

Objective:

Ensure the proper phase relationship for the Linear motor BEMF, Halls and Encoder for the Servostar S series.

Scope:

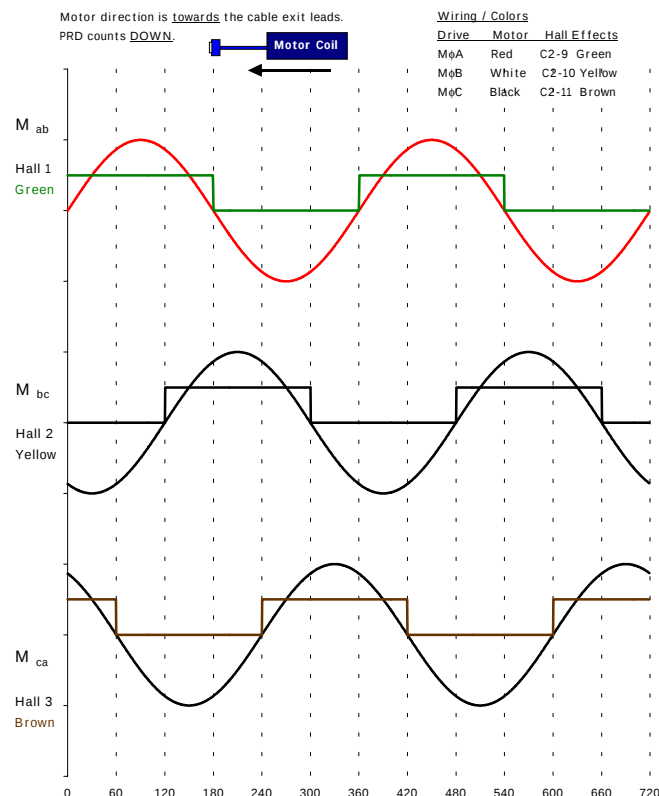
The scope of this procedure will include the following:

- Set up and measuring the Motor BEMF phase relationship with respect to each of the individual motor phases with a Digital Oscilloscope (Tektronix TDS 340 or equivalent)
- Set up and measuring the Motor phase relationship with respect to each of the Hall effect phases
- Set up and measuring the encoder phase relationship with respect to itself, CH A vs. CHB.

By assuring that the connections are correct with the following procedure, power will be applied to the drive, which will then be ready to be configured for the selected motor model that is being set up.

BEMF and Phase definitions

All Kollmorgen Platinum DDL linear motors are wired to the same phasing convention. Phase AB leads phase BC by 120 degrees, with the cable exit 'leading' as shown in the motor commutation diagram. The term AB is defined as the back emf voltage produced by the motor while it is moving. When connecting the scope probe to motor phase A and return to motor phase B, one can observe the BEMF voltage of the motor with a two-channel oscilloscope. Note that all three motor and Hall effect phases are shown in this diagram, on a true oscilloscope display, only two waveforms are displayed.



Motor Phasing Procedure

Procedure 1: Check BEMF motor phase AB and BC

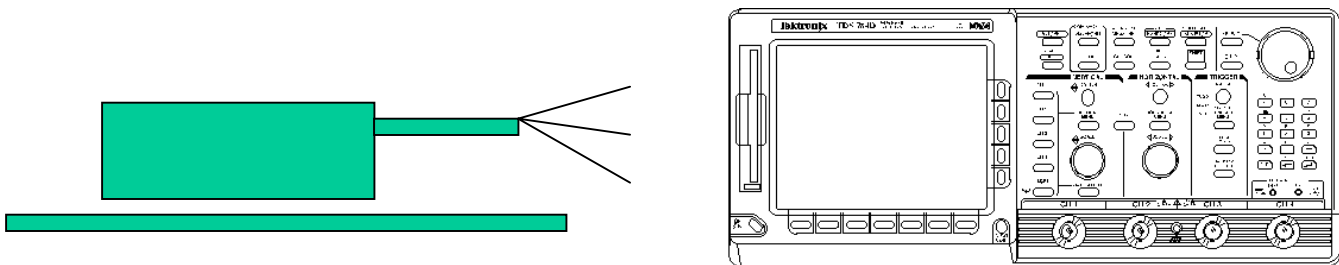
Equipment Required

- Digital Oscilloscope, or storage scope
 - 2 - 10x scope probes
 - Motor System to be tested
 - Includes Ironcore or Inonless
 - Servostar S Series Drive
 - 25 pin connector adapter for the C2 connector
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Step 1. Set up the equipment as shown in the following illustration:

Connect the oscilloscope CH 1 probe to phase A (red wire) with the ground connected to phase B.

Connect the oscilloscope CH 2 probe to phase C (black wire) with the ground connected to phase B.



Step 2: Scope settings

Set the scope to the following settings:

Vertical:

Input	CH 1	CH 2
Scale	5 Volts/div	5 Volts/div
Ground position	+ 2 divisions	- 2 divisions
Coupling	DC	DC
Invert	OFF	ON

Horizontal Timebase

Scale	25 msec/div
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Trigger

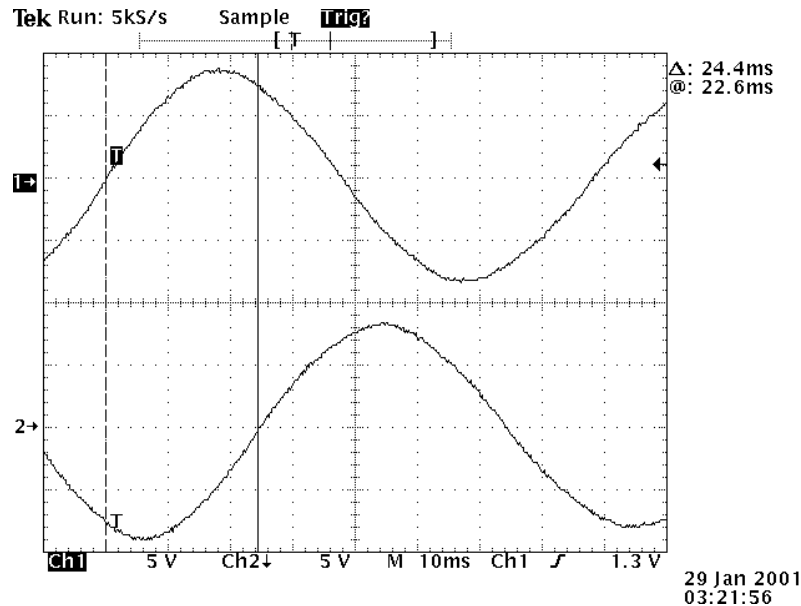
Mode	Normal
Source	CH1
Trigger Level	+1.0 Volt
Coupling	HF reject
Slope	Positive

Step 3: Move the motor coil and observe waveform **AB** to **BC** phase relationship on oscilloscope.

Push the motor by hand in the direction of the cable leads as shown in figure 1. You will see 2 sinusoidal waveforms on the scope. These waveforms represent the back emf voltage of motor phases **AB** and **BC**.

From this you can observe that phase **AB** (Channel 1 scope input) leads phase **BC** (Channel 2 scope input) by 120° .

This agrees with the waveforms illustrated below and the motor commutation diagram. Note that the phase **AB** crosses zero going positive at the trigger point 'T' and phase **BC** crosses zero 120° after phase **AB** (notice the solid vertical line at the 120° point).

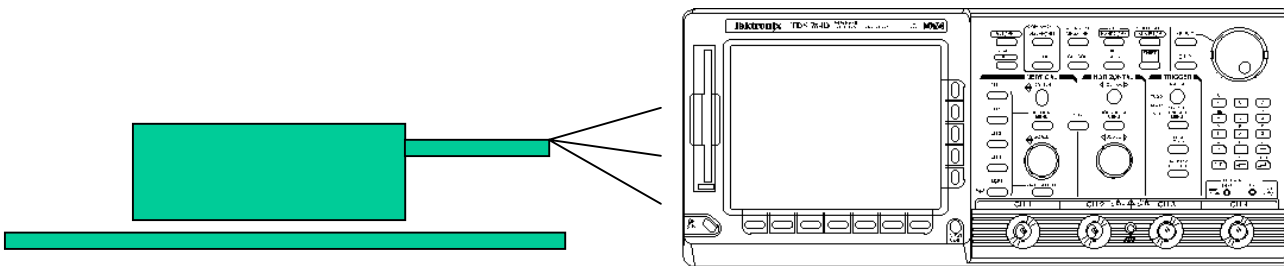


Step 4 Check phase of Motor phase BC with respect to CA

Move the oscilloscope CH 1 probe to phase B (white wire) with the ground connected to phase C.

Move the oscilloscope CH 2 probe to phase A (red wire) with the ground connected to phase C.

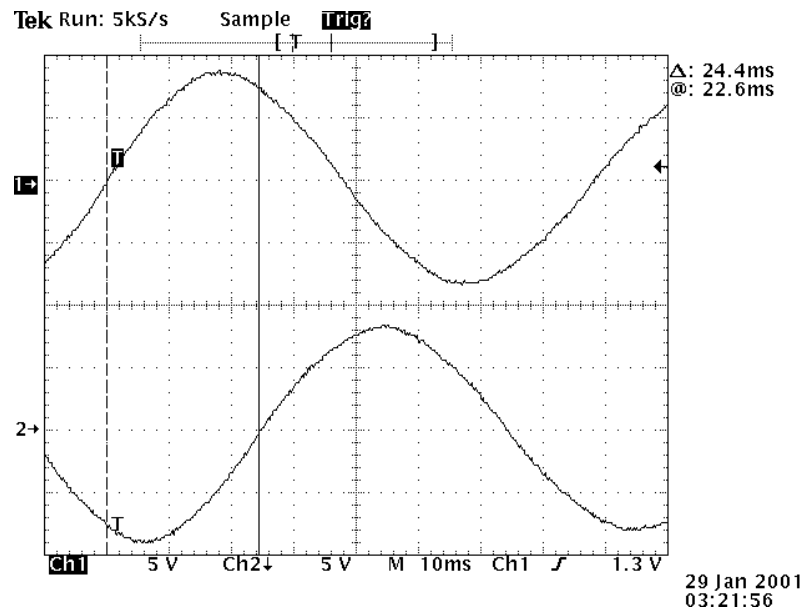
Ensure that the CH 2 vertical channel is still inverted.



Step 5: Move the motor coil and observe waveform **BC** to **CA** phase relationship on oscilloscope.

Push the motor by hand in the direction of the cable leads as shown in figure 1. You will see 2 sinusoidal waveforms on the scope. These waveforms represent the back emf voltage of motor phases **BC** and **CA**. From this you can observe that phase **BC** (Channel 1 scope input) leads phase **CA** (Channel 2 scope input) by 120° . This agrees with the waveforms illustrated below and the motor

commutation diagram. Note that the phase **BC** crosses zero going positive at the trigger point 'T' and phase **CA** crosses zero 120° after phase **BC** (notice the solid vertical line at the 120° point).



This procedure illustrates the proper phase relationship of the individual motor windings, Phase AB with respect to phase BC and next, phase BC with respect to phase CA.

Procedure 2: Check BEMF motor phase to Hall phases 1,2 and 3

Hall Effect Phasing

By monitoring the Hall effect signals, you can also find a pair of motor phases that is aligned with each individual hall effects.

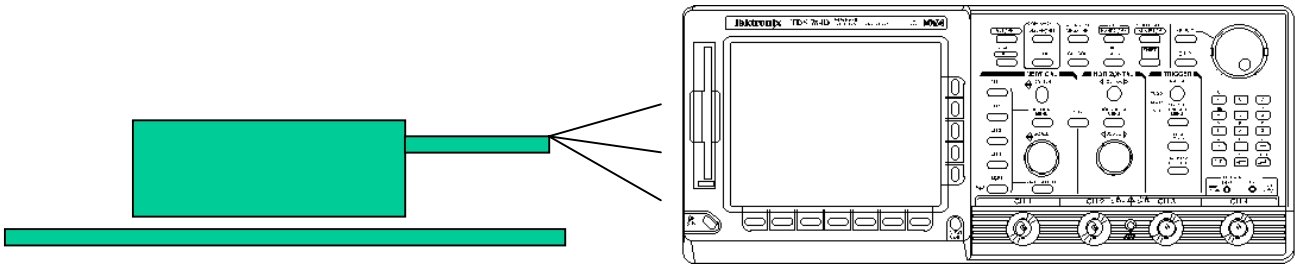
Now, we need to determine the proper Hall effect and motor phase relationship. Phase AB, needs to be in proper alignment with the Hall effect inputs on the Servo Star C2 connector. The following chart lists the pin numbers and the signal names for the Hall effect signals.

Hall Effect pin number designation	
Signal Name	Pin number C2
Hall 1	9
Hall 2	10
Hall 3	11

Step 1, setup oscilloscope and connections

Connect the oscilloscope CH 1 probe to phase A (red wire) with the ground connected to phase B.

Connect Channel 2-scope probe to C2 pin 9 with respect to ground on the drive. This is the Hall effect Hall 1 input. Use the 25-pin adapter connector to secure the probe on to the pin.



Step 2: Scope settings

Set the scope to the following settings:

Vertical:

Input	CH 1	CH 2
Scale	5 Volts/div	5 Volts/div
Ground position	+ 2 divisions	- 2 divisions
Coupling	DC	DC
Invert	OFF	OFF

Horizontal Timebase

Scale	25 msec/div
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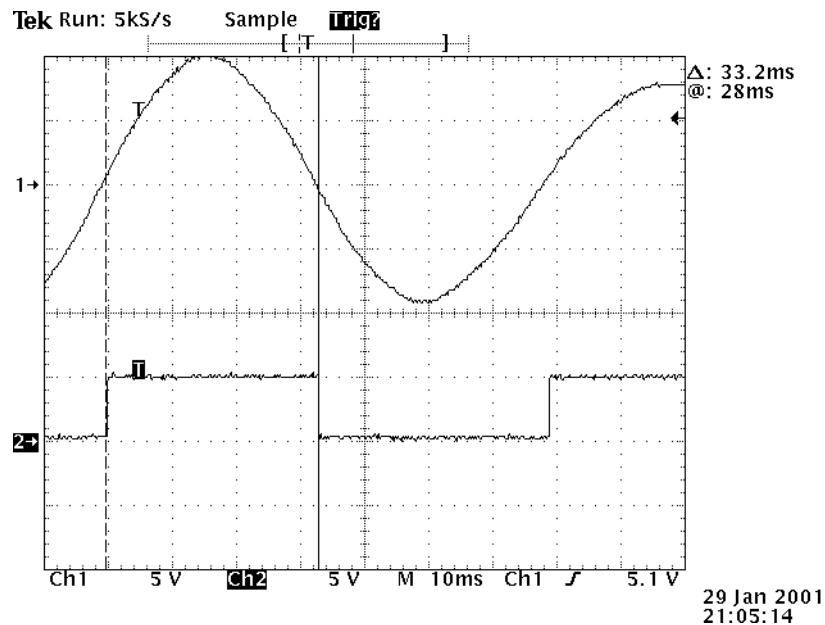
Trigger

Mode	Normal
Source	CH1
Trigger Level	+1.0 Volt
Coupling	HF reject
Slope	Positive

Step 4: Move the motor coil and observe waveform to **AB** phase relationship with **Hall 1** on oscilloscope.

Power up the drive and leave the motor leads disconnected from the terminals on the drive.

Push the motor in the direction of the cable leads as shown in figure 1. The scope display will be as follows:



Note that the Ch1 signal, (Motor phase AB) and the Ch 2 (Hall phase 1signal) cross **zero at the same time**. This is represented by Hall phase 1, the Digital Hall effect signal is positive going as the motor BEMF goes positive. This is the desired relationship; the two signals, motor and Hall effect are in phase with each other.

Do the same for Motor Phase BC and Hall 2 (C2 pin 10) and then again for Motor phase CA and Hall 3 (C2 pin 11)

Ensure that each of these tests are performed which indicate the proper phase relationship as mentioned above.

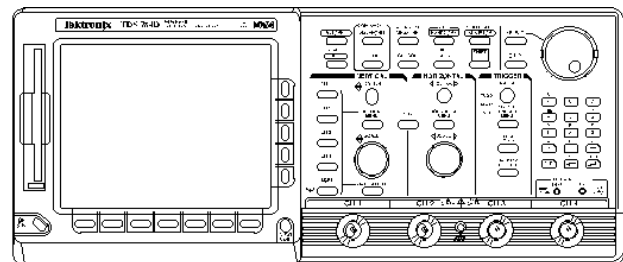
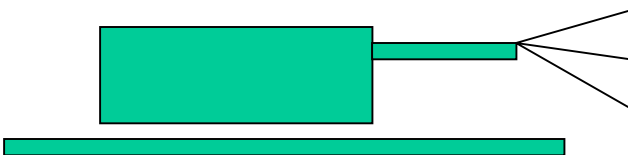
Procedure 3: Encoder phasing, Channel A to Channel B

Encoder phasing

Step 1: Connection of the encoder CHA and CH B signals

Connect the oscilloscope CH 1 probe to Encoder Channel A (C2- pin 1) with the ground connected to GND (C2 pin 7).

Connect the oscilloscope CH 2 probe to Encoder Channel B (C2- pin 4) with the ground connected to GND (C2 pin 7)



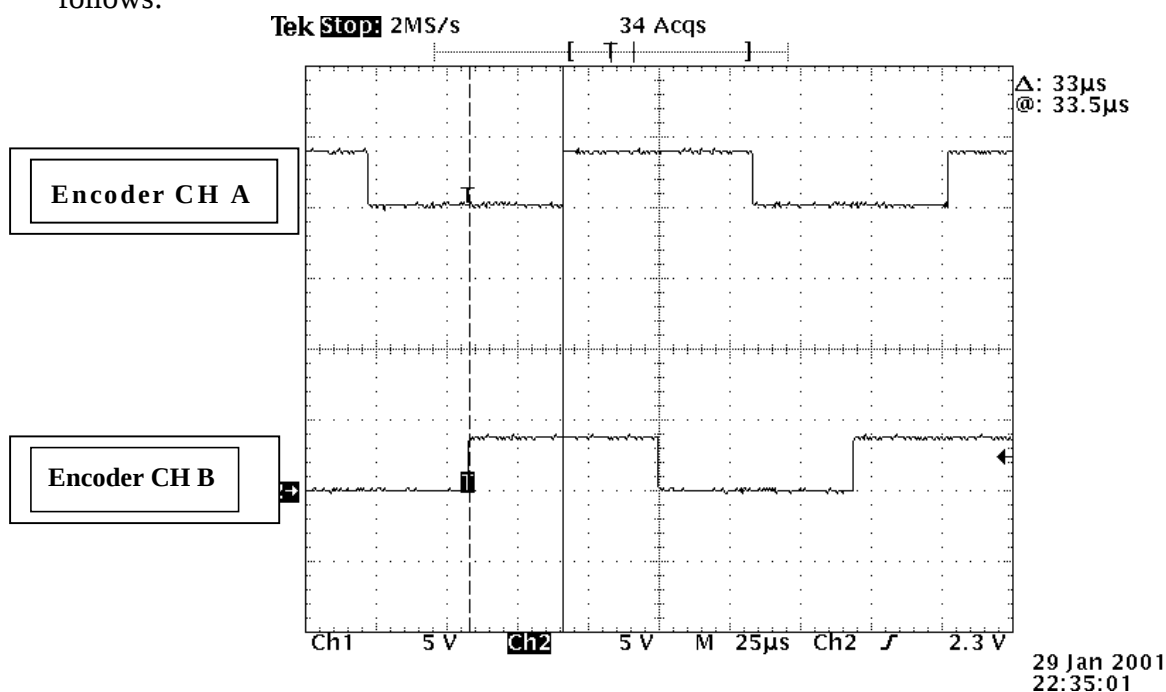
Set the scope to the following settings:

Input	CH 1	CH 2
Scale	5 Volts/div	5 Volts/div
Ground position	+ 2 divisions	- 2 divisions
Coupling	DC	DC
Invert	OFF	OFF

Scale 25 μ sec/div

Mode	Normal
Source	CH2
Trigger Level	+1.0 Volt
Coupling	DC
Slope	Positive

Push the motor in the direction of the cable leads as shown in figure 1. The scope display will be as follows:



Note that Encoder **Channel B** (scope probe CH 2, bottom display) **LEADS** Encoder **Channel A** (CH 1 scope probe, upper display) by 90°. This also causes the position feedback counter on the Servo Star Motion Link to count DOWN.