Closing the Position Loop with External Feedback for AKD2G

Rev. A | Jake Jacobs | 9/29/23

Key takeaways

- Set which feedback will be used to close the position loop. This can be set in the Feedback screen under the Axis' Settings. For more details see the "Setting the external feedback to close the position loop" section of this document below.
- Determine the scaling factor (PIN and POUT values) by using the Units screen and entering the systems mechanics. For more details see the "Scaling for external feedback – Units Screen" section of this document below.
- Using the PIN and POUT values from the Units screen, set the AXIS#.PL.KFB.PIN and AXIS#.PL.KFB.POUT to scale the physical system. For more details see the "Scaling for external feedback – AXIS#.PL.KFB" section of this document below.
- Set AXIS#.MOTOR.PITCH to 1 in the terminal screen
- Use the AXIS#.PL.KFB.PIN to set the direction of the system. For more details see the "Determining direction of motion" section of this document below.

Introduction – Benefits and Purpose

For most users, closing the position loop using an external encoder is used so feedback is generated directly from the application, rather than the rotary motor driving the application. Some benefits to using an external encoder are:

- Higher positioning precision directly linked to the application which can support any backlash that may be seen on the motor's side.
- Having the ability to use encoders that fit closer to the application's needs (i.e. linear encoders for linear applications)
- Increased confidence the system is behaving as intended.

Initial safety considerations

Improperly scaled systems could possibly run away and lead to damaged mechanisms and/or harm users. It is recommended to set speed and current limits to safe levels determined by the users before operation.

Setting the external feedback to close the position loop

Under "Device Settings" in the Workbench software there is the "Feedback Devices" menu. The different feedback devices relate to a specific input on the drive, as seen in **Figure 1**. For example, Feedback 1 is related to the X1 input, Feedback 3 is X23, and so on. In **Figure 1** Feedback 3 (X23) is being used to close the commutation, velocity, and position loops.
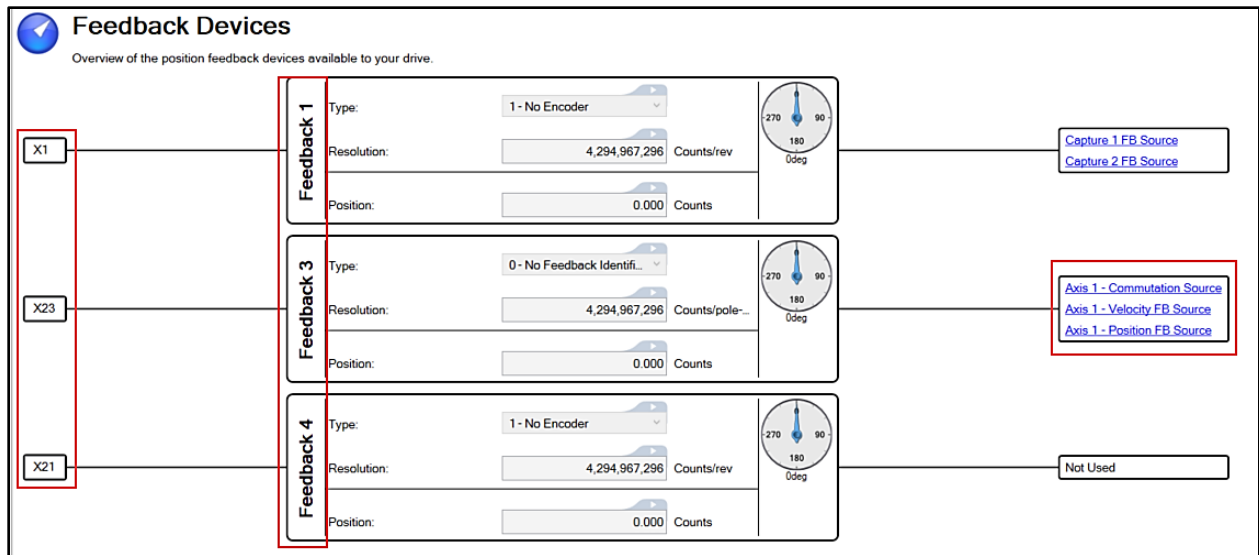
Figure 1. Main feedback device screen in Workbench.

The feedback being used to close the commutation, velocity, and position loops can be changed in the Feedback screen under Axis # → Settings → Feedback. For instance, if a linear encoder is being used to close the position loop through the X23 input but would like to use X1 for commutation and velocity their settings would be similar to **Figure 2**.
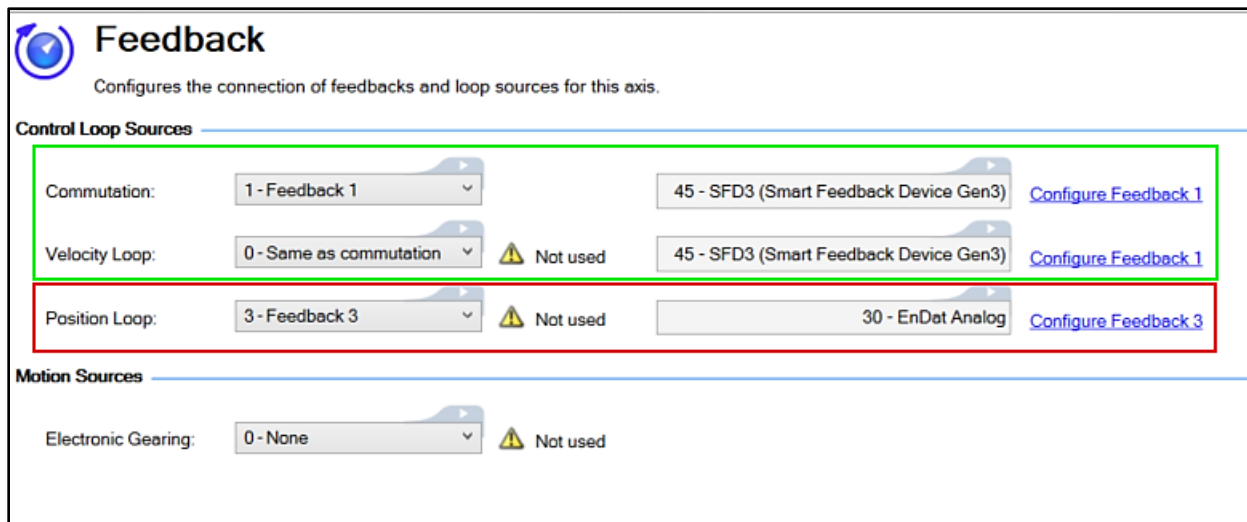

Figure 2. Setting external feedback to close position loop.

Scaling for external feedback – Units Screen

Systems can vary in several different ways such as gear box ratios, leadscrew pitches, and pulley diameters. With all these variations, scaling is crucial for external feedbacks to work properly. The focus

of this app note will be on a leadscrew application. However, the following instructions can be translated to other system types as well.

The Units screen, found under Axis # → Settings, is the starting point for scaling. Here the mechanics can be selected that fits the system and input gear ratios and/or system specific mechanics. For the leadscrew, this would be the pitch of the leadscrew.

The position unit can be changed to "Custom (mechanics dependent)," because with linear applications we want to work with linear units, not rotary. At the same time, the custom position unit can be changed to the desired linear units.

Click on the "More >>" button to view the feedback position, PIN, POUT, and Label which should show the linear units being used for the application. The PIN and POUT values are equal to your AXIS#.UNIT.PIN and AXIS#.UNIT.POUT parameters. Note that the AXIS#.UNIT.POUT and AXIS#.UNIT.PIN parameters do not affect the physical scaling of the system, but rather they affect the feedback value displayed by AXIS#.PL.FB in workbench. These values are shown in **Figure 3**. These values will be helpful when scaling the AXIS#.PL.FB to the real-world value by using AXIS#.PL.KFB.
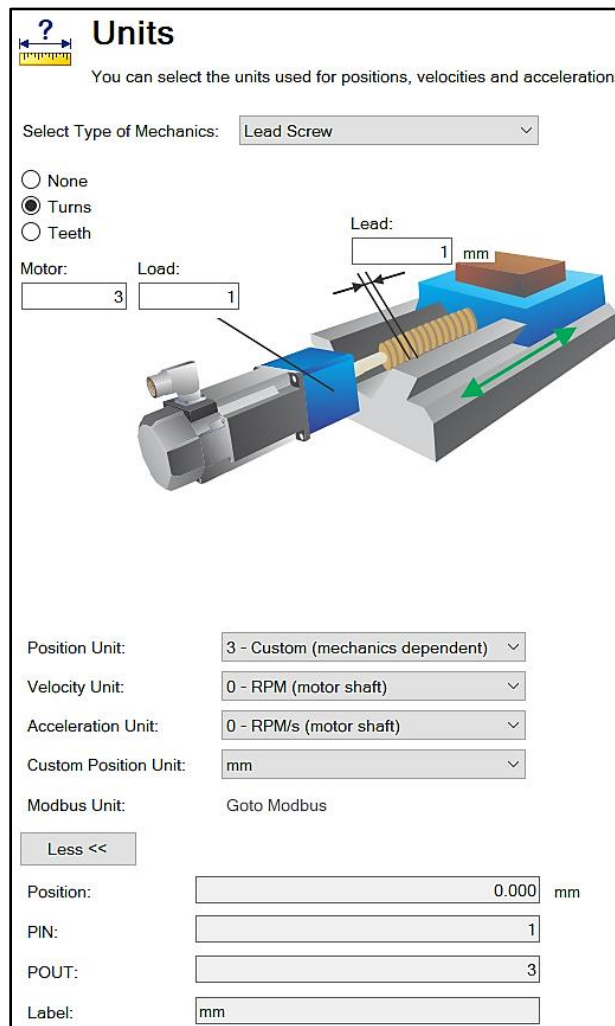

Figure 3. Leadscrew application with 3:1 gearbox and leadscrew pitch of 1mm/rev.

Scaling for external feedback – AXIS#.PL.KFB

AXIS#.PL.KFB is dependent on two values: AXIS#.PL.KFB.PIN and AXIS#.PL.KFB.POUT. See equation 1 for this relationship.

$$AXIS\#.PL.KFB = \frac{AXIS\#.PL.KFB.PIN}{AXIS\#.PL.KFB.POUT}$$
1)

AXIS#.PL.KFB.PIN and AXIS#.PL.KFB.POUT are important variables, because this is what will provide the scaling for the system so the position feedback seen in Workbench matches the real world. AXIS#.PL.KFB.PIN has a range of - 2,147,483,648 to 2,147,483,647, whereas AXIS#.PL.KFB.POUT has a range of 1 to 2,147,483,647. The reason for this range is because the sign of AXIS#.PL.KFB.PIN will be used to set your positive and negative direction.

Set AXIS#.PL.KFB.PIN equal to the value of AXIS#.UNIT.POUT. Set AXIS#.PL.KFB.POUT equal to the value of AXIS#.UNIT.PIN.

While AXIS#.PL.KFB can be written to, it is recommended to use AXIS#.PL.KFB.PIN and AXIS#.PL.KFB.POUT to calculate AXIS#.PL.KFB instead due to possible precision loss. For example, the gear ratio 1:3 is precisely represented with the fraction 1/3 but lacks precision as a floating-point number 0.333333.

AXIS#.MOTOR.PITCH will need to be changed from the default value of 32 to 1, or else the motor will run away.

Determining direction of motion

Now that the PIN and POUT values are established, determining what will be the positive and negative direction of the system as well as the home position is the next step.

Caution: Before any motion is applied to the system, it is recommended to go into the Limits screen and lower the positive and negative current and speed limits so both the user and system are safe.

AXIS#.PL.FB can be added to the watch window to monitor how position value changes with motion. If the system moves in the intended positive direction, but AXIS#.PL.FB moves negative, a negative sign will be needed for AXIS#.PL.KFB.PIN. If movement by hand is not possible, applying a slow pulsed motion in the Service Motion or the Job function screen will work. Once the direction is determined, the system can be homed, and motion tasking can begin.

Example:

System Description:

- A leadscrew application that uses a 3.14:1 gear box and a 5mm screw lead.
- The position loop is being closed using an EnDat 2.2 linear encoder wired to X23. SFD3, the motor's feedback device, is closing commutation and velocity loops through X1.

Feedback Screen Setup:

Here the EnDat Analog linear encoder is being used to close the position loop:

Here the EnDat Analog is being shown to close the position loop in the "Feedback Devices" screen:

Units Screen Setup:

Since the system position loop is being closed with a linear encoder, changing the position units to linear units makes sense. Here, millimeters (mm) are being used to measure position.
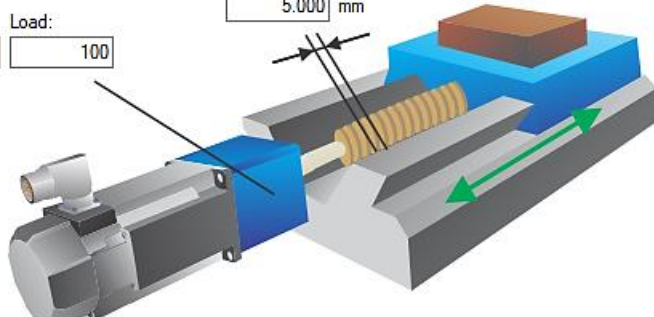

Set these parameters in the watch window or the terminal screen:

- AXIS1.PL.KFB.PIN = 157 (or -157 if direction needs to be switched)
- AXIS1.PL.KFB.POUT = 250
- AXIS1.MOTOR.PITCH = 1