Manual No. 100-5314-01
Rev. 2

Parker

406LXR Series Product Manual

Effective: August 12, 2004
Supersedes:

Electromechanical Positioning Systems

Parker
Automation

Important User Information

WARNING

FAILURE OR IMPROPER SELECTION OR IMPROPER USE OF THE PRODUCTS AND/OR SYSTEMS DESCRIBED HEREIN OR RELATED ITEMS CAN CAUSE DEATH, PERSONAL INJURY AND PROPERTY DAMAGE.

This document and other information from Parker Hannifin Corporation, its subsidiaries, and authorized distributors provide product and/or systems options for further investigation by users having technical expertise. It is important that you analyze all aspects of your application and review the information concerning the product or system in the current product catalog. Due to the variety of operating conditions and applications for these product systems, the user, through its own analysis and testing, is solely responsible for making the final selection of the products and systems and assuming that all performance, safety, and warning requirements of the application are met.

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Since Parker Hannifin Corporation, Electromechanical Automation-Parker constantly strives to improve all of its products, we reserve the right to change this product manual and equipment mentioned therein at any time without notice.

For assistance contact:
Parker Hannifin Corporation
Electromechanical Automation-Daedal
1140 Sandy Hill Road
Irwin, PA 15642
Phone: 724/861-8200
800/245-6903
Fax: 724/861-3330
E-mail: ddlcat@parker.com
Web site: www.daedalpositioning.com

Table of Contents

Revision Notes

Revision 1

- Original Document

Revision 2

- Updated entire manual for Second Generation LXR product. Significant changes to the maintenance section.

CHAPTER ONE

Introduction

IN THIS CHAPTER

Product Description

406LXR Positioner

The 406LXR is a slotless, brushless linear servo motor positioner with square rail bearings housed within a high strength, extruded aluminum body with magnetically retained protective seals. The positioner is powered by a single row of high energy rare earth magnets. Advanced structural design provides high load and moment capacity, dynamic stiffness and precise straightness and flatness of travel, while minimizing total system weight. The positioner's integral linear encoder provides high precision, non-contact positional feedback with selectable resolutions from 0.1 to 5.0 microns. The positioner is also offered with hall effect limit & home sensors, and a "Quick Connect", extended life, cable transport system.

Unpacking

Unpacking

Carefully remove the positioner from the shipping container and inspect the unit for any evidence of shipping damage. Report any damage immediately to your local authorized distributor. Please save the shipping container for damage inspection or future transportation.

Incorrect handling of the positioner may adversely affect the performance of the unit in its application. Please observe the following guidelines for handling and mounting of your new positioner.

DO NOT allow the positioner to drop onto the mounting surface. Dropping the positioner can generate impact loads that may result in flat spots on bearing surfaces or misalignment of drive components.

DO NOT drill holes into the positioner. Drilling holes into the positioner can generate particles and machining forces that may effect the operation of the positioner. Parker will drill holes if necessary; contact your local authorized distributor.

DO NOT subject the unit to impact loads such as hammering, riveting, etc. Impacts loads generated by hammering or riveting may result in flat spots on bearing surfaces or misalignment of drive components.

DO NOT lift the positioner by cables or cable management system. Lifting positioner by cables or cable management system may effect electrical connections and/or cable management assembly. The unit should be lifted by the base structure only.

DO NOT push on magnetically retained strip seals when removing positioner from shipping crate. Damaging strip seals may create additional friction during travel and may jeopardize the ability of the strip seals to protect the interior of the positioner.

DO NOT submerge positioner in liquids or expose to large amount of liquid spray.

DO NOT disassemble positioner. Unauthorized adjustments may alter the positioner's specifications and void the product warranty.

Return Information

Returns

All returns must reference a "*R*eturn *M*aterial *A*uthorization" *(RMA)* number. Please call your local authorized distributor or Parker Customer Service Department at 800-245-6903 to obtain a "RMA" number.

Repair Information

Out-of-Warranty Repair

Our Customer Service Department repairs Out-of-Warranty products. All returns must reference a "RMA" number. Please call your local authorized distributor or Parker Customer Service Department at 800-245-6903 to obtain a "RMA" number. You will be notified of any cost prior to making the repair.

Warnings and Precautions

Hot Surfaces

DO NOT touch the 'carriage forcer', (see page 5, *Assembly Diagram*, for component location), after high duty cycle operation. Unit *may* be too HOT to handle.

Electrical Shock

DO NOT take apart or touch any internal components of the positioner while unit is plugged into an electrical outlet. SHUT OFF power before replacing components to avoid electrical shock.

High Magnetic Field

Unit may be HAZARDOUS to people with Pace Makers or any other 'magnetically-sensitive' medical devices. Unit may have an effect on 'magnetically-sensitive' applications.

Ferrous Materials

The positioner's 'protective seals' MAY NOT keep out all small ferrous materials in applications with air born metallic particles. The customer must take additional precautions in these applications to prevent intrusion of these ferrous particles.

Vertical Operation

The 406LXR is NOT recommended for vertical operation. If the table is used in a vertical position, the carriage and customer's load will fall in power loss situations potentially causing product or load damage or personal injury.

General Safety

Because linear motors can accelerate up to 5 g's, and sometimes positioners move without warning, keep all personnel away from dynamic travel range of positioner.

Specification Conditions

Specifications Are Temperature Dependent

Catalog specifications are obtained and measured at 20 Degrees C. Specifications at any other temperature may deviate from catalog specifications. Minimum to maximum continuous operating temperature range (with NO guarantee of any specification except motion) of a standard unit before failure is 5 - 40 degrees C.

Specifications Are Mounting Surface Dependent

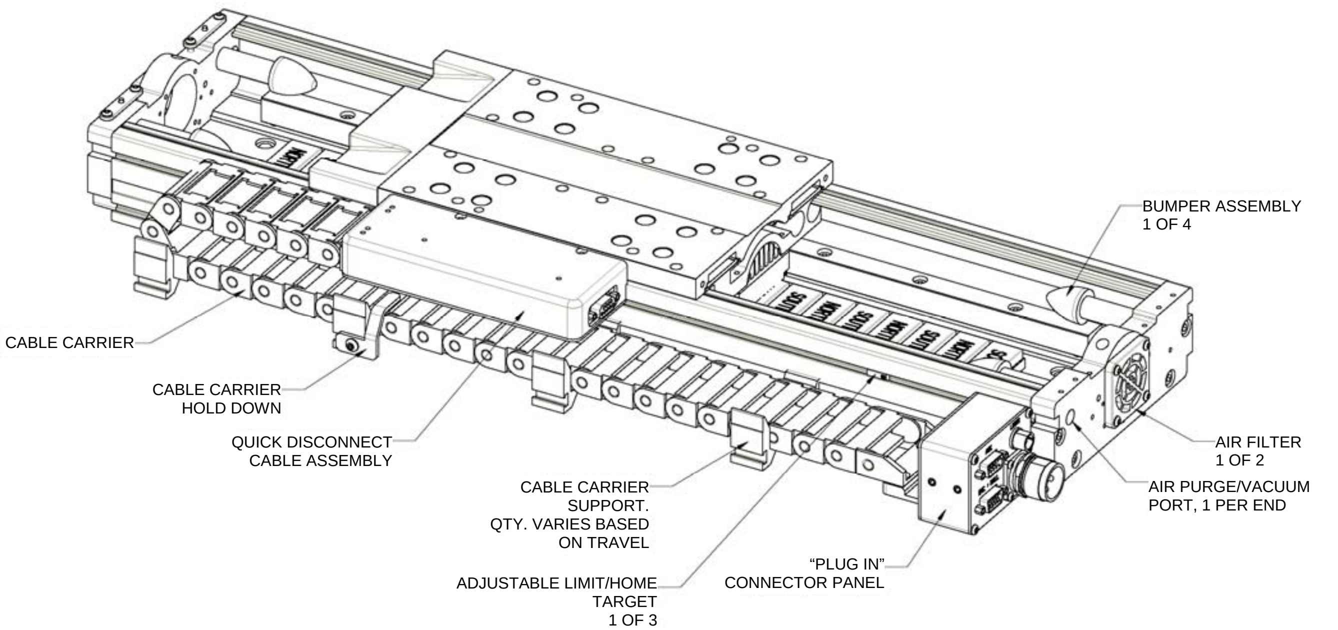
Catalog specifications are obtained and measured when the positioner is fully supported, bolted down, and mounted to a work surface that has a maximum flatness error of:
0.013mm/300mm (0.0005"/ft).

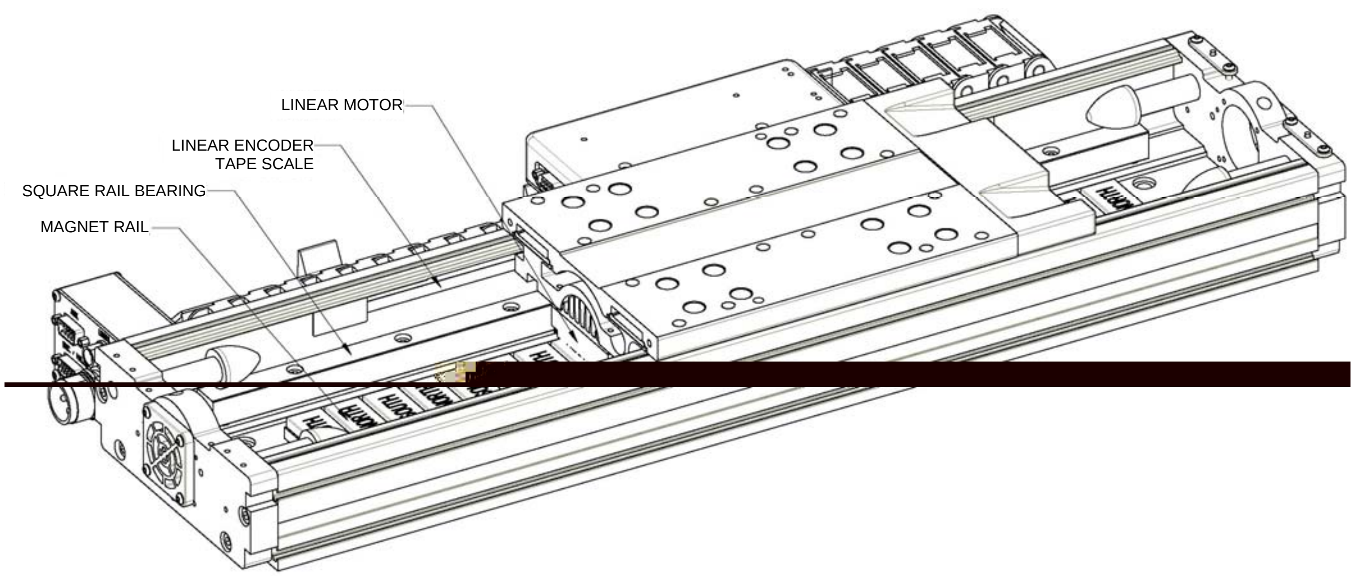
Specifications Are Point of Measurement Dependent

Catalog specifications and specifications in this manual are measured from the center of the carriage, 50 mm above the carriage surface. All measurements taken at any other location may deviate from these values.

Assembly Diagrams

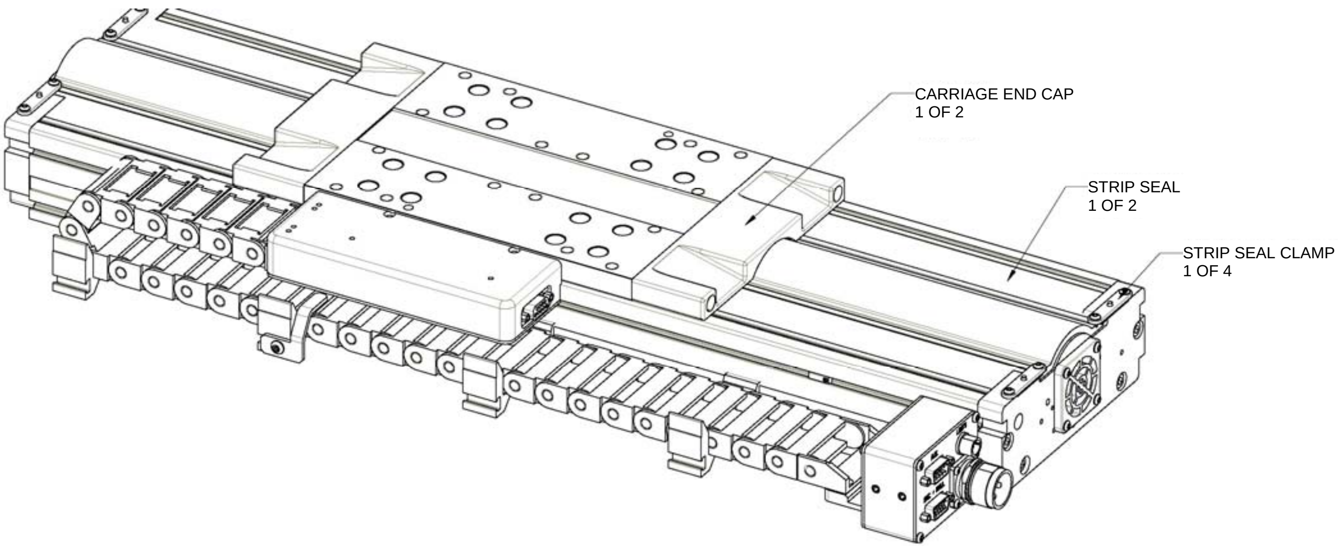
Components common to all motorized configurations.





Assembly Diagrams (continued)

Strip seal components



CHAPTER TWO

Table Specifications

IN THIS CHAPTER

Part Number Identification

406LXR - How to Order

Order Example: 406 T09 LXR M P D13 H2 L2 CM02 Z2 E2 R1 A4 P1

Series
Series 406

Travel (mm)

8 Pole Motor	12 Pole Motor	Code
50	n/a	T01
150	50	T02
250	150	T03
350	250	T04
450	350	T05
550	450	T06
650	550	T07
750	650	T08
850	750	T09
950	850	T10
1200	1100	T11
1450	1350	T12
1700	1600	T13
1950	1850	T14

Model
Model .... LXR

Mounting (metric)
Mounting (metric).......... M

Grade
Precision .... P

Drive Type
Free Travel (No Motor)
- 8 Pole Carriage (no mtr.) ... D3
- 12 Pole Carriage (no mtr.) ... D5

Linear Motor
- 8 Pole Motor Carriage D13
- 12 Pole Motor Carriage D15

Home Sensor
- None - Free Travel (only) ... H1
- N.C. Current Sinking H2
- N.O. Current Sinking H3
- N.C. Current Sourcing H4
- N.O. Current Sourcing H5

Limit Sensor
- None - Free Travel (only) ... L1
- N.C. Current Sinking L2
- N.O. Current Sinking L3
- N.C. Current Sourcing L4
- N.O. Current Sourcing L5

Pinning Option
- P1 No Multi-Axis Pinning
- P2 X-Axis Carriage - Dowel Pins (matched to Y-Axis Base)
- P3 Y-Axis Base - Dowel Pin Holes (matched to X-Axis Carriage)

Digital Drive
- A1 No Drive ..
- A4 Gemini Drive GV-U6E
- A5 Gemini Controller/Drive GV6-U6E
- A6 Gemini Controller/Drive GV6K-U6E
- A62 Aries Drive AR-04AE

Environmental
- R1 Strip Seal
- R2 Hard Cover w/ Class 10 Clean Room Prep

Encoder Option
- E1 None
- E2 1.0 µm Resolution
- E3 0.5 µm Resolution
- E4 0.1 µm Resolution
- E5 5.0 µm Resolution
- E7 Sine Output Encoder

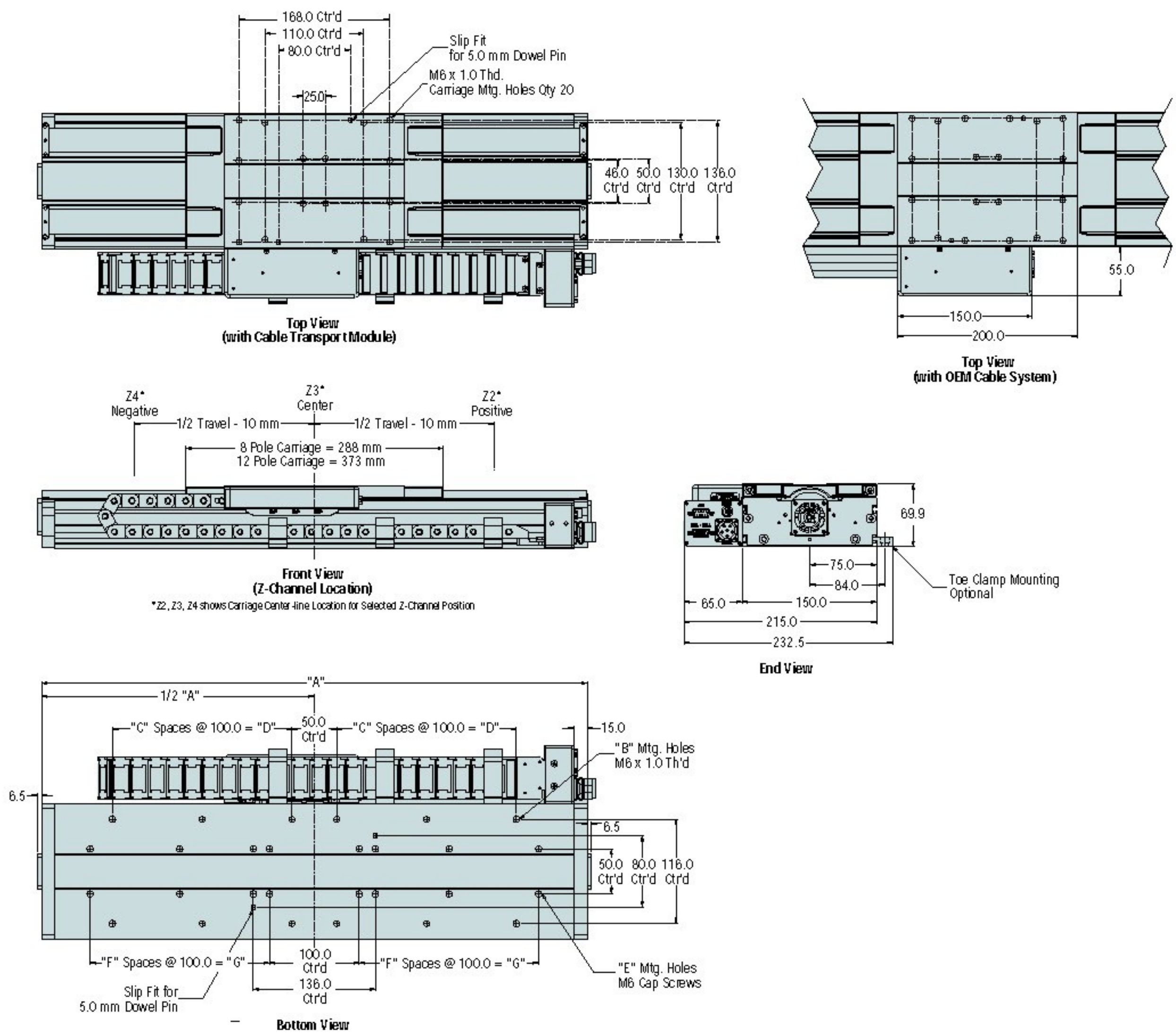
Z Channel Location*
- Z1 None
- Z2 Positive End Position
- Z3 Center Position
- Z4 Negative End Position

Cable Management
- CM01 No Cables - Free Travel
- CM02 Cable Transport Module (only)
- CM03 3.0 m OEM Cable Set-FL
- CM04 7.5 m OEM Cable Set-FL
- CM05 3.0 m OEM Cable Set-Gemini
- CM06 7.5 m OEM Cable Set-Gemini
- CM07 Cable Trans Mod. w/ 3.0 m-FL*
- CM08 Cable Trans Mod. w/ 7.5 m-FL*
- CM09 Cable Trans Mod. w/ 3.0 m-Gemini*
- CM10 Cable Trans Mod. w/ 7.5 m-Gemini*
- CM11 3.0 m OEM Cable Set-Aries
- CM12 7.5 m OEM Cable Set-Aries
- CM13 Cable Trans Mod. w/ 3.0 m-Aries*
- CM14 Cable Trans Mod. w/ 7.5 m-Aries*

*Extension Cable for pass through connection is available and can be ordered seperately.

406LXR Series Dimension (mm)

CAD Files...
Download from
daedalpositioning.com



Model	Travel (mm) 8 Pole	Travel (mm) 12 Pole	A	B	C	D	E	F	G
406T01LXR	50	N/A	408	8	1	100.0	12	1	100.0
406T02LXR	150	50	508	8	1	100.0	12	1	100.0
406T03LXR	250	150	608	12	2	200.0	16	2	200.0
406T04LXR	350	250	708	12	2	200.0	16	2	200.0
406T05LXR	450	350	808	16	3	300.0	20	3	300.0
406T06LXR	550	450	908	16	3	300.0	20	3	300.0
406T07LXR	650	550	1008	20	4	400.0	24	4	400.0
406T08LXR	750	650	1108	20	4	400.0	24	4	400.0
406T09LXR	850	750	1208	24	5	500.0	28	5	500.0
406T10LXR	950	850	1308	24	5	500.0	28	5	500.0
406T11LXR	1200	1100	1558	32	7	700.0	32	6	600.0
406T12LXR	1450	1350	1808	36	8	800.0	40	8	800.0
406T13LXR	1700	1600	2058	40	9	900.0	44	9	900.0
406T14LXR	1950	1850	2308	44	10	1000.0	48	10	1000.0

General Table Specifications

Travel Dependent Specifications

Travel, mm	Accuracy*, µm			Unit Weight, kg	
	Positional		Straightness & Flatness Accuracy*, µm	406LXR 8 Pole	406LXR 12 Pole
	0.1, 0.5, 1.0 resolution, µm	5.0 resolution, µm			
50	6	16	6	8.7	11.1 -
100	7	17	7	-	--
150	8	18	9	10.3	13.4
200	10	20	11	-	-
250	12	22	14	12.6	14.1
300	14	24	17	-	-
350	16	26	19	13.3	15.7
400	18	28	22	-	-
450	20	30	24	14.8	17.2
500	21	31	26	-	-
550	23	33	29	16.4	18.7
600	25	35	31	-	-
650	26	36	33	17.9	20.2
700	28	38	35	-	-
750	29	39	37	19.4	21.8
800	31	41	39	-	-
850	32	43	41	20.9	23.3
900	33	44	43	-	-
950	34	44	45	22.5	-
1000	35	45	47	-	27.1
1050	37	47	51	-	-
1200	39	49	55	26.3	-
1350	42	52	60	-	30.9
1450	43	53	63	30.1	-
1500	44	54	64	-	-
1600	45	55	68	-	34.7
1700	46	56	71	33.9	-
1750	46	56	75	-	-
1850	47	57	75	-	38.6
1950	48	58	78	37.7	-

*Accuracy stated is at 20°C, utilizing slope correction factor provided.

Specifications

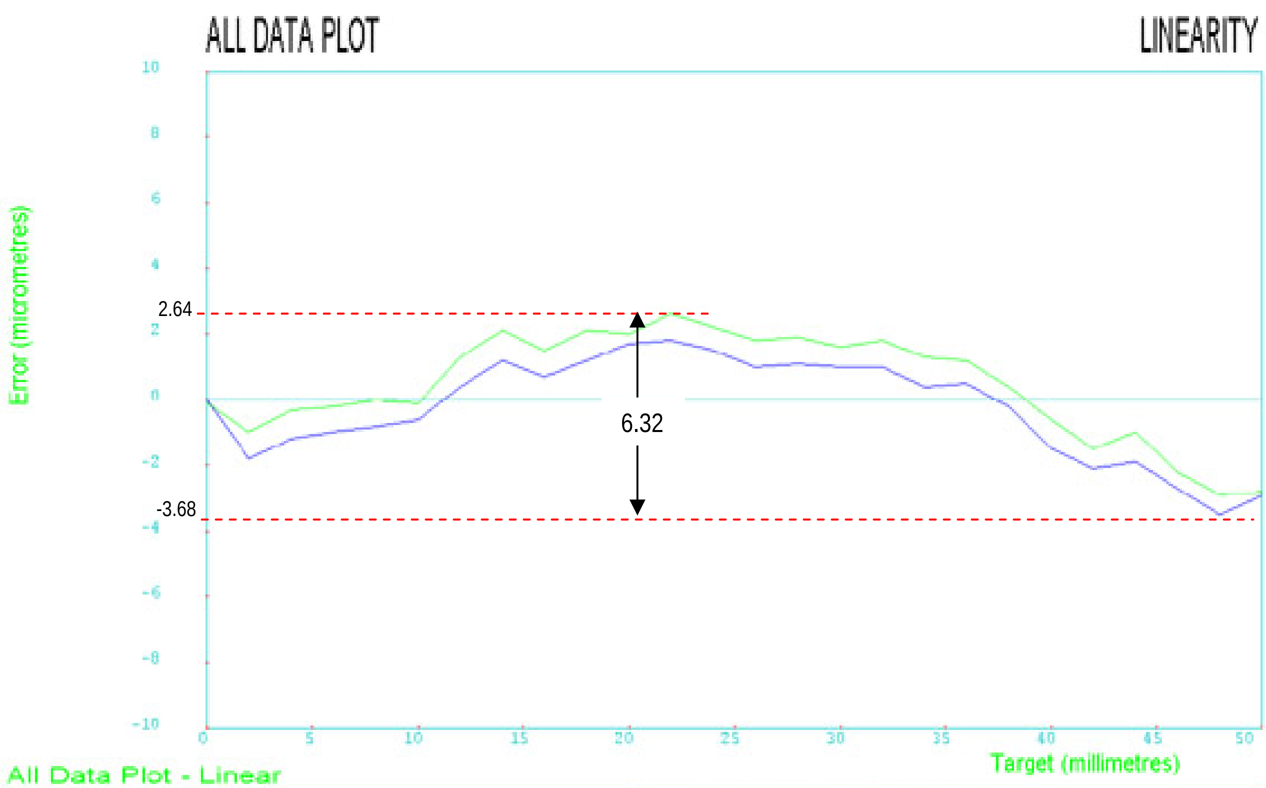
Model Motor	406LXR 8 Pole	406LXR 12 Pole
Rated Load kg	180	180
Maximum Acceleration	5 Gs	
Maximum Velocity m/s Encoder Resolution 0.1µm 0.5µm 1.0µm 5.0µm Sine Output	 0.3 1.5 3.0 3.0 3.0	
Positional Repeatability Encoder Resolution 0.1µm 0.5µm 1.0µm 5.0µm Sine Output	 ±1.0µm ±1.0µm ±2.0µm ±10.0µm (interpolation dependant)	
Maximum Peak Force N (lb)	225 (50)	330 (75)
Maximum Peak Force N (lb)	75 (17)	110 (25)
Carriage Weight kg	3.2	4.1

Test Methodology

Published accuracy and repeatability specifications are subject to the testing methodology. Parker's methodology provides specifications over the entire table travel regardless of start or finish position. The accuracy and repeatability specifications are based on the peak to peak error measured by a laser interferometer and prism located at 50mm above the center of the table. This type of measurement sums the X, Y, Z, roll, pitch, and yaw errors. Temperature deviations from test condition may cause deviations in straightness, flatness, accuracy, and repeatability from catalog specifications. Tests are performed with the table mounted to a granite table, unloaded at 20^{o} C.

Example:

The accuracy ranges from -3.68 microns to 2.64 microns. This table would have its accuracy specified as 6.32 micron since the worst case would be starting at one extreme and traveling to the other.

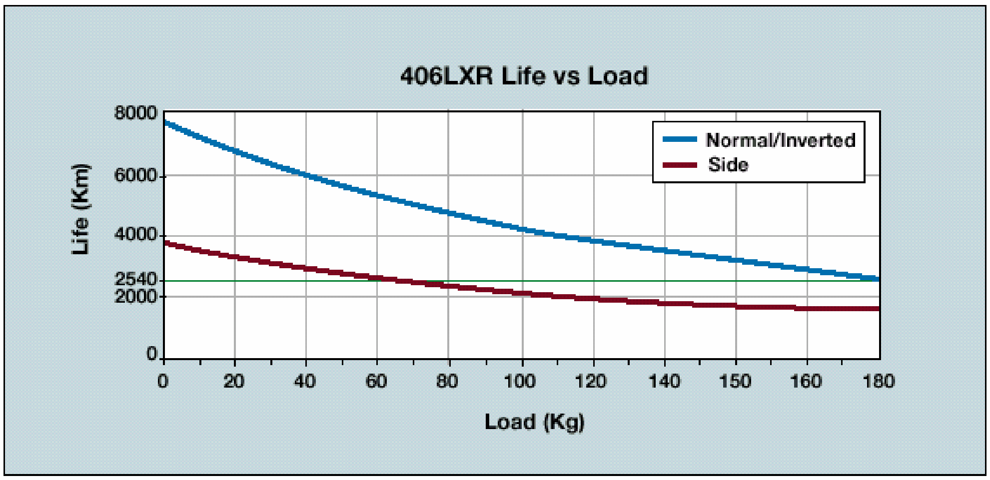


406LXR Series Technical Data

The useful life of a linear table at full catalog specifications is dependent on the forces acting upon it. These forces include both static components resulting from payload weight, and dynamic components due to acceleration/deceleration of the load. In multi-axes applications, the primary positioner at the bottom of the stack usually establishes the load limits for the combined axes. When determining load/life, it is critical to include the weight of all positioning elements that contribute to the load supported by the primary axis. The life/load charts are used to establish the table life relative to the applied loads.

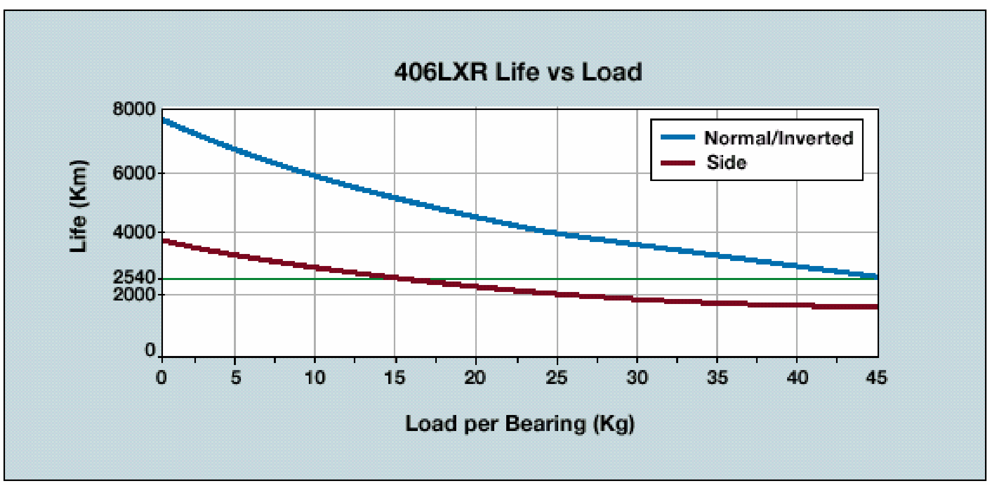
Table Load Chart

The "Table Load" chart is intended to provide a rough-cut evaluation "life/load" characteristics of the carriage support bearings. This curve is based on the applied load being centered on the carriage, normal to the carriage mounting surface.



Bearing Load Chart

The "Bearing Load" chart is to be used in conjunction with the corresponding formulas on the following pages to establish the life/load for each bearing (4 per table). Several dimensions and the load geometry are required for these computations. The dimensions are referenced below.



	d1	d2	da
8 Pole	114 mm	90,3 mm	42,5 mm
12 Pole	199 mm	90,3 mm	42,5 mm

Horizontal Translation — Normal Load

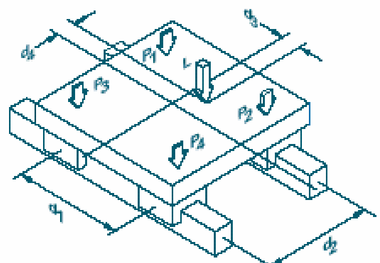


Figure 1: Horizontal Load

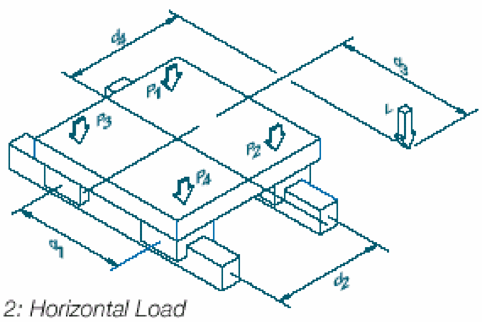


Figure 2: Horizontal Load

$$P_1 = \left[\frac{L}{4}\right] - \left[\frac{L}{2}\cdot\frac{d_3}{d_1}\right] + \left[\frac{L}{2}\cdot\frac{d_4}{d_2}\right]$$

$$P_2 = \left[\frac{L}{4}\right] + \left[\frac{L}{2}\cdot\frac{d_3}{d_1}\right] + \left[\frac{L}{2}\cdot\frac{d_4}{d_2}\right]$$

$$P_3 = \left[\frac{L}{4}\right] - \left[\frac{L}{2}\cdot\frac{d_3}{d_1}\right] - \left[\frac{L}{2}\cdot\frac{d_4}{d_2}\right]$$

$$P_4 = \left[\frac{L}{4}\right] + \left[\frac{L}{2}\cdot\frac{d_3}{d_1}\right] - \left[\frac{L}{2}\cdot\frac{d_4}{d_2}\right]$$

Figure 1 shows a normal load applied to the carriage translating horizontally. The vector L, defined by the CG of the load, is shown applied at a point whose coordinate distances from the center of the carriage are given by distances d3 and d4.

With the positioner at rest or moving with uniform velocity, the loads on each of the four bearing blocks are given by the above equations:

Note that each of the four bearing blocks will experience either compressional or tensional loading; the magnitude of these forces at each bearing is dependent upon the location of the load vector with respect to the center of the positioner carriage. For each bearing, the maximum of the forces in tension and compression is plotted on the load charts for the specific model positioner to determine the life of the table in the application.

The calculations for loads whose CG falls outside the carriage mounting surface area, as shown in Figure 2, are identical to those used with Figure 1. In either case, accelerations and decelerations of the load must be considered in calculating the dynamic forces which determine the life of the system in a particular application.

Horizontal Translation — Side Load

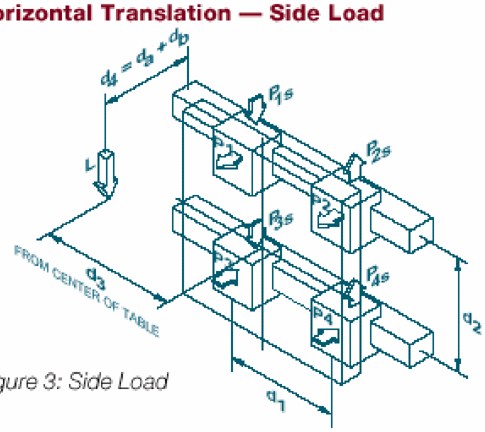


Figure 3: Side Load

$$P_1 = P_2 = \frac{L}{2}\left[\frac{d_4}{d_2}\right]$$

$$P_3 = P_4 = -\frac{L}{2}\left[\frac{d_4}{d_2}\right]$$

$$P_{1s} = P_{3s} = \frac{L}{4} + \left[\frac{L}{2}\cdot\frac{d_3}{d_1}\right]$$

$$P_{2s} = P_{4s} = \frac{L}{4} - \left[\frac{L}{2}\cdot\frac{d_3}{d_1}\right]$$

The previous loading scenarios have involved only normal forces (compressional or tensional) on the bearings. Consider a positioner as shown in Figure 3, which involves a lateral (side) load applied to the carriage which translates horizontally. The load vector (L) is shown applied at a point whose coordinate distances from the center of the carriage bearing system are given by dimensions d3 and d4. Note that d4 is the sum of distance da—the distance between bearing and center and carriage surface which is provided for each linear positioner—plus db, the distance of the load CG from the mounting surface of the carriage.

The loading felt by each of the four bearing blocks when the positioner is stationary or moving with uniform velocity is given by the above equations:

Here P1, P2, P3 and P4 are the normal loads (tensional and compressional) and P1S, P2S, P3S and P4S are the side loads. For each bearing, the largest side loads and normal loads in both tension and compression are identified for calculating the positioner life in the application.

For round rail/ball bushing type bearings, the forces are plotted individually on the appropriate curves to determine the service life.

For linear motion guide bearing positioners, an "equivalent load per bearing" is calculated for the life determination. Equations listed in Table A, page 22, apply for the Daedal positioners which incorporate linear motion guide bearings. As shown in Table A, this "equivalent load" is plotted on the indicated load/life graph to determine the positioner's service life.

Again, accelerations and decelerations of the load must be considered in calculating the dynamic forces which determine the life of the system in a particular application.

Table A - Linear Motion Guide Bearing Life/Load Computation

Positioner	Loads	Compute	Evaluate Life On
406LXR	Side & tension Ps > Pt Side & tension Ps ≤ Pt	Pe = (0.5 x Pt) + Ps Pe = (0.5 x Ps) + Pt	Side load chart Tension chart
	Side & compression Ps > Pc Side & compression Ps ≤ Pc	Pe = (0.5 x Pc) + Ps Pe = (0.5 x Ps) + Pc	Side load chart Compression chart

Example Computations

Example 1

Horizontal Translation with Side Loads, 406LXR-8 Pole Positioner

L = 10 Kgf
130 mm from carriage surface;
50 mm from carriage center.

Figure 3 (page 16) shows this configuration with dimensions given here.

d1 = 114 mm

db = 130 mm

d2 = 90.3 mm

d3 = 50 mm

da = 42.5 mm

d4 = da + db = 172.5 mm

The normal and side force components on each bearing block are computed from the equations as shown:

$$P_1 = P_2 = \frac{L}{2}\left[\frac{d_4}{d_2}\right] = 15.7 \text{ (tension) Kgf}$$

$$P_3 = P_4 = -\frac{L}{2}\left[\frac{d_4}{d_2}\right] = -15.7 \text{ (compression) Kgf}$$

$$P_{1s} = P_{3s} = \frac{L}{4} + \left[\frac{L}{2} * \frac{d_3}{d_1}\right] = 21.3 \text{ Kgf}$$

$$P_{2s} = P_{4s} = \frac{L}{4} - \left[\frac{L}{2} * \frac{d_3}{d_1}\right] = -11.3 \text{ Kgf}$$

Life for each bearing needs to be evaluated independently. For bearings with a side load, refer to the combined equivalent loading factors (Table A).

Example:

Bearing 3 has P3=9.6 Kgf tension and P3s=4.7 Kgf side load

Ps≤ Pc⇛Pe=(0.5 x Ps)+Pc=12 Kgf

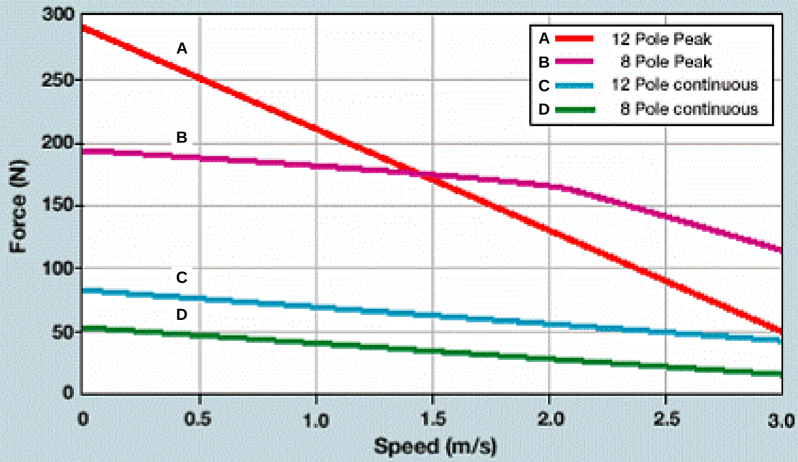
Refer to side load chart (page 15)

Life @ 12 Kgf=5500 km

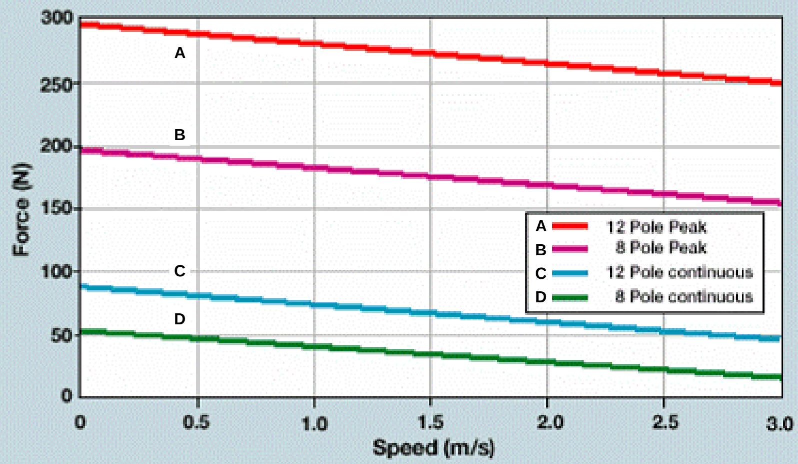
406 LXR Series Technical Data
Force Speed Charts

The charts on this page illustrate the characteristics of the 406LXR linear motor. The force/speed charts show the characteristics of the motor with either a 120 VAC or 240 VAC power input.

Gemini GV-U6E
Aries AR-04AE
120 VAC Input

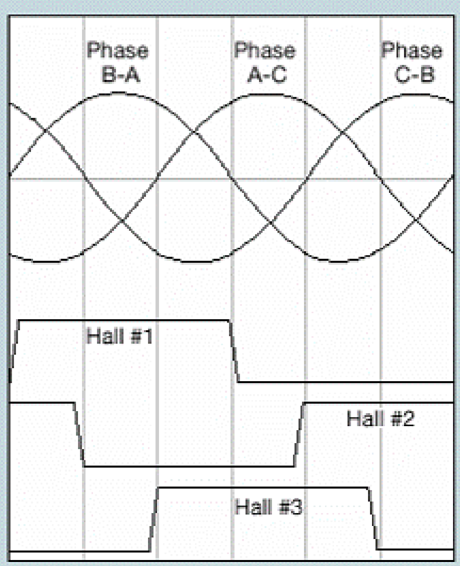


Gemini GV-U6E
Aries AR-04AE
240 VAC Input



Commutation Chart

Pattern established with the carriage moving in Positive Direction.



Commutation Chart

Linear Motor Specifications

Parameter	8 Pole	12 Pole	Units
Continuous Force [1]	75	110	N
Continuous Current [1,4,8]	3.5	3.4	Amps Peak
Continuous Current [1,7]	3.0	2.9	Amps DC
Peak Force [6]	225	330	N
Peak Current [4,6,8]	10.4	10.1	Amps Peak
Peak Current [6,7]	9.0	8.7	Amps DC
Voltage Constant [3,4]	25.15	37.7	Volt/m/sec
Force Constant [9]	21.78	32.64	N/Amps Peak
Force Constant [3,4]	25.15	37.7	N/Amp DC
Resistance [3]	10.2	15.28	Ohms
Inductance [5]	2.63	4.49	mH
Maximum Bus Voltage	340	340	Volts DC
Thermal Resist. Wind-Ambient	0.56	0.4	C/watt
Viscous Damping	13.3	13.3	N/m/s
Static Friction [13]	25	30	N
Intermit. Force Duration [10]	7	7	Seconds
Peak Force Duration [11]	3	3	Seconds
Magnetic Attraction [2]	280	420	N
Electrical Pitch [12]	42	42	mm
Mass-Motor Carriage	3.2	4.6	Kg
Rated Winding Temp.	90	90	C
Winding Class	H	H	–

1. @ 25°C ambient, 90°C Winding Temperature
2. Measured with a 0.76 mm gap
3. Measured Line to Line +/-10%
4. Value is measured peak of sine
5. +/-30% Line to Line, inductance bridge measurement @ 1Khz
6. Initial winding temperature must be 60°C or less before Peak Current is applied
7. DC current through a pair of motor phases of a trapezoidal (six state) commutated motor
8. Peak of the sinusoidal current in any phase for a sinusoidal commutated motor
9. Total motor force per peak of the sinusoidal amps measured in any phase, +/-10%
10. Maximum Time duration with 2 times rated current applied with initial winding temperature at 60°C
11. Maximum Time duration with 3 times rated current applied with initial winding temp at 60°C
12. The Distance from the leading edge of the north pole to the leading edge of the next north pole
13. Average Friction over total table travel

Encoder Specifications

Description	Specification
Input Power	5 VDC +/- 5% 150 mA
Output (Incremental)	Square wave differential line driver (EIA RS422) 2 channels A and B in quadrature (90) phase shift.
Reference (Z channel):	Synchronized pulse, duration equal to one resolution bit. Repeatability of position (page C2) is unidirectional moving toward positive direction.
Maximum Speed	5,0 micron resolution = 3,0 meters/sec 1,0 micron resolution = 3,0 meters/sec 0,5 micron resolution = 1,5 meters/sec 0,1 micron resolution = 0,3 meters/sec

Gemini Drive Specifications

Description	Specification
Drive Input Power	
Voltage	96 - 265 VAC
Phase	1Ø
Frequency	50/60 Hz
24V Keep Alive (Optional)	24 VDC - 20%
Drive Output Power	
Bus Voltage	170 or 340 VDC
Switching Frequency	8 or 16 kHz
Continuous Current	4.5 Amps
Peak Current	11.25 Amps
Commutation	Sinusoidal
Command Inputs	
Velocity and Torque	+/-10V
Position Mode	Step & Direction or CW & CCW
Encoder Track Mode	Allows post quadrature encoder to be used as command signals
Inputs	
Enable (Required)	0-24 VDC
Reset	
Pos/Neg Limits	
User Faults	
Outputs	
Fault	Open collector, 300 mA sink capability
At Limit	Open collector, 300 mA sink capability
Position Error	Open collector, 300 mA sink capability
Analog Monitors	+/- 10 V scalable, 8 bit (not to be used as control functions)
Relay	Normally open, dry contact
Communications	
Type	RS232/RS485 (4 wire)
Baud Rate	Fixed at 9600
Daisy Chain	Up to 98
Environmental	
Temperture	Still air 32°F (0°C) - 113°F (46°C), moving air: 32°F (0°C) - 122°F (50°C)
Humidity	0 - 95%, non-condensing
Shock/Vibration	Shock: 15G half-sign @ 11 msec/vibration: 2G, 10-2000 Hz
Protection	
Short Circuit	Phase-to-phase, phase-to-ground
Brownout	AC drops below 85 VAC
Over Temperature	Shutdown fault at 131°F (55°C)
Standards	UL, cUL, CE (LVD), CE (EMC)

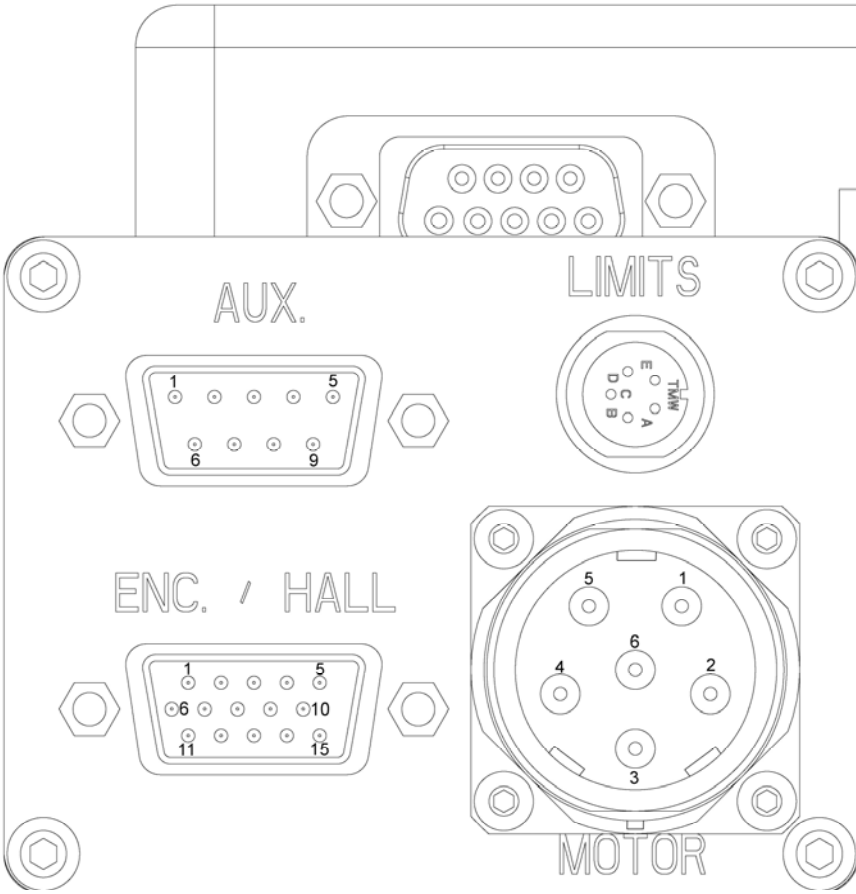
Limit and Home Sensor Specifications

Description	Specification
Input Power	+5 to +24 VDC 60 mA (20 mA per sensor)
Output	Output form is selectable with product: Normally Closed Current Sinking Normally Open Current Sinking Normally Closed Current Sourcing Normally Open Current Sourcing All types Sink or Source maximum of 100 mA
Repeatability	Limits: +/- 10 microns (unidirectional) Home: See Z channel specifications

Hall Effect Specifications

Description	Specification
Input Power	+5 to +24 VDC, 30 mA
Output	Open collector, Current Sinking, 20 mA Max

Cable and Wiring Diagrams



Encoder/Hall

15 pin D connector

Pin Number	Function	OEM Wire color
1	+5VDC Enc.	Red
2	A+	White
3	A-	Yellow
4	B+	Green
5	B-	Blue
6	Z+	Orange
7	Z-	Brown
8	Ground Enc.	Black
9	+5VDC Hall	White/Blue
10	Hall 1	White/Brown
11	Hall 2	White/Orange
12	Hall 3	White/Violet
13	Temp	Yellow/Orange
14	Temp	Yellow/Orange
15	Ground Hall	White/Green
Case	Shield	Green/Yellow

Limit/Home

5 pin round connector

Pin Number	Function	OEM Wire color
A	5-24 VDC	Red
B	Neg. Limit	Blue
C	Pos. Limit	Orange
D	Home	Green
E	Ground	Black
Case	Shield	Braid Shield

Motor Power

6 pin round connector

Pin Number	Function	OEM Wire color
1	U	Black 1
2	V	Black 2
3	Ground	Green/Yellow
4	Reserved	-
5	Reserved	-
6	W	Black 3
Case	Shield	Braid Shield

Auxiliary

9 pin D connector

All pins on this connector pass thru to matching connector on carriage side of cable management. AWG 26. Max 48VDC, 1 A per conductor

Pin Number	OEM Wire color
1	Red
2	Blue
3	White
4	Yellow
5	Orange
6	Green
7	Violet
8	Brown
9	Black
Case	Braid Shield

Cleanroom Preparation

There is no cleanroom 'rating' for motion control products, just individual compatibility with class of cleanrooms. The compatibility is also dependant on measurement location. A point directly below a component may have a different particle count than at a side location. In an effort to clarify the class of cleanroom that our products can be used in with out affecting the overall rating of the cleanroom, Parker provides a Cleanroom Class Compatibility chart for product intended for use in such environments. Due to the linear motor design of the 406LXR, minimal particle generation occurs during operation. 406LXR tables with cleanroom preparation were tested in Parker's vertical laminar flow work station which utilizes ULPA filters to produce an environment having a cleanliness of class 10 prior to testing. Tables were tested in a variety of orientations with sampling both below the table and at the carriage mounting surface with a particle counter capable of measuring 0.3 μm diameter and larger particles. Based on results from testing following the 209E Federal Standard, the following chart shows the expected cleanroom compatibility of the 406LXR with Class 10 cleanroom prep. Consult factory for details on test methodology and results.

406LXR Cleanroom Class Compatibility[1]

Velocity	Standard Mount		Side Mount	
[mm/sec]	4.5" below	At stage top	4.5" below	At stage top
250	25	1	25	1
500	25	1	25	1
750	25	5	50	5
1000	50	5	100	5

Standard Cleanroom Preparation

Stringent cleaning and handling measures
Cleanroom rated lubricant

1) Compatibility is defined as not affecting the cleanroom class rating with the addition of this product for classes shown. The Class 1 rating in the table refers to class 1 levels of 0.3μm and larger particles detected in Parker's Class 10 chamber. For complete class 1 compatibility, the particle count for the 0.1 and 0.2μm particles would also need to be taken into consideration.

CHAPTER THREE

Setup and Usage

IN THIS CHAPTER

Mounting Surface Requirements

***Proper mounting* of the 406LXR is *essential* to optimum product performance. All specifications are based on the following conditions:**

- The positioner must be bolted down along its entire length.
- The positioner must be mounted to a flat, stable surface, with a flatness error less than or equal to 0.013mm/300mm.
- Catalog specifications may deviate for positioners mounted to surfaces that do not meet the above conditions.
- If the surface does not met these specifications the surface can be shimmed to comply with these requirements.
- If mounting conditions require that the table base is *overhung*, table specifications will not be met over that portion of the table. Additionally, in *X-Y Systems* the *overhung* portion of the Y-axis may not met specifications due to the additional error caused by deflection and non-support of the base. Contact Daedal for guidelines on specifications of overhang applications.

Mounting Methods

The 406LXR can be mounted via the three ***(3)*** following methods:

1. Toe Clamps, figure A
2. Thru-Holes inside LXR, figure B
3. Taped Holes on the underside of the LXR, figure C

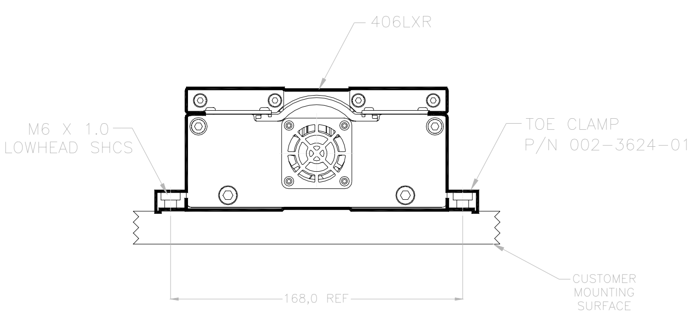


FIG. A

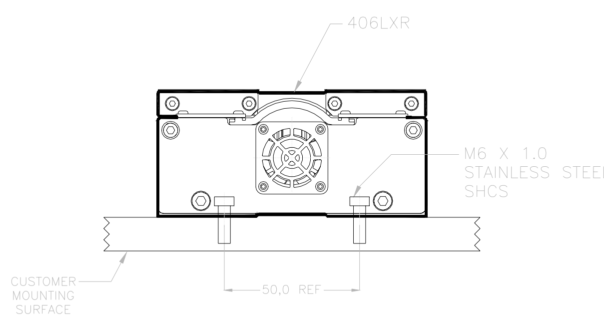


FIG. B

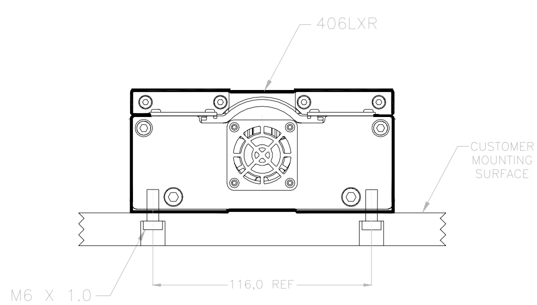


FIG. C

Side and Inverted Mounting Cautions

Side Mounting

- Cable transport modules are NOT to be used on side mounted positioners with travels greater than 650 mm due to cable drag. Contact factory for special bracketry.

Inverted Mounting

- Cable transport modules are NOT to be used on inverted mounted positioners with travels greater than 450 mm due to cable drag. Contact factory for special bracketry.

Setting Travel Limit Sensors

The 406LXR is supplied with over-travel limit sensors. Set the position of the sensors before applying motor power. The limit sensors are set at the factory for maximum travel. These factory settings only allow for 3mm (0.12") before the carriage contacts the deceleration bumper. In slow speed applications this may be adequate, however as the top speed of the application increases the required deceleration distance increases. To determine the safe **Deceleration Distance** the **Maximum Speed** and the **Maximum Obtainable Deceleration Rate** must be *known* or *calculated*. The maximum speed should be known from your application requirements. *Velocity limits* should be set in your program or in your amplifier to cause a fault if the speed exceeds this value. The maximum deceleration is a factor of load and available peak force of the table. Using F = ma, calculate maximum acceleration and then required deceleration distance. See the following example for calculating *maximum deceleration* for an application with a payload = 5kg on a 406LXR-D13 (8 pole motor), with a maximum speed of 1.5 m/s.

Example 1.

$$\text{Total mass} = \text{Payload mass} + \text{Carriage mass} = 5\text{ kg} + 3.2\text{kg} = 8.2\text{ kg}$$

$$\text{Maximum Speed} = 0.5\text{ m/sec}$$

$$\text{Available peak force at } 1.5\text{ m/sec} = 180\text{N} \quad \text{(See Chapter 2, Force / Speed Curves)}$$

Thus...

$$F = ma \Rightarrow a = \frac{F}{m} \Rightarrow a = \frac{180\text{ N}}{8.2\text{kg}} = 21.95\text{ m/s}^2 = 2.24\text{ G}$$

The Maximum Obtainable Deceleration Rate for this application is 21.95 m/s^2.

Now, calculate the Deceleration Distance for linear deceleration.

First… find the Deceleration time.

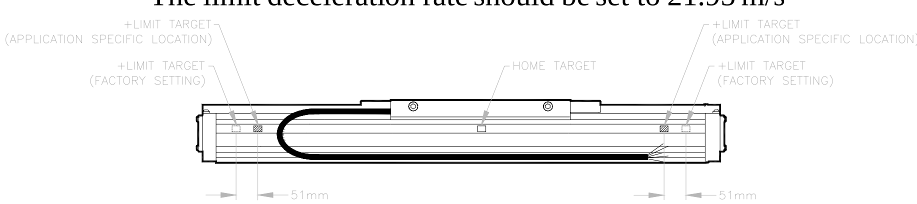
$$T_a = \frac{\text{Max Velocity}}{\text{Deceleration Rate}} = \frac{1.5\text{ m/s}}{21.95\text{ m/s}^2} = 0.068\text{ seconds}$$

Second… find the Deceleration Distance.

$$\text{Distance} = \frac{\text{Max Velocity} \times T_a}{2} = \frac{1.5\text{ m/s} \times 0.068\text{ s}}{2} = 0.051\text{ m} = 51\text{ mm}$$

This means that both the positive and negative limit switch targets must be moved inward by 51 mm.

The limit deceleration rate should be set to 21.95 m/s^2



LIMIT TARGET ADJUSTMENT DIAGRAM
(SEE ABOVE EXAMPLE)

NOTE: DIMENSIONS SPECIFIC TO ABOVE EXAMPLE

Setting Home Sensor

The 406LXR is equipped with a "home" position reference sensor. This hall effect sensor in located in the limit/home module. This sensor is typically used in conjunction with the encoder "Z" marker (refer to "Z" channel reference below). If the unit is equipped with this option it will be set at the "Z" channel location. If another home location is desired the home target can be adjusted by loosening the set screw on the target and sliding it along the track. Note: If the home sensor is used without "Z" channel, repeatability is reduced to +/-10 microns.

Z Channel Position Reference

The Z channel is an output on the encoder. Many servo controllers support this input. The Z channel on the 406LXR is located in one of three positions, (positive end, mid travel, or negative end). The location depends on how the unit was ordered (See Chapter 2, *Part Number Identification*). The Z channel is a unidirectional device. This means that the final homing direction must occur in one direction. The 406LXR is set that the final home direction is to be toward the positive side of the table (See Chapter 2, *Dimensional Drawing*, for positive direction definition). The repeatability of the Z channel is equal to +/- 2 resolution counts of the encoder (except for 0.1 µm scales which have a repeatability of +/-1 µm). Thus the repeatability of the "Z" channel equals:

Encoder Resolution	Z Channel Repeatability
5 µm	+/- 10 µm
1 µm	+/- 2 µm
0.5 µm	+/- 1 µm
0.1 µm	+/- 1 µm

NOTE: Home repeatability is also very dependent on controller input speed and homing algorithms. The above repeatability does not include possible controller tolerance. Additionally, to achieve the highest repeatability the final homing speed must be slow. Slower final speed usually results in higher repeatability.

NOTE: The "Z" channel output is only one resolution count wide. Thus the on-time may be very brief. Due to this some controllers may have difficulty reading the signal. If you are experiencing the positioner not finding the "Z" channel during homing, try reducing final homing speed; also refer to your controller manual for frequency rates of the "Z" channel input.

Grounding / Shielding

All cables are shielded. These shields are to be grounded to a good earth ground. Failure to ground shields properly may cause electrical noise problems. These noise problems may result in positioning errors and possible run away conditions.

Cabling

The 406LXR is available with two (2) types of cabling:

Cable Transport Module

- This is a complete cable management system including high flex ribbon cable (life rating of 20 million cycles), cable carriers, and connector system. This has been engineered for high life, maintenance free operation. Extension cables are used to connect the table connector block to the amplifier and controller. Refer to cabling diagrams for pin-out and wire color information.

- The Cable transport module is replaceable. For detailed instructions on cable module removal and installation please see Chapter 6 - *Maintenance and Lubrication* refer to the section Titled *Cable Management Module Replacement.*

Un-harnessed OEM Cable System

- This option provides high flex round cables directly from the carriage. This option is provided for applications where the design of the machine already has a cable management system. Five cables come from the carriage connector: motor, encoder, Hall effect, limit/home and auxiliary cables.

- Recommended bend radius for these cables is 100mm. This radius will provide 10 million cycles of the cable. Smaller bend radius will reduce cable life while larger bend radius will increase life. The un-harnessed OEM cable system can be replaced. Refer to *Cable Management Module Replacement* in Chapter 6.

- NOTE: The Cable Transport Module and the OEM Cable System are interchangeable in the field. For detail please contact Parker Hannifin or your local Parker distributor.

CHAPTER FOUR

Performance

IN THIS CHAPTER

Acceleration Limits

Acceleration of the 406LXR is limited by four *(4)* factors:

- Linear Bearings

The Linear bearings used in the 406LXR have a continuous acceleration limit of 2 g's. This means that the bearings are design to take repetitive acceleration of 2 g's and maintain the rated bearing life. Additionally, the bearings can take a periodic acceleration of up to 5 g's, however continued accelerations of these magnitudes will reduce bearing life.

- Reduced Bearing Life

Bearing loading due to high acceleration may reduce bearing life to an unacceptable application limit. This is not usually a limiting factor unless loading is significantly cantilevered causing high moment loads during accelerations. See Chapter 2, *406LXR Series Technical Data* to determine bearing load life for your application.

- Available Motor Force

This is the primary factor that reduces acceleration. This is simply the amount of motor force available to produce acceleration. The larger the inertial and or frictional load the lower the accelerations limit. Motor force data can be found in Chapter 2, *406LXR Table Specifications* .

- Settling Time

In many applications reducing cycle time is a primary concern. To this end, the "settling" time (the amount of time needed after a move is completed for table and load oscillating to come within acceptable limits) becomes very important. In many cases where very small incremental moves are executed, the settling time is greater than the actual move time. In these cases accelerations may need to be reduced thus reducing the settling time.

Speed Limits

The Maximum Speed of the 406LXR is limited by three *(3)* factors:

1. Linear Bearings
   The linear bearings are limited to a maximum speed of 3 meters/second.

2. Linear Encoder Limit
   The linear encoder has speed limits relative to encoder resolution; these limits are listed below

Encoder Resolution	Maximum Velocity	Required Post Quadrature Input Bandwidth[2]
5 micron	5 m/s[1]	2 Mhz
1 micron	3 m/s	6.7 Mhz
0.5 micron	1.5 m/s	6.7 Mhz
0.1 micron	0.3 m/s	10 Mhz

3. Force / Speed Limit
   The available force of the 406LXR reduces as speed increases. (Chapter 2, *406LXR Series Technical Data*)

Encoder Accuracy and Slope Correction

Encoder Accuracy

The 406LXR Series makes use of an optical linear encoder for positional feedback. This device consists of a *readhead*, which is connected to the carriage, and a *steel tape scale*, which is mounted inside the base of the 406LXR.

The linearity of this scale is +/-3 microns per meter, however the absolute accuracy can be many times larger. To compensate for this error, an error plot of each 406LXR is done at the factory using a laser interferometer. From this plot a linear slope correction factor is calculated (see below). Then a second error plot is run using the slope correction factor. These tests are conducted with the Point of Measurement (P.O.M.) in the center of the carriage 50mm above the carriage surface.

Slope Correction

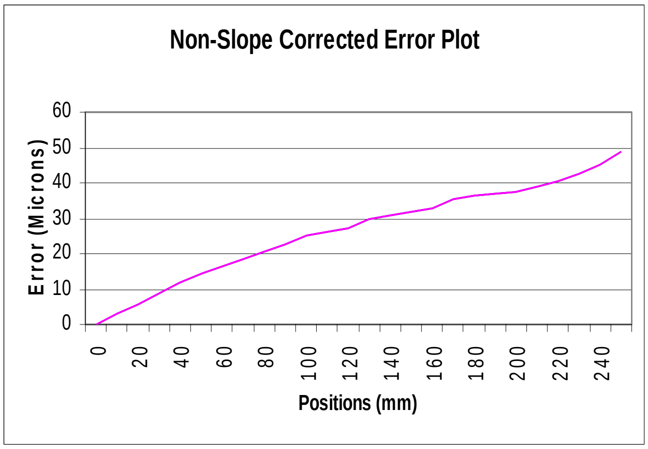
Slope correction is simply removing the linear error of the table. The graphs below show an example of a non-slope corrected error plot and the same plot with slope correction. As can be seen, the absolute accuracy has been greatly improved.

The slope factor is marked on each unit. It is the slope of the line in microns per meter. This factor may be positive or negative, depending on the direction of the error.

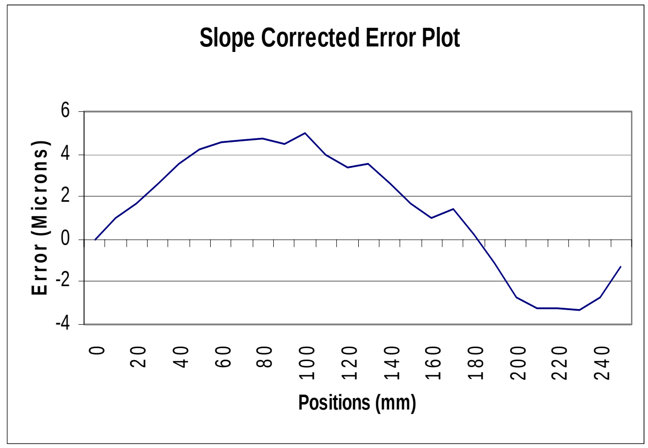
1. When using an encoder with 5 micron resolution, the maximum speed is limited by the square rail bearings.
2. This is the bandwidth frequency that the amplifier or servo control input should have to operate properly with the encoder output at maximum speeds. This frequency is post-quadrature, to determine pre-quadrature divide above values by 4. Above frequencies include a safety factor for encoder tolerances and line loses.

If your application requires absolute accuracy, the slope factor must be incorporated into the motion program. This is a matter of either assigning variables for motion positions and using the slope correction in the variable equation, or if your controller has floating decimal scaling (with high enough precision) the slope correction can be accounted for in scaling.

NOTE: The zero position (or starting point) of the error plots are at the extreme NEGATIVE end of travel (refer to Chapter 2, *Dimensional Drawing*, for Negative end location).



Non-Slope Corrected Error Plot, Total error *48µm*
Note: Slope Factor is 200*µm*/m in this example.



Slope Corrected Error Plot, Total error *8.5µm*

Example:

Below is a sample program showing how to correct for slope error using variables. This example program will work with the 6K as well as the 6000 Series Parker, Compumotor Controllers.
Step 2 through 3 of this program should be made a subroutine. This subroutine can then be executed for each distance.

Step 1

```
VAR1 = 1280; IN THIS CASE THE DESIRED DISTANCE IS 1280mm.
```

Step 2

```
DEL SLCORR ; DELETE SLCORR PROGRAM
DEF SLCORR ; DEFINE SLCORR PROGRAM
VAR2 = (VAR1/1000)* (0.085); VAR2 EQUALS DESIRED DISTANCE (IN METERS) TIMES THE
SLOPE FACTOR (mm/meter)
```

Step 3

```
VAR3 = (VAR1-VAR2); SUBTRACT SLOPE ERROR FROM DESIRED DISTANCE
```

Step 4

```
D(VAR3); SET DISTANCE AS VAR3
END ; END SUBROUTINE
```

In the example above, the required move distance is 1280 mm. But the LXR has a slope error of 0.085mm per meter. This is a positive slope error meaning that if uncorrected the LXR will move 0.085 mm too far for every meter it travels. To correct we must command a smaller position.

Step 1: The required move distance is set as variable #1.

Step 2: In this step, we first convert 1280 mm to 1.28 meters my dividing by 1000. Next we multiply by the slope factor to calculate the slope error distance of this move (1.28 * 0.085) = 0.1088 mm.

Step 3: We subtract the error from the original distance (1280 – 0.1088) = 1279.8912 mm.

Step 4: Here we simply assign the new calculated distance as our current command distance.

This same program works if the slope error is negative. For example, if the slope error was –0.085 instead of +0.085 the equation would work out like this:

VAR2 = (1280/1000)*(-0.085) = -0.1088
VAR3 = 1280 – (-0.1088) = 1280.1088

Thus correcting for the negative slope.

Note: Above are examples for incremental moves. The same program works if programming in absolute coordinates.

Note: Each unit is shipped with both the non-slope corrected accuracy plot and a slope corrected plot. These plots can be used to "MAP" the table, making positioning even more accurate. Mapping is correcting for the error of the device at each location. This can be done by knowing the motion positions and the error at each of these positions and setting up a matrix of variables in your motion program. This method provides excellent accuracy but is time consuming to setup.

Attainable Accuracy with Slope Correction			
Travel (mm)	Accuracy (µm)	Travel (mm)	Accuracy (µm)
50	12	750	36
150	12	850	36
250	12	950	40
350	16	1200	48
450	24	1550	64
550	24	1750	72
650	28	1950	84

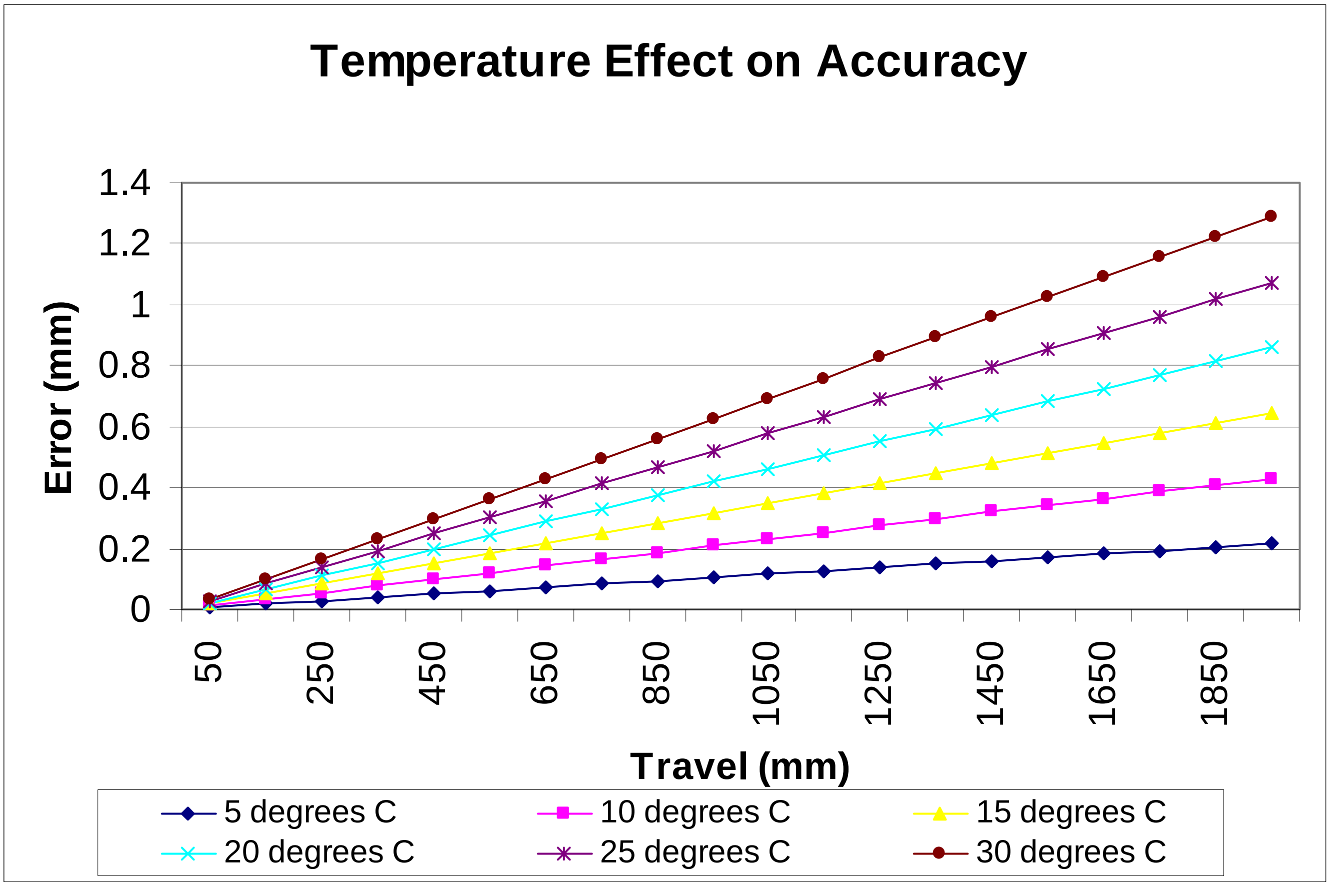
Thermal Effects on Accuracy

All specifications for the 406LXR are taken at 20° C. Variation from this temperature will cause additional positional errors. If the base of the 406LXR varies from this temperature the encoder scale will expand or contract, thus changing its measuring length and thus encoder resolution.

The factor by which this thermal effect occurs is 0.000022mm/mm/° C. Although this sounds like a very small number it can make significant accuracy and repeatability effects on your applications, especially on longer travel applications. To understand this better let's look at an example:

Example: A 406LXR with 950mm travel is being used. The accuracy over the entire travel is 40 microns at 20° C. If the base temperature increases by 5° C an additional error of 105 microns will be added over the total travel (0.000022mm/mm/° C)*950mm*5° C. As you can see this error is significant. However, this additional error can be compensated for since the error is linear.

Below is a graph of the accuracy of the 406LXR with respect to base temperature and travel. Each line represents the additional error of the table caused by the elevated temperature.



Thermal Effects on Repeatability

Repeatability will not be effected as long as the temperature remains constant. However the repeatability will be effected as the temperature changes from one level to another. This is most commonly experienced when starting an application cold. Then as the application runs the 406LXR comes to its operational temperature. The positions defined when the unit was “cold” will now be offset by the thermal expansion of the unit. To compensate for this offset, all positions should be defined after the system has been exercised and brought to operational temperature.

Causes of Temperature Increases

One or more of the following conditions may effect the temperature of the 406LXR base:

Ambient Temperature

This is the air temperature that surrounds the 406LXR.

Application or Environment Sources

These are mounting surfaces or other items which produce a thermal change that effect the temperature of the 406LXR base (i.e. Machine base with motors or other heat generating devices that heat the mounting surface and thus thermally effect the 406LXR base).

Motor Heating From 406LXR

Since the 406LXR uses a servo motor as its drive, it produces no heat unless there is motion, or a force being generated. In low duty cycle applications heat generation is low, however as duty cycles increase, temperature of the 406LXR will increase, causing thermal expansion of the base. With very high duty cycles these temperatures can reach temperatures as high as 30° C above ambient.

Compensating for Thermal Effects

How much you will have to compensate for the above thermal effects depend on the application requirements for accuracy. If your accuracy requirements are high, you either need to control base temperature or program a thermal compensation factor into your motion program. *Controlling the base temperature* is the best method. However, this means controlling the ambient temperature by removing all heat/cold generators from the area and operating at very low duty cycles. *Compensation* is the other way of achieving accuracy without sacrificing performance. In this case the system must be exercised through its normal operating cycle. The temperature of the base should be measured and recorded from the beginning (cold) until the base becomes thermally stable. This base temperature should be used in a compensation equation. Below is the fundamental *thermal compensation equation*:

$$C_d = I_d - \left(I_d \cdot \delta_T \cdot \Delta T\right)$$

$C_d = \text{Corrected displacement (mm)}$

$I_d = \text{Incremental displacement (mm)}$

$\delta_T = \text{Thermal Expansion } (0.000022 \text{ mm/mm/}^\circ\text{C})$

$\Delta T = \text{Temperature Differential from } 20^\circ\text{C}$

Example :

Base Temperature of 32° C

Required move 100mm

$$C_d = 100\text{mm} - (100\text{mm} \ \ \delta_T \ \ 12^\circ\text{C}) = 99.9736\text{mm}$$

In this move the commanded move should be 26.4 microns less (100mm – 99.9736mm) than the desired move. This will compensate for the thermal expansion of the scale.

This is a simple linear correction factor and can be programmed in to most servo controllers using variables for the position commands.

CHAPTER FIVE

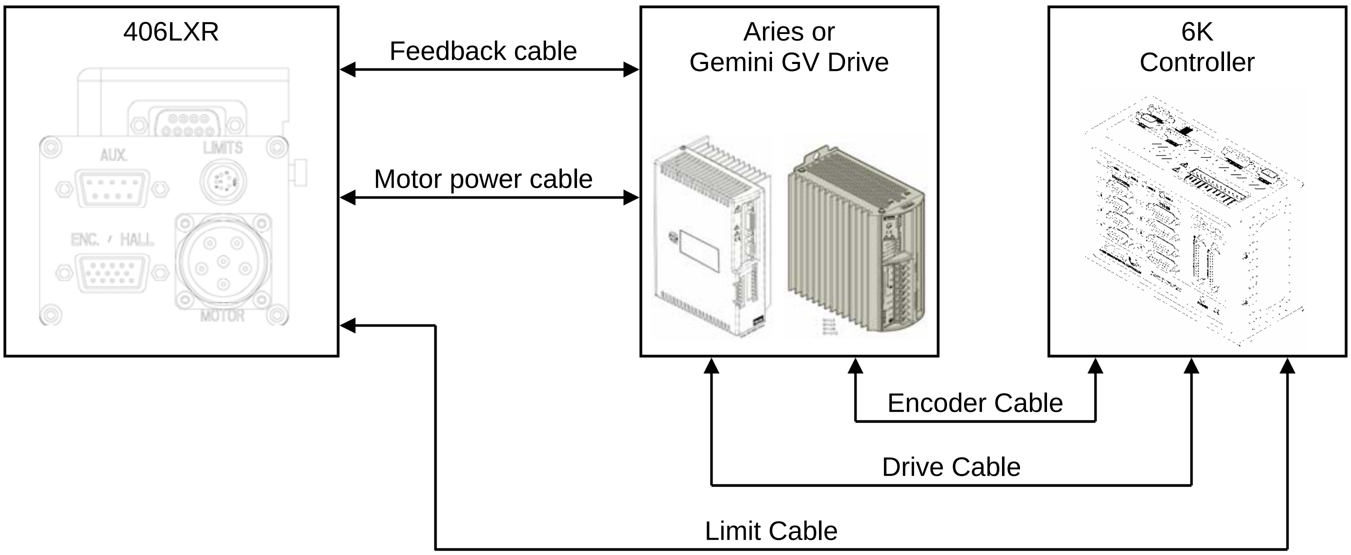
Connecting the Drive / Amplifier

IN THIS CHAPTER

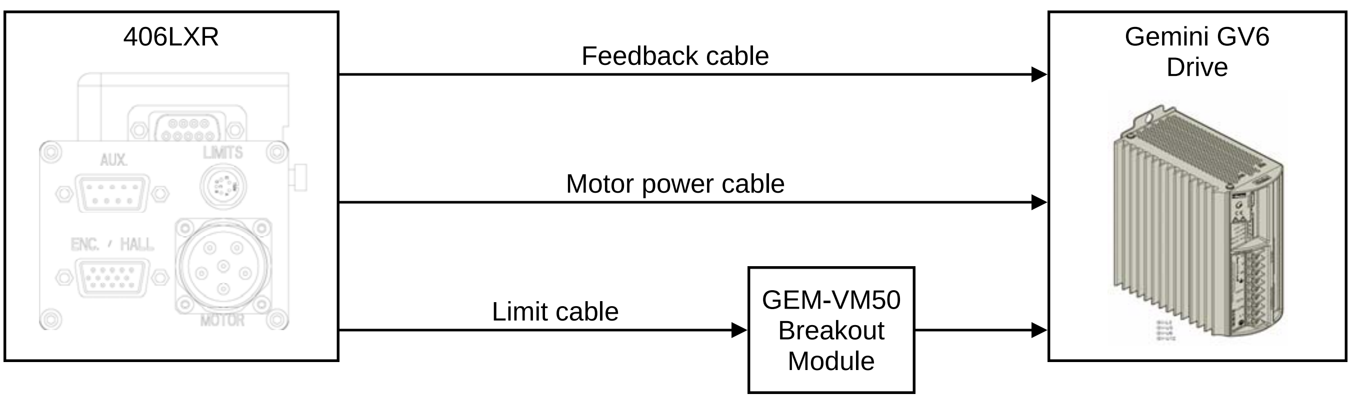
Drive connection

The images below give and overview of how to connect a 406LXR to a Gemini or Aries digital servo drive. Examples are shown for the A4 drive only and the A5 drive/controller options.

With an Aries or Gemini GV Drive and a 6K controller



With a Gemini GV6 Drive/Controller



Drive cables and Accessories

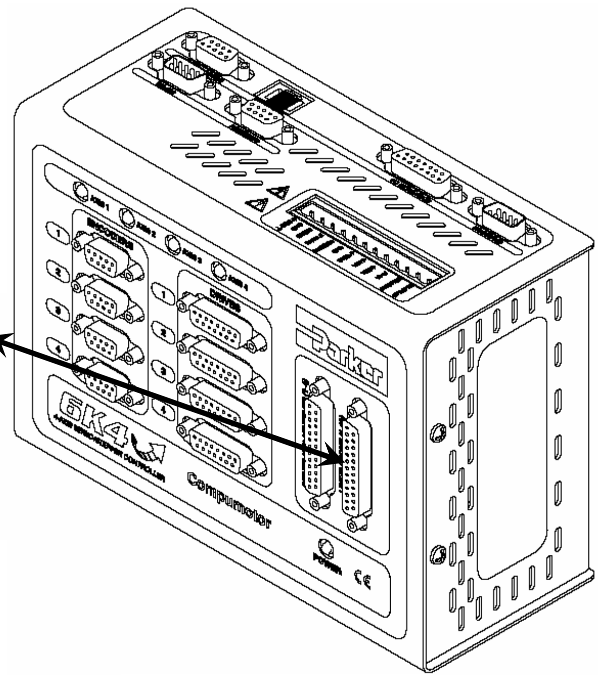
Cables

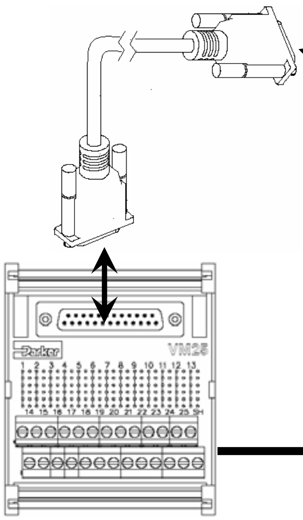
Model No.	Description
006-1683-01	Gemini Adapter Cable
006-1740-01	Motor Cable, 3 m, Flying Leads
006-1740-02	Motor Cable, 7.5 m , Flying Leads
006-1743-01	Auxiliary Extension Cable, 3m, Flying Leads
006-1743-02	Auxiliary Extension Cable, 7.5m, Flying Leads
006-1738-01	Encoder / Hall Cable, 3 m, Flying Leads
006-1738-02	Encoder / Hall Cable, 7.5 m, Flying Leads
006-1742-01	Limit/Home Cable, 3 m, Flying Leads
006-1742-02	Limit/Home Cable, 7.5m, Flying Leads
006-1788-01	Complete Cable Set, 3 m, Flying Leads (without auxiliary cable)
006-1788-02	Complete Cable Set, 7.5m , Flying Leads (without auxiliary cable)
006-1739-01	Encoder/Hall Cable,3m w/Gemini Connector
006-1739-02	Encoder/Hall Cable,7.5m w/Gemini Connector
006-1789-01	Complete Cable Set, 3 m, Gemini (without auxiliary cable)
006-1789-02	Complete Cable Set,7.5m, Gemini (without auxiliary cable)
006-1889-3.0	Encoder/Hall Cable,3m w/Aries Connector
006-1889-7.5	Encoder/Hall Cable,7.5m w/Aries Connector
006-1942-3.0	Complete Cable Set, 3 m, Aries (without auxiliary cable)
006-1942-7.5	Complete Cable Set,7.5m , Aries (without auxiliary cable)

Adapters and Accessories

Model No.	Description
01-01986-01	50-pin screw terminal Gemini breakout module
71-016939-10	10’ cable, RS-232/485 null modem, CE(LVD&EMC)
71-016943-10	10’ cable, 50-pin high density Amp Champ
71-016945-03	3’ cable, 50-pin high density Amp Champ
71-016966-10	Gemini to 6K Step & Direction command cable, 10’
71-016987-10	Gemini to 6K Analog command cable, 10’, CE
GC-26	Gemini Feedback Connector with 26-pin terminal strip
GC-50	Gemini I/O Connector with 50-pin terminal strip
GEM-VM50 Kit	consisting of one 71-016945-03 and one 01-016986-01
GFB-KIT	26-pin Gemini Connector Kit, solder leads

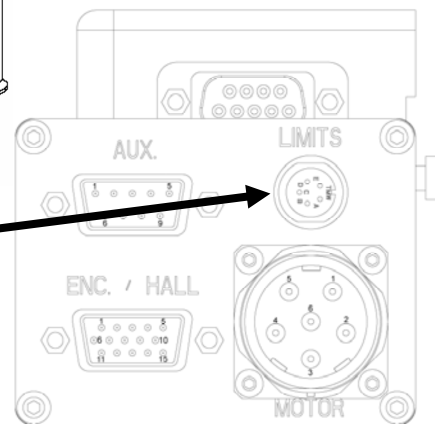
Limit/Home Connection





VM25

LXR Limit/Home Cable
P/N 006-1742-0X



Pin Number	Function	OEM Wire color
A	5-24 VDC	Red
B	Neg. Limit	Blue
C	Pos. Limit	Orange
D	Home	Green
E	Ground	Black
Case	Shield	Braid Shield

PIN OUTS & SPECIFICATIONS

Pin #	In/Out	Axes 1-4	Axes 5-8	Description (input functions programmed by LIMFNC)
25	-----	-----	-----	RESERVED
23	IN	1POS	5POS	Positive direction end-of-travel limit, axis 1 or 5.
21	IN	1NEG	5NEG	Negative direction end-of-travel limit, axis 1 or 5.
19	IN	1HOME	5HOME	Home limit, axis 1 or 5.
17	IN	2POS	6POS	Positive direction end-of-travel limit, axis 2 or 6.
15	IN	2NEG	6NEG	Negative direction end-of-travel limit, axis 2 or 6.
13	IN	2HOME	6HOME	Home limit, axis 2 or 6.
11	IN	3POS *	7POS *	Positive direction end-of-travel limit for axis 3 or 7.
9	IN	3NEG *	7NEG *	Negative direction end-of-travel limit for axis 3 or 7.
7	IN	3HOME *	7HOME *	Home limit, or general purpose input for axis 3 or 7.
5	IN	4POS *	8POS *	Positive direction end-of-travel limit for axis 4 or 8.
3	IN	4NEG *	8NEG *	Negative direction end-of-travel limit for axis 4 or 8.
1	IN	4HOME *	8HOME *	Home limit for axis 4 or 8.

Specification for limit inputs

- Voltage range is 0-24VDC.
- Switching levels: Low ≤ 1/3 VINref voltage, High ≥ 2/3 VINref voltage (factory default VINref voltage is +24VDC, but you can connect a different voltage to the VINref terminal**). To make all limit inputs sinking inputs, connect the LIM-P terminal** to the GND terminal**.
- Status: Check with TLIM or LIM.
- Active level is set with the LIMLVL command. Default is active low: end-of-travel limits which require a n.c. switch and home limits which require a n.o. switch.

All even number pins are connected to isolated logic ground.

* On 6K2 and 6K6 products, these pins function as general-purpose inputs (function is set with the LIMFNCi-A command).

** The VINref, LIM-P, and GND terminals are located on the screw-terminal connector on top of the 6K chassis.

CHAPTER SIX

Maintenance and Lubrication

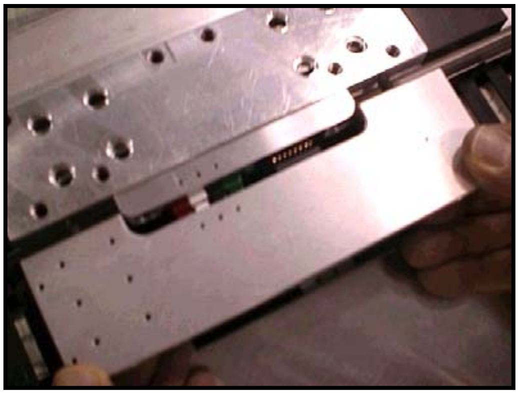
IN THIS CHAPTER

LXR Identification

Over the life of the LXR product line a number of improvements have been made. The most visible and important of these are changes to the cable management and limit module. This page will allow you to identify which version of the LXR you have.

Generation 1 LXR:

G1 LXR's were produced from 2000 to 2002 and are most easily identified by the cable management. The G1 carriage connector has square corners and is attached by two (2) 5mm socket cap screws thru the side of the connector.
Note: Use



Generation 2 LXR:

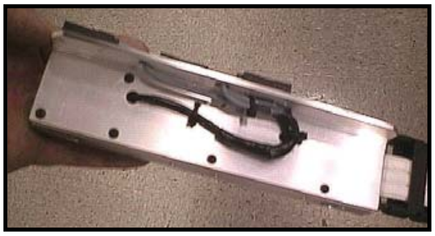
G2 LXR's are current production spec from 2002 on and as with G1 units are most easily identified by their cable management. The G2 carriage connector has round corners and is attached by two (2) small flat head socket cap screws thru the top of the connector near the carriage. G2 cable management also features an auxiliary pass thru port on the carriage connector and connector panel. G2 LXR's and cable management are shown throughout this manual.

Limit Module Identification

G1: Individual sensors are attached to an aluminum angle. G1 limits are ONLY usable on G1 LXR's. Contact factory for replacement information. Utilizes ferrous targets.

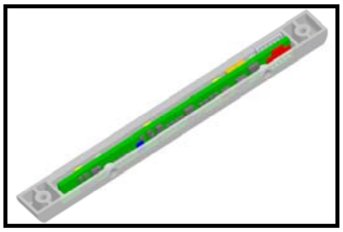
G2: Integrated sensor module featuring adjustable sensor type and compact design. Machined black plastic housing and epoxy encapsulated circuit board. Wires exit directly from encapsulation. Utilizes magnetic targets.
No longer in production replace with G3 module. Contact factory for more information.

G3: Integrated sensor module featuring increased circuit protection. Injection molded clear plastic housing with screw retained circuit board. Connector directly on circuit board. Utilizes magnetic targets. Current production spec for all LXR's. Contact factory for replacement information.



G1 Limit Module

G2 Limit Module

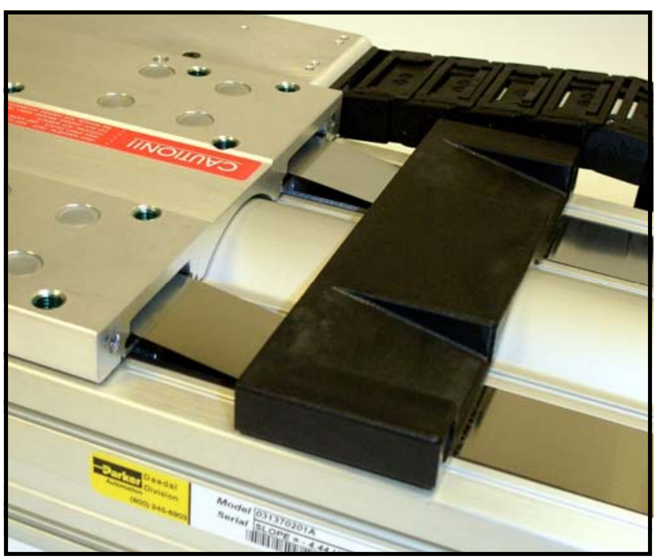


G3 Limit Module

Internal Access Procedure for travels < 1250mm

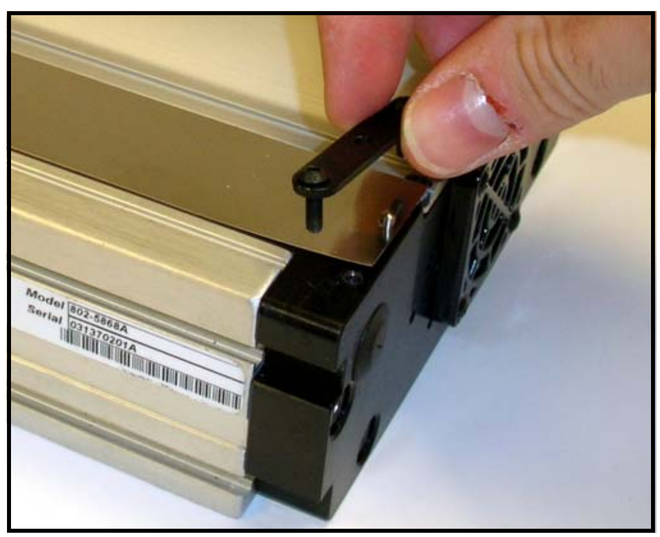
Tools Requires:
Hex keys: 2.5mm and 2mm
Straight blade screw driver.

1. Remove carriage end caps by removing four (4) hex socket shoulder screws with compression spring preload (2 per end cap) using a 2.5 mm hex key.



2. Remove all four (4) strip seals clamps by removing eight (8) M3 Button Head Cap Screws using a 2 mm hex key.

Caution! Do not use a ball nose driver as the button head screw hex interface is easily striped.



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3. Lift both strip seals over locator pins with screwdriver.

Caution! The strip seal ends are VERY SHARP. It is recommended that a screwdriver or other thin object be used to lift strip seals over the locator pins. Do not use your finger nail!

Note: Later version LXR's may have thicker clamping bars without locating pins. Thicker clamping bars can be retro fitted to older LXR's by simple removing the locating pins with pliers.

2. Pull both strip seals through carriage.

Caution! The strip seal ends are VERY SHARP.

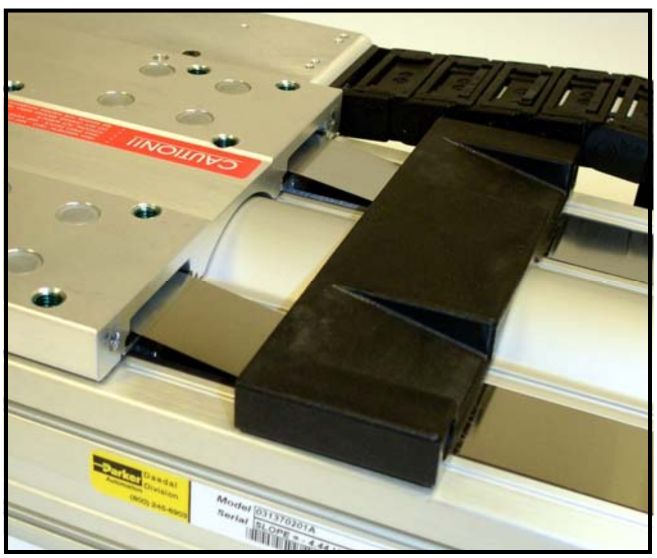
5. Pull center cover through carriage.

Reassemble is the reverse of disassembly.

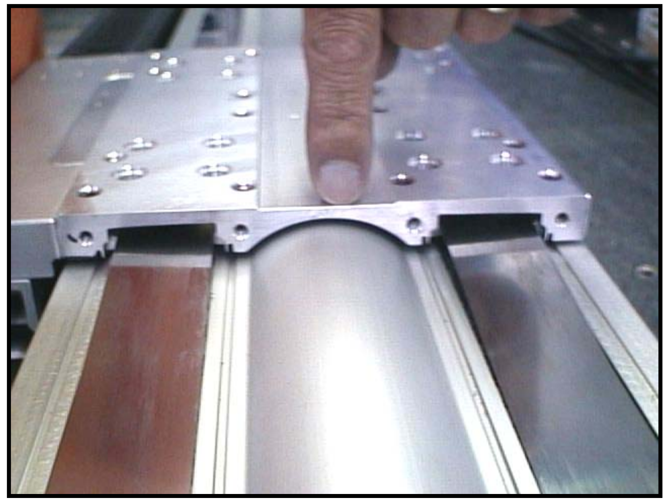
Note:
1. Take care not to dislodge wear bars from the carriage ends when passing strip seal thru carriage.
2. Insure that the compression springs are present under the shoulder screws in the carriage end caps. Due to springs screws will need to be pressed into holes to start thread engagement.

Internal Access Procedure for travels > 1250mm

1. Remove carriage end caps by removing four (4) hex socket shoulder screws with compression spring preload (2 per end cap) using a 2.5 mm hex key.



2. Measure gap between top (crown) of center cover and bottom of carriage when carriage is at **center of travel**. Write down this measurement. You will need to match this dimension when reassembling the positioner.



3. Remove all four (4) strip seals clamps by removing eight (8) M3 Button Head Cap Screws using a 2 mm hex key.

Caution! Do not use a ball nose driver as the button head screw hex interface is easily striped.

4. Lift both strip seals over locator pins with screwdriver.

Caution! The strip seal ends are VERY SHARP. It is recommended that a screwdriver or other thin object be used to lift strip seals over the locator pins. Do not use your finger nail!

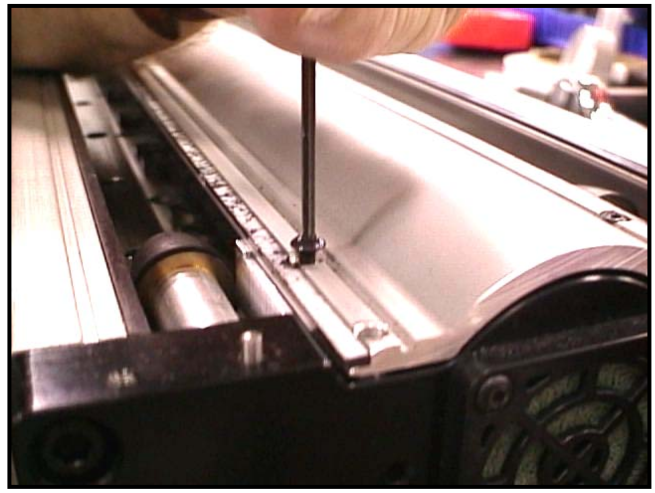
Note: Later version LXR's may have thicker clamping bars without locating pins. Thicker clamping bars can be retro fitted to older LXR's by simple removing the locating pins with pliers.

5. Pull both strip seals through carriage.

Caution! The strip seal ends are VERY SHARP.

6. Remove four (4) M3 Adjustment Button Head Cap Screws from counter bored holes in center cover using a 2 mm hex key.

Caution! Do not use a ball nose driver as the button head screw hex interface is easily striped.



7. Pull center cover through carriage.

Reassembly procedure begins on next page.

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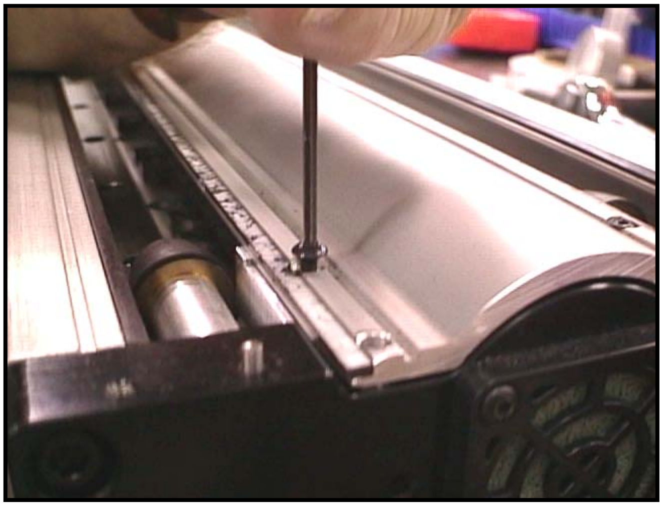
Reassembly Procedure for travels > 1250mm

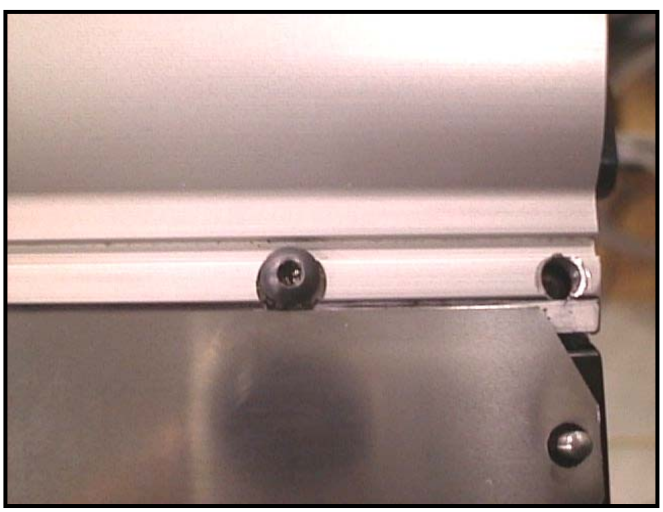
1. Pull center cover through carriage and return center cover to original position. Loosely thread in four (4) M3 *Adjustment* Button Head Cap Screws into the center cover using a 2 mm Hex key.

Note: Do not tighten screws at this point.



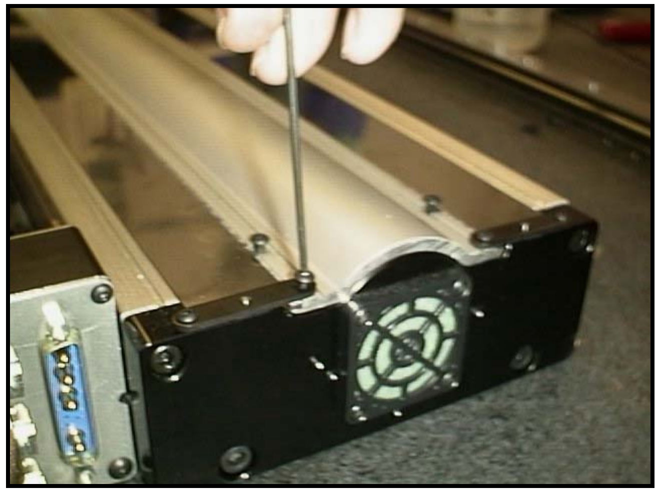
2. Feed the strip seals back through the carriage. Strip seals and *Adjustment* Button Head Cap Screws will be very close in proximity to one another. Make sure *Adjustment* Button Head Cap Screws will NOT pinch strip seals when tightened down. Place strip seals over locator pins.

Caution! The strip seal ends are VERY SHARP.



3. Reassemble all four (4) strip seal clamps by repositioning clamps and starting eight (8) M3 Button Head Cap Screws using a 2 mm hex key.

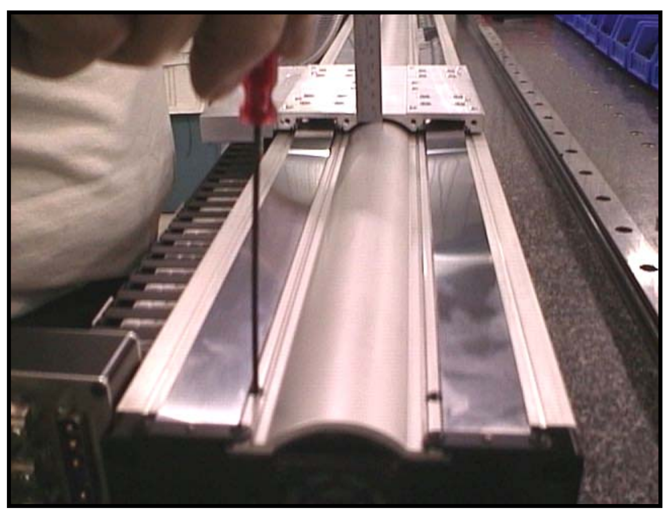
Note: Leave all eight (8) slightly loose. These screws will be tightened in a later step.



4. Tighten *Adjustment* Button Head Cap Screws using a 2 mm Hex key. Tighten until you match the carriage to cover dimension that you wrote down during disassembly step 2.

Note: Make sure *Adjustment* Screws do not interfere with underside of carriage.

5. After center cover adjustment is complete finish tightening the eight (8) strip seal clamp screws.



6. Remount carriage end caps. Insure that the compression springs are present under the shoulder screws in the carriage end caps. Due to springs screws will need to be pressed into holes to start thread engagement.

Square Rail Bearing Lubrication

See previous section on *Internal Access* for access to interior of positioner.

Tools Requires:

Daedal Grease type #1
Isopropyl Alcohol
Clean paper towels
Small brush

Lubrication Type:

Daedal grease type #1. Lithium 12 hydoxstearate soap base containing additives to enhance oxidation resistance and rust protection (viscosity, 70/80 CST at 100 degrees C) is recommended for grease lubrication.

Lubricant Appearance:

Blue and very tacky

Maintenance Frequency:

Square rail bearing blocks are lubricated at our facility prior to shipment. For lubrication inspection and supply intervals following shipment, apply grease every 1000 hours of usage. The time period may change depending on frequency of use and environment. Inspect for contamination, chips, etc, and replenish according to inspection results.

Lubricant Application:

Wipe the rails down the entire length with a clean cloth. Apply lubrication on the rails allowing a film of fresh grease to pass under the wipers and into the recirculating bearings. After bearings are relubricated, clean encoder tape scale located on inside wall of table. Use only isopropyl alcohol and a clean lint free cloth or paper towel. Using a lint free cloth, wipe down linear tape scale to remove and dirt or grease.

Caution! DO NOT use and other solvent to clean the encoder scale. Use of other solvents will permanently damage the encoder scale. Use only isopropyl alcohol.

Note: Do not use/mix petroleum base grease with synthetic base grease at any time. For lubrication under special conditions consult factory.

Cable Management Module Replacement

Tools Requires:

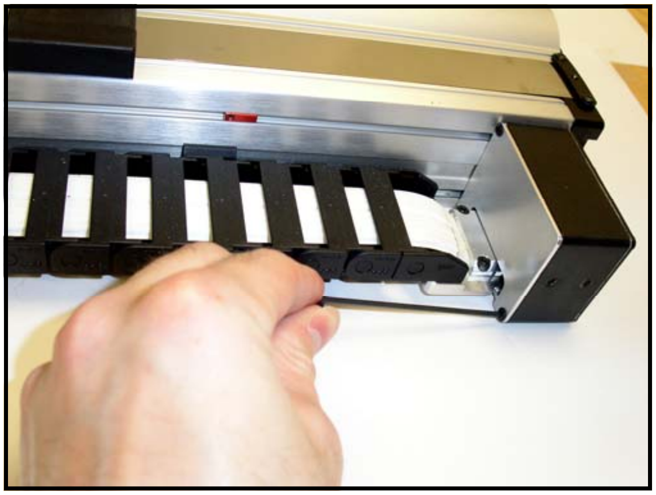
Replacement Cable Management Module
Hex keys: 2.5mm and 2mm
Ball nose hex key: 3mm

Replacement Cable Module Part Numbers

Travel Code	Replacement Part Number	Travel Code	Replacement Part Number	Travel Code	Replacement Part Number
T01	006-1794-01	T06	006-1794-06	T11	006-1794-11
T02	006-1794-02	T07	006-1794-07	T12	006-1794-12
T03	006-1794-03	T08	006-1794-08	T13	006-1794-13
T04	006-1794-04	T09	006-1794-09	T14	006-1794-14
T05	006-1794-05	T10	006-1794-10		

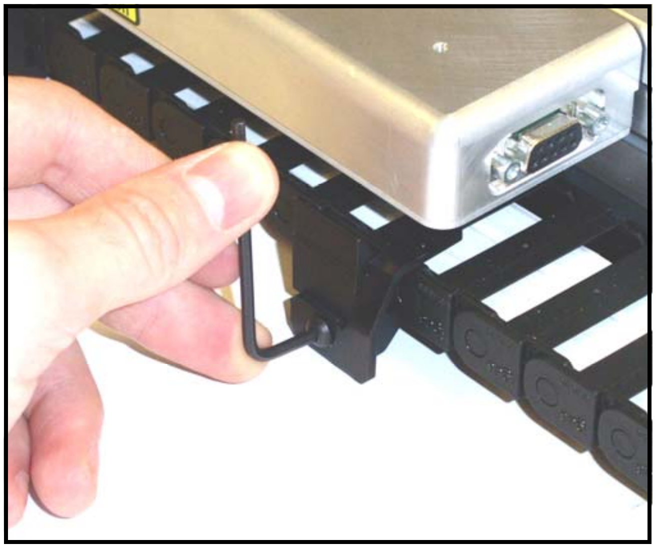
1. Remove two (2) M3 button head cap screws using a 2mm hex key. Remove the silver back cover from the connector block.

Caution! Do not use a ball nose driver until the screws are broken loose as the button head screw hex interface is easily striped.



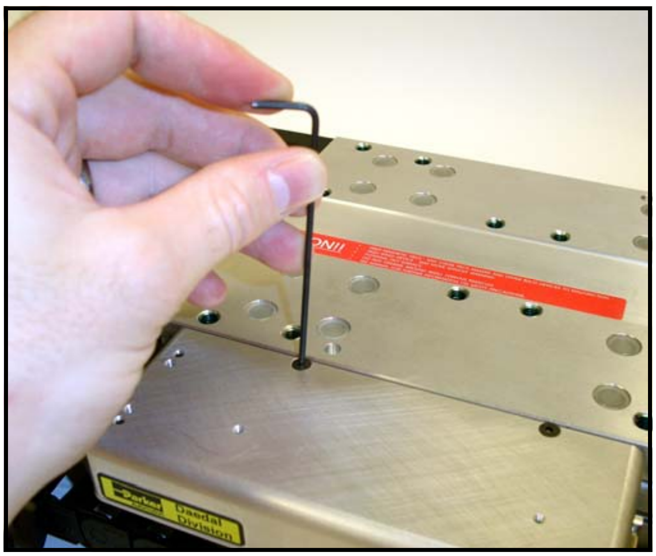
2. Using a 3mm ball nose hex key loosen but do not remove the two (2) screws found inside the connector hosing.

3. Loosen the M4 button head screw using a 2.5mm hex key. Slide the cable carrier hold clamp off of the cable carrier support. Mark or take careful note of which cable support the hold down is attached to for reinstallation.

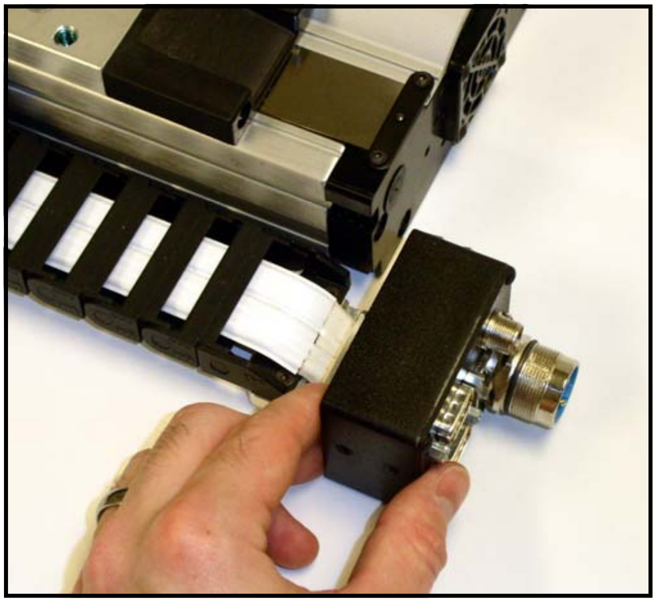


4. Using a 2mm hex key. Remove the two (2) flat head screw on the top of the carriage connector module.

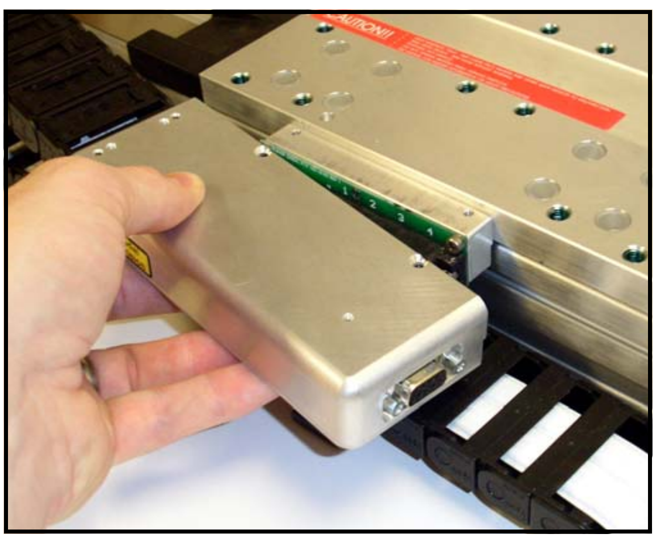
Caution! Do not use a ball nose driver until the screws are broken loose as the flat head screw hex interface is easily striped.



5. Slide the carriage all the way to the end of travel on the connector block end. This will provide the most cable carrier "slack" for removal of the carriage connector.
   Slide the connector block off the end of the base.



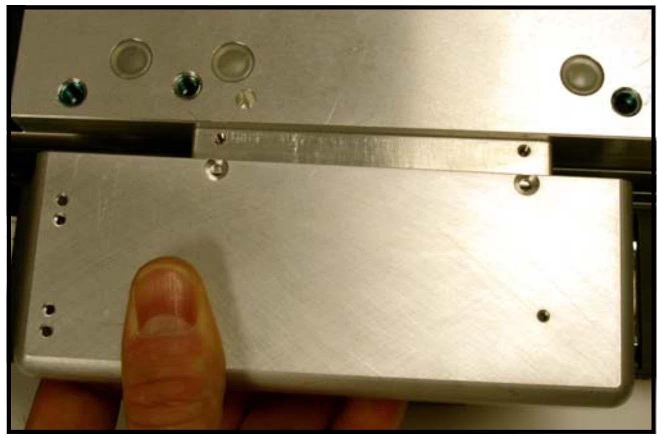
6. Pull the carriage connector straight away from the carriage. Then lift the cable carrier up out of the cable carrier supports.



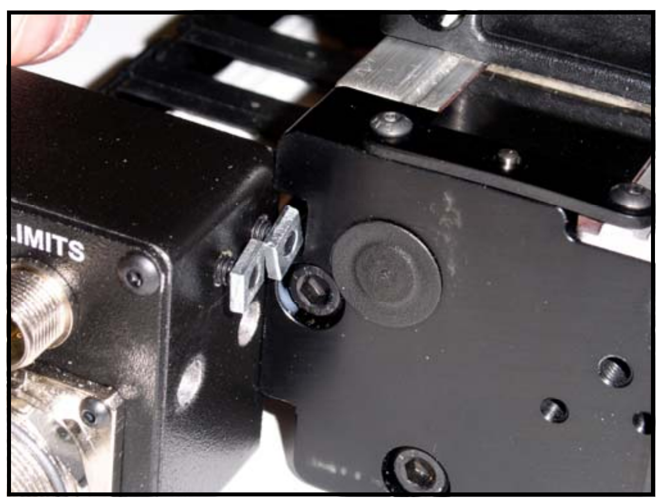
Cable Module Reassembly

1. With the carriage moved to the end of travel on the connector panel end. Place the cable carrier into the carrier supports with the connector panel slid off the end of the table.

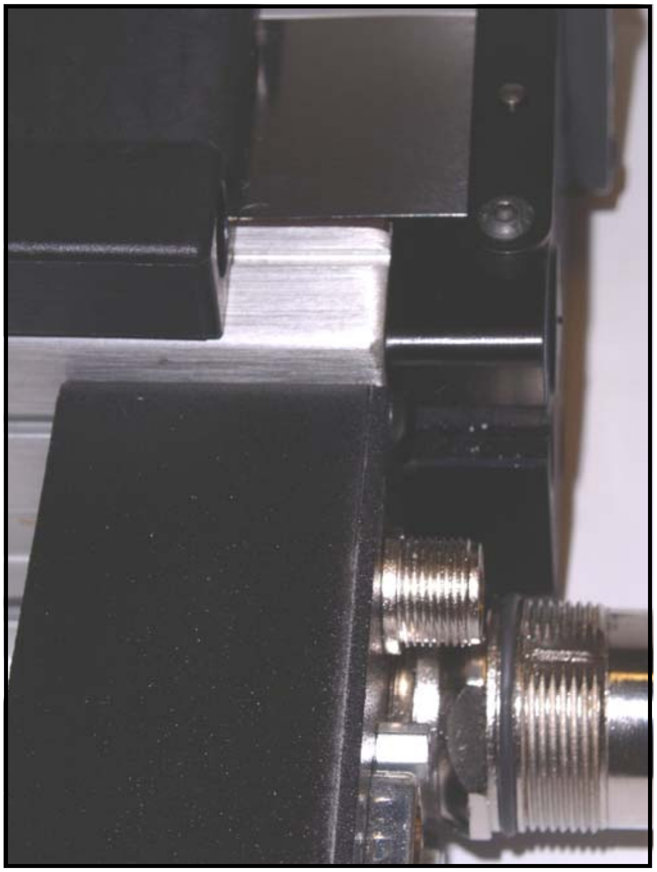
2. Slide the carriage connector straight onto the carriage using the mounting holes as an alignment guide. Fasten with two (2) flat head screws removed earlier.



3. Align the square nuts and slide the connector panel into the T-slot on the base.



4. Slide the connector panel into the T-slot until the front face of the connector panel is aligned with the back of the base end cap as shown below. Using a 3mm ball nose hex key tighten the two socket cap screws inside the panel.



5. Reinstall the silver back cover onto the connector panel and tighten the two button head screws.

Note: The back cover is symmetrical and can be installed two ways with no affect on performance. However installation of the screws will be easiest if the cover is oriented so the lower screw hole is away from the table.

6. Reinstall the cable carrier hold down on the same support it was removed from.

Cable Carrier Support Adjustment.

Typically no adjustment of the cable carrier supports is needed. However If the support becomes lose or a slight movement of the support is needed for clearance or access to associated equipment the support can be moved easily. Even spacing of the carrier supports is required moving any one support less than 25mm will not cause problems but larger movement may be unacceptable particularly if there is no additional support under the carriers i.e. A table or other flat surface.

To adjust the supports simple loosen the set screw located under the support using a 1.5mm hex key. The support is now free to slide in the T-slot. When in desired position tighten set screw to secure.

Limit/Home Module Replacement

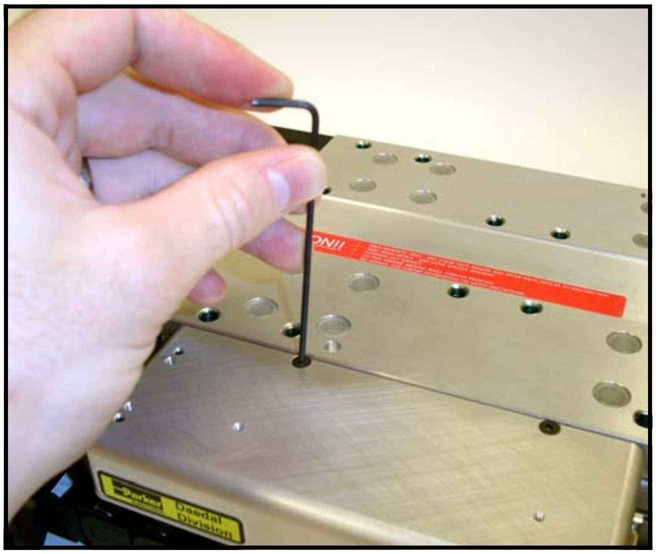
The limit module on the LXR had been designed to be quite robust and withstand most out of specification conditions such as over voltage, reverse polarity and short circuiting. However some extreme condition can cause the failure of the module. Is such a case the module is easily replaceable in the field. Please contact your local distributor or Parker Hannifin for replacement part number information.

Tools Requires:

Hex keys: 2mm, 1.5mm
T6 Torx® or Torx Plus® driver
Miniature straight blade screwdriver (1.5-3mm wide)

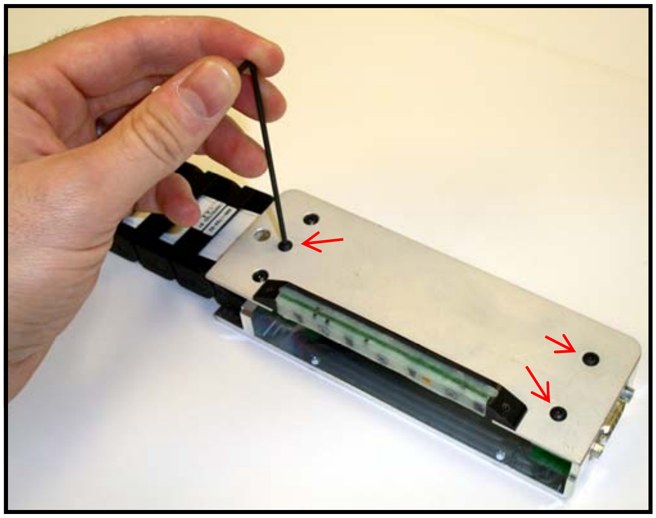
1. Using a 2mm hex key. Remove the two (2) flat head screw on the top of the carriage connector module.

Caution! Do not use a ball nose driver until the screws are broken loose as the flat head screw hex interface is easily striped.



2. Pull the carriage connector straight away from the carriage and flip the connector over laying it out flat along side the table. Complete removal of the cable module is not required. The limit module should now be visible under the carriage connector.

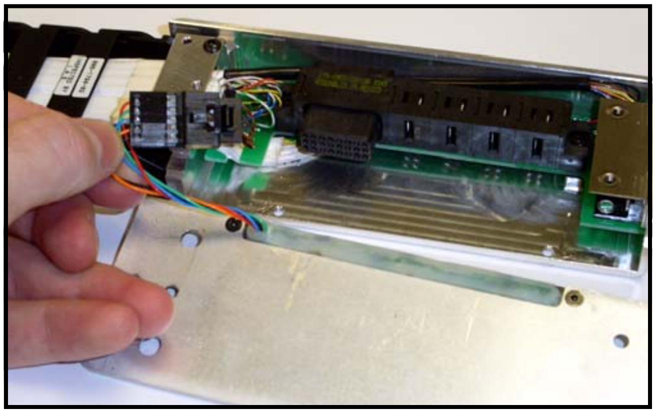
3. Remove the three button head screws indicated below using a 2mm hex key.



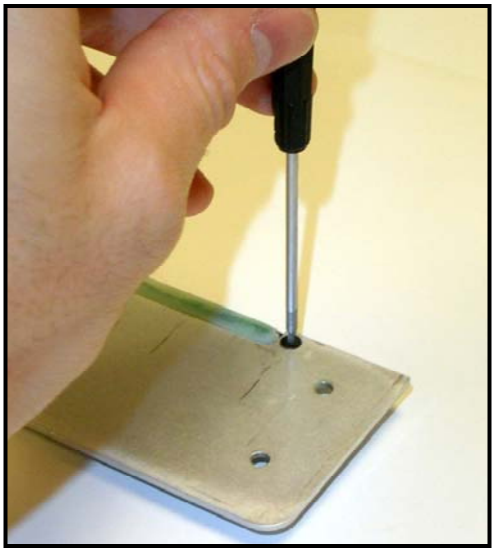
Note:

LXR's produced from September 2004 on have a 3rd generation limit module (G3) featuring increased circuit protection and slight physical redesign. Please see the first page of this chapter to identify which generation of cable management and limit module you have.

4. Flip the cover over to expose limit module connector.
   G2: Disconnect black connector by depressing latch and pulling apart holding the housing not the wires. See picture below.
   G3: Disconnect beige connector from circuit board. Use a small screwdriver to pry connector away from housing. Do not pull on wires to disconnect. (No picture)



5. Remove two (2) flat head screws attaching limit module to aluminum plate.
   G2: Use 1.5mm hex driver
   G3: Use T6 Torx® or Torx Plus® driver



Reassembly

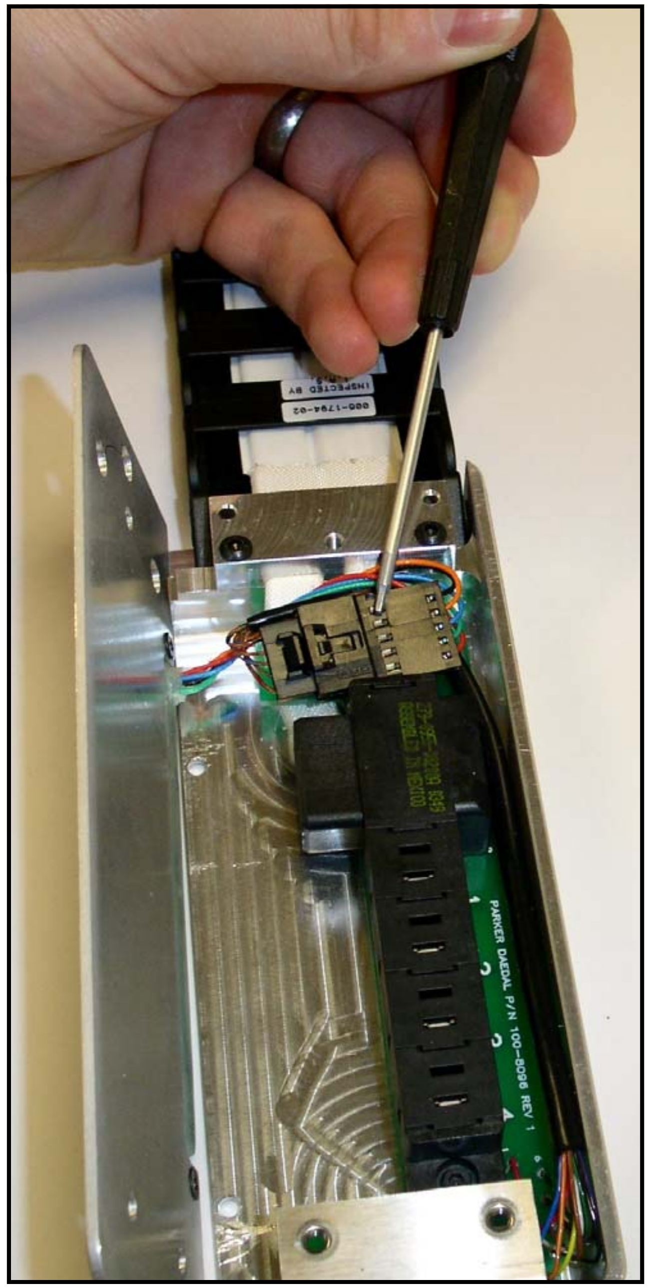
1. Install new limit module using screws appropriate to housing (G2 hex socket, G3 Torx®). Make sure limit housing is oriented correctly.

Note: Be careful not to strip module attachment screws. Very little torque is needed to attach hosing.

2. Connect cable module wiring to limit module. Check that connection is secure:
   G2: Latch should click in place
   G3: Connector should be fully engaged and flush with connector housing.

Note: If replacing a G2 module with a G3 unit an adapter cable is required and should have been included with your replacement limit/home module. Please contact factory if cable is missing.

3. When attaching the cover plate with limit module to the carriage connector assembly ensure that black G2 connector is flat and located as shown below.



Remainder of reassembly is reverse of disassembly steps 1-3.

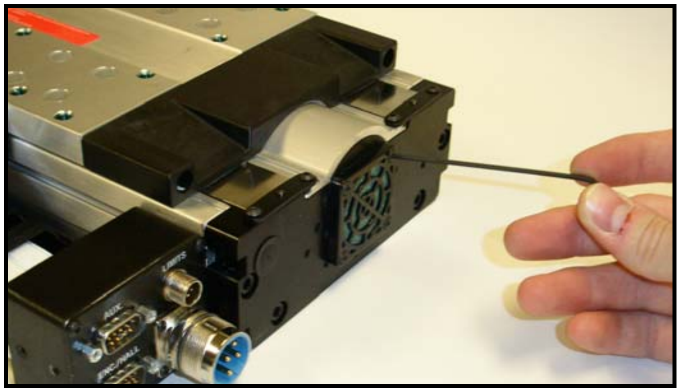
Filter Cleaning and Replacement.

During operation air is drawn into the body of the LXR thru the vents located on each end of the base. The movement of the carriage pulls air in and out of the body cavity in considerable volume. These vents are covered by filters to prevent the build up of dust and other air borne contaminates in the body of the table. With out these filters dust build up could damage the linear bearings and/or optical encoder. Depending on the operating environment these filters will need to be cleaned or replaced at regular intervals. When dust buildup is visible on the filter media maintenance is required.

Tools Requires:

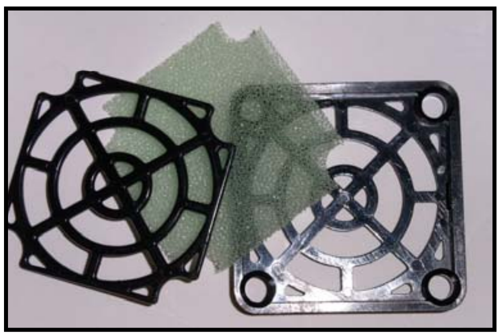
Hex keys: 2mm

1. Remove the four (4) screws on each filter using a 2mm hex key.



Cleaning:

2. Using a small screwdriver or finger nail pry the media retainer out of the back side of the filer assembly
3. The filter media can now be washed with soap and clean water. Rinse thoroughly and allow the filter to dry completely before reassembly. Blotting the filter with paper towels will speed drying.
4. Place the filter media between the filter body and media retain and press the retainer into the body until it snaps into place.



Reassembly:

4. Using four (4) button head screws per end attach the filter assembly to the end block.

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Appendices

IN THIS SECTION

Appendix A – Understanding Linear Motors

The Linear Motor Concept

Linear Motors are basically a conventional rotary servo motor unwrapped. So now what was the stator is now called a forcer and the rotor becomes a magnet rail. With this design, the load is connected directly to the motor. No more need for a rotary to linear transmission device.

Linear Motor Benefits

High speeds: Only the bus voltage and the speed of the control electronics limit the maximum speed of a linear motor. Typical speeds for linear motors are 3 meters per second with 1 micron resolution and over 5 meters per second with courser resolution.
Note: Motors must be sized for specific loading conditions.

High Precision: The feedback device controls the accuracy, resolution, and repeatability of a linear motor driven device. And with the wide range of linear feedback devices available today, resolution and accuracy are primarily limited to budget and control system bandwidth.

Fast Response: The response rate of a linear motor driven device can be over 100 times faster than some mechanical transmissions. This is simply because there is no mechanical linkage. This means faster accelerations and settling times, thus more throughput.

Stiffness: Because there is no mechanical linkage in a linear motor, increasing the stiffness is simply a matter of gain and current. Thus the spring rate of a linear motor driven system can be many times that of a ball screw driven device. However it must be noted that this is limited by the motor's peak force, the current available, and the resolution of the feedback.

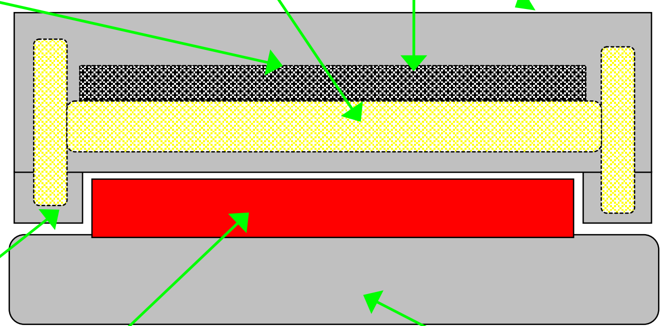
Zero Backlash: Since there are no mechanical components there is no backlash. There are however, resolution considerations which effect the repeatability of the positioner (See Chapter 2, *General Table Specifications*, Chapter 3, *Setting Home Sensor* and *Z Channel Position Reference*)

Maintenance Free Drive Train: Because linear motors of today have no contacting parts, in contrast with screw and belt driven positioners, there is no wear on the drive mechanism.

Slotless Linear Motor Design

The Linear Motor inside the 406LXR is a Slotless Linear Motor. The following will give a brief description of the motor design and construction:

Construction: Designed by the Compumotor and Daedal Divisions of Parker Hannifin, the motor takes its operating principle from Parker's slotless rotary motors which have grown popular over the past few years. The magnetic rail is simply a flat iron plate with magnets bonded to it. The forcer is unique. It begins with a coil and a "backiron" plate, which is placed behind the coil. This assembly is placed inside an aluminum housing with an open bottom. The housing is then filled with epoxy, securing the winding and "backiron" into the housing. The thermal sensors and hall effect sensors are mounted to the housing.



Advantages & Disadvantages of Slotless Linear Motors

Lower Weight Magnetic Rail: Since this is a single magnet rail the weight is less then half of dual magnet rail motors. This means less load and higher throughput in multi-axis systems.

Structurally Strong Forcer: With the body of the forcer being made of aluminum and the windings being bonded to this housing, the strength of the forcer is much greater than that of the epoxy only housed motors. Thus reducing the possibility of motor fatigue failures.

Light Weight Forcer: Because of its aluminum body construction, the slotless linear motor forcer weight is approximately 2/3 that of an equivalent iron core linear motor. Thus resulting in higher throughput in light load applications.

Lower Attractive Forces: The slotless design has a "backiron" causing attractive forces between the forcer and the rail. However, this attractive force is significantly less than other linear motors. Thus significantly reducing loading on the linear guide bearings and increasing bearing life.

Lower Cogging: Due to the larger magnetic gap between the magnets and forcer "backiron" the slotless design has lower cogging. This enables the slotless design to operate in applications that require very good velocity control.

Heat Dissipation: The slotless design, with the coil resting across the "backiron", which is in direct contact with the aluminum housing, has very good heat transfer characteristics and is easy to manage.

Appendix B - Internal Protection

The 406LXR is protected from its environment via magnetically retained protective seals. Daedal has conducted testing to determine the *degree* to which the positioner is protected by using a British standard called an **Ingress Protection Rating (IP Rating)**.

Definition

Reference: British standard EN 60529 : 1992

This standard describes a system of classifying degrees of protection provided by enclosures of electrical equipment. Standardized test methods and the establishment of a two digit numeric rating verify the extent of protection provided against access to hazardous parts, against ingress of solid foreign objects, and against the ingress of water.

First Number – The first number indicates protection of persons against access to dangerous parts and protection of internal equipment against the ingress of solid foreign objects.

1 - Protection against access to hazardous parts with the back of a hand, and protected against solid foreign objects of 50 mm diameter and larger.

2 - Protection of fingers against access to dangerous parts, and protection of equipment against solid foreign objects of 12.5 mm diameter and larger.

3 - Protection against access to hazardous parts with a tool, and protection against solid foreign objects of 2.5 mm diameter and larger.

Second Number – The second number indicates protection of internal equipment against harmful ingress of water.

0 - No special protection provided.

Note: Number Indicators above represent only a partial list of IP Rating specifications.

Warnings (Points of Clarity)

The specification applies to protection of particles, tools, parts of the body, etc., against access to hazardous parts inside the enclosure. This does not cover external features such as pinch points causes by the motion of the carriage, or cable carrier assemblies.

The testing method as specified in the standard uses a solid steel rod of the appropriate diameter at a specified force. The specification does not consider soft or pliable particles. Due to the design of the table and sealing method, a soft particle can compress due to the motion of the table, and reduce its cross-section. This can allow particles to enter the unit.

In application, shavings or chips commonly created in a machining operation are a greater concern. If any edge or dimension of the “chip” is under the appropriate diameter, it can wedge under and start to the lift the seals. This action will allow larger particles to do the same until failure is reached.

Product Rating

All standard configurations will pass IP20 specifications with the following exception:

The cable carrier is not covered by the specification.

All standard configurations, (less cable carrier), can be configured to pass IP30 specifications by utilizing the "IP ship kit" supplied with each unit as follows:

1. Using the supplied *Foil Discs*, cover all *counter-bored base mounting holes* that are not covered by your mounting surface.
2. Using the supplied M6 *set screws*, plug all unused *carriage mounting holes* that are not covered by the load or load plate. Note: Only insert the set screws until they are flush or slightly recessed from the mounting surface. If they are inserted too deeply they will make contact with the extrusion or center cover and may cause failure.
3. Using the supplied M6 *set screws*, plug all *threaded base mounting holes* that are not covered by your mounting surface. Depending on the travel length, some set screws will not be used.
4. Using the supplied M4 *set screws*, plug the *exposed threaded holes on both end blocks* of the unit (3 holes per end block). A few drops of Loctite® should be applied to the threads prior to insertion to ensure they do not come loose during normal operation.
5. Using the supplied plastic plugs plug the Vent/Air purge holes in each end block.

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