USER MANUAL

Accessory 51E

UMAC 4096 Interpolator

3Ax-603438-xUxx

February 10, 2016

DELTA TAU
Data Systems, Inc.
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REVISION HISTORY				
REV.	**DESCRIPTION**	**DATE**	**CHG**	**APPVD**
1	UPDATED PARTS INFO FOR REV 104 & 105	05/17/06	CP	S. MILICI
2	ADDED CE DECLARATION OF CONFORMITY	07/06/06	CP	S. FIERRO
3	ADDED UL SEAL TO MANUAL COVER UPDATED AGENCY APPROVAL/SAFETY SECTION	09/30/09	CP	S.FIERRO
4	UPDATED HIPERFACE ABSOLUTE POSITION EXAMPLE	11/25/09	CP	R.NADDAF
5	UPDATED JUMPER DESCRIPTION – REMOVED E20	02/10/16	Sgm	S. MILICI

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INTRODUCTION

Delta Tau's Acc-51E UMAC Interpolator Accessory is a sine wave input interpolator designed to interface two (optionally four) analog quadrature encoders to Delta Tau Data System's UMAC Euro card style devices.

The Acc-51E is a 3U size card that mounts in the same racks as Delta Tau's Turbo UMAC or MACRO station processors.

Features

The Interpolator accepts inputs from two (optionally four) sinusoidal or quasi-sinusoidal encoders and provides encoder position data to the motion processor. This interpolator creates 4,096 steps per sine-wave cycle.

The Interpolator can accept a voltage-source (1Vp-p) signal from the encoder. A jumper selects between unterminated or 120Ω input termination.

The maximum sine-cycle frequency input is approximately 8 MHz (8,000,000 SIN cycles/sec), which gives a maximum speed of about 32.768 billion steps per second.

When used with a 1000 line sinusoidal rotary encoder, there will be 4,096,000 discrete states per revolution (128,000 software counts). The maximum calculated electrical speed of this encoder would be 8,000 RPS or 480,000 RPM, which exceeds the maximum physical speed of most encoders.

The Acc-51E is considered an axis device in the UBUS backplane. Therefore, the memory map for this card is similar to the Acc-24E2x style axis cards.

Limitations when Used With Original UMAC MACRO CPU (602804)

The original UMAC MACRO CPU has been designed as an 8-axis device. The Acc-51E occupies the same backplane select lines as Acc-24E2 style axis cards and is configured using the same I-Variables as that of a typical MACRO Station. Therefore, the Acc-51E occupies a minimum of four axes in the MACRO station application.

If there are more than four motors to be configured in the UMAC MACRO system Delta Tau recommends using the MACRO16 CPU (603719) which can service six Servo IC cards (16 servo channels total).

Board Configuration

Base Configuration

The base version of the Acc-51E consists of a 3U-size board with two sinusoidal encoder inputs, each individually configurable to accommodate 1V p-p sinusoidal encoders.

Options

Option 1:	301-603195-OPT	Additional two axes (Axis 3 and 4)
Option 2:	302-603195-OPT	Hiperface Interface

Option 1: Provides the interface circuitry and connectors for two additional sinusoidal encoders, for a total of four encoders on the Acc-51E.

Option 2: Provides the on-board circuitry to read the absolute position of Stegmann Sincos® and SinCoder® encoders using their digital interface, Hiperface®.

Note:

The options described above must be installed at the factory.

Indicators

Refer to the layout diagram of the UBUS interpolator for the location of the indicators on the board.

D4, D5, {D6, D7 Opt 1} AQUAD Indicators

These LEDs indicate the A-channel quadrature input. When the encoder is operating normally, this indicator will flicker with a rate that is dependent upon the speed of the moving encoder.

D4 is input #1, and D5 is input #2. With Acc-51E Option 1 D6 is input #3, and D7 is input #4.

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 w/o Option 1A	220 g	Front , Top, and Bottom plates included
Terminal Block Connectors	FRONT-MC1,5/10-ST3,81	Terminal Blocks from Phoenix Contact. UL-94V0
DB Option Connectors	DB9 Female	UL-94V0
The width is the width of the front plate. The length and height are the dimensions of the PCB.		

Electrical Specifications

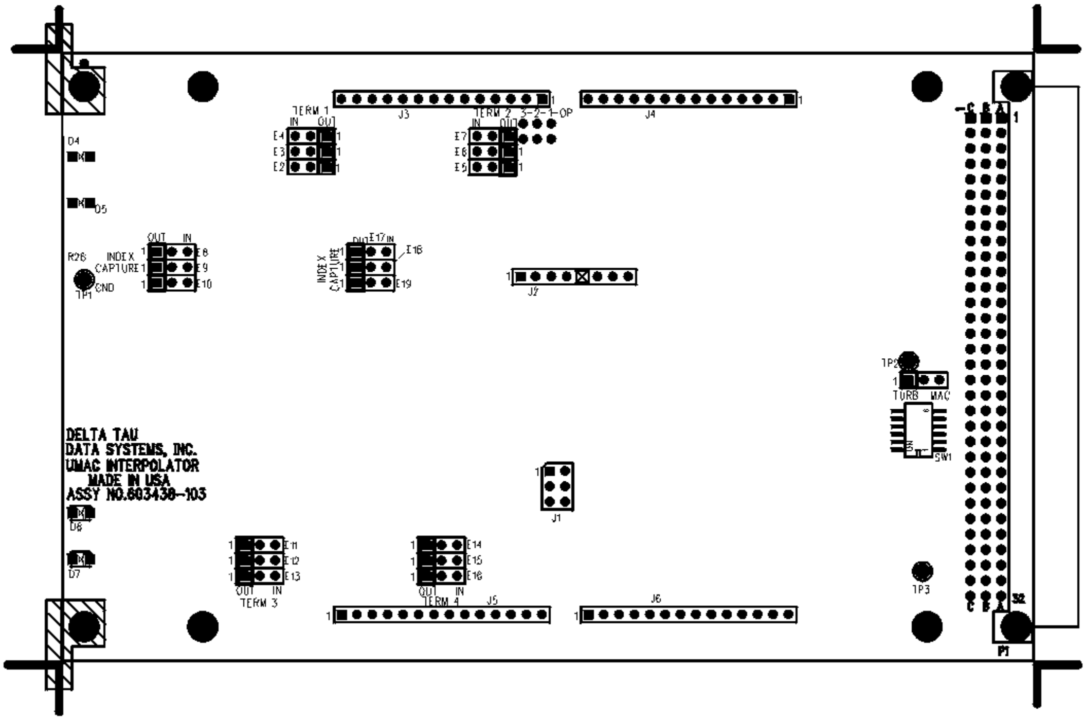
Description	Specification	Notes
ACC-51E Power Requirements	5V @ 0.5A (±10%) +15V @ 0.08A (±10%) -15V @ 0.04A (±10%)	

Agency Approval and Safety

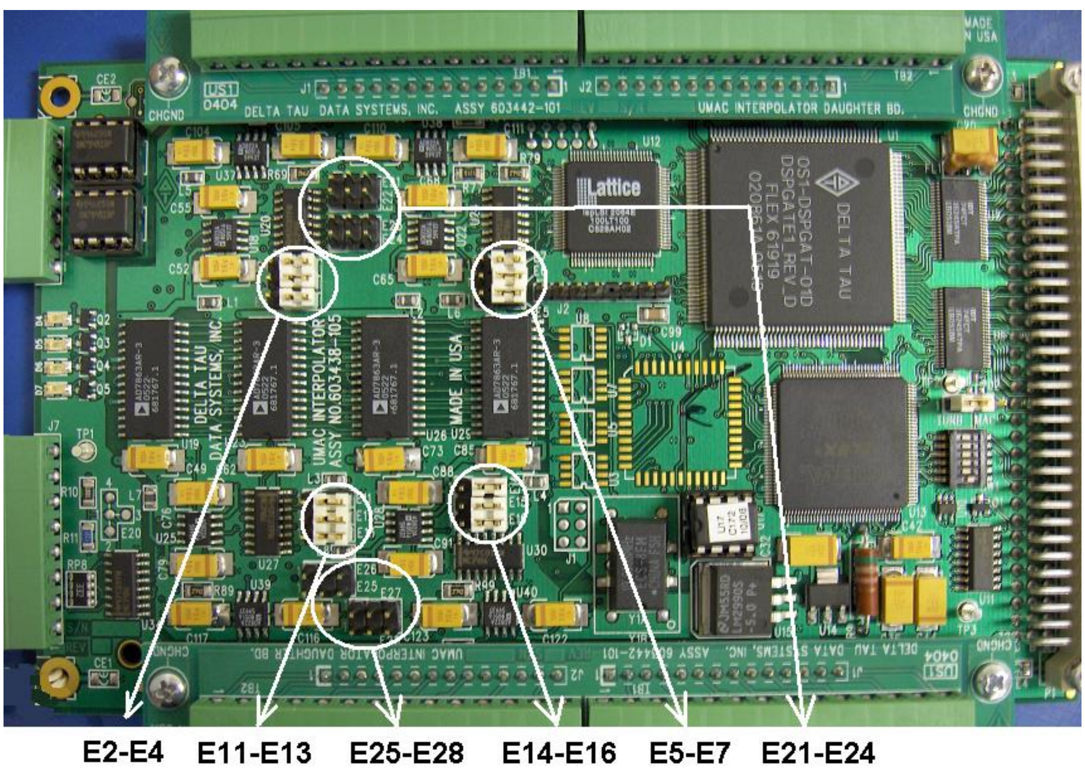
Item	Description
CE Mark	Full Compliance
EMC	EN55011 Class A Group 1 EN61000-3-2 Class A EN61000-3-3 EN61000-4-2 EN61000-4-3 EN61000-4-4 EN61000-4-5 EN61000-4-6 EN61000-4-11
Safety	EN 61010-1
UL	UL 61010-1 File E314517
cUL	CAN/CSA C22.2 No. 1010.1-92 File E314517
Flammability Class	UL 94V-0

LAYOUT OF ACC-51E, UBUS INTERPOLATOR

This diagram shows jumpers and connectors on the Acc-51E for rev 4 and below.



This diagram shows jumpers and connectors on the Acc-51E for rev 5.



Dipswitch and E1 Jumper Configuration

S1 is a 6-point dipswitch that determines how the Acc-51E is to be mapped to a Turbo UMAC processor or MACRO station processor.

Jumper E1 selects between MACRO station and Turbo UBUS backplane addressing.

On backplanes that are using addressable slots, all dipswitch positions should be left in the ON position.

On non-addressed backplanes, addressing must be selected.

Two addressing schemes are used, depending upon the type of UMAC Processor. The UMAC Turbo Processor table is shown, followed by the table used by the UMAC MACRO Station processor.

Acc-51E Mappings when Used with UMAC Turbo CPU

The table below shows the addresses and switch settings used for the Turbo UMAC models:

Acc-51E Mapping Table
{CS2, CS3 Mappings When Used With UMAC Turbo CPU}

Interp SW1 Settings						Turbo PMAC Servo IC # (m)	1st Channel	2nd Channel	3rd Channel	4th Channel	I-Variables	CS16 Ident. Address
6	5	4	3	2	1							
on	on	on	on	on	on	2	$78200	$78208	$78210	$78218	I7200-I7249	$78F08
on	on	on	on	on	off	3	$78300	$78308	$78010	$78318	I7300-I7349	$78F0C
on	on	on	off	on	on	4	$79200	$79208	$79210	$79218	I7400-I7449	$79F08
on	on	on	off	on	off	5	$79300	$79308	$79310	$79318	I7500-I7549	$79F0C
on	on	off	on	on	on	6	$7A200	$7A208	$7A210	$7A218	I7600-I7649	$7AF08
on	on	off	on	on	off	7	$7A300	$7A308	$7A310	$7A318	I7700-I7749	$7AF0C
on	on	off	off	on	on	8	$7B200	$7B208	$7B210	$7B218	I7800-I7849	$7BF08
on	on	off	off	on	off	9	$7B300	$7B308	$7B310	$7B318	I7900-I7949	$7BF0C
on	on	on	on	off	on	2*	$78220	$78228	$78230	$78238	I7250-I7299	$78F28
on	on	on	on	off	off	3*	$78320	$78328	$78030	$78338	I7350-I7399	$78F2C
on	on	on	off	off	on	4*	$79220	$79228	$79230	$79238	I7450-I7499	$79F28
on	on	on	off	off	off	5*	$79320	$79328	$79330	$79338	I7550-I7599	$79F2C
on	on	off	on	off	on	6*	$7A220	$7A228	$7A230	$7A238	I7650-I7699	$7AF28
on	on	off	on	off	off	7*	$7A320	$7A328	$7A330	$7A338	I7750-I7799	$7AF2C
on	on	off	off	off	on	8*	$7B220	$7B228	$7B230	$7B238	I7850-I7899	$7BF28
on	on	off	off	off	off	9*	$7B320	$7B328	$7B330	$7B338	I7950-I7999	$7BF2C
on=closed, off=open												

The memory mapping for Turbo UMAC models allows for a total of 64 encoder channels to be selected. The dipswitch selects among any of the 16 banks of memory. This allows up to 16 Acc-51Es to be logically configured.

Note:

The Acc-51E defines the mapping for its encoder channels as the same as the mapping for other devices that provide encoder inputs. Therefore, although there are 16 4- channel memory slots to place the Acc-51E into, these same slots are shared with the axis cards.

Acc-51E Mappings when Used with UMAC MACRO Station CPU

The addressing of the Acc-51E when used with a UMAC MACRO CPU is dependent only on the setting of SW1-1. The settings of SW1-2 through SW1-6 do not matter

The table below shows the addresses and switch settings used for the UMAC MACRO Station:

Acc-51E Mapping Table
{CS2, CS3 Mappings when Used with UMAC MACRO Station CPU}

SW1-1 Settings	1st Channel	2nd Channel	3rd Channel	4th Channel
on	$C040	$C048	$C050	$C058
off	$C060	$C068	$C070	$C078
on=closed, off=open				

The memory mapping for UMAC MACRO models allows for a total of eight encoder channels to be selected. The dipswitch selects between only two base addresses. This allows for up to two Acc-51Es to be logically configured.

When using a slot addressable backplane, the repeated entries in the table above indicate the addresses that are applied at each slot.

Jumper E1 should be placed in the Turbo (1-2) select mode for MACRO Station processors that are revision 5 and higher. Older revision MACRO Station processors (revision 4 and lower) should have jumper E1 in the MACRO position (2-3).

Note:

The Acc-51E defines the mapping for its encoder channels as the same as the mapping for other devices that provide encoder inputs. Therefore, although there are two 4- channel memory slots to place the Acc-51E into, these same slots are shared with backplane axis cards. Stack style 2-axis cards do not have conflicts with the Acc-51E.

Jumper Configurations

Table of Jumpers for rev 104 and below

Nomenclature	Physical Layout	Description	Factory Default
E1	1 - 2 - 3	MACRO station / Turbo Select 1 - 2 Turbo UMAC Controller and MACRO Station Controllers (Rev 5 and up) 2 - 3 MACRO Station Controller (Rev 4 and older)	1 - 2
E2, E3, E4	1 - 2 - 3	Channel 1 Encoder Termination 1 - 2 Unterminated inputs 2 - 3 Terminated (120Ω) inputs (E4 is index termination)	2 - 3
E5, E6, E7	1 - 2 - 3	Channel 2 Encoder Termination 1 - 2 Unterminated inputs 2 - 3 Terminated (120Ω) inputs (E7 is index termination)	2 - 3
E8, E9, E10	1 - 2 - 3	Channel 1 index capture 1 - 2 Channel 2 is selected 2 - 3 Index capture is selected	1 - 2
E11, E12, E13	1 - 2 - 3	Channel 3 Encoder Term (opt1) 1 - 2 Unterminated inputs 2 - 3 Terminated (120Ω) inputs (E4 is index termination)	2 - 3
E14, E15, E16	1 - 2 - 3	Channel 4 Encoder Term (opt1) 1 - 2 Unterminated inputs 2 - 3 Terminated (120Ω) inputs (E4 is index termination)	2 - 3
E17, E18, E19	1 - 2 - 3	Channel 3 index capture 1 - 2 Channel 4 is selected 2 - 3 Index capture is selected	1 - 2

E1 - MACRO Station/Turbo Select

This jumper allows the use of a MACRO Station processor on this UBUS accessory. Since the MACRO Station was developed prior to the UBUS, there was a subtle address bus change. This jumper provides for the addressing difference between the two architectures.

E2, E3, E4, E5, E6, E7 - Encoder Input Select Channel 1 and 2

These jumpers allow the user to select which type of input loading is to be used for the encoder. A 120Ω termination is selectable. The inputs are approx. 20kΩ when not terminated.

E8, E9, E10 - Index Capture Select for Channel 1

These jumpers allow the user to select whether channel 2 is used for an encoder input or index capture for channel 1. This mode is not supported by software.

Channel 2 is not used when channel 1 index capture is selected.

E11, E12, E13, E14, E15, E16 - Encoder Input Select (Option 1- Additional Two Channels)

These jumpers allow the selection of which type of input loading is to be used for the encoder. A 120Ω termination is selectable. The inputs are approx 20KΩ when not terminated.

E17, E18, E19 - Index Capture Select for Channel 3 (Option 1- Additional Two Channels)

These jumpers allow the selection of whether channel 4 is used for an encoder input or index capture for channel 3. This mode is not supported by software.

Channel 4 is not used when channel 3 index capture is selected.

Table of Jumpers for rev 105

Nomenclature	Physical Layout	Description	Factory Default
E1	1 - 2 - 3	MACRO station / Turbo Select 1 - 2 Turbo UMAC Controller and MACRO Station Controllers (Rev 5 and up) 2 - 3 MACRO Station Controller (Rev 4 and older)	1 - 2
E2, E3, E4	1 - 2 - 3	Channel 1 SIN/COS Encoder Termination 1 - 2 Unterminated inputs 2 - 3 Terminated (120Ω) inputs (E4 is index termination)	2 - 3
E5, E6, E7	1 - 2 - 3	Channel 2 SIN/COS Encoder Termination 1 - 2 Unterminated inputs 2 - 3 Terminated (120Ω) inputs (E7 is index termination)	2 - 3
E21, E22	1 - 2 - 3	Channel 1 Hyperface/ENDAT Termination 1 - 2 Unterminated inputs 2 - 3 Terminated (120Ω) inputs	2 - 3
E23, E24	1 - 2 - 3	Channel 2 Hyperface/ENDAT Termination 1 - 2 Unterminated inputs 2 - 3 Terminated (120Ω) inputs	2 - 3
E11, E12, E13	1 - 2 - 3	Channel 3 SIN/COS Encoder Term (opt1) 1 - 2 Unterminated inputs 2 - 3 Terminated (120Ω) inputs (E13 is index termination)	2 - 3
E14, E15, E16	1 - 2 - 3	Channel 4 SIN/COS Encoder Term (opt1) 1 - 2 Unterminated inputs 2 - 3 Terminated (120Ω) inputs (E16 is index termination)	2 - 3
E25, E26	1 - 2 - 3	Channel 3 Hyperface/ENDAT Termination 1 - 2 Unterminated inputs 2 - 3 Terminated (120Ω) inputs	2 - 3
E27, E28	1 - 2 - 3	Channel 4 Hyperface/ENDAT Termination 1 - 2 Unterminated inputs 2 - 3 Terminated (120Ω) inputs	2 - 3

E1 - MACRO Station/Turbo Select

This jumper allows the use of a MACRO Station processor on this UBUS accessory. Since the MACRO Station was developed prior to the UBUS, there was a subtle address bus change. This jumper provides for the addressing difference between the two architectures.

E2, E3, E4, E5, E6, E7 – SIN/COS Encoder Input Select Channel 1 and 2

These jumpers allow the user to select which type of input loading is to be used for the encoder. A 120Ω termination is selectable. The inputs are approx. 20kΩ when not terminated.

E21, E22, E23, E24 – Hyperface/ENDAT Input Select Channel 1 and 2

These jumpers allow the user to select which type of input loading is to be used. A 120Ω termination is selectable. The inputs are approx. 20kΩ when not terminated.

E11, E12, E13, E14, E15, E16 – SIN/COS Encoder Input Select (Option 1- Additional Two Channels)

These jumpers allow the selection of which type of input loading is to be used for the encoder. A 120Ω termination is selectable. The inputs are approx 20KΩ when not terminated.

E25, E26, E27, E28 – Hyperface/ENDAT Input Select (Option 1- Additional Two Channels)

These jumpers allow the user to select which type of input loading is to be used. A 120Ω termination is selectable. The inputs are approx. 20kΩ when not terminated.

ENCODER CONNECTIONS

1. Be sure to use shielded, twisted pair cabling for sinusoidal encoder wiring. Double insulated is the best. The sinusoidal signals are very small and must be kept as noise free as possible. Avoid cable routing near noisy motor or driver wiring. Refer to the appendix for tips on encoder wiring.
2. The use of single-ended output style sinusoidal encoders at very slow speeds has been shown to provide large amounts of velocity-ripple. When very slow speeds are desired, it is best to use differential output style sinusoidal encoders. The 3-line encoder table entry (which is available with Turbo PMAC models) has been designed to help adjust the offsets that may be present with single-ended encoders.
3. The Acc-51E uses voltage mode 1Vp-p encoders only.
4. It is possible to reduce noise in the encoder lines of a motor-based system by the use of inductors that are placed between the motor and the amplifier. Improper grounding techniques may also contribute to noisy encoder signals.

Sinusoidal Encoder Wiring

Sinusoidal encoders operate on the concept that there are two analog signal outputs 90 degrees out of phase. They are available with different drive characteristics, some of which are described below.

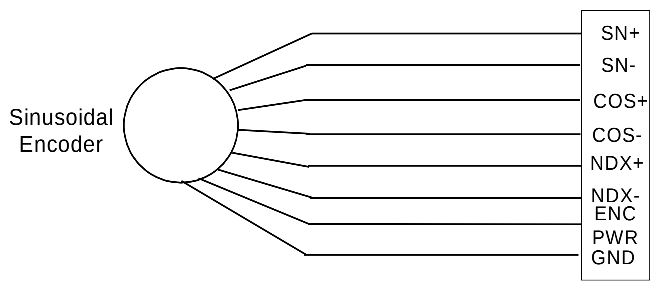
Differential Format

The differential format provides a means of using twisted pair wiring that allows for better noise immunity when wired into machinery.

There are two common output types available with differential style sinusoidal encoders. They are current mode and voltage mode style encoder outputs.

The current mode encoder output uses a high impedance 11µA pk-pk output. The voltage mode output encoder uses a low impedance 1 V pk-pk output.

The voltage mode encoder type is connected to the interpolator as shown. Usually, termination is selected by using jumpers on the interpolator board.



Differential Encoder Connection

Note:

Voltage mode encoders are becoming the more popular choice for machine designs due to their lower impedance outputs. Lower impedance outputs represent better noise immunity, and therefore more reliable encoder interfaces.

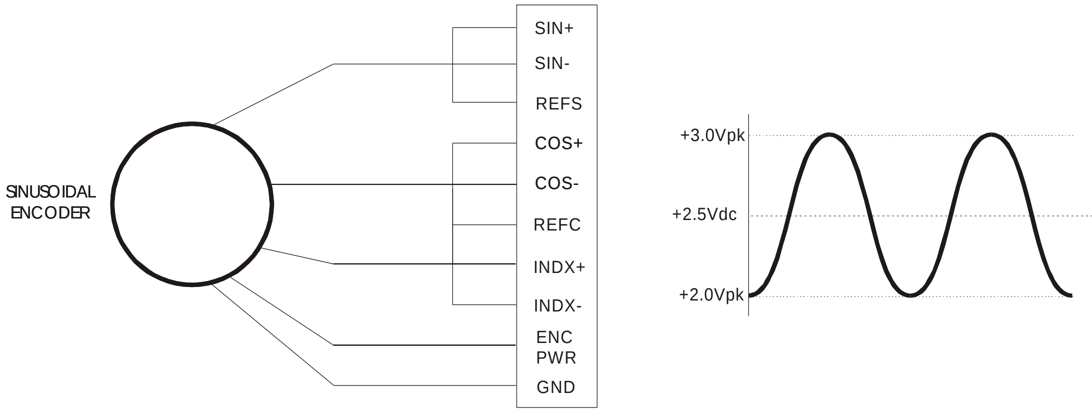
The Acc-51P uses only voltage mode encoders.

Single-Ended Format

The single-ended formats provide a simpler means of using a sinusoidal encoder. Typically, fewer wires are needed and the encoders are always of the lower impedance voltage output type.

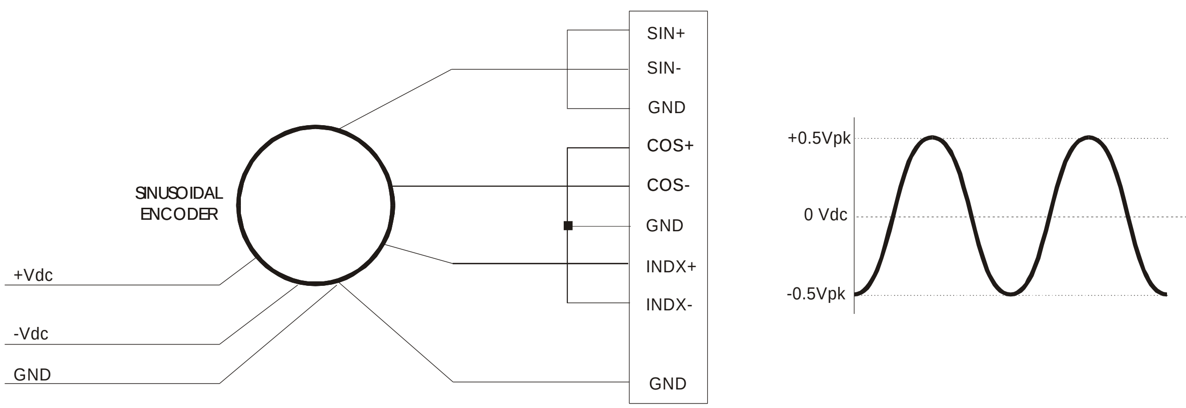
It should be noted that all the single-ended encoder formats shown here might have velocity-ripple effects at very slow speeds due to the effects of op-amp V_{io} offsets. These offsets cause the sinusoidal signal to be centered at a value that is slightly different from the reference or servo ground.

The diagram shown below is a simple single-ended encoder-wiring interface. This encoder has SIN and COS outputs that provide a 1V peak-to-peak output with a voltage offset of 2.5 Vdc. Note that the SIN-, COS-, and INDEX- lines are tied to the 2.5V internal references on the interpolator card.



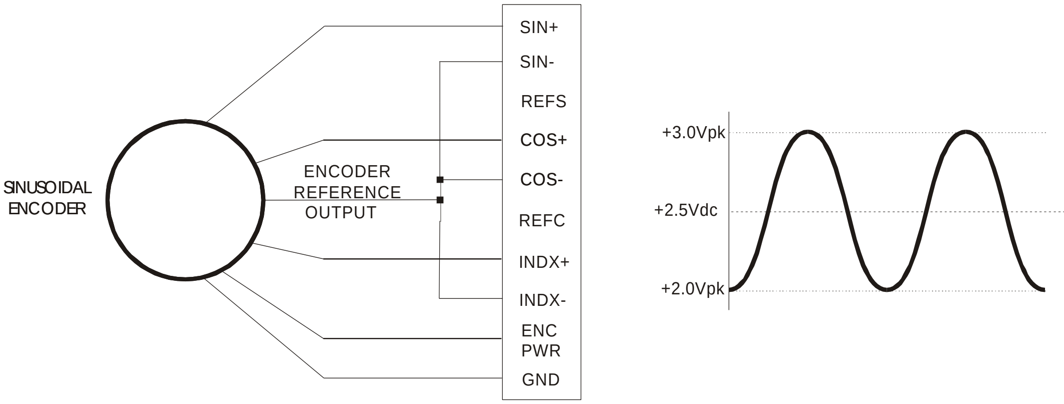
Single-Ended Encoder Connection

The diagram shown below is similar to the diagram above. This encoder has SIN and COS outputs that provide a 1V peak-to-peak output with a voltage offset of 0.0 Vdc. Note that the SIN-, COS-, and INDEX- lines are tied to the GND on the interpolator card, and the encoder usually requires a bipolar supply.



Alternate Single-Ended Encoder Connection

The diagram shown below is a single-ended encoder that provides a reference output. This encoder has SIN and COS outputs which provide a 1V peak to peak output with a voltage offset that is provided as an output of the encoder. The SIN-, COS-, and INDEX- lines are tied to the encoder's reference output. This type of encoder connection is expected to be more precise than the typical single-ended encoder as shown in the first diagram above because the internal reference (usually set at 2.5Vdc) is the mechanism that establishes the offsets for the SIN+, COS+, and INDEX+ outputs.



Single-Ended Encoder Connection
using the Encoder's Reference Output

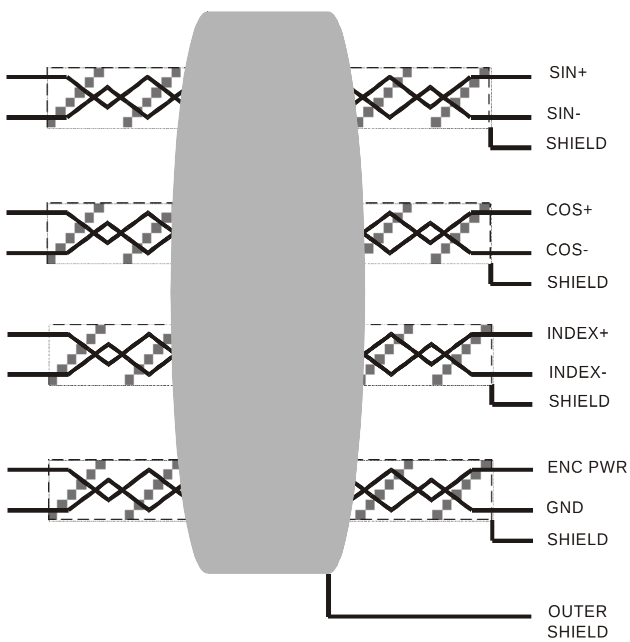
Note:

Do not connect the reference output of the encoder to the REFS and REFC lines on the interpolator card. Doing so will cause the interpolator to function incorrectly.

Type of Cable for Encoder Wiring

Low capacitance shielded twisted pair cable is ideal for wiring differential encoders. The better the shield wires, the better the noise immunity to the external equipment wiring. Wiring practice for shielded cables is not an exact science. Different applications will present different sources of noise, and experimentation may be required to achieve the desired results. Therefore, the following recommendations are based upon some experiences that we at Delta Tau Data Systems have acquired.

If possible, the best cabling to use is a double-shielded twisted pair cable. Typically, there are four pairs used in a differential encoder's wiring. The picture below shows how the wiring may be implemented for a typical differential encoder using double shielded twisted pair cable.



Example of Double Shielded
4 Twisted Pair Cable

The shield wires should be tied to ground (Vcc return) at the interpolator end. It is acceptable to tie the shield wires together if there are not enough terminals available. Keep the exposed wire lengths as close as possible to the terminals on the interpolator.

Note:

It has been observed that there is an inconsistency in the shielding styles that are used by different encoder manufacturers.

Be sure to check pre-wired encoders to ensure that the shield wires are not connected at the encoder's side. Shield wires should be connected only on one side of the cable.

If the encoder has shield wires that are connected to the case ground of the encoder, ensure that the encoder and motor cases are sufficiently grounded. Do not connect the shield at the interpolator end.

If the encoder has pre-wired double shielded cable that has only the outer shield connected at the encoder, then connect only the inner shield wires to the interpolator. Be sure not to mix the shield interconnections.

One possible cable type for encoders is Belden 8164 or ALPHA 6318. This is a 4-pair individually shielded cable that has an overall shield. This double-shielded cable has a relatively low capacitance and is a 100Ω impedance cable.

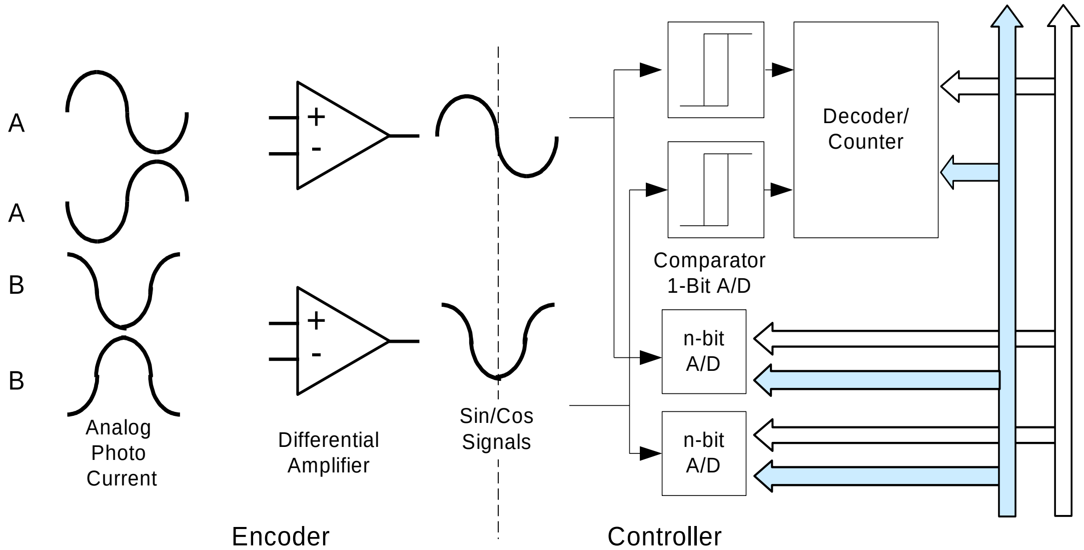
Cables for single-ended encoders should be shielded for the best noise immunity. Single-ended encoder types cannot take advantage of the differential noise immunity that comes with twisted pair cables.

Note:

If noise is a problem in the application, careful attention must be given to the method of grounding that is used in the system. Amplifier and motor grounding can play a significant role in how noise is generated in a machine.

Noise may be reduced in a motor-based system by the use of inductors placed between the motor and the amplifier.

PRINCIPLE OF OPERATION



The sine and cosine signals from the encoder are processed in two ways in the Acc-51 board (see diagram). First, they are sent through comparators that square up the signals into digital quadrature and sent into the quadrature decoding and counting circuit of the Servo IC on the Acc-51. The decoding must be set up for “quadrature times-4” decode (I9n0 or I7mn0 = 3 or 7) to generate four counts per line in the hardware counter.

The units of the hardware counter, which are called hardware counts, are thus ¼ of a line. For most users, this fact is an intermediate value, an internal detail that does not concern them. However, there are two cases in which this is important. First, if the sinusoidal encoder is used for PMAC-based brushless-motor commutation, the hardware counter, not the fully interpolated position value, will be used for the commutation position feedback. The units of Ixx71 will therefore be hardware counts.

Second, if the hardware position-compare circuits in the Servo IC are used, the units of the compare register are hardware counts. (The same is true of the hardware position-capture circuits, but often these scaling issues are handled automatically through the move-until-trigger constructs).

The second, parallel, processing of the sine and cosine signals is through analog-to-digital converters, which produce numbers proportional to the input voltages. These numbers are used to calculate mathematically an arctangent value that represents the location within a single line. This is calculated to 1/4096 of a line, so there are 4096 unique states per line, or 1024 states per hardware count.

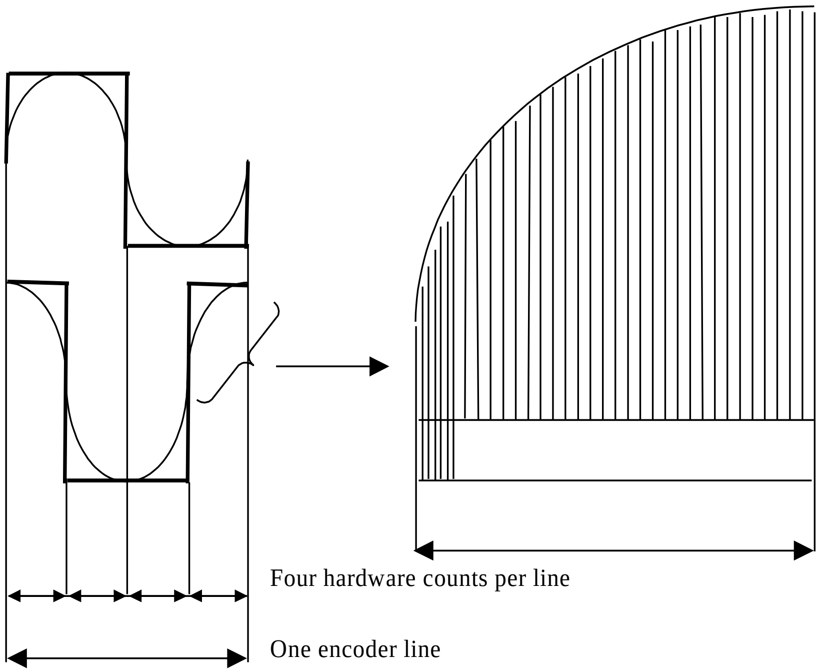
For historical reasons, PMAC expects the position it reads for its servo feedback software to have units of 1/32 of a count. That is, it considers the least significant bit (LSB) of whatever it reads for position feedback to have a magnitude of 1/32 of a count for the purposes of its software scaling calculations. We call the resulting software units “software counts,” and any software parameter that uses counts from the servo feedback (e.g. jog speed in counts/msec, axis scale factor in counts/engineering-unit) is using these software counts. In most cases, such as digital quadrature feedback, these software counts are equivalent to hardware counts.

However, with the added resolution produced by the Acc-51 interpolator, software counts and hardware counts are no longer the same. The LSB produced by the interpolator (through the encoder conversion table processing) is 1/1024 of a hardware count, but PMAC software considers it 1/32 of a software count. Therefore, with the Acc-51, a software count is 1/32 the size of a hardware count.

The following equations express the relationships between the different units when using the Acc-51:

1 line = 4 hardware counts = 128 software counts = 4096 states (LSBs)
¼-line = 1 hardware count = 32 software counts = 1024 states (LSBs)
1/128-line = 1/32-hardware count = 1 software count = 32 states (LSBs)
1/4096-line = 1/1024-hardware count = 1/32-software count = 1 state (LSB)

Note that these are all just naming conventions. Even the position data that is fractional in terms of software counts is real. The servo loop can see it and react to it, and the trajectory generator can command to it.



Example 1:

A 4-pole rotary brushless motor has a sinusoidal encoder with 2000 lines. It directly drives a screw with a 5-mm pitch. The encoder is used for both commutation and servo feedback.

The commutation uses the hardware counter. There are 8000 hardware counts per revolution, and 2 commutation cycles per revolution of the 4-pole motor. Therefore, Ix70 will be set to 2, and Ix71 will be set to 8000. Ix83 will contain the address of the hardware counter's phase capture register.

For the servo, we use the interpolated results of the conversion table. There are 128 software counts per line, or 256,000 software counts per revolution. With each revolution corresponding to 5 mm on the screw, there are 51,200 software counts per millimeter. The measurement resolution, at 4096 states per line, is 1/8,192,000 of a revolution, or 1/1,638,400 of a millimeter (~0.6 nanometers/state).

Example 2:

A linear brushless motor has a commutation cycle of 60.96 mm (2.4 inches). It has a linear scale with a 20-micron line pitch. The scale is used for both commutation and servo feedback.

The commutation uses the hardware counter. There are 200 hardware counts per millimeter (5 microns per count), so 12,192 hardware counts per commutation cycle. Ix70 should be set to 1, and Ix71 should be set to 12,192.

The servo uses the interpolated results of the conversion table. With 128 software counts per line, and 50 lines per millimeter, there are 6400 software counts per millimeter (or 162,560 software counts per inch). The measurement resolution, at 4096 states per line, is 204,800 states per mm (~5 nanometers/state).

TURBO UMAC AND THE UMAC INTERPOLATOR

I-Variables for Turbo UMAC Processor

Refer to the Turbo PMAC Software Reference Manual for a more detailed description of the use of the I-Variables as described below.

To process the interpolator's data properly, several I-Variables must be set:

Encoder Decode Control I-Variables (I7mn0)

I7mn0 is used to establish encoder decoding. 'm' is the servo IC number as established by the Acc-51E mapping table (in the previous section); 'n' is the channel number, which is the same as the encoder number (1-4) on the Acc-51E board. The encoder decode control I-variable is set for each channel to which an interpolator is connected.

For Servo IC's that use the alternate addressing labeled Servo ICs 2* through 9*. Servo IC m* is representing channels 6 to 9. For example: the I-variable for the first channel on Servo IC 2* is I7260 to I7269.

Refer to the Acc-51E mapping table described in the Dipswitch and Mapping section of this manual for the servo IC number 'm' value.

A value of 7 is used as default for CCW x4 Quadrature decode. Changing the decode direction requires the operator to save the Turbo PMAC's parameters and perform a **$$$** or cycle power.

Note:

Reset the PMAC if the encoder direction has been changed to prevent encoder instability.

Motor xx Counts per N Commutation Cycles (Ixx71)

For a Turbo PMAC-commutated motor, this parameter defines the size of a commutation cycle in conjunction with Ixx70 (hardware counts/cycle = Ixx71/Ixx70. For example, if a sinusoidal encoder with 2000 lines is used, Ix71 will be set to 8000 hardware counts.

Motor xx Number of Commutation Cycles (N) (Ixx70)

For a PMAC-commutated motor (Ixx01=1), Ixx70 is used in combination with Ixx71 to define the size of the commutation cycle, as Ixx71/Ixx70 counts. For example, a 4-pole rotary brushless motor has a sinusoidal encoder with 2000 lines. There are 8000 hardware counts per revolution, and two commutation cycles per revolution of the 4-pole motor. Therefore, Ix70 will be set to 2, and Ix71 will be set to 8000. Ix83 will contain the address of the hardware counter's phase capture register.

Commutation Position I-Variables (Ixx83)

The Acc-51E contains a quadrature-based encoder register that may be used for commutation position. The PMAC2 does not use the Acc-51's full interpolation to track a motor's position.

The number of commutation counts per pole revolution or linear scale distance is related to the pitch of the encoder's sinusoidal output multiplied by 4. Therefore, commutation appears to the PMAC2 as if it were a quadrature-based encoder.

The table below shows the addresses of the quadrature register in the Acc-51E:

Interp SW1 Settings						Turbo PMAC Servo IC # (m)	1st Channel	2nd Channel	3rd Channel	4th Channel
6	5	4	3	2	1					
on	on	on	on	on	on	2	$78201	$78209	$78211	$78219
on	on	on	on	on	off	3	$78301	$78309	$78011	$78319
on	on	on	off	on	on	4	$79201	$79209	$79211	$79219
on	on	on	off	on	off	5	$79301	$79309	$79311	$79319
on	on	off	on	on	on	6	$7A201	$7A209	$7A211	$7A219
on	on	off	on	on	off	7	$7A301	$7A309	$7A311	$7A319
on	on	off	off	on	on	8	$7B201	$7B209	$7B211	$7B219
on	on	off	off	on	off	9	$7B301	$7B309	$7B311	$7B319
on	on	on	on	off	on	2*	$78221	$78229	$78231	$78239
on	on	on	on	off	off	3*	$78321	$78329	$78031	$78339
on	on	on	off	off	on	4*	$79221	$79229	$79231	$79239
on	on	on	off	off	off	5*	$79321	$79329	$79331	$79339
on	on	off	on	off	on	6*	$7A221	$7A229	$7A231	$7A239
on	on	off	on	off	off	7*	$7A321	$7A329	$7A331	$7A339
on	on	off	off	off	on	8*	$7B221	$7B229	$7B231	$7B239
on	on	off	off	off	off	9*	$7B321	$7B329	$7B331	$7B339
on=closed, off=open										

Encoder Conversion Table

The encoder conversion table is a user-configurable list of entries that may be assigned to different specific data processing inputs. The interpolator is assigned into the encoder conversion table as a High Resolution Encoder Interpolator when using Pewin's executive program conversion table setup menu.

An ECT entry in which the first hex digit of the first line is $F and the first hex digit of the second line is $0 processes the result of a high-resolution interpolator for analog sine-wave encoders, such as the Acc-51E. This entry, when used with a high-resolution interpolator, produces a value with 4096 states per line. The entry must read both an encoder channel for the whole number of lines of the encoder and a pair of A/D converters to determine the location within the line, mathematically combining the values to produce a single position value.

Encoder Channel Address: The first line of the three-line entry contains $F in the first hex digit and the base address of the encoder channel to be read in the low 19 bits (bits 0 to 18). If the bit-19 mode switch of the line is set to 0, Turbo PMAC expects a PMAC-style Servo IC on the interpolator, as in the Acc-51P. If the bit-19 mode switch bit is set to1, Turbo PMAC expects a PMAC2-style Servo IC on the interpolator, as in the Acc-51E.

The following table shows the possible entries when PMAC2-style Servo ICs are used, as in the Acc-51E:

Servo IC #	Channel 1	Channel 2	Channel 3	Channel 4
2	$FF8200	$FF8208	$FF8210	$FF8218
3	$FF8300	$FF8308	$FF8310	$FF8318
4	$FF9200	$FF9208	$FF9210	$FF9218
5	$FF9300	$FF9308	$FF9310	$FF9318
6	$FFA200	$FFA208	$FFA210	$FFA218
7	$FFA300	$FFA308	$FFA310	$FFA318
8	$FFB200	$FFB208	$FFB210	$FFB218
9	$FFB300	$FFB308	$FFB310	$FFB318
2*	$FF8220	$FF8228	$FF8230	$FF8238
3*	$FF8320	$FF8328	$FF8330	$FF8338
4*	$FF9220	$FF9228	$FF9230	$FF9238
5*	$FF9320	$FF9328	$FF9330	$FF9338
6*	$FFA220	$FFA228	$FFA230	$FFA238
7*	$FFA320	$FFA328	$FFA330	$FFA338
8*	$FFB220	$FFB228	$FFB230	$FFB238
9*	$FFB320	$FFB328	$FFB130	$FFB338

Note:

By setting the bit-19 mode switch to 1, the second hex digit changes from 7 to F.

A/D Converter Address: The second line of the entry contains $0 in the first hex digit and the base address of the first of two A/D converters to be read in the low 19 bits (bits 0 to 18). The second A/D converter will be read at the next higher address. The following table shows the possible entries when PMAC2-style Servo ICs are used, as in the Acc-51E:

Servo IC #	Channel 1	Channel 2	Channel 3	Channel 4
2	$078205	$07820D	$078215	$07821D
3	$078305	$07830D	$078315	$07831D
4	$079205	$07920D	$079215	$07921D
5	$079305	$07930D	$079315	$07931D
6	$07A205	$07A20D	$07A215	$07A21D
7	$07A305	$07A30D	$07A315	$07A31D
8	$07B205	$07B20D	$07B215	$07B21D
9	$07B305	$07B30D	$07B315	$07B31D
2*	$078225	$07822D	$078235	$07823D
3*	$078325	$07832D	$078335	$07833D
4*	$079225	$07922D	$079235	$07923D
5*	$079325	$07932D	$079335	$07933D
6*	$07A225	$07A22D	$07A235	$07A23D
7*	$07A325	$07A32D	$07A335	$07A33D
8*	$07B225	$07B22D	$07B235	$07B23D
9*	$07B325	$07B32D	$07B335	$07B33D

A/D Bias Term: The third line of the entry contains the bias in the A/D converter values. This line should contain the value that the A/D converters report when ideally they should report zero. Turbo PMAC subtracts this value from both A/D readings before calculating the arctangent. Many users will leave this value at 0, but it is particularly useful to remove the offsets of single-ended analog encoder signals.

This line is scaled so that the maximum A/D converter reading provides the full value of the 24-bit register (+/-2^{23}, or +/-8,388,608). Generally, it is set by reading the A/D converter values directly as 24-bit values, computing the average value over a cycle or cycles, and entering this value here.

Conversion Result: The result of the conversion is placed in the X-register of the third line of the entry. Careful attention must be paid to the scaling of this 24-bit result. The least significant bit (Bit 0) of the result represents 1/4096 of a line of the sine/cosine encoder.

When Turbo PMAC software reads this data for servo use with Ixx03, Ixx04, Ixx05, or Isx93, it expects to find data in units of 1/32 of a count. Therefore, PMAC software regards this format as producing 128 counts per line. (The fact that the hardware counter used produces four counts per line is not relevant to the actual use of this format; this fact would be used only when reading the actual hardware counter for commutation or debugging purposes.)

Example: This format is used to interpolate a linear scale with a 40-micron pitch (40µm/line), producing a resolution of about 10 nanometers (40,000/4096), used as position feedback for a motor. PMAC considers a count to be 1/128 of a line, yielding a count length of 40/128 = 0.3125 µm. To set user units of millimeters for the axis, the axis scale factor would be:

$$AxisScaleFactor = \frac{1mm}{UserUnit} * \frac{1000\,\mu m}{mm} * \frac{count}{0.3125\,\mu m} = 3200\frac{counts}{UserUnit}$$

It should be noted that a 2-channel Acc-51E Interpolator (without OPT 1) uses 4-channel address field settings. 2-channel interpolators may not overlap 4-channel boundaries.

SW1 position #4 must always be on for Turbo PMAC products.

As a UBUS device, the interpolator input is seen as a whole number counter with three fractional digits. 32 sub-steps occur per single whole number step. Each change of the data is seen by PMAC as 1/32 (0.03125) count. Since PMAC uses fractional arithmetic, the result will be accurate to 1/32 of a whole number step. Refer to the appendix section of this manual for information on how to display encoder position, which includes fractional data.

Note:

The encoder channels in the Acc-51E interpolator are additional to AB digital quadrature inputs that are present on the PMAC's axis card channels. The digital encoder inputs on the axis cards are still available for dual feedback uses such as velocity feedback inputs or handwheel encoders.

Using the PMAC Executive

The PMAC executive program is ideal for setting up the encoder conversion table. There is a list of configuration options in the Configure Encoder Table part of the executive.

1. Choose consecutive entries as desired for each encoder's configuration.
2. Select High-Resolution Interpolator as the conversion style.
3. Be sure that the correct encoder source channel number is also selected.
4. Note the address of the processed data reported in the upper-left portion of the window.
5. Download the new encoder table data to PMAC and select the View All Encoder Entries function to verify that your entries are correct.
6. When finished, close the Configure Encoder Table window and type **SAVE** to store the new encoder table data.

With the above process completed, notice that the data from the interpolator appears in the position window (when Ixx00=1).

Example: Turbo PMAC with Acc-51E for two Encoders

Two 3-line encoder table entries starting at the ninth line in the Encoder Conversion Table.

Turbo PMAC - I Variable	Turbo PMAC Memory Location	
I8008=$FF8200	$3509	
I8009=$078205	$350A	
I8010=$000000	$350B	;data for I103 & I104
I8011=$FF8208	$350C	
I8012=$07820D	$350D	
I8013=$000000	$350E	;data for I203 & I204
I103=$350B	;position 1 feedback address	
I104=$350B	;velocity 1 feedback address	
I203=$350E	;position 2 feedback address	
I204=$350E	;velocity 2 feedback address	
I7210=7	;channel 9 decode	
I7220=7	;channel 10 decode	

Motor xx Homing and Hardware Capture in Triggered Moves

Note:

For the instructions listed below the Turbo PMAC must have firmware version 1.940 or newer.

1. The home and/or index pulse trigger flags must be connected to the Acc-51E board.
2. Set variables I7mn2 and I7mn3 for this Acc-51E channel setup for proper edges of index and/or home flags.
3. Ixx25 must have base address of the corresponding Acc-51E channel.
4. Ixx42 and Ixx43 can be used for separate address for amplifier and limit flags. Usually, these flags are connected to an Acc-24E2x board.
5. Bit 11 of Ixx24 must be set to 1 for capture register to be scaled correctly with interpolated feedback.
6. For sub-count capture (not recommended for homing, but good for probing and registration) set I7mn9=1 and bit 12 of Ixx24=1. This will enable the hardware 1/T interpolation in ASIC and use the sub-count in trigger position. In this case, bits 12 – 23 of the Y-register of the channel's base address (Y:$078000 for Servo IC 0 Channel 1), contain the captured fractional count value. Bit 23 has a value of ½-count, bit 22 has a value of ¼-count, and so on. A count in this context is a "hardware count," which is not necessarily the same as the motor's "software count."
7. Set bit 0 of Ixx97=0 (default) for hardware capture.

Motor xx Homing and Software Capture in Triggered Moves

Ixx97 is used to establish position capture (i.e. Index Position Input). This variable must be set to 1 to function as software index capture. Note that there is a background cycle delay (typically 2-3 mSec), which limits the accuracy of the capture.

A status flag is addressed by Ixx25 points to the address of the flags for software or index capture. If limit switches are used on the axis, Ixx25 must point to the address at which the limit switches occur. If the encoder's index channel is desired for software based homing, and limit switches are used on the axis, the encoder's index signal must be physically cross wired to the same hardware channel input as the flags for this function to work. Usually, the location of the cross-wired index channel input is on the same accessory card on which the limit flags are connected.

Encoder Servo Feedback I- Variables

Servo feedback is established from the set of I-variables for each channel that is located at Ixx03 and Ixx04. These values are addresses that establish an encoder reference that is used by the servo feedback algorithms to maintain a motor's position.

The following encoder table addresses are suggested when they are set up from the procedure that is outlined in Encoder Conversion Table in the PMAC software manuals. Refer to the table below:

	Ixx03,Ixx04 Value	**Conversion Table 1st Line Entry**	**Conversion Table 2nd line Entry**	**Conversion Table 3rd line Entry**
Processed Encoder #1	$3501	I8000	n.a. (single-line entry)	
Processed Encoder #2	$3502	I8001	n.a.	
Processed Encoder #3	$3503	I8002	n.a.	
Processed Encoder #4	$3504	I8003	n.a.	
Processed Encoder #5	$3505	I8004	n.a.	
Processed Encoder #6	$3506	I8005	n.a.	
Processed Encoder #7	$3507	I8006	n.a.	
Processed Encoder #8	$3508	I8007	n.a.	
Processed Encoder #9	$350B	I8008=$FF8200	I8009=$78205	I8010=00
Processed Encoder #10	$350E	I8011=$FF8208	I8012=$7820D	I8013=00
Processed Encoder #11	$3511	I8014=$FF8210	I8015=$78215	I8016=00
Processed Encoder #12	$3514	I8017=$FF8218	I8018=-$7821D	I8019=00
Processed Encoder #13	$3517	I8020=$FF8310	I8021=-$78305	I8022=00

These addresses are actually the default addresses used by Turbo PMACs for single-line encoder table references that represent axis 1 through 8. Processed encoders 9 through 12 represent sample entries for a UBUS interpolator with SW1 settings selected for all switches on or configurable slot #1(refer to tables in the previous section).

Note:

The encoder table addressing starts at memory location $3501. Turbo PMAC processes all table entries until it finds a first line entry set to 00 (unused). There must not be any address gaps between the first and last encoder table entry.

Note:

Due to timing constraints with the interpolator's conversion processes, the interpolator's encoder conversion table entries should be placed at the contiguous end of the table. The interpolator may place unnecessary wait states back to the Turbo PMAC's processor if the conversion table entries are placed at the beginning of the conversion table.

UMAC MACRO STATION PROCESSOR AND THE UMAC INTERPOLATOR

There are two ways to establish a setup for the Acc-51E when it is used with the UMAC MACRO Station Processor.

Method 1: Assign Acc-51E into Four Axes

The easiest way to configure the interface requires that the Acc-51E appears as four axes to the MACRO station processor. When used in the configuration, I-variables are available for establishing the encoder decode control and position compare registers.

Note:

Hiperface is not available if the Acc-51E is configured as axes on the MACRO station.

I-Variables for UMAC MACRO Station Processor

Refer to the UMAC MACRO Station Software Reference for details about how to set the MI-Variables.

To properly process the interpolator's data, several I-Variables must be set in the UMAC MACRO Station:

MS{node},MI101 - MI108 Ongoing Position Source Address

MS{node},MI101 - MI108 is used to point to the MACRO Station's encoder table (see encoder conversion table section below) as referenced by MI-Variables MI120 - MI151.

The following table shows how these variables are established for the Acc-51E:

MI-Var	Motor Node	Value For Acc-51E
MI101	First Motor	$0012
MI102	Second Motor	$0015
MI103	Third Motor	$0018
MI104	Fourth Motor	$001B

The encoder table entries for Acc-51E are three lines long. The table above shows how the first four axes might be assigned.

MS{node},MI910 Encoder/Timer n Decode Control

MS{node},MI910 is used to establish encoder decoding. Node is the MACRO Station's slave node number as established by the setting of SW1 on the UMAC MACRO CPU processor card. The encoder decode control I-Variable is set for each channel that an interpolator is connected to.

A value of 7 is used as default for CCW x4 Quadrature decode. Changing the decode direction requires the operator to save the UMAC MACRO Processor's parameters and perform a $$$ or cycle power.

Note:

The MACRO Processor must be reset if the encoder direction has been changed, to prevent encoder instability.

Motor Homing, Software Capture

Motor Homing Capture is done in the MACRO Master controller. Typically, these are the PMAC2 Ultralite or the Turbo PMAC2 Ultralite.

PMAC2 Software Homing

Ix03, Ix25, I9n2, and I9n3 are set in the PMAC2 Ultralite to configure for software homing capture. Refer to the PMAC/PMAC2 Software Reference Manual for the details of setting these I-variables.

Ix03 Notes

Bit 16 must be set to 1 in I-variable Ix03 on the PMAC2 Ultralite. This register also contains the address of the position feedback register. For single encoder feedback applications, Ix04 is set to the same value as Ix03 (except bit 16 is always 0).

Ix25 Notes
Ix25 is set to the address of the flag inputs. This does not need to be the same address as Ix03. However, if the value of Ix25 is different from Ix03, the Index input on the Acc-5E must be wired to the channel that is pointed to by Ix25.

Usually, Ix25 is set to the same address as Ix03 except when limit switches are used (such as PLIM, MLIM, HOMEFLG, USER).

I9n2 Notes
I9n2 is set to determine the kind of position triggering that will occur in the homing move. Set this value to 1 or 5 if only the index (channel C) of the encoder is used. The software reference manual provides the details for setting this variable.

I9n3 Notes
I9n3 is set only if I9n2 has a setting that involves flags (such as PLIM, MLIM, HOMEFLG, USER).

Turbo PMAC2 UltraLite Software Homing
Ixx03, Ixx24, Ixx25, Ixx97, I68n2, I7mn2, I68n3 and I7mn3 are set in the Turbo PMAC2 Ultralite to configure for software homing capture. Refer to the Turbo PMAC2 Software Reference manual for the details of setting these I-variables.

Ixx03 Notes
This register contains the address of the position feedback register. For single encoder feedback applications, Ix04 is set to the same value as Ixx03.

Ixx24 Notes
This register is default set by the Turbo Ultralite to $840001.

Ixx25 Notes
Ixx25 is set to the location of the flag inputs. This does not need to be the same location as Ixx03. However, if the value of Ixx25 is different from Ixx03, the Index input (encoder channel C) on the Acc-5E must be physically wired to the channel that is pointed to by Ixx25.

Usually, Ixx25 is set to the same address as Ixx03 except when limit switches are used (such as PLIM, MLIM, HOMEFLG, USER).

Ixx97 Notes
Ixx97 is used to establish position capture (i.e. Index Position Input). This variable must be set to 1 to function as software index capture. Note that there is a background cycle delay (typically 2-3 mSec), which limits the accuracy of the capture.

Encoder Conversion Table (in UMAC MACRO CPU)
The encoder conversion table is a user-configurable list of entries that may be assigned to different specific data processing inputs. The interpolator is assigned into the encoder conversion table inside the UMAC MACRO CPU. This entry uses an encoder method digit value (bit 16-19) of $Fxxxx. Refer to the description of I-Variables MI120-MI151in the UMAC MACRO Station Software Reference for Encoder Conversion Table, Entries (I-variables I8000-I8191) for details.

Note:

The UMAC MACRO CPU has the encoder conversion table that is located inside the MACRO station. The actual data conversion is performed inside the station and gets shifted to the appropriate MACRO registers as feedback to the PMAC2 Ultralite controller. The encoder table in the PMAC Ultralite controller usually needs no modification from factory default values to receive data from a MACRO Station.

The following table describes the three-line MI-variables that must be configured for the UBUS Interpolator. Note the dipswitch configuration: addressable backplane is not allowed for UMAC MACRO Station systems.

Interp SW1 Settings:		**4**	**3**	**2**	**1**	**CS2**
	1st Intrp	off	off	on	on	

I-Variable	1st Line Setting	2nd Line Setting	3rd Line Setting	Meaning
MI120,MI121,MI122	$F0C040	$C045	$00	Acc-51E Encoder Ch 1
MI123,MI124,MI125	$F0C048	$C04D	$00	Acc-51E Encoder Ch 2
MI126,MI127,MI128	$F0C050	$C055	$00	Acc-51E Encoder Ch 3
MI129,MI130,MI131	$F0C058	$C05D	$00	Acc-51E Encoder Ch 4

Interp SW1 Settings:		**4**	**3**	**2**	**1**	**CS3**
	2nd Intrp	off	off	off	off	

I-Var.	1st Line Setting	2nd Line Setting	3rd Line Setting	Meaning
MI120,MI121,MI122	$F0C060	$C065	$00	Acc-51E Encoder Ch 1
MI123,MI124,MI125	$F0C068	$C06D	$00	Acc-51E Encoder Ch 2
MI126,MI127,MI128	$F0C070	$C075	$00	Acc-51E Encoder Ch 3
MI129,MI130,MI131	$F0C078	$C07D	$00	Acc-51E Encoder Ch 4

It should be noted that a 2-channel Acc-51E Interpolator (without OPT 1) uses 4-channel address field settings. 2-channel interpolators may not overlap 4-channel boundaries.

On the Acc-51E, SW1 position #3 and #4 must always be off for Turbo PMAC products. Jumper E1 (if present) should always be set to Turbo (pos 1 - 2) for proper address decoding.

As a UBUS device, the interpolator input is seen as a whole number counter with three fractional digits. 32 sub-steps occur per single whole number step. Each change of the data is seen by PMAC as 1/32 (0.03125) count. Since PMAC devices use fractional arithmetic, the result will be accurate to 1/32 of a whole number step.

Note:

The encoder channels in the Acc-51E interpolator are additional to AB digital quadrature inputs that are present on the PMAC's axis card channels. The digital encoder inputs on the axis cards are still available for dual feedback uses such as velocity feedback inputs or handwheel encoders.

When dual feedback is used, the MI-Variable values shown in the table above will be different.

Method 2: Set Registers Using MI198 and MI199

The general idea of this method is to set the registers in the Acc-51E to their proper values and not use up the four axes as they are used in Method 1 above. The Acc-51E may be mapped into an unused address space and manually configured.

Since it is possible to have a UMAC MACRO Station that has two 4-axis stack cards, it is possible to insert up to two Acc-51E cards into the MACRO station and not have any address conflicts. This will allow up to eight axes with dual-encoder feedback to be used where each axis has a single quadrature encoder and a sinusoidal encoder.

This method uses MI198 and MI199 and requires a startup PLC to be written in the PMAC2 Ultralite controller. Refer to the UMAC MACRO Station Software reference for the typical usage of these variables.

The values that are set into the registers do not need to be exactly what is referenced here, but to simplify the method of configuration; the values presented here are based upon defaults commonly used with the Acc-51 interpolators.

Configure UMAC MACRO Station MI-Variables for Acc-51E

MS{node},MI101 - MI108 Ongoing Position Source Address

MS{node},MI101 - MI108 is used to point to the MACRO Station's encoder table (see encoder conversion table section below) as referenced by MI-Variables MI120 - MI151.

The table below shows how these variables are established for the Acc-51E:

MI-Var	Motor Node	Value For Acc-51E
MI101	1st Motor	$0012
MI102	2nd Motor	$0015
MI103	3rd Motor	$0018
MI104	4th Motor	$001B

The encoder table entries for Acc-51E are three lines long. The table above shows how the first four axes might be assigned.

Encoder Conversion Table

To set up the MACRO Station for a single Acc-51E accessory card, the configuration in the following table might be chosen. This will locate the Acc-51E at a memory base address of $C060. This is the location of CS3- in the MACRO station's backplane address.

Interp SW1 Settings:		**4**	**3**	**2**	**1**	**CS3**
	2nd Intrp	off	off	off	off	

I-Var.	1st Line Setting	2nd Line Setting	3rd Line Setting	Meaning
MI120,MI121,MI122	$F0C060	$C065	$00	Acc-51E Encoder Ch 1
MI123,MI124,MI125	$F0C068	$C06D	$00	Acc-51E Encoder Ch 2
MI126,MI127,MI128	$F0C070	$C075	$00	Acc-51E Encoder Ch 3
MI129,MI130,MI131	$F0C078	$C07D	$00	Acc-51E Encoder Ch 4

This table is identical to the table described in method #1 above. The encoder conversion table in the MACRO Station must always be configured. Save the MACRO Station's EErom (type MSSAVx) to preserve the above table's data.

Configure Registers Inside the Acc-51E

To set up the registers in the Acc-51E accessory card, the data in the following table is recommended:

Register Address	Value	Description
X:$C064	$0038D2	Global Clock Control for Channels 1 - 4
X:$C065	$000007	Control Word for Channel 1
X:$C06D	$000007	Control Word for Channel 2
X:$C075	$000007	Control Word for Channel 3
X:$C07D	$000007	Control Word for Channel 4

Global Clock Control Word

X:$C064 IC Global Control Word.
X:$C064 bits 0-11 (is set similar to MI903)
X:$C064 bit 12 Phase Clock Direction (0=output, 1=input) (This must be 1 in Acc-51E)
X:$C064 bit 13 Servo Clock Direction (0=output, 1=input) (This must be 1 in Acc-51E)
X:$C064 bit 14 - 23, not used- Set to zeros

Control Word for Channels 1 - 4

X:$C065, $C06D, $C075, $C07D Channel n Control Word
Bits 0-3 Encoder Decode Control (is set similar to MI910):

00: Pulse and direction decode
01: x1 quadrature decode
10: x2 quadrature decode
11: x4 quadrature decode

Bits 2-3: Direction & Timer Control (Acc-51E uses 00 or 01 only to establish encoder direction)

00: Standard timer control, external signal source, no inversion
01: Standard timer control, external signal source, invert direction
10: Standard timer control, internal PFM source, no inversion (not used by Acc-51E)
11: Alternate timer control, external signal source (not used by Acc-51E)

Bits 4-23: Not used by the Acc-51E (Set these values to 0)

Note:

The Acc-51E uses a DSPGATE1 gate array device. A more detailed description of the registers may be obtained from the PMAC software reference manuals.

Configure Registers Inside the UMAC MACRO Station Processor

There is a single parameter per channel that must be poked into the MACRO Station processor's registers; this data is dependent upon the direction that was set in the control word when configuring the Acc-51E registers.

Put the data that is copied into the control word for each channel into the X register of the first encoder table entry for the channel used.

The chart below indicates where the encoder table entries MI120 - MI151 are pointing to in the UMAC MACRO station's memory map:

MI-Var.	Address	MI-Var.	Address	MI-Var.	Address	MI-Var.	Address
MI120	$0010	MI128	$0018	MI136	$0020	MI144	$0028
MI121	$0011	MI129	$0019	MI137	$0021	MI145	$0029
MI122	$0012	MI130	$001A	MI138	$0022	MI146	$002A
MI123	$0013	MI131	$001B	MI139	$0023	MI147	$002B
MI124	$0014	MI135	$001C	MI140	$0024	MI148	$002C
MI125	$0015	MI136	$001D	MI141	$0025	MI149	$002D
MI126	$0016	MI137	$001E	MI142	$0026	MI150	$002E
MI127	$0017	MI138	$001F	MI143	$0027	MI151	$002F

If the base address of the encoder conversion table entry is at MI120, then the value of the control word (recommended in the above section as $000007) should be poked into the MACRO Station processor's memory at X:$0010.

Example Program to Configure Registers MI198 & MI199

The following example shows a startup PLC that must be written in the PMAC Ultralite Master controller that will configure the registers needed to operate the Acc-51E.

This sample program will set the registers for four channels of sinusoidal encoder inputs that will appear at axes 1 through 4 on the UMAC MACRO Station controller. The controller should not be configured to include the Acc-51E interpolator as four axes for this example to work correctly.

The dipswitches should be set per the second Interp addressing as described in the table above.

```
OPEN PLC1 CLEAR
P1=$E8C064 MSW0,MI198,P1      ;Point to Global Clock Control Register.
P2=$0038D2 MSW0,M199,P2       ;Put $38D2 into the register.
P1=$E8C065 MSW0,MI198,P1      ;Point to control word for channel 1.
P2=$000007 MSW0,MI199,P2      ;Put $07 into the register.
P1=$E8C06D MSW0,MI198,P1      ;Point to control word for channel 2.
MSW0,MI199,P2                 ;Put $07 into the register.
P1=$E8C075 MSW0,MI198,P1      ;Point to control word for channel 3.
MSW0,MI199,P2                 ;Put $07 into the register.
P1=$E8C07D MSW0,MI198,P1      ;Point to control word for channel 4.
MSW0,MI199,P2                 ;Put $07 into the register.
P1=$E80010 MSW0,MI198,P1      ;Point to 1st 3-line entry in encoder conversion table (X side).
P2=$000007 MSW0,MI199,P2      ;Place control word here (must be the same as #1 above)
P1=$E80013 MSW0,MI198,P1      ;Point to 2nd 3-line entry in encoder conversion table (X side).
MSW0,MI199,P2                 ;Place control word here (must be the same as #2 above)
P1=$E80016 MSW0,MI198,P1      ;Point to 3rd 3-line entry in encoder conversion table (X side).
MSW0,MI199,P2                 ;Place control word here (must be the same as #3 above)
P1=$E80019,MSW0,MI198,P1      ;Point to 4th 3-line entry in encoder conversion table (X side).
MSW0,MI199,P2                 ;Place control word here (must be the same as #4 above)
DISPLC1                       ;Run this PLC only once at startup or MACRO Station reset.
CLOSE
```

The above program assumes that the UMAC MACRO Station is set to operate at node 0. Refer to the PMAC2 Software Reference Manual or the Turbo PMAC2 Software Reference Manual for the usage of the MSWx and MSRx commands.

This program must be executed only once at power-up or station reset in the UMAC MACRO Station.

HIPERFACE INTERFACE OPTION (OPT2)

The Hiperface interface option is designed to operate the digital portion of SINCOS and SINCODER devices from Stegmann Corporation. The High Resolution Interpolator with Hiperface option supports commands that apply to the motion needs of PMAC products. These commands include absolute position, encoder temperature, sine-output mux (sincoder), index on RS485 lines (sincoder), encoder reset, error status, and encoder type.

SINCOS Encoders

SINCOS encoders from Stegmann Corp. use a microcontroller inside their encoders to provide a serial link, which is capable of transferring data to and from the encoder without affecting the sinusoidal output. Depending upon the model of encoder, different parameters pertaining to absolute position (single or multi-turn), encoder temperature, encoder type, and presence of encoder may be determined.

Absolute position is returned with a resolution of 16,384 counts per revolution in the SCS/SCM 60 and SCS/SCM 70 encoders.

The SCM 60 and SCM 70 models are capable of multi-turn absolute position reporting of up to 4096 revolutions of 16,384 steps per revolution. They have absolute position counters that roll over at 67,108,864 counts.

The SCS 60 and SCS 70 models are capable of single-turn absolute position reporting of 16,384 steps per revolution. They have absolute position counters that roll over at 16,384 counts.

Note:

An application for the SINCOS Hiperface interface option is PMAC's power-on position for establishing the commutation position in brushless servomotors. This application uses the SINCOS encoder models in single-turn configuration.

SINCODER Encoders

SINCODER encoders from Stegmann Corp. also use a microcontroller inside their encoders to provide a serial link, which is capable of obtaining data from the encoder without affecting the sinusoidal output. Parameters pertaining to encoder type and presence of encoder may be determined on a SINCODER.

SINCODERs are also capable of changing the type of sinusoidal outputs that they provide. The power-up default output resolution is typically 1024 sine cycles per revolution. The SINCODER is capable of being switched into a mode that outputs one sine cycle per revolution.

The serial data line may be set to output the index pulse from the sincoder. This output, when selected, sets the RS485 digital output until the index mark is reached. The RS485 line drops low when the index pulse is reached inside the encoder.

How to Contact Stegmann Inc.

USA:	Europe: (Encoder Division)
Ph: (937) 454-1956	Ph: +49-771-807-121
Fx: (937) 454-1955	Fx: +49-771-807-100
Web: http://www.stegmann.com	Web: http://www.stegmann.de

Using Hiperface

Upon power-up the Hiperface interface performs a Read Position Shifted command and leaves its data in the output registers.

Hiperface is defined as a 32-bit protocol. Therefore, in the 24-bit PMAC environment there are two sets of 24-bit registers needed for Hiperface transactions.

<table>
<tr><th>Bit</th><th>23</th><th>22</th><th>21</th><th>20</th><th>19</th><th>18</th><th>17</th><th>16</th><th>15</th><th>14</th><th>13</th><th>12</th><th>11</th><th>10</th><th>9</th><th>8</th><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th>0</th></tr>
<tr><td rowspan="2">Base + 2 address</td><td colspan="24">24 LSB Bits of Result</td></tr>
<tr><td colspan="16">Don't Care</td><td colspan="8">Encoder Command Word</td></tr>
</table>

<table>
<tr><th>Bit</th><th>23</th><th>22</th><th>21</th><th>20</th><th>19</th><th>18</th><th>17</th><th>16</th><th>15</th><th>14</th><th>13</th><th>12</th><th>11</th><th>10</th><th>9</th><th>8</th><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th>0</th></tr>
<tr><td>Base + 3 address</td><td colspan="16">Status Bits</td><td colspan="8">8 MSB Bits of Result</td></tr>
</table>

The diagrams above show how the two registers are used. By placing a command into the eight LSBs of the first register, all four encoders are commanded to respond.

Note:

All four encoders are commanded to respond when any one of the command registers receives a command. Therefore, it is necessary to issue only one command for all connected encoders.

Using M-variables for Hiperface (Turbo Processor Only)

When using a Turbo PMAC the Hiperface interface involves the use of three M-variables. A PLC program should be written that implements the transactions that are used with these m-variables.

If the base address of the Acc-51E is at $78200, assign the M-variables as follows:

FLAG M-Variables

	UMAC Turbo
Channel 1	M10->y:$78203,16,1
Channel 2	M20->y:$78203,17,1
Channel 3	M30->y:$78203,18,1
Channel 4	M40->y:$78203,19,1

LSB Register M-Variables

	UMAC Turbo
Channel 1	M11->y:$78202,24
Channel 2	M21->y:$7820A,24
Channel 3	M31->y:$78212,24
Channel 4	M41->y:$7821A,24

MSB Register M-Variables

	UMAC Turbo
Channel 1	M12->y:$78203,0,8
Channel 2	M22->y:$7820B,,08
Channel 3	M32->y:$78213,0,8
Channel 4	M42->y:$7821B,0,8

Hiperface Register Operation

The flag M-variables are set to 1 while the Hiperface interface is performing the commanded operation. At the beginning of the commanded operation, the LSB Register is set to 000000 for the conversion.

When the commanded operation is complete, the LSB and MSB registers will contain data and the flag register will be set to 0.

If the flag register remains a 1 and the LSB register has a number other than 000000 then there is an error on that encoder's response.

HiperFace Absolute Position Read Example

```
// Definitions and Substitutions:
M10->y:$78203,16,1      ; Channel1 Status Bit
M20->y:$78203,17,1      ; Channel2 Status Bit
M30->y:$78203,18,1      ; Channel3 Status Bit
M40->y:$78203,19,1      ; Channel4 Status Bit
M11->y:$78202,24        ; Channel1 LSB data word (24 bits)
M21->y:$7820A,24        ; Channel2 LSB data word (24 bits)
M31->y:$78212,24        ; Channel3 LSB data word (24 bits)
M41->y:$7821A,24        ; Channel4 LSB data word (24 bits)
M12->y:$78203,0,8       ; Channel1 MSB data word (upper 8 bits of 32-bit)
M22->y:$7820B,0,8       ; Channel2 MSB data word (upper 8 bits of 32-bit)
M32->y:$78213,0,8       ; Channel3 MSB data word (upper 8 bits of 32-bit)
M42->y:$7821B,0,8       ; Channel4 MSB data word (upper 8 bits of 32-bit)

I5=I5|2                 ; Allow Background PLCs to run
// Example PLC to read absolute position, Channel1:
OPEN PLC 1 CLEAR                            ; Open Buffer, clear contents
M11= $42                                    ; HiperFace Command, Read Position
I5111=20*8388608/I10 while(I5111>0) EndW    ; 20 msec delay to allow conversion
While( M10=1 and M11=0 )EndW                ; Wait until conversion is complete
IF( M10=1 )                                 ; Check for error condition
(M11<>0)
      SENDS"ERROR - CODE ="                 ; Send MSG if so
      CMDS"M11"                             ; This is error number
ELSE
      P1=(M12*65536)+M11                    ; No error, send Encoder Position
ENDIF
DIS PLC1                                    ; Run PLC only once
CLOSE
```

Hiperface Commands

Refer to the encoder's manual for the details of each Hiperface command.

The following commands are available for Hiperface Encoders:

Sincos	Sincoder	Value	Description	4TH Byte (8 Bits)	3RD Byte (8 Bits)	2ND Byte (8 Bits)	1ST Byte (8 Bits)
[		030h	Enc Temperature	00	00	Bits 8-15	Bits 0-7
	[	038h	Set to 1024 Lines	00	00	00	00h
	[	039h	Set to 1 line	00	00	00	01h
[		03Fh	Read Position Shifted	Bits 24-31	Bits 16-23	Bits 8-15	Bits 0-7
[		042h	Read Position	Bits 24-31	Bits 16-23	Bits 8-15	Bits 0-7
[		043h	Set Position to 00	00	00	00	00
[	[	050h	Error Status	00	00	00	Value
[	[	052h	Encoder Type	RS485 mode	Enc Type	EErom Size	Channel
[	[	053h	Encoder Reset	00	00	00	00
	[	054h	Set Index Output	00	00	00	00
	[	05Fh	Set Index Perm	00	00	00	00

030h Encoder Temperature

This command returns a 16-bit value of encoder temperature in °C. Use the following equation to obtain the actual encoder temperature:

$$Enc.\ Temp\ (^{\circ}C) = \frac{Digital\ value + 40}{2.048}$$

038h Set Sincoder to 1024 Line Mode

This command sets a sincoder's MUX to 1024 lines/revolution mode. This is the default value for the SINCODER at power-up. The value returned should be 00 in the LSB registers.

039h Set Sincoder to 1 Line Mode

This command sets a sincoder's MUX to 1 lines/revolution mode. The value returned should be 00 in the LSB registers.

03Fh Read Sincos Absolute Position Shifted

This command returns the 32-bit absolute position counter value of the Sincos encoder shifted by 4 bits. This function is required by the PMAC for proper data scaling when calculating power-on position. This command executes automatically at startup.

042h Read Sincos Absolute Position

This command returns the 32-bit absolute position counter value of the Sincos encoder.

043h Set Sincos Absolute Position to Zero

This command resets the encoder's absolute position counter to a value of zero. The value of the return registers is set to zero.

050h Read Encoder Error Status Register

This command returns the value that is stored in an error register inside the Hiperface encoder. After reading, this register is reset to 00.

00h	No Errors	
01h	Encoder analog signals are unreliable	
02h	Wrong synchronization or offset	
03h	Data field operations disabled	*
04h	Analog monitoring inoperative	
05h,06h,07h	Internal hardware fault detected, encoder not operational	
08h	Counting register overflow	*
09h	Transmitted parity is incorrect	
0Ah	Checksum of transmitted data is wrong	
0Bh	Invalid command code	
0Ch	Wrong number of data bytes sent	
0Dh	Illegal transmitted command argument	
0Eh	Selected field has Read Only status	*
0Fh	Wrong access authorization specified	
10h	Data field definition error (field size is incorrect)	*
11h	Specified field address not available	*
12h	Selected field does not exist	*
1Ch, 1Dh	Sampling error, encoder not operational	
1Eh	Permissible operating temperature exceeded	
*These error codes are related to functions that are not used by PMAC's Hiperface interface. They are provided here for reference purposes only.		

052h Read Encoder Characteristics

This command returns the encoder's characteristics. There are four 8-bit data fields returned from this command. They are:

First byte	Channel
Second byte	EEPROM size
Third byte	Encoder type
Fourth byte	RS485 mode

Channel -	**The number of optional analog inputs**
EEPROM size -	Encoder's built-in EEPROM size (EEPROM size * 16) - 128 = EEPROM memory size in bytes
Encoder Type -	Type of encoder: Multi-turn = 07h Single-turn= 02h SINCODER = 12h
RS485 mode -	Serial data mode Should be E4h - 9600Baud, parity odd, 4.5mS timeout, With 120Ω terminating resistor.

053h Reset Encoder

This command is used for reinitializing the encoder.

054h Set Sincoder to Index Output Temporarily

This command sets the Sincoder to apply a low signal to the RS485 digital output lines until an internal index mark is detected.

The low signal occurs approximately 6mS after the command is received at the Sincoder. The output will go to high level to show the index mark present for the duration of the active index mark location. When the Sincoder is removed from the index mark, the signal will go low for approximately 5mS and then revert to the digital RS485 mode and await more Hiperface commands.

05Fh Set Sincoder to Index Output Permanently

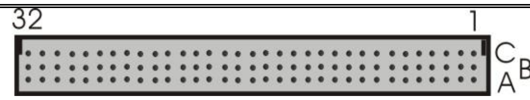
This command sets the Sincoder to apply the index mark to the RS485 digital output lines.

The low signal occurs approximately 6mS after the command is received at the Sincoder. The output will go to high level to show the index mark present for the duration of the active index mark location.

When power is removed from the Sincoder, it will revert to the digital RS485 mode.

CONNECTOR DESCRIPTIONS

P1: UBUS Interface Connector

(96 pin EURO-Connector)		 Front View on Accessory Card	
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	PWRGUD	+15Vdc
31	GND	GND	GND
32	+5Vdc	+5Vdc	+5Vdc

Note:

This table represents the standard UBUS backplane connector. The gray boxes represent signals that are not connected on this accessory board.

J1 Programming Header (Option 2)

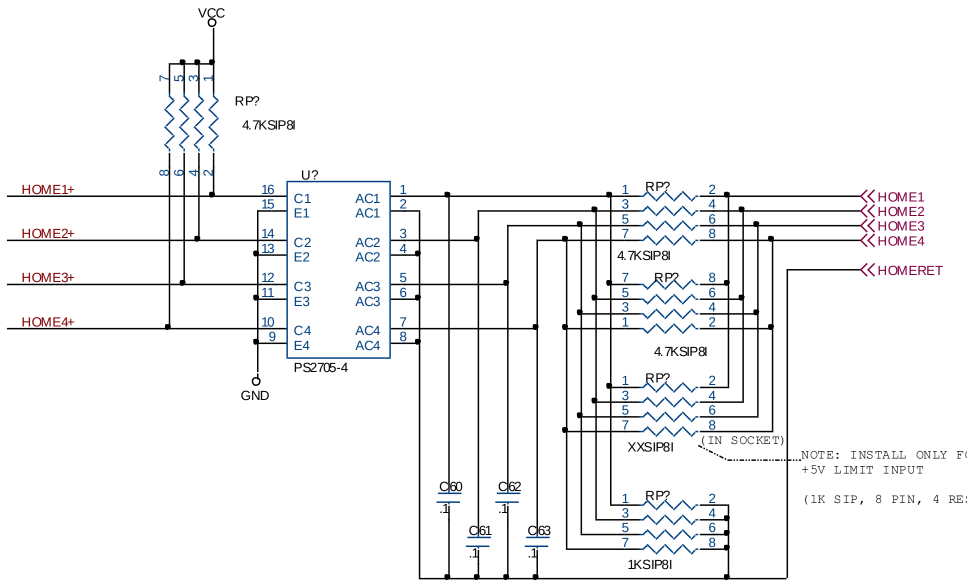
This 6-pin header is used by manufacturing to program the on-board processor.

J2 Programming Header

This 6-pin header is used by manufacturing to program the UMAC decoder chip.

Home Flag Circuit for rev 104 and below

The circuit used for the home flag inputs is shown below for reference. This circuit is used when the home capture firmware is implemented (Second Quarter 2000).

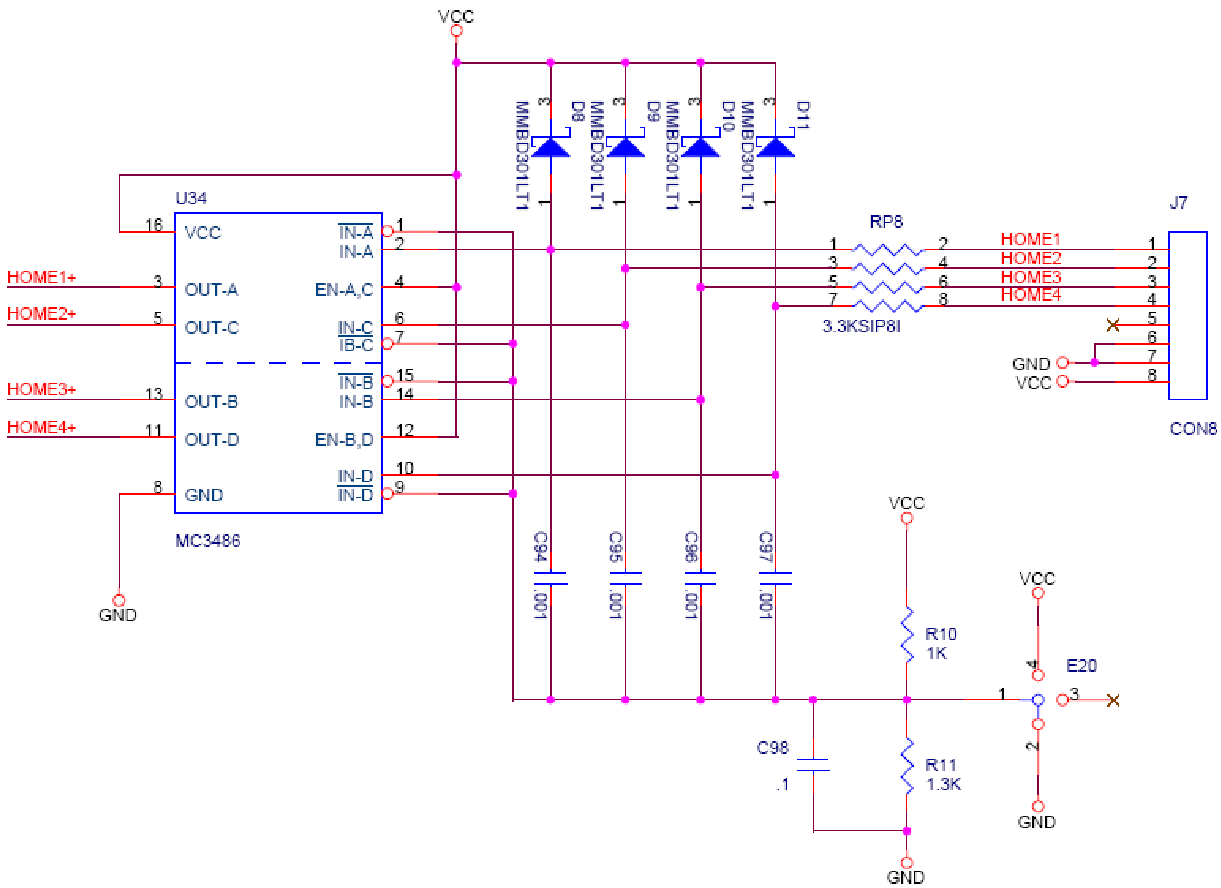


Home Flag Circuit for rev 105

The circuit used for the home flag inputs is shown below for reference. This circuit is used when the home capture firmware is implemented (Second Quarter 2000).

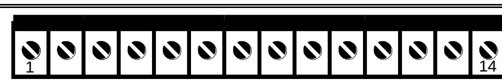
J7 Home Flag Header

Pin#	Symbol	Function	Description	Notes
1	HOME1	Output	TTL EQU Signal	
2	HOME2	Output	TTL EQU Signal	
3	HOME3	Output	TTL EQU Signal	
4	HOME4	Output	TTL EQU Signal	
5	N.C.			
6	GND		Digital ground	
7	GND		Digital ground	
8	VCC	Input		



J3, J4 Encoder Inputs for rev 104 and below

(14 pin Mini-Combicon)

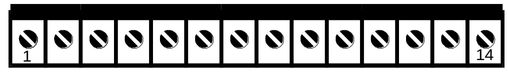


Pin #	Symbol	Function	Description	Notes
1	SIN+	Analog Input	Sinusoidal input+	
2	SIN-	Analog Input	Sinusoidal input-	
3	COS+	Analog Input	Cosine input+	
4	COS-	Analog Input	Cosine input-	
5	INDEX+	Input	Index input	Analog or TTL levels
6	INDEX-	Input	Index input	Analog or TTL levels
7	ENCPWR	Output	Encoder power	+5Vdc (from UBUS)
8	GND		Digital ground	
9	GND		Digital ground	
10	HOME	Input	Home Circuit	
11	HOMERET	Input	Home circuit return	This circuit return is connected to J3, J4, J5, J6
12	DATA+	I/O	RS485 digital +	Hiperface (Option 2)
13	DATA-	I/O	RS485 digital -	Hiperface (Option 2)
14	VREF	2.5V Output	A-D reference output	5KΩ output

J3 is for the first channel input and J4 is for the second channel input to the UBUS interpolator.

J5, J6 Encoder Inputs (Opt 1) for rev 104 and below

(14 pin Mini-Combicon)



Front View

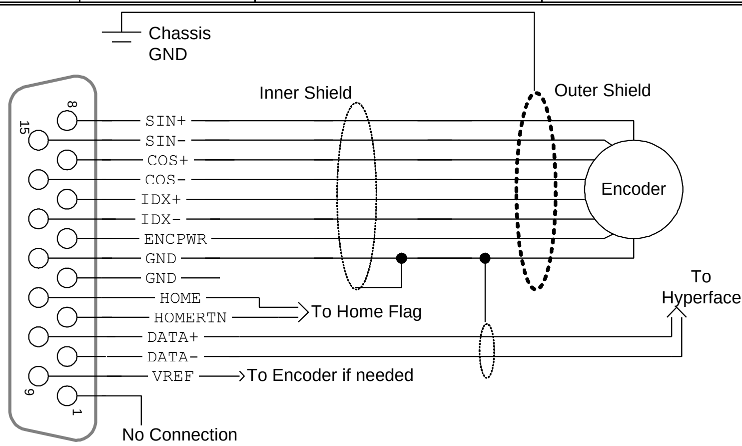
Pin #	Symbol	Function	Description	Notes
1	SIN+	Analog Input	Sinusoidal input+	
2	SIN-	Analog Input	Sinusoidal input-	
3	COS+	Analog Input	Cosine input+	
4	COS-	Analog Input	Cosine input-	
5	INDEX+	Input	Index input	Analog or TTL levels
6	INDEX-	Input	Index input	Analog or TTL levels
7	ENCPWR	Output	Encoder power	+5Vdc (from UBUS)
8	GND		Digital ground	
9	GND		Digital ground	
10	HOME	Input	Home Circuit	
11	HOMERET	Input	Home circuit return	This circuit return is connected to J3, J4, J5, J6
12	DATA+	I/O	RS485 digital +	Hiperface (Option 2)
13	DATA-	I/O	RS485 digital -	Hiperface (Option 2)
14	VREF	2.5V Output	A-D reference output	5KΩ output
J5 is for the first channel input and J6 is for the second channel input to the UBUS interpolator.				

J1A, J2A Top - Enc 1 & 2 for rev 104 and below

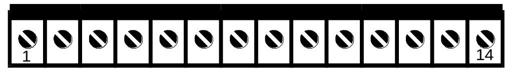
Pin#	Symbol	Function	Description	Notes
1				No Connection
2	DATA-	I/O	RS485 digital -	Hiperface (Option 2)
3	HOMERET	Input	Home circuit return	This circuit return is connected to J3, J4, J5, J6
4	GND		Digital ground	
5	ENCPWR	Output	Encoder power	+5Vdc (from UBUS)
6	INDEX+	Input	Index input	Analog or TTL levels
7	COS+	Analog Input	Cosine input+	
8	SIN+	Analog Input	Sinusoidal input+	
9	VREF	2.5V Output	A-D reference output	5KΩ output
10	DATA+	I/O	RS485 digital +	Hiperface (Option 2)
11	HOME	Input	Home Circuit	
12	GND		Digital ground	
13	INDEX-	Input	Index input	Analog or TTL levels
14	COS-	Analog Input	Cosine input-	
15	SIN-	Analog Input	Sinusoidal input-	

DB15 Style Connector J1A, J2A Bottom - Encoder 3 & 4

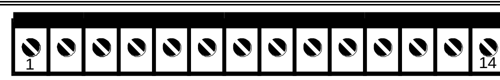
Pin#	Symbol	Function	Description	Notes
1				No Connection
2	DATA-	I/O	RS485 digital -	Hiperface (Option 2)
3	HOMERET	Input	Home circuit return	This circuit return is connected to J3, J4, J5, J6
4	GND		Digital ground	
5	ENCPWR	Output	Encoder power	+5Vdc (from UBUS)
6	INDEX+	Input	Index input	Analog or TTL levels
7	COS+	Analog Input	Cosine input+	
8	SIN+	Analog Input	Sinusoidal input+	
9	VREF	2.5V Output	A-D reference output	5KΩ output
10	DATA+	I/O	RS485 digital +	Hiperface (Option 2)
11	HOME	Input	Home Circuit	
12	GND		Digital ground	
13	INDEX-	Input	Index input	Analog or TTL levels
14	COS-	Analog Input	Cosine input-	
15	SIN-	Analog Input	Sinusoidal input-	



DB15 Style Connector J3, J4 Encoder Inputs rev 105

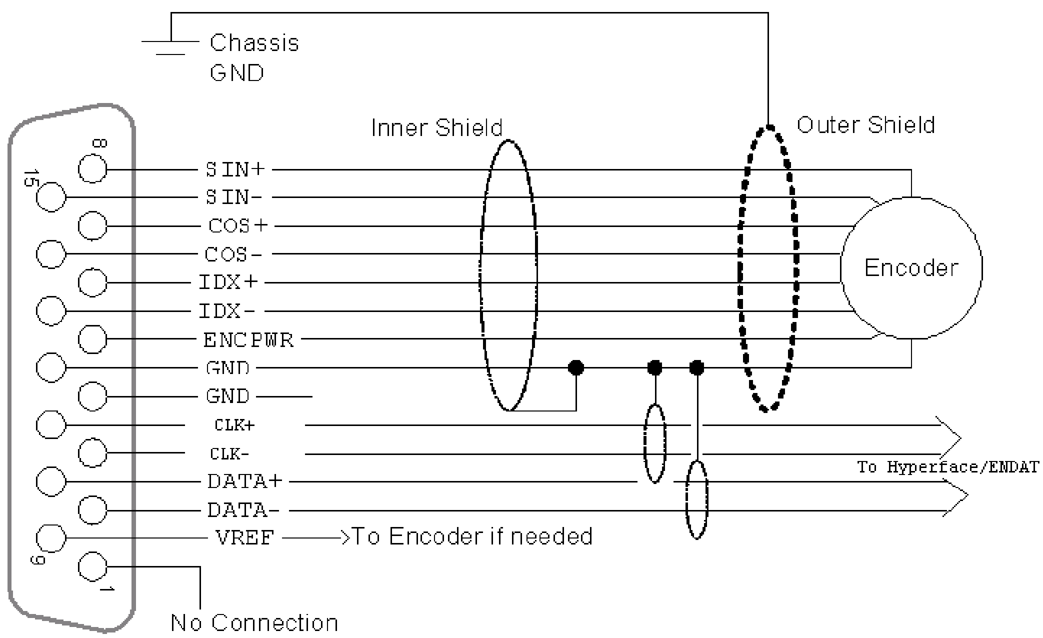
(14 pin Mini-Combicon)			 Front View	
Pin #	**Symbol**	**Function**	**Description**	**Notes**
1	SIN+	Analog Input	Sinusoidal input+	
2	SIN-	Analog Input	Sinusoidal input-	
3	COS+	Analog Input	Cosine input+	
4	COS-	Analog Input	Cosine input-	
5	INDEX+	Input	Index input	Analog or TTL levels
6	INDEX-	Input	Index input	Analog or TTL levels
7	ENCPWR	Output	Encoder power	+5Vdc (from UBUS)
8	GND		Digital ground	
9	GND		Digital ground	
10	CLK+	Input	RS485 digital +	ENDAT (Option 3)
11	CLK-	Input	RS485 digital -	ENDAT (Option 3)
12	DATA+	I/O	RS485 digital +	Hiperface/ENDAT (Option 2)
13	DATA-	I/O	RS485 digital -	Hiperface/ENDAT (Option 2)
14	VREF	2.5V Output	A-D reference output	5KΩ output
J3 is for the first channel input and J4 is for the second channel input to the UBUS interpolator.				

J5, J6 Encoder Inputs (Opt 1) for rev 105

(14 pin Mini-Combicon)			 Front View	
Pin #	**Symbol**	**Function**	**Description**	**Notes**
1	SIN+	Analog Input	Sinusoidal input+	
2	SIN-	Analog Input	Sinusoidal input-	
3	COS+	Analog Input	Cosine input+	
4	COS-	Analog Input	Cosine input-	
5	INDEX+	Input	Index input	Analog or TTL levels
6	INDEX-	Input	Index input	Analog or TTL levels
7	ENCPWR	Output	Encoder power	+5Vdc (from UBUS)
8	GND		Digital ground	
9	GND		Digital ground	
10	CLK+	Input	RS485 digital +	ENDAT (Option 3)
11	CLK-	Input	RS485 digital -	ENDAT (Option 3)
12	DATA+	I/O	RS485 digital +	Hiperface/ENDAT (Option 2)
13	DATA-	I/O	RS485 digital -	Hiperface/ENDAT (Option 2)
14	VREF	2.5V Output	A-D reference output	5KΩ output
J5 is for the first channel input and J6 is for the second channel input to the UBUS interpolator.				

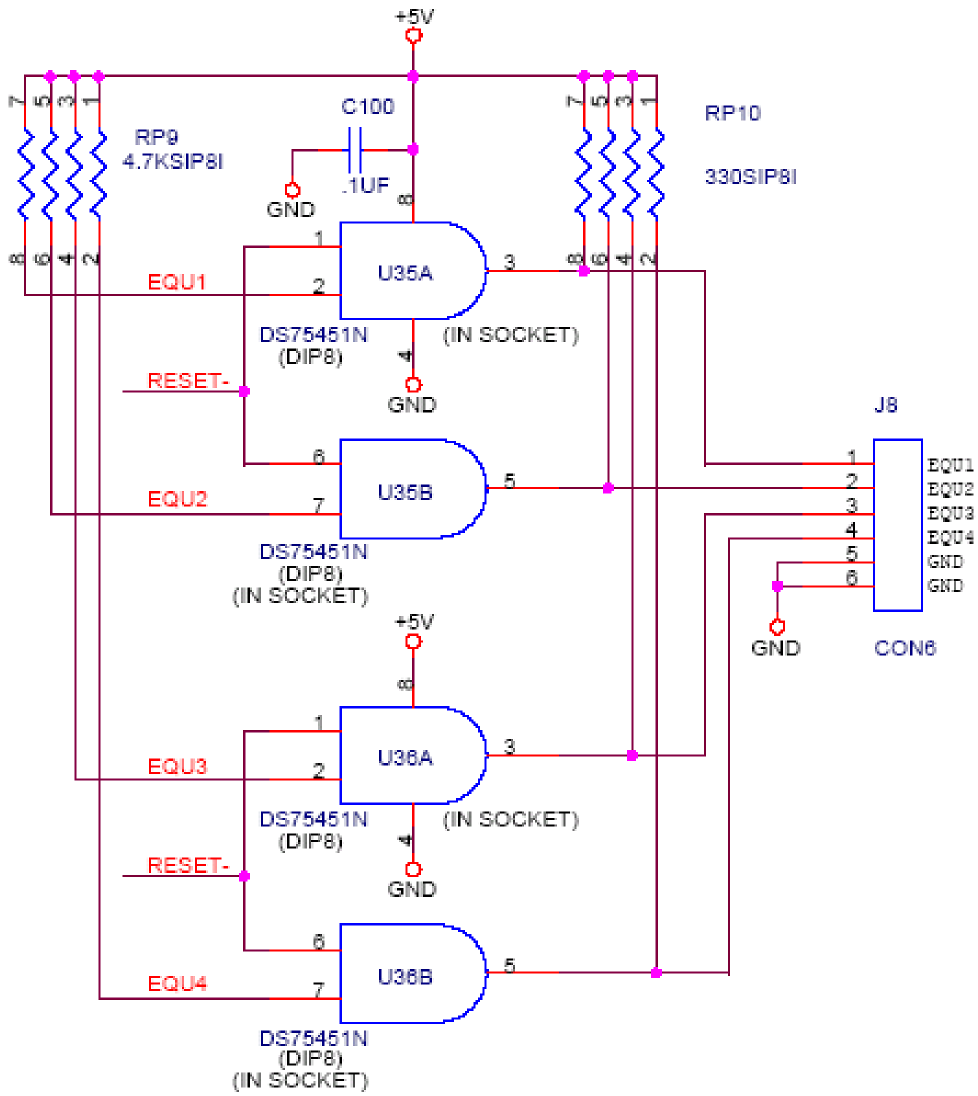
DB15 Style Connector J1A, J2A Top - Enc 1 & 2 for rev 105

Pin#	Symbol	Function	Description	Notes
1				No Connection
2	DATA-	I/O	RS485 digital -	Hiperface/ENDAT (Option 2)
3	CLK-	Input	RS485 digital -	ENDAT (Option 3)
4	GND		Digital ground	
5	ENCPWR	Output	Encoder power	+5Vdc (from UBUS)
6	INDEX+	Input	Index input	Analog or TTL levels
7	COS+	Analog Input	Cosine input+	
8	SIN+	Analog Input	Sinusoidal input+	
9	VREF	2.5V Output	A-D reference output	5KΩ output
10	DATA+	I/O	RS485 digital +	Hiperface/ENDAT (Option 2)
11	CLK+	Input	RS485 digital +	ENDAT (Option 3)
12	GND		Digital ground	
13	INDEX-	Input	Index input	Analog or TTL levels
14	COS-	Analog Input	Cosine input-	
15	SIN-	Analog Input	Sinusoidal input-	



J8 EQU1-4 Header

Pin#	Symbol	Function	Description	Notes
1	EQU1	Output	TTL EQU Signal	
2	EQU2	Output	TTL EQU Signal	
3	EQU3	Output	TTL EQU Signal	
4	EQU4	Output	TTL EQU Signal	
5	GND		Digital ground	
6	GND		Digital ground	



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 51E
Model Number:	603438

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

Mark of Compliance

CE

APPENDICES

Offset Register Mapping Definitions

Most of the registers in the table below are located inside the DSPGATE1. Refer to the DSPGATE1 in the Turbo Software Reference Manual under PMAC2 I/O Control Registers for details on the use of these registers. The Hiperface option registers and the Ext ADC registers are not a part of DSPGATE1.

	ADDR	X -Memory	Y-Memory
First Channel	Base + 00h	Status Word 1	Time Between Enc Counts (SCLKs)
	Base + 01h	Phase Raw Count 1	Time Since Last Enc Count (SCLKs)
	Base + 02h	Servo Count 1	24 LSBs (Hiperface)
	Base + 03h	Flag Position Capture 1	FLAGS + 8MSBs (Hiperface)
	Base + 04h	Global Clock Control 1-4	PWM C1
	Base + 05h	Control Word 1	Ext ADC_A
	Base + 06h	Enc Compare Auto Increment 1	Ext ADC_B
	Base + 07h	Enc Compare Value B1	Enc Compare Value B1
Second Channel	Base + 08h	Status Word 2	Time Between Enc Counts (SCLKs)
	Base + 09h	Phase Raw Count 2	Time Since Last Enc Count (SCLKs)
	Base + 0Ah	Servo Count 2	24 LSBs (Hiperface)
	Base + 0Bh	Flag Position Capture 2	FLAGS + 8MSBs (Hiperface)
	Base + 0Ch	DAC Strobe Output Word 1-4	PWM C2
	Base + 0Dh	Control Word 2	Ext ADC_A
	Base + 0Eh	Enc Compare Auto Increment 2	Ext ADC_B
	Base + 0Fh	Enc Compare Value B2	Enc Compare Value B2
Third Channel	Base + 10h	Status Word 3	Time Between Enc Counts (SCLKs)
	Base + 11h	Phase Raw Count 3	Time Since Last Enc Count (SCLKs)
	Base + 12h	Servo Count 3	24 LSBs (Hiperface)
	Base + 13h	Flag Position Capture 3	FLAGS + 8MSBs (Hiperface)
	Base + 14h	ADC Strobe Output Word 1-4	PWM C3
	Base + 15h	Control Word 3	Ext ADC_A
	Base + 16h	Enc Compare Auto Increment 3	Ext ADC_B
	Base + 17h	Enc Compare Value B3	Enc Compare Value B3
Fourth Channel	Base + 18h	Status Word 4	Time Between Enc Counts (SCLKs)
	Base + 19h	Phase Raw Count 4	Time Since Last Enc Count (SCLKs)
	Base + 1Ah	Servo Count 4	24 LSBs (Hiperface)
	Base + 1Bh	Flag Position Capture 4	FLAGS + 8MSBs (Hiperface)
	Base + 1Ch	PWM Freq/Dead time/PFM Width 1-4	PWM C4
	Base + 1Dh	Control Word 4	Ext ADC_A
	Base + 1Eh	Enc Compare Auto Increment 4	Ext ADC_B
	Base + 1Fh	Enc Compare Value B4	Enc Compare Value B4

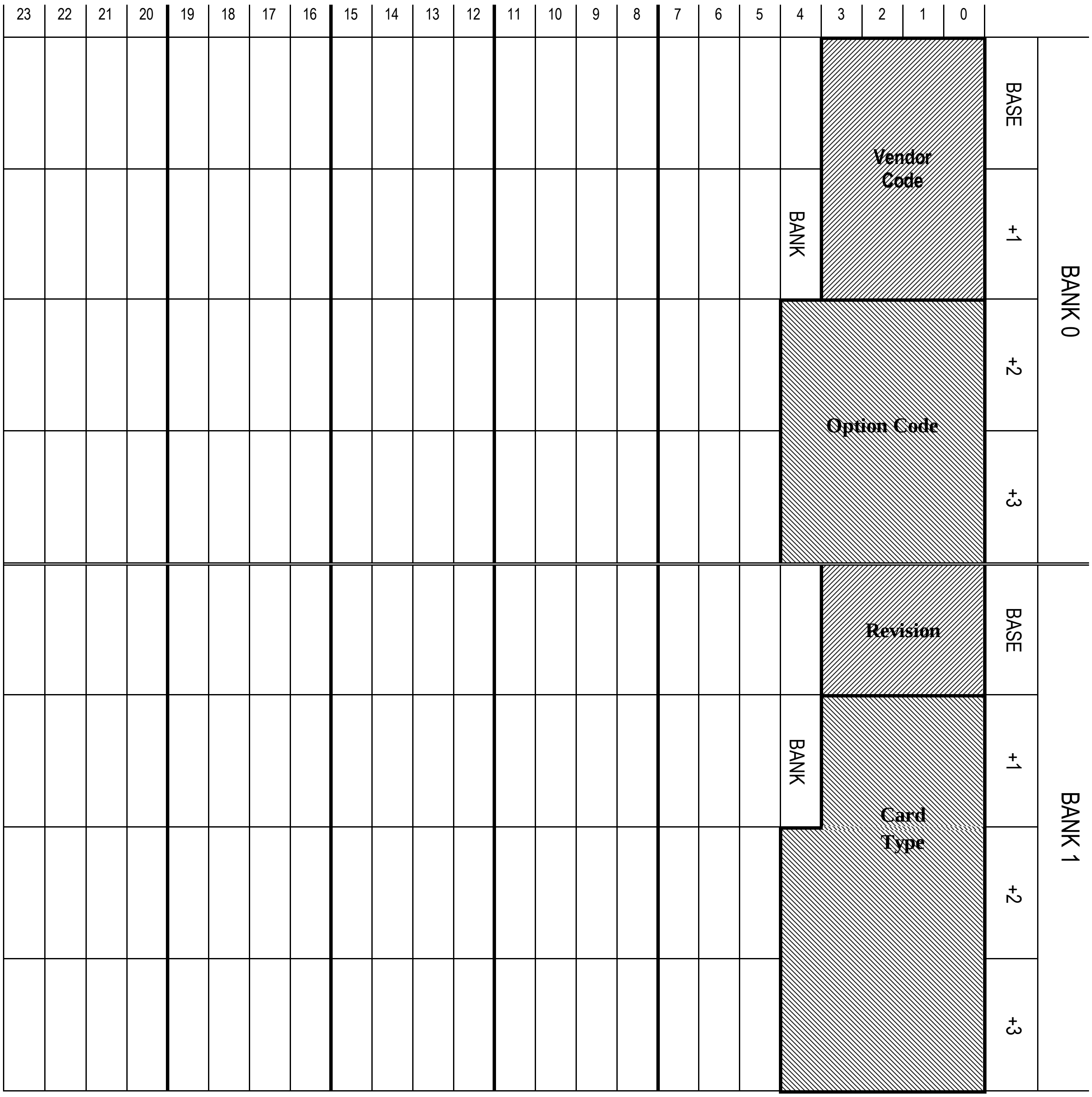
Ext ADC_A and Ext ADC_B are addresses to the same A-D converter. When accessed twice, the sine data is followed by the cosine data.

Board Configuration Memory Map

The board configuration memory mapping for UMAC Turbo models contains data pertaining to the configuration of products that are plugged into the UBUS backplane.

On power-up or at any time that is needed, the UBUS processor (normally a Turbo UMAC processor) is capable of polling this block of memory to establish the mapping of hardware.

Each block of memory contains four address locations that may be polled. There are two banks of four address locations that can be selected so that the processor can read data from up to eight address locations.



Bank: Place a 0 into this bit to select BANK 0. Place a 1 into this bit to select BANK 1.

Vendor Code: Delta Tau Data Systems Inc. products will always have a 1 in this 4 bit address field. Products from other companies will have other values returned in this field.

Option Code: This 5-bit field contains data that pertains to options that are installed on the accessory card. Each product will have a different meaning to the data in this field.

Revision: This 4-bit field indicates the revision level the board assembly. This value is usually hard coded in the circuitry of the board fabrication.

Card Type: This-14 bit address field contains information pertaining to a part number assigned to the board. This value usually relates to a vendor's board assembly part number. Delta Tau Data Systems Inc. uses their 6-digit part number converted to hexadecimal in this field.

Option Codes: The CS2 and CS3 selects that are used for the Acc-51E and axis cards allows for up to 16 board configuration slots to be used. The dipswitch selects between any of the 16 banks of memory. This allows for up to 16 Acc-51Es to be logically configured.