

Dual Loop (Slip Compensation) with the PTi-210 Module

Objective

Demonstrate how to setup a system using the Dual Loop mode.

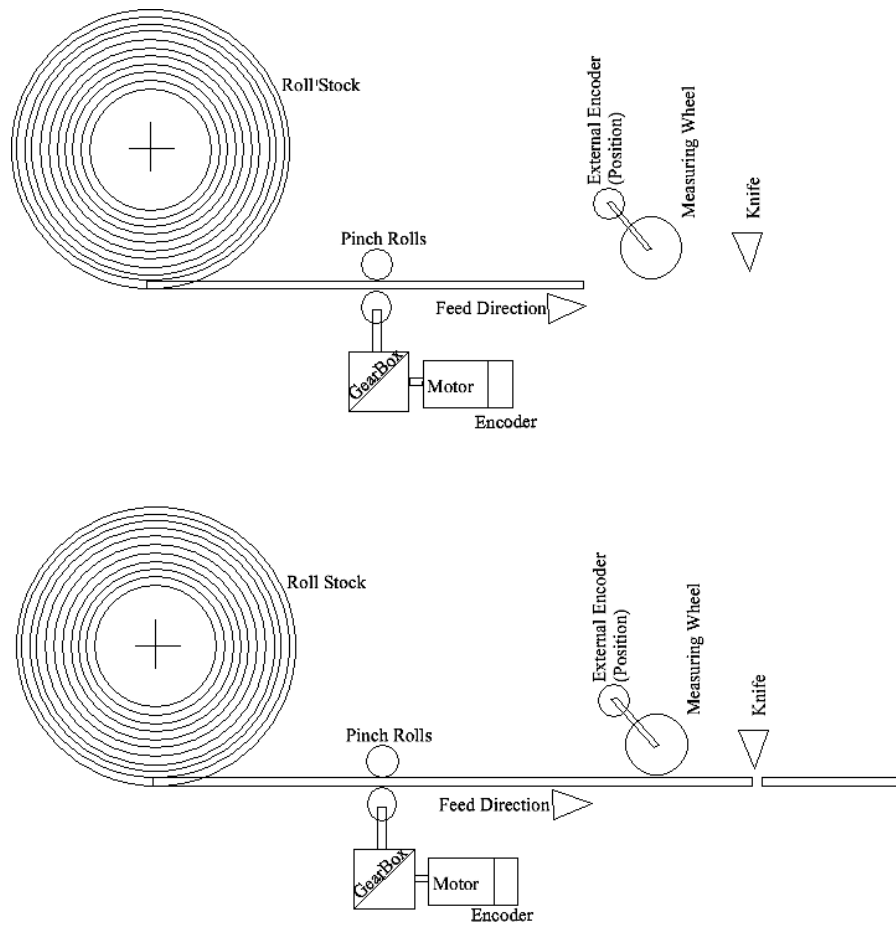
Solution Summary

With PowerTools Studio software setting up the application becomes very simple. There are a few definitions that need to be addressed first.

This is a typical application for using Dual Loop mode: Roll stock is fed through pinch rollers by a servo driven motor and gear box. The material is fed out to the knife and a cut-to-length process takes place. If the product slips as the pinch rolls drive it forward, the motor position is no longer accurate enough for the cut-to-length process. A second position encoder is needed to measure product length. This secondary encoder is often mechanically tied to a measuring wheel whose circumference is accurately manufactured. The motor encoder controls the system's velocity and the external encoder controls the feed position.



Typically, during setup, the material needs to be fed from the roll stock to the measuring wheel. Prior to reaching the measuring wheel, the system may need to run in a standard single loop mode so that the material position is measured from the servo motor's encoder. Or alternatively if the system is in dual loop position mode, the motor's velocity must be limited such that the lack of position information (from the external encoder that is not moving) does not cause a runaway or excessive velocity condition.



Step 1 – Mechanical Definitions

Let's apply some real world numbers into our application example:

1. Motor Encoder: 4096 lines/rev
2. External Encoder: 3000 lines/rev
3. Measuring Wheel: 12 inch circumference
4. Measuring Wheel to External Encoder gear ratio 1:1
5. Pinch Rolls: 3 inch diameter
6. Gear Box: 10:1 ratio

Step 2 – Drive Hardware Setup

Configuration	
Drive Model	03200050
Motor Type	067EDA300
<input checked="" type="checkbox"/> Thermistor Mode Enable	
Drive mode	RFC-S
Thermistor Type	Encoder
Thermistor Fault	Temperature
Trip Threshold	3300 ohms
Reset Threshold	1800 ohms

Drive Encoder P1	Drive Encoder P2	Motor
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Encoder Configuration

Encoder Type

EnDat

Encoder Setup

Encoder Supply Voltage

5 Volts

Enable Auto Encoder Configuration

☒

Encoder Turns

16

Encoder Comms Resolution

0

Lines Per Rev

4096

Encoder Comms Baud Rate

300K

Termination Select

1

Error Detection

Enable wire break detection

☐

Enable Phase Error Detection

☐

Enable Power Supply Alarm

☐

Enable commutator wire break detection

☐

Enable marker wire break detection

☐

Advanced Features

Additional Power Up delay

0.0

Feedback Filter

Disabled

Normalisation Turns

16

Feedback Reverse

☐

Calculation Time

5

Step 3 – External Encoder Setup

For Unidrive M700 and Digitax HD the secondary encoder requires a SI Universal Encoder module input port. The SI Universal Encoder can be installed in any slot, but our example we have used Slot 2.

Warning: Do not use any other SI encoder input module other than the SI Universal Encoder, as they have processing delays with will cause poor servo performance.

Alternatively, the motor encoder can be wired to the SI Universal Encoder and the External Encoder can be wired to the drive's encoder input, the setup would need change accordingly.

The screenshot displays the configuration interface for Axis 1. On the left, a tree view shows the hardware configuration: Slot 1 is empty, Slot 2 contains an SI-Universal Encoder, and Slot 3 contains a PTi210. The main panel is titled 'Slot Configuration' and shows 'Slot Number' as Slot 2 and 'Module Type' as SI-Universal Encoder. Below this, the 'SI-Universal Encoder' section is active, showing 'P1 Interface' and 'P2 Interface' tabs. The 'Encoder Configuration' section shows 'Encoder Type' as AB. The 'Encoder Setup' section includes fields for 'Encoder Supply Voltage' (5 Volts), 'Enable Auto Encoder Configuration' (checked), 'Encoder Turns' (16), 'Encoder Comms Resolution' (0), 'Lines Per Rev' (3000), 'Lines Per Rev Divider' (1.000), 'Encoder Comms Baud Rate' (300K), and 'Termination Select' (1). The 'Error Detection' section has checkboxes for 'Enable wire break detection', 'Enable Phase Error Detection', and 'Enable Power Supply Alarm', all of which are unchecked. The 'Advanced Features' section includes 'Additional Power Up delay' (0.0), 'Feedback Filter' (Disabled), 'Normalisation Turns' (16), 'Feedback Reverse' (unchecked), and 'Calculation Time' (5).

Axis 1

- Status
- Graph
- Hardware
 - Drive/ Encoder/ Motor
 - Slot 1 - empty
 - Slot 2 - SI-Universal Encoder
 - Slot 3 - PTi210
 - Comms Slot - Onboard Ethernet
- Setup
- Devices / Vars
- I/O Setup
- Motion
- Programs
- Network

Slot Configuration

Slot Number: Slot 2

Module Type: SI-Universal Encoder

SI-Universal Encoder

P1 Interface P2 Interface

Encoder Configuration

Encoder Type: AB

Encoder Setup

Encoder Supply Voltage: 5 Volts

Enable Auto Encoder Configuration: ☒

Encoder Turns: 16

Encoder Comms Resolution: 0

Lines Per Rev: 3000

Lines Per Rev Divider: 1.000

Encoder Comms Baud Rate: 300K

Termination Select: 1

Error Detection

Enable wire break detection: ☐

Enable Phase Error Detection: ☐

Enable Power Supply Alarm: ☐

Advanced Features

Additional Power Up delay: 0.0

Feedback Filter: Disabled

Normalisation Turns: 16

Feedback Reverse: ☐

Calculation Time: 5

Step 4 – Dual Loop Setup

Dual Loop mode Check Box
If checked, the system will power up in Dual Loop mode. If unchecked the system will power up in the normal single loop mode. This selection can be changed in a user program

Select the appropriate Motor Encoder port

Select the appropriate Secondary Encoder port

Enter the calculated Encoder ratio

Calculating the Encoder Ratio:

Determine how many encoder lines each encoder produces over an equivalent distance:

Secondary Encoder

By its design the external encoder produces 3000 lines per 1 revolution of the measuring wheel = 12 inches.

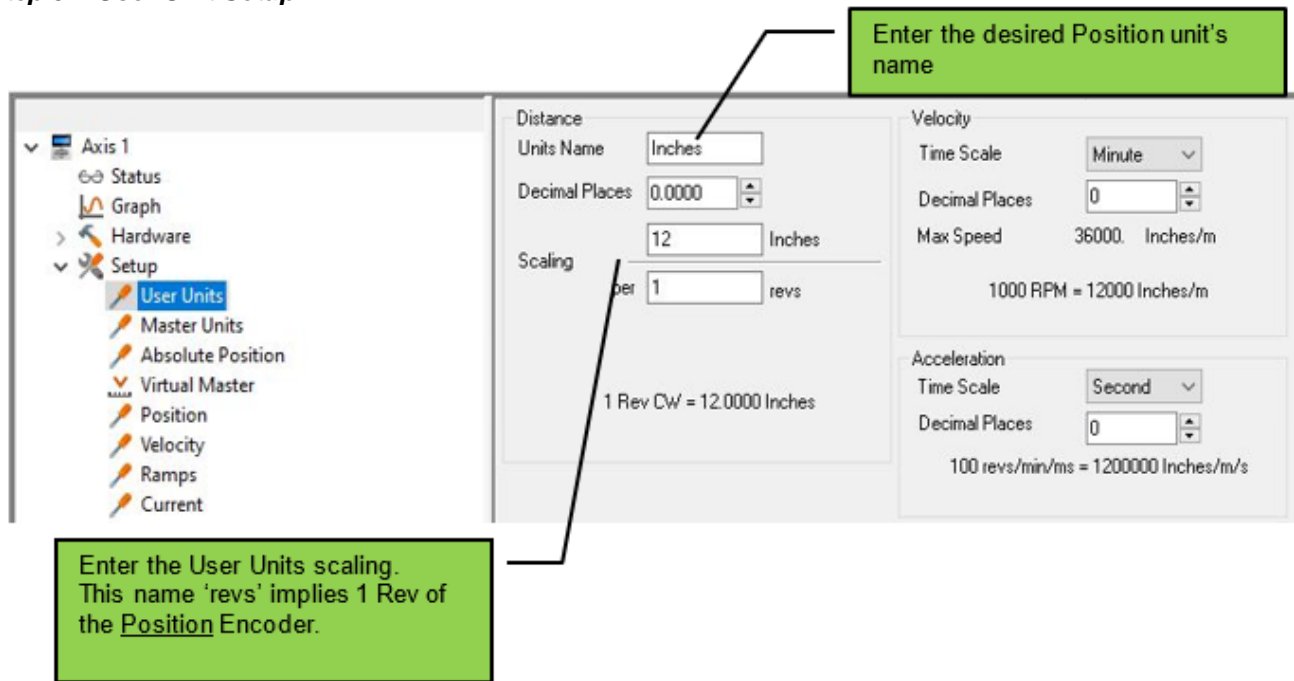
Motor Encoder

Since we used a 12 inch length in the secondary encoder calculation, calculate how many lines are produced from the motor encoder over 12 inches of the pinch roll travel:

$$\begin{array}{ccccccc}
 2048 \text{ lines} & 10 \text{ rev motor} & 1 \text{ rev Pinch Roll} & 12 \text{ inches} & & & \\
 \text{-----} \times & \text{-----} \times & \text{-----} & \times \text{-----} & = & & 26075 \text{ lines} \\
 1 \text{ rev motor} & 1 \text{ rev Pinch Roll} & 3 \text{ PI inches} & & & &
 \end{array}$$

Remember to use either lines (pre-quadrature) or counts (post-quadrature) in both calculations.

Step 5 – User Unit Setup

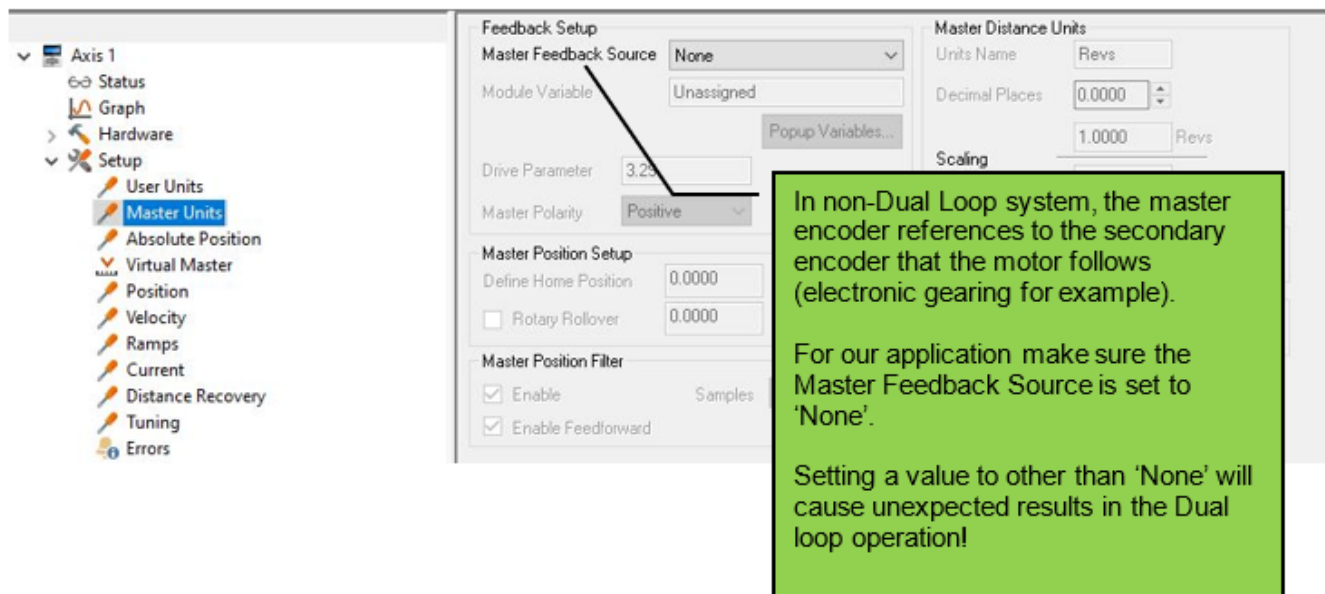


Enter the desired Position unit's name

Enter the User Units scaling. This name 'revs' implies 1 Rev of the Position Encoder.

1 Rev CW = 12.0000 Inches

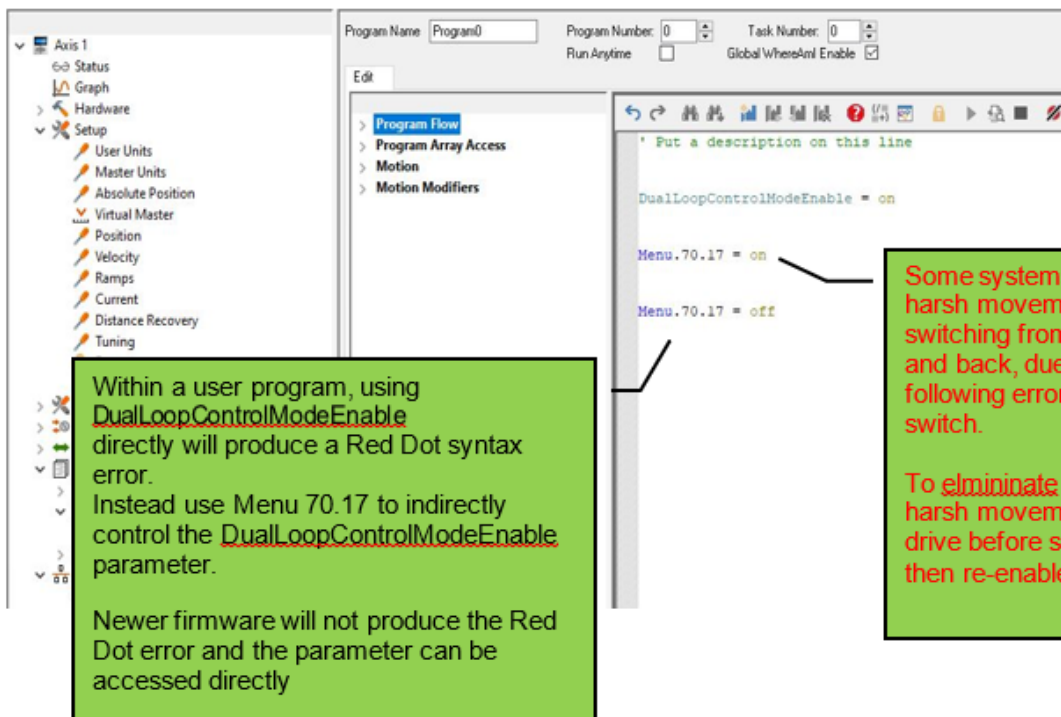
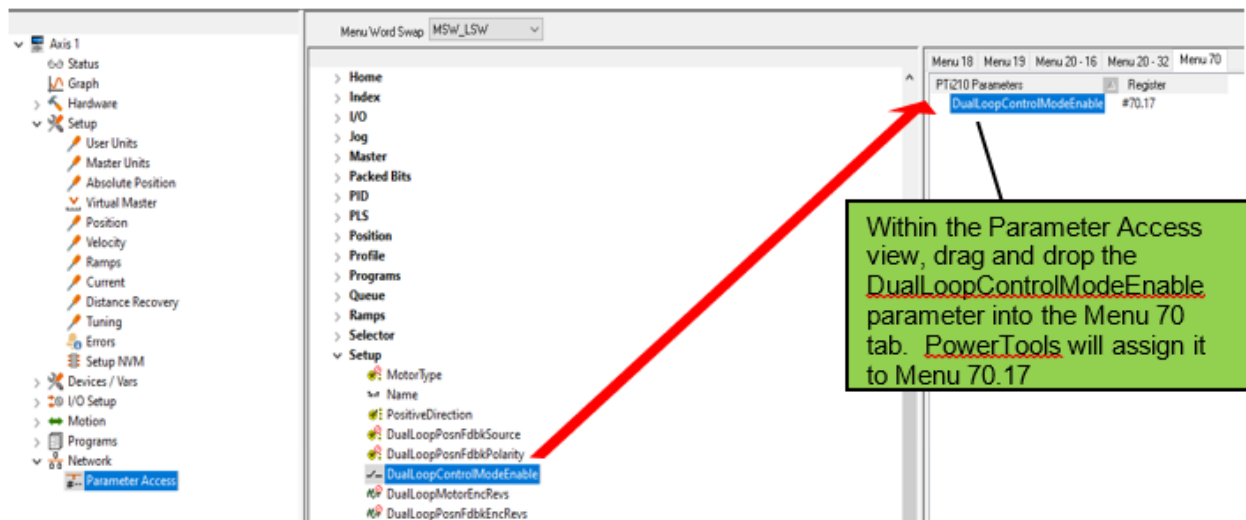
Step 6 – Master Unit Setup



In non-Dual Loop system, the master encoder references to the secondary encoder that the motor follows (electronic gearing for example). For our application make sure the Master Feedback Source is set to 'None'. Setting a value to other than 'None' will cause unexpected results in the Dual loop operation!

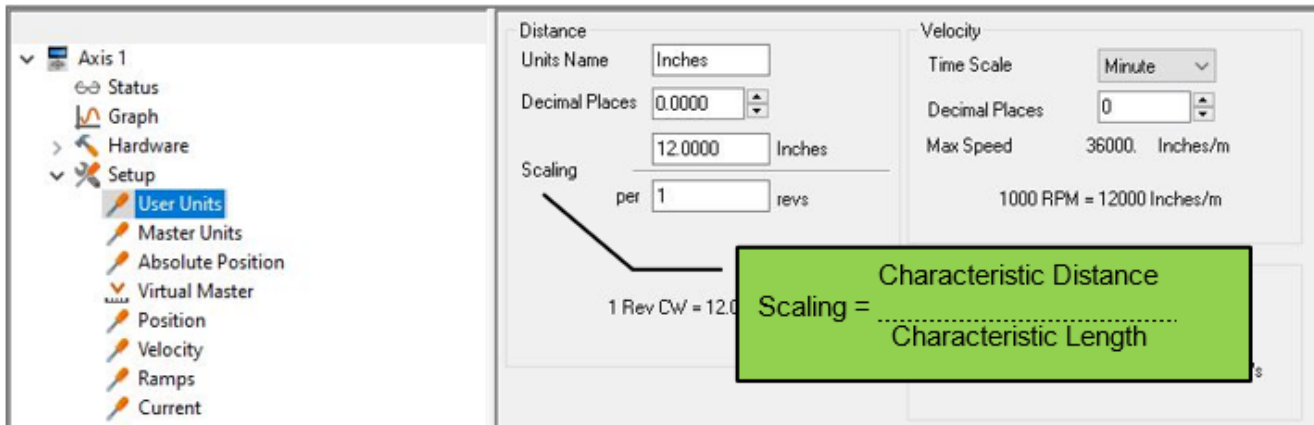
Step 6b – Turning Dual Loop Mode On/OFF

Once the setup above is downloaded to the drive, the system is ready to run in Dual Loop mode. If your application requires Dual Loop to be turned on and off at different times, a user program can be used. Older firmware versions (B2 and below) require the use of a Menu 70 assignment:



Step 7 – Changing Distance Units

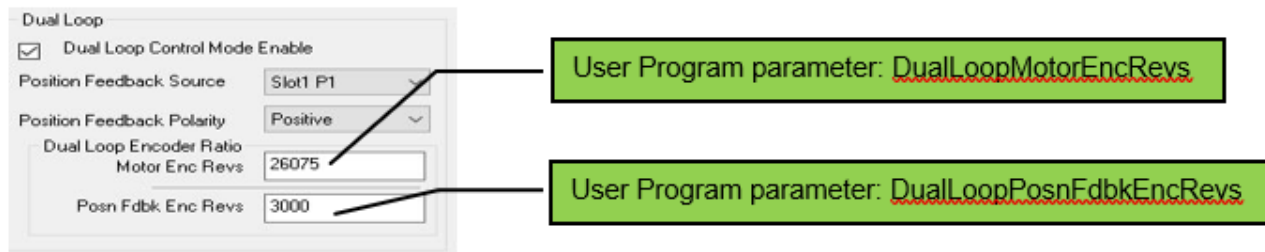
Changing the system Scaling of the can be done in a user program, however this can lead to harsh movements and unexpected results if the servo is enabled when the changes are made. For systems that must remain enabled during transitions to/from Dual Loop mode, its best to simply rescale the Jog or Index distance/velocity in a user program and run the jog or index



For example, if Dual Loop is enabled and you initiate an index distance of 12 inches and velocity of 24 inches per second, the pinch rolls would drive the material forward 12 inches as measured by the second encoder.

With dual loop off, the motor would index the pinch rolls $12 * 26075 / 3000$ inches, we simply need to divide out the ratio for the index distance (and velocity).

The conversion for a index distance and velocity can be easily calculated from the Dual Loop ratio



User Program example:

```

If DualLoopControlModeEnable = Off Then
    Index.0.Dist = 12 * DualLoopPosnFdbkEncRevs / DualLoopMotorEncRevs
    Index.0.Initiate 'Index0,Incremental,Dist=12.0000 revs,Vel=24 revs/m
Else
    Index.0.Dist = 12
    Index.0.Initiate 'Index0,Incremental,Dist=12.0000 revs,Vel=24 revs/m
EndIf

```