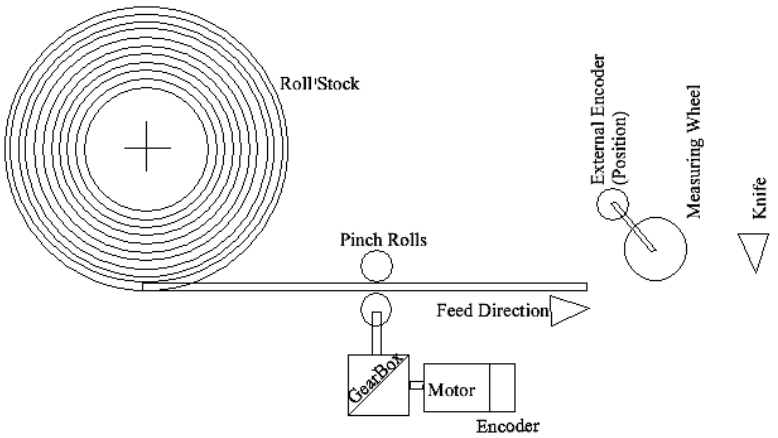
Dual Loop (Slip Compensation) with the SM-EZMotion Module

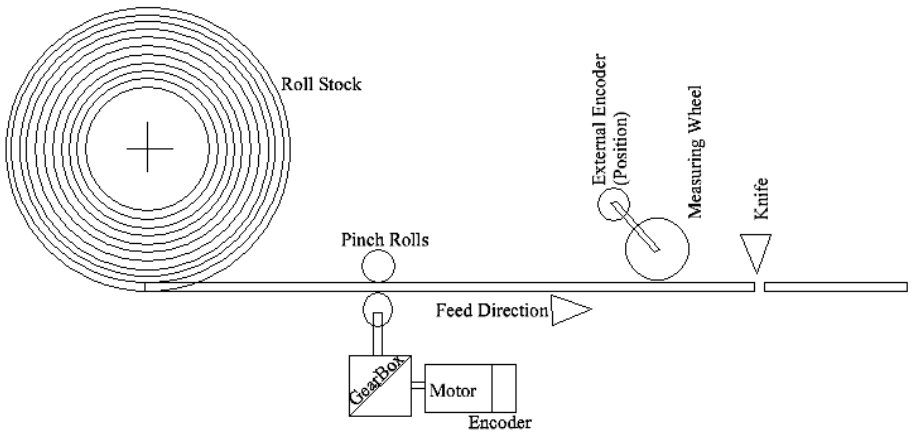
Objective
Demonstrate how to setup a system using the Dual Loop mode.

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.





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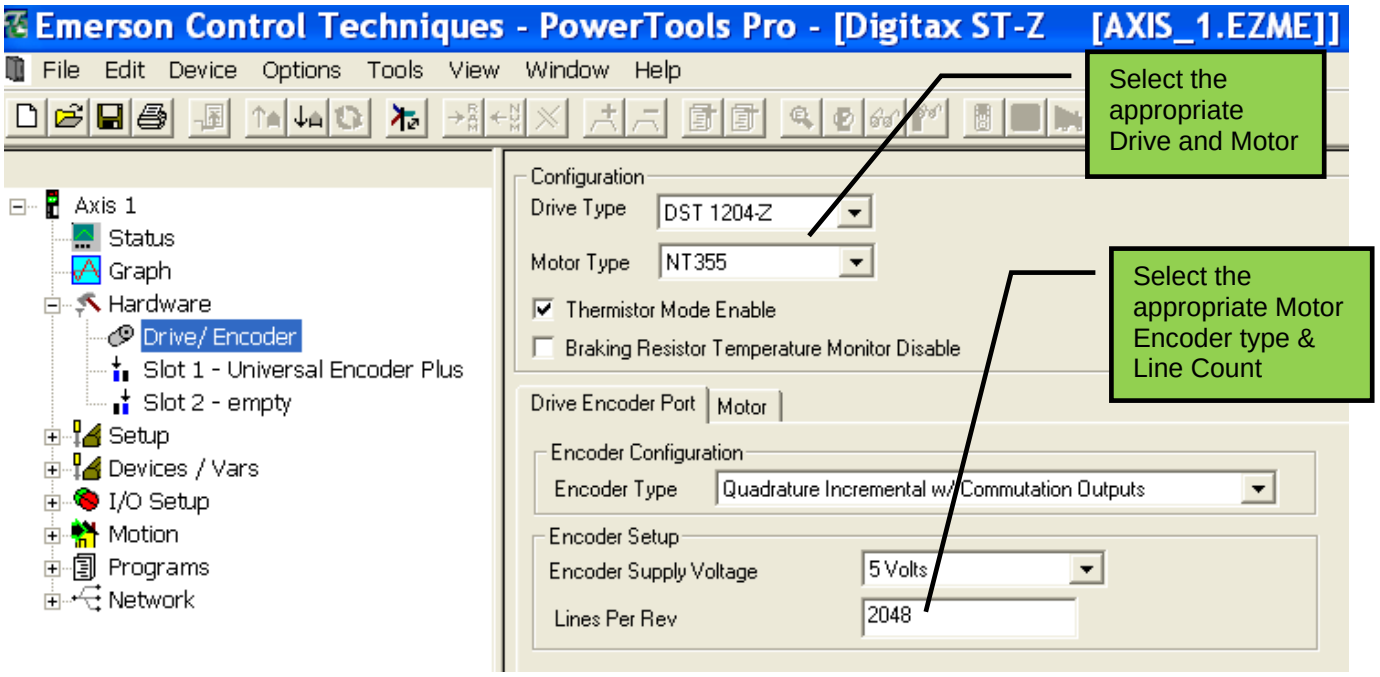
Step 1 – Mechanical Definitions

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



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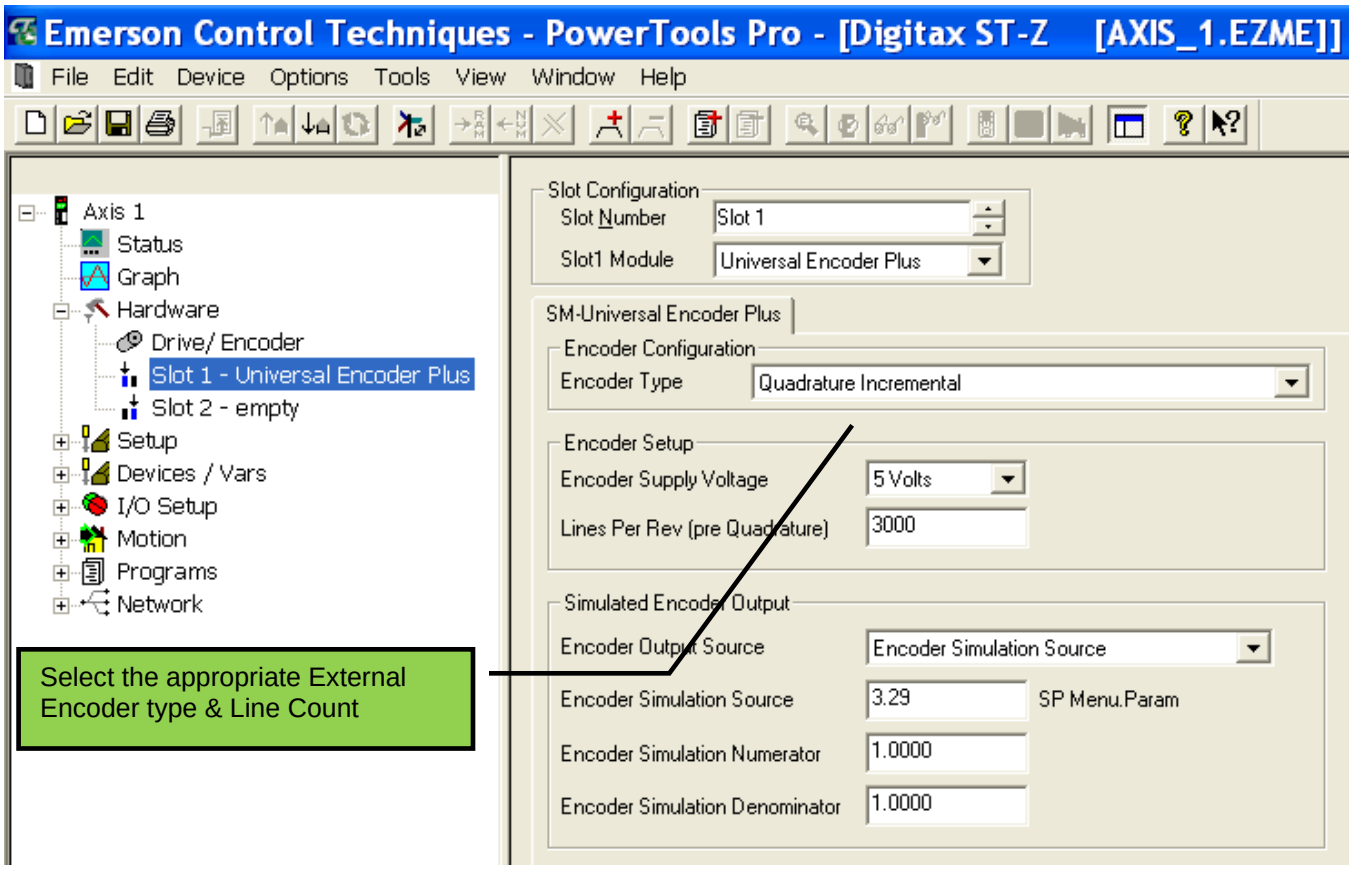
Step 3 – External Encoder Setup

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.



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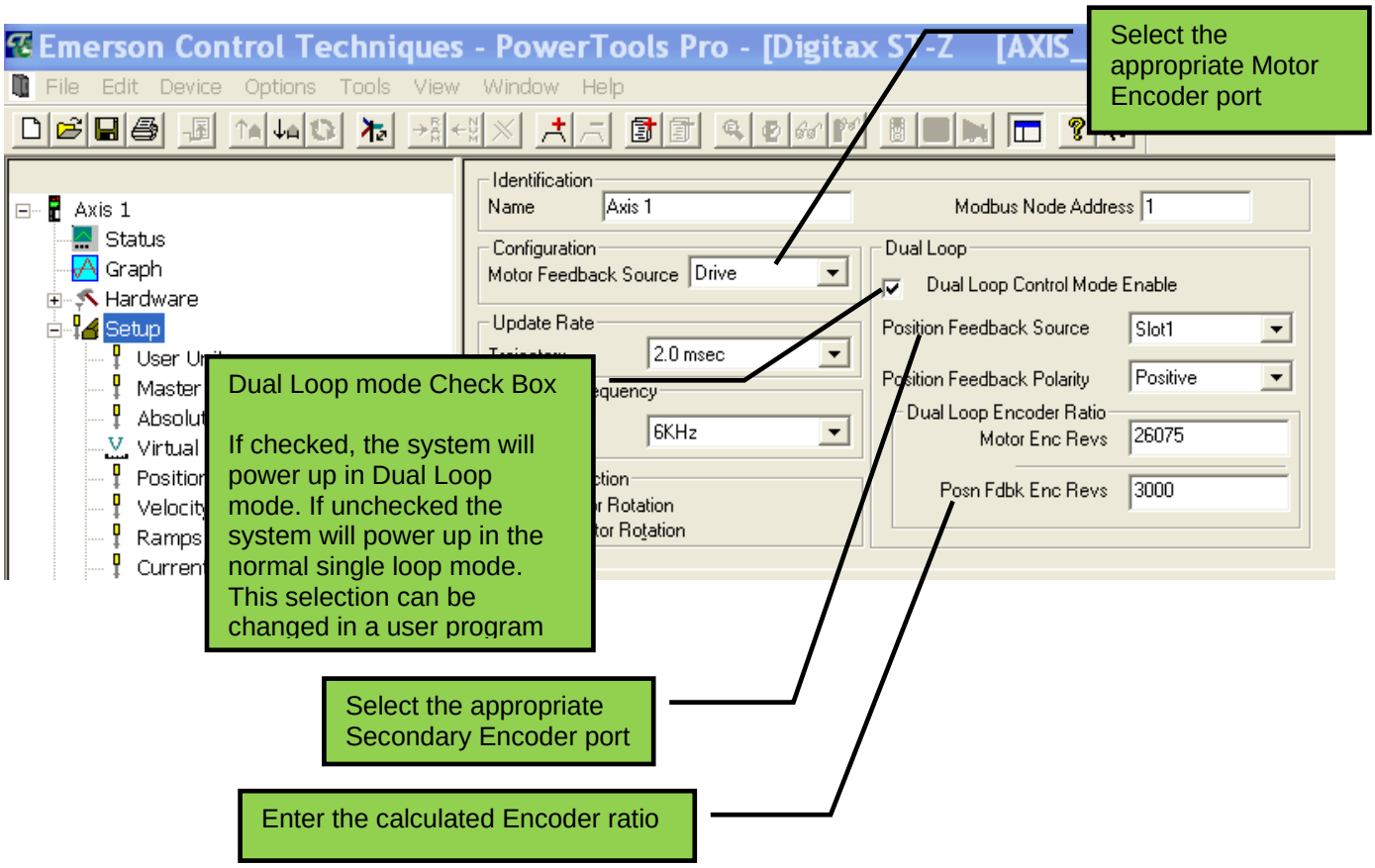
Step 4 – Dual Loop Setup



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:

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

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

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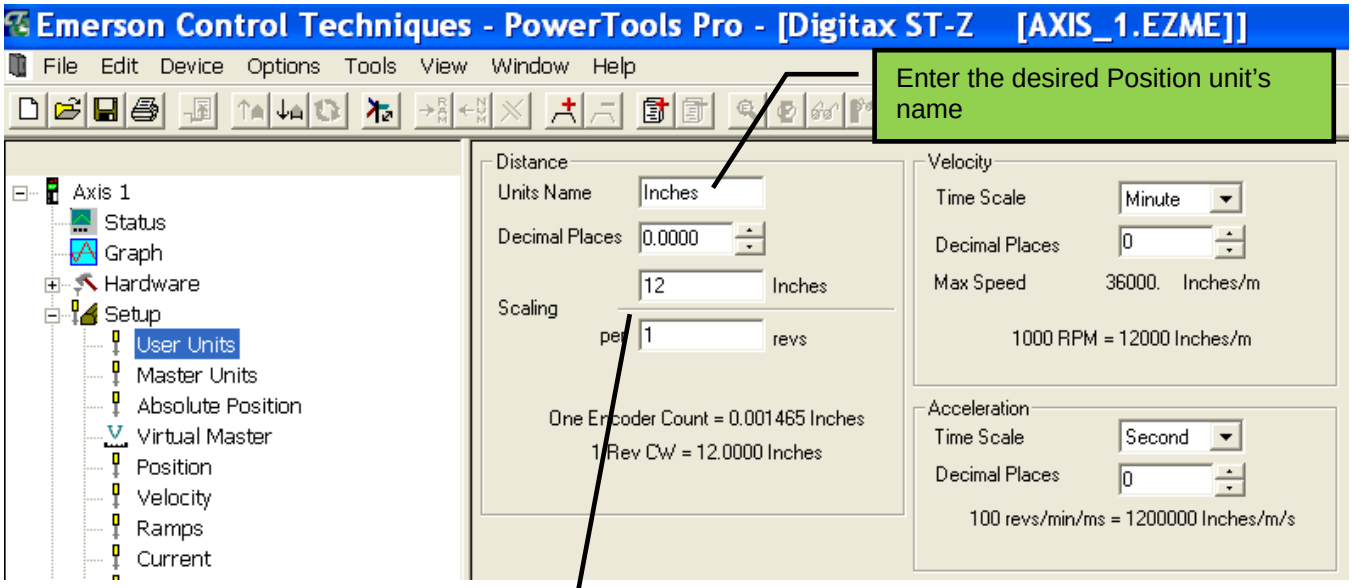
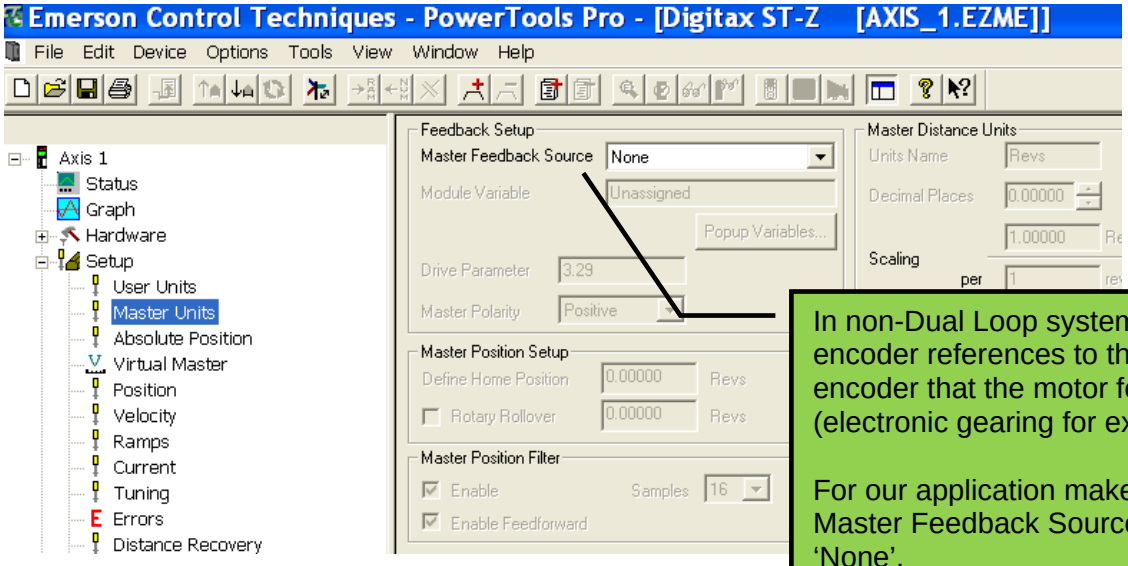
Step 5 – User Unit Setup



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!

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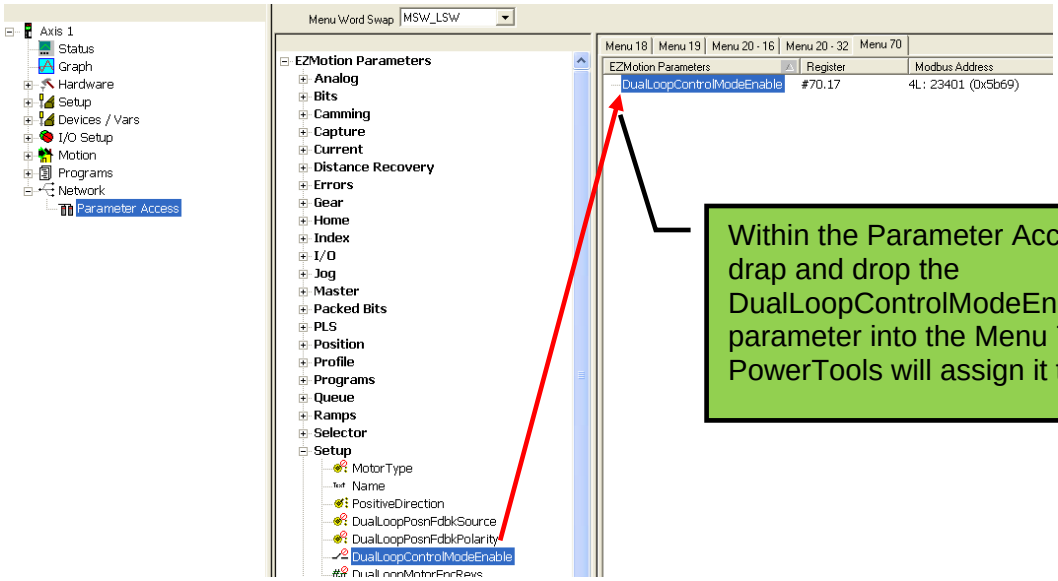
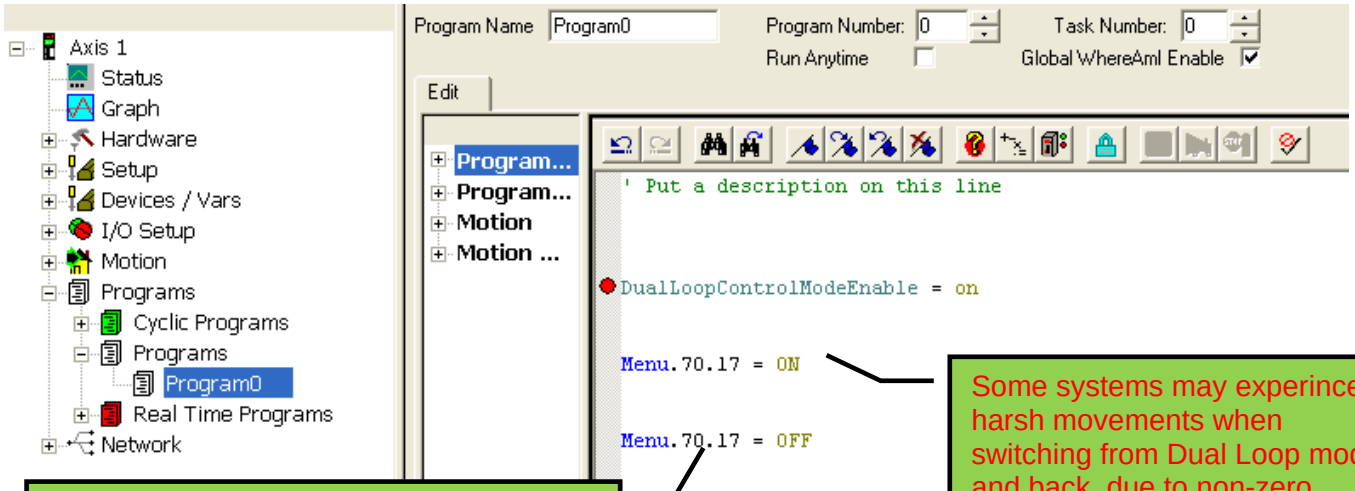
Step 6 – Turning Dual Loop Mode On/OFF

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

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

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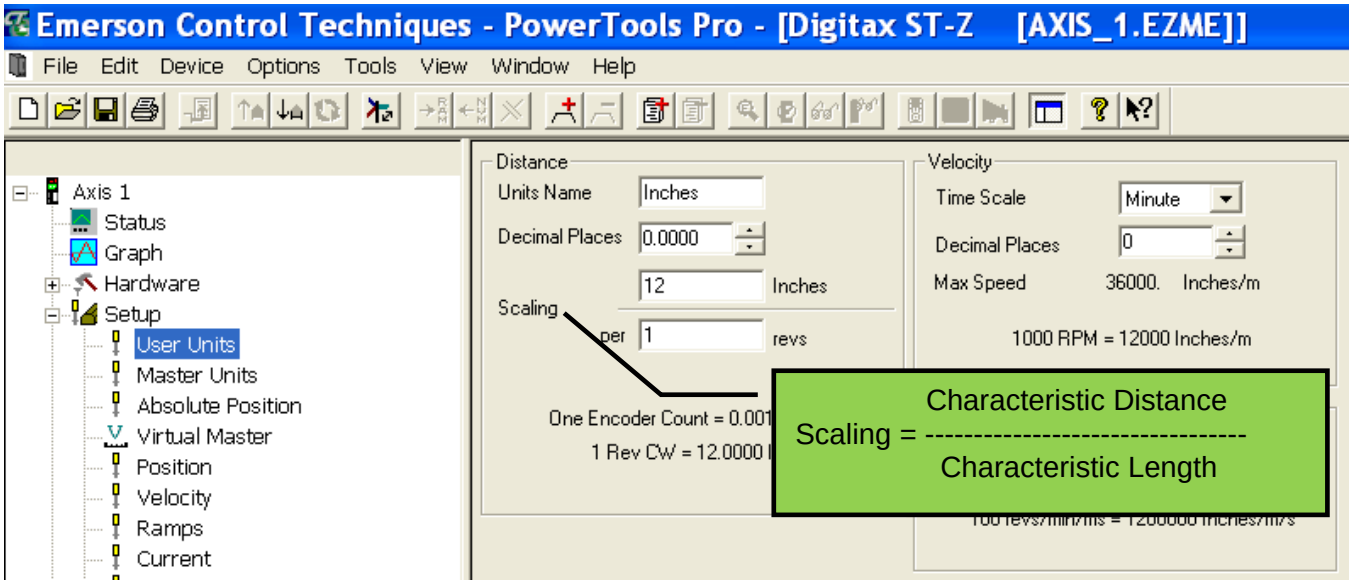
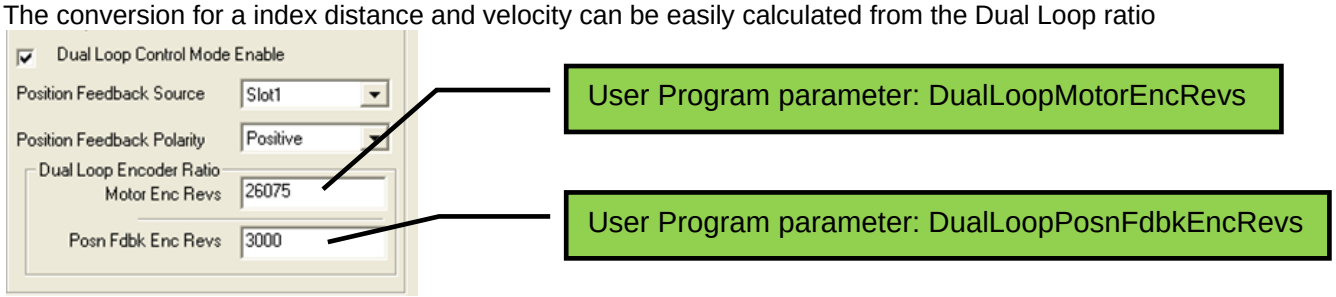
Step 7 – Changing Distance Units

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 initiat 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
```