USER MANUAL

Accessory 28B

16 Bit Analog to Digital Converter Board

3Ax-602678-xUxx

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INTRODUCTION

Delta Tau's Accessory 28B (Acc-28B) is a 2 or 4-channel analog to digital converter interface board (Option 1) designed to provide a means for precision voltage measurement as an input to PMAC and PMAC2. This accessory uses four 16-bit analog-to-digital converters that provide voltage measurements that are accurate to ±2 bits.

Jumpers will allow each A-D converter to be selected for Bipolar or Unipolar convert modes. When selected for bipolar mode, differential inputs allow the user to apply input voltages to ±5V (10V p-p) and single-ended inputs allow application of input voltages to ±10V. When selected for unipolar mode, differential inputs allow the application of input voltages from 0V to 5V and single-ended inputs allow the application of input voltages from 0V to +10V. In unipolar mode, negative input voltages will not damage the A-D converters.

Voltage references are provided for ratiometric style input control. The VREF output is provided for equipment which uses a scaled input for accurate tracking. The +5Vdc and -5Vdc supply taps are less precise and are provided to allow bias potentiometers to be biased without the need for an external power supply.

Other features include:

- Input nulling trimmers are provided to allow for precise adjustment of input signals.
- Opto-couplers are used to isolate the Acc-28B's circuitry from the PMAC/PMAC2.
- When used with PMAC or Acc-24P, each Acc-28B occupies four channels using the PMAC's JS1 or JS2 interface connector.
- When used with PMAC2, each Acc-28B occupies two channels and is connected to an Acc-8T at J2.
- When used with PMAC2, all four A-D conversions are simultaneous.
- When used with PMAC2, an Acc-8T accessory card is required for connection to signals that are available on the JMACH connector.
- Acc-28B requires ±15Vdc.
- The Acc-28B comes with mating connectors and a 16-conductor 24" long ribbon cable.

When used with PMAC2, the Acc-28B uses the same serial data inputs as is used by digital current loop devices. Therefore, the Acc-28B is not to be used on the same channel pairs as Acc-8K1, Acc-8K2, Acc-8F, or other devices which utilize the strobed serial input data lines.

Options

The Acc-28B is available with the following options:

- Option 1: Additional two axes (makes Acc-28B into 4 axis system)
- Option 2A: 25-pin DSUB connector at P1.
- Option 2B: 10-pin terminal blocks at TB1 and TB2.

Note:

Select either option 2A or option 2B above.

Input Offset Nulling

Input nulling is performed with the A-D inputs shorted together using Bipolar conversion. If the equipment has output offsets, it is possible to adjust the VR1, VR2, VR3, and VR4 to zero the inputs.

The input voltage adjustment swing is limited to approximately 60mV.

To adjust nulling, be sure that the temperature has stabilized on the Acc-28B by powering it for about 20 minutes then applying zeroed inputs. Adjust VR1 for channel 1, VR2 for channel 2, VR3 for channel 3, and VR4 for channel 4 for the desired readings on the A-D.

When selected for Bipolar conversion, a 0Vdc input should read a number around 32,768 on the A-D input. When selected for Unipolar conversion, the input should be adjusted to 00.

Things to Know

PMAC performs a sequential conversion of one A-D converter channel at a time. PMAC2 performs a simultaneous conversion of all A-D channels at the same time.

Jumpers E3 & E4 select whether the board is addressed by a PMAC or PMAC2, respectively.

Be sure to adjust the ADCLK frequency for 1.25MHz. The A-D converters on the ACC28B have a maximum conversion rate of approximately 1.7MHz.

PMAC AND ACC-28B

The A-D CLK jumpers must be adjusted for a conversion value of 1.22MHz. On the PMAC PC, place jumper E98 into position 2-3.

Using Acc-28B in Programs

The Acc-28B operates by converting data and transmitting it serially to the PMAC. There are eight registers which receive the serial data. These registers may be accessed directly by selection of M-Variables. There are subtle addressing differences between PMAC and PMAC2. PMAC references are shown here:

PMAC A-D Registers

PMAC 1	Turbo PMAC1	ADC #	Connection
M105->Y:$C006,8,16,U	M105->Y:$78006,8,16,U	1	
M205->Y:$C007,8,16,U	M205->Y:$78007,8,16,U	2	Connect Acc-28Bs
M305->Y:$C00E,8,16,U	M305->Y:$7800E,8,16,U	3	J2 to PMAC's JS1
M405->Y:$C00F,8,16,U	M405->Y:$7800F,8,16,U	4	
M505->Y:$C016,8,16,U	M505->Y:$78106,8,16,U	5	
M605->Y:$C017,8,16,U	M605->Y:$78107,8,16,U	6	Connect Acc-28Bs
M705->Y:$C01E,8,16,U	M705->Y:$7810E,8,16,U	7	J2 to PMAC's JS2
M805->Y:$C01F,8,16,U	M805->Y:$7810F,8,16,U	8	

On PMAC, M-Variables are ideal for passing the A-D values into programs. The following is an example of a program that displays the value of A-D input #1 on an LCD display (Acc-12):

```
OPEN PLC1
CLEAR
DISPLAY 0,"A-D VALUE IS -      "    ; DISPLAY HEADER.
WHILE (0<1)                         ; CREATE LOOP.
DISPLAY 14, 5.0, M105               ; DISPLAY A-D DATA.
ENDWHILE
CLOSE
```

PMAC2 AND ACC-28B

The A/D clock must be adjusted to operate at 1.25MHz. On PMAC2 models, this is accomplished by adjusting the value of I903 and/or I907. On Turbo PMAC2 models, adjust the A/D clock with the I7m03 variable (where *m* stands for the Servo IC number). If no other values of clock are to be adjusted on the PMAC2, set I903/I907/I7m03 to a value of 2770. Refer to the PMAC2 Software Addendum manual for details on setting the I903 and/or I907 variables and refer to the Turbo PMAC/PMAC2 Software Reference Manual for the details of the I7m03 setting.

The PMAC2 A-D registers are listed below:

	PMAC2 Hardware Address	**Turbo PMAC2 Memory Address**	**Name**
1st A-D Channel	Y:$C005,8,16,U	Y:$78005,8,16,U	ADC1A
2nd A-D Channel	Y:$C006,8,16,U	Y:$78006,8,16,U	ADC1B
3rd A-D Channel	Y:$C00D,8,16,U	Y:$7800D,8,16,U	ADC2A
4th A-D Channel	Y:$C00E,8,16,U	Y:$7800E,8,16,U	ADC2B
5th A-D Channel	Y:$C015,8,16,U	Y:$78015,8,16,U	ADC3A
6th A-D Channel	Y:$C016,8,16,U	Y:$78016,8,16,U	ADC3B
7th A-D Channel	Y:$C01D,8,16,U	Y:$7801D,8,16,U	ADC4A
8th A-D Channel	Y:$C01E,8,16,U	Y:$7801E,8,16,U	ADC4B
9th A-D Channel	Y:$C025,8,16,U	Y:$78105,8,16,U	ADC5A
10th A-D Channel	Y:$C026,8,16,U	Y:$78106,8,16,U	ADC5B
11th A-D Channel	Y:$C02D,8,16,U	Y:$7810D,8,16,U	ADC6A
12th A-D Channel	Y:$C02E,8,16,U	Y:$7810E,8,16,U	ADC6B
13th A-D Channel	Y:$C035,8,16,U	Y:$78115,8,16,U	ADC7A
14th A-D Channel	Y:$C036,8,16,U	Y:$78116,8,16,U	ADC7B
15th A-D Channel	Y:$C03D,8,16,U	Y:$7811D,8,16,U	ADC8A
16th A-D Channel	Y:$C03E,8,16,U	Y:$7811E,8,16,U	ADC8B

Example:
A PLC program must read the value from the third A-D channel (ADC2A).

1. Assign an M-variable to point to ADC2A:

```
M205->Y:$C00D,8,16,U        ;For non-Turbo PMAC2
I903=2770                   ;Set Clock to 1.23 MHz
```

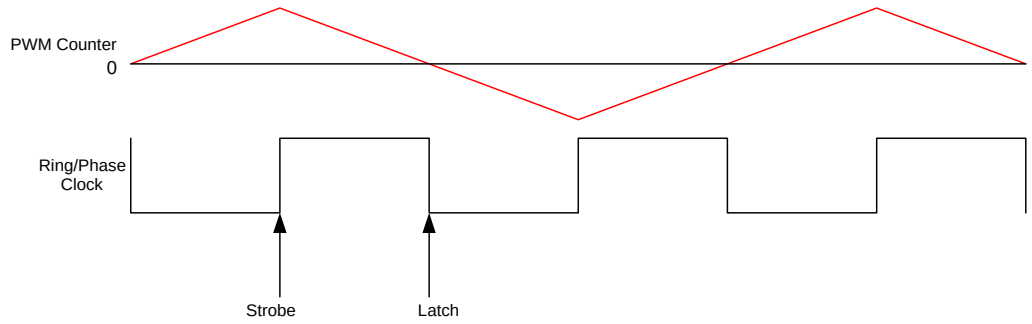
or

```
M205->Y:$7800D,8,16,U       ;For Turbo PMAC2
I7003=2770                  ;Set Clock to 1.23 MHz
```

2. When referenced, M205 will equal the value in ADC2A. Save the M-variables after they have been assigned.

Phase Clock Setting Limitation

When using the Acc-28B the user must be aware of certain limitations. The first limitation is the ADC clock rate. For this product, the maximum ADC clock rate is 1.2MHz. This leads to the next limitation that is the maximum rate at which it can be sampled. The data is sampled during the phase clock. When the phase clock goes from low to high, it is strobed and then the data must be latched by the time phase clock goes from high to low.



The data from the ADC comes from a 24-bit register and each bit will be processed every ADC clock cycle. Therefore, it will take a minimum of 24 ADC clock cycles to return the proper ADC value to the PMAC. So, if we are limited to 1.2MHz ADC clock and it takes 24 cycles to read the data, then the minimum of 20 μsec* is needed to read the data. The 20 μsec represents the time from the strobe to the latch of the phase clock. To have a phase clock on time of about 20 μsec, set the phase clock to about 24 KHz. 24KHz is the maximum phase clock frequency that can be set in the PMAC2 when using Acc-28B.

*The 20 μsec is calculated by taking 1.2Mhz/24 cycles.

ACC-28B WITH ENCODER CONVERSION TABLE OPTIONS ON PMAC AND PMAC2

The encoder conversion table can be modified using either PMAC's Executive Program Encoder Conversion Table dialog box or the on-line commands in Executive terminal mode.

The Encoder Conversion Table is used when motor position is desired from A-D inputs. Refer to the PMAC Software User manual for Encoder Conversion Table uses and applications.

Unsigned Analog Conversion

The A-D converters on the Acc-28B return unsigned data to a PMAC or PMAC2.

If bit 19 of the analog conversion setup word is set to 1 ($18xxxx for normal analog), then PMAC/PMAC2 treats the A-D number in the high 16 bits of the source word (left-justified of 24 bits) as an unsigned number in the range of 0 to 65535.

Unsigned analog conversion requires PMAC or PMAC2 Firmware release Version 1.16 or newer to accommodate unsigned A-D input values.

A typical setup word for this type of feedback is $18C005 for non-Turbo or $1F8005 for Turbo, which provides for a non-filtered unsigned left-justified conversion of the data word fed by A-D #1 of the Acc-28B connected to PMAC.

Converted Data

The converted data from the parallel word is put in the X data word of the encoder table entry. This address is used by programs and PMAC pointers for the A-D value. For instance, if the first setup entry (address Y:$0720) in the conversion table were $18C005, the result would be left-shifted at address X:$720. For Turbo PMAC, if the first encoder conversion table entry (address Y:$003501) in the conversion table were $1F8005, the result would be left-shifted at address X:$3501.

Encoder Table Entry

X-Words	Y-words
Latched data: Unsigned 16 bit word	Source and process Bits 0-15: Address of source data Bits 16-23: = $18

Encoder Table Usage

Using the above table entry example, an encoder address may be set to point to the X memory side of the table. This allows the sampling of data inside a servo/phase interrupt routine.

Non-Turbo Example:

The encoder table entry is placed at memory address Y:$0720 (as in previous converted data statement), $18C006:

```
WY:$720,$18C006
```

The encoder address (Ix03, Ix04) is set to look at the converted result in the Encoder Table:

```
I103 = $720
```

Turbo Example:

For the Turbo PMAC, set up the encoder conversion table with direct writes to the I-variables (ECT is located at I8000 to I8191).

```
I8000=$1F8005
```

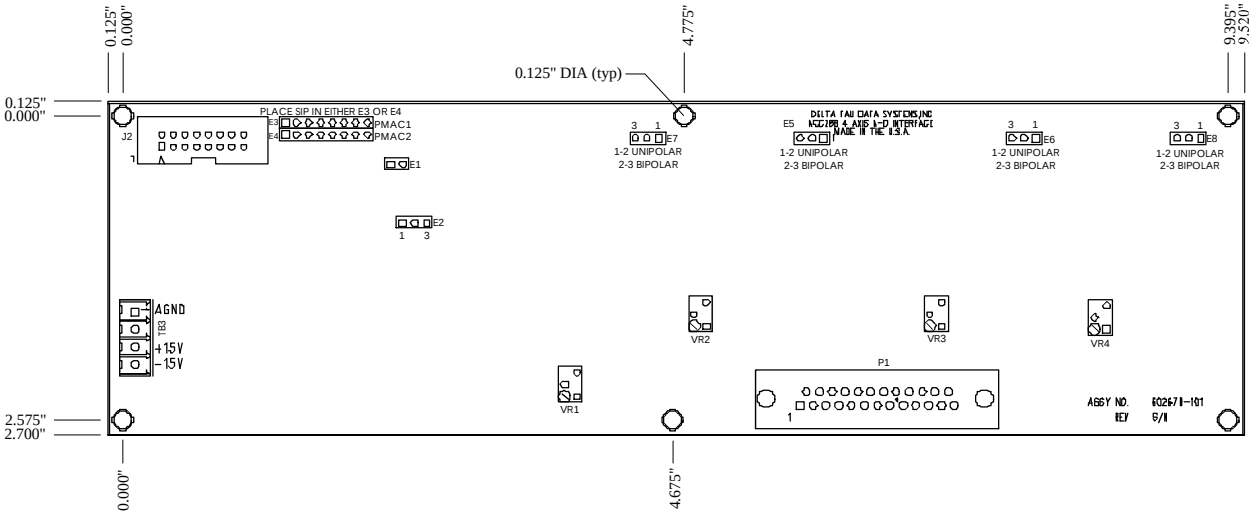
The encoder address (Ix03, Ix04) is set to look at the converted result in the encoder table:

```
I103 = $3501
```

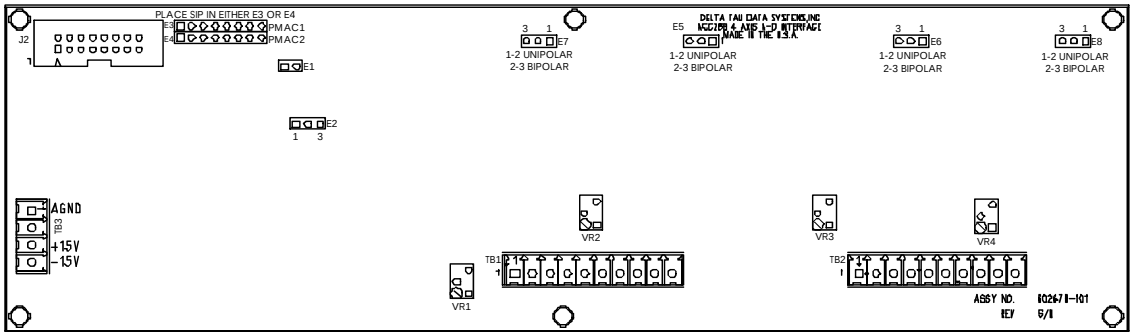
For PMAC2 (optionally for PMAC), create an encoder table entry for each A-D input that is to be used. On PMAC2, this is a requirement since the circuitry used for A-D conversion is not accessed synchronously with a PLC program.

LAYOUT DIAGRAM AND JUMPERS

Layout Diagram-28B OPT 2A, Connectors and Jumpers



Layout Diagram Acc-28B OPT 2B, Connectors and Jumpers



Jumpers

Refer to the previous layout diagram for the location of the jumpers on the board. A position listing for each jumper is provided in this section.

E1 - PMAC Ground

This jumper is used to connect PMAC's ground to the power supply ground.

E2

Not used.

E3, E4 - PMAC/PMAC2 Select

This SIP jumper selects whether the Acc-28B is connected to PMAC or PMAC2. When connected to PMAC, data conversion occurs one channel at a time. When connected to PMAC2, data is simultaneously converted for all four channels.

E5, E6, E7, E8 - Unipolar/Bipolar Convert

These jumpers allow the selection of the method of A-D conversion for each channel. Position 1-2 allows unipolar conversions, which returns an unsigned value of 0 to 65535 for input voltages ranging from 0 to 10V (approximately). Position 2-3 allows bipolar conversions, which return an unsigned value of 0 to 65535 for input voltages ranging from -10V to +10V (20V pk-pk).

Jumper Table

E Point	Pin Layout	Description	Default
E1	1 - 2	Jumper pin 1 to 2 to connect the PMAC/PMAC2 power supply common to the supplied AGND.	1 to 2 on -100 boards; Open on others
E2	1 - 2 - 3	Spare - unused jumper	
E3, E4	SIP socket	Place the 10Ω SIP resistors in either socket position. E3 - PMAC1 E4 - PMAC2	E3
E5, E6, E7, E8	1 - 2 - 3	Jumper pin 1 to 2 for Unipolar convert. Jumper pin 2 to 3 for Bipolar convert. E7 - Channel #1 E5 - Channel #2 E6 - Channel #3 E8 - Channel #4	2 to 3

CONNECTOR PINOUTS

J1: Program Header

This is used only at the factory.

J2: PMAC Interface

This 16-pin box header attaches the Acc-28B to PMAC's JS1 or JS2 connector. On PMAC2, J2 is connected to J2 on the Acc-8T.

Pin #	Symbol	Function	Description	Notes
1	DCLK	Input	A-D converter clock	
2	n.c.		Not connected	
3	ASEL0-	Input	PMAC address select	Not on PMAC2
4	ASEL1-	Input	PMAC address select	Not on PMAC2
5	CONV	Input	Start convert	
6	ADCIN1	Output	PMAC serial data	Not on PMAC2
7	n.c.		Not connected	
8	n.c.		Not connected	
9	n.c.		Not connected	
10	n.c.		Not connected	
11	ADC0	Output	PMAC2 serial data Channel 1	PMAC2 only*
12	ADC1	Output	PMAC2 serial data Channel 2	PMAC2 only*
13	ADC2	Output	PMAC2 serial data Channel 3	PMAC2 only*
14	ADC3	Output	PMAC2 serial data Channel 4	PMAC2 only*
15	+5V		PMAC/PMAC2 +5V	
16	GND		PMAC/PMAC2 GND	
*These terminals are disconnected when jumper E3 is selected (PMAC1 configuration).				

P1: A-D Converter Input

This 25-pin DSUB contains the inputs and reference outputs for the ACC28B. The reference taps are ±5Vdc, 4.096Vdc (VREF) and RET. This is available with Option 2A only.

Pin #	Symbol	Function	Description	Notes
1	ADC1+	Input	A-D converter channel 1+	
2	ADC1-	Input	A-D converter channel 1-	5
3	ADC2+	Input	A-D converter channel 2+	
4	ADC2-	Input	A-D converter channel 2-	5
5	ADC3+	Input	A-D converter channel 3+	1
6	ADC3-	Input	A-D converter channel 3-	1, 5
7	ADC4+	Input	A-D converter channel 4+	1
8	ADC4-	Input	A-D converter channel 4-	1, 5
9	n.c.			
10	n.c.			
11	VREF	Output	4.096Vdc precision reference	2
12	+5Vdc	Output	+5V reference output	3
13	-5Vdc	Output	-5V reference output	3
14	SHIELD	Gnd	Shield	4
15	SHIELD	Gnd	Shield	4
16	SHIELD	Gnd	Shield	4
17	SHIELD	Gnd	Shield	4
18	SHIELD	Gnd	Shield	4
19	SHIELD	Gnd	Shield	4
20	SHIELD	Gnd	Shield	4
21	SHIELD	Gnd	Shield	4
22	n.c.		Not connected	
23	n.c.		Not connected	
24	RET	Gnd	VREF return	4
25	RET	Gnd	±5Vdc return	4

1. These signals exist on Option 1 (4-channel) boards only.
2. This is a buffered tap from the A-D precision reference. Typically, external hardware that uses this signal reference will scale it for a full-scale A-D voltage input.
3. +5Vdc and -5Vdc are a less precise A-D reference. When used with an A-D input in the unipolar mode, it is possible to get approximately full-scale inputs. This requires the -5Vdc to be connected to the ADCx- input (ideal for metering potentiometers).
4. The shields are connected internally to the ground plane inside the Acc-28B. Normally, shields are connected at one end of the wire only (this eliminates possible system ground loops). In addition, the VREF and ±5Vdc return lines are connected to the internal ground plane.
5. For single-ended inputs, ADCn should be connected to GND at pin24 or 25.

TB1: A-D Converter Input (Axes 1 and 2)

This 10-pin terminal block contains the inputs for channel 1 and channel 2. Reference outputs of ±5Vdc, 4.096Vdc (VREF) and RET (AGND) are provided on this connector. This is available with Option 2B only.

Pin #	Symbol	Function	Description	Notes
1	ADC1+	Input	A-D converter Channel 1+	
2	ADC1-	Input	A-D converter Channel 1-	4
3	AGND	Gnd	Shield	1
4	ADC2+	Input	A-D converter Channel 2+	
5	ADC2-	Input	A-D converter Channel 2-	4
6	AGND	Gnd	Shield	1
7	VREF	Output	4.096Vdc precision reference	2
8	AGND	Gnd		1
9	+5Vdc	Output	+5V reference output	3
10	-5Vdc	Output	-5V reference output	3

1. The shields are connected internally to the ground plane inside the Acc-28B. Normally, shields are connected at one end of the wire only (this eliminates possible system ground loops). Also the PIN 8 AGND line is connected to the internal ground plane.
2. This is a buffered tap from the A-D precision reference. Typically, external hardware that uses this signal reference will scale it for a full-scale A-D voltage input.
3. +5Vdc and -5Vdc are a less precise A-D reference. When used with an A-D input in the unipolar mode, it is possible to get approximately full-scale inputs. This requires the -5Vdc to be connected to the ADCx- input (ideal for metering potentiometers).
4. For single-ended inputs, ADCn should be connected to GND at pin 3, 6 or 8.

TB2: A-D Converter (Axes 3 and 4)

This 10-pin terminal block contains the inputs for channel 3 and channel 4. Reference outputs of ±5Vdc, 4.096Vdc (VREF) and RET (AGND) are provided on this connector. This is available with Options 1 and 2B only.

Pin #	Symbol	Function	Description	Notes
1	ADC3+	Input	A-D converter Channel 3+	
2	ADC3-	Input	A-D converter Channel 3-	4
3	AGND	Gnd	Shield	1
4	ADC4+	Input	A-D converter Channel 4+	
5	ADC4-	Input	A-D converter Channel 4-	4
6	AGND	Gnd	Shield	1
7	VREF	Output	4.096Vdc precision reference	2
8	AGND	Gnd		1
9	+5Vdc	Output	+5V reference output	3
10	-5Vdc	Output	-5V reference output	3

1. The shields are connected internally to the ground plane inside the Acc-28B. Normally, shields are connected at one end of the wire only (this eliminates possible system ground loops). In addition, the pin 8 AGND line is connected to the internal ground plane.
2. This is a buffered tap from the A-D precision reference. Typically, external hardware that uses this signal reference will scale it for a full-scale A-D voltage input.
3. +5Vdc and -5Vdc are a less precise A-D reference. When used with an A-D input in the unipolar mode, it is possible to get approximately full-scale inputs. This requires the -5Vdc to be connected to the ADCx- input (ideal for metering potentiometers).
4. For single-ended inputs, ADCn should be connected to GND at pin 3, 6 or 8.

TB3: Power Supply Input

Pin #	Symbol	Function	Description	Notes
1	AGND	Common	Power supply return	
2	N.C.		Not connected	
3	+15Vdc	Input	+15V power input	1
4	-15Vdc	Input	-15V power input	2

1. +15Vdc requires a 200mA supply current. However, if the supply or reference taps at P1, TB1 or TB2 are used and the current requirement may be greater.
2. -15Vdc requires 70mA supply current. However, if the supply taps at P1, TB1 or TB2 are used and the current requirement may be greater.