KOLLMORGEN

AKD System Configuration with Kollmorgen DDL Linear Motors

By Kenny Hampton

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Rev. N

This document shows the wiring requirements for connecting the DDL linear motors to the AKD servo drive. It also describes the setup procedure for configuring the AKD drive in the Workbench software.

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AKD System Configuration with Kollmorgen DDL linear motors with standard convention

Overview

This procedure covers the case where the feedback (PL.FB) counts up or positive when moving the coil in the same direction as the motor lead exit. In the case the feedback counts down or negative using this convention the standard procedure can still be followed assuming your feedback type is one where wiring changes can change the sign or direction of the feedback. If your feedback type does not allow the feedback count to be resolved by wiring, please follow the conventions in Appendix A.

Feedback Types that can be inverted by wiring:

Incremental Encoder with or without Halls
Sine Encoder with or without Halls

Types that cannot be inverted:

BiSS
EnDAT
Hiperface
Hiperface DSL
Renishaw BISS C

System Wiring Configuration

1. AKD System Cable Diagram

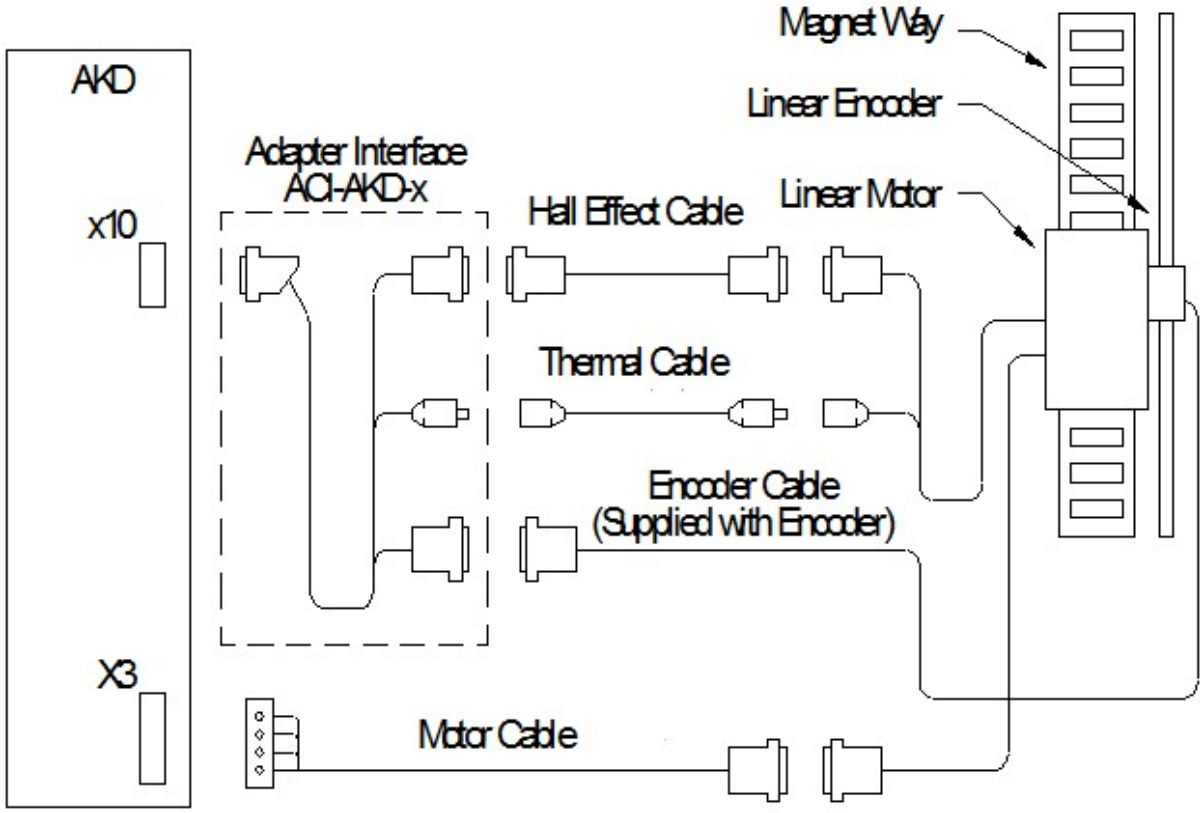
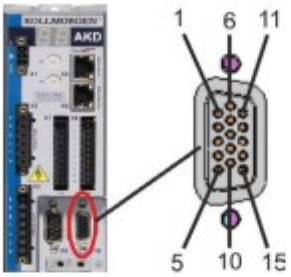


Figure 1

2. AKD FEEDBACK X10

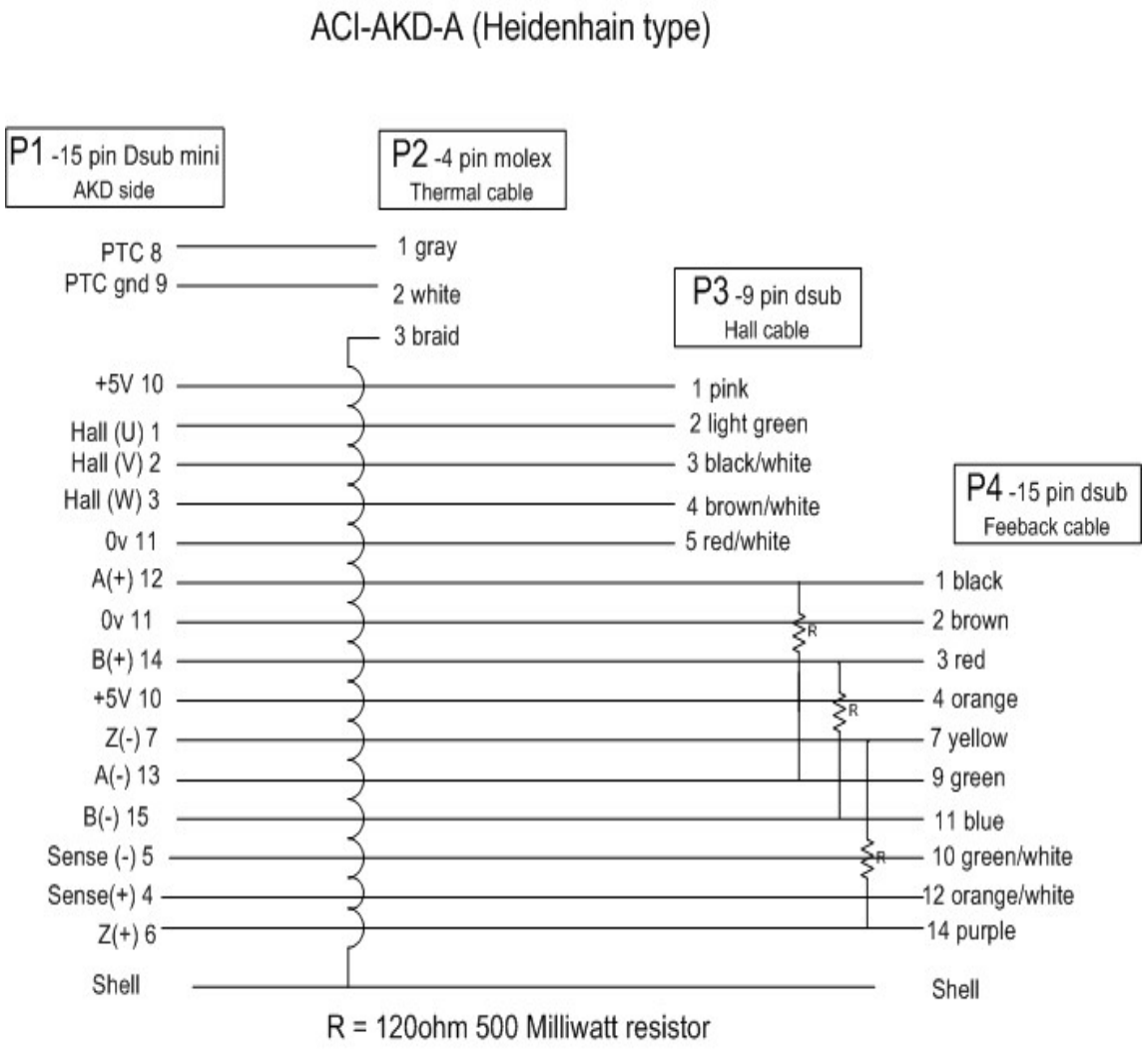
Feedback connector (X10)



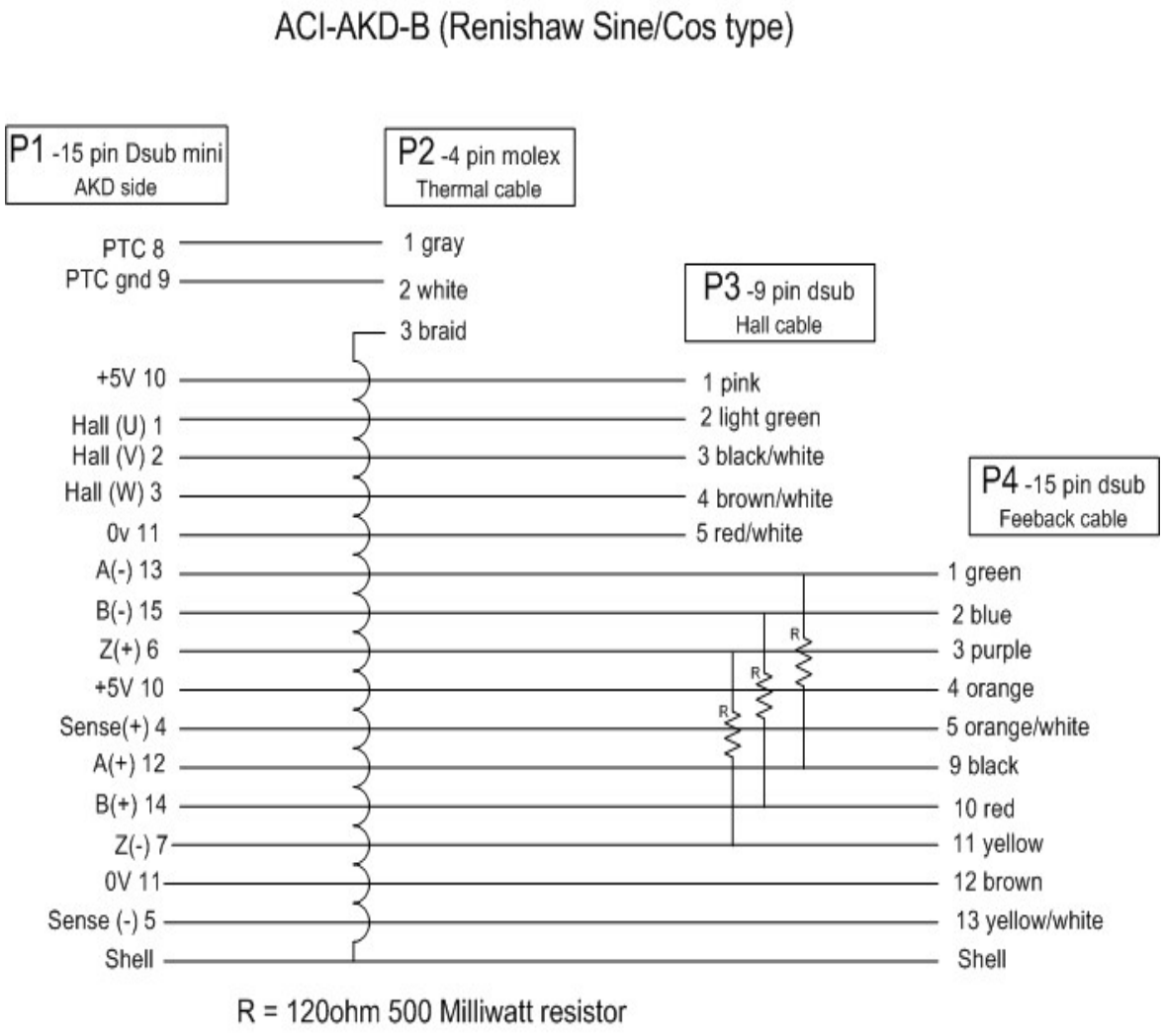
PIN	SFD	SFD3/ DSL	Resolver	BiSS B (analog)	BiSS C (digital)	EnDAT 2.1	EnDAT 2.2	Hiper-face	Sine Enc. +Hall	Tama-gawa Smart Abs*	Incr. Enc. +Hall
1	-	-	-	-	-	-	-	-	Hall U	-	Hall U
2	-	-	-	CLK+	CLK+	CLK+	CLK+	-	Hall V	-	Hall V
3	-	-	-	CLK-	CLK-	CLK-	CLK-	-	Hall W	-	Hall W
4	SEN+	-	-	SEN+	SEN+	SEN+	SEN+	SEN+	SEN+	SEN+	SEN+
5	SEN-	-	-	SEN-	SEN-	SEN-	SEN-	SEN-	SEN-	SEN-	SEN-
6	COM+	COM+	R1 Ref+	DAT+	DAT+	DAT+	DAT+	DAT+	Zero+	SD+	Zero+
7	COM-	COM-	R2 Ref-	DAT-	DAT-	DAT-	DAT-	DAT-	Zero-	SD-	Zero-
8	-	-	Thermal control (+)								
9	-	-	Thermal control (-)								
10	+5 V	+5 V	-	+5 V	+5 V	+5 V	+5 V	+8 to +9 V	+5 V	+5 V	+5 V
11	0 V	0 V	-	0 V	0 V	0 V	0 V	0 V	0 V	0 V	0 V
12	-	-	S1 SIN+	A+	-	A+	-	SIN+	A+	-	A+
13	-	-	S3 SIN-	A-	-	A-	-	SIN-	A-	-	A-
14	-	-	S2 COS+	B+	-	B+	-	COS+	B+	-	B+
15	-	-	S4 COS-	B-	-	B-	-	COS-	B-	-	B-

CLK = CLOCK, DAT = DATA, SEN = SENSE, *= for AKD with "NB" (rev 8+) only

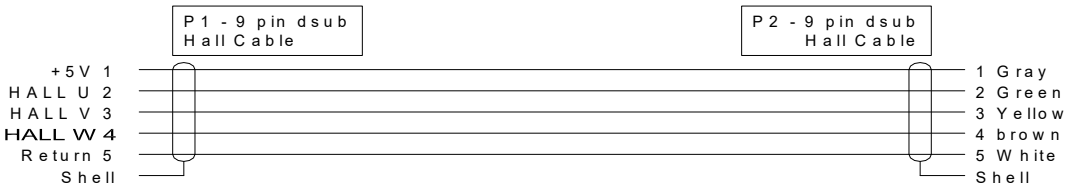
3. ACI-AKD-A (Heidenhain Sin/Cos)



4. ACI-AKD-B (Renishaw Sin/Cos)

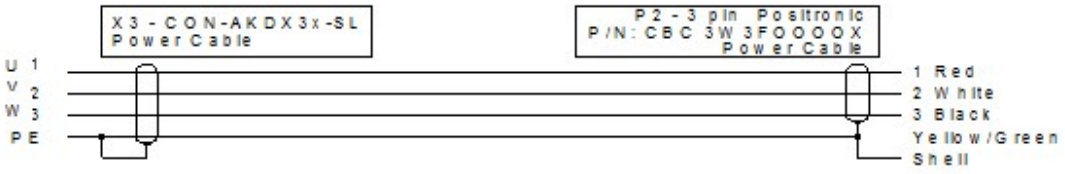


5. Hall Effect Cable

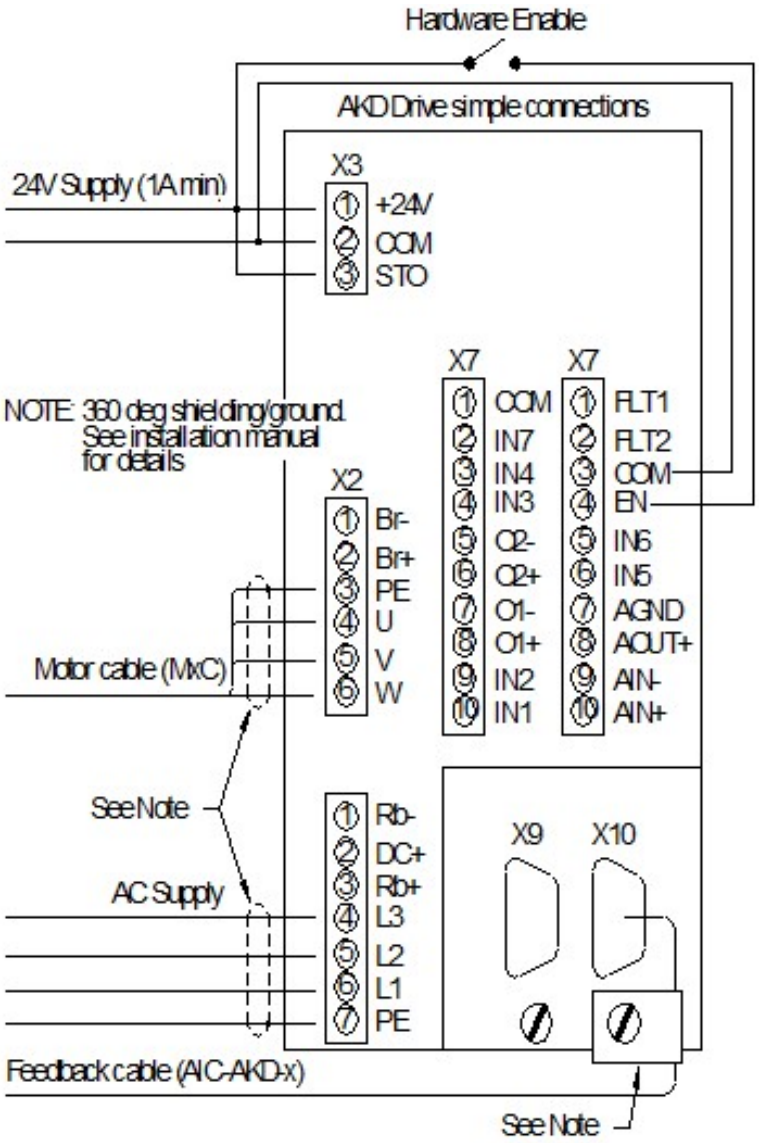


6. Thermal Sensor Cable

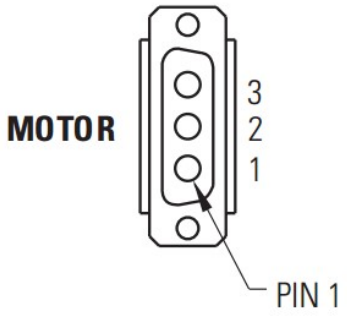
7. Motor Power Cable



8. Minimum Wiring Requirement for the AKD Drive

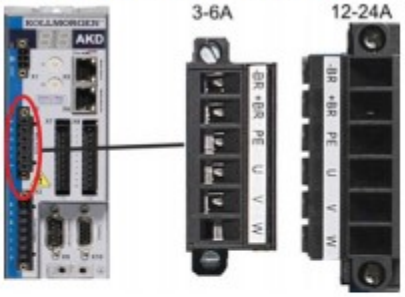


9. DDL Motor Coil Connections

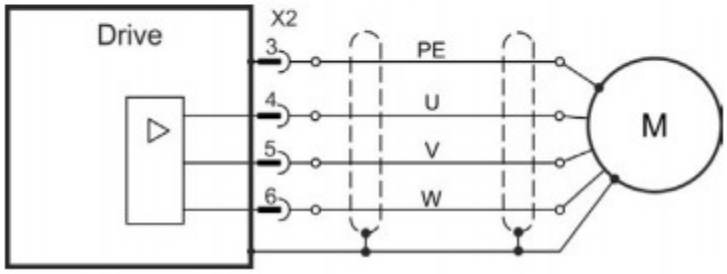


Motor Connector Pin Numbers	Motor Coil Wire Color	AKD Drive Connection Connector X2
1	Red	U
2	White	V
3	Black	W
Connector Shell	Grn/Yel	PE GND
Connector Shell	Violet	Shield

AKD-x003 to 024, power connector X2

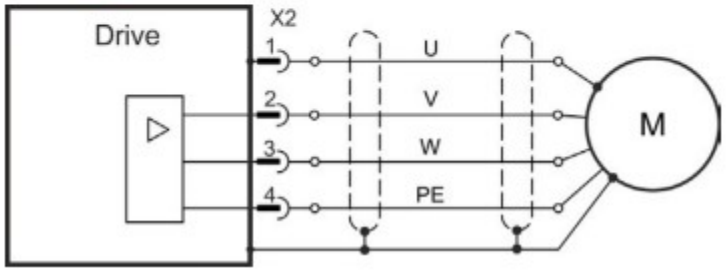


Pin	Signal	Description
1	-BR	Motor holding brake (➜ p. 112)
2	+BR	Motor holding brake (➜ p. 112)
3	PE	Protective earth (motor housing)
4	U	Motor phase U
5	V	Motor phase V
6	W	Motor phase W



AKD-x048, power connector X2

Pin	Signal	Description
1	U	Motor phase U
2	V	Motor phase V
3	W	Motor phase W
4	PE	Protective earth (motor housing)

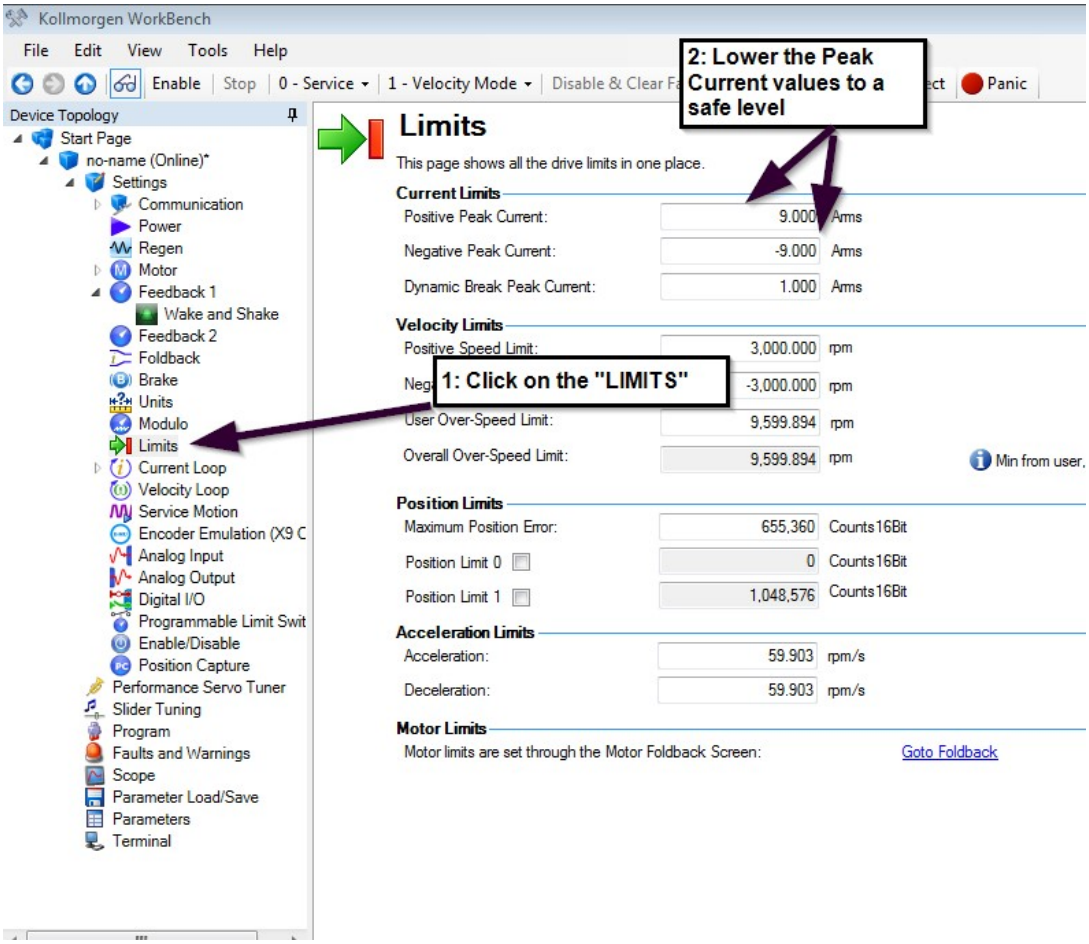


Configure the AKD Drive Using the Workbench Software

Install AKD Workbench. The software program can be found on the website (http://www.kollmorgen.com/en-us/products/drives/servo/akd/), (http://kdn.kollmorgen.com/) and the Product Support Package (PSP) CD-ROM packaged with the drive. Follow the installation instructions. (If in doubt, install "Kollmorgen WorkBench GUI Full Version.")

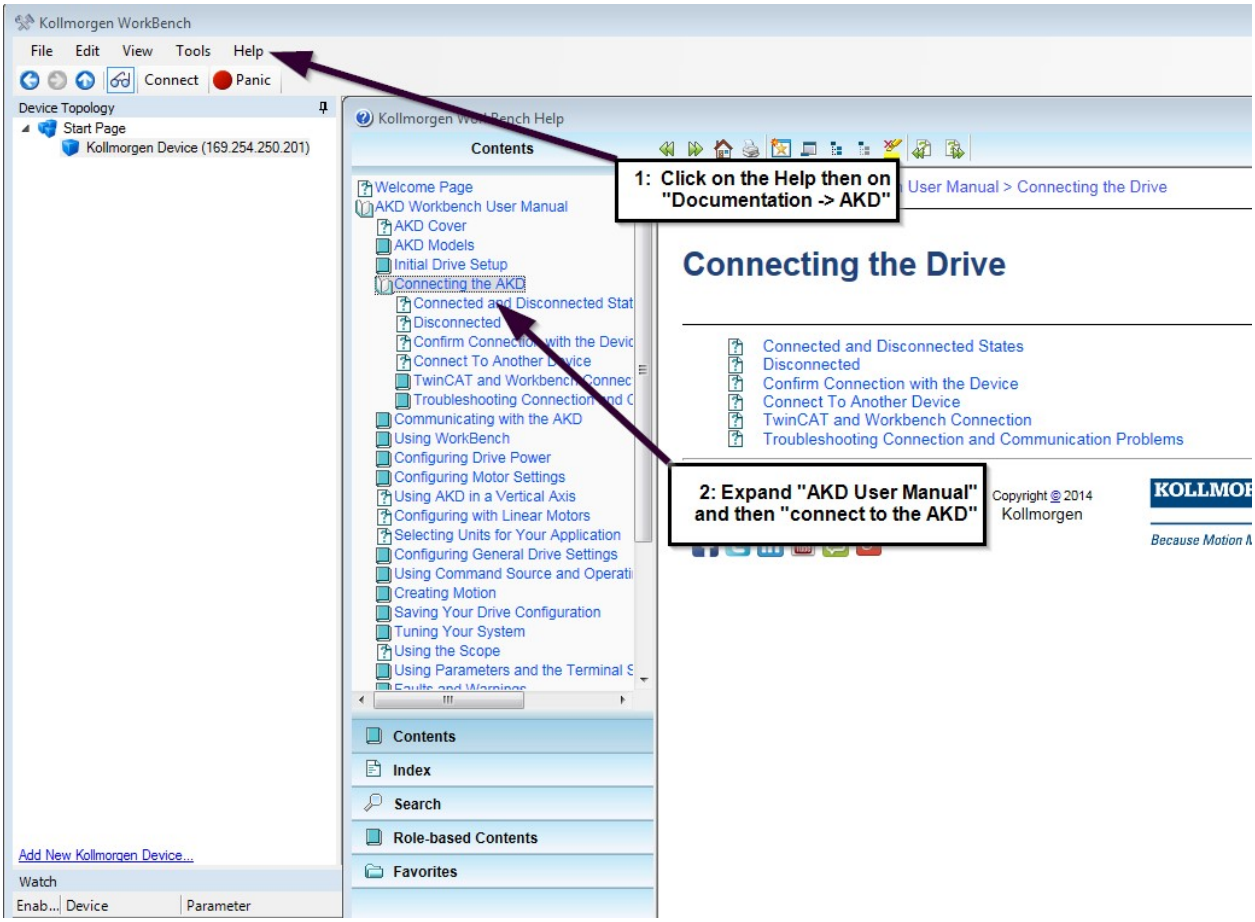
1. Safety First

When first starting up the system, it is recommended to limit the peak current of the drive to a safe value and add wood blocks at each motor end stop to confirm it is operating correctly. If the motor was to run away at its full output force capability, it could cause serious injury or damage to the equipment.

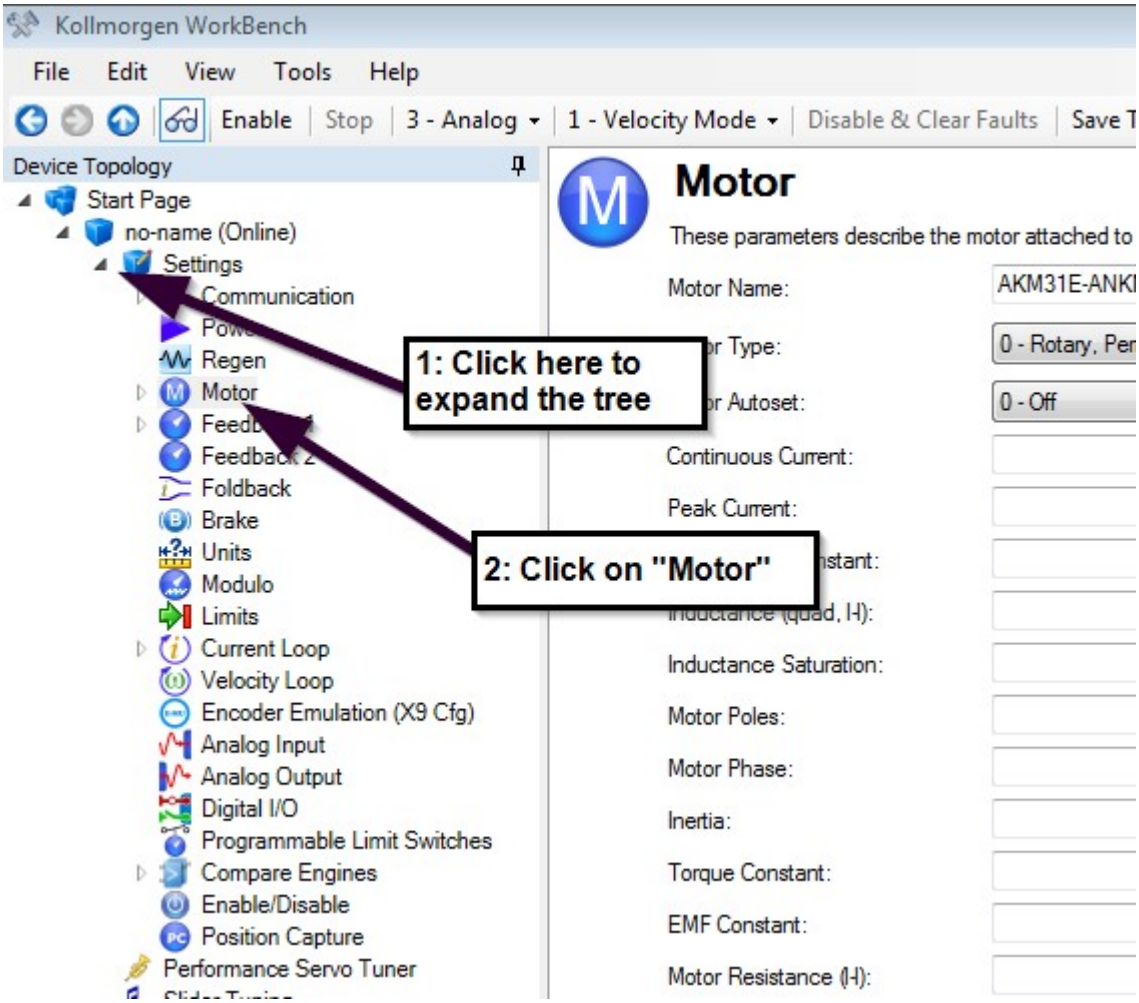


2. Connect to the AKD Drive

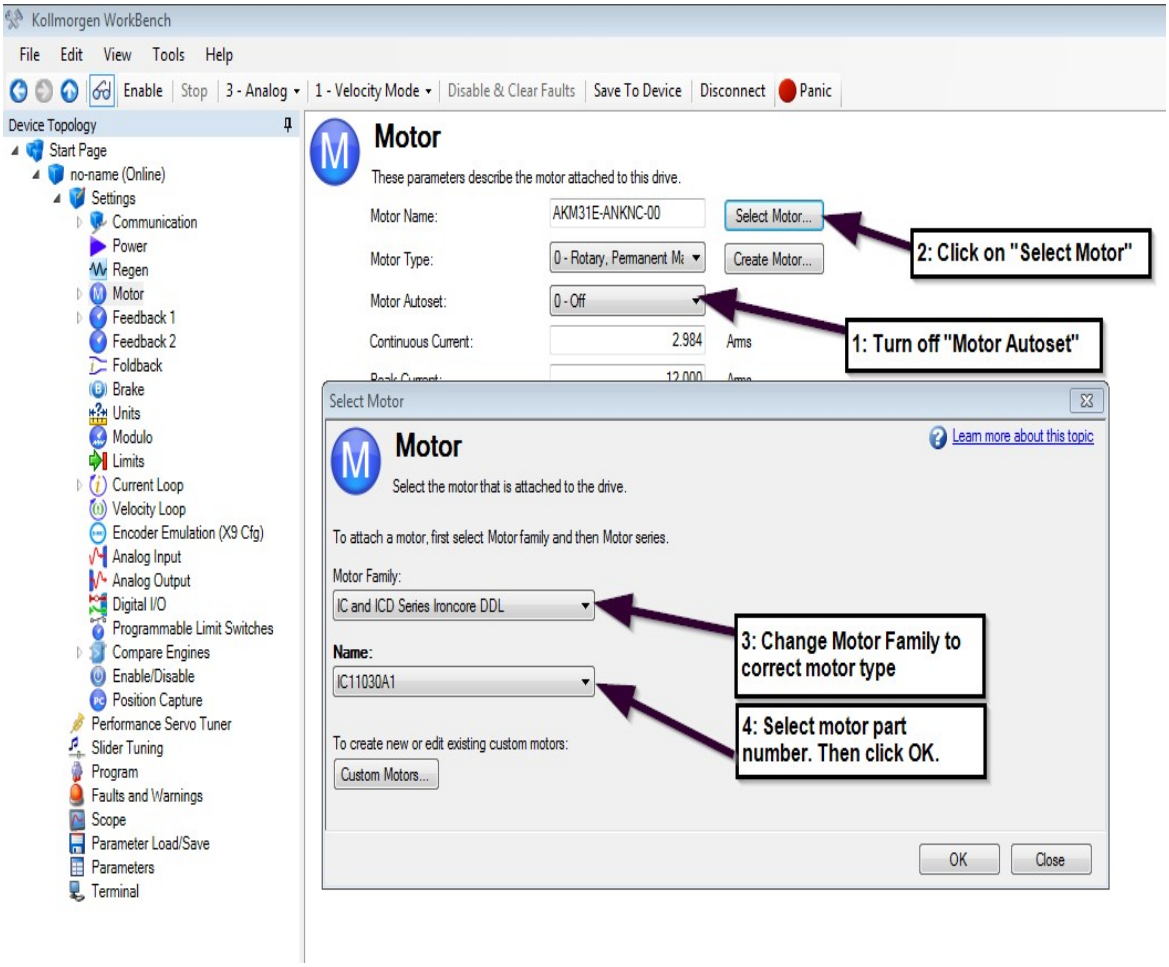
Follow the instruction from the WorkBench help file.



3. Expand “Settings” and Select the Motor Setup Screen



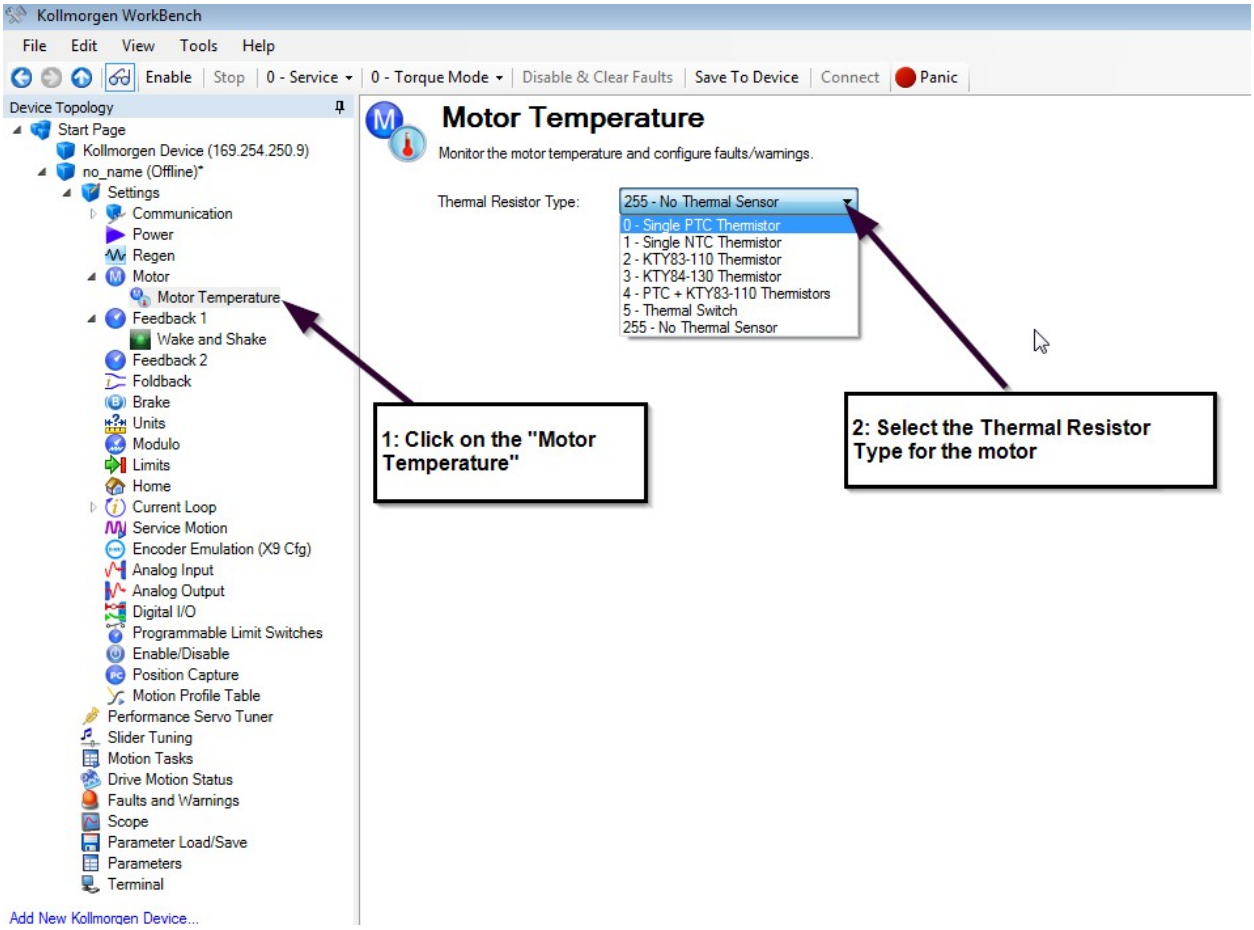
4. Select Motor from Pull Down List



NOTE

If the motor cannot be found in the database, Custom motors can be setup using the "Edit Custom Motors" tools under "Edit" on the tool bar. Instructions for use can be found in the WorkBench help file.

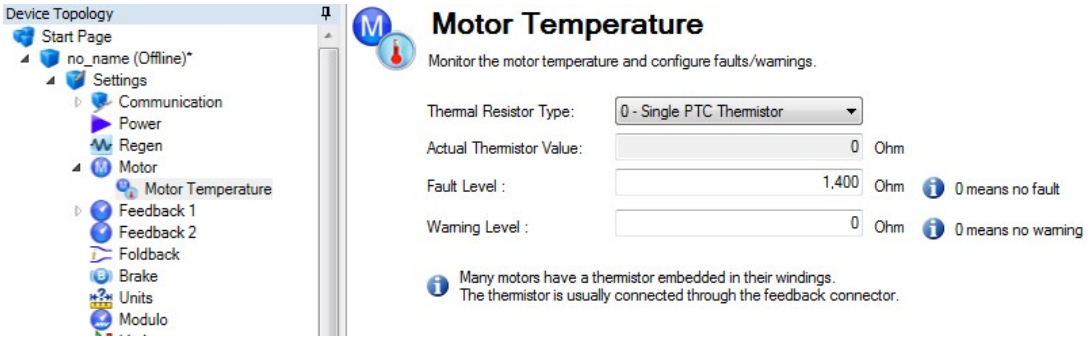
5. Select Motor Temperature Sensor



Note to double-click on “Motor” to expand the project tree if “Motor Temperature” is not visible.

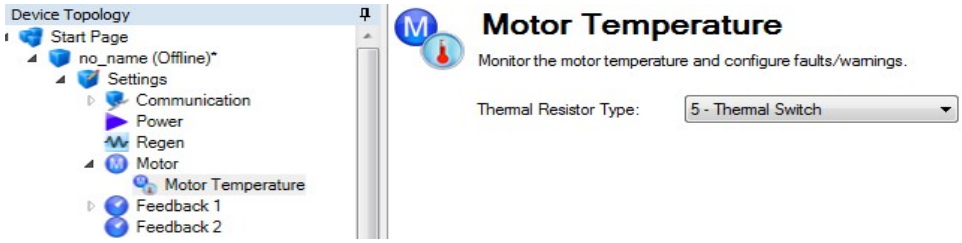
1. Thermostat Option type “TR”: PTC thermistor sensor

Kollmorgen DDL linear motors use a PTC thermistor sensor if the Thermostat Option selected is TR “Thermistor” (MOTOR.RTYPE = 0, “Single PTC Thermistor”). Set the value for the MOTOR.TEMPFAULT =1400.



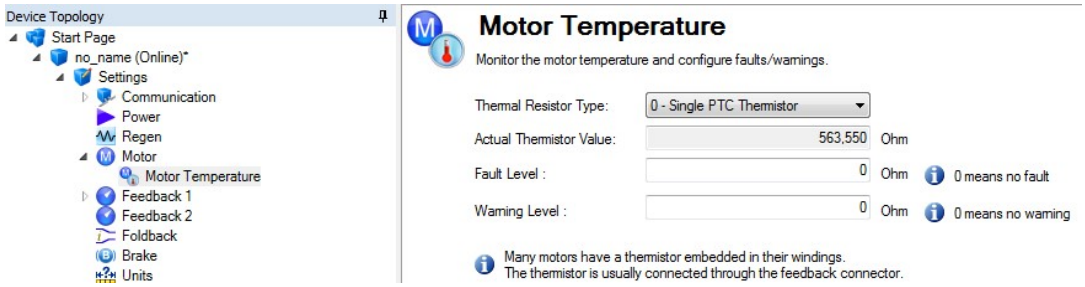
2. Thermostat Option type “TS”: Thermal switch

Kollmorgen DDL linear motors use a thermal switch if the Thermostat Option selected is TS Thermostat (MOTOR.RTYPE = 5, “Thermal Switch”)



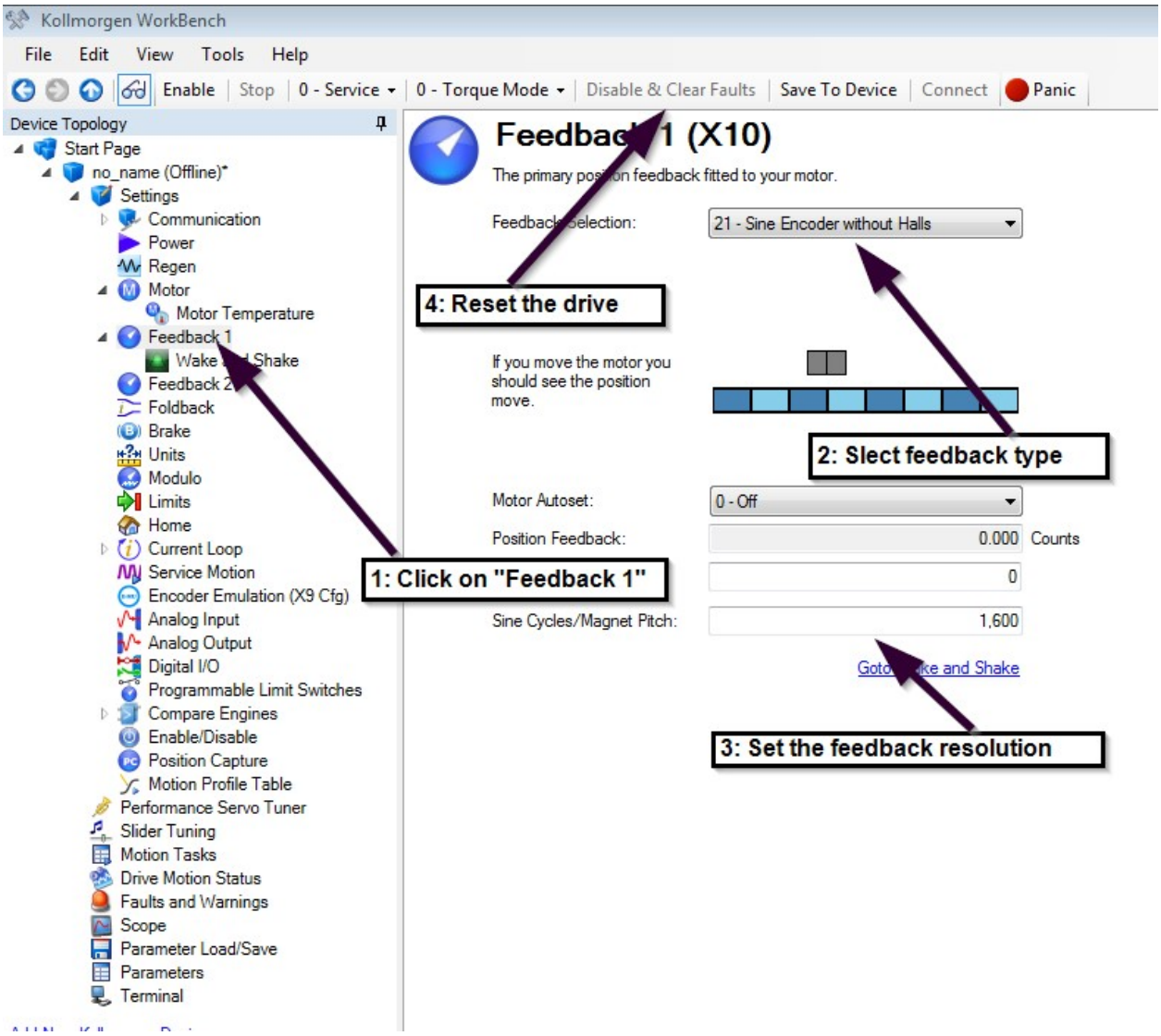
3. No Thermal Sensor

In the case a thermal sensor is not used in the application, the thermal protection feature can be defeated by setting the (MOTOR.TEMPFAULT = 0, the “Fault Level”)



6. Select Feedback Type

Notes on the resolution setting are explained below.



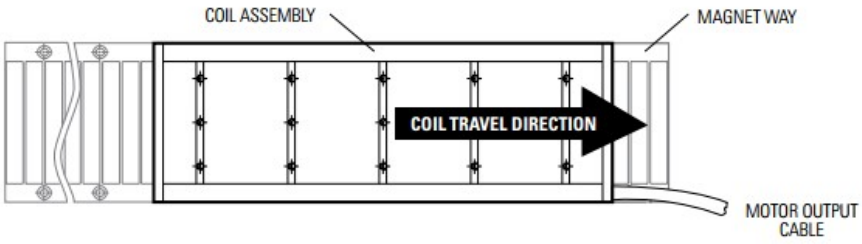
7. Configuring Encoder Feedback Resolution

The encoder resolution is based on the magnet pitch of the motor divided by the encoder resolution. The units are lines/pitch. Kollmorgen DDL motors have a magnet pitch of 32 mm. For example, if the encoder has a 20 micron pitch, enter (32mm / 20 micron pitch *1000) = 1600 line count (lines per 32mm) as your encoder resolution. The following chart provides typical encoder resolution figures and their equivalent AKD value.

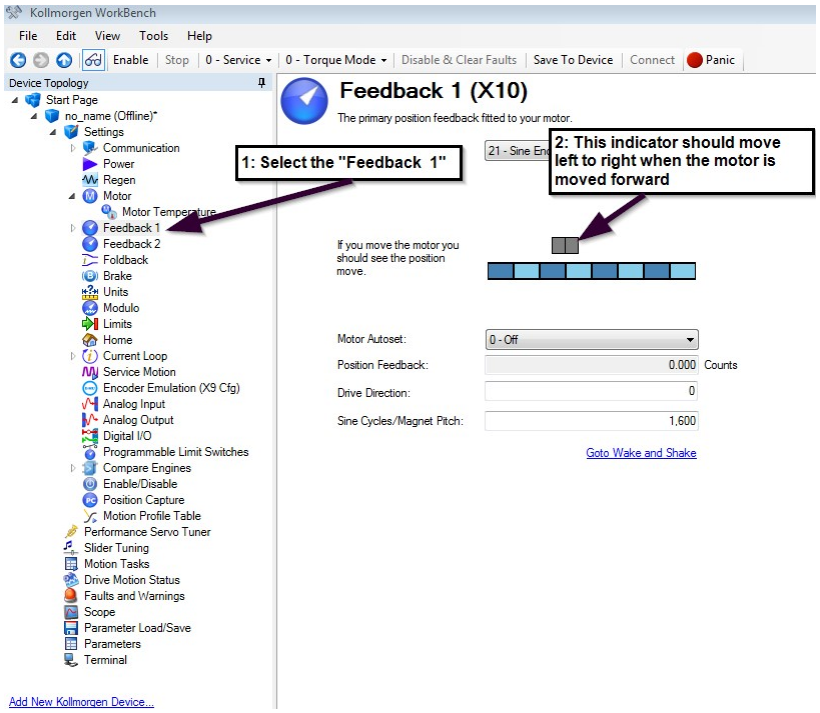
Encoder Equivalent Resolution µm Line Count	AKD Resolution lines/pitch	Encoder Equivalent Resolution µm Line Count	AKD Resolution lines/pitch
50	640	0.25	128000
40	800	0.2	160000
25	1280	0.1	320000
20	1600	0.08	400000
10	3200	0.05	640000
5	6400	0.04	800000
2.5	12800	0.02	1600000
2	16000	0.01	3200000
1	32000		
0.5	64000		
0..4	80000		

8. Test Encoder Direction and Resolution

The direction of the encoder, the motor phase sequence, and hall sequence all need to match exactly. The hall phasing also needs to match the motor phasing exactly. This is very difficult to do by trial and error. **Drive Direction has to be set to zero ("DRV.DIR =0")**. From the commutation drawings in Figure 2 the motor "positive" direction is toward the end of the motor where the wires exit the motor. This is the standard convention. Appendix A covers the non-standard convention where the feedback counts down or negative when the coil moves in the direction of the motor output cable leads and the feedback type cannot be inverted by wiring changes on the feedback.



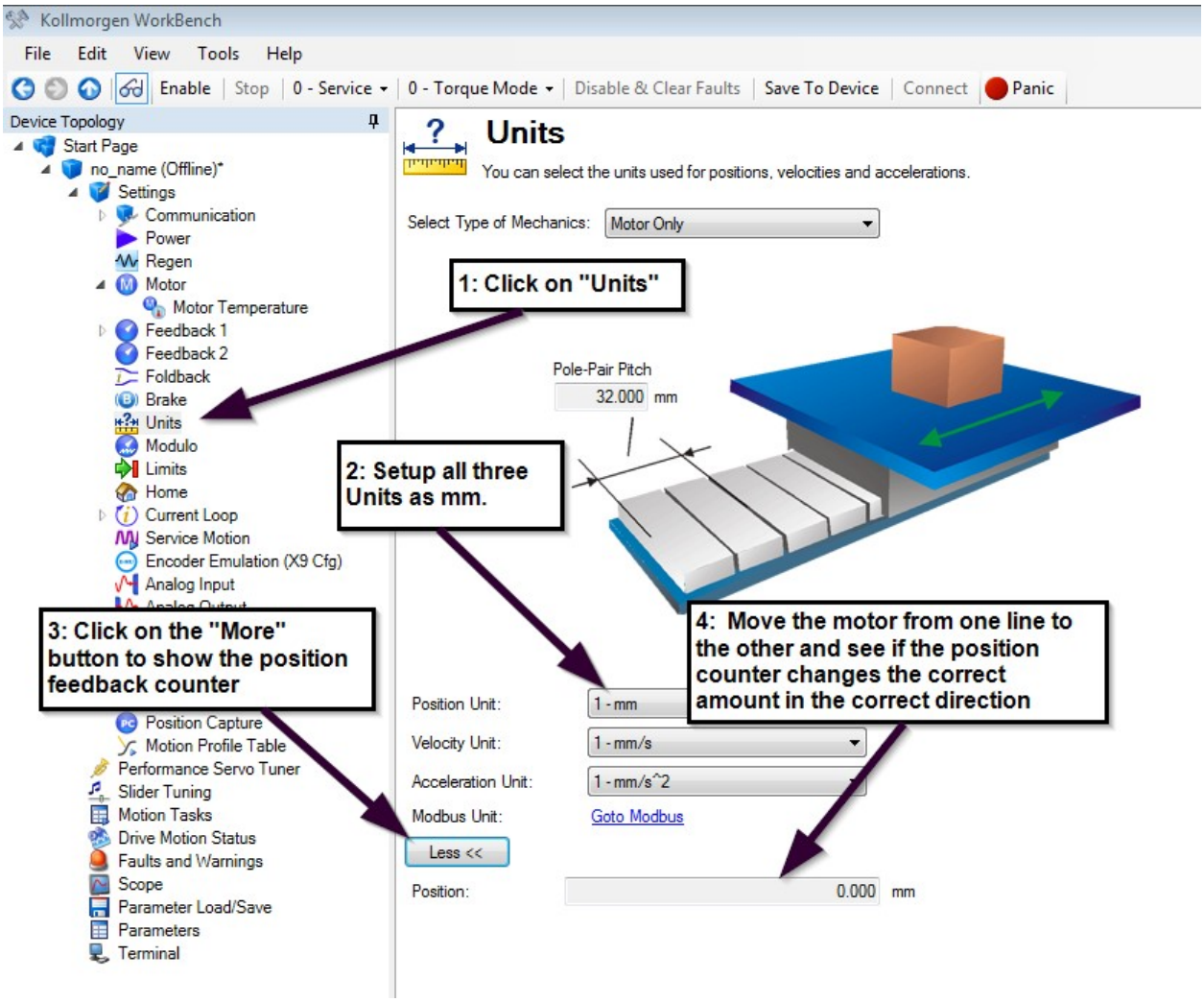
The Feedback test available is the movement of the indicator on the motor feedback screen.



If the encoder is counting in the wrong direction, swap the Sine+ and Sine- signal or the A and A\ signal. If this cannot be done if the Data channels of the encoder are being used. If changing the feedback direction is not possible, use Appendix A (Page 29) for the wiring configuration of the Hall sensors and the motor power connections.

9. Checking Motor Feedback Resolution

The feedback resolution can be tested by marking two lines on the magnet way 32mm apart. You can use whatever length you want, but longer is more accurate. Change the User Units to “mm”.

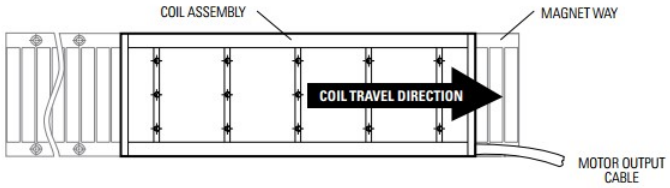


If the position display does not match the distance the motor is moved, you may need to revisit the encoder scaling section of this manual or confirm the feedback device scale.

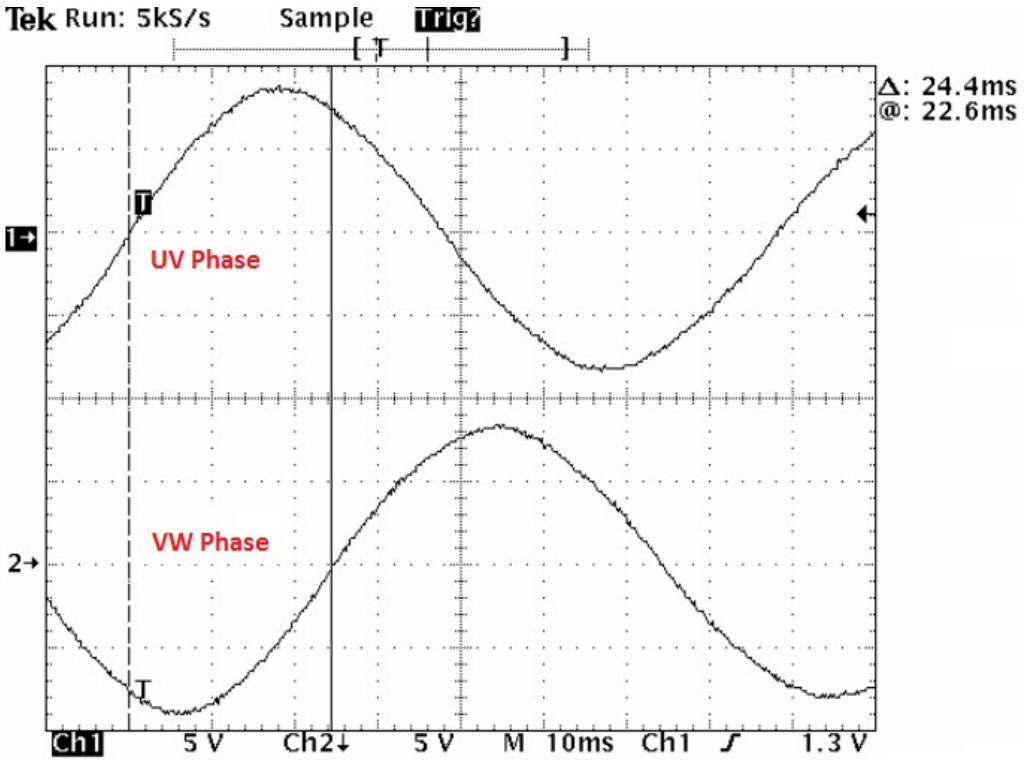
10. Check Motor Phasing of Any Servo Motor

This is useful for commissioning a third-party motor, as well as any frameless Kollmorgen motor, or any servo motor for which the phasing is unknown.

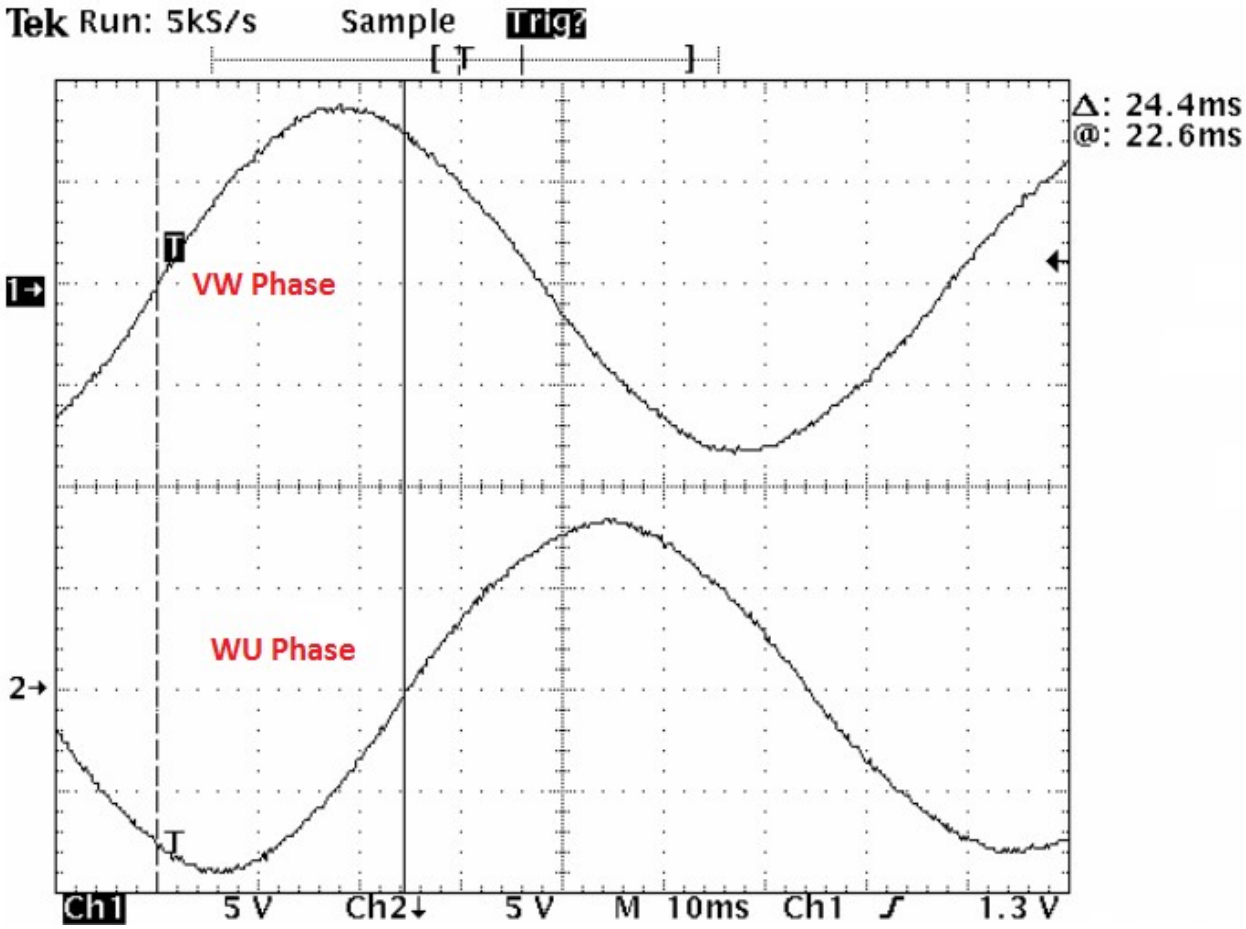
This part of the setup will require a two channel oscilloscope with isolated channels. Move the motor in the positive direction based on the motor manufactures specification. The AKD commutates a motor in the phase sequence of U V W in the positive direction.



When determining the motor phasing, the U phase (U phase with reference to V phase) will lead the back emf voltage waveform by 120° of the V phase (V phase with reference to W phase).



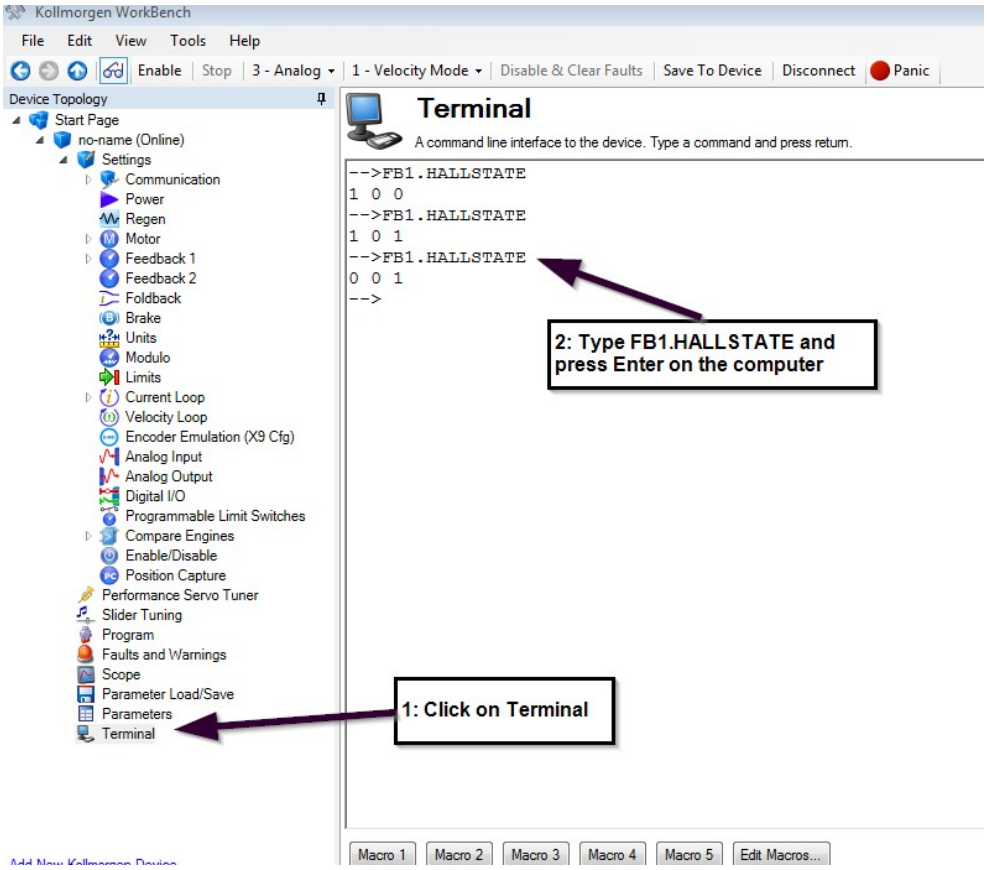
While moving the motor in a positive direction the motor V phase (V phase with reference to W phase) will lead the back emf voltage waveform by 120° of W phase (W phase with reference to U phase).



Use Figure 2 to determine the Hall Sensor alignment of the motor. Make sure the feedback position value (PL.FB) is counting in the positive direction.

10. Test Hall Sequence When Moving Motor in the Positive Direction

The hall phasing can be check with the parameter FB1.HALLSTATE. This is a binary value, where “001” is Hall U, “010” is Hall V, and “100” is Hall W.



Hall Sensor Sequence when FeedBack (PL.FB) Is Counting Positive When Using AKD Firmware Version = or > 01-13-10-001. Do not use the parameter FB1.HALLSTATE in the oscilloscope feature to monitor Hall sensor state.

Step(CW)	FB1.HALLSTATEW	FB1.HALLSTATEV	FB1.HALLSTATEU
1	0	0	1
2	0	1	1
3	0	1	0
4	1	1	0
5	1	0	0
6	1	0	1
7	0	0	1

Hall Sensor Sequence when FeedBack (PL.FB) Is Counting Positive When Using AKD Firmware Version < 01-13-10-001. Do not use the parameter FB1.HALLSTATE in the oscilloscope feature to monitor Hall sensor state.

Step(CW)	FB1.HALLSTATEW	FB1.HALLSTATEV	FB1.HALLSTATEU
1	0	0	1
2	1	0	1
3	1	0	0
4	1	1	0
5	0	1	0
6	0	1	1
7	0	0	1

11. Motor Back emf And Hall Sensor Signal Alignment

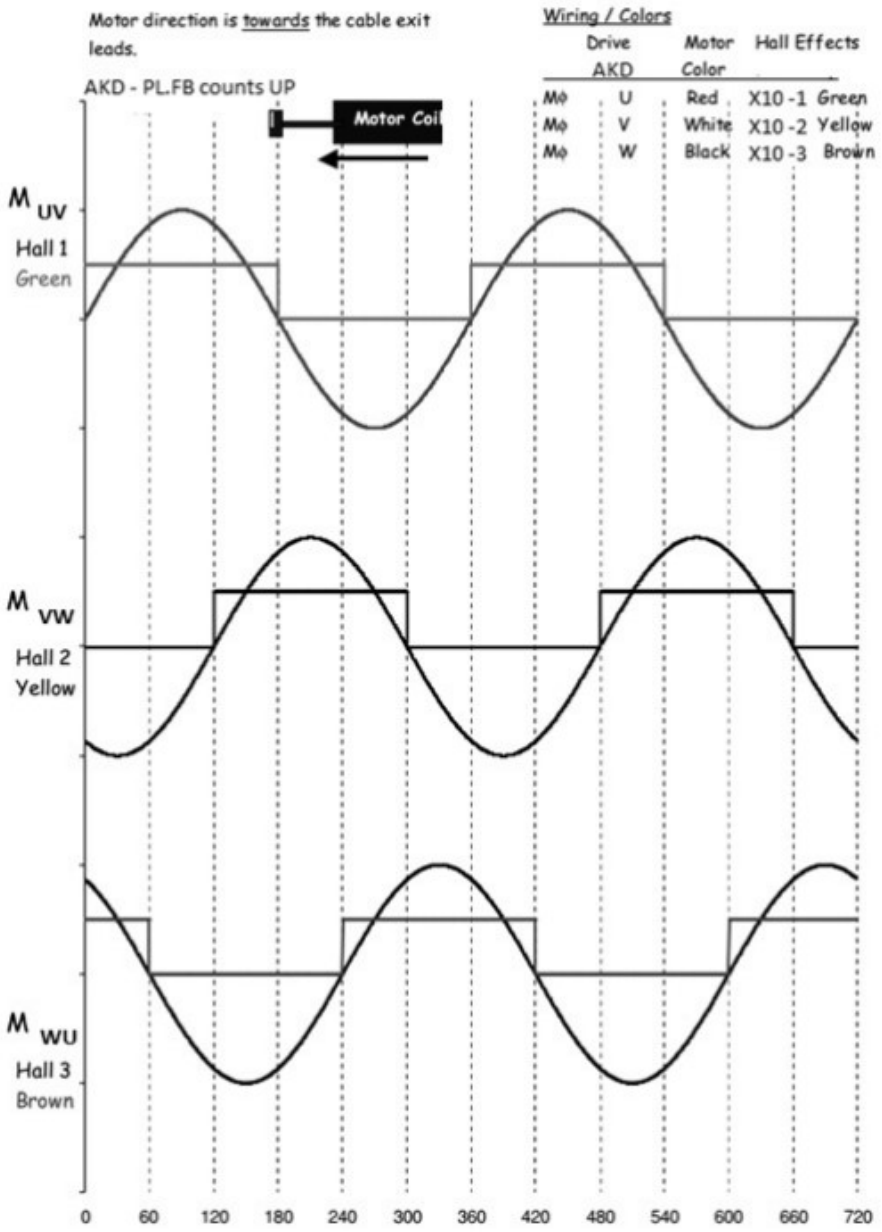
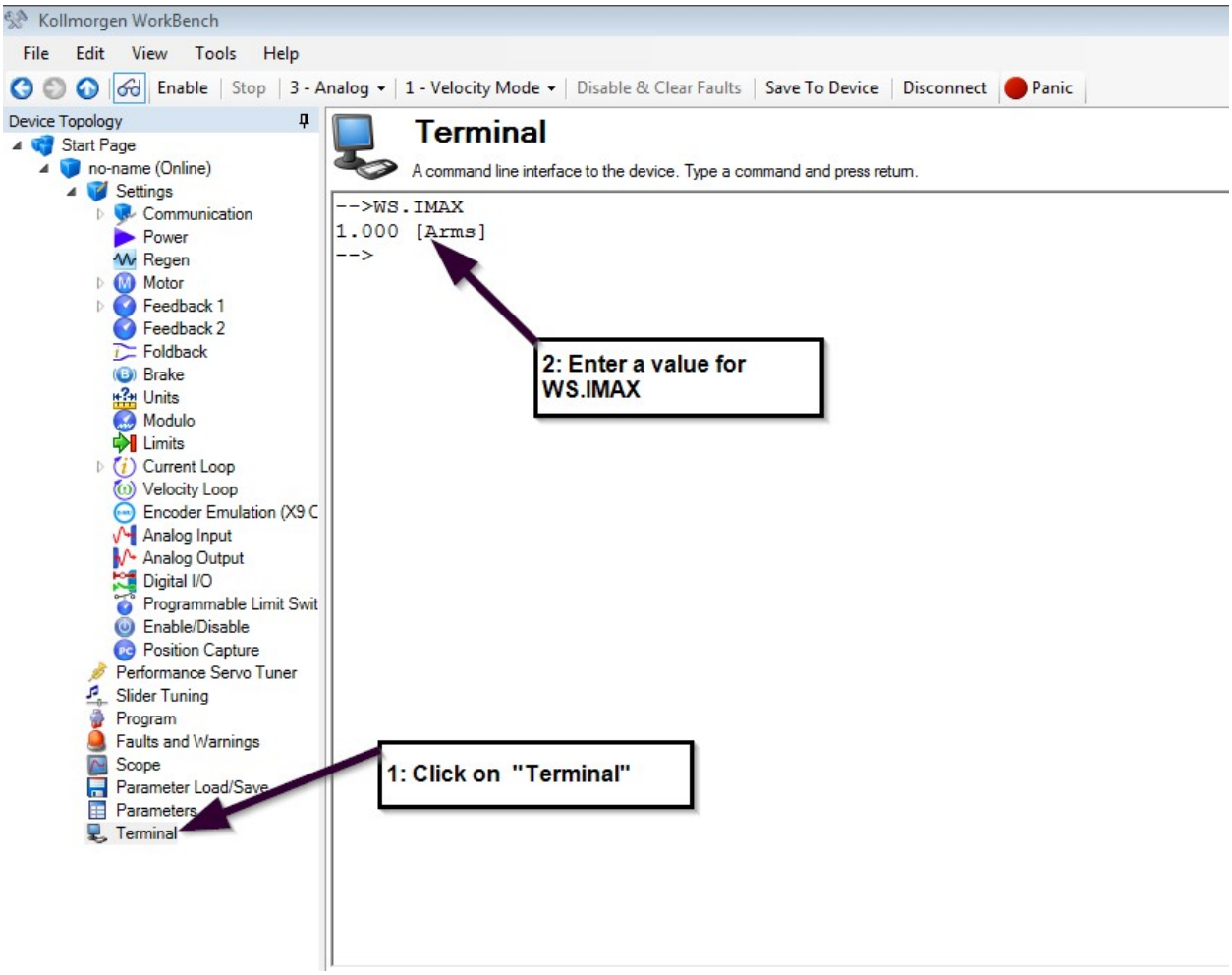


Figure 2

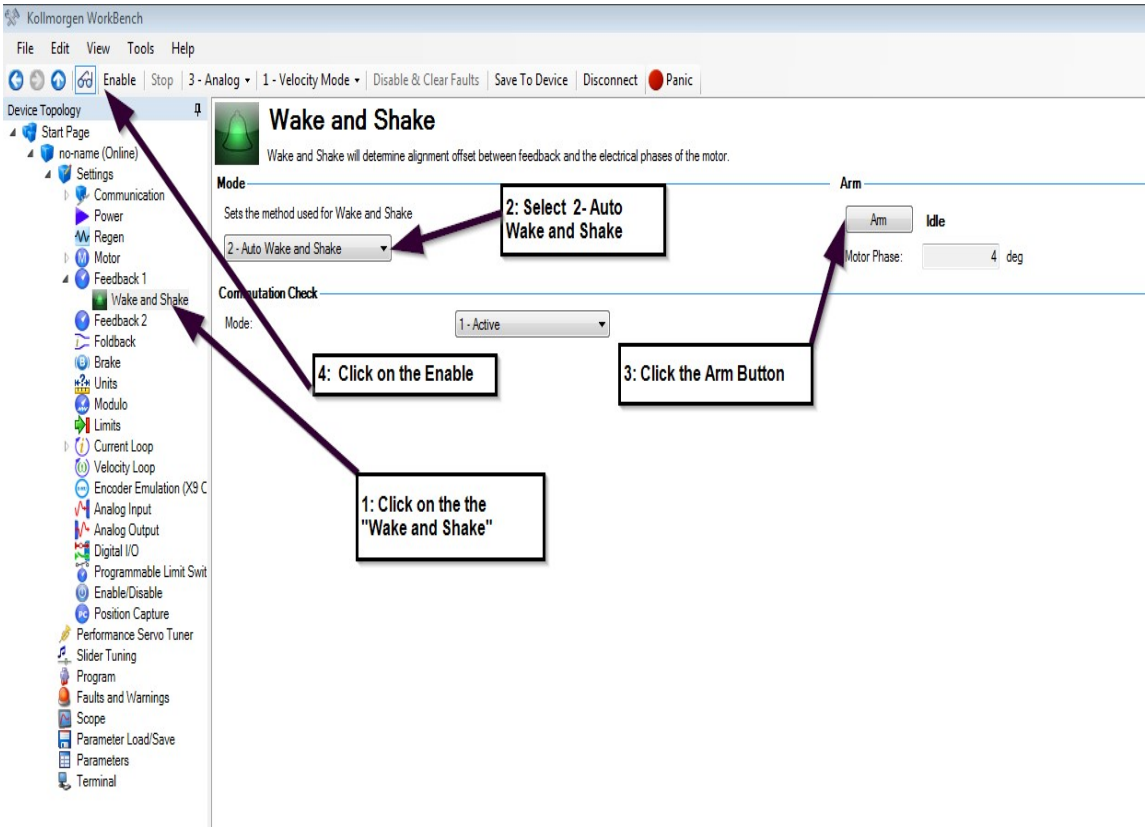
When using a Kollmorgen DDL motor in the standard convention, **MOTOR.PHASE = 120** when the feedback direction is positive toward the “Lead Exit End” of motor (that is, the end of the motor where the leads come out), and when the hall alignment and motor phasing match exactly as shown in Figure 2.

12. How to Verify the Motor's Commutation Alignment Angle (MOTOR.PHASE)

Set the Wake & Shake Current WS.IMAX equal to continuous of your linear motor in the Terminal Screen.

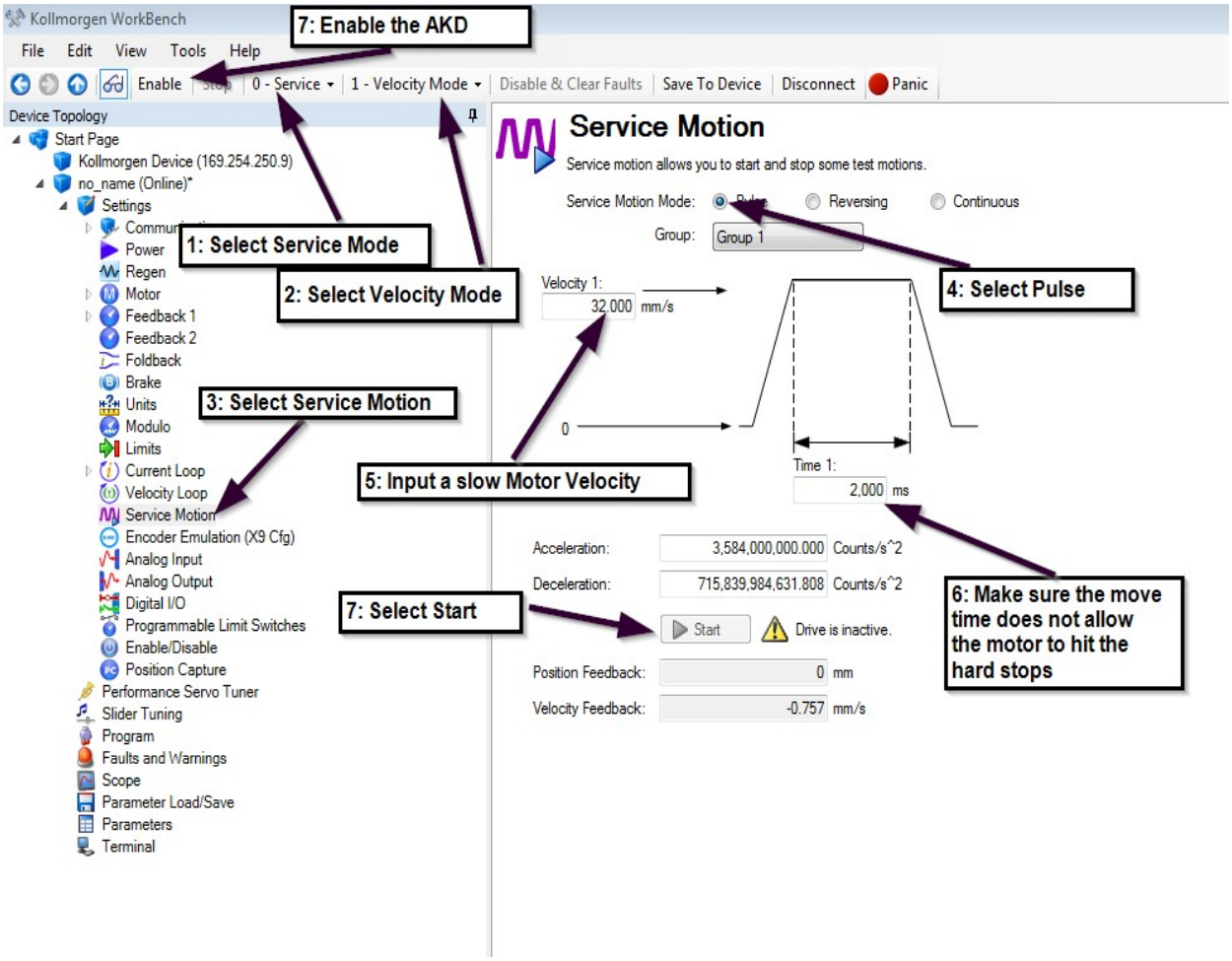


13. Start the Wake and Shake Routine



Start the Wake and Shake routine to find the MOTOR.PHASE offset value. When commissioning the linear motor system, the Wake and shake routine should be performed in several different positions of the motor's travel. The MOTOR.PHASE values should be no more than 5 degrees different in the different positions.

14. Verify the Motor is Setup Correctly by Jogging it in Both Directions



Make sure the AKD drive's peak current is limited before doing this exercise. A linear motor runaway can result in damage to the system equipment or possible bodily injury.

The linear motor initial commissioning is now complete!

Appendix A

Configuring a DDL Liner Motor with Feedback Counting in the Opposite Direction

Appendix A covers the case where the feedback (PL.FB) counts down or negative when moving the coil in the same direction as the motor lead exit as the established POSITIVE convention in the standard startup procedure of this guide. Appendix A also assumes the feedback type where wiring changes will not change the sign or direction of the feedback. If your feedback type that allows the feedback count to be resolved by wiring, please remedy and use the standard conventions in this document. If it is one of the types that cannot be inverted, please follow the conventions in Appendix A.

Feedback Types that can be inverted by wiring:

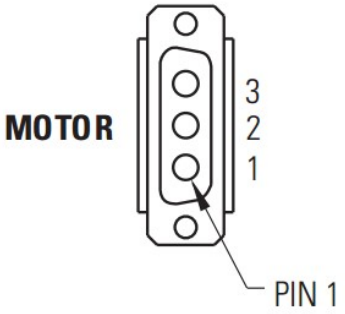
Resolver
Incremental Encoder with or without Halls
Sine Encoder with or without Halls

Types that cannot be inverted:

BISS
EnDAT
Hiperface
Hiperface DSL
SFD
SFD3
Renishaw BISS C

1. DDL Motor Coil Connections

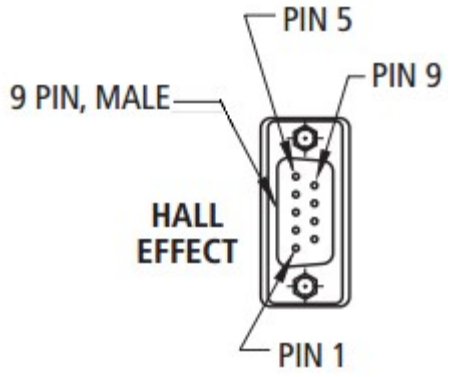
Note the standard convention of UVW has been changed to WVU (non-standard).



Motor Connector Pin Numbers	Motor Coil Wire Color	AKD Drive Connection Connector X2
1	Red	W
2	White	V
3	Black	U
Connector Shell	Grn/Yel	PE GND
Connector Shell	Violet	Shield

2. DDL Motor Hall Sensor Connections

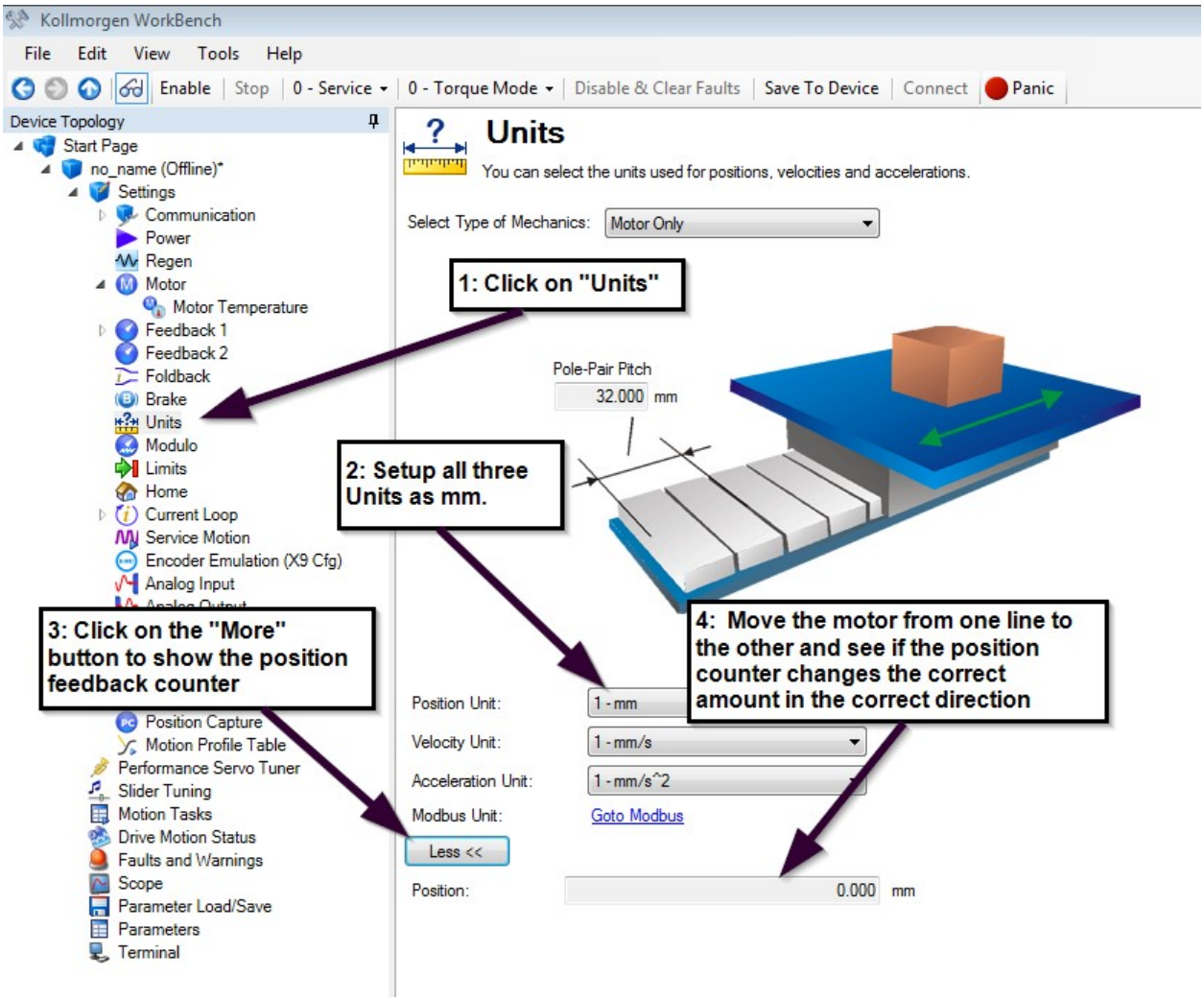
Note the halls have been changed from the standard 1,2,3 on the drive end to 2,1,3 to coincide with the motor phase changes in motor phasing in step 1.



Motor Connector Pin Numbers	Motor Hall Effect Colors	AKD Drive Connection Connector X10 Pin No.
1	Yellow	2
2	Green	1
3	Black	3

3. Checking Motor Feedback Resolution

The feedback resolution can be tested by marking two lines on the magnet way 32mm apart. You can use whatever length you want, but longer is more accurate. Change the User Units to “mm”.

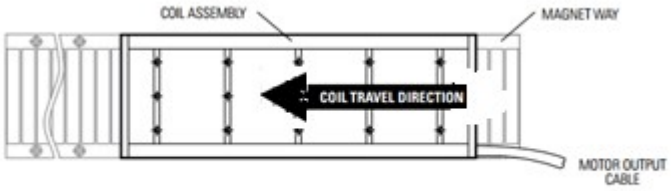


If the position display does not match the distance the motor is moved, you may need to revisit the encoder scaling section of this manual or confirm the feedback device scale.

4. Check Motor Phasing of Any Servo Motor

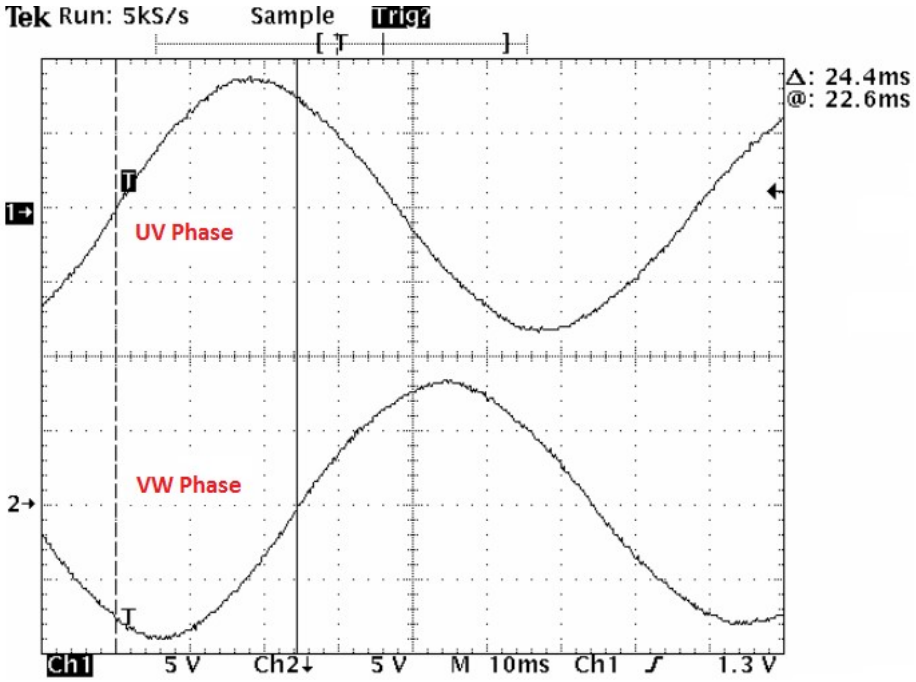
This is useful for commissioning a third-party motor, as well as any frameless Kollmorgen motor, or any servo motor for which the phasing is unknown. Note this is for the case where the feedback counts down or negative with the standard convention and the feedback type cannot resolve the direction by wiring changes.

This part of the setup will require a two channel oscilloscope with isolated channels. Move the motor in the positive direction based on the motor manufactures specification. The AKD commutates a motor in the phase sequence of U V W in the positive direction.

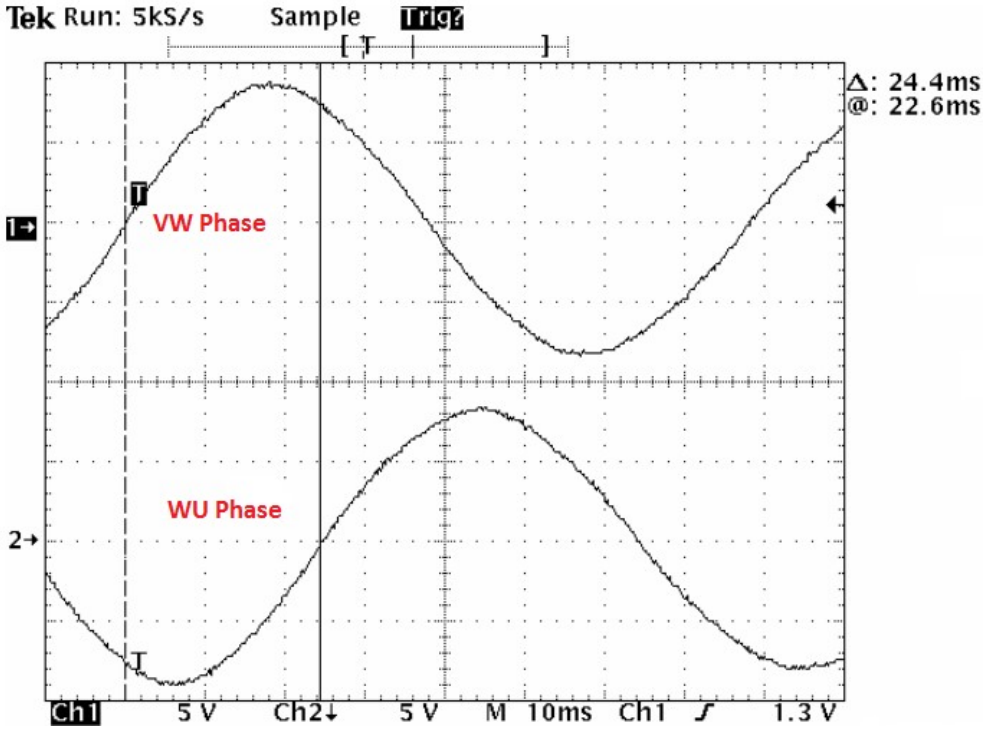


Non-Standard Convention: Feedback PL.FB counts up when the coil travel direction is AWAY from the exit motor output leads.

When determining the motor phasing, the U phase (U phase with reference to V phase) will lead the back emf voltage waveform by 120° of the V phase (V phase with reference to W phase).



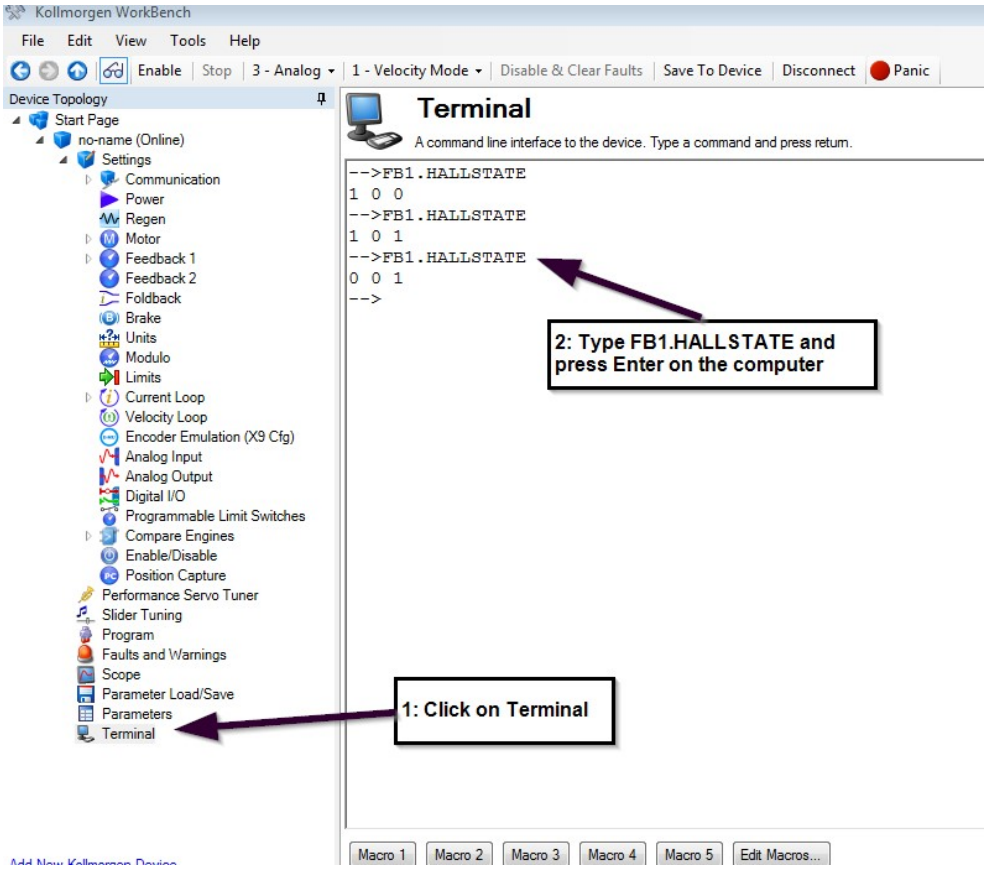
While moving the motor in a positive direction the motor V phase (V phase with reference to W phase) will lead the back emf voltage waveform by 120° of W phase (W phase with reference to U phase).



Use Figure 3 to determine the Hall Sensor alignment of the motor. Make sure the feedback position value (PL.FB) is counting in the positive direction.

5. Test Hall Sequence When Moving Motor in the Positive Direction

The hall phasing can be check with the parameter FB1.HALLSTATE. This is a binary value, where “001” is Hall U, “010” is Hall V, and “100” is Hall W.



6. Monitoring the Hall Sensors States

Hall Sensor Sequence when FeedBack (PL.FB) Is Counting Positive

When Using AKD Firmware Version = or > 01-13-10-001. Do not use

the parameter FB1.HALLSTATE in the oscilloscope feature to monitor

Hall sensor state. Note from Workbench Help that FB1.HALLSTATE reports from left to right halls W, V, U in Workbench Terminal so Terminal should follow the same convention as the chart below.

Step(CW)	FB1.HALLSTATEW	FB1.HALLSTATEV	FB1.HALLSTATEU
1	0	0	1
2	0	1	1
3	0	1	0
4	1	1	0
5	1	0	0
6	1	0	1
7	0	0	1

Hall Sensor Sequence when FeedBack (PL.FB) Is Counting Positive

When Using AKD Firmware Version < 01-13-10-001. Do not use

the parameter FB1.HALLSTATE in the oscilloscope feature to monitor

Hall sensor state. Note from Workbench Help that FB1.HALLSTATE reports from left to right halls W, V, U in Workbench Terminal so Terminal should follow the same convention as the chart below.

Step(CW)	FB1.HALLSTATEW	FB1.HALLSTATEV	FB1.HALLSTATEU
1	0	0	1
2	1	0	1
3	1	0	0
4	1	1	0
5	0	1	0
6	0	1	1
7	0	0	1

7. MOTOR BACK EMF AND HALL SENSOR SIGNAL ALIGNMENT

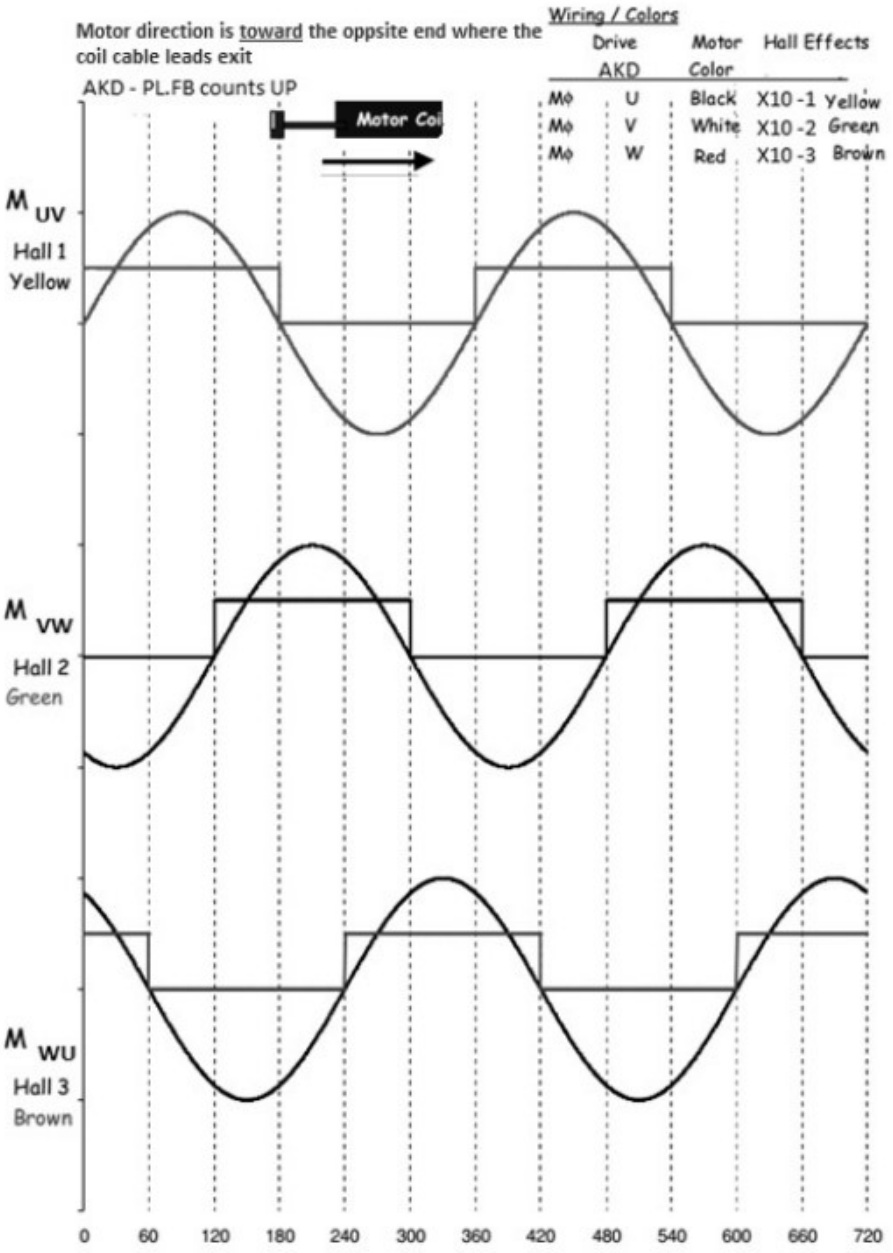


Figure 3

When using a Kollmorgen DDL motor in the non-standard convention, **MOTOR.PHASE = 120** when the feedback direction is positive away from the “Lead Exit End” of motor (that is, the end of the motor where the leads come out), and when the hall alignment and motor phasing match exactly as shown in Figure 3.

Return to **13. Start the Wake and Shake Routine** on “page 26”