EnDat 2.2 encoder set as a tertiary feedback.

Firmware version: M-01-12-01-000

This article explains how to set an EnDat 2.2 encoder as tertiary feedback (FB3) in AKD. The article contains:

- Introduction
- Initial settings
- Parameters
- Examples

Introduction

Note: The configuration of EnDat 2.2 as tertiary feedback is **only** supported with drives: AKD-x-xxxxx-NBxx-xxxx

AKD offers the possibility to connect a second feedback for position reference. If the second feedback is an EnDat 2.2 encoder, then the whole configuration is actually called tertiary feedback. More information of how to connect an EnDat 2.2 as tertiary feedback can be found in the "AKD user Guide" or under following link:

Kollmorgen WorkBench Help - Encoder Emulation

Initial settings

Following parameters should be set to recognize an EnDat 2.2 as tertiary feedback.

DRV.EMUEMODE = 11 FB3 Input as tertiary feedback
PL.FBSOURCE = 2 Tertiary feedback connected to X9

Parameters

The following table shows which FB3 parameters should be also configured:

Keyword	Description	Default value	Range
FB3.DIR	Sets the counting direction for PB3.P and therefore the counting direction of the position feedback (PL.FB), when PL.FBSOURCE = 2. For more information see the example below or follow this link: Kollmorgen WorkBench Help - FB3.DIR	0	0 to 1
FB3.ENCRES	Sets the resolution of the motor encoder for FB3 and it is directly related to FB3.PUNIT and PL.FB. FB3.ENCRES is natively scaled to 2^{32} counts per revolution (rotary motors) or motor pole pitch (linear motors). For more information see the example below or follow this link:	0	0 to 2^{32}

	Kollmorgen WorkBench Help - FB3.ENCRES		
FB3.MODE	Selects the type of feedback connected to X9. The position is reported as tertiary feedback position, by FB3.P. For more information follow this link: Kollmorgen WorkBench Help - FB3.MODE	0	0
FB3.MOTORPHASE	Reserved for IL.FBSORCE = 2 and MOTOR.TYPE = 4		
FB3.MOTORPOLES	Reserved for IL.FBSORCE = 2 and MOTOR.TYPE = 4		
FB3.P	Reads the position back from the tertiary feedback device that is connected to X9, when DRV.EMUEMODE = 11. The position can be read as 64-bit counts or in customer units (FB3.PIN/FB3.POUT). Values read by this parameter depend on FB3.DIR and FB3.OFFSET. The output format is 32:32 the upper 32 bits represents the multiturns and the lower 32 bits for position of the feedback. For more information see the example below or follow this link: Kollmorgen WorkBench Help - FB3.P	N/A	N/A
FB3.PDIR	Sets the sign and consequently the counting direction for FB3. In other words, FB3.PDIR will change the sign and consequently the direction of only feedback channel 3 (FB3.P). For more information see the example below or follow this link: Kollmorgen WorkBench Help - FB3.PDIR	0	0 to 1
FB3.PIN	Sets gear IN for FB3.P. In other words, FB3.IN in combination with FB3.POUT set the user units for FB3.P. For more information follow this link: Kollmorgen WorkBench - FB3.PIN	100	0 to 2^{32}
FB3.POFFSET	FB3.POFFSET is the value added to the primary feedback position. For more information see the example below or follow this link: Kollmorgen WorkBench - FB3.POFFSET	0	
FB3.POUT	Use FB3.POUT with FB3.PIN to set the user units for FB3.P. Kollmorgen WorkBench Help - FB3.POUT	20	0 to 2^{32}
FB3.PUNIT	Sets the position unit for FB3.P. Kollmorgen WorkBench - FB3.PUNIT	0	0, 3

Examples

Note: The following examples do not include a gear box.

I. Commissioning a rotary motor with a SFD as primary feedback and a rotary feedback EnDat 2.2 as tertiary feedback with a resolution of 1 rev = 2^{32} counts.

1. **Read a position from FB3**. As previous step, be sure that your EnDat 2.2 encoder is sending a position value. Therefore, set DRV.EMUEMODE=11 and PL.FBSOURCE=0 and check that AKD is reading a position. If the position is being read, a value in FB3.P should be shown.
2. **Set the units for FB3**. Through FB3.PUNIT you can set the units for FB3.P as counts or customer units (FB3.PIN / FB3.POUT). In this example, we select FB3.PUNIT = 0, then FB3.P = counts
3. **Set the resolution of FB3**. Now the resolution of your tertiary feedback should be set in FB3.ENCRES. As default FB3.ENCRES = 0 and means a resolution of 1 rev = 2^{32} counts. In this example, our FB3 has a resolution of 2^{32}, therefore FB3.ENCRES = 0. To ensure that your resolution is correct and is set correctly, move your shaft one revolution and FB3.P should increase in a step of 2^{32}.
4. **Set EnDat 2.2 as tertiary feedback**. For this, you should set PL.FBSOURCE = 2. After that PL.FB is the same or directly proportional to FB3.P, depending on UNIT.PROTARY, UNIT.PIN and UNIT.POUT.
5. **Customize counting direction and sign of FB3**. So far FB3 is giving a correct position to PL.FB. There are still three variables to customize FB3.P according to your application. Two of them (FB3.DIR and FB3.PDIR) are responsible for the counting direction and sign of FB3.P. In the following, every combination of FB3.DIR and FB3.PDIR and the values of FB3.P are shown. Such values are based on an initial position, while the shaft is rotated 90 degrees in positive and negative (Positive means: having the motor shaft in front of you, it is rotated clockwise).

   If FB3.DIR = 0 AND FB3.PDIR = 0

   - Initial position + 90° -> PL.FB = FB3.P = 4 197 152 555 912
   - Initial position = 0° -> PL.FB = FB3.P = 4 196 095 204 864
   - Initial position -90° -> PL.FB = FB3.P = 4 195 012 530 800

   If FB3.DIR = 1 AND FB3.PDIR = 0

   - Initial position + 90° -> PL.FB = FB3.P = 4 195 277 413 840
   - Initial position = 0° -> PL.FB = FB3.P = 4 196 207 245 336
   - Initial position -90° -> PL.FB = FB3.P = 4 197 332 750 920

   If FB3.DIR = 0 AND FB3.PDIR = 1

   - Initial position + 90° -> PL.FB = -FB3.P = -4 197 152 555 912
   - Initial position = 0° -> PL.FB = -FB3.P = -4 196 095 204 864
   - Initial position -90° -> PL.FB = -FB3.P = -4 195 012 530 800

IF FB3.DIR = 1 AND FB3.PDIR = 1

- Initial position + 90° -> PL.FB = -FB3.P = -4 195 277 413 840
- Initial position = 0° -> PL.FB = -FB3.P = -4 196 207 245 336
- Initial position -90° -> PL.FB = -FB3.P = -4 197 332 750 920

6. **Customize an offset**. If you should include an offset, set it through FB3.POFFSET. The value of such offset is based on FB3.PUNIT. In this example, FB3.POFFSET = 1 000 000 000
   If FB3.POFFSET = 0, then FB3.P = 4 196 207 245 336
   If FB3.POFFSET = 1 000 000 000, then FB3.P = 4 19**7** 207 245 336

II. Considering the same motor of example I, but this time the (rotary) tertiary feedback device is place at the load which has a 1:4 gear ratio (motor does four revolutions per revolution of tertiary feedback) and the customer has a gear IN of 360 and a gear out of 1. Besides, the position should be in customer units

1. **Read a position from FB3.** Here the procedure is the same**.**
2. **Set the units for FB3.** The customer application has a gear IN of 360 and a gear OUT of 1, therefore, the following parameters should be set: FB3.PIN = 360, FB3.POUT = 1. To define the customer units, set FB3.PUNIT = 3. So far, 1 rev = 360PIN/POUT.
3. **Set the resolution of FB3.** Although the position is in customer units, the resolution FB3.ENCRES is **always** in counts. For the example, the load has a gear ratio 1:4, then FB3.ENCRES = 2^{32}/gear ratio $2^{32}/4$

Steps 4, 5 and 6 are the same as example I.

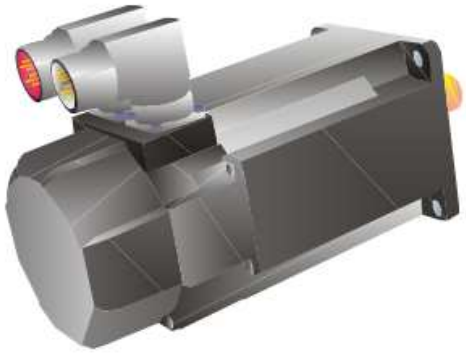
The examples I and II are based on the same rotary motor with the same (rotary) tertiary feedback for PL.FB, but in example I the gear ratio (load: motor) is 1:1 while in example II is 1:4. Now, lets commission an linear EnDat 2.2 encoder

III. Commissioning a rotary motor with a SFD as primary feedback and a linear feedback EnDat 2.2 as tertiary feedback, with a resolution of 5nm and the relationship between rotary motor and linear feedback is 2cm = 1rev.

0. **Get ready units.** Before you start commissioning the tertiary feedback, set the factors and units in such way that makes the understanding and analysis easier. As we know, motor and tertiary feedback have a factor 2cm = 1rev. Set this custom factor as follows: UNIT.PIN = 2, UNIT.LABEL = cm, UNIT.POUT = 1rev. Now set the units as custom units as follows: UNIT.PROTARY = UNIT.VROTARY = UNIT.ACCROTARY = 3 that represent cm, cm/s and cm/s^2 respectively (see Fig. 1).
1. **Read a position from FB3.** Here the procedure is the same**.**

2. **Set the units for FB3.** The customer application has a relationship IN of 2cm and a gear OUT of 1rev, therefore, the following parameters should be set: FB3.PIN = 2, FB3.POUT = 1. To define the customer units, set FB3.PUNIT = 3. So far, 1 rev = 2PIN/POUT.
3. **Set the resolution of FB3.** Although the position is in customer units, the resolution FB3.ENCRES is **always** in counts. For the example, we have a relationship 2cm = 1rev and the encoder resolution is 5nm, then FB3.ENCRES = 2cm/5nm = 4000000.

Steps 4, 5 and 6 are the same as example I.



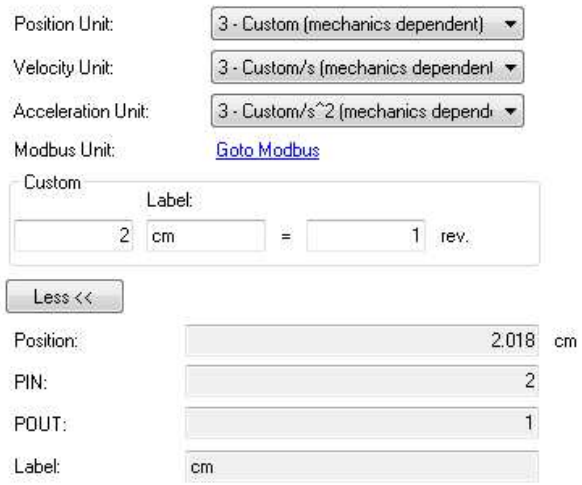


Figure 1: UNIT

The following figures show how your variables and units look at one initial position and after 2 cm

Initial

Parameter	Value	Units
PL.CMD - Position command	-0.001	cm
PL.FB - Position feedback	-0.001	cm
PL.ERR - Position error	0.000	cm
FB3.P - Feedback 3 scaled position	4.202	PIN/POUT
VL.CMD - Velocity command	0.000	(cm)/s
DRV.ACC - Drive acceleration ramp - velocity loop	1,000.002	(cm)/s^2

Figure 2: Initial variables

After moving 2cm

Parameter	Value	Units
PL.CMD - Position command	2.018	cm
PL.FB - Position feedback	2.018	cm
PL.ERR - Position error	0.000	cm
FB3.P - Feedback 3 scaled position	6.222	PIN/POUT
VL.CMD - Velocity command	0.000	(cm)/s
DRV.ACC - Drive acceleration ramp - velocity loop	1,000.002	(cm)/s^2

Figure 3: variables after moving 2cm