 Stepper interface allows the use of both an electronic encoder feedback and/or physical encoder feedback (depending upon the hardware settings). When used with an actual physical encoder, the axis should be tuned as if it were a typical servo motor.

The process of tuning the simulated feedback loop is identical to tuning a servo motor except that some of the parameters become more predictable:

Ix30 Motor x Proportional Gain

To create a closed loop position response with a natural frequency of approximately 25Hz and a damping ratio of 1, use the following calculation:

$$Ix30 = \frac{660000}{Ix08 x PFMClock(MHz)}$$

Example: PFMCLK is set to default of 9.83 MHz, and Ix08 is set to default of 96.

```
Ix30 = 660,000 / (96 * 9.83) = 700.
```

Ix31 Motor x Derivative Gain

Derivative Gain is set to 0 because the motor system behaves like a velocity-loop servo drive. This parameter sets the system damping which should be unnecessary.

Ix32 Motor x Velocity Feedforward Gain

Use the following equation to establish a value for Ix32:

$$Ix32 = 6660 x ServoFreq(kHz)$$

ServoFreq (kHz) is the frequency of the servo interrupt as established by I900, I901, and I902.

Example: ServoFreq is set to default of 2.258 kHz (I900 = 6527, I901 = 0, I902 = 3).

```
Ix32 = 6660 ×2.258 ≈15,050.
```


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Note:

If Ix30 were set differently than the above calculation, then Ix32 would change inversely. For instance, if Ix30 were twice the above calculation, then Ix32 would be half its calculation.

Ix33 Motor x Integral Gain

Typically, this I-variable should be set to 0. The digital electronic loop does not present offsets or disturbances, which need correction in the PMAC2.

It is possible that Ix33 might be set to force zero steady-state errors, if they are present with electronic encoder feedback.

Ix34 Motor x Integration Mode

The default value of 1 is sufficient for this since usually Ix33 is set to zero. When Ix33 is set to 0, this I-variable has no effect.

Ix35 Motor x Acceleration Feedforward Gain

This I-variable is set to 0. Typically, this value does not need to be changed. However, Ix35 might be adjusted to compensate for the minor delays created by the electronics when accelerating the stepper.

The effect of adjusting Ix35 will be to reduce a slight following error during motor acceleration.

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MLDT FEEDBACK FOR UMAC-TURBO & UMAC-MACRO

The Acc-24E2S can provide direct interface to magnetostrictive linear displacement transducers (MLDTs) through its encoder connectors. This interface is for MLDTs with an external excitation format (often called RS-422 format because of the signal levels). The Acc-24E2S provides the excitation pulse, and receives the echo pulse, both with RS-422 signal formats.

This section provides basic information for using MLDTs with the Acc-24E2S. More information can be found in the User Manuals for the Turbo PMAC or the MACRO Station.

MLDT Hardware Setup of the Acc-24E2S

The Acc-24E2S must be set up to output the differential pulse on what is normally the T and W input flags on the encoder connector. This is done by setting the jumper setting to 1-2 on E-points E1 for channel 1, E2 for channel 2, E3 for channel 3, and E4 for channel 4. These jumpers are set to 1-2 configuration by default.

The PULSE+ (high during the pulse) and PULSE- (low during the pulse) outputs from the encoder connector are connected to the differential pulse inputs on the MLDT. The echo pulse differential outputs from the MLDT are connected to the CHA+ and CHA- input pins on the same encoder connector.

If the MLDT uses RPM format, in which there is a brief start echo pulse, and a brief stop echo pulse, the "+" output from the MLDT should be connected to the CHA+ input on the Acc-24E2S, and the "-" output should be connected to the CHA- input.

If the MLDT uses DPM format, in which there is a single long echo pulse, with the delay to the trailing edge measuring the position, the "+" output from the MLDT should be connected to the CHA- input on the Acc-24E2S, and the "-" output should be connected to the CHA+ input.

MLDT Software Setup of the UMAC Turbo

When the Acc-24E2S is used for MLDT feedback in a UMAC Turbo system, a few I-variables must be set up properly.

Hardware Setup I-Variables for Servo IC m

I7m03 (PFM Clock Frequency): In almost all cases, the clock frequency driving the pulse-generation circuitry for all channels on Servo IC m can be left at its default value of 9.83 MHz (0.102 μsec). I7m03 also controls other clock signal, has a default value of 2258 and rarely needs to be changed.

I7m04 (PFM Pulse Width): The pulse width, set by I7m04 in units of PFM clock cycles must be set long enough for the MLDT to see, and long enough to contain the rising edge of the RPM start echo pulse, or the rising edge of the single DPM echo pulse. For example, if this edge can come up to 2 μsec after the start of the excitation pulse, and the PMAC clock cycle is at its default of about 0.1 μsec, then I7m04 must be set at least to 20.

I7mn6 (Output Format Select): For Servo IC m Channel n to be used for MLDT feedback, I7mn6 must be set to 1 or 3 for the C sub-channel to be used for PFM-format output. On an Acc-24E2A, I7mn6 must then be set to 3 for the A and B sub-channels to be used for DAC-format output.

I7mn0 (MLDT Feedback Select): For Servo IC m Channel n to be used for MLDT feedback, I7mn0 must be set to 12. In this mode, the pulse timer is cleared on the output pulse, and latched on the echo pulse, counting in between at 117.96 MHz.

Conversion Table Processing I-Variables

The pulse timer for Servo IC m Channel n holds a number proportional to the time and therefore the position. This must be processed in the conversion table before it can be used by the servo loop. It is best to use the filtered parallel data conversion, a 3-line entry in the table (three consecutive I-variables).

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Line 1 (Method and Address): This 24-bit value (6 hex digits) should begin with a 3 (filtered parallel data) followed by the address of the timer register. The possible values for this line are shown in the following table:

Encoder Conversion Table Parallel Filtered Data Format First Line for Acc-24E2S Boards with Servo IC m Channel n

Acc-24 #	Servo IC #	Channel 1	Channel 2	Channel 3	Channel 4
1A	2	$378200	$378208	$378210	$378218
1B	3	$378300	$378308	$378310	$378318
2A	4	$379200	$379208	$379210	$379218
2B	5	$379300	$379308	$379310	$379318
3A	6	$37A200	$37A208	$37A210	$37A218
3B	7	$37A300	$37A308	$37A310	$37A318
4A	8	$37B200	$37B208	$37B210	$37B218
4B	9	$37B300	$37B308	$37B310	$37B318

Line 2 (Width and Start): This 24-bit value should be set to $013000 to specify the use of 19 bits ($013) starting at bit 0.

Line 3 (Max Change): This 24-bit value should be set to a value slightly greater than the maximum true velocity ever expected, expressed in timer LSBs per servo cycle. With a typical MLDT, the 117.96 MHz timer LSB represents 0.024 mm (0.00094 inches); the default servo cycle is 0.442 msec.

The result of this conversion is in the X-register of the third line. Any functions using this value should address this register. For example, if this were the first entry in the table, which starts at $003501, the result would be in X:$003503.

Motor I-Variables

Ixx03 (Position Loop Feedback Address)
To use the result of the conversion table for position-loop feedback for Motor xx, Ixx03 should contain the address of the result register in the conversion table - $003503 in the above example.

Ixx04 (Velocity Loop Feedback Address)
To use the result of the conversion table for velocity-loop feedback for Motor xx, Ixx04 should contain the address of the result register in the conversion table - $003503 in the above example.

Ixx05 (Master Position Address)
To use the result of the conversion table for the master position for Motor xx, Ixx05 should contain the address of the result register in the conversion table - $003503 in the above example.

Ixx10 and Ixx95 (Power-On Position Address and Format)
To use the MLDT for absolute power-on position for Motor xx, Ixx95 should be set to $180000 (up to 24 bits of parallel Y-data) and Ixx10 should be set to the address of the timer register used:

Ixx10 for Acc-24E2A MLDT Timer Registers (Ixx95=$180000)

Acc-24 #	Servo IC #	Channel 1	Channel 2	Channel 3	Channel 4
1A	2	$078200	$078208	$078210	$078218
1B	3	$078300	$078308	$078310	$078318
2A	4	$079200	$079208	$079210	$079218
2B	5	$079300	$079308	$079310	$079318
3A	6	$07A200	$07A208	$07A210	$07A218
3B	7	$07A300	$07A308	$07A310	$07A318
4A	8	$07B200	$07B208	$07B210	$07B218
4B	9	$07B300	$07B308	$07B310	$07B318

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Ixx80 (Power-On Mode)
Set Ixx80 to 4 to delay the absolute power-on position read until the pulse-output frequency can be set.

Ixx81 and Ixx91 (Power-On Phase Position Address and Format)
Occasionally the MLDT is used to establish an absolute phase reference position for Turbo-PMAC-commutated motors. In this case, Ixx81 and Ixx91 are set to the same values as Ixx10 and Ixx95, respectively (see above).

Pulse Output Frequency

The pulse-output frequency is established by assigning an M-variable to the C sub-channel command register, and writing a value to that M-variable after every power-up/reset. The suggested M-variable for the Motor xx using this register is:

```
Mxx07->Y:{address},8,16,S
```

where **{address}** is specified according to the following table:

Mxx07 for Acc-24E2S MLDT Pulse-Output Registers

Acc-24 #	Servo IC #	Channel 1	Channel 2	Channel 3	Channel 4
1A	2	$078204	$07820C	$078214	$07821C
1B	3	$078304	$07830C	$078314	$07831C
2A	4	$079204	$07920C	$079214	$07921C
2B	5	$079304	$07930C	$079314	$07931C
3A	6	$07A204	$07A20C	$07A214	$07A21C
3B	7	$07A304	$07A30C	$07A314	$07A31C
4A	8	$07B204	$07B20C	$07B214	$07B21C
4B	9	$07B304	$07B30C	$07B314	$07B31C

The frequency of the pulse output should produce a period just slightly longer than the longest expected response time for the echo pulse. For MLDTs, the response time is approximately 0.35 μsec/mm (9 μsec/inch). On an MLDT 1500 mm (~60 in) long, the longest response time is approximately 540 μsec; a recommended period between pulse outputs for this device is 600 μsec, for a frequency of 1667 Hz.

To produce the desired pulse output frequency, the following formula can be used (assuming a 16-bit M-variable definition):

$$OutputFreq(kHz) = \frac{Mxx07}{65{,}536} PFMCLK_Freq(kHz)$$

or:

$$Mxx07 = 65{,}536 * \frac{OutputFreq(kHz)}{PFMCLK_Freq(kHz)}$$

To produce a pulse output frequency of 1.667 kHz with the default PFMCLK frequency of 9.83 MHz, calculate:

$$Mxx07 = 65536 * \frac{1.667}{9{,}380} \cong 11$$

To write this value to the register, a power-on PLC routine is suggested; this can also be done with on-line commands from the host computer. Sample PLC code to do this for Channel 1, using the above example value, is:

```
OPEN PLC 1                    ; PLC 1 is first program to execute
CLEAR
  M107=11                     ; Set pulse frequency
  CMD"$*"                     ; Absolute Position Read
DISABLE PLC 1                 ; So will not execute again
CLOSE
```


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PMAC2/Turbo PMAC2 Conversion Table and Motor I-Variables

Once the MACRO Station has been set up to process the MLDT feedback, the PMAC2 or Turbo PMAC2 can process the ongoing position feedback with its conversion table, Ix03, and Ix04 just as for any other feedback from a MACRO Station.

If the MLDT is used for absolute power-on position for the servo loop, the proper variables must be set on the PMAC2 or Turbo PMAC2:

PMAC2 Ix10 (Power-On Position Address and Format)
To get the absolute position in this format for Motor x through MACRO node n (n = 0 to 15 decimal), Ix10 should be set to $74000n, where n here is the hexadecimal representation of the node number (n = 0 to F hex).

Turbo PMAC2 Ixx10 and Ixx95 (Power-On Position Address and Format)
To get the absolute position for Motor xx through MACRO node n (n = 0 to 63 decimal), Ixx10 should be set to n; in hex-format $0000nn, where nn is the hexadecimal representation of the node number (nn = 00 to 3F hex). If node 0 is used, Ixx10 should be set to $000100 (256 decimal). Ixx95 should be set to $740000 to specify parallel data through a MACRO node.

If the MLDT is used for absolute power-on phase position for commutation, the proper variables must be set on the PMAC2 or Turbo PMAC2:

PMAC2 Ix81 (Power-On Phase Position Address and Format)
To get the absolute phase position in this format for Motor x through MACRO node n (n = 0 to 15 decimal), Ix81 should be set to $74000n, where n is the hexadecimal representation of the node number (n = 0 to F hex).

Turbo PMAC2 Ixx81 and Ixx91 (Power-On Phase Position Address and Format)
To get the absolute phase position for Motor xx through MACRO node n (n = 0 to 63 decimal), Ixx81 should be set to n; in hex-format $0000nn, where nn is the hexadecimal representation of the node number (nn = 00 to 3F hex). If node 0 is used, Ixx81 should be set to $000100 (256 decimal). Ixx91 should be set to $740000 to specify parallel data through a MACRO node.

MLDT Feedback for UMAC-MACRO

The data from the MLDT is processed as a parallel word input at the MACRO Station and then transmitted back to the Ultralite using the traditional Servo Node. The encoder conversion table at the MACRO Station must be modified to process this data. From the Ultralite standpoint, nothing must be modified to read the position and velocity data.

Since the data is absolute, the data can be sent at the Ultralite also as absolute data for correct position at power-up. This is accomplished with the proper setup of MSn,MI11x at the MACRO Station, and Ix10 at the Ultralite or Ix10 and Ix95 with the Turbo Ultralite. Regardless of the type of Ultralite, retrieving the power-on-position is the same. The information must be retrieved from MACRO Station variable MSn,MI920 for each node transfer as specified by Ix10 at the Ultralite. MSn,MI920 does not have to be set up because the MACRO Station will place the power-on position in the appropriate register at power-up.

MLDT Software Setup of the UMAC MACRO

When the Acc-24E2S is used for MLDT feedback in a UMAC MACRO system, there are a few MI-variables in the MACRO Station, and a few in the PMAC2 or Turbo PMAC2 driving the Station, that must be set up properly.

Station Hardware Setup I-Variables for Servo IC

MS{anynode},MI903/MI907 (PFM Clock Frequency)
In almost all cases, the clock frequency driving the pulse-generation circuitry for all channels on the Servo IC can be left at its default value of 9.83 MHz (0.102 μsec). Few will need to change MI903/MI907, which also controls other clock signals, from its default value of 2258.

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MS{anynode},MI904/MI908 (PFM Pulse Width)
The pulse width, set by MI904/MI908 in units of PFM clock cycles must be set long enough for the MLDT to see, and long enough to contain the rising edge of the RPM start echo pulse, or the rising edge of the single DPM echo pulse. For example, if this edge can come up to 2 μsec after the start of the excitation pulse, and the PMAC clock cycle is at its default of about 0.1 μsec, then I7m04 must be set at least to 20.

MS{node},MI916 (Output Format Select)
For the channel associated with this node to be used for MLDT feedback, MI916 must be set to 1 or 3 for the C sub-channel to be used for PFM-format output. On an Acc-24E2A, I7mn6 must then be set to 3 for the A and B sub-channels to be used for DAC-format output.

MS{node},MI910 (MLDT Feedback Select)
For the channel associated with this node to be used for MLDT feedback, MI910 must be set to 12. In this mode, the pulse timer is cleared on the output pulse, and latched on the echo pulse, counting in between at 117.96 MHz.

Station Conversion Table Processing I-Variables

The pulse timer for Servo IC m Channel n holds a number proportional to the time and therefore the position. This must be processed in the conversion table before it can be used by the servo loop. It is best to use the filtered parallel data conversion, a 3-line entry in the table (three consecutive MI-variables). The MI-variables for the conversion table start at MI120.

Line 1 (Method and Address)
This 24-bit value (6 hex digits) should begin with a 3 (filtered parallel data) followed by the address of the timer register. The possible values for this line are shown in the following table:

Encoder Conversion Table Parallel Filtered Data Format First Line for Acc-24E2A Boards

Acc-24 #	Channel 1	Channel 2	Channel 3	Channel 4
1	$30C040	$30C048	$30C050	$30C058
2	$30C060	$30C068	$30C070	$30C078

Line 2 (Bits Used Mask)
This 24-bit value should be set to $07FFFF to specify the use of the low 19 bits of the 24-bit source word.

Line 3 (Max Change)
This 24-bit value should be set to a value slightly greater than the maximum true velocity ever expected, expressed in timer LSBs per servo cycle. With a typical MLDT, the 117.96 MHz timer LSB represents 0.024 mm (0.00094 inches); the default servo cycle is 0.442 msec.

The result of this conversion is in the X-register of the third line. Any functions using this value should address this register. For example, if this were the first entry in the table, which starts at $000010, the result would be in X:$0012.

Station Motor Node I-Variables

MS{anynode}, MI10x (xth Motor Node Position Loop Feedback Address)
To use the result of the conversion table for position-loop feedback for the xth motor node, MI10x should contain the address of the result register in the conversion table - $0012 in the above example.

MS{anynode}, MI11x (xth Motor Node Absolute Position Address)
To use the MLDT for absolute power-on position for the xth motor node, set MI11x to $18xxxx (up to 24 bits of parallel Y-data) from Station address xxxx, where xxxx is the address of the timer register.

MS{anynode},MI11x xth Motor Node Absolute Position

Acc-24 #	Channel 1	Channel 2	Channel 3	Channel 4
1	$30C042	$30C04A	$30C052	$30C05A
2	$30C062	$30C06A	$30C072	$30C07A

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MS{anynode}, MI16x (xth Motor Node MLDT Frequency Control)
This variable establishes the frequency of the excitation pulse sent to the MLDT. Its value is written automatically to the full 24-bit C sub-channel command register for the channel assigned to this node, so the PFM circuit will create a pulse train at this frequency.

To compute the output frequency as a function of MI16x, the following formula can be used:

$$OutputFreq(kHz) = \frac{MI16x}{16{,}777{,}216} PFMCLK_Freq(kHz)$$

To compute the required value of MI16x as a function of the desired output frequency, the following formula can be used:

$$MI16x = 16{,}777{,}216 * \frac{OutputFreq(kHz)}{PFMCLK_Freq(kHz)}$$

Power-On Feedback Address for PMAC2 Ultralite

Both the Ultralite and the Turbo Ultralite can obtain absolute position at power up or upon request (#n$*). The Ultralite must have Ix10 setup and the Turbo Ultralite needs both Ixx10 and Ixx95 setup to enable this power on position function. For power on position reads as specified in this document, MACRO firmware version 1.114 or newer is needed, the Turbo Ultralite firmware must be 1.936 or newer, and the standard Ultralite must have firmware version 1.16H or newer.

Ix10 permits an automatic read of an absolute position sensor at power-on/reset. If Ix10 is set to 0, the power-on/reset position for the motor will be considered to be 0, regardless of the type of sensor used. There are specific settings of PMAC's/PMAC2's Ix10 for each type of MACRO interface. If a Turbo Ultralite is used, Ixx95 must also be set appropriately. The Compact MACRO Station has a corresponding variable I11x for each node that must be set.

Absolute Position for Ultralite

Compact MACRO Station Feedback Type (firmware version 1.16H and above)	Ix10 (Unsigned)	Ix10 (Signed)
Acc-8D Opt 7 Resolver/Digital Converter	$73000n	$F3000n
Acc-8D Opt 9 Yaskawa Absolute Encoder Converter	$72000n	$F2000n
Acc-8D Opt 10 Sanyo Absolute Encoder Converter	$74000n	$F4000n
Acc-28B or Acc-28E Analog/Digital Converter	$74000n	$F4000n
MACRO Station Option 1C/Acc-6E A/D Converter	$74000n	$F4000n
MACRO Station Parallel Input	$74000n	$F4000n
MACRO Station MLDT Input	$74000n	$F4000n
n is the MACRO node number used for Motor x: 0, 1, 4, 5, 8, 9, C(12), or D(13).		

Absolute Position for Turbo Ultralite (Ixx95=$720000 - $740000, $F20000 - $F40000)
Addresses are MACRO Node Numbers

MACRO Node Number	Ixx10 for MACRO IC 0	Ixx10 for MACRO IC 1	Ixx10 for MACRO IC 2	Ixx10 for MACRO IC 3
0	$000100	$000010	$000020	$000030
1	$000001	$000011	$000021	$000031
4	$000004	$000014	$000024	$000034
5	$000005	$000015	$000025	$000035
8	$000008	$000018	$000028	$000038
9	$000009	$000019	$000029	$000039
12	$00000C	$00001C	$00002C	$00003C
13	$00000D	$00001D	$00002D	$00003D

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Compact MACRO Station Feedback Type	Ixx95 (Unsigned)	Ixx95 (Signed)
Acc-8D Opt 7 Resolver/Digital Converter	$730000	$F30000
Acc-8D Opt 9 Yaskawa Absolute Encoder Converter	$720000	$F20000
Acc-8D Opt 10 Sanyo Absolute Encoder Converter	$740000	$F40000
Acc-28B Analog/Digital Converter	$740000	$F40000
MACRO Station Option 1C/Acc-6E A/D Converter	$740000	$F40000
MACRO Station Parallel Input, MLDT, SSI	$740000	$F40000

When PMAC or PMAC2 has Ix10 set to get absolute position over MACRO, it executes a station auxiliary read command MS{node},I920 to request the absolute position from the Compact MACRO Station. The station then references its own I11x value to determine the type, format, and address of the data to be read.

MACRO Parallel Absolute Position Setup

MI111 through MI118 (MI11*x*) specify whether, where, and how absolute position is to be read on the Compact MACRO Station for a motor node (MI11*x* controls the *x*th motor node, which usually corresponds to Motor *x* on PMAC) and sent back to the Ultralite.

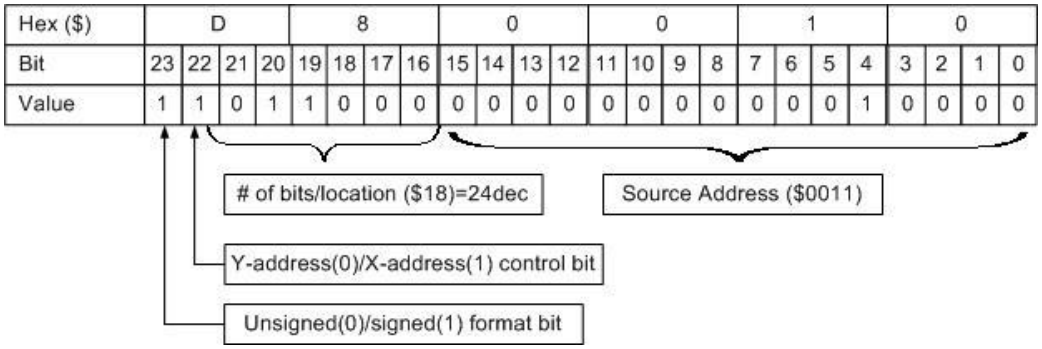
If MI11*x* is set to 0, no power-on reset absolute position value will be returned to PMAC. If MI11*x* is set to a value greater than 0, then when the PMAC requests the absolute position because its Ix10 and/or Ix81 values are set to obtain absolute position through MACRO (sending an auxiliary **`MS{node},MI920`** command), the Compact MACRO Station will use MI11*x* to determine how to read the absolute position, and report that position back to PMAC as an auxiliary response.

For an MLDT, take the output from the encoder conversion table (ECT) at the MACRO Station and process it as an absolute position because the information in the ECT is synchronized properly. Remember that the output from the encoder conversion table will reside in the X register. For example, with the following entry:

```
MS0,MI120=$30C040      ($10 of ECT)
MS0,MI121=$FFFFFF      ($11 of ECT)
MS0,MI122=32           ($12 of ECT)
```

The output from the ECT will reside in X:$12 and this will be the register to obtain the absolute data from.

MI11*x* consists of two parts. The low 16 bits (last four hexadecimal digits) specify the address on the MACRO Station from which the absolute position information is read. The high eight bits (first two hexadecimal digits) tells the Compact MACRO Station how to interpret the data at that address.



X/Y Address Bit: If bit 22 of Ix10 is 0, the PMAC looks for the parallel sensor in its Y address space. This is the standard choice, since all I/O ports map into the Y address space. If this bit is 1, PMAC looks for the parallel sensor in its X address space.

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Signed/Unsigned Bit: If the most significant bit (MSB bit 23) of MI11x is 0, the value read from the absolute sensor is treated as an unsigned quantity. If the MSB is 1, which adds $80 to the high eight bits of MI11x, the value read from the sensor is treated as a signed, twos-complement quantity.

```
MS0,MI111=$D80010              ;read signed 24-bit absolute power on position
                               ;from X:$0010
```

Example MLDT Setup for UMAC-MACRO

```
MS0,i161=3825                  ;(15*255)
Ms0,i903=2258                  ;default
MS0,I904=25                    ;might need to increase from factory default
MS0,I910=12
MS0,I916=3
MS0,i120=$30C040
MS0,I121=$FFFFFF               ;24-bit
MS0,I122=32                    ;output at $12
MS0,i101=$12
Ms0,i111=$D80010               ;grab data from 1st entry of ECT X register
I110=$740000                   ;read abs from
```


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ACC-24E2S TERMINAL BLOCK DESCRIPTION

The terminal blocks on the Acc-24E2S are described as TB1 Top, TB2 Top, TB3 Top, TB1 Bottom, TB2 Bottom, TB3 Bottom, and TB1 Front. The top connectors have the Encoder signals, the bottom connectors have the Amplifier signals, and the front connectors contain the Limit and Flag signals.

Connector TB1 Top – Output1/Encoder 1

Pin #	Symbol	Function	Description	Notes
1	CHA1+	Input	Enc 1 Pos. A Chan.	
2	CHA1-	Input	Enc 1 Neg. A Chan.	
3	CHB1+	Input	Enc 1 Pos. B Chan.	
4	CHB1-	Input	Enc 1 Neg. B Chan.	
5	CHC1+/AENA1+	Input	Enc 1 Pos. C Chan. or AENA1+	Also AENA1+
6	CHC1-/AENA1-	Input	Enc 1 Neg. C Chan. or AENA1-	Also AENA1-
7	ENCPWR	Input		Power for encoder
8	GND	Common	Digital Reference	
9	CHU1+/DIR_1+	I/O	Supplemental Flag U or Direction 1+	Also Direction Output
10	CHV1+/DIR_1-	I/O	Supplemental Flag V or Direction 1-	Also Direction Output
11	CHW1+/PUL_1+	I/O	Supplemental Flag W or Pulse Output 1+	Also Pulse Output
12	CHT1+/PUL_1-	I/O	Supplemental Flag T or Pulse Output 1-	Also Pulse Output

Connector TB2 Top – Output2/Encoder 2

Pin #	Symbol	Function	Description	Notes
1	CHA2+	Input	Enc 2 Pos. A Chan.	
2	CHA2-	Input	Enc 2 Neg. A Chan.	
3	CHB2+	Input	Enc 2 Pos. B Chan.	
4	CHB2-	Input	Enc 2 Neg. B Chan.	
5	CHC2+/AENA2+	Input	Enc 2 Pos. C Chan. or AENA2+	Also AENA2+
6	CHC2-/AENA2-	Input	Enc 2 Neg. C Chan. or AENA2-	Also AENA2-
7	ENCPWR	Input		Power for encoder
8	GND	Common	Digital Reference	
9	CHU1+/DIR_2+	I/O	Supplemental Flag U or Direction 2+	Also Direction Output
10	CHV1+/DIR_2-	I/O	Supplemental Flag V or Direction 2-	Also Direction Output
11	CHW1+/PUL_2+	I/O	Supplemental Flag W or Pulse Output 2+	Also Pulse Output
12	CHT1+/PUL_2-	I/O	Supplemental Flag T or Pulse Output 2-	Also Pulse Output

Connector TB3 Top – EQU Outputs

Pin #	Symbol	Function	Description	Notes
1	GND	Common	Digital Reference	
2	BEQU1	Output	Compare Output 1	
3	BEQU2	Output	Compare Output 2	

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Connector TB1 Bottom Encoder 3

Pin #	Symbol	Function	Description	Notes
1	CHA3+	Input	Enc 3 Pos. A Chan.	
2	CHA3-	Input	Enc 3 Neg. A Chan.	
3	CHB3+	Input	Enc 3 Pos. B Chan.	
4	CHB3-	Input	Enc 3 Neg. B Chan.	
5	CHC3+/AENA3+	Input	Enc 3 Pos. C Chan. or AENA3+	Also AENA3+
6	CHC3-/AENA3-	Input	Enc 3 Neg. C Chan. or AENA3-	Also AENA3-
7	ENCPWR	Input		Power for encoder
8	GND	Common	Digital Reference	
9	CHU3+/DIR_3+	I/O	Supplemental Flag U or Direction 3+	Also Direction Output
10	CHV3+/DIR_3-	I/O	Supplemental Flag V or Direction 3-	Also Direction Output
11	CHW3+/PUL_3+	I/O	Supplemental Flag W or Pulse Output 3+	Also Pulse Output
12	CHT3+/PUL_3-	I/O	Supplemental Flag T or Pulse Output 3-	Also Pulse Output

Connector TB2 Bottom Encoder 4

Pin #	Symbol	Function	Description	Notes
1	CHA4+	Input	Enc 4 Pos. A Chan.	
2	CHA4-	Input	Enc 4 Neg. A Chan.	
3	CHB4+	Input	Enc 4 Pos. B Chan.	
4	CHB4-	Input	Enc 4 Neg. B Chan.	
5	CHC4+/AENA4+	Input	Enc 4 Pos. C Chan. or AENA4+	Also AENA4+
6	CHC4-/AENA4-	Input	Enc 4 Neg. C Chan. or AENA4-	Also AENA4-
7	ENCPWR	Input		Power for encoder
8	GND	Common	Digital Reference	
9	CHU1+/DIR_4+	I/O	Supplemental Flag U or Direction 4+	Also Direction Output
10	CHV1+/DIR_4-	I/O	Supplemental Flag V or Direction 4-	Also Direction Output
11	CHW1+/PUL_4+	I/O	Supplemental Flag W or Pulse Output 4+	Also Pulse Output
12	CHT1+/PUL_4-	I/O	Supplemental Flag T or Pulse Output 4-	Also Pulse Output

Connector TB3 Bottom- Compare Outputs

Pin #	Symbol	Function	Description	Notes
1	GND	Common	Digital Reference	
2	BEQU3	Output	Compare Output 3	
3	BEQU4	Output	Compare Output 4	

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Connector TB1 Front- Limits 1

Pin #	Symbol	Function	Description	Notes
1	USER1	Input	General Capture Flag 1	Sinking Or Sourcing
2	PLIM1	Input	Positive Limit Flag 1	Sinking Or Sourcing
3	MLIM1	Input	Negative Limit Flag 1	Sinking Or Sourcing
4	HOME1	Input	Home Flag 1	Sinking Or Sourcing
5	FLG_1_RET	Input	Return For All Flags 1	+V (12 To 24v) Or 0v
6	USER2	Input	General Capture Flag 2	Sinking Or Sourcing
7	PLIM2	Input	Positive Limit Flag 2	Sinking Or Sourcing
8	MLIM2	Input	Negative Limit Flag 2	Sinking Or Sourcing
9	HOME2	Input	Home Flag 2	Sinking Or Sourcing
10	FLG_2_RET	Input	Return For All Flags 2	+V (12 To 24v) Or 0v
11	USER3	Input	General Capture Flag 3	Sinking Or Sourcing
12	PLIM3	Input	Positive Limit Flag 3	Sinking Or Sourcing
13	MLIM3	Input	Negative Limit Flag 3	Sinking Or Sourcing
14	HOME3	Input	Home Flag 3	Sinking Or Sourcing
15	FLG_3_RET	Input	Return For All Flags 3	+V (12 To 24v) Or 0v
16	USER4	Input	General Capture Flag 4	Sinking Or Sourcing
17	PLIM4	Input	Positive Limit Flag 4	Sinking Or Sourcing
18	MLIM4	Input	Negative Limit Flag 4	Sinking Or Sourcing
19	HOME4	Input	Home Flag 4	Sinking Or Sourcing
20	FLG_4_RET	Input	Return For All Flags 4	+V (12 To 24v) Or 0v

DB15 Style Connector J1 Top - Encoder 1 / EQU

Pin#	Symbol	Function	Description	Notes
1	CHT1+/PUL_1-	I/O	Supplemental Flag T or Pulse Output 1-	Also Pulse Output
2	CHV1+/DIR_1-	I/O	Supplemental Flag V or Direction 1-	Also Direction Output
3	GND	Common	Digital Reference	
4	CHC1-/AENA1-	I/O	Enc 1 Neg. C Chan. or AENA1-	Also Amplifier Enable
5	CHB1-	Input	Enc 1 Neg. B Chan.	
6	CHA1-	Input	Enc 1 Neg. A Chan.	
7	GND	Common	Digital Reference	
8	BEQU2	Output	Compare Output 2	
9	CHW1+/PUL_1+	I/O	Supplemental Flag W or Pulse Output 1+	Also Pulse Output
10	CHU1+/DIR_1+	I/O	Supplemental Flag U or Direction 1+	Also Direction Output
11	ENCPWR	Output	Digital Supply	Power for encoder
12	CHC1+/AENA1+	Input	Enc 1 Pos. C Chan. or AENA1+	Also Amplifier Enable
13	CHB1+	Input	Enc 1 Pos. B Chan.	
14	CHA1+	Input	Enc 1 Pos. A Chan.	
15	BEQU1	Output	Compare Output 1	

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DB15 Style Connector J2 Top - Encoder 2 / EQU

Pin#	Symbol	Function	Description	Notes
1	CHT2+/PUL_2-	I/O	Supplemental Flag T or Pulse Output 2-	Also Pulse Output
2	CHV2+/DIR_2-	I/O	Supplemental Flag V or Direction 2-	Also Direction Output
3	GND	Common	Digital Reference	
4	CHC2-/AENA2-	I/O	Enc 2 Neg. C Chan. or AENA2-	Also Amplifier Enable
5	CHB2-	Input	Enc 2 Neg. B Chan.	
6	CHA2-	Input	Enc 2 Neg. A Chan.	
7	GND	Common	Digital Reference	
8	BEQU2	Output	Compare output2	
9	CHW2+/PUL_2+	I/O	Supplemental Flag W or Pulse Output 2+	Also Pulse Output
10	CHU2+/DIR_2+	I/O	Supplemental Flag U or Direction 2+	Also Direction Output
11	ENCPWR	Output	Digital Supply	Power for encoder
12	CHC2+/AENA2-	I/O	Enc 2 Pos. C Chan. or AENA2+	Also Amplifier Enable
13	CHB2+	Input	Enc 2 Pos. B Chan.	
14	CHA2+	Input	Enc 2 Pos. A Chan.	
15	BEQU1	Output	Compare output1	

DB15 Style Connector J1 Bottom - Encoder 3 / EQU

Pin#	Symbol	Function	Description	Notes
1	CHT3+/PUL_3-	I/O	Supplemental Flag T or Pulse Output 3-	Also Pulse Output
2	CHV3+/DIR_3-	I/O	Supplemental Flag V or Direction 3-	Also Direction Output
3	GND	Common	Digital Reference	
4	CHC3-/AENA3-	I/O	Enc 3 Neg. C Chan. or AENA3-	Also Amplifier Enable
5	CHB3-	Input	Enc 3 Neg. B Chan.	
6	CHA3-	Input	Enc 3 Neg. A Chan.	
7	GND	Common	Digital Reference	
8	BEQU4	Output	Compare output4	
9	CHW3+/PUL_3+	I/O	Supplemental Flag W or Pulse Output 3+	Also Pulse Output
10	CHU3+/DIR_3+	I/O	Supplemental Flag U or Direction 3+	Also Direction Output
11	ENCPWR	Output	Digital Supply	Power for encoder
12	CHC3+/AENA3+	Input	Enc 3 Pos. C Chan. or AENA3+	Also Amplifier Enable
13	CHB3+	Input	Enc 3 Pos. B Chan.	
14	CHA3+	Input	Enc 3 Pos. A Chan.	
15	BEQU3	Output	Compare output3	

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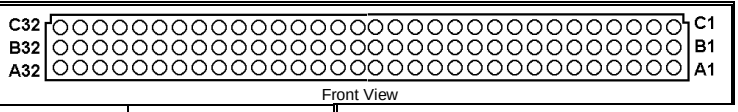
DB15 Style Connector J2 Bottom - Encoder 4 / EQU

Pin#	Symbol	Function	Description	Notes
1	CHT4+/PUL_4-	I/O	Supplemental Flag T or Pulse Output 4-	Also Pulse Output
2	CHV4+/DIR_4-	I/O	Supplemental Flag V or Direction 4-	Also Direction Output
3	GND	Common	Digital Reference	
4	CHC4-/AENA4-	I/O	Enc 4 Neg. C Chan. or AENA4-	Also Amplifier Enable
5	CHB4-	Input	Enc 4 Neg. B Chan.	
6	CHA4-	Input	Enc 4 Neg. A Chan.	
7	GND	Common	Digital Reference	
8	BEQU4	Output	Compare output4	
9	CHW4+/PUL_4+	I/O	Supplemental Flag W or Pulse Output 4+	Also Pulse Output
10	CHU4+/DIR_4+	I/O	Supplemental Flag U or Direction 4+	Also Direction Output
11	ENCPWR	Output	Digital Supply	Power for encoder
12	CHC4+/AENA4-	I/O	Enc 4 Pos. C Chan. or AENA4+	Also Amplifier Enable
13	CHB4+	Input	Enc 4 Pos. B Chan.	
14	CHA4+	Input	Enc 4 Pos. A Chan.	
15	BEQU3	Output	Compare output3	

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UBUS PINOUTS

P1 UBUS (96-Pin Header)



Pin #	Row A	Row B	Row C
1	+5Vdc	+5Vdc	+5Vdc
2	GND	GND	GND
3	BD01	DAT0	BD00
4	BD03	SEL0	BD02
5	BD05	DAT1	BD04
6	BD07	SEL1	BD06
7	BD09	DAT2	BD08
8	BD11	SEL2	BD10
9	BD13	DAT3	BD12
10	BD15	SEL3	BD14
11	BD17	DAT4	BD16
12	BD19	SEL4	BD18
13	BD21	DAT5	BD20
14	BD23	SEL5	BD22
15	BS1	DAT6	BS0
16	BA01	SEL6	BA00
17	BA03	DAT7	BA02
18	BX/Y	SEL7	BA04
19	CS3-	BA06	CS2-
20	BA05	BA07	CS4-
21	CS12-	BA08	CS10-
22	CS16-	BA09	CS14-
23	BA13	BA10	BA12
24	BRD-	BA11	BWR-
25	BS3	MEMCS0-	BS2
26	WAIT-	MEMCS1-	RESET
27	PHASE+	IREQ1-	SERVO+
28	PHASE-	IREQ2-	SERVO-
29	ANALOG	GND IREQ3-	ANALOG GND
30	-15Vdc	PWRGND	+15Vdc
31	GND	GND	GND
32	+5Vdc	+5Vdc	+5Vdc

For more details about the JEXP, see the UBUS Specification Document.

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DECLARATION OF CONFORMITY

Application of Council Directive: 89/336/EEC, 72/23/EEC

Manufacturers Name: Delta Tau Data Systems, Inc.

Manufacturers Address: 21314 Lassen Street
Chatsworth, CA 91311
USA

We, Delta Tau Data Systems, Inc. hereby declare that the product
Product Name: Accessory 24E2S
Model Number: 603441
And all of its options conforms to the following standards:

EN61326: 1997	Electrical equipment for measurement, control, and laboratory use- EMC requirements
EN55011: 1998	Limits and methods of measurements of radio disturbance characteristics of information technology equipment
EN61010-1	Electrical equipment for measurement, control, and laboratory use- Safety requirements
EN61000-3-2 :1995 A14:1998	Limits for harmonic current emissions. Criteria A
EN61000-3-3: 1995	Limitation of voltage fluctuations and flicker in low-voltage supply systems for equipment with rated current ≤ 16A. Criteria B.
EN61000-4-2:1995 A1: 1998	Electro Static Discharge immunity test. Criteria B
EN61000-4-3: 1995 A1: 1998	Radiated, radio-frequency, electromagnetic field immunity test. Criteria A
EN61000-4-4: 1995	Electrical fast transients/burst immunity test. Criteria B
EN61000-4-5: 1995	Surge Test. Criteria B
EN61000-4-6: 1996	Conducted immunity test. Criteria A
EN61000-4-11: 1994	Voltage dips test. Criteria B and C

Date Issued: 11 May 2006
Place Issued: Chatsworth, California USA

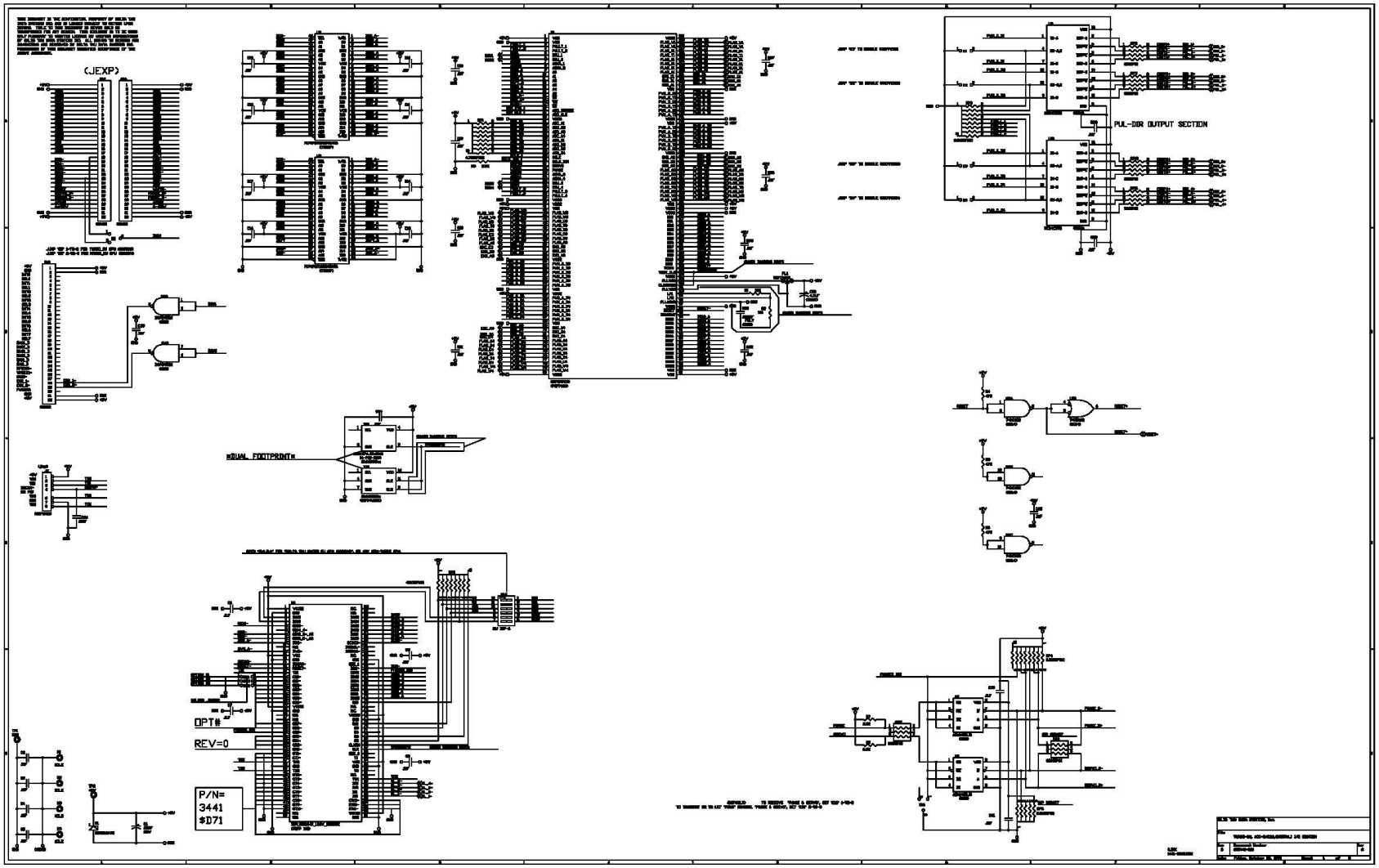
Yolande Cano
Quality Assurance Manager

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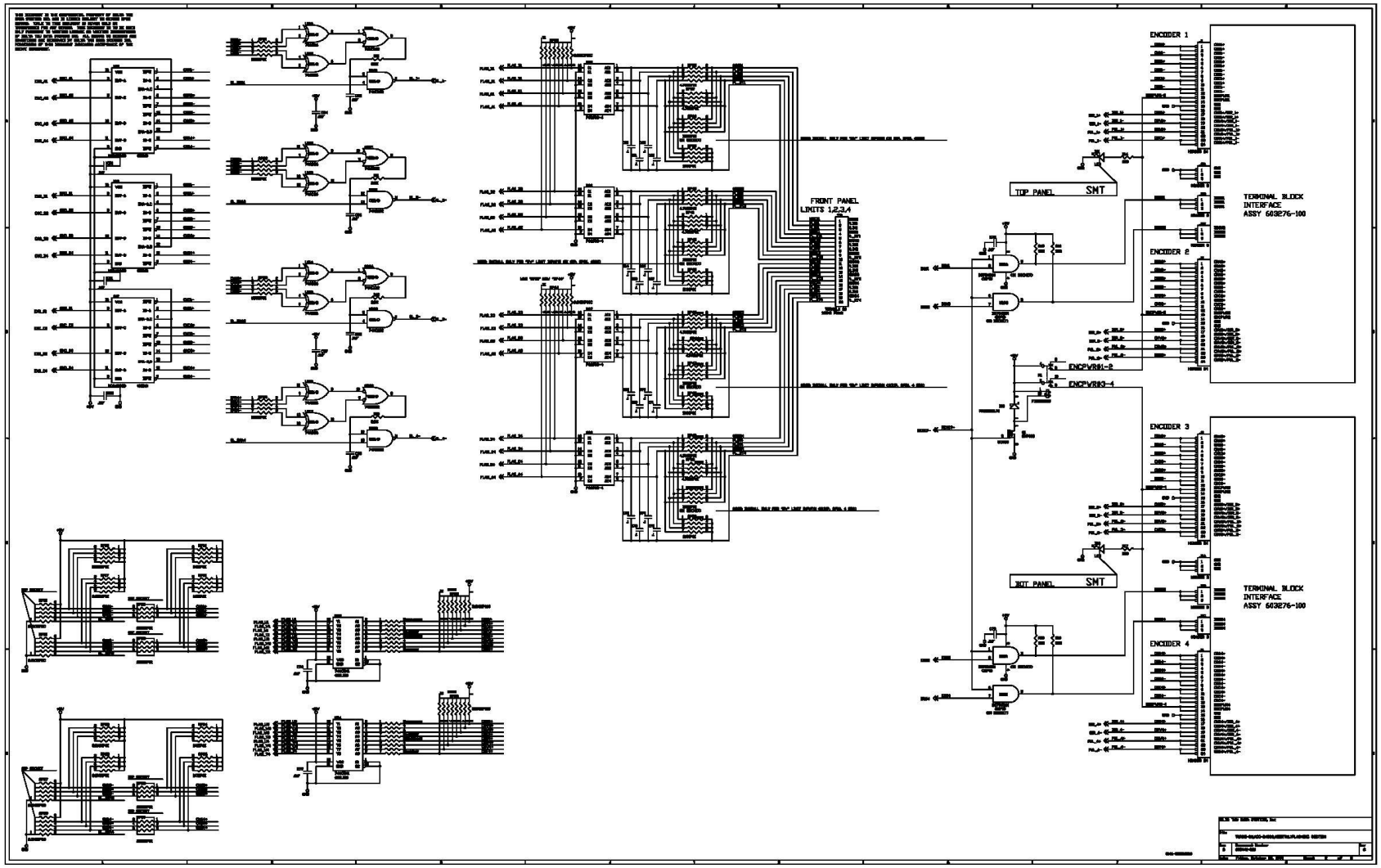
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