



Manual No. 100-5321-01
Rev. 7

412XR Series Product Manual

Effective: May 1, 2008
Supersedes: February 23, 2007



Electromechanical Positioning Systems

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 system 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 products or systems, the user, through its own analysis and testing, is solely responsible for making the final selection of the products and systems and assuring that all performance, safety and warning requirements of the application are met.

The products described herein, including without limitation, product features, specifications, designs, availability and pricing, are subject to change by Parker Hannifin Corporation and its subsidiaries at any time without notice.

The information in the product manual, including any apparatus, methods, techniques, and concepts described herein, are the proprietary property of Parker Hannifin Corporation or its licensors, and may not be copied, disclosed, or used for any purpose not expressly authorized by the owner thereof.

Since Parker Hannifin Corporation 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
• 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.parkermotion.com
.....

412XR Series Product Manual

Table of Contents

REVISION NOTES	4
CHAPTER 1 - INTRODUCTION.....	5
PRODUCT DESCRIPTION	5
UNPACKING.....	5
RETURN INFORMATION	6
REPAIR INFORMATION	6
WARNINGS AND PRECAUTIONS	6
SPECIFICATION CONDITIONS AND CONVERSIONS	6
ASSEMBLY DIAGRAMS.....	7
CHAPTER 2 - 412XR SERIES TABLE SPECIFICATIONS.....	8
ORDER NUMBER NOMENCLATURE	8
DIMENSIONAL DRAWINGS.....	10
GENERAL TABLE SPECIFICATIONS.....	11
GROUND BALLSCREW DRIVE	15
CHAPTER 3 - COMPONENT SPECIFICATIONS.....	16
LINEAR ENCODERS	16
<i>Z-Channel Position Reference</i>	<i>16</i>
<i>Linear Encoder Speed Limit</i>	<i>17</i>
<i>Linear Encoder Wiring Diagram.....</i>	<i>17</i>
LIMIT & HOME SENSORS	18
ROTARY ENCODER	18
BRAKE	19
COUPLINGS.....	19
CHAPTER 4 - BASE MOUNTING PROCEDURES	20
MOUNTING SURFACE REQUIREMENTS.....	20
BASE MOUNTING METHODS	20
CHAPTER 5 - COMPONENT MOUNTING PROCEDURES	21
CENTER DRIVE MOTOR MOUNTING	21
PARALLEL MOTOR MOUNTING	21
LIMIT/HOME SWITCH MOUNTING PROCEDURE.....	22
ROTARY BRAKE ASSEMBLY	23
CHAPTER 6 - INTERNAL ACCESS AND LUBRICATION	25
INTERNAL ACCESS PROCEDURE	25
SQUARE RAIL BEARING LUBRICATION	28
GROUND BALLSCREW LUBRICATION.....	28
APPENDIX A - INTERNAL PROTECTION	29
USING THE "IP SHIP KIT"	30

Revision Notes

Rev. 2 – Effective March 13, 2002 – Updated order number nomenclature to include a 0.1 μm encoder, added a note on travel dependent characteristics.

Rev. 3 – Effective August 31, 2004 – Clarified description of linear encoder pin out. No technical changes made.

Rev. 4

Rev. 5 – Effective June 13, 2005 - Clarified description of limit location adjustments. No technical changes made.

Rev.6 – Effective February 23, 2007- Updated grease information to Shell Alvania RL2 was Mobil HP.

Rev.7 – Effective May 1, 2008 – Corrected 412XR screw speed chart Page 15

Chapter 1 - Introduction

Product Description

412XR Positioner

The 412XR is a rugged heavy duty linear table (285 mm x 105 mm profile) that enables massive loads (up to 1470 kg) to be precisely positioned over distances up to two meters. An unrivaled array of options combined with mounting compatibility with the smaller 400XR tables makes the 412XR ideal as the base unit for multi-axis positioning of heavier payloads.

400XR Product Family

The “400XR” precision linear positioners family has achieved global recognition for consistent accuracy, reliable performance, high strength, and unmatched versatility. The XR’s have excelled in industries such as fiber optics and instrumentation, where the highest degree of precision is demanded. And yet, because of the rugged construction, strength, and sealed design, these units have been used extensively for industrial automation applications (packaging, automotive, etc). The XR family offers an unrivaled array of features and options which are easily matched to fit any application, from the very basic to the highly complex. Premier performance, modular compatibility, and quick delivery have made these tables the perfect building blocks for cost-effective multi-axis systems.

Unpacking



Unpacking

Carefully remove the positioner from the shipping crate and inspect the unit for any evidence of shipping damage. Report any damage immediately to your local authorized distributor. Please save the shipping crate 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 Hannifin Corporation 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 push in 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 the positioner in liquids.
- 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 "Return Material Authorization", (RMA), number. Please call your local authorized distributor or Parker Hannifin Corporation Customer Service Department at 800-245-6903 to obtain a "RMA" number. See Parker Hannifin Corporation Catalog #8080/USA, page D34, for additional information on returns and warranty.

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 Hannifin Corporation 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



Vertical Operation

Depending upon your load and ballscrew selection the carriage and load may 'backdrive' in power loss situations potentially causing product damage or personal injury.



Strain Relieve Electrical Components

All electrical components (such as brakes, encoders, and limit/home switches) must be strain relieved. Failure to strain relieve electrical wires or cables may result in component failure and/or possible personal injury.

Specification Conditions and Conversions

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 - 70 Degrees C. Certain components can be eliminated or substituted to improve operation at these temperatures. Positioners with low temperature or high temperature components will be handled as specials, contact your local distributor.

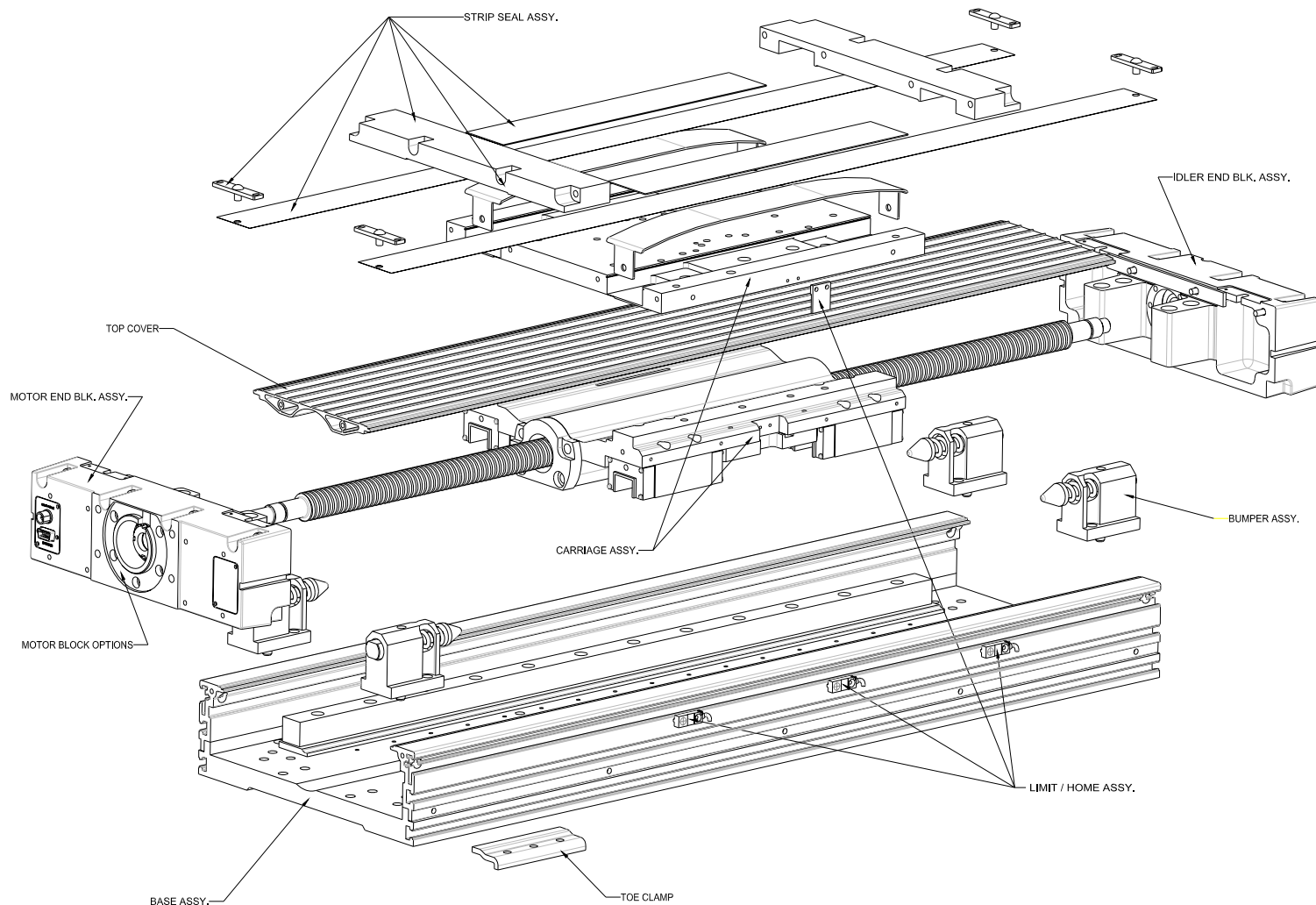
Specifications are Mounting Surface Dependent

Catalog Specifications are obtained and measured when the positioner is *fully supported, bolted down* (to eliminate any extrusion deviation), and is 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 in the center of the carriage, 37.5mm above the carriage surface. All measurements taken at any other location may deviate from these values.

Assembly Diagrams



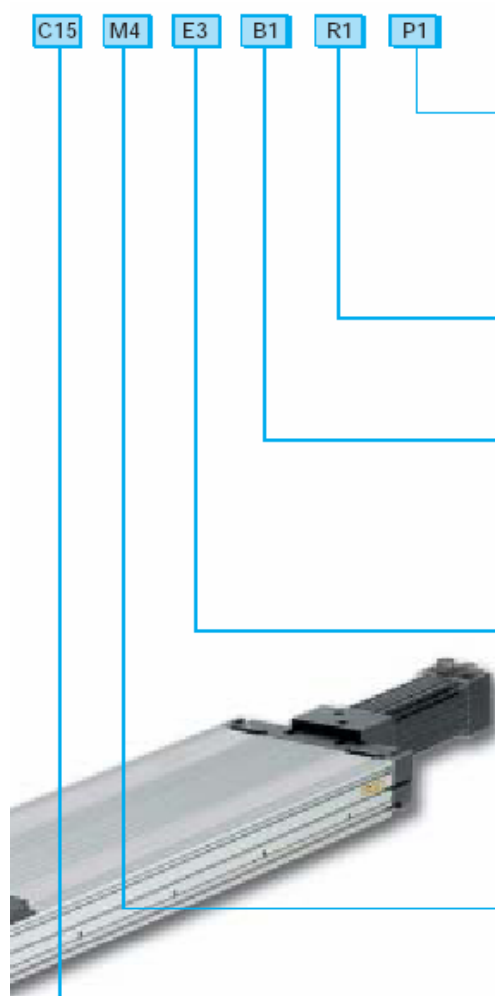
Chapter 2 - 412XR Series Table Specifications

Order Number Nomenclature

412XR Series How to Order

Order Example		412	T03	XR	M	S	-	D2	H3	L3	R1
<input checked="" type="checkbox"/> Model Series		412									
<input checked="" type="checkbox"/> Table Travel (mm)											
150			T01								
250			T02								
350			T03								
650			T04								
800			T05								
1000			T06								
1200			T07								
1500			T08								
1750			T09								
2000			T10								
<input checked="" type="checkbox"/> Table Style				XR							
<input checked="" type="checkbox"/> Mounting (Metric)					M						
<input checked="" type="checkbox"/> Grade											
Standard grade						S					
<input checked="" type="checkbox"/> Drive Screw											
Free travel								D1			
5 mm lead								D2			
10 mm lead								D3			
25 mm lead								D5			
32 mm lead								D6			
<input checked="" type="checkbox"/> Home Sensor											
No home sensor									H1		
N.C. current sinking									H2		
N.O. current sinking									H3		
N.C. current sourcing									H4		
N.O. current sourcing									H5		
<input checked="" type="checkbox"/> Travel Limit Sensor											
No limit sensor										L1	
N.C. current sinking										L2	
N.O. current sinking										L3	
N.C. current sourcing										L4	
N.O. current sourcing										L5	
<input checked="" type="checkbox"/> Clean Room Preparation											
Class 1000, strip seals											R1
Class 100, no strip seals											R2





- ☒
- Pinning Option

- P1 No multi-axis pinning
- P2 X axis carriage dowel pins (matched to Y or Z axis base)
- P3 Y axis base – dowel pins (matched to X axis carriage)
- P4 Z axis base dowel pins (matched to X axis carriage)

- ☒ Clean Room Preparation

- | | |
|----|---------------------------|
| R1 | Class 1000, strip seals |
| R2 | Class 100, no strip seals |

- ☒ Brake Option

- | | |
|----|--------------|
| B1 | No brake |
| B2 | Shaft brake† |

- ☒
- Encoder Option

- | | |
|----|-------------------------------------|
| E1 | No encoder |
| E2 | 1 μm resolution linear |
| E3 | 0,5 μm resolution linear |
| E4 | 0,1 μm resolution linear |
| E5 | 5 μm resolution linear |
| E6 | Rotary encoder† |
| E7 | Sine encoder |

- ☒
- Motor Mount

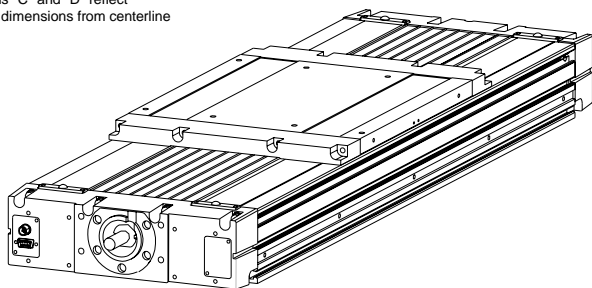
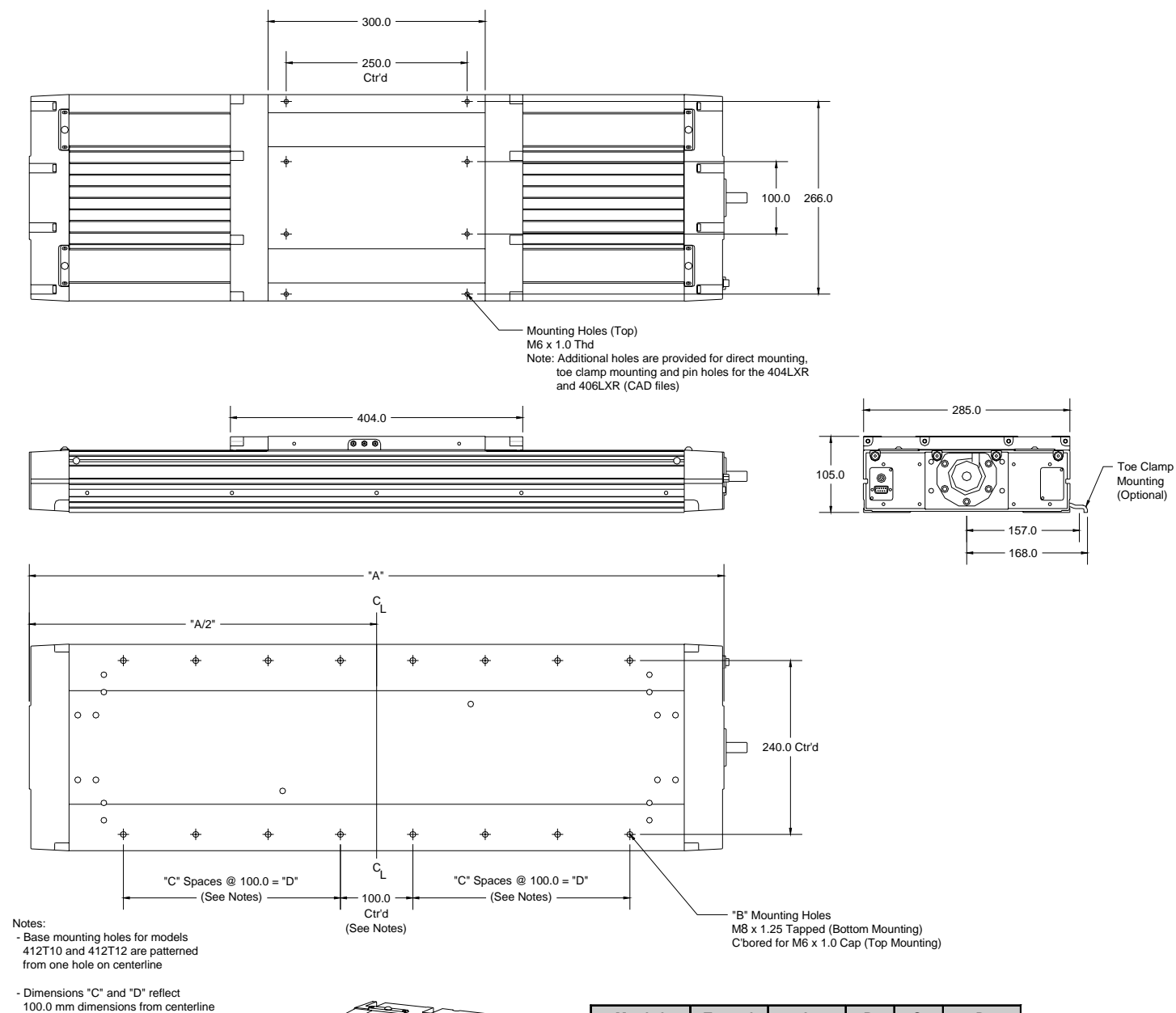
- | | |
|-----|--|
| M1 | No motor mount |
| M4 | NEMA 34 - In-line mounting |
| M14 | NEMA 34 - Parallel mounting, "A" position |
| M15 | NEMA 34 - Parallel mounting, "B" position |
| M17 | Neometric 34 - In-line mounting |
| M18 | Neometric 34 - Parallel mounting, "A" position |
| M19 | Neometric 34 - Parallel mounting, "B" position |
| M21 | Neometric 70 - In-line mounting |
| M22 | Neometric 70 - Parallel mounting, "A" position |
| M23 | Neometric 70 - Parallel mounting, "B" position |
| M29 | Neometric 92 - In-line mounting |
| M30 | Neometric 92 - Parallel mounting, "A" position |
| M31 | Neometric 92 - Parallel mounting, "B" position |
| M33 | HDY 115 - In-line mounting |

- ☒ **Motor Coupling**

- | | | | |
|-----------|-----------------------------|------------|-------------------------|
| C1 | No coupling | C8 | 12,7 mm (0.50") Oldham |
| C4 | 9,5 mm (0.38") bore Oldham | C9 | 12,7 mm (0.50") Bellows |
| C5 | 9,5 mm (0.38") bore Bellows | C10 | 14,0 mm (0.55") Oldham |
| C6 | 11,0 mm (0.43") Oldham | C11 | 14,0 mm (0.55") Bellows |
| C7 | 11,0 mm (0.43") Bellows | C14 | 19,0 mm (0.75") Oldham |
| | | C15 | 19,0 mm (0.75") Bellows |

†Rotary encoder cannot be used in conjunction with brake option.

Dimensional Drawings



Model	Travel	A	B	C	D
412T01	150	764	12	2	200
412T02	250	864	16	3	300
412T03	350	964	16	3	300
412T04	650	1264	24	5	500
412T05	800	1414	24	5	500
412T06	1000	1614	28	6	600
412T07	1200	1814	32	7	700
412T08	1500	2114	40	9	900
412T09	1750	2364	44	10	1000
412T10	2000	2614	50	12	1200

General Table Specifications

Common Characteristics	5, 10, 25 mm	32 mm
Performance		
Bidirectional Repeatability (μm)	+/- 5	+/- 5
Duty Cycle	100%	100%
Max Acceleration – m/sec^2 (in/sec^2)	3 (118)	3 (118)
Rated Capacity		
Normal load – kgf (lbs)	1470 (3241)	1470 (3241)
Axial load – kgf (lbs)	200 (441)	460 (1014)
Motor Sizing		
Drive Screw Efficiency	90%	80%
Max Break-Away Torque – Nm (in-oz)	0.61 (86)	0.76 (108)
Max Running Torque – Nm (in-oz)	0.55 (78)	0.69 (98)
Linear Bearing – Coefficient of Friction	0.01	0.01
Ballscrew Diameter (mm)	25	32
Carriage Weight – kg (lbs)	12 (27)	13 (28)

Travel Dependent Characteristics

Travel (mm)	Positional Accuracy (μm) ^(2, 3)	Straightness & Flatness Accuracy (μm)	Input Inertia 10^{-5} kg-m^2				Max Screw Speed (Revs Per Second)		Total Table Weight (kg)	
			5 mm	10 mm	25 mm	32 mm	5, 10, 25 mm	32 mm	5, 10, 25 mm	32 mm
150	64	9	27.20	29.45	46.76	98.20	351	458	39.6	41.5
250	66	15	30.21	32.46	49.78	106.28	239	312	42.9	45.0
350	71	21	33.23	35.48	52.79	114.37	173	226	46.2	48.5
650	91	36	42.27	44.52	61.83	138.63	83	108	56.1	59.0
800	94	43	46.79	49.04	66.35	150.76	62	81	61.0	64.2
1000	105	52	52.81	55.06	72.37	166.94	45	58	67.6	71.2
1250	118	62	58.84	61.09	78.40	183.11	34	44	74.2	78.2
1500	134	71	67.87	70.12	87.44	207.38	24	31	84.1	88.7
1750	154	79	75.41	77.66	94.97	227.59	18	24	92.4	97.5
2000	159	87	82.94	85.19	102.50	247.81	15	19	100.6	106.2

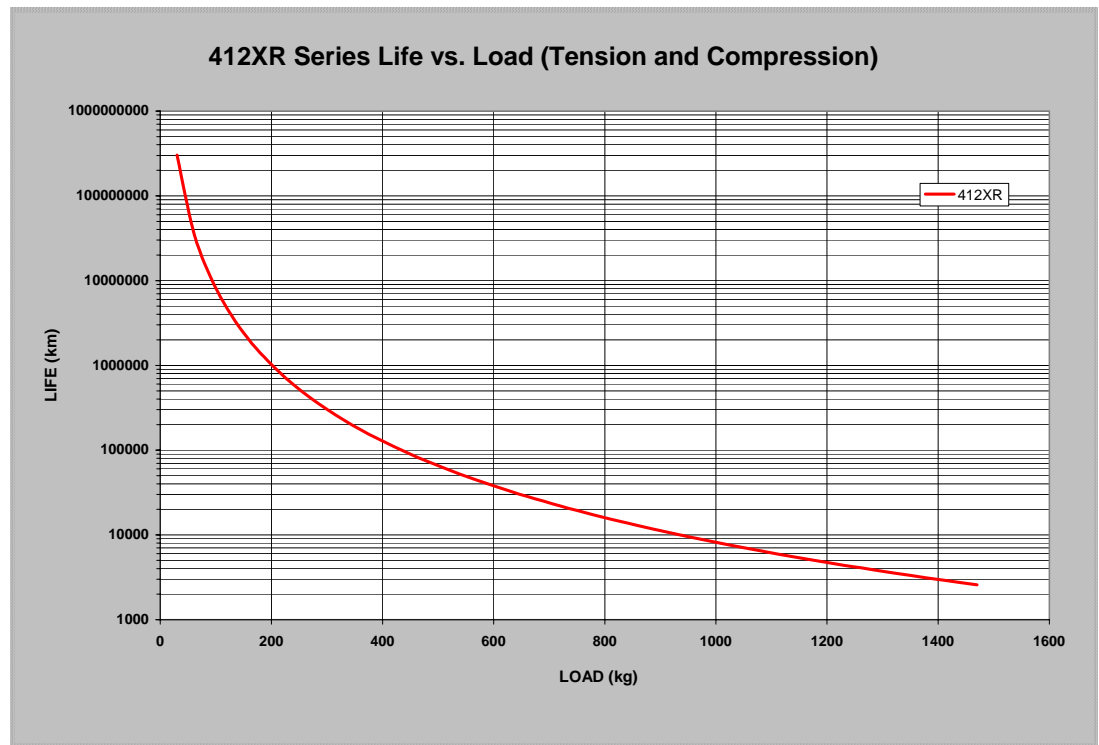
⁽²⁾ Positional accuracy applies to in-line motor configurations only. Contact factory for parallel motor specifications.

⁽³⁾ Consult factory for encoder specifications.

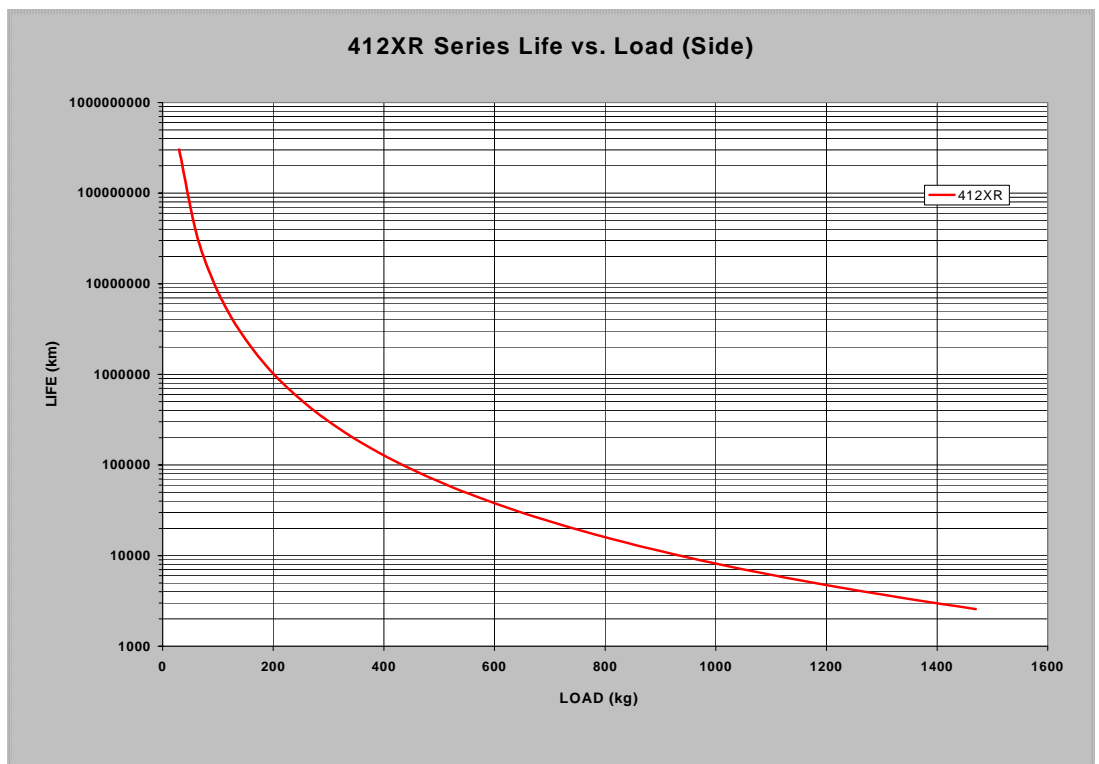
412XR Series Technical Data

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.



Side Load Chart
The “Side 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	205
d2	192
da	43

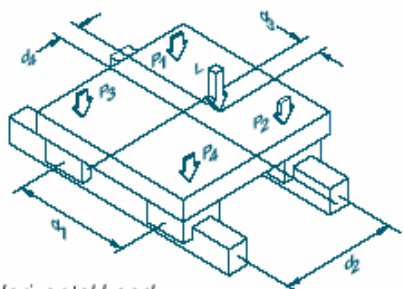
Horizontal Translation — Normal Load

Figure 1: Horizontal Load

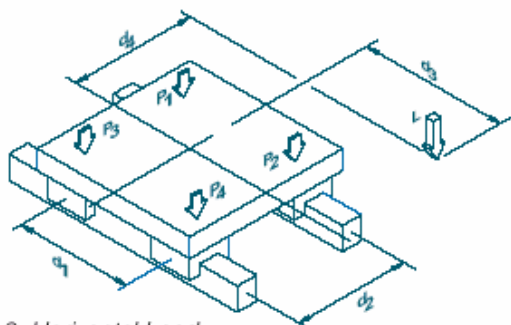


Figure 2: Horizontal Load

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

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

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

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

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 d_3 and d_4 .

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.

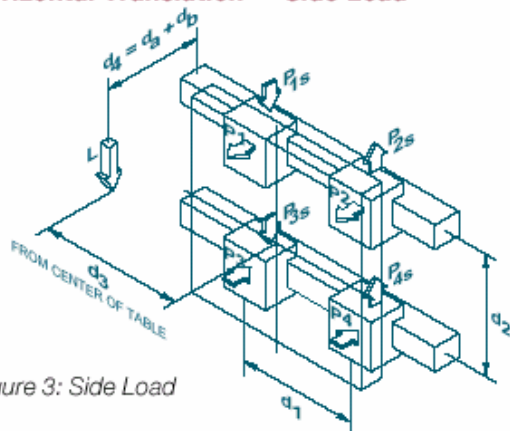
Horizontal Translation — Side Load

Figure 3: Side Load

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 d_3 and d_4 . Note that d_4 is the sum of distance d_a —the distance between bearing and center and

carriage surface which is provided for each linear positioner—plus d_b , 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 P_1 , P_2 , P_3 and P_4 are the normal loads (tensional and compression) and P_{1s} , P_{2s} , P_{3s} and P_{4s} are the side loads. For each

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

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

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

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

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
412LXR	Side & tension $P_s > P_t$ Side & tension $P_s \leq P_t$	$P_e = (0.5 \times P_t) + P_s$ $P_e = (0.5 \times P_s) + P_t$	Side load chart Tension chart
	Side & compression $P_s > P_c$ Side & compression $P_s \leq P_c$	$P_e = (0.5 \times P_c) + P_s$ $P_e = (0.5 \times P_s) + P_c$	Side load chart Compression chart

Note: Individual bearing life/load can be found by dividing the carriage **load** by four for both Tension/Compression and Side Load.

Example Computations

Example 1

Horizontal Translation
with Side Loads, 412XR
Positioner

L = 150 Kgf
130 mm from
carriage surface;
50 mm from carriage
center.

Page 13 shows this
configuration with dimensions
given here.

$$d1 = 205 \text{ mm}$$

$$db = 130 \text{ mm}$$

$$d2 = 192 \text{ mm}$$

$$d3 = 50 \text{ mm}$$

$$da = 43 \text{ mm}$$

$$d4 = da + db = 173$$

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

$$P_1 = P_2 = \frac{L}{2} \left[\frac{d_4}{d_2} \right] = 67.6 \text{ (tension) Kgf}$$

$$P_3 = P_4 = -\frac{L}{2} \left[\frac{d_4}{d_2} \right] = -67.6 \text{ (compression) Kgf}$$

$$P_{1s} = P_{3s} = \frac{L}{4} + \left[\frac{L}{2} \cdot \frac{d_3}{d_1} \right] = 37.0 \text{ (side load) Kgf}$$

$$P_{2s} = P_{4s} = \frac{L}{4} - \left[\frac{L}{2} \cdot \frac{d_3}{d_1} \right] = -0.5 \text{ (side load) Kgf}$$

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 2

Bearing 3 had $P_3 = 39.6$ Kgf tension and $P_{3s} = 9.7$
Kgf side load

$$P_s \leq P_c \Rightarrow P_e = (0.5 \times P_s) + P_c = 44.5 \text{ Kgf}$$

Refer to Bearing Life Tension and Compression
Load (page 13)

Life @ 44.5 Kgf = 1,000,000 km

Ground Ballscrew Drive

Technical Data

Topic: **Maximum Screw Speed** (Revs/Sec)

Travel mm	5 mm		10 mm		25 mm		32 mm	
	rpm	mm/s	rpm	mm/s	rpm	mm/s	rpm	mm/s
150	47	235	47	470	47	1175	42	1344
250	47	235	47	470	47	1175	42	1344
350	47	235	47	470	47	1175	42	1344
650	47	235	47	470	47	1175	42	1344
800	47	235	47	470	47	1175	42	1344
1000	45	225	45	450	45	1125	42	1344
1200	34	170	34	340	34	850	41	1312
1500	24	120	24	240	24	600	31	992
1750	18	90	18	180	18	450	24	768
2000	15	75	15	150	15	375	19	608

Chapter 3 - Component Specifications

Linear Encoders

Description	Specification
Input Power	5 VDC +/- 5% 150mA
Output (incremental)	Square wave differential line driver (EIA RS422) 2 channels A and B in quadrature (90) phase shift
Reference (Z channel) – see below for additional information	Synchronized pulse, duration equal to one resolution bit. Repeatability of position is unidirectional moving toward non-motor end.
Positional Accuracy	+/- 3 microns after linear slope correction
Extension Cable	3.0 meter – 006-1686-01 7.5 meter – 006-1686-02
Maximum Speed – see page 14 for additional information	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

Z-Channel Position Reference

The Z channel is an output on the encoder. Many servo controllers support this input. The Z channel on the 412XR is located at mid travel. The Z channel is a unidirectional device. This means that the final homing direction must occur in one direction. The 412XR is set so that the final home direction is to be toward the non-motor end of the table. The repeatability of the Z channel is equal to +/- 2 resolution counts of the encoder (except for 0.1 micron scales which have a repeatability of +/-1 microns). Thus the repeatability of the “Z” channel equals:

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

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.

Linear Encoder Speed Limit

The linear encoder has speed limits relative to encoder resolution; these limits are listed below:

Encoder Resolution	Maximum Velocity (2)	Required Post Quadrature Input Bandwidth (1)
5 micron	3 meters/second	6.7 Mhz
1 micron	3 meters/second	6.7 Mhz
0.5 micron	1.5 meters/second	6.7 Mhz
0.1 micron	0.3 meters/second	10 Mhz

- (1) 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 losses.
- (2) Maximum encoder speed may exceed maximum speed of positioner – See page 11, General Table Specifications, for maximum screw speed.

Linear Encoder Wiring Diagram

Termination: 9 pin connector

Pin	Function	Signal Name	Encoder Wire Color
1	Power	+5V	Brown
2	Incremental Signal	Ch A+	Green
3		Ch A-	Yellow
4		Ch B+	Blue
5		Ch B-	Red
6	Reference	Z+	Pink
7		Z-	Grey
8	N/A	N/A	N/A
9	Ground	Ground	White
Shield	Shield	Shield	Shield

Limit & Home Sensors

Switch Type	Proximity		
Input Power	5-30VDC, 20mA		
Output	100mA (max)		
Repeatability	+/- 10 microns (unidirectional)		
Wire Color Code	Function	Cable Wire Color	Connector
	+5 to +24 VDC	Red	A
	Limit 1 (LXR -)	Blue	B
	Limit 2 (LXR +)	Orange	C
	Home	Green	D
	Ground	Black	E
	Shield	Shield	Shield Case
LED Color	Yellow		
Switch Location	The L2-L9 limit sensors are fixed at the end of travel locations. The H2-H9 home sensors are fixed at the center of travel.		
N.O./N.C. Options	Normally Open (N.O.) switches are typically used as home sensors and are typically located between the limit sensors. Normally Closed (N.C.) switches are generally used as defense circuits to prevent damage to components caused by over-travel.		
Sinking/Sourcing Options	Sinking Switches (a.k.a. NPN): The output lead of this switch provides an electrical path to ground when activated. Sourcing Switches (a.k.a. PNP): The output lead of this switch provides a positive (+) voltage potential relative to ground. Note: refer to the controller's manual for input compatibility.		
Temperature Range	-14° F to +158° F		
Vacuum Rating	1 x 10 ⁻³ Torr		

Note: Limit 2 is the limit switch on the connector end of the table.

Rotary Encoder

Description	Specification		
Encoder Type	Modular Rotary Encoder		
Input Power	5VDC, 135mA		
Output	A/B quadrature and reference mark, differential line drive output		
Resolution	1250 lines/rev; 5000 counts post quadrature (1 micron resolution when using a 5mm lead ballscrew)		
Accuracy	+/- 2 arc minutes		
Cable Color Code	Pin Number	Function	Wire Color
	1	+VCC	Red
	2	Ground	Black
	3	CH A	White
	4	CH A NOT	Yellow
	5	CH B	Green
	6	CH B NOT	Blue
	7	Index	Orange
	8	Index NOT	Brown
	Shield	Drain	
Temperature Range	Operation (-10°C to +100°C). Storage (-30°C to +110°C)		
Cable length/Cable material	0.47 meters --- Material: PVC (std.)		

Brake

Description	Specification
Brake Type	Electromagnetic
Input Power	24VDC, 0.75A
Holding Torque	9.0 N-m
Output	100mA (max)
Wire Color Code	(+) supply Brown Output Black (-) supply Blue
Temperature Range	Operation (-40 ⁰ F to +180 ⁰ F)

Couplings

Coupling Grade (Style): **Standard Grade (Oldham)**

Catalog Coupling Code	Bore Diameter (Motor Side)	Outside Diameter (in)	Length (in)	Rated Torque (Nm)	Torsional Windup (Nm/Rad)	Misalignment Specifications		
						Lateral (mm)	Axial (mm)	Angular
C4	0.375"	1.97	2.35	29.9	1375	+/- 0.254	+/- 0.203	+/- 0.5 ⁰
C6	11mm	1.97	2.35	29.9	1375	+/- 0.254	+/- 0.203	+/- 0.5 ⁰
C8	0.500"	1.97	2.35	29.9	1375	+/- 0.254	+/- 0.203	+/- 0.5 ⁰
C10	14mm	1.97	2.35	29.9	1375	+/- 0.254	+/- 0.203	+/- 0.5 ⁰
C14	19mm	1.97	2.35	29.9	1375	+/- 0.254	+/- 0.203	+/- 0.5 ⁰

Coupling Grade (Style): **Precision Grade (Bellows)**

Catalog Coupling Code	Bore Diameter (Motor Side)	Outside Diameter (mm)	Length (mm)	Rated Torque (Nm)	Torsional Windup (Nm/Rad)	Misalignment Specifications		
						Lateral (mm)	Axial (mm)	Angular
C5	0.375"	40.5	47	10	8070	+/- 0.15	+/- 0.4	+/- 1.2 ⁰
C7	11mm	40.5	47	10	8070	+/- 0.15	+/- 0.4	+/- 1.2 ⁰
C9	0.500"	40.5	47	10	8070	+/- 0.15	+/- 0.4	+/- 1.2 ⁰
C11	14mm	40.5	47	10	8070	+/- 0.15	+/- 0.4	+/- 1.2 ⁰
C15	19mm	40.5	47	10	8070	+/- 0.15	+/- 0.4	+/- 1.2 ⁰

Output Shaft Diameter: 14.0 mm

Replacement Couplings: Consult factory for replacement couplings.

Chapter 4 - Base Mounting Procedures

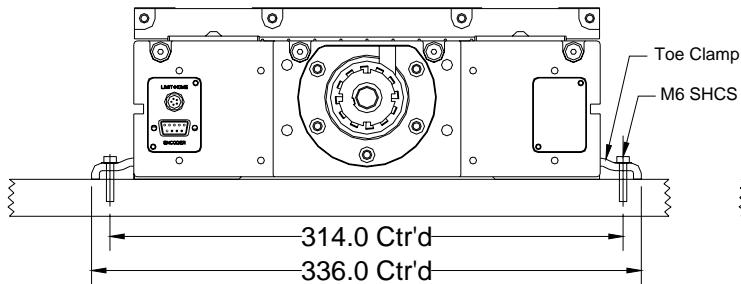
Mounting Surface Requirements

Proper mounting of the 412XR is essential to optimize product performance. All specifications are based on the following conditions:

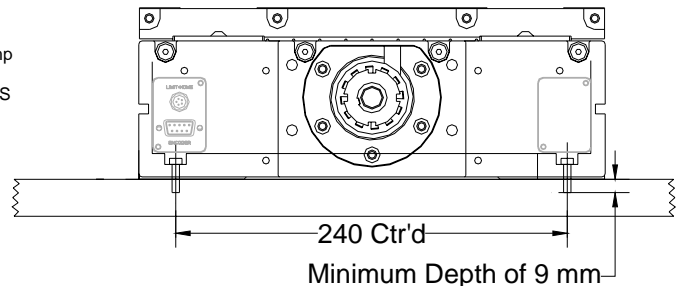
- The positioner must be bolted down along its entire length.
- The positioner must be mounted to a flat, stable surface with a flatness error less than or equal to 0.013mm/300mm.
 - Catalog specifications may deviate for positioners mounted to surfaces that do not meet the above conditions.
 - If the 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 Parker Hannifin Corporation for guidelines on specifications of overhang applications.

Base Mounting Methods

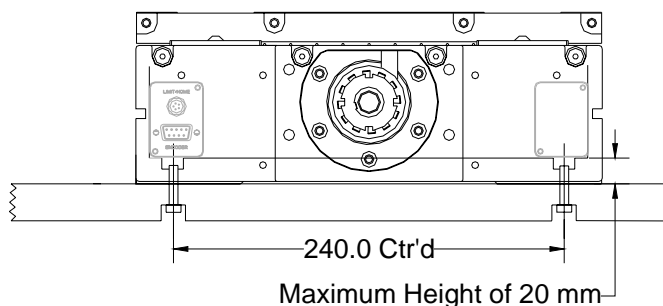
The 412XR can be mounted via the three (3) following methods:



Toe Clamp Mounting
P/N 100-6766-01
Three (3) M6 SHCS Per Toe Clamp



Base Through Holes
Use M6 SHCS
Note: Minimum Screw Length of 22 mm



Bottom Tapped Holes
Use M8 SHCS
Note Maximum Length

Chapter 5 - Component Mounting Procedures

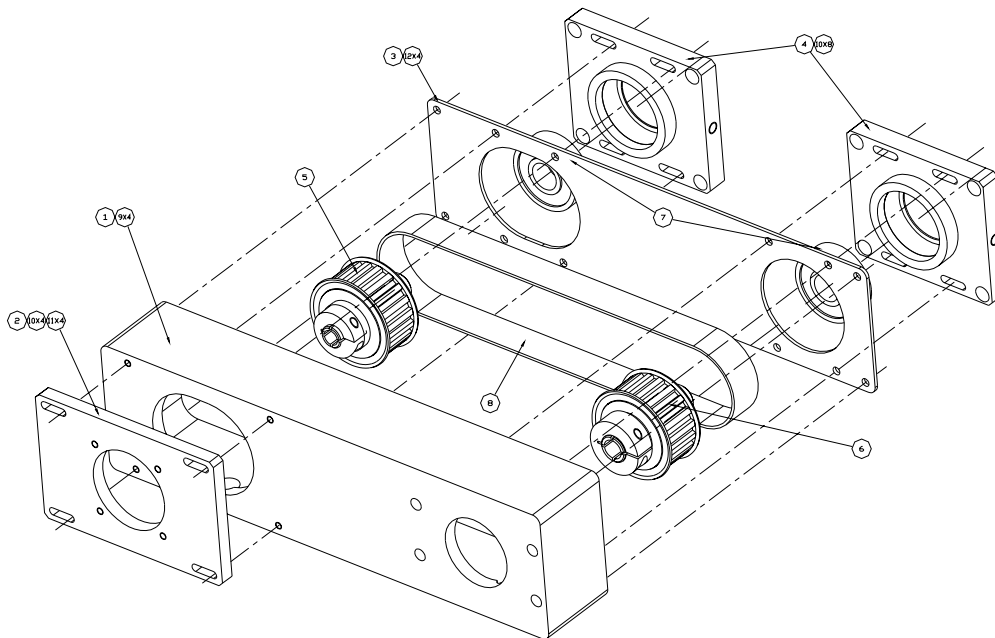
Center Drive Motor Mounting

Tools Required: Allen Key

- Slip coupling over drive shaft and tighten the screw on the drive shaft side of the coupling. **Note: Do not use Loctite on coupling screws.**
- Slide motor into motor adapter plate and into coupling. Select the appropriate hardware and tighten all bolts.
- Tighten the coupling screw on the motor shaft side. Turn motor by the rear shaft to make sure carriage moves. Then hold carriage and rotate motor again by the rear shaft to make sure coupling won't slip. If the motor does not have a rear shaft be certain that the coupling screws are tight.

Note: Do not use Loctite on coupling screws.

Parallel Motor Mounting



Part Number	Item #	Qty	Part Description
100-6786-01	1	1	Parallel Motor Mount Body
Varies per application	2	1	Motor Flange
100-6787-01	3	1	Outboard Bearing Housing
100-6790-01	4	2	Outboard Bearing Housing
002-1918-03	5	1	Pulley Assembly
002-1918-03	6	1	Pulley Assembly
003-2228-01	7	2	Radial Bearing
003-3109-01	8	1	Belt
SCH-M008-020	9	4	M8 x 1.25 x 20mm SHCS
SCH-M005-020	10	12	M5 x 0.8 x 20mm SHCS
SCH-M006-020	11	4	M6 x 0.8 x 20mm SHCS
SCH-M005-010	12	4	M5 x 0.8 x 10mm SHCS

Limit/Home Switch Mounting Procedure

Tools Required For Adjustment: Allen Key

Travel limit sensors signal the motor to stop whenever the table carriage is approaching the end of travel. These sensors can be adjusted over the table travel. The home sensor provides a fixed reference point which the carriage can be commanded to return repeatedly

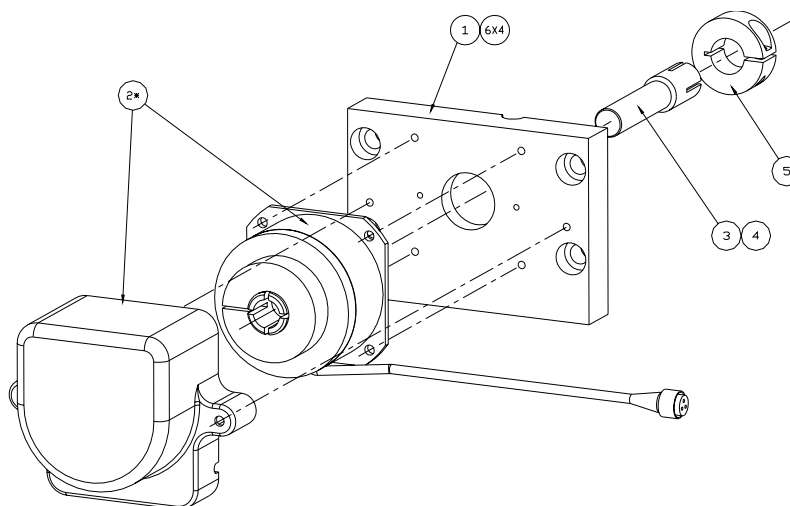
- Remove the tripper flag from the carriage by removing the two (2) M2 Flat Head Screws. Peel off the slot cover.



- Move the switches to the desired locations by loosening the M2.5 Flat Head Screw. Limit 2 is the limit switch on the motor end of the table.



Rotary Brake Assembly

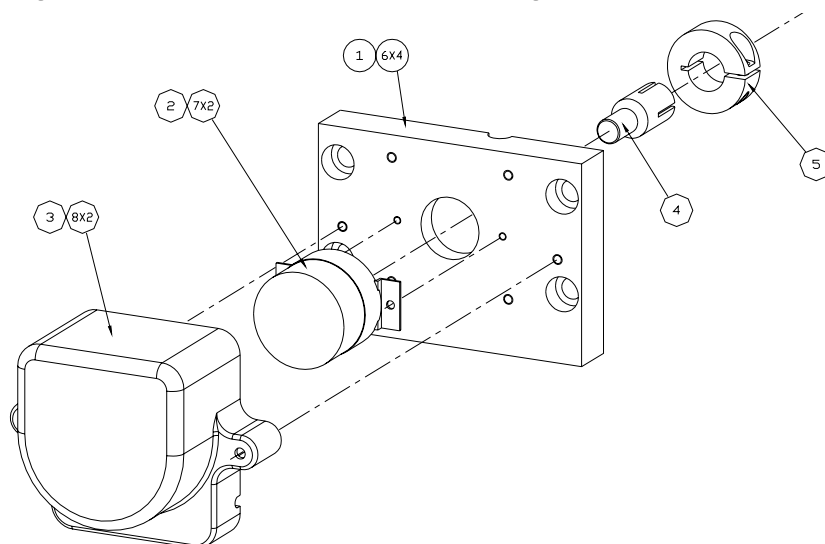


Part Number	Item #	Qty	Part Description
100-6781-01	1	1	Brake/Encoder Mount
003-3187-01	2	1	Brake Kit – Complete
003-6798-01	3	1	Shaft Extension
003-6789-01	4	1	Key
003-2604-14	5	1	Clamp Collar, Metric 16mm
SCH-M008-020	6	4	M8 x 1.25 x 20mm SHCS

Tools Required for Adjustment: Allen Key, Loctite #272, 24V power source Dial indicator

- Locate and remove ballscrew drive cover plate (opposite motor end) by removing two (2) button head screws. Clean idler end of the ballscrew shaft extending through the bearing block using a clean cloth, and acetone or alcohol. Remove all oil or foreign material that might be present.
- Locate clamp collar (p/n 003-2604-14) and shaft extension (p/n 003-6798-01). Slip the clamp collar over the large end of the shaft extension and slide it up until it contacts the shoulder. Slip the mandrel through the end block and over the extended portion of the screw shaft. Using the access hole through the end block, tighten the clamp collar screw.
- Verify concentricity. Using a dial indicator, measure the run out (wobble) on the end of the screw shaft by turning the drive screw. Run out should not exceed 0.001 inches.
- Add brake torque disk. Remove the brake's hexagon shaped torque disk. This disk is shaped like a thin hex-shaped nut with the flats on the shaft extension. Slip the nut over the shaft extension and align the set screws in the nut with the flats on the mandrel. Gap the disk to a distance of 3mm (0.118 in) from the face of the end block. Tighten the set screws evenly.
- Mount brake assembly. Orient the brake so the thin side of the brake (with the hex pocket) is toward the table. Slide the brake over the shaft extension and torque disk (nut) until the nut seats completely into the hexagon shaped pocket in the brake. The face of the brake will be flush to the end block when seated properly. If there is a space between the brake plate and the end block, the gap may need readjustment.
- Attach brake. Rotate the brake until the bolt holes are aligned to the bolt holes in the end block. Apply a few drops of Loctite #272 to the socket head cap screws, insert them through the provided spacers, and tighten. The wire should be positioned near the top of the assembly.
- Verify brake. Apply 24VDC to the brake (deactivate) and transverse the carriage. The shaft should spin freely (same without the brake) without any foreign noises or increased torque. Remove the brake from the power source and verify the brake has activated and the screw shaft is unable to spin freely.

Rotary Encoder Assembly



Part Number	Item #	Qty	Part Description
100-6781-01	1	1	Brake/Encoder Mount
003-3102-01	2	1	Rotary Encoder
003-3188-01	3	1	Encoder/Brake Cover
003-6798-01	4	1	Shaft Extension
003-2604-14	5	1	Clamp Collar
SCH-M008-020	6	4	M8 x 1.25 x 20mm SHCS
SCH-M003-008	7	2	M3 x 0.5 x 8mm SHCS
SCH-M004-030	8	2	M4 x 0.7 x 30mm SHCS

Tools Required for Adjustment: Allen Key, Loctite #272, 24V power source Dial indicator

- Locate and remove ballscrew drive cover plate (opposite motor end) by removing two (2) button head screws. Clean the idler end of the ballscrew shaft extending through the bearing block using a clean cloth, and acetone or alcohol. Remove all oil or foreign material that might be present.
- Locate rotary encoder (p/n 003-3102-01) and remove cover. Locate clamp collar (p/n 003-2604-14) and shaft extension (p/n 003-6798-01). Slip the clamp collar over the large end of the shaft extension and slide it up until it contacts the shoulder. Slip the shaft extension through the end block and over the extended portion of the screw shaft. Using the access hole through the end block, tighten the clamp collar screw.
- Verify concentricity. Using a dial indicator, measure the run out (wobble) on the end of the screw shaft by turning the drive screw. Run out should not exceed 0.001 inches. Align hub on the encoder with the shaft and gently push hub onto shaft until the encoder is resting on the mounting surface. **DO NOT** push down on encoder - Push on Hub Only!
- Align the set screw with one of the flats on the mandrel. This can be accomplished by spinning the mandrel (traversing the table). Maintain pressure on hub to insure that it is seated in centering mechanism and secure hub to shaft by rotating set screw clockwise until set screw makes contact to shaft. Make sure flat on shaft is aligned with set screw clockwise until set screw makes contact to shaft.
- Insert the short leg of Allen Wrench and rotate additional ¼ in clockwise to apply 20 oz/in torque. (Warning: Over tightening will cause burnelling of the shaft which will make it difficult to remove the encoder necessary!!). Align the encoder with the threaded holes in the end block. Insert button head screws and tighten.
- Push slide lock in completely. Visually verify that a gap is present between the disk and mask on the underside of the PC board. If no gap is present, remove encoder and reinstall. Verify encoder mounting by traversing carriage. The shaft and encoder PC board should spin freely without any noises or increased torque.
- Install cover by snapping it into place.

Chapter 6 – Internal Access and Lubrication

Internal Access Procedure

The following procedure outlines the steps required to access the interior of the positioner.

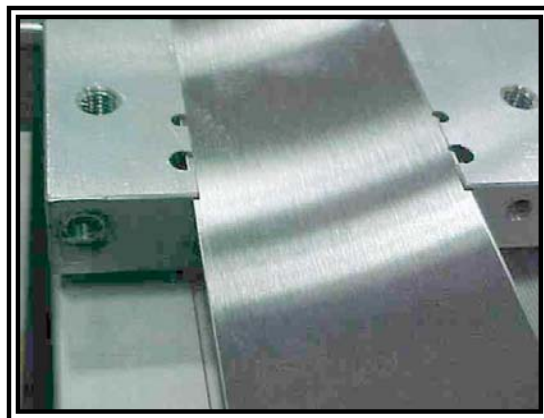
- Remove carriage end caps by removing eight (8) M6 Socket Head Cap Screws (4pc/carriage side).



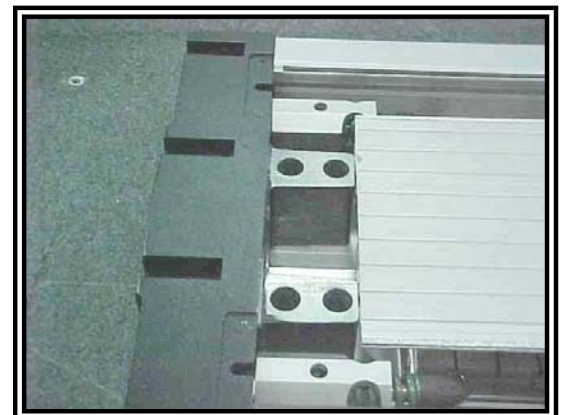
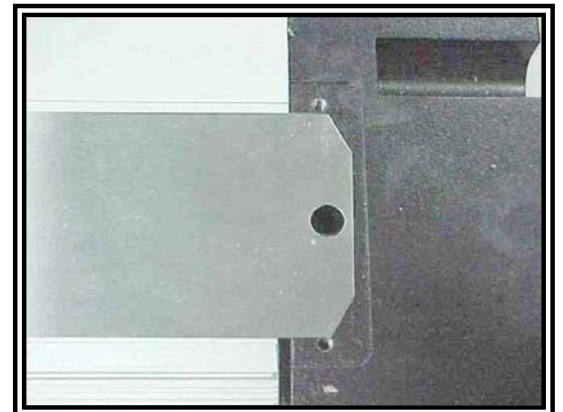
- Pull carriage end caps off. Carriage end caps on both sides of carriage must be removed.



- Remove the two (2) strip seal cover plates.



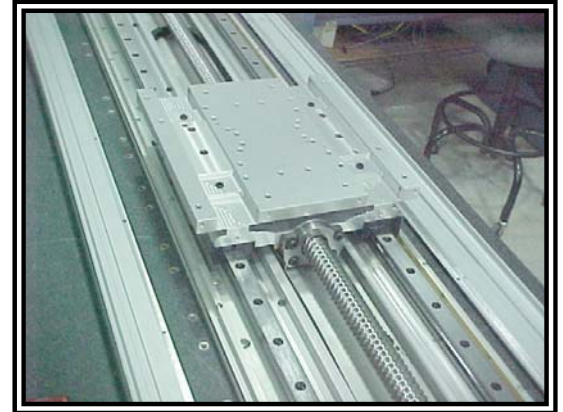
- Remove the four (4) strip seal clamps by removing eight (8) M3 Socket Head Cap Screws (2pc/clamp).
- Remove the eight (8) “shoulder bolts” on both ends of the table, M4 Socket Head Cap Screws (4pc/end).
- Carefully pull the strip seal through the carriage.
- Caution: The strip seal ends are VERY SHARP.
- Carefully lift one end of the top cover so that it clears the edge of the end block. Push the top cover through the carriage and set aside.



- Remove the M3 Button Head Cap Screws that attach the side covers to the base.



- Slide the side cover off the base.



- The base mounting holes can now be accessed.
- Great care should be used when inserting and tightening screws on the side with the encoder tape scale. If the tape is damaged the linear encoder will not function properly and the table may “run away.”



Reassemble positioner by reversing steps.

Note: When installing the strip seals to the unit, completely tighten one clamp while leaving the other side loose. Thread, but do not tighten the screws on the other end. Pull the clamp away from the carriage and tighten the screws to ensure the strip seal is pulled taught.

Square Rail Bearing Lubrication

See Section on *Internal Access* for procedure to access interior of positioner.

Materials Required: Shell Alvania RL 2, Isopropyl Alcohol, Clean Cloth, Small Brush

- **Lubrication Type:**

Use Shell Alvania RL 2 pn# 003-3686-30, non-EP, lithium soap thickened greases. This grease also inhibited with additives that promote long service life and provide excellent lubrication and corrosion protection. Shell Alvania Grease RL 2 is readily pumpable in pressure grease dispensing systems.

- **Lubricant Appearance:**

smooth-textured, amber colored.

- **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.

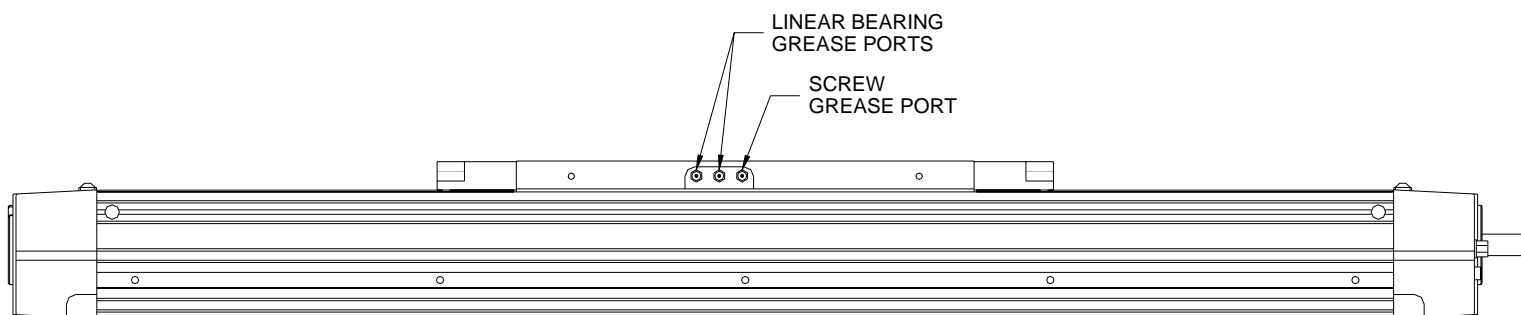
- **Lubricant Application:**

Locate the two grease fittings on the side of the carriage (see below). Apply only one pump of grease per rail at a time. Move the carriage 700mm and apply again if necessary. If there is a buildup of grease, wipe the rails down with a clean cloth. After greasing the rails check the encoder scale on the inside wall of the table. If there is grease on the scale clean with a lint free cloth, removing all dirt and grease. Using a lint free cloth, wipe down linear tape scale with isopropyl alcohol. Check the encoder to make sure it is getting the proper counts by moving the carriage by hand.

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

Ground Ballscrew Lubrication

Locate the ballscrew grease fitting on the side of the carriage (see below). Apply one pump of grease and move the carriage 700mm and apply again if necessary.



Appendix A - Internal Protection

The 412XR is protected from its environment via magnetically retained Protective Seals. Parker Hannifin Corporation 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 switch pinch points, pinch points caused 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 lift the seals. This action will allow larger particles to do the same until failure is reached.

Using the "IP Ship Kit"

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

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

- Using the supplied *aluminum foil disks*, cover all *counter-bored base mounting holes* that are not covered by your mounting surface. The disks should be installed from the outside of the unit. Depending on the travel length, some disks will not be used. Use the 0.75 inch diameter disk to cover the large hole on the drive end of the unit.
- Using the supplied *aluminum foil disks*, plug any *exposed holes on side covers* of the unit. The number of holes on the side covers will vary with the options ordered.