

## Delta Tau® PMAC2™ PWM with Copley Digital

### Introduction

The PMAC2 can be used in PWM command mode to drive Copley digital amplifiers in the velocity or current mode. The advantage of PWM command vs. direct H-bridge control is the increased current loop bandwidth provided by the Copley amplifier. The PMAC2 will typically produce only 300Hz of current loop bandwidth, sufficient for most applications however, for reduction of 120Hz line noise on the buss voltage and other disturbances in the control systems, more current loop bandwidth may be required. The Copley Digital amplifiers can typically produce 3k Hz of current loop bandwidth.

*Sr. Copley Design Engineer “Bandwidth is not a brick-wall, but a gradual decrease in performance, which occurs in the region of the break frequency. If the current loop bandwidth is 300 Hz, and the disturbance is at 120Hz, you can expect a little more than a 2:1 attenuation of the disturbance by the current loop. Any mechanical resonance near 120Hz will exaggerate the effect. The solution to the problem is higher current loop bandwidth.”*

### PMAC2 Controllers

#### PMAC2-PCI

This board could be used installed in a PCI bus host computer or used as a stand-alone motion controller. The base version without options provides 4 axes (with PWM command, +/-10V command, or Step and direction) when combined with the appropriate accessory ACC-8x it provides up to 8 axes (PWM command ACC-8S, +/-10V command ACC-8E, or Step and direction ACC-8S)

#### Turbo PMAC2-PCI

This board can be used installed in a PCI bus host computer or used as a stand-alone motion controller. The base Turbo PMAC2-PC board can control up to 8 axes (with PWM command, +/-10V command, or Step and direction) the necessary channels to control up to 32 axes are provided by optional ACC-24P2 boards.

#### PMAC2A-PC/104

This board can be used as a stand-alone motion controller or commanded by a host computer with its RS-232 serial port or the optional PC/104 bus interface, USB or Ethernet communication methods The base version without options provides 4 axes (with PWM command, +/-10V command, or Step and direction) When combined with the ACC-1P: it provides up to 8 axes (PWM command, +/-10V command, or Step and direction)



Image of PMAC2A-PC/104 Base Board shown stacked with the ACC-1P axes board.

### PWM Parameters

On a PMAC2, I900 sets the PWM frequency for Channels 1-4 (these are the channels on the main PMAC2A-PC/104 board); and I906 sets the PWM frequency for Channels 5-8 (these are the channels on the ACC-1P Axis 5-8 board for the PMAC2A-PC/104). Using the default value of 6527 creates a PWM frequency of 4.5kHz and provides 13+ bits of resolution. On a Turbo PMAC2, the comparable variable is I7m00 for each Servo IC m (m= 0 - 9).

On a PMAC2, I904 sets the PWM deadtime for Channels 1-4 and I908 sets the PWM deadtime for Channels 5-8. In this mode of operation, these variables should be set to 0 (not the default), because no deadtime is required. On a Turbo PMAC2, the comparable variable is I7m04 for each Servo IC m.

On a PMAC2, I9n6 sets the output mode for Channel n (n = 1 - 8). Setting I9n6 to the default value of 0 specifies PWM outputs for Channel n. On a Turbo PMAC2, the comparable variable is I7mn6 for Servo IC m Channel n.

On the main PMAC2A-PC/104 board, The DIR\_n output will now serve as PWMnTOP.

On most PMAC2 and Turbo PMAC2 systems, the "C" sub-channel for each Channel n is the easiest place to access a single-phase PWM signal. This signal is available on simple and inexpensive stepper-interface connectors and breakout boards. On these, the signal of interest is usually labeled as DIRn, for the sub-channel's alternate format of pulse-and-direction output. With I9n6 [I7mn6] set to 0, this signal will serve as PWMnTOP. (The PULSEn line will serve as WMnBOT, which with zero deadtime will be the exact mirror of the top signal.)

With a command value of zero written to the register that drives this signal, PWMnTOP will have 50% duty cycle.

With a command value equal to +I900 [I7m00] written to this register, PWMnTOP will have 100% duty cycle.

With a command value equal to -I900 [-I7m00] written to this register, PWMnTOP will have 0% duty cycle.

Variable Ix02 for Motor x specifies the address of the register to which Motor x writes its servo-loop output. Typically the "x" motor number is the same as the "n" channel number, but this does not necessarily have to be the case. The default value of Ix02 writes to the "A" sub-channel command register of Channel n (n=x). To write to the "C" sub-channel command register, simply add 2 to the default value (e.g. for Channel 1-C, use address \$C004 instead of \$C002). In the Ix02 description in the manual, these are the same addresses as for stepper pulse output.

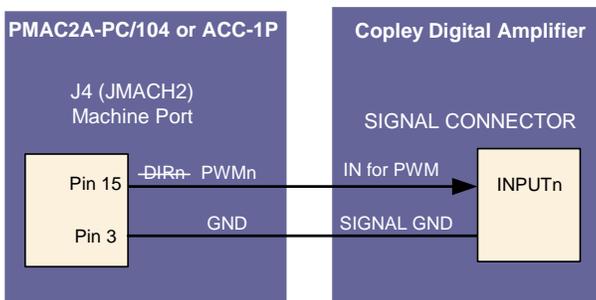
Variable Ix69 for Motor x specifies the maximum numerical output from the servo loop. To use the full range of PWM duty cycle, this should be set equal to the value of I900 or I906 [I7m00 for a Turbo].

*–Provided by Delta Tau VP Engineering*



## PWM Connections

The channels provided by the PMAC2A-PC/104 board or the ACC-1P board can output PWM signals for controlling PWM input on Copley amplifiers. These signals are at TTL levels.



On the main PMAC2A-PC/104 board, The DIR\_n output will now serve as PWMnTOP.

Example: On the PMAC2A-PC/104 J4(JMACH2):Machine Port 15pin "DIR\_1+" is now "PWM\_1TOP")

## Copley Digital Amplifiers

All the Copley Digital amplifiers can take the modern PWM command input for velocity or current mode.

The Xenus (AC powered), Accelus (DC powered), and Junus (DC Brush) can also take classical +/-10V command for velocity or current mode. The AccelNet Module is PWM only.

Another popular command mode, for precision are bearing nanometer applications, using the PMAC2™, is the Dual analog command. The 7xx5ACF will close a high resolution and high bandwidth current loop with zero crossover distortion.

Copley does manufacture the 7xx9AC, a direct H-Bridge amplifier for use with PMAC2 direct H-Bridge control. However, due to the low current loop bandwidth produced by the PMAC2, Copley does not recommend the use of direct H-Bridge control in most applications. Copley does recommend the use of the PMAC2 for PWM command with Copley Digital amplifiers for high current loop bandwidths (typically 3k Hz).

## Testimonial

It works great!

Below is the Turbo PMAC file with the necessary settings.

My setup had a 3U Turbo PMAC2 in a UMAC Rack with an ACC24E2A. Rather than tap into the PWM lines I just used the C Channel, which is available at the W Flag Input/Pulse Output terminal. This is also available on the ACC 8E for PMAC2.

The PWM signal is a 50/50 style. I was running the Accelus in Velocity mode. I know it will work just as well in torque mode.

**Tom Schneiberg**

**Automation & Process Controls  
235 Roselawn Avenue East, Suite 18  
Maplewood, MN 55117**

```
***** ACCELUS-PWM.PMC *****
;
; This file sets up motor 1 as a PWM Driven Accelus Amplifier.
; This is where the PWM input signal from the "C" Channel is the Command
; input signal, in place of the DAC Signal.
;
; ACC24E2A Setup
; E1A - E1D are ON
; The CHW1+/PUL_!+ signal (Pin 11, ENC 1) is connected to IN6 (Pin 3, J3) On the Accelus
; The GND (Pin 8, ENC 1) is connected to the GND (Pin 13, J3) on the Accelus
;
I100=1           ;Motor 1 Activate
I101=0           ;Motor 1 Commutation Enable
I102=$78204      ;Motor 1 Command Output Address
I119=0.1         ;Motor 1 Maximum Jog Acceleration
I120=0           ;Motor 1 Jog/Home Acceleration Time
I121=50          ;Motor 1 Jog/Home S-Curve Time
I122=250         ;Motor 1 Jog Speed
I124=$20001      ;Motor 1 Flag Mode Control
I129=-120        ;Motor 1 Output/1st Phase Offset
I130=3000        ;Motor 1 PID Proportional Gain
I131=300         ;Motor 1 PID Derivative Gain
I132=7160        ;Motor 1 PID Velocity Feed Forward Gain
I133=0           ;Motor 1 PID Integral Gain
I134=1           ;Motor 1 PID Integration Mode
I135=0           ;Motor 1 PID Acceleration Feed Forward Gain

I7216=1         ; Set Output Mode to Analog/PWM
```