USER MANUAL

Accessory 39

PMAC Handwheel Encoder Interface Board

3Ax-602378-xUxx

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INTRODUCTION

PMAC's accessory 39 (Acc-39) is a small printed circuit board designed for the purpose of interfacing the PMAC controller with a hand wheel or a slow time base encoder. Acc-39 provides a cost effective solution for PMAC applications in which the four or the eight standard high speed encoder decode circuits on the PMAC's DSPGATES are used already and yet there is an additional need for just one hand wheel encoder input. This accessory accepts one pair of A QUAD B encoder signals. The maximum rate is approximately 31 A/B square waves per servo cycle. With PMAC's default servo frequency of 2.262 KHz this translates to a maximum encoder line rate of 62.5 KHz. The x4 circuitry provides a maximum of 250,000 counts per second at this servo frequency. The x4 circuitry is fixed in hardware and cannot be changed. In addition, in contrast to the standard high-speed encoder circuits of PMAC, this accessory board does not allow software programmability for direction selection (to switch direction one must physically exchange the input from the encoder A signal with the input from encoder B signal). Moreover, the 1/T interpolation is not performed, so there may be more quantization noise from the encoder. The extra noise may not be noticeable for master hand wheel following. However, it may have a detectable adverse effect when using the encoder for the time base function.

Acc-39 can be interfaced to both single-ended (A and B) and differential line driver encoder inputs (A, A/ and B, B/). In addition, it can also be interfaced to the less popular complementary open collector encoder signals that use A, B, A/ and B/. In this case the resistor pack RP2 should mounted in the reverse direction from the factory supplied default setting.

Note:

Acc-39 interfaces to PMAC through PMAC's front panel port (JPAN) via the supplied 26-pin flat cable. When this accessory is installed then the normal PMAC panel functions cannot be used at the same time (I2 should be set to 1 or 3). Also when connecting this cable to PMAC one must make sure that it is the JPAN (J2) header and not the JTHW (J3) header to which the cable is connected. Connecting the cable to JTHW will damage the cable.

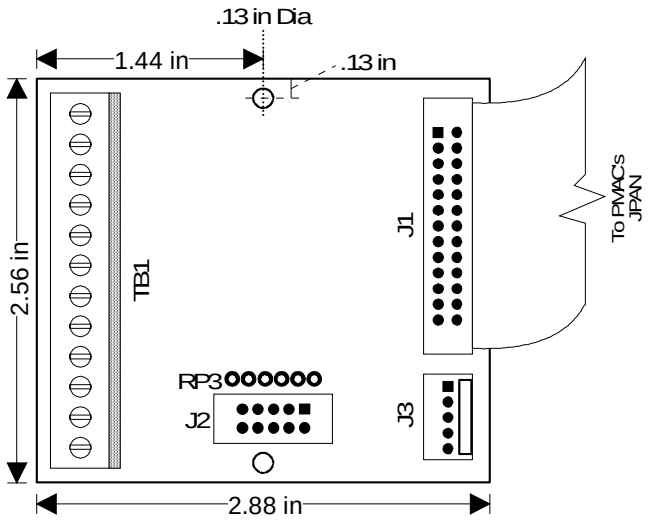
Connectors

Refer to the enclosed layout diagram for the location of the connectors on the printed circuit board. The pin definition listing for each connector is provided at the end of this manual.

J1

This connector is a 26-pin header through which Acc-39 links to PMAC via PMAC's JPAN (J2) connector. Also the +5 volt power supply for Acc-39 and the encoder is brought in from PMAC through this connector. A 26-pin flat ribbon cable is provided for this purpose.

ACC - 39
Handwheel Encoder
Interface Board



J2

This connector is a 10-pin header. It provides a convenient means for the direct input of encoder signals to Acc-39. The header is compatible with HP HEDS-5000, 6000, 7500 encoders.

J3

This connector is a 5-pin header. It provides a convenient means for the direct input of encoder signals to Acc-39. The header is compatible with HP HEDS-5500 and 9000, and HRPG encoders.

TB1

This is a 12 pin terminal block which provides the means for the connection of both single-ended and differential encoder signals to Acc-39. In addition, the INIT/ signal of PMAC's JPAN is brought out through this connector. This input can be used to reset PMAC. Also a +5V power supply output for the encoder is provided on this terminal block.

PMAC SETUP

In order to utilize Acc-39 in conjunction with PMAC a few preliminary steps are required. Once these steps are completed for the first time, the procedure need not be repeated again upon subsequent power up cycles. The initialization procedure involves creating a dedicated entry in the PMAC's Encoder Conversion Table for Acc-39 and changing a few I-variables.

Encoder Conversion Table Entry

Acc-39 converts the A QUAD B hand wheel encoder signals to up/down counts and then accumulates the result as an 8-bit binary number. PMAC reads this number as an 8-bit parallel data from the position sensor via the Encoder Conversion Table format every servo cycle. For PMAC PC, Lite, and VME this number appears as bits 8 to 15 of memory location Y:$FFC0. For PMAC STD, this number appears as bits 0 to 7 of memory location Y:$FFFB.

For PMAC PC, Lite, and VME, one must add a parallel word conversion entry (with or without filter) to the Encoder Conversion Table (refer to the PMAC User Manual for details of the Encoder Conversion Table). The user should use the new Unshifted conversion format which is available in firmware version 1.14 and above. Note that the PMAC Executive program Version 2.x and below do not support the Unshifted format. As a result, it is recommended that the user should simply type in the entry via the Executive terminal screen at the end of the current Encoder Conversion Table. For example, the required entry may be added to the end of the default Conversion Table by simply entering the following on-line command:

```
WY:$072A,$38FFC0,$00FF00,$001000
```

The address $072A is pointing to the end of the default Conversion table. The entry $38FFC0 is a parallel entry from memory location $FFC0, 3 specifies that it is from the Y memory and 8 specifies that it should be treated as Unshifted* (the usual format has zero in the fifth hex. digit which shifts the data 5-bits to the left for compatibility with the 1/T sub-count convention of PMAC). The next number $00FF00 specifies that only bits 8 to 15 of Y:$FFC0 should be used as the data source. And the last number $001000 is an optional filter which limits the maximum rate of change to 4096 counts/servo cycle. Finally Ix05, the master following address for motor x, should be changed to point to this entry. For example for motor number 1, I105 should be changed as follows:

```
I105 = $072C
```

For PMAC STD, since the data appears on bits 0 to 7, one should use the normal shifted format. For example, to add the entry at the end of the default Conversion Table:

```
WY:$072A,$30FFFB,$0000FF,$001000
```

Again Ix05 should be modified to point to this entry.

I-Variable Setup

Apart from Ix05 modifications, I2 should be set to 1 or 3 to disable the normal panel functions of JPAN. Also for PMAC PC, Lite, and VME, Ix07 should be set to be 1/8 (one eighth) of Ix08 for 1:1 gearing ratio between the hand wheel encoder and the feedback encoder (e.g. Ix07=12 and Ix08=96 results in 1:1 gearing for the above mentioned versions of PMAC). For PMAC STD, Ix08=Ix07 results in 1:1 gearing ratio.

Time Base Application

If the encoder signal brought in through Acc-39 is used as a time base source, add a time base entry to the Encoder Conversion Table. This entry would take as its source the same entry that Ix05 would use for position following. For PMAC PC, Lite, and VME, the time base scale factor should be set to 1/8 of the value that would be used for a normal encoder channel. For PMAC STD, the scale factor would be the same as for a normal PMAC encoder channel. Continuing with the example, for a time base source with the normal scale factor computed would be 2048 ($800), for PMAC PC etc.:

```
WY:$072D,$40072C,$001000
```

* See supplement section at end of this manual for definition.

For PMAC STD

```
WY $072D,$40072C,$000800
```

Finally Ix93 should be set to $072E to use the above entry as the time base for coordinate system x (for more details refer to the PMAC User Manual).

Resistor Packs

There are two socketed resistor packs on Acc-39, RP2 and RP3. The resistor pack RP2 is factory installed so that pin 1 of the pack matches pin 1 of the socket. This arrangement is suitable for single-ended encoder signals. It also would work with differential line driver encoder signals. For complementary (differential) open collector encoder signals (using A, B, and A/, B/) this resistor pack must be reversed. The RP3 socket is provided for termination resistors (see the schematic circuit diagram).

CONNECTOR PINOUTS

J1 (JPAN)

Pin #	Symbol	Function	Description	Notes
1	+5V	Input	+5V Power	For digital logic and encoder
2	GND	Common	PMAC Common	
3	FPD0/	Not Connected		
4	D0	I/O	Data Line 0	
5	FPD1/	Not Connected		
6	D1	I/O	Data Line 1	
7	D2	I/O	Data Line 2	
8	D3	I/O	Data Line 3	
9	D4	I/O	Data Line 5	
10	D5	I/O	Data Line 5	
11	D6	I/O	Data Line 6	
12	D7	I/O	Data Line 7	
13	FPD3/	Not Connected		
14	FPD4/	Not Connected		
15	INIT/	Output	Reset PMAC	Brought in through TB1
16	HWCA	Output	Encoder A Channel	
17	IPLD/	Not Connected		
18	BLFD/	Not Connected		
19	ERLD/	Not Connected		
20	WIPER	Not Connected		
21	SPARE	Not Connected		
22	HWCB	Output	Encoder B Channel	
23	F1LD/	Not Connected		
24	F2LD/	Not Connected		
25	+5V	Input	+5V Power	
26	GND	Common	PMAC Common	
This connector is a 26-pin header through which Acc-39 links to PMAC via PMAC's JPAN (J2) connector. Also the +5V power supply for Acc-39 and the encoder is brought in from PMAC through this connector. A 26-pin flat ribbon cable is provided for this purpose.				

J2

Pin #	Symbol	Function	Description	Notes
1	HWCHA+	Input	Encoder A Channel Positive	H.P. standard
2	+5V	Output	Power Supply	H.P. standard
3	GND	Common	Digital Common	H.P. standard
4	HWCHA-	Input	Encoder A Channel Negative	Added
5	HWCHB-	Input	Encoder B Channel Negative	Added
6	GND	Common	Digital Common	H.P. standard
7	+5V	Output	Power Supply	H.P. standard
8	HWCHB+	Input	Encoder B Channel Positive	H.P. standard
9	+5V	Output	Power Supply	H.P. standard
10	CHC	Not connected		
This connector is a 10-pin header. It provides a convenient means for the direct input of encoder signals to Acc-39. The header is compatible with HP HEDS-5000, 6000, 7500 encoders.				

J3

Pin #	Symbol	Function	Description	Notes
1	GND	Common	Digital Ground	H.P. standard
2	N.C.		No Connect	H.P. standard
3	HWCHA+	Input	Encoder A Channel Positive	H.P. standard
4	+5V	Output	Power Supply	H.P. standard
5	HWCHB+	Input	Encoder B Channel Positive	H.P. standard
This connector is a 5-pin header. It provides a convenient means for the direct input of encoder signals to Acc-39. The header is compatible with HP HEDS-5500 and 9000, and HRPG encoders.				

TB1

Pin #	Symbol	Function	Description	Notes
1	HWCHA+	Input	Encoder A Channel Positive	
2	HWCHA-	Input	Encoder A Channel Negative	
3	HWCHB+	Input	Encoder B Channel Positive	
4	HWCHB-	Input	Encoder B Channel Negative	
5	HWAOUT+	Output	Buffered Encoder A+	
6	HWAOUT-	Output	Buffered Encoder A-	
7	HWBOUT+	Output	Buffered Encoder B+	
8	HWBOUT-	Output	Buffered Encoder B-	
9	GND	Common	Digital ground	
10	+5V	Output	Power supply	
11	GND	Common	Digital ground	
12	INIT/	Input	PMAC Reset	
This is a 12 pin terminal block which provides the means for the connection of both single-ended and differential encoder signals to Acc-39. In addition, the `INIT/` signal of PMAC's JPAN is brought out through this connector. This input can be used to reset PMAC. Also a +5V power supply output for the encoder is provided on this terminal block.				

SUPPLEMENT FOR ACCESSORY 39

For PMAC PC

Important memory locations and I-Variables for Accessory 39:

Y:$FFC0 Location where converted A QUAD B hand wheel encoder signals (8 bit binary) are

$072A Points to the end of the default encoder conversion table

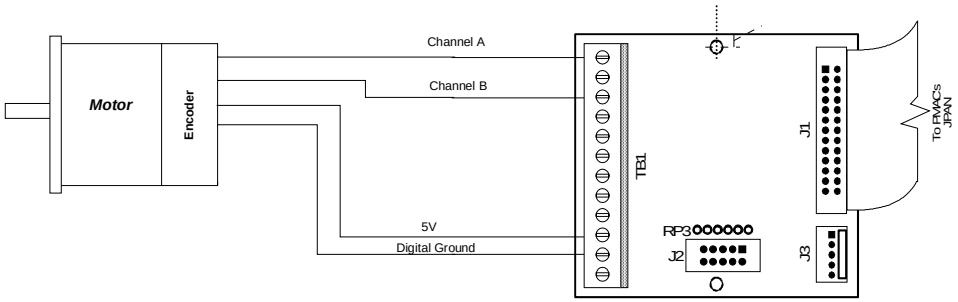
I-Variables	Value	Definition
I2	1	Control Panel disable
Ix05	$72C	Master Handwheel Position Address
Ix06	1	Motor x Master (handwheel) following enable
Ix07	12	Motor x Master (handwheel) position scale factor
Ix08	96	Motor x position scale factor
Ix93		Coordinate system time based control register address

Add parallel word conversion to Encoder Conversion Table, change the I-variables and define an M-variable to point to the X-memory location.

```
WY:$072A, $38FFC0, $00FF00, $001000
Ix05=$072C
I2=1
Ix08=96
Ix07=12 (Ix08/8)
M50->X:$072C,0,24,S
```

After you place these variables into PMAC, you should now be able to slave the previously installed motor by simply turning the encoder by hand. Placing variable into the M50 variable in the Watch window in the Executive.

A simple test setup for the Acc-39 has been developed. To test the existing system with an Acc-39, use an A QUAD B encoder. The diagram below shows the connections needed to use an extra encoder.



Example:

A 4-axis PMAC controls four motors which all have encoder feedback. However, motor #4 should be controlled by the movements of another motor not being controlled by PMAC (i.e. slave the extra motor). Since all encoder channels are used by PMAC, use Acc-39 to monitor the position of the extra motor.

Connect the encoder to Acc-39 as the diagram shows. The accessory board receives +5V and digital ground from PMAC's JPAN (J2) port.

Unshifted Conversion (from Addendum 1.15 pg. 47)

If bit 19 of the source and process word for a parallel data conversion is set to 1, the converted data contains no fractional bits. Entries of this form would have the conversion formats (bits 16-23 of this word) $28, $38, $68, or $78, as opposed to the standard entries $20, $30, $60, and $70, which provide five fractional bits in the converted data.

Uses

This unshifted format is intended for very high-speed, very high-resolution applications, typically with parallel laser-interferometer feedback. With the normal shifted format, PMAC's internal velocity registers saturate when the counts/sec * Ix08 exceed 256M (268,435,456). With the unshifted format, this limit is 32 times higher: 8G (8,589,934,592).

Using this unshifted format, be aware that PMAC will treat the LSBit of the feedback device as 1/32 of a count, not as a full count. For example, if there is a sensor on motor 1 (X-axis) with 2.5 nanometer resolution, and the axis should be programmed in millimeters, treat one count as 80 nm (2.5*32) and make the axis definition #1->12500X (1,000,000 / 80).

Another use of this format is with the Acc-39 Handwheel Decoder. This board contains an HCTL-2000 quadrature decoder IC that converts the quadrature signal from a handwheel to an 8-bit parallel word that is brought in on the JPAN control panel port. On the PMAC PC, Lite, and VME, this byte appears on bits 8-15 of register Y:$FFC0. A shifted parallel conversion would put the 1's bit of the handwheel counter at bit 13, effectively making it 256 times greater than if it were at the normal bit-5 location. This unshifted conversion leaves the 1's bit at bit 8, only eight times greater than normal.

The conversion table entry for this would consist of a source and process word $38FFC2 (unshifted parallel conversion of Y:$FFC2), a mask word $00FF00 (to use only the middle eight bits of the 24-bit word), and a filter word value of something like $000020 (maximum speed 32 counts per servo cycle). Ix05 for any motor x to be slaved to this handwheel would be set to the address of the third line of this entry in the table. For a 1:1 following ratio and a default Ix08 value of 96, Ix07 would be set to 12 instead of the usual 96, to reflect that fact that each count from this accessory appears eight times bigger than normal.