



USERS' MANUAL
FOR
Linear Encoder Options LCA, LCB, LCC,
LCD and LCE
AVAILABLE WITH
MOOG ADVANCED-HIGH FORCE LINEAR MOTORS

UM-103 Revision B
Date: 03/17/09

Linear Encoder Option designed by Motor Option Numbers

LCA, LCB, LCC, LCD and LCE

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1. Safety:

Moog motors are capable of producing high forces and velocities. Always follow appropriate safety precautions when installing and applying these motors. Equipment should be designed and utilized to prevent personnel from coming in contact with moving parts that could potentially cause injury.

Read the Moog Linear Motor User's Manual which applies to the motor you are using before attempting to operate this device.

Read all cautions, warnings and notes before attempting to operate this device.

Follow all applicable codes and standards.

2. Warnings, Cautions and Notes:

The following conventions are used on the equipment and found in this manual. Please read all equipment labels and manuals before attempting to use Moog Linear Motors.



WARNING: Identifies information about practices or circumstances that can lead to personal injury, property damage, or loss of life if not correctly followed.

A WARNING identifies information that is critical for identifying and avoiding a hazard that could lead to serious personnel injury or equipment damage.



CAUTION: Identifies information about practices or circumstances that can lead to severe equipment damage.

A CAUTION identifies information that is critical to prevent permanent equipment damage.

NOTE: Identifies information that is critical for successful application and understanding of the product.

A NOTE identifies information that is critical for successful application and understanding of the product.

Follow all warnings and cautions listed in this manual and in the applicable Moog Linear Motor User's Manual when working with Moog Components Group High Force Linear Motors.



WARNING: Do not remove the Linear Position Sensor Cover plates or otherwise disassemble the Linear Position Sensor. Hands, fingers or clothing may be pinched or caught in the moving parts.



WARNING: Do not step onto or apply lateral Loads to the Linear Position Sensor Housing.



CAUTION: The Moog Linear Motor Bearing System is not designed to support large lateral loads. Lateral loading of the shaft during movement will limit bearing life and cause Linear Position Sensor misalignment leading to loss of position control and phasing.



CAUTION: The Moog Linear Position Sensor is not designed to accommodate shaft rotation. An external torque applied to the shaft will cause Linear Position Sensor misalignment leading to loss of position control and phasing.



CAUTION: The Moog Linear Position Sensor contains electronic circuitry that can be damaged by misapplication of electrical power, or by applying electrical power of the wrong voltage or polarity. To avoid damaging the Linear Position Sensor, always use the correct Moog – approved cable intended for the Drive in use. Ensure correct sensor power supply voltage and that all custom sensor cables are properly wired before applying power.



CAUTION: The Linear Encoder Option is not designed to be removed, aligned, adjusted, disassembled or installed by the user.



CAUTION: When pigtail Linear Position Sensor cables are used (EC series) do not leave stripped wire ends unprotected. Shorting of the wire ends will damage the Encoder.



CAUTION: Electrical Phasing of the Linear Position Sensor Commutation Track is set by the factory and normally should not require adjustment. Loosening of the magnet track screws will allow the magnet track to misalign, resulting in loss of commutation. Excessive loosening of the magnet track screws will allow the magnet track to fall toward and strike the Linear Motor shaft necessitating repair by Moog.



CAUTION: The Moog Linear Position Sensor is not designed to accommodate shock loads greater than 100 G. Ensure that the shaft does not slam into either end stop. Slamming may result in encoder misalignment and / or damage to the Encoder.

3. Scope:

This manual provides information for the installation of Linear Encoder Options LCA, LCB, LCC, LCD and LCE which are available with the Moog 4020/5020 Linear Motors. For all other aspects of Linear Motor installation, please refer to the appropriate user's manual.

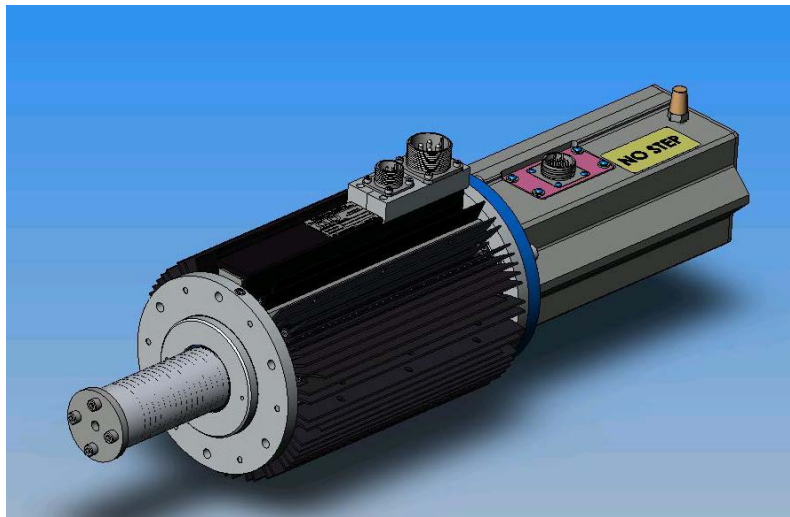


Fig 3-1
Linear Encoder Option on a 50204C Motor.

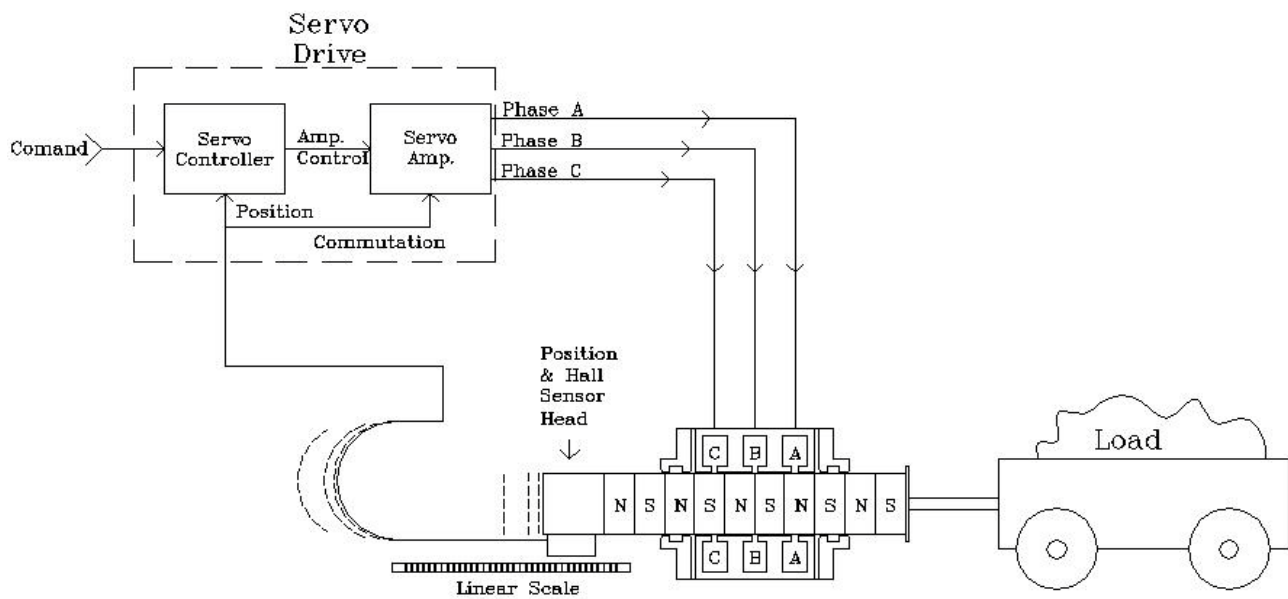
4. Introduction:

The Linear Encoder Option is provided as a mechanically integral part of the Linear Motor. Depending upon the motor drive system and the Linear Encoder option specified, it provides the required Position Feedback, Commutation data, Reference Mark, Limit switch and Encoder Fault alarm functions.



CAUTION: The Linear Encoder Option is not designed to be removed, aligned, adjusted, disassembled or installed by the user.

Typical Servo System with Moog Motor:



Moog Motor with Linear Scale Option LCX

Fig 4-1

Options LCX provide Integral Motor Position Sensing as part of the Linear Motor System.

4.1. Installation Sequence:

Use the following sequence when installing a Moog linear motor the Linear Sensor Option. Those steps in **bold** apply specifically to this Linear Encoder Installation manual.

1. Read the applicable motor installation manual and observe all warnings, cautions, and notes in Sections 1 and 2 of that manual.
2. **Read additionally and observe this manual's warnings, cautions, and notes (Sections 1 and 2 of this manual).**
3. Properly mount the motor (Section 5 of the Motor Installation Manual).
4. **Ensure that no lateral loads or torques are applied to the motor shaft which will impair encoder operation (Section 6 of this manual).**
5. Configure Encoder position signals and Commutation signals to indicate positive motion consistent with positive Drive effort and positive shaft movement (Section 7 of the Motor Installation Manual).
6. **Make the Encoder cable connections (Section 7 of this manual)**
7. Interconnect the motor to the control system (Section 6 of the Motor Installation Manual).
8. Ensure good electrical shielding and grounding throughout the system (Section 6.5 of the Motor Installation Manual).
9. Initialize the motor with the control system, limits and controller / Drive sensing and commutation parameters for the Encoder option used) (Section 7 of the Motor Installation manual).
10. Attach the load in a manner that does not induce or cause binding when the motor is stationary or moving (Section 5.3 of the Motor Installation Manual).
11. Tune the system for desired performance and accuracy (Section 7.4 of the Motor Installation Manual).

5. Information for Drive or Controller Setup:

The motor part number specifies the Linear Encoder Option:

CLD4020D06-**LCX**-T-CV

LCX is either LCA, LCB, LCC, LCD or LCE. Linear Encoder options A through E provide different resolutions, signal types, and compatibility. The Interface Control Drawing for the Linear Encoder option contains the relevant specifications.

Option	Scale	Resolution	Feedback Type
LCA	5 micron	5080 cts/inch	Quadrature Incremental
LCB	1 micron	25400 cts/inch	Quadrature Incremental
LCC	0.5 micron	50800 cts/inch	Quadrature Incremental
LCD	0.1 micron	254000 cts/inch	Quadrature Incremental
LCE	20 micron	See Note 1	Sin/Cos

Table 5-1. Summary of Linear Encoder Options

Note 1: Resolution of the Sin/Cos encoder depends on the level of interpolation provided by the encoder interface of your control system.

Note that all options provide 120 degree, Positive Hall format Commutation Signals per NEMA ICS 16.

6. Mechanical Mounting Notes:

6.1. Encoder Alignment:

The Linear Encoder Option provides Position Feedback, Commutation data, Indexing and Home switch functions required to control the Motor.

With the encoder option, encoder and Hall device “heads” are mounted together on one end of the motor shaft. The heads move with the shaft and read positional and commutation data from separate, stationary tracks mounted to the encoder rail.

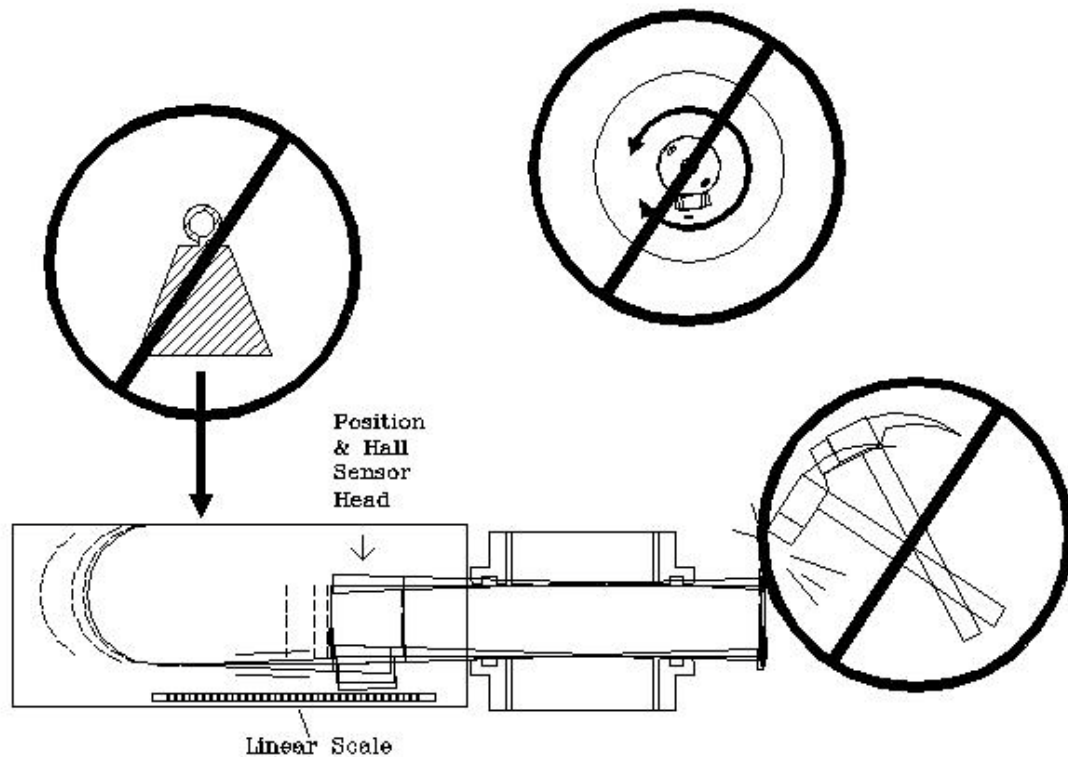


Fig 6-1

Side loads and Torques may impair encoder alignment.

Linear bearings within the encoder rail physically align the heads and shaft with the stationary tracks. These bearings also prevent shaft rotation. Do not allow loads to apply torque or lateral loads to the shaft during installation or use. Do not apply lateral loads to the Encoder Rail housing. Excessive Torque or Lateral Loads will cause binding or reduce the life of the bearings within the encoder rail and result in misalignment of the encoder.

Encoder heads are aligned at the factory before shipping and should not be adjusted by the user.

6.2. Dual-Face Mounting:

Dual-Face Mounting can only be utilized without an integral Moog position sensor. For information on Dual-Face Mounting please refer to the appropriate Moog user's manual.

6.3. End-Stops:

Two End Stops are provided on the Moog Motor. The internal End Stop is not to be removed by the user.

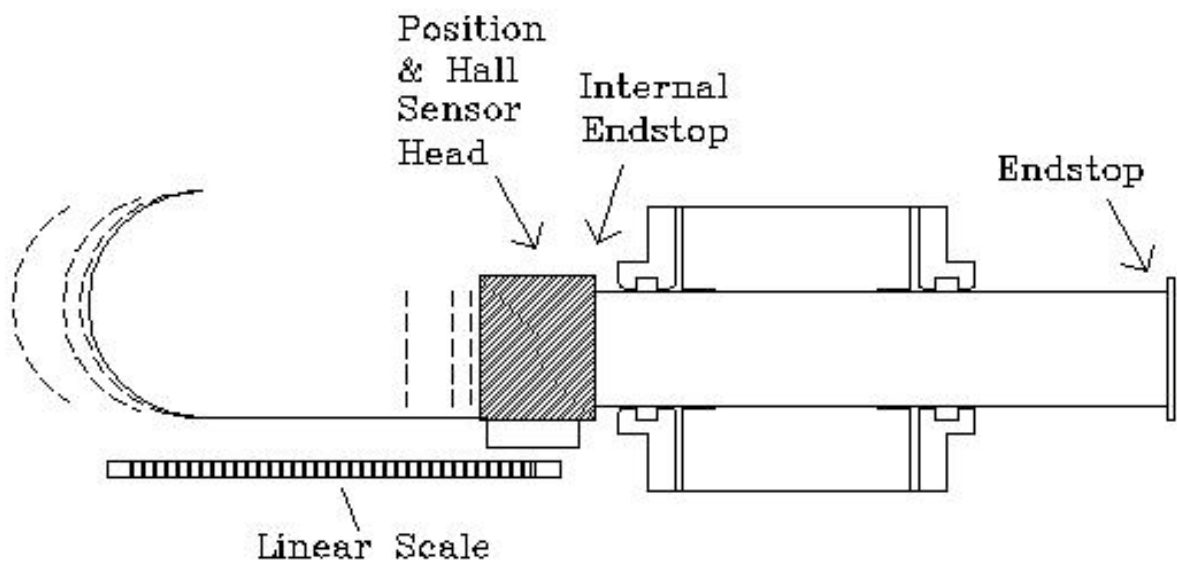


Fig 6-2

LCX Option provides an internal End Stop.

6.4. Notes:



WARNING: Standard End-Stops shipped with Moog motors are not designed for large loads. Thicker End Stops with threaded mounting holes are available if needed.



WARNING: Do not remove the Linear Position Sensor Cover plates or otherwise disassemble the Linear Position Sensor. Do not operate the Moog Linear Motor with Linear Position Sensor option when the Linear Position Sensor cover plates are removed. Hands, fingers or clothing may be pinched or caught in the moving parts.



WARNING: Do not **step** onto or apply lateral Loads onto the Linear Position Sensor Housing.



CAUTION: The Moog Linear Position Sensor is not designed to accommodate shaft rotation. An external torque applied to the shaft will cause Linear Position Sensor misalignment leading to loss of position control and phasing.



CAUTION: The Moog Linear Position Sensor is not designed to accommodate shock loads greater than 100 G. Ensure that the shaft does not slam into either end stop. Repeated slamming will result in encoder misalignment or malfunction.



CAUTION: The FSC-LC-XX cable is terminated on the Drive End with colored insulated wire leads. These leads are supplied with unstripped ends. Don't strip any ends that you will not be using. This may result in short circuits, or other misconnections which will damage the Linear Encoder circuitry.

7. Encoder Cable Connections:

Encoder cables are available from Moog in standard configurations compatible with major Drive manufacturers. A pigtail version is also available which allows custom wiring to suit other Drives.

If you are using one of the Drives for which a standard cable is available, plug the Circular connector end of the cable into the Encoder connector on the Motor and the other end into the Drive. The position and commutation connections should at this point be properly wired.

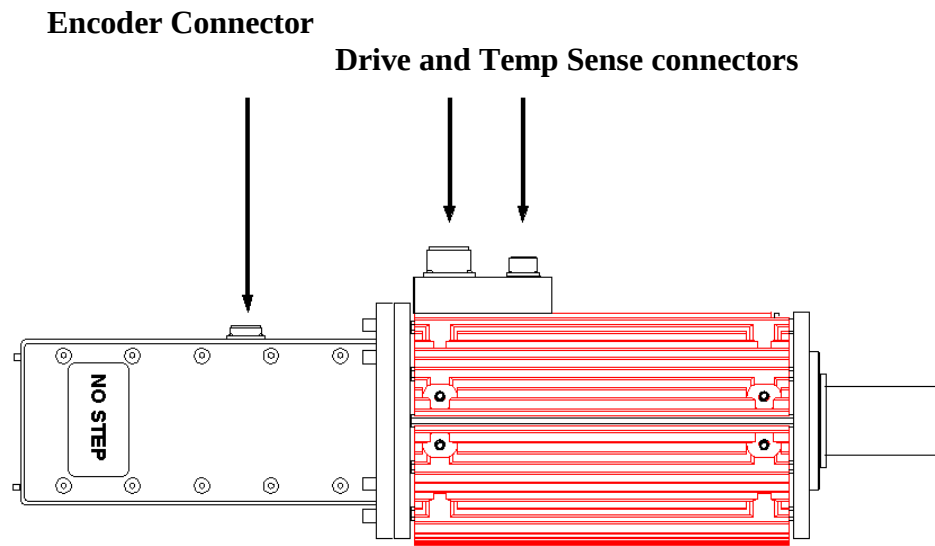
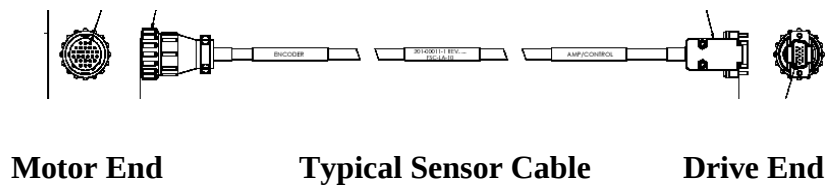


Figure 7-1

Modular Cables connect the Drive / Amplifier with the Linear Motor.

7.1. Selecting the Linear Encoder Modular Cables:

Modular Cables. Wiring can be greatly simplified if a Drive or Amplifier is used for which a Moog standard cable already exists. See Moog product literature to select a cable on the basis of Drive model and required cable length.

7.2. Wiring the Linear Encoder to the Drive with the Pigtail Cable:

If you cannot use a modular cable, connect the drive using the following “pigtail” cable:

FSC-EC-XX

where XX = 02, 10 or 25, corresponds to cable length in feet.

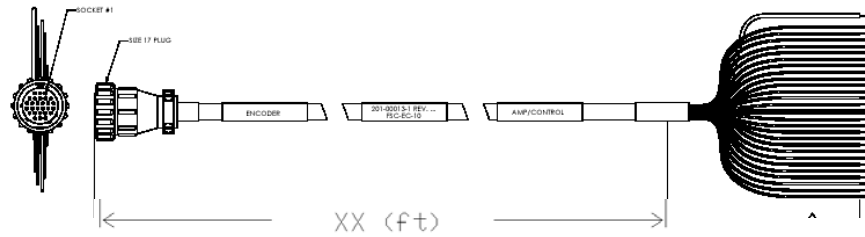


Figure 7-2

Pigtail Cable provides termination to most compatible Drives.

7.2.1. Pigtail Lead Terminations:



CAUTION: The FSC-EC-XX cable is terminated on the Drive End with colored insulated wire leads. These leads are supplied with stripped ends. Trim or insulate any ends that you will not be using. Failure to do so may result in short circuits, or other misconnections which will damage the Linear Encoder circuitry.

The FSC-LC-XX cable is a 30 Conductor cable per AWM 2464. The Drive End is terminated in colored leads of 24 Gauge. When stripped, these can be terminated to Terminal Blocks, pins or sockets as required by the Drive connectors.

7.2.2. Pigtail cable signal descriptions:

In addition to sensor power, five general types of signals are accessed by the Linear Encoder connector: Position, Hall, Fault / Signal Quality, Reference Mark and Index. Additional, auxiliary pins are reserved for future use.

Identify and wire the Encoder Power and signals for Position, Commutation, Encoder Fault, Reference Mark and Index functions per Figure 7-4 and the following signal descriptions.

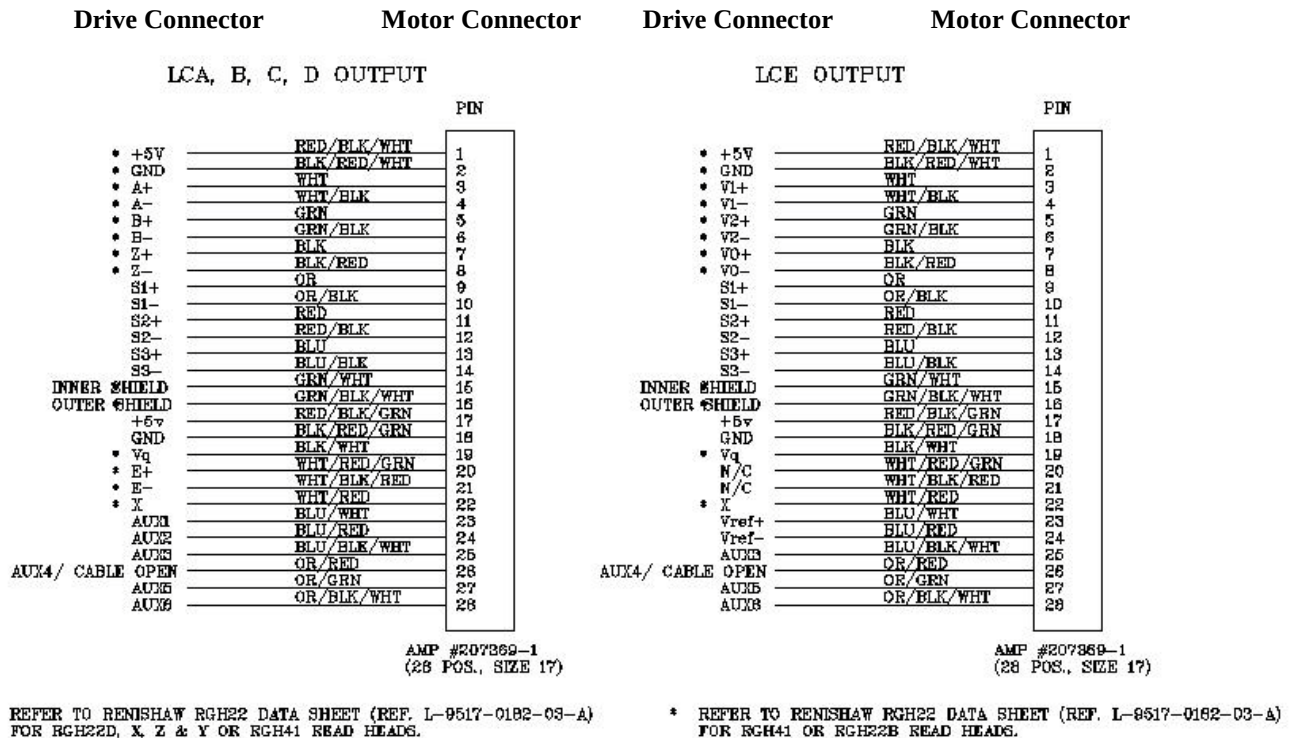


Figure 7-3

Pinouts and Wire Colors for the FSC-EC-XX Cable / LCX Encoder option.

7.2.2.1. Encoder and Hall Sensor Power:

The Position Sensor requires DC Power at 5.0 V +/- 5% at the Encoder Cable leads providing at least 100 mA DC. The Encoder power supply is applied to +5V and GND at pins 1 and 2 respectively.

The Hall sensor head is powered separately from the Encoder and requires DC Power at 5.0 V +/- 5% at the Encoder Cable leads, providing at least 20 mA DC. The Hall sensor power supply is applied to +5V and GND at pins 17 and 18 respectively.

If both Hall sensor and Encoder are used, connect both grounds and +5V pins.

7.2.2.2. Digital Quadrature Incremental Signals A and B:

Encoder options LCA, LCB, LCC and LCD provide Differential Mode Digital Quadrature Incremental Encoder data lines A+, A-, B+ and B-. These 0 to 5V (TTL level) signals connect to both single ended and Differential mode “A quad B” inputs and are electrically compatible with the industry standard RS-422 transmission protocol using the 26LS31 Buffer IC per Figure 7-4.

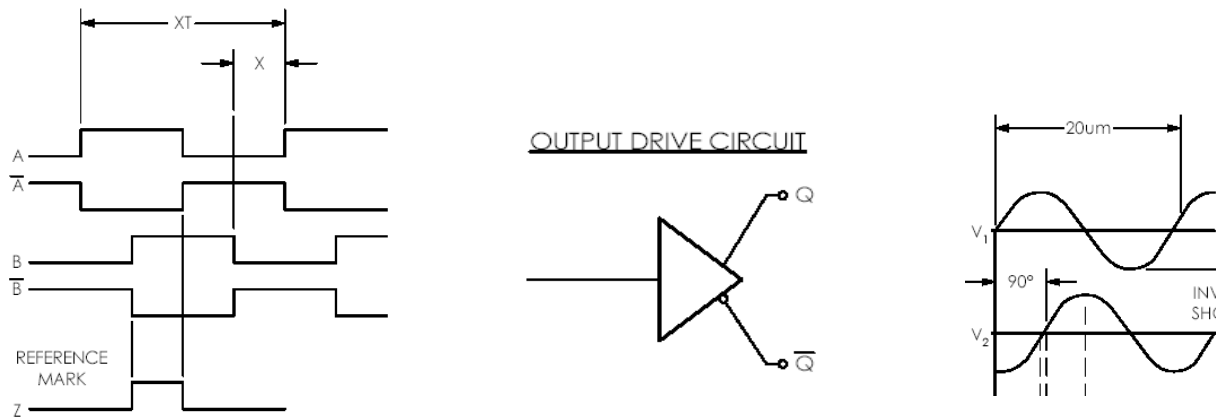


Figure 7-4

Digital Quadrature and Analog Quadrature (Sin/Cos) signals.

7.2.2.3. Sin/Cos signals using Option LCE:

Encoder option LCE provides Differential Mode Quadrature Sin/Cos Incremental Encoder data lines V1+, V1-, V2+ and V2-. These 0.3 – 1.2Vpp signals connect to both single ended and industry standard Differential mode “Sin/Cos” inputs per Figure 7-4.

7.2.2.4. Encoder Misalignment Fault Alarm E:

Encoder options LCA, LCB, LCC and LCD provide a HIGH state on TTL level Differential alarm outputs E when the optical encoder signal falls below 45% nominal range.

7.2.2.5. Signal Quality / Alignment signal X:

Signal Quality pin X is provided only for encoder setup and alignment, and is not generally required by the Motor User. See the Installation manual for the Renishaw series RGH Encoder Heads for more information.

7.2.2.6. Reference Mark (Z, Vo) and Limit Switch (Vq) signals:

A Differential Mode TTL Level (0-5V) voltage signal, active “HIGH” provides an accurate absolute position reference to designate the rated Mid stroke shaft position. (The Reference Mark is designated “Z” in options LCA, LCB, LCC and LCD and “Vo” in option LCE).

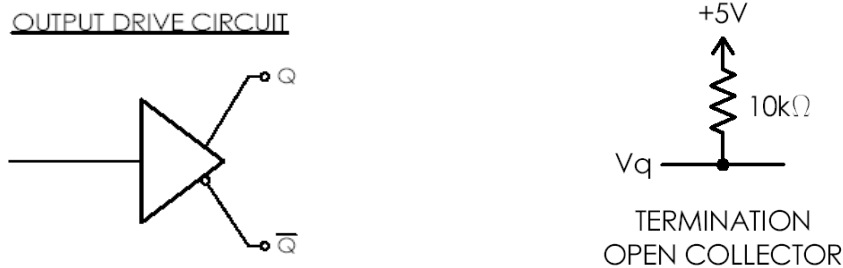


Figure 7-5

Electrical ports for Reference Mark and Limit Switch signals

A Limit Switch signal Vq is pulled low by a single ended Open Collector TTL Level (0 to 5V) signal when the shaft is within 0.25 inches (10 mm) of either End – of – Rated Stroke shaft position as shown in Figure 7-6.

SEE TABLE - 1

TABLE - 1				
STROKE LENGTH	DIM. "A"	DIM. "B"	DIM. "C"	DIM. "D"
2.0	6.6	2.33	1.00	1.75
4.0	8.6	3.48	2.00	3.75
6.0	10.6	4.40	3.00	5.75
8.0	12.6	5.33	4.00	7.75
10.0	14.6	6.25	5.00	9.75
12.0	16.6	7.18	6.00	11.75

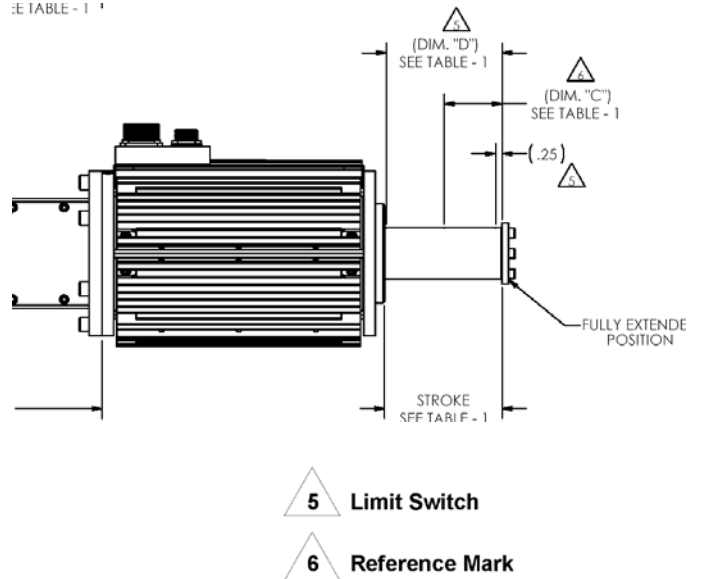


Figure 7-6

Reference Mark Limit Switch Location.

The Reference Mark is Synchronous with both Digital and Analog Quadrature signal phase.

Repeatability of the Reference mark is limited in Digital and Analog sensors by one quadrature Line Count or by $+0 / -18$ degrees of Sin/Cos signal phase respectively.

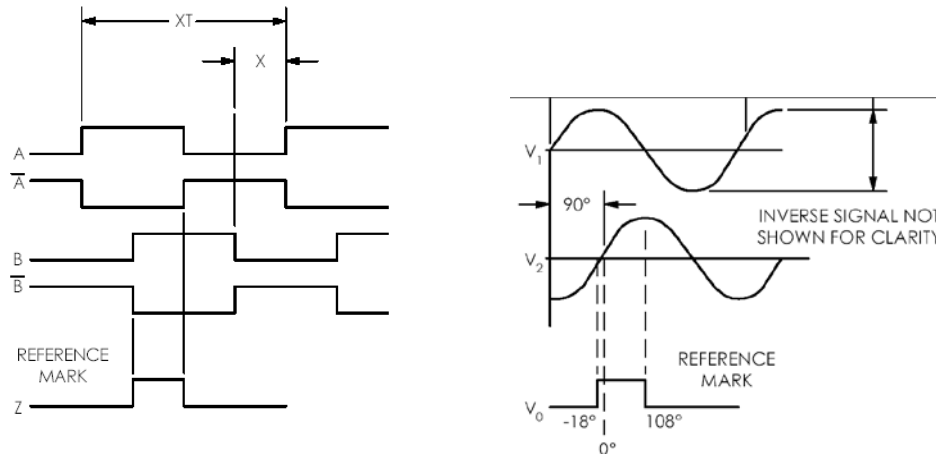


Figure 7-7

Reference Mark Signal is synchronous with Quadrature Encoder Signals.

The Limit Switch signal V_q is asynchronous with respect to the Quadrature Encoder signal phase. Repeatability of the Limit Switch positions is $+0 / -0.1$ mm (.004 inches).

7.2.2.7. Commutation (Hall Sensor) Connections:

0 to 5V (TTL level) Differential mode Hall sensor signals are electrically compatible with the industry standard RS-422 transmission protocol using the 26LS31 Buffer IC. These signals are compatible with Drive Hall sensor inputs equipped with or without pull up resistors.

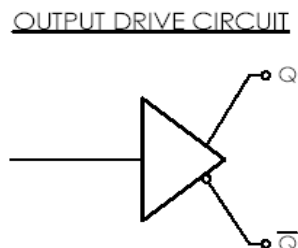


Figure 7-8

Hall Sensor Outputs.

7.2.2.8. Inner and Outer Shields:

Inner and Outer shields mitigate the effects of electrical noise on the encoder signal. In typical installations the inner shield is connected to encoder and / or Hall input signal Ground, and the outer shield to the Drive / Controller chassis.

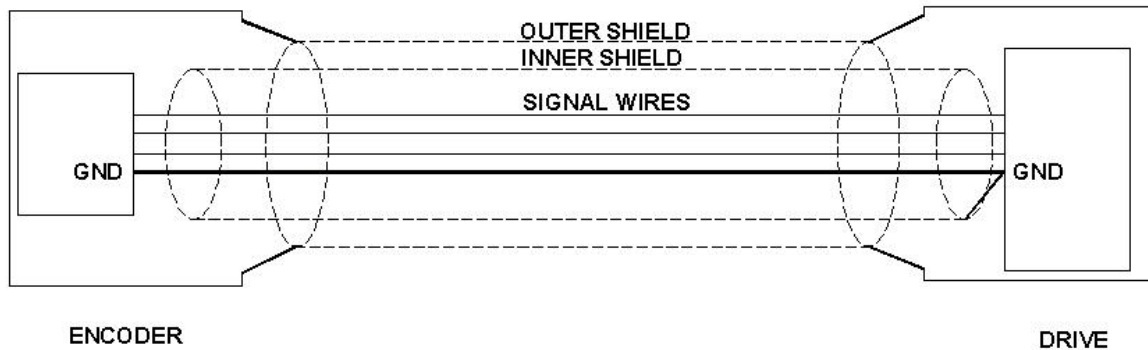


Figure 7-9

Inner and Outer Shield connections.

Grounding and Shielding of the Drive cables are also important for safety and for proper sensor electrical noise immunity. For more detail in system Grounding and Shielding, please see the Moog Linear Motor User's Manual.



CAUTION: Poor ground or shield connections or wiring can cause unpredictable motion, and could damage the motor, control system or machine.

7.2.2.9. Voltage Sense wires Vref+ and Vref-:

In Option LCE, Vref+ and Vref- provide remote voltage sensing for regulation of the Encoder Power Supply to compensate for Encoder Power Supply voltage drop in long encoder cables. If remote sensing is not provided in the Drive, Vref+ and Vref- can be used as additional (paralleled) encoder power conductors by connecting Vref- and Vref+ to Ground and +5V respectively..

Appendix-A: (Revision History)

<i>ECO #</i>	<i>Revision</i>	<i>Change</i>	<i>Date</i>
0112	A	Initial Release	April 1, 2003
	B	Moog Update	March 17, 2009