

How to configure an AKD Drive with Hall Feedback as the Primary Feedback Device

By Steve Crockett

1.2 Target Group

This manual addresses personnel with the following qualifications:

- Transport: only by personnel with knowledge of handling electrostatically sensitive components.
- Unpacking: only by electrically qualified personnel.
- Installation: only by electrically qualified personnel.
- Basic tests: only by qualified personnel with extensive knowledge of electrical engineering and drive technology

The qualified personnel must know and observe the following standards:

- ISO 12100, IEC 60364 and IEC 60664
- National accident prevention regulations

⚠ WARNING	During operation, hazards exist that can cause death, severe injury, or material damage. To safely operate the AKD, you must follow all safety instructions in this manual. The operator of systems using the AKD must require that all personnel who work with the drive read and understand the manual before using the drive.
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Purpose of the Content of this Document: This document explains how to configure the wiring to the AKD for operation with typical Kollmorgen motors that “only” incorporates Hall feedback. It also will cover the necessary work to be done in the Workbench setup software.

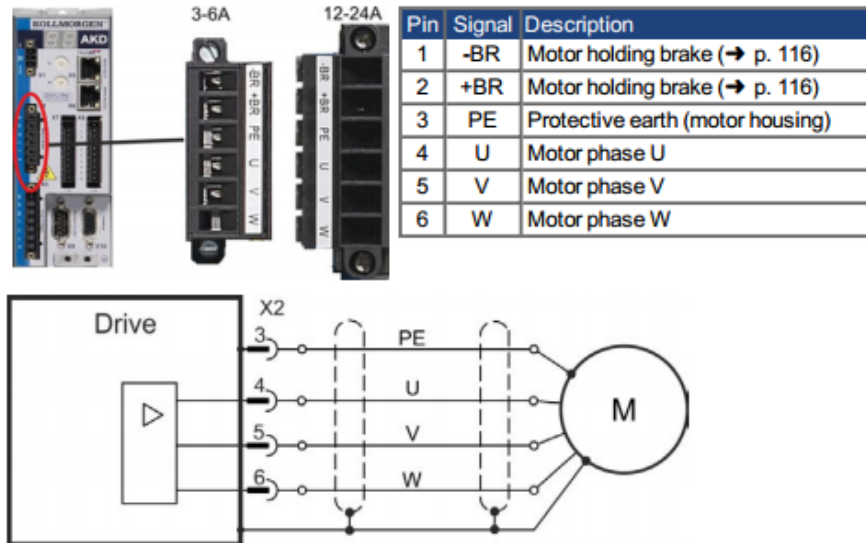
- **AKD Systems wiring. Motor Power to X2.**
- **AKD Systems wiring. Hall wiring into x10.**
- **Description for motor phase / hall phase relationship when wiring into the AKD.**
- **Workbench setup, Motor selection: How to select the correct Kollmorgen motor to be used.**
- **Workbench setup, Feedback selection and system test - torque mode.**
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AKD Systems wiring. Motor Power to X2. From the AKD installation manual

Identify the motor phases UVW & PE, Note (ABC = UVW), connect the motor phases and PE to the drive on connector X2. (See below).

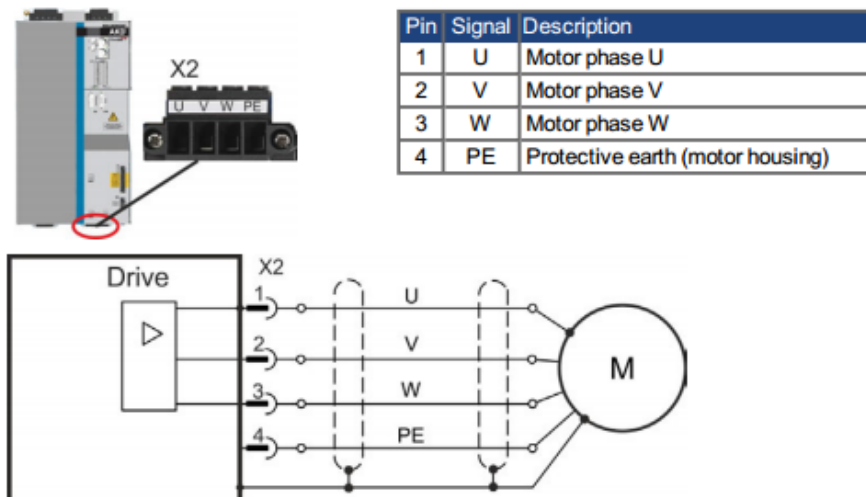
AKD Installation | 8 Electrical Installation

8.10.1 AKD-x003 to 024, power connector X2



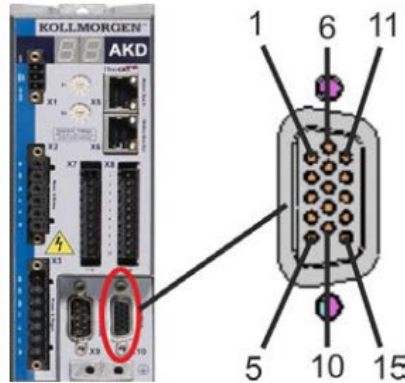
8.10.2 AKD-x048, power connector X2

NOTE Cable length maximum 25 m.



AKD Systems wiring. Hall wiring into x10. *** Basically the Motor HALL signals are shifted 120 degrees “out of phase” with the Motor Power phases.

8.11.1 Feedback connector (X10)

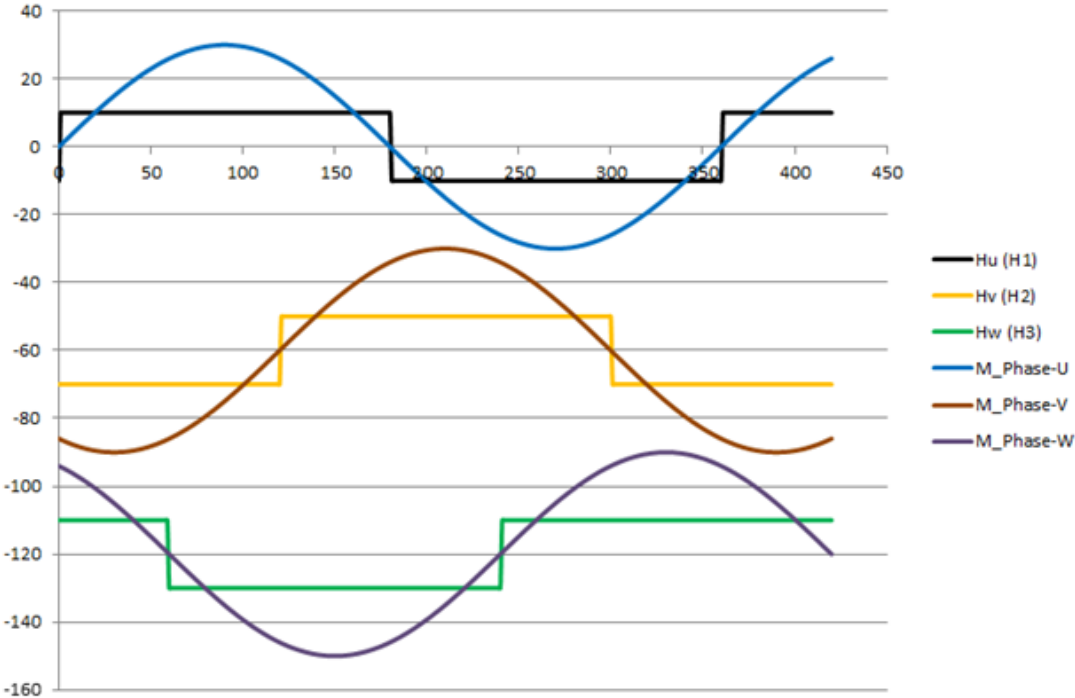


AKD		KBM(S)		TBM(S)		VLM (H)		IC, ICH, IL, ID		
Pin	Signal	Color	Name	Color	Name	Color	Name	Color	Pin	Name
X2/3	PE	added	GND	added	GND	Yel/Grn	GND	Yel/Grn	Shell	GND
X2 /4	Power U	Blue	U	Red	A	Blue	U	Red	1	A
X2 /5	Power V	Brown	V	White	B	Brown	V	White	2	B
X2 /6	Power W	Violet	W	Black	C	Violet	W	Black	3	C
X10 /2	Hall V	Brown	H1	Brown	H-Ab	Brown	Hall V	Green	SubD 9/2	S1
X10 /3	Hall W	Orange	H2	Orange	H-Bc	White	Hall W	Yellow	SubD 9/3	S2
X10 /1	Hall U	Yellow	H3	Yellow	H-CA	Green	Hall U	Brown	SubD 9/4	S3
X10/8	Temp +	Violet	Temp +	(special)	Temp +	Gray	Temp +	BLK/WHT	Molex 1	Temp +
X10/9	Temp -	Violet	Temp -	(special)	Temp -	Violet	Temp -	BLK/WHT	Molex 2	Temp -
X10/10	+5V	Blue	+5V	Blue	+5V	Red	+5V	Gray	SubD 9/1	+5V
X10/11	0V	Green	0V	Green	0V	Black	0V	White	SubD 9/5	0V

VLM motor “Labeling” of Hall channels do not reflect the relationship to the VLM motor phases, Halls signals are actually 120 degrees shifted. This shift resolves the AKD wiring requirement.

Description for Motor Phase / Hall “relationship” for wiring into the AKD.

1st. Identify each Motor Phase and it’s associated Hall by their positive transistion. The transistion occurs when the Motor Phase BEMF is crossing zero and moving positive (+) and it’s associated Hall is also transistioning positive (+) at that “same” point. The table below shows this relationship for Motor Phases and Halls by the sequence U , V , W for a positive direction. The identification of labels for Motor Phase and Halls can vary based on the motor mfg. standards.

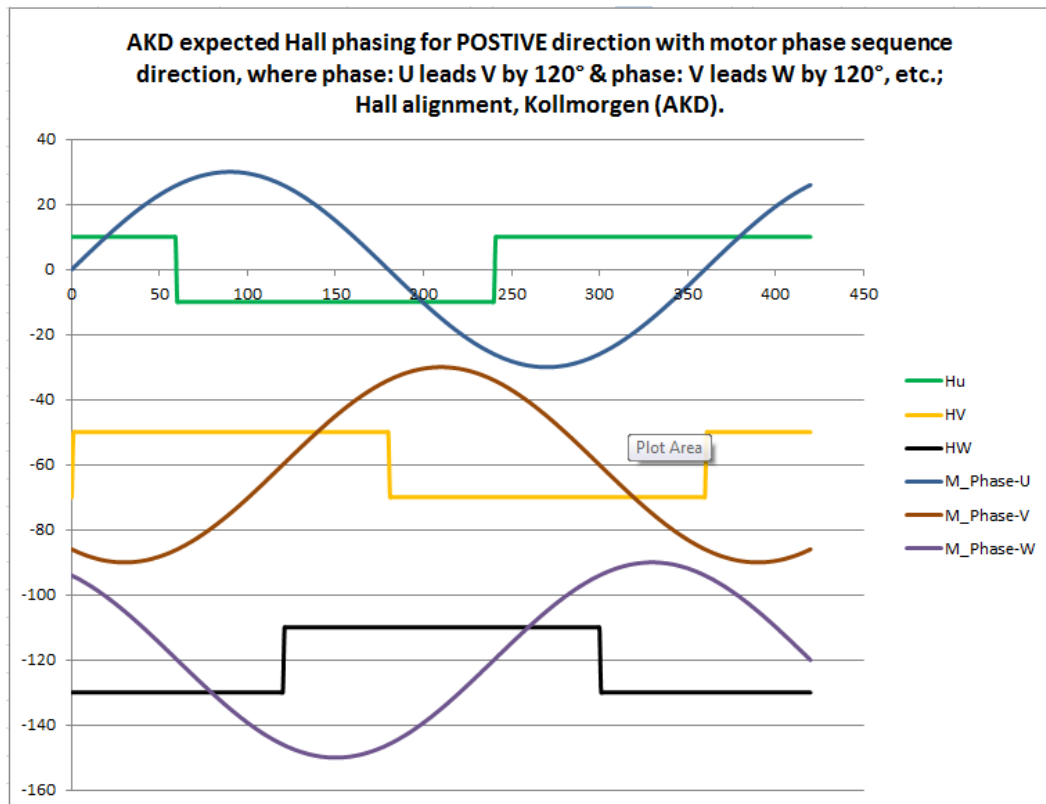


2nd. The following table is used to wire motor power and feedback to the AKD.

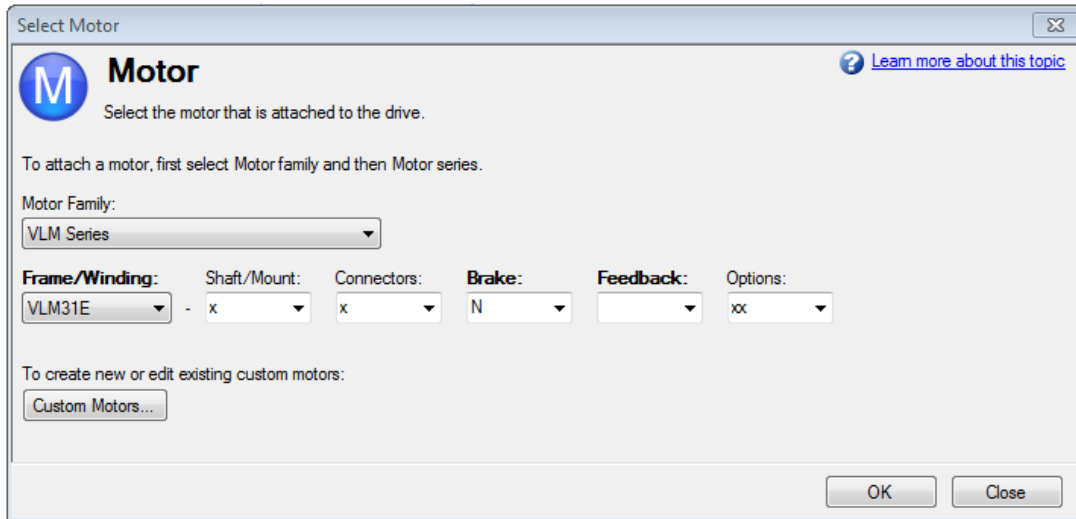
***(AKD 3-24amp vs. AKD 48 amp) - reference page 2 in this document for the correct pinout of X2 power wiring.**

Motor Power				Motor Feedback "Hall only"	
AKD/X2	-	Motor Phase		AKD/X10	Motor Halls
U	-	U	--	Pin 1	Hw - Hall
V	-	V	--	Pin 2	Hu - Hall
W	-	W	--	Pin 3	Hv - Hall
PE	-	GND	--	Pin 10	+5v - Hall
			--	Pin 11	0v - Hall

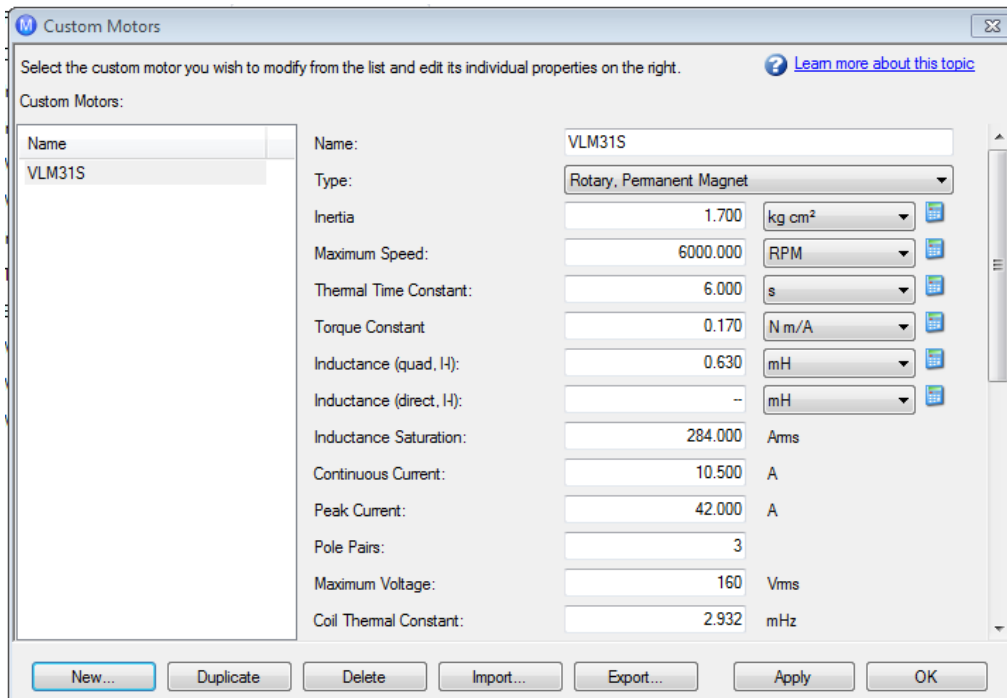
The AKD has a requirement for Hall phasing "120 deg shift" see example below.



Workbench setup, Motor selection: How to select the correct Kollmorgen motor to be used.




Workbench setup, Custom Motor “create a motor file” it is used for Kollmorgen brand motors not found in the Workbench motor data base or it can be used for 3rd party motors file creation. * **F1 for HELP**- * **Definitions** for the parameters used in motor setup can be found in the help section (F1) of the Workbench. **“MOTOR”**.



Workbench setup, Feedback selection: Selection for the Feedback - Halls Only

Once the selection for Halls only is made, a test can be performed to verify the hall signals with reference to the direction of motor rotation.

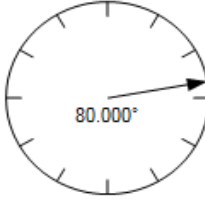


Feedback 1 (X10)

The primary position feedback fitted to your motor.

Feedback Selection: 12 - Halls Only

If you rotate the motor shaft you should see the dial move.



FB1.SELECT

General Information	
Type	NV Parameter
Description	Sets user entered type or identified type (-1).
Units	N/A
Range	-1, 1, 10, 11, 12 , 20, 21, 30, 31, 32, 33, 34, 40, 41, 42, 43, 45, 46, 50
Default Value	-1
Data Type	Integer
Start Version	M_01-00-00-000
Input Value	Description
12	<p>Manually sets the type to Halls Only feedback (added 01-13-08-000).</p> <p>This feedback type only supports operating in Torque mode and Velocity mode.</p> <p>Due to heavy quantization, large current spikes occur at hall transition points, it is advisable to tune the observer to a low frequency (like 10Hz) and set the observer gain appropriately to achieve the best operating results</p>

Workbench setup, Feedback selection and system test in the drive Torque mode.

Drive / motor wiring complete.

Motor disconnected from the load, (motor shaft only, remove or secure any loose keys)

Workbench setup - Limit the speed of the system to a **safe value** by lowering the velocity parameter, VL.THRESH

The screenshot displays the Kollmorgen WorkBench interface. The left sidebar shows a tree view of settings, with 'Limits' highlighted. The main window is titled 'Limits' and contains the following configuration sections:

- Current Limits**
 - Positive Peak Current: 9.000 Ams
 - Negative Peak Current: -9.000 Ams
 - Dynamic Break Peak Current: 1.000 Ams
- Velocity Limits**
 - Positive Speed Limit: 3,000,000 rpm (Warning: Not used)
 - Negative Speed Limit: -3,000,000 rpm (Warning: Not used)
 - User Over-Speed Limit: 500,000 rpm** (Highlighted with a red box and yellow background)
 - Overall Over-Speed Limit: 3,600,000 rpm (Info: Min from user, motor mechanical and back EMF limits)
- Position Limits**
 - Maximum Position Error: 655,360,000 Counts16Bt
 - Position Limit 0: 0.000 Counts16Bt
 - Position Limit 1: 1,048,576.000 Counts16Bt
- Acceleration Limits**
 - Acceleration: 10,000.170 rpm/s
 - Deceleration: 10,000.170 rpm/s
- Motor Limits**
 - Motor limits are set through the Motor Foldback Screen: [Goto Foldback](#)

Drive setup should be completed.

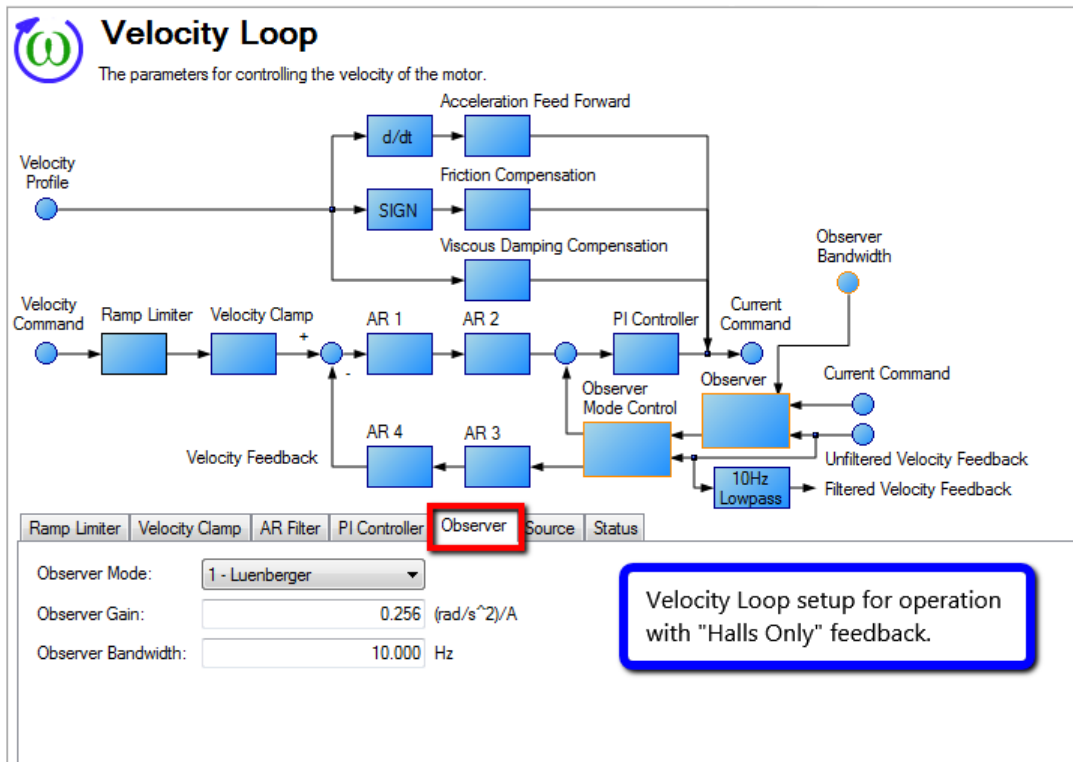
“Torque Mode” selected and command source “Service Motion” selected.

The AKD system can be enabled. Using a current command "continuous" at a low value should overcome the motor friction and rotate. Complete rotation and the direction of rotation should be noted. (Based on motor configuration) a positive command should generate a positive direction of rotation and positive velocity.

The screenshot displays the Kollmorgen WorkBench software interface. The top menu bar includes File, Edit, View, Tools, and Help. Below the menu bar, there are navigation buttons (back, forward, home) and a status bar with buttons for Disable, Stop, 0 - Service, 0 - Torque Mode, Disable & Clear Faults, Save To Device, Disconnect, and Panic. The left sidebar shows the Device Topology tree, with 'Service Motion' selected and highlighted by a blue arrow. The main window is titled 'Service Motion' and contains the following configuration options:

- Service Motion Mode: Pulse Reversing Continuous (indicated by a blue arrow)
- Group: Group 1
- Current 1: 0.250 Ams (indicated by a blue arrow)
- 0
- Start button (indicated by a blue arrow and a callout box labeled 'start and stop button')
- Position Feedback: 141,441,251.556 Counts16Bit
- Velocity Feedback: -0.014 rpm
- Current Feedback: -0.014 Ams

Workbench setup, Velocity operation, Luenberger Observer settings for Halls Only feedback.



Due to heavy quantization, large current spikes occur at hall transition points, it is advisable to tune the observer to a low frequency (like 10Hz) and set the observer gain appropriately to achieve the best operating results.

Workbench System Test “Velocity Mode”

Operation test in the torque mode successfully.

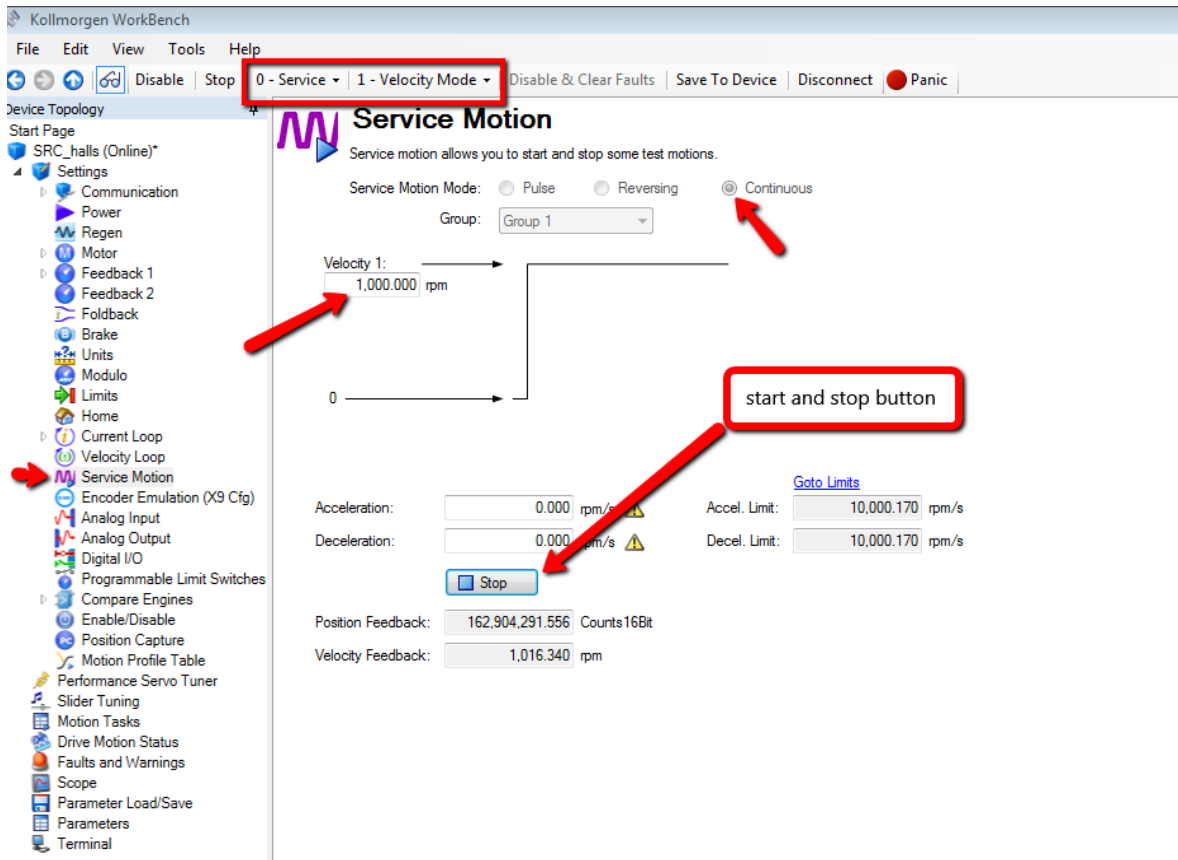
Motor disconnected from the load, (motor shaft only), Workbench - Increase the velocity limit VL.THRESH, back to a normal value.

“Velocity Mode” selected and command source “Service Motion” selected.

Luenberger Observer - enabled and values set. The AKD system can now be enabled. Using a velocity command "continuous" at a higher velocity approximately 500 to 1000rpm should be issued and system operation noted. The direction of rotation should be following the command. (Based on motor configuration) a positive command should generate a positive direction of rotation and positive velocity. Following stability and control of the motor in the unloaded condition, velocity tuning will need to be optimized for the system once the application load is attached.

*Note when using AKD systems with Halls only feedback - Workbench - Performance Tuner is **not operational** due to the low resolution of the Hall feedback !

Workbench tuning options for these systems are the “Slider Tuner” or the manual method of tuning. The Workbench O’scope sections provide a quick access to the tuning variables you will need and the scope is fully functional to verify system performance.



Comments for Hall system performance at zero rpm and low speed operation.

1. Stability at zero rpm can oscillate if velocity gains are set high and loads have low friction.

Low speed operation can be difficult based on the motor size and pole count.

The following is a description of motor speed vs. frequencies for estimating the minimum system velocity's when using HALL feedback and AKD drives.

With the AKD and using the observer you should be able to duplicate that performance metric easily. We just need the Hall edge rate to be about 5 times the filter frequencies we use.

Example for the AKD we will use 25 Hz implying a 125 Hz edge rate needed. 125 Hz edge rate with 10 pole (AKM 4) is only $(125/6/5*60) = 250$ RPM.

Really only good for applications with the Hall frequency above 15 Hz. This sets a lower mechanical usability speed of $(15*P/2*60)$ in RPM. For Kollmorgen AKM motors this gives:

AKM1, 2 6 Pole > 500 RPM

AKM3 8 pole > 350 RPM

AKM4-8 10 pole > 250 RPM

We have rounded the number in the above. The usable speed goes even lower with the relatively speaking higher pole counts of the part set motors. (KBM(S), TBM(S)).