## Introduction

The purpose of this app-note is to guide end users through the process of controlling a servo motor using PWM (Pulse Width Modulation). This guide also provides the necessary steps to configure a Copley Servo drive in Position Mode with PWM.

Overview

PWM produces a digital square wave which can be used to control motion in a servo motor, as well as many other applications. In a PWM signal the minimum and maximum voltage are the values that limit the square wave oscillation. The space between the Vmin and Vmax is called amplitude.

A cycle is the interval of the wave that completes one full repetition, and the time a cycle takes to finish is called a period. Another important concept in PWM is the duty cycle. The duty cycle represents the period in which the signal is high, or on the wave.
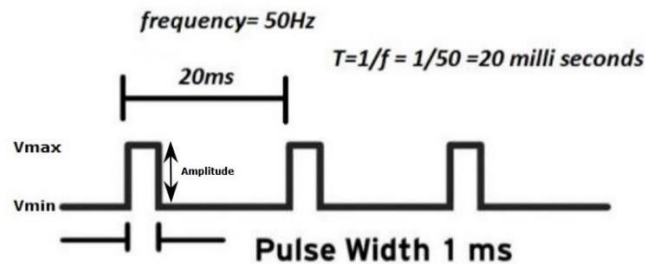
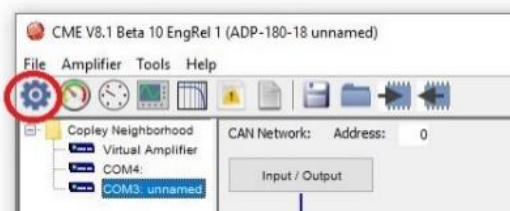Copley takes standard hobby RC PWM commands:
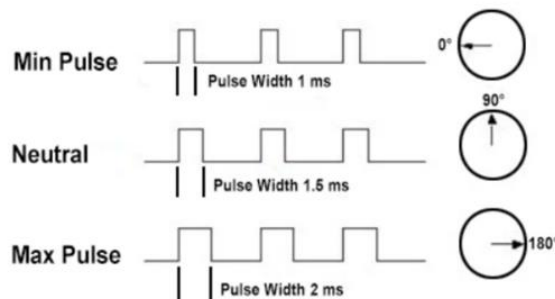
The picture below depicts a twisted pair of wires and the breaded shield, connecting to the frame ground pin on the Copley driver.
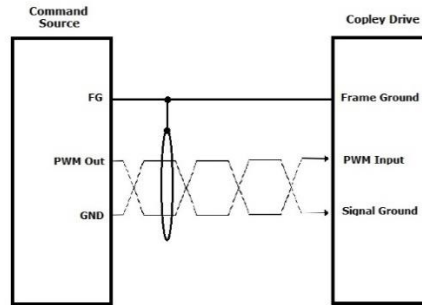
## Configuring a Drive for use in Position Mode with PWM

Use the following procedures to configure a drive in CME for use in Position Mode with PWM.

1. In CME, click the **Setup** icon.

2. Click the Next button until the screen below appears. On this screen select **Position** in the Operation Mode field and select **Digital Input** in the Command Source field.
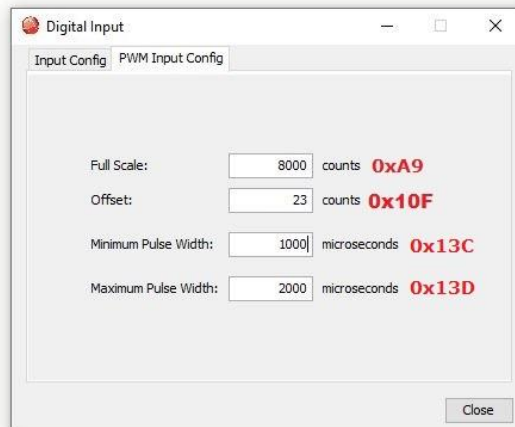
   Note: High speed, single ended inputs, or differential Multi-mode port is available for use with PWM.
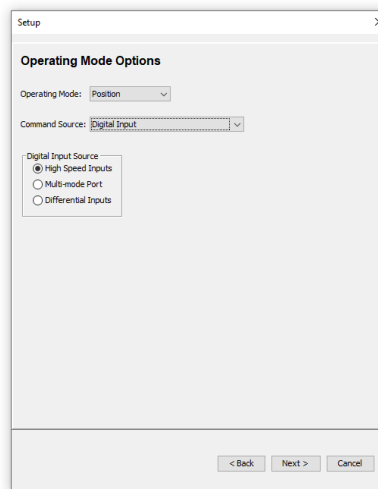
3. On the main CME screen, select the **Digital Input** tab, then in the new screen select **PWM**.
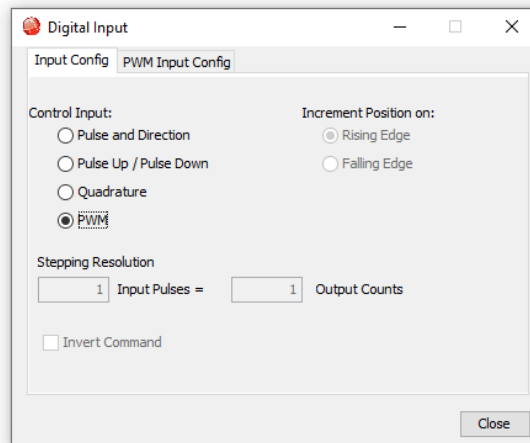
4. Select the **PWM tab Input Config** tab, and then configure the position range and pulse width options.


- Parameter 0xA9 (PWM Input scaling) gives the number of encoders that correspond to the full range of motion from minimum PWM pulse width to maximum PWM pulse width.

- Parameter 0x10F (Registration Offset for Pulse and Direction Mode) gives the number of encoder counts to use as an offset on the final calculated position.

- Parameter 0x13C (Minimum PWM Pulse Width) gives the minimum pulse width in microseconds.

- Parameter 0x13D (Maximum PWM Pulse Width) gives the max pulse width in microseconds.

5. On the main CME screen, select the **P-loop** tab. On the new screen select the **Trajectory Values** tab. If Copley is controlling the trajectory limits, please see the values in the screenshot below.
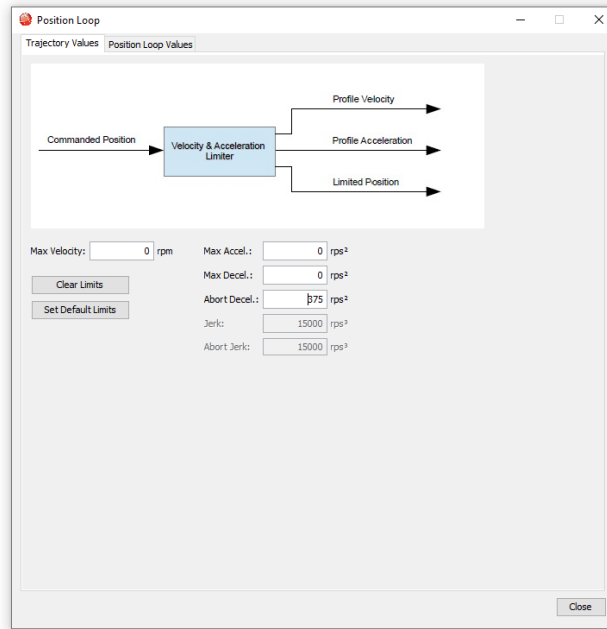
Note: Do not press the **Clear Limits** button unless a third-party external device is controlling or limiting the trajectory.

Once the basic PWM configuration is done, verify the signal is wired to the correct input. Click the Input/Output tab in main CME screen and the Input/Output screen displays. One of the inputs should carry a PWM signal to the Copley Controller. In the example below IN3 is carrying the PWM signal to the Copley Controller.
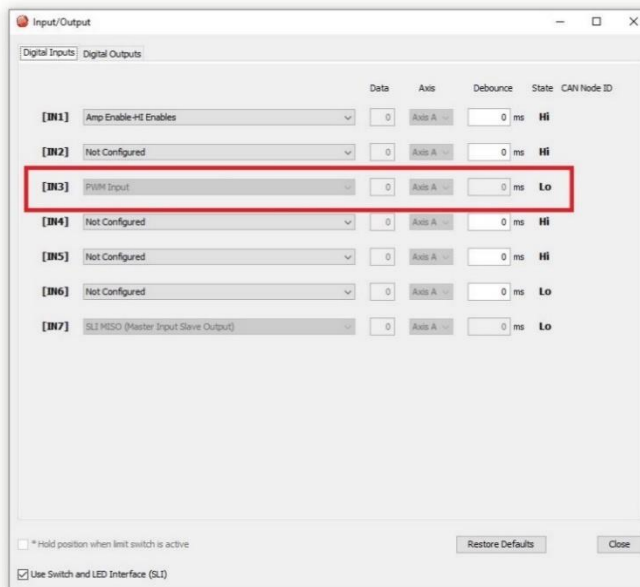

Note: Please keep in mind that different drive models might display differently.

Configuration Notes

Before the drive can be used in PWM Position Mode, there are several key bits of configuration that need to be checked and verified. This section highlights the key points of configuration that should be checked to ensure the driver is properly prepared after setup has been complete.

1. To operate correctly, PWM requires Parameter 0x24 (Desired State) to be set to state 23 (digital inputs drive position).

    To verify that the drive is properly configured to state 23, open the **Tools** menu and select ASCII Command Line option.
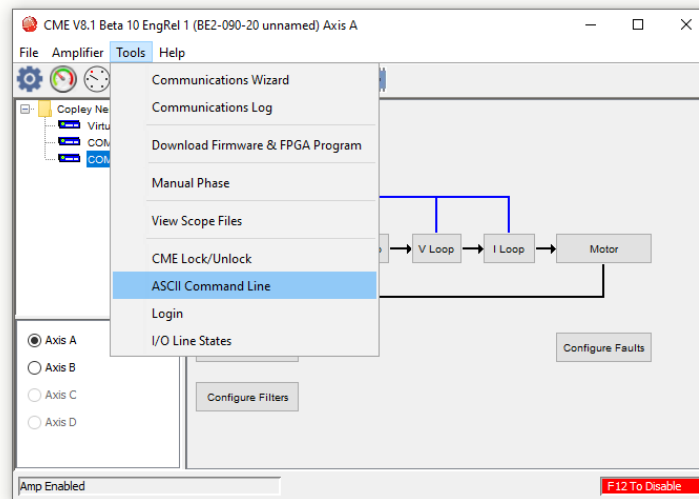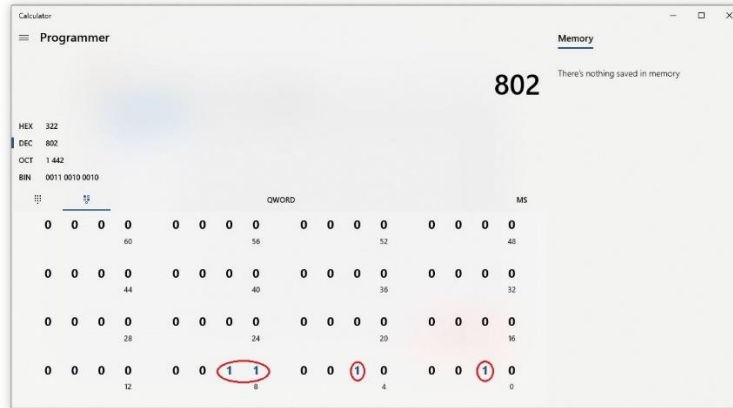

In the Command field type, "g r0x24" and then press the Enter key.
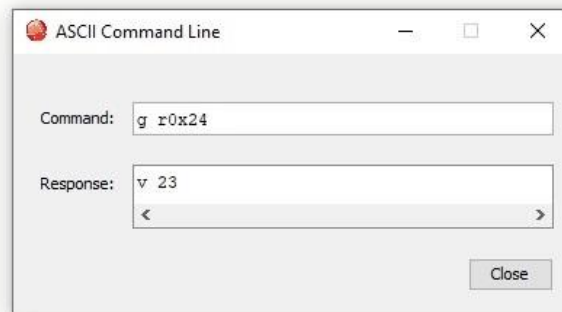
The value returned in the Response field should read as "v 23". If the value does not return as "v 23" then type, "s r0x24 23" into the Command field, and press the Enter key. This saves the value of 23 to flash for Parameter 0x24.

2. To enable PWM mode, the PWM Digital Input Command parameter (0xA8) needs to have several bits set:

   - Bit 1 inverts the PWM input.

   - Bit 5 configures the PWM inputs to allow for very slow PWM periods. It should be set since most users are using very slow PWM periods (20ms).

   - Bits 8 and 9 are used for Input pin interpretation for position mode. They also define the style of input.

   When using the windows calculator (Programmer mode) a value of 802 is returned for all bits used in PWM Position mode.

The ASCII Command Line can be used to easily set all bits to the required values, and then can be saved to Flash. In the Command field type, "s r0xa8 802" and the press the Enter key.
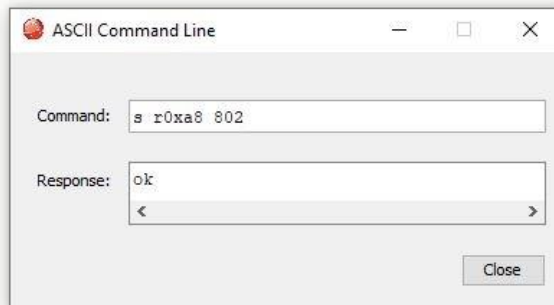
3. Before inputting any commands for motion, ensure that the system is using some conservative values. In the example below a motor is used that has a full rotation of the motor shaft at 4000 counts. To test PWM pulses, the following values are used in the PWM Input Config screen. These values are set to equal half of the rotation.
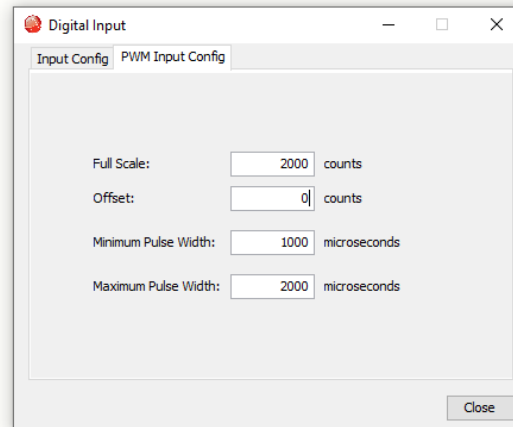
For this example, an inexpensive RC pulse generator is being used that is like the one in the screen shot below.

For the model above the Select button changes the circulation patterns, the Pulse Width button controls the frequency, and the knob controls the speed of the amplitude signal.

4. Once the PWM generator is wired to the correct input, commanded position can be calculated. The absolute commanded position is calculated as follows:

$$POS = \left(\frac{PW - MIN}{MAX - MIN}\right) * SCALE + OFFSET$$

PW = captured pulse width (microseconds)

MIN = minimum pulse width

MAX = maximum pulse width

SCALE = scaling factor

OFFSET = position offset

General notes

PWM in position mode works on drives with processor DSP 8367, and with firmware 3.62 or higher.

PWM in position mode works on ARM drives with firmware 2.02 or higher.

PWM in position mode works on Plus drives with firmware 4.66 or higher.

Revision History

Date	Version	Revision
11/23/2021	Rev 00	Initial release