

Dual Loop (Slip Compensation) with the SM-EZMotion Module

Objective

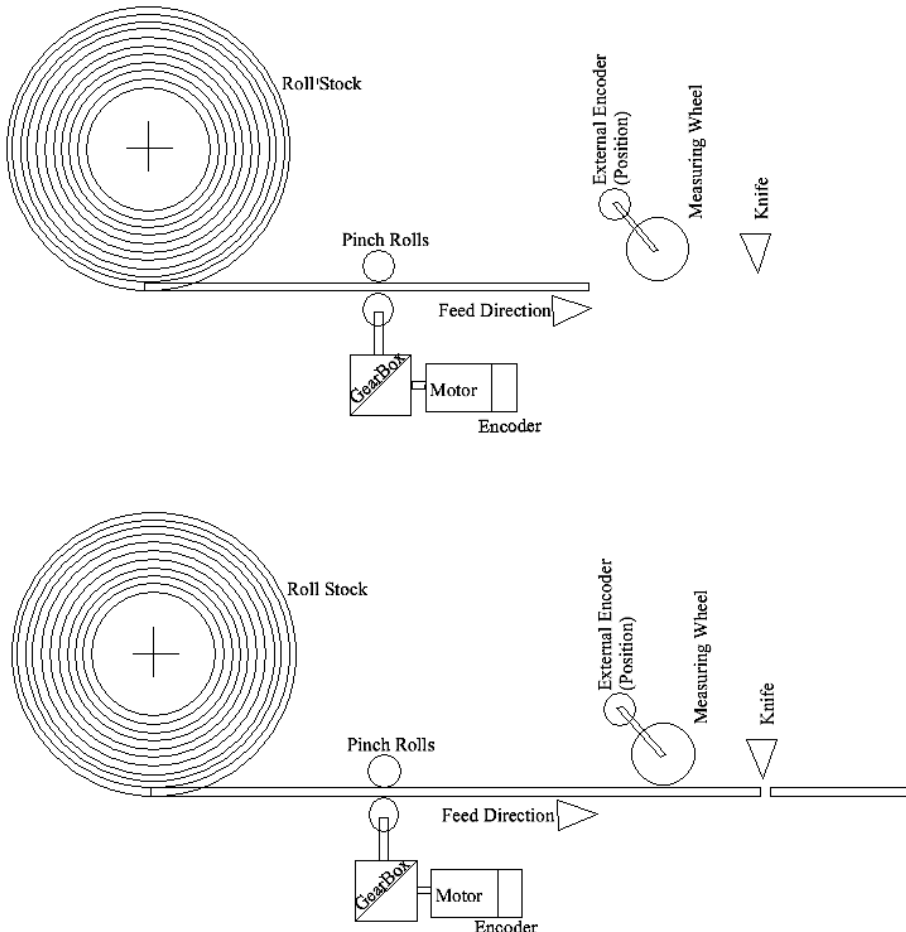
Demonstrate how to setup a system using the Dual Loop mode.

Solution Summary

With PowerTools Pro 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 run away or excessive velocity condition.

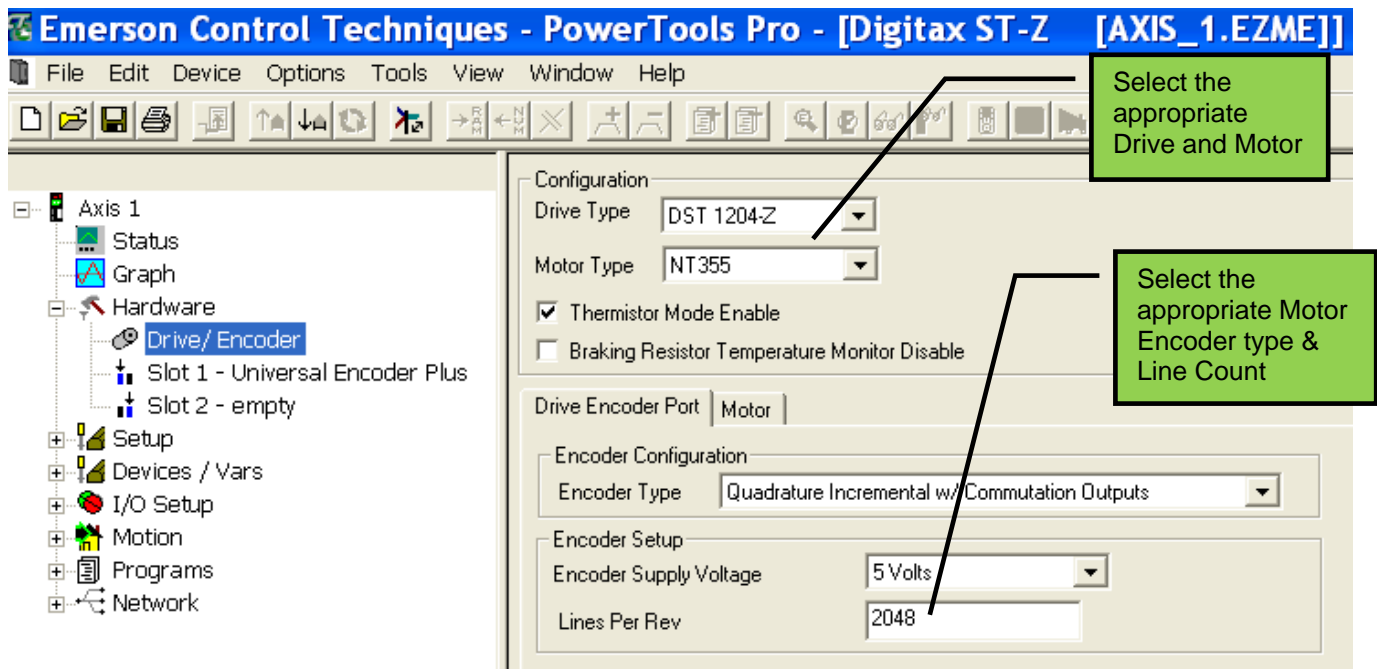


Step 1 – Mechanical Definitions

Lets' apply some real world numbers into our application example:

1. Motor Encoder: 2048 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



The screenshot displays the 'Emerson Control Techniques - PowerTools Pro - [Digitax ST-Z [AXIS_1.EZME]]' application window. The interface includes a menu bar (File, Edit, Device, Options, Tools, View, Window, Help) and a toolbar. A tree view on the left shows the project structure for 'Axis 1', with 'Hardware' expanded to show 'Drive/Encoder', 'Slot 1 - Universal Encoder Plus', and 'Slot 2 - empty'. The main configuration area is titled 'Configuration' and contains the following settings:

- Drive Type: DST 1204-Z
- Motor Type: NT355
- Thermistor Mode Enable:
- Braking Resistor Temperature Monitor Disable:
- Drive Encoder Port: Motor
- Encoder Configuration: Quadrature Incremental w/ Commutation Outputs
- Encoder Setup: Encoder Supply Voltage: 5 Volts
- Lines Per Rev: 2048

Two green callout boxes with arrows point to specific settings:

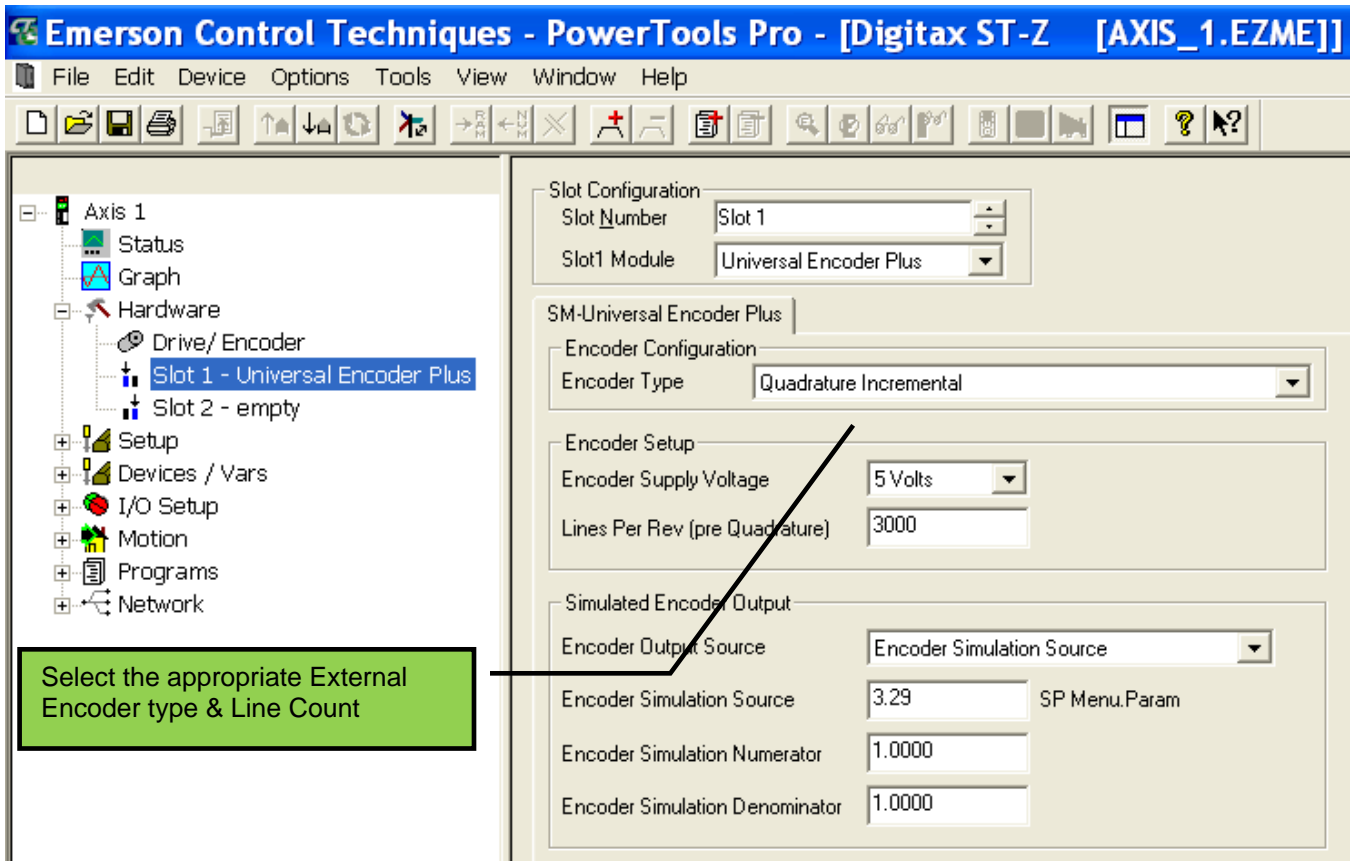
- The first callout points to the 'Drive Type' dropdown menu and contains the text: "Select the appropriate Drive and Motor".
- The second callout points to the 'Motor Type' dropdown menu and the 'Lines Per Rev' text box, and contains the text: "Select the appropriate Motor Encoder type & Line Count".

Step 3 – External Encoder Setup

For Unidrive SP and Digitax ST the secondary encoder requires a SM Universal Encoder Plus module input port. The SM 'uni plus' can be installed in any slot, but our example we have used Slot 1.

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

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



Emerson Control Techniques - PowerTools Pro - [Digitax ST-Z [AXIS_1.EZME]]

File Edit Device Options Tools View Window Help

Axis 1

- Status
- Graph
- Hardware
 - Drive/ Encoder
 - Slot 1 - Universal Encoder Plus**
 - Slot 2 - empty
- Setup
- Devices / Vars
- I/O Setup
- Motion
- Programs
- Network

Slot Configuration

Slot Number: Slot 1

Slot1 Module: Universal Encoder Plus

SM-Universal Encoder Plus

Encoder Configuration

Encoder Type: Quadrature Incremental

Encoder Setup

Encoder Supply Voltage: 5 Volts

Lines Per Rev (pre Quadrature): 3000

Simulated Encoder Output

Encoder Output Source: Encoder Simulation Source

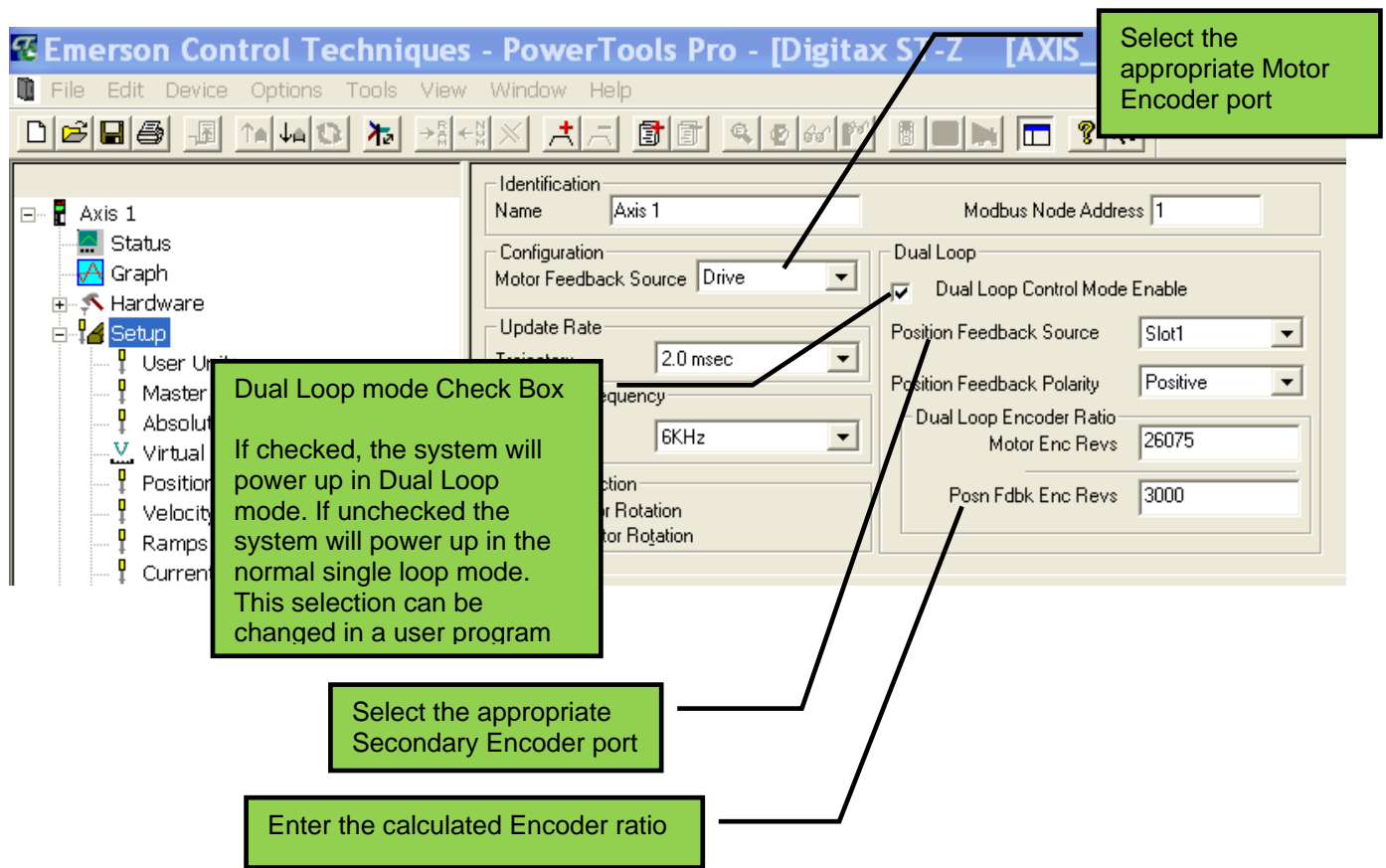
Encoder Simulation Source: 3.29 SP Menu.Param

Encoder Simulation Numerator: 1.0000

Encoder Simulation Denominator: 1.0000

Select the appropriate External Encoder type & Line Count

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.

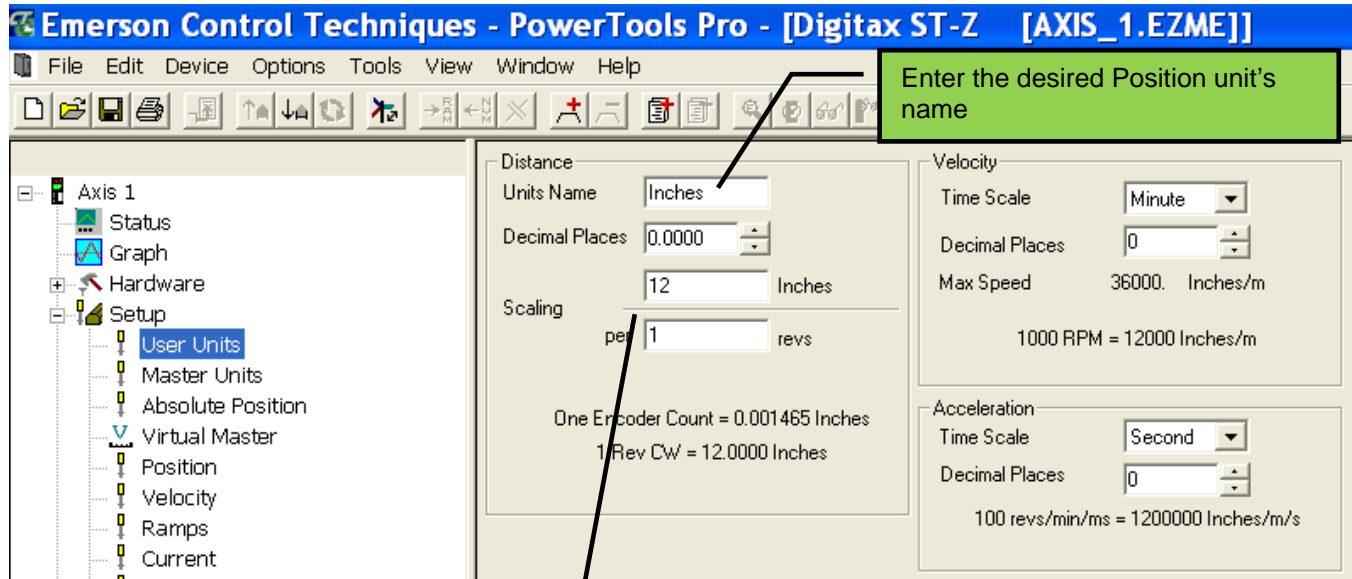
Motor Encoder

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:

$$\frac{2048 \text{ lines}}{1 \text{ rev motor}} \times \frac{10 \text{ rev motor}}{1 \text{ rev PinchRoll}} \times \frac{1 \text{ rev PinchRoll}}{3 \text{ PI inches}} \times \frac{12 \text{ inches}}{12 \text{ inches}} = 26075 \text{ lines}$$

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

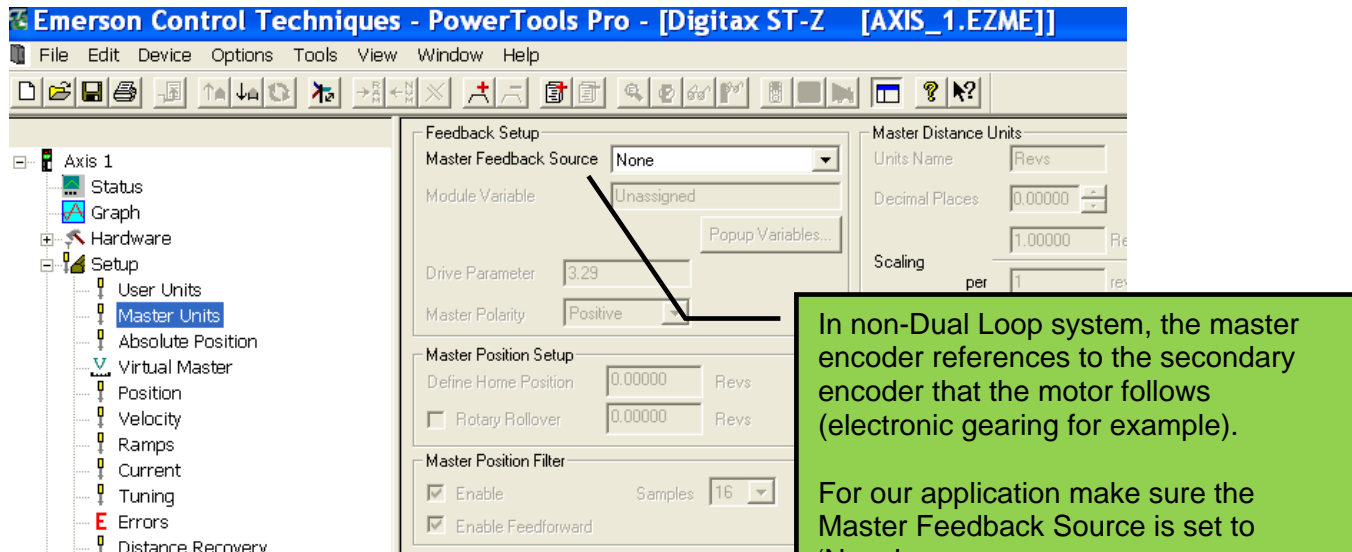
Step 5 – User Unit Setup



Enter the desired Position unit's name

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

Step 6 – Master Unit Setup



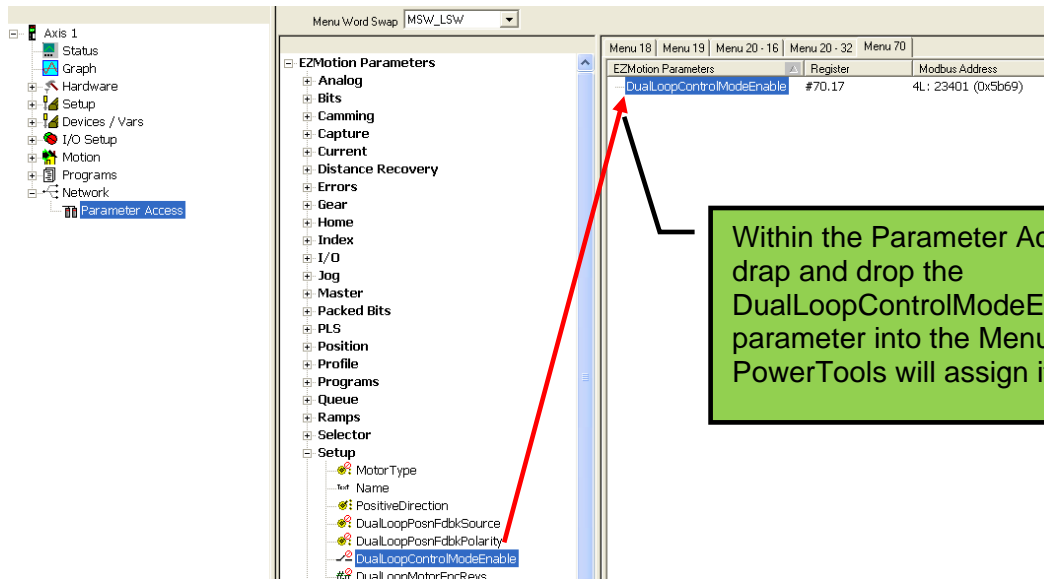
In non-Dual Loop system, the master encoder references to the secondary encoder that the motor follows (electronic gearing for example).

For our application make sure the Master Feedback Source is set to 'None'.

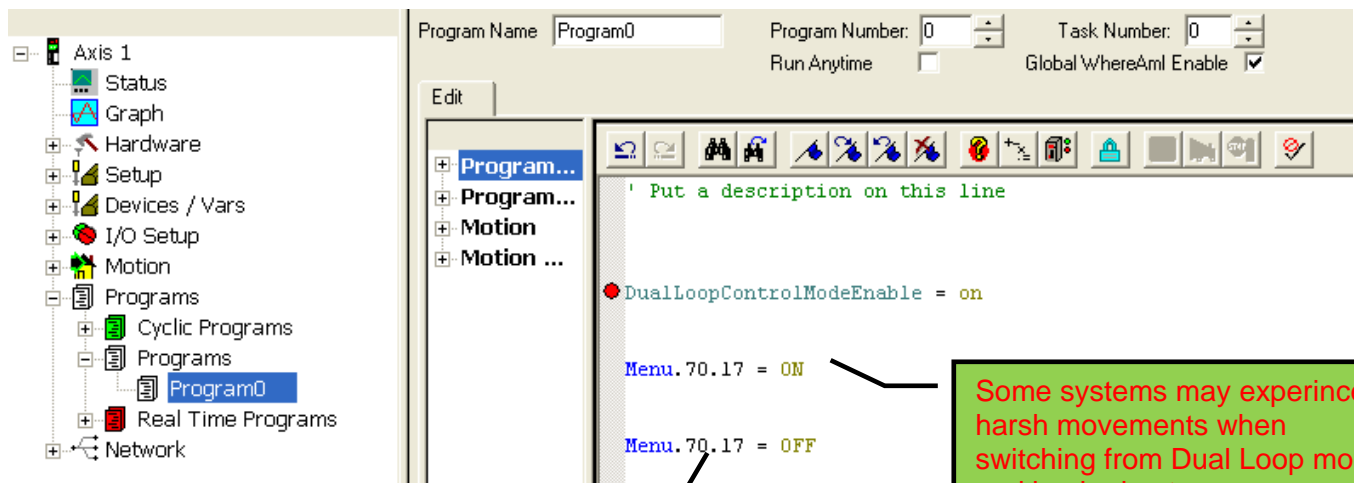
Setting a value to other than 'None' will cause unexpected results in the Dual loop operation!

Step 6 – 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:



Within the Parameter Access view, drag and drop the DualLoopControlModeEnable parameter into the Menu 70 tab. PowerTools will assign it to Menu 70.17



Within a user program, using DualLoopControlModeEnable directly will produce a Red Dot syntax error. Instead use Menu 70.17 to indirectly control the DualLoopControlModeEnable parameter.

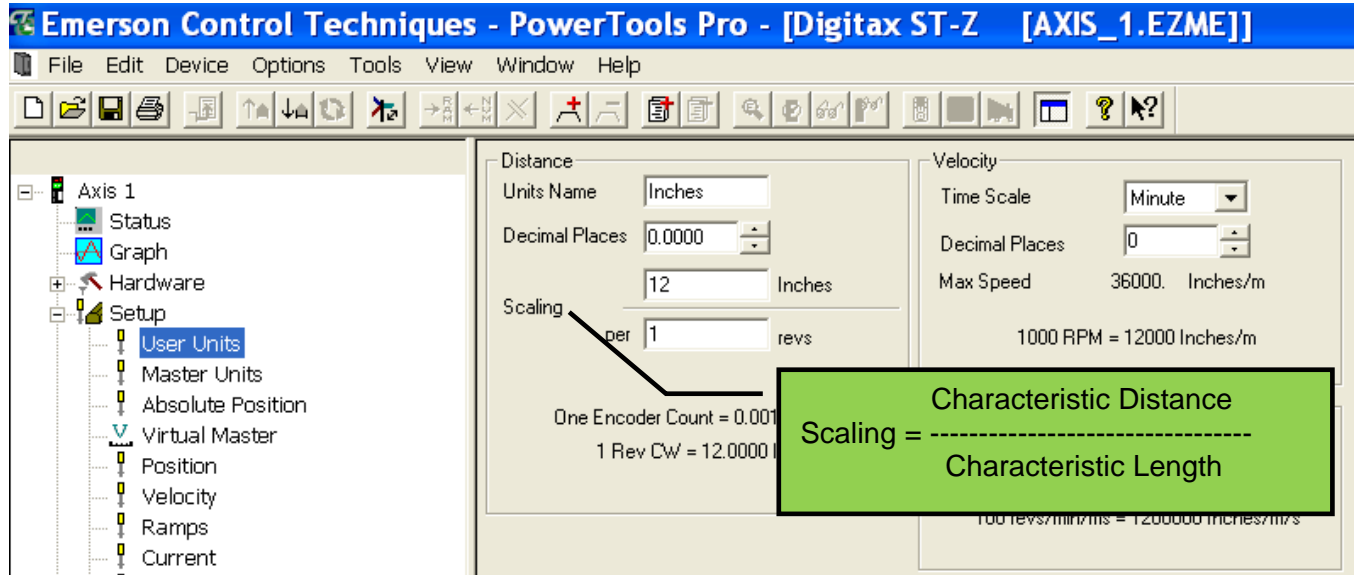
Newer firmware will not produce the Red Dot error and the parameter can be accessed directly

Some systems may experience harsh movements when switching from Dual Loop mode and back, due to non-zero following error at the time of the switch.

To eliminate any potential for harsh movements, disable the drive before switching mode, then re-enable the drive.

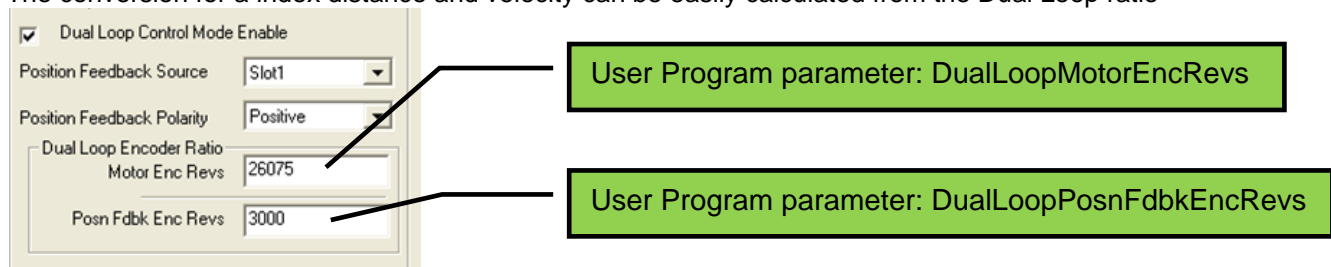
Step 7 – Changing Distance Units

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
  
```