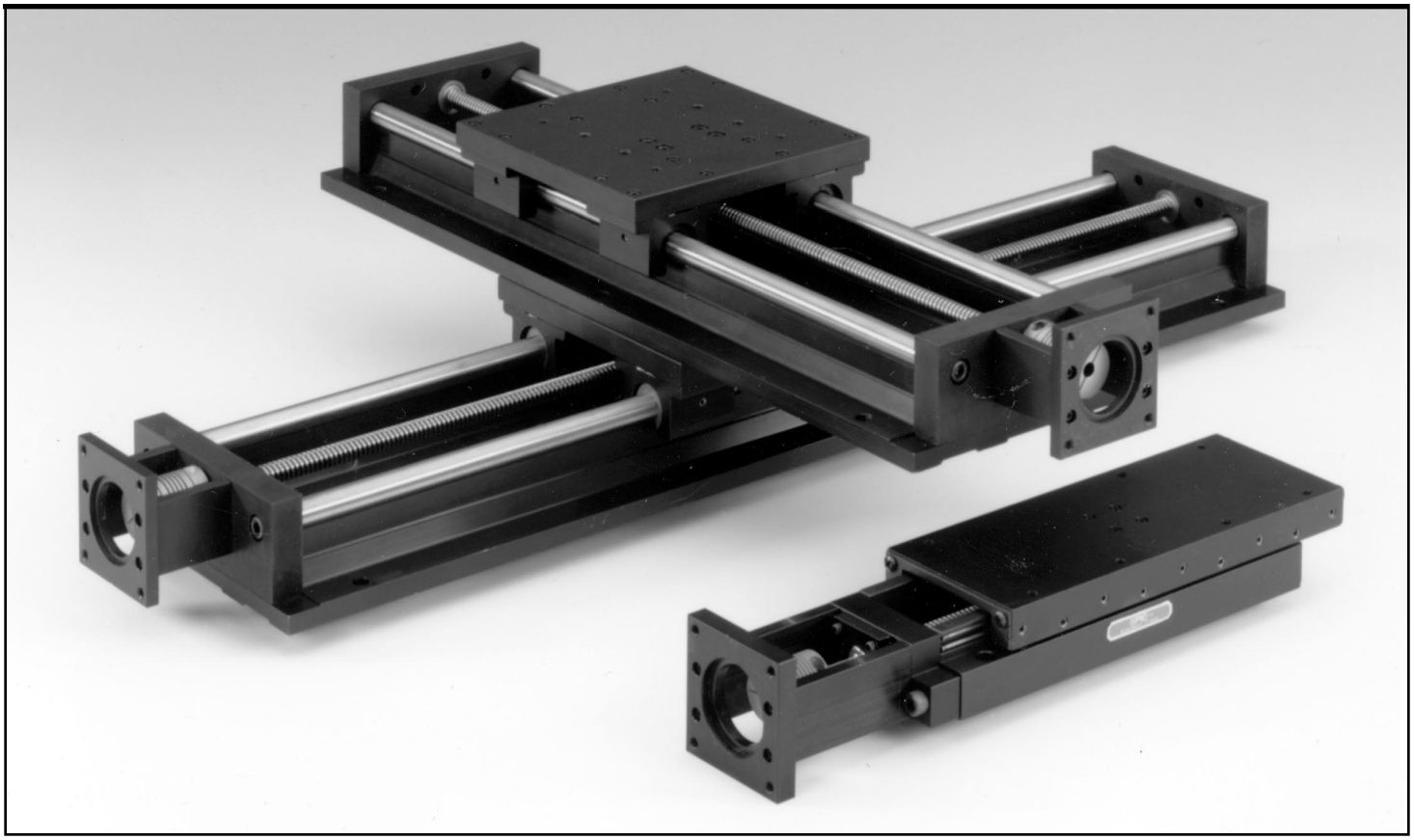
PIC® DESIGN

PRECISION INDUSTRIAL COMPONENTS

LINEAR MOTION SYSTEMS

User-assembled or Pre-assembled



PIC now offers a comprehensive line of linear motion systems, either pre-assembled or as complete component sets for user assembly. Specifying these PIC products is a smart, cost-effective approach for a wide spectrum of applications. Single sourcing eliminates the need for extensive, expensive component and system design and time-consuming searches through different manufacturers' catalogs for all required designs and sizes. Because all PIC linear motion systems feature *modular design*, assembly is simplified and all parts fit together precisely.

PIC linear motion systems are available in both inch and metric sizes. They are designed from standard, in-stock, precision products, and are backed by the PIC reputation for quality and service.

System and Component Selection Information

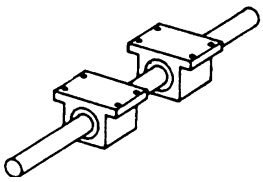
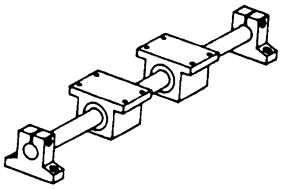
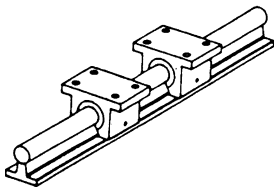
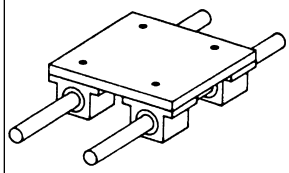
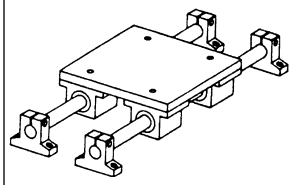
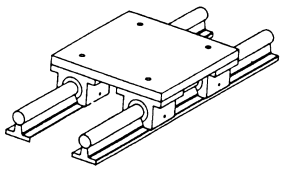
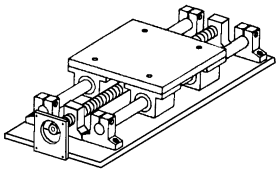
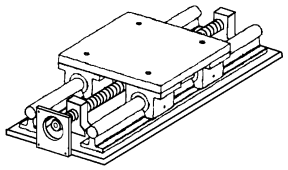
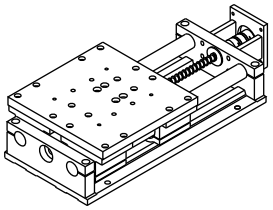
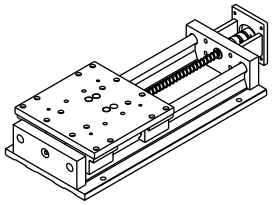
PIC offers ten standard linear motion systems. (See next page for diagrams.) Each system is available in either inch or metric sizes and a wide range of dimensions. Choosing the system that best suits the application is normally a function of the design engineering department. The information provided in this section will enable users to select all standard PIC components required for the chosen system and application.

To select the appropriate components for a system, all loads and the magnitude and direction of forces for the application must first be determined. This information will aid in the selection of the appropriate linear bearings to carry the load and provide the desired system life. After determining the bearing load and evaluating shaft deflection, the designer can select the necessary components from the PIC standard parts listed for each system.

Many factors are involved in the selection of a linear motion system and its components. The steps usually required for such selection are as follows:

1. Selection of the type of system that best suits the application
2. Calculation of system loading and bearing selection
3. Determination of shaft deflection
4. Selection of other system components
5. Selection of lead screw assemblies (systems 7 through 10).

LINEAR MOTION SYSTEMS

SYSTEM 1 	*SYSTEM 2* 	*SYSTEM 3* 	*SYSTEM 4* 	*SYSTEM 5* 
SYSTEM 6 	*SYSTEM 7* 	*SYSTEM 8* 	*SYSTEM 9* 	*SYSTEM 10* 

STEP 1

SYSTEM SELECTION

Note: *For quick delivery at an economical cost, see PIC Pre-assembled Systems 9 and 10.*

The initial selection of the type of system that suits the application is best done by the design engineer. PIC offers ten standard systems, illustrated above and described below.

System 1 — Two linear bearings mounted in housings, with an unsupported shaft through both bearings

System 2 — Two linear bearings mounted in housings, with a supported shaft through both bearings

System 3 — Two linear bearings mounted in housings, with a shaft and shaft support rail through both bearings (particularly effective when shaft deflection may be a problem)

System 4 — Four linear bearings mounted in housings, with two parallel unsupported shafts through two bearings and joined by a carriage top

System 5 — Four linear bearings mounted in housings, with two parallel supported shafts through two bearings and supports at both ends for mounting to a base and joined by a carriage top

System 6 — Four linear bearings mounted in housings, with two parallel shafts and shaft support rails through two bearings and joined by a carriage top

System 7 — Same as system 5, but with lead screw, anti-backlash nut, ball bearings and housings, coupling, and motor adaptor, mounted on a common aluminum base

System 8 — Same as system 6, but with lead screw, anti-backlash nut, ball bearings and housings, coupling, and motor adaptor, mounted on a common aluminum base

System 9 — Specialized version of System 7. Precise alignment of rails and special linear bearing housings. The key to this unit is standard, one-size shafting which allows for quick delivery at a discounted cost

System 10 — Specialized version of System 8. One-piece base plate with integral rail supports, precision machined to allow for superior specifications. The key to this unit is standard, one-size shafting which allows for quick delivery at a discounted cost

END SUPPORTS VS RAIL SUPPORT

Systems 2, 5, 7 & 9 vs.
Systems 3, 6, 8 & 10

The proper diameter of the shafts in the linear motion system depends on the load that is to be carried. The shaft deflection at the center of the stroke can be estimated from the shaft selection table (table 5 or 6). If shaft deflection must be minimized, a continuous or intermittent support rail should be used.

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STEP 2

CALCULATION OF SYSTEM LOADING AND BEARING SELECTION

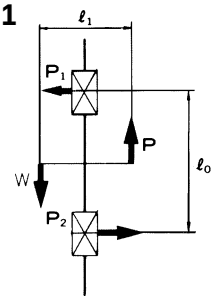
LOAD CALCULATION

The main factors involved in the selection of bearing material and size are the load on a single bearing and the total travel life required. The load on a single bearing varies with the position of the center of gravity on the table top or carriage. To calculate the load on a single bearing:

1. For systems 1, 2, and 3, use load calculation diagram 1 for vertical applications, and load calculation diagram 2 for horizontal applications.
2. For systems 4, 5, 6, 7, and 8, use load calculation diagram 3 for horizontal axis, load calculation diagram 4 for vertical axis, and load calculation diagram 5 for vertical lateral axes.

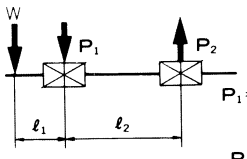
LOAD CALCULATION DIAGRAMS

DIAGRAM 1



$$P_1 = P_2 = \frac{\ell_1}{\ell_0} W$$

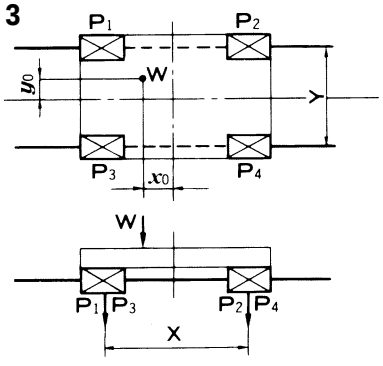
DIAGRAM 2



$$P_1 = \frac{\ell_1 + \ell_2}{\ell_2} W$$

$$P_2 = \frac{\ell_1}{\ell_2} W$$

DIAGRAM 3



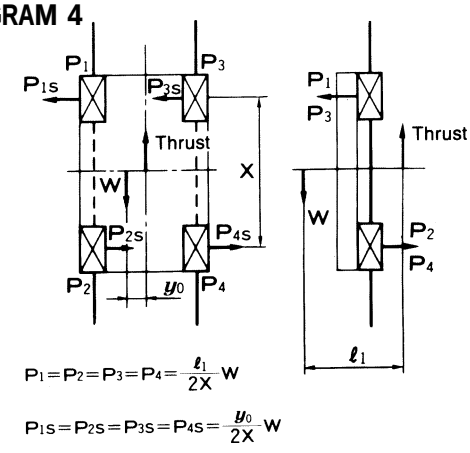
$$P_1 = \frac{1}{4} W + \frac{x_0}{2X} W + \frac{y_0}{2Y} W$$

$$P_2 = \frac{1}{4} W - \frac{x_0}{2X} W + \frac{y_0}{2Y} W$$

$$P_3 = \frac{1}{4} W + \frac{x_0}{2X} W - \frac{y_0}{2Y} W$$

$$P_4 = \frac{1}{4} W - \frac{x_0}{2X} W - \frac{y_0}{2Y} W$$

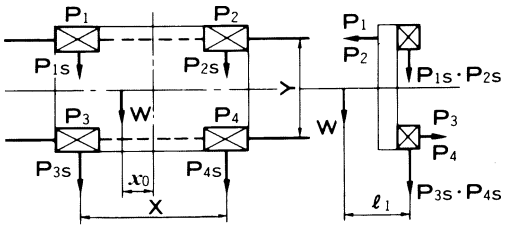
DIAGRAM 4



$$P_1 = P_2 = P_3 = P_4 = \frac{\ell_1}{2X} W$$

$$P_{1S} = P_{2S} = P_{3S} = P_{4S} = \frac{y_0}{2X} W$$

DIAGRAM 5



$$P_1 = P_2 = P_3 = P_4 = \frac{\ell_1}{2Y} W$$

$$P_{1S} = P_{3S} = \frac{1}{4} W + \frac{x_0}{2X} W$$

$$P_{2S} = P_{4S} = \frac{1}{4} W - \frac{x_0}{2X} W$$

P = FORCE ON BEARINGS
W = WEIGHT ON SYSTEM

STEP 2

CONTINUED FROM PREVIOUS PAGE

BEARING SELECTION

Two types of bearings, self-aligning recirculating ball bearings and engineered plastic bearings, are available from PIC for use in linear motion systems. Both types are available in inch or metric sizes, and closed or open styles.

SELF-ALIGNING BEARINGS

The formulas and tables listed below will enable the designer to select the proper self-aligning bearings to meet the required life.

Basic Dynamic Load Rating and Life Expectancy

The basic dynamic load rating of a self-aligning bearing is the load which allows a rating life of 2,000,000 inches or 50,000 meters of travel, without change in magnitude or direction. The rating life of a bearing for a particular application can be calculated from the following equations:

For inch calculations,

$$L = \left[\frac{f_h}{f_w} \bullet \frac{C}{P}\right]^3 \bullet 2 \bullet 10^6$$

For metric calculations,

$$L = \left[\frac{f_h}{f_w} \bullet \frac{C}{P}\right]^3 \bullet 10^5$$

With:

- L = rating life in inches for inch calculations, in meters for metric calculations
- f_h = hardness factor (1.0); shafts are 60-65 HRC
- f_w = load coefficient (refer to table 1)
- C = basic design load rating in pounds for inch calculations, in Newtons for metric calculations (refer to table 2 or 3)
- P = force in pounds for inch calculations, force in Newtons for metric calculations, determined from load calculation diagrams 1 through 5, as applicable

Rating life in hours can be calculated from the travel distance per unit of time, as follows:

$$L_h = \frac{L}{2 \bullet L_s \bullet n_1 \bullet 60}$$

With:

- L_h = rating life in hours
- L_s = stroke length in inches for inch calculations, in meters for metric calculations
- n_1 = rating in cycles per minute

To calculate the basic dynamic load rating, use the following formulas:

For distances in inches,

$$C = \sqrt[3]{\frac{L}{2 \bullet 10^6}} \bullet \frac{f_w}{f_h} \bullet P$$

For distances in kilometers,

$$C = \sqrt[3]{\frac{L}{1 \bullet 10^5}} \bullet \frac{f_w}{f_h} \bullet P$$

Example of Calculations

System Type:	5
Expected Life:	20,000 hours
Number Of Bearings:	4
Weight On Carriage:	175 lb
Stroke Distance:	24 inches
Traveling Speed:	1000 in. / min
Cycle:	2 x 24 inches
Shaft:	A10L series

From the life expectancy in hours formula, the life expectancy in traveling distance is:

$$L_h = \frac{L}{2 L_s n_1 \bullet 60}$$

$$L = L_h \bullet 2 \bullet L_s \bullet n_1 \bullet 60$$

$$L = 20{,}000 \bullet 2 \bullet 24 \bullet \frac{1000}{2 \bullet 24} \bullet 60$$

$$L = 1.20 \times 10^9 \text{ inches}$$

From the dynamic load rating formula:

$$C = \sqrt[3]{\frac{L}{2 \bullet 10^6}} \bullet \frac{f_w}{f_h} \bullet P$$

$$C = \sqrt[3]{\frac{1.2 \bullet 10^9}{2 \bullet 10^6}} \bullet \frac{1.5}{1.0} \bullet \frac{175}{4}$$

$$C = 553 \text{ lb}$$

The assumption is that the 175 pound load is distributed evenly between bearings; therefore, PIC system 5 with 1-inch diameter bearings having a load capacity of 850 pounds is selected.

Table 1. Load Coefficient

Operating Conditions	f_w
Operation at low speed (50 ft / min or 15 m / min or less) without impulsive shock from outside	1 - 1.5
Operation at intermediate speed (200 ft/min or 60 m/min or less) without impulsive shock	1.5 - 2.0
Operation at high speed (over 200 ft / min or 60 m / min) with impulsive shock from outside	2.0 - 3.5

Table 2. C Dynamic Load Rating of Inch Bearings

Shaft Diameter (inch)	Rating (lb)	PIC Part No.	
		Closed	Open
1/4	60	**PFL-4**	—
3/8	95	**PFL-6**	—
1/2	230	**PFL-8**	**PFL0-8**
5/8	400	**PFL-10**	**PFL0-10**
3/4	470	**PFL-12**	**PFL0-12**
1	850	**PFL-16**	**PFL0-16**
1 1/4	1230	**PFL-20**	**PFL0-20**
1 1/2	1480	**PFL-24**	**PFL0-24**

Table 3. C Dynamic Load Rating of Metric Bearings

Shaft Diameter (mm)	Rating (Newtons)	PIC Part No.
CLOSED TYPE		
12	650	**MPFL-12**
16	800	**MPFL-16**
20	1500	**MPFL-20**
25	2500	**MPFL-25**
30	3200	**MPFL-30**
40	5550	**MPFL-40**
OPEN TYPE		
12	750	**MPFL0-12**
16	920	**MPFL0-16**
20	1560	**MPFLO-20**
25	2600	**MPFLO-25**
30	3330	**MPFL0-30**
40	5740	**MPFL0-40**

ENGINEERED PLASTIC LINEAR BEARINGS

PIC self-lubricating plastic bearings are maintenance free, run quietly, are not subject to catastrophic failure, do not gall or brinell the mating shaft, and can run on “soft” non-corrosive 303 stainless steel shafting. These bearings are also capable of operation in hostile environments and are interchangeable with PIC self-aligning, recirculating bearings.

Bearing PV Rating

The performance capabilities of engineered plastic linear bearings are defined by the PV rating of the bearings, where P is the pressure in pounds per square inch on the projected bearing area, and V is the velocity in feet per minute of the wear surface. Maximum PV for continuous operation is 7500 PSI/FPM. To calculate PV for a particular application, divide the total load in pounds on the bearing by the effective area in square inches, and multiply by the average bearing velocity in feet per minute.

Example of Calculation:

System Type:	5
Number Of Bearings:	4
Weight On Carriage:	175 lb
Load Per Bearing:	175/4 = 43.75 lb
Traveling Speed:	1000 in./min or 83.33 ft/min
Bearing Selected:	PLC-16 (1 in. = ID, 2.25 in. long = L)

$$P = \frac{\text{Load (lb.)}}{\text{ID} \bullet \text{L}} = \frac{43.75}{1 \bullet 2.25} = 19.44 \text{ PSI}$$

$$PV = 19.44 \bullet 83.33 = 1620 \text{ PSI/FPM}$$

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STEP 3

DETERMINATION OF SHAFT DEFLECTION

Once the appropriate bearing has been selected to fulfill the load requirements of the application, the shaft deflection must be determined. Dimensions and tolerances of PIC shafts are listed in table 4. The required shaft diameter is dictated by the ID of the selected bearing, and the deflection can be determined from table 5 or 6 for inch or metric systems, respectively.

Table 4. Shaft Diameters and Tolerances

Diameter (inch)	PIC Series	Tolerance (inch)
1/4	A10L-4	0.2495 / 0.2490
3/8	A10L-6	0.3745 / 0.3740
1/2	A10L-8	0.4995 / 0.4990
5/8	A10L-10	0.6245 / 0.6240
3/4	A10L-12	0.7495 / 0.7490
1	A10L-16	0.9995 / 0.9990
1 1/4	A10L-20	1.2495 / 1.2490
1 1/2	A10L-24	1.4994 / 1.4989

Table 5. Shaft Deflection Table (Inch Systems). Deflection Per Pound At Center Of Fixed Supporting Shaft.

Shaft Diameter (inches)	Length Of Unsupported Section (inches)												
	4	6	8	10	12	16	20	24	30	36	42	48	72
1/4	5.85×10^{-5}	1.98×10^{-4}	4.68×10^{-4}	9.15×10^{-4}	1.58×10^{-3}	3.75×10^{-3}	7.32×10^{-3}	1.26×10^{-2}	2.5×10^{-2}				
3/8	1.20×10^{-5}	4.05×10^{-5}	9.63×10^{-5}	1.79×10^{-4}	3.25×10^{-4}	7.68×10^{-4}	1.43×10^{-3}	2.60×10^{-3}	4.83×10^{-3}	8.33×10^{-3}	1.32×10^{-2}	1.98×10^{-2}	
1/2	3.63×10^{-6}	1.23×10^{-5}	2.90×10^{-5}	5.68×10^{-5}	9.83×10^{-5}	2.33×10^{-4}	4.50×10^{-4}	7.85×10^{-4}	1.53×10^{-3}	2.65×10^{-3}	4.20×10^{-3}	6.28×10^{-3}	2.12×10^{-2}
3/4	7.15×10^{-7}	2.42×10^{-6}	5.73×10^{-6}	1.12×10^{-5}	1.94×10^{-5}	4.58×10^{-5}	8.95×10^{-5}	1.55×10^{-4}	3.02×10^{-4}	5.23×10^{-4}	8.30×10^{-4}	1.24×10^{-3}	4.18×10^{-3}
1	2.25×10^{-7}	7.70×10^{-7}	1.76×10^{-6}	3.55×10^{-6}	6.15×10^{-6}	1.46×10^{-5}	2.85×10^{-5}	4.93×10^{-5}	9.63×10^{-5}	1.66×10^{-4}	2.63×10^{-4}	3.93×10^{-4}	1.33×10^{-3}
1 1/4	9.30×10^{-8}	3.13×10^{-7}	7.45×10^{-7}	1.45×10^{-6}	2.50×10^{-6}	5.95×10^{-6}	1.16×10^{-5}	2.01×10^{-5}	3.93×10^{-5}	6.78×10^{-5}	1.08×10^{-4}	1.61×10^{-4}	5.43×10^{-4}
1 1/2	4.48×10^{-8}	1.51×10^{-7}	3.58×10^{-5}	7.00×10^{-7}	1.21×10^{-6}	2.88×10^{-6}	5.60×10^{-6}	9.68×10^{-6}	1.89×10^{-5}	3.28×10^{-5}	5.18×10^{-5}	7.75×10^{-5}	2.58×10^{-4}
2	1.42×10^{-8}	4.78×10^{-8}	1.13×10^{-7}	2.21×10^{-7}	3.83×10^{-7}	9.05×10^{-7}	1.77×10^{-6}	3.05×10^{-6}	5.98×10^{-6}	1.03×10^{-5}	1.64×10^{-5}	2.45×10^{-5}	8.25×10^{-5}

Note:

Deflections listed above are based on system being fixed at both ends, with load in center of span.

Using the formula:

$$\text{Deflection} = \frac{W_S L^3}{192EI}$$

W_S = Load on shaft
L = Length
E = Modulus of elasticity
I = Moment of inertia of cross section

Example:

Shaft: 1/4 in. diameter
Load: 8 pounds
Length: 10 inches
Multiplier (From Table 5): 9.15×10^{-4} inches/pound

$$\text{Deflection} = \frac{9.15 \times 10^{-4} \text{ inches}}{\text{pound}} \times 8 \text{ pounds} = .0073 \text{ inches}$$

Table 6. Shaft Deflection Table (Metric Systems). Deflection Per kgf At Center Of Fixed Supporting Shaft.

Shaft Diameter (mm)	Length Of Unsupported Section (mm)							
	125	250	500	750	1000	1250	1500	2000
12	4.75×10^{-4}	3.80×10^{-3}	3.04×10^{-2}	1.02×10^{-1}	2.4×10^{-1}	4.75×10^{-1}	8.21×10^{-1}	1.95
16	1.50×10^{-4}	1.20×10^{-3}	9.62×10^{-3}	3.25×10^{-2}	7.7×10^{-2}	1.50×10^{-1}	2.59×10^{-1}	6.16×10^{-1}
20	6.15×10^{-5}	4.92×10^{-4}	3.94×10^{-3}	1.33×10^{-2}	3.15×10^{-2}	6.15×10^{-2}	1.06×10^{-1}	2.52×10^{-1}
25	2.52×10^{-5}	2.02×10^{-4}	1.62×10^{-3}	5.45×10^{-3}	1.29×10^{-2}	2.52×10^{-2}	4.36×10^{-2}	1.03×10^{-1}
30	1.21×10^{-5}	9.72×10^{-5}	7.78×10^{-4}	2.63×10^{-3}	6.23×10^{-3}	1.21×10^{-2}	2.10×10^{-2}	4.98×10^{-2}
40	3.84×10^{-6}	3.07×10^{-5}	2.45×10^{-4}	8.30×10^{-4}	1.96×10^{-3}	3.84×10^{-3}	6.64×10^{-3}	1.57×10^{-2}

Note:

Deflections listed above are based on system being fixed at both ends, with load in center of span.

Using the formula:

$$\text{Deflection} = \frac{W_S L^3}{192EI}$$

W_S = Load on shaft
L = Length
E = Modulus of elasticity
I = Moment of inertia of cross section

Example:

Shaft: 20 mm diameter
Load: 25 kgf
Length: 1000 mm
Multiplier (From Table 6): 3.15×10^{-2} mm/kg

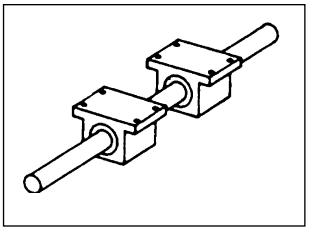
$$\text{Deflection} = \frac{3.15 \times 10^{-2} \text{ mm}}{\text{kgf}} \times 25 \text{ kgf} = 0.7875 \text{ mm}$$

$$\textbf{Shaft Load} = \frac{\textbf{Total Load}}{\textbf{Number of Shafts}}$$

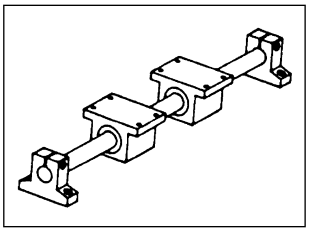
STEP 4

COMPONENT SELECTION

User Assembled †



SYSTEM 1



SYSTEM 2

After selecting the type of system, the size and type of bearings, and the shaft deflection, the designer can select the required PIC components from the listed bills of materials for systems 1 through 6 that follow.

COMPONENT SELECTION SYSTEMS 1 AND 2 / INCH & METRIC

NOTE —
For system 2, specify all components including shaft hangers; for system 1, specify all components except shaft hangers.

Example

System 1 Bill of Material Example:

48 inches long with self aligning recirculating bearings would consist of the following:

- 2 PFL-8 bearings
- 2 S5-3 bearing housings
- 1 A10L-8-48 shaft

System 2 Bill of Material Example:

Add 2 SHA-8 shaft hangers to the Bill of Materials for System 1.

For PIC assembled systems, see System Ordering Code on page 1-12

Example — System 1:

48" long, 1/2" shaft with self-aligining recirculating bearings.

Part Number = LS18-48

Bill of Material — Systems 1 and 2 / Inch

Shaft Dia. (in)	Section A * Bearing Type	Bearing Part No.	Bearing QTY	Bearing Housing Part No.	Housing QTY	Shafting Type	Shafting Part No.	Section B * Shaft Hanger Part No.	Shaft Hanger QTY
1/4	Self-Aligning	PFL-4	2	S5-1	2	1060 Steel	A10L-4-**	SHA-4	2
	Engr. Plastic	PLC-4	2			303 Stainless	A11-4-**		
3/8	Self-Aligning	PFL-6	2	S5-2	2	1060 Steel	A10L-6-**	SHA-6	2
	Engr. Plastic	PLC-6	2			303 Stainless	A11-6-**		
1/2	Self-Aligning	PFL-8	2	S5-3	2	1060 Steel	A10L-8-**	SHA-8	2
	Engr. Plastic	PLC-8	2			303 Stainless	A11-8-**		
5/8	Self-Aligning	PFL-10	2	S5-4	2	1060 Steel	A10L-10-**	SHA-10	2
	Engr. Plastic	PLC-10	2			303 Stainless	A11-10-**		
3/4	Self-Aligning	PFL-12	2	S5-5	2	1060 Steel	A10L-12-**	SHA-12	2
	Engr. Plastic	PLC-12	2			303 Stainless	A11-12-**		
1	Self-Aligning	PFL-16	2	S5-6	2	1060 Steel	A10L-16-**	SHA-16	2
	Engr. Plastic	PLC-16	2			303 Stainless	A11-16-**		
1 1/4	Self-Aligning	PFL-20	2	S5-7	2	1060 Steel	A10L-20-**	SHA-20	2
	Engr. Plastic	PLC-20	2			303 Stainless	A11-20-**		
1 1/2	Self-Aligning	PFL-24	2	S5-8	2	1060 Steel	A10L-24-**	SHA-24	2
	Engr. Plastic	PLC-24	2			303 Stainless	A11-24-**		

Bill of Material — Systems 1 and 2 / Metric

Shaft Dia. (mm)	Section A * Bearing Type	Bearing Part No.	Bearing QTY	Bearing Housing Part No.	Housing QTY	Shafting Type	Shafting Part No.	Section B * Shaft Hanger Part No.	Shaft Hanger QTY
12	Self-Aligning	MPFL-12	2	MSC-12	2	1060 Steel	MA10-12-**	MSHA-12	2
	Engr. Plastic	MPLC-12	2			303 Stainless	MA11-12-**		
16	Self-Aligning	MPFL-16	2	MSC-16	2	1060 Steel	MA10-16-**	MSHA-16	2
	Engr. Plastic	MPLC-16	2			303 Stainless	MA11-16-**		
20	Self-Aligning	MPFL-20	2	MSC-20	2	1060 Steel	MA10-20-**	MSHA-20	2
	Engr. Plastic	MPLC-20	2			303 Stainless	MA11-20-**		
25	Self-Aligning	MPFL-25	2	MSC-25	2	1060 Steel	MA10-25-**	MSHA-25	2
	Engr. Plastic	MPLC-25	2			303 Stainless	MA11-25-**		
30	Self-Aligning	MPFL-30	2	MSC-30	2	1060 Steel	MA10-30-**	MSHA-30	2
	Engr. Plastic	MPLC-30	2			303 Stainless	MA11-30-**		
40	Self-Aligning	MPFL-40	2	MSC-40	2	1060 Steel	MA10-40-**	MSHA-40	2
	Engr. Plastic	MPLC-40	2			303 Stainless	MA11-40-**		

NOTE: * System 1 consists of Section A
System 2 consists of Section A plus Section B

**** Length of shaft in inches for inch systems.
Length of shaft in millimeters for metric systems.

† Can be ordered pre-assembled by PIC DESIGN

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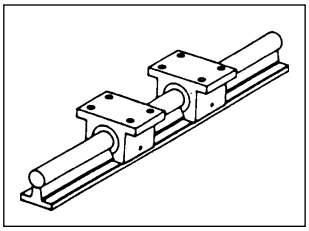
STEP 4



SYSTEM 3

COMPONENT SELECTION SYSTEMS 3 / INCH & METRIC

Bill of Material — Systems 3 / Inch

Shaft Dia. (in)	Bearing			Bearing Housing		Shafting		Shaft Support Rail	
	Type	Part No.	QTY	Part No.	QTY	Type	Part No.	Part No.	QTY *
1/2	Self-Aligning	PFLO-8	2	S5-13S	2	1060 Steel	A10-8D-**	PSR-8-PD	1
	Engr. Plastic	PLO-8	2	S5-13		303 Stainless	A11-8D-**		
5/8	Self-Aligning	PFLO-10	2	S5-14S	2	1060 Steel	A10-10D-**	PSR-10-PD	1
	Engr. Plastic	PLO-10	2	S5-14		303 Stainless	A11-10D-**		
3/4	Self-Aligning	PFLO-12	2	S5-15S	2	1060 Steel	A10-12D-**	PSR-12-PD	1
	Engr. Plastic	PLO-12	2	S5-15		303 Stainless	A11-12D-**		
1	Self-Aligning	PFLO-16	2	S5-16S	2	1060 Steel	A10-16D-**	PSR-16-PD	1
	Engr. Plastic	PLO-16	2	S5-16		303 Stainless	A11-16D-**		
1 1/4	Self-Aligning	PFLO-20	2	S5-17S	2	1060 Steel	A10-20D-**	PSR-20-PD	1
	Engr. Plastic	PLO-20	2	S5-17		303 Stainless	A11-20D-**		
1 1/2	Self-Aligning	PFLO-24	2	S5-18S	2	1060 Steel	A10-24D-**	PSR-24-PD	1
	Engr. Plastic	PLO-24	2	S5-18		303 Stainless	A11-24D-**		

Bill of Material — Systems 3 / Metric

Shaft Dia. (mm)	Bearing			Bearing Housing		Shafting			Shaft Support Rail	
	Type	Part No.	QTY	Part No.	QTY	Type	Part No.	QTY	Part No.	QTY *
12	Self-Aligning	MPFLO-12	2	MSO-12	2	1060 Steel	MA10-12D-**	1	MPSR-12-PD	1
	Engr. Plastic	MPLO-12	2			303 Stainless	MA11-12D-**			
16	Self-Aligning	MPFLO-16	2	MSO-16	2	1060 Steel	MA10-16D-**	1	MPSR-16-PD	1
	Engr. Plastic	MPLO-16	2			303 Stainless	MA11-16D-**			
20	Self-Aligning	MPFLO-20	2	MSO-20	2	1060 Steel	MA10-20D-**	1	MPSR-20-PD	1
	Engr. Plastic	MPLO-20	2			303 Stainless	MA11-20D-**			
25	Self-Aligning	MPFLO-25	2	MSO-25	2	1060 Steel	MA10-25D-**	1	MPSR-25-PD	1
	Engr. Plastic	MPLO-25	2			303 Stainless	MA11-25D-**			
30	Self-Aligning	MPFLO-30	2	MSO-30	2	1060 Steel	MA10-30D-**	1	MPSR-30-PD	1
	Engr. Plastic	MPLO-30	2			303 Stainless	MA11-30D-**			
40	Self-Aligning	MPFLO-40	2	MSO-40	2	1060 Steel	MA10-40D-**	1	MPSR-40-PD	1
	Engr. Plastic	MPLO-40	2			303 Stainless	MA11-40D-**			

Example

System 3 Bill of Material Example:

System 3, 48 inches long, with self-aligning recirculating bearings would consist of the following:

- 2 PFLO-8 bearings
- 2 S5-13S bearing housings
- 1 A10-8D-48 shaft
- 2 PSR-8-PD shaft support rails

For PIC assembled systems, see System Ordering Code on page 1-12

Example — System 3:

48" long, 1/2" shaft with self-aligining recirculating bearings.

Part Number = LS38-48

NOTE: * Quantity of support rail depends on shaft length: each support rail is 24 inches (610 mm) long.

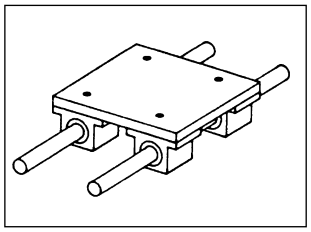
** Length of shaft in inches for inch systems. Length of shaft in millimeters for metric systems.

† Can be ordered pre-assembled by PIC DESIGN

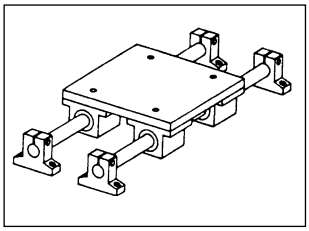
STEP 4

CONTINUED FROM PREVIOUS PAGE

User Assembled †



SYSTEM 4



SYSTEM 5

COMPONENT SELECTION SYSTEMS 4 AND 5 / INCH & METRIC

NOTE —
For system 5, specify all components, including shaft hangers; for system 4, specify all components except shaft hangers.

Bill of Material — Systems 4 and 5 / Inch

Shaft Dia. (in)	Section A * Bearing Type	Bearing Part No.	Bearing QTY	Bearing Housing Part No.	Bearing Housing QTY	Shafting Type	Shafting Part No.	Shafting QTY	Table Top Part No.	Table Top QTY	Section B * Shaft Hanger Part No.	Shaft Hanger QTY
1/4	Self-Aligning	PFL-4	4	S5-1	4	1060 Steel	A10L-4-**	2	LMT25-40	1	SHA-4	4
	Engr. Plastic	PLC-4	4			303 Stainless	A11-4-**					
3/8	Self-Aligning	PFL-6	4	S5-2	4	1060 Steel	A10L-6-**	2	LMT37-40	1	SHA-6	4
	Engr. Plastic	PLC-6	4			303 Stainless	A11-6-**					
1/2	Self-Aligning	PFL-8	4	S5-3	4	1060 Steel	A10L-8-**	2	LMT50-55	1	SHA-8	4
	Engr. Plastic	PLC-8	4			303 Stainless	A11-8-**					
5/8	Self-Aligning	PFL-10	4	S5-4	4	1060 Steel	A10L-10-**	2	LMT62-55	1	SHA-10	4
	Engr. Plastic	PLC-10	4			303 Stainless	A11-10-**					
3/4	Self-Aligning	PFL-12	4	S5-5	4	1060 Steel	A10L-12-**	2	LMT75-75	1	SHA-12	4
	Engr. Plastic	PLC-12	4			303 Stainless	A11-12-**					
1	Self-Aligning	PFL-16	4	S5-6	4	1060 Steel	A10L-16-**	2	LMT100-75	1	SHA-16	4
	Engr. Plastic	PLC-16	4			303 Stainless	A11-16-**					
1 1/4	Self-Aligning	PFL-20	4	S5-7	4	1060 Steel	A10L-20-**	2	LMT125-100	1	SHA-20	4
	Engr. Plastic	PLC-20	4			303 Stainless	A11-20-**					
1 1/2	Self-Aligning	PFL-24	4	S5-8	4	1060 Steel	A10L-24-**	2	LMT150-130	1	SHA-24	4
	Engr. Plastic	PLC-24	4			303 Stainless	A11-24-**					

Bill of Material — Systems 4 and 5 / Metric

Shaft Dia. (in)	Section A * Bearing Type	Bearing Part No.	Bearing QTY	Bearing Housing Part No.	Bearing Housing QTY	Shafting Type	Shafting Part No.	Shafting QTY	Table Top Part No.	Table Top QTY	Section B * Shaft Hanger Part No.	Shaft Hanger QTY
12	Self-Aligning	MPFL-12	4	MSC-12	4	1060 Steel	MA10-12-**	2	MLMT12-125	1	MSHA-12	4
	Engr. Plastic	MPLC-12	4			303 Stainless	MA11-12-**					
16	Self-Aligning	MPFL-16	4	MSC-16	4	1060 Steel	MA10-16-**	2	MLMT16-125	1	MSHA-16	4
	Engr. Plastic	MPLC-16	4			303 Stainless	MA11-16-**					
20	Self-Aligning	MPFL-20	4	MSC-20	4	1060 Steel	MA10-16-**	2	MLMT20-200	1	MSHA-20	4
	Engr. Plastic	MPLC-20	4			303 Stainless	MA11-16-**					
25	Self-Aligning	MPFL-25	4	MSC-25	4	1060 Steel	MA10-20-**	2	MLMT25-200	1	MSHA-25	4
	Engr. Plastic	MPLC-25	4			303 Stainless	MA11-20-**					
30	Self-Aligning	MPFL-30	4	MSC-30	4	1060 Steel	MA10-30-**	2	MLMT30-250	1	MSHA-30	4
	Engr. Plastic	MPLC-30	4			303 Stainless	MA11-30-**					
40	Self-Aligning	MPFL-40	4	MSC-40	4	1060 Steel	MA10-40-**	2	MLMT40-320	1	MSHA-40	4
	Engr. Plastic	MPLC-40	4			303 Stainless	MA11-40-**					

Example

System 4 Bill of Material Example:

48 inches long with self aligning recirculating bearings

- 4 PFL-8 Bearings
- 4 S5-3 Bearing Housings
- 2 A10L-8-48 Shafts
- 1 LMT50-55 Table Top

System 5 Bill of Material Example:

Add 4 SHA-8 shaft hangers to the Bill of Materials for System 4.

For PIC assembled systems, see System Ordering Code on page 1-12

Example — System 4:

48" long, 1/2" shaft with self-aligining recirculating bearings.

Part Number = LS48-48

NOTE: * System 4 consists of Section A
System 5 consists of Section A plus Section B

** Length of shaft in inches for inch systems. Length of shaft in millimeters for metric systems.

† Can be ordered pre-assembled by PIC DESIGN

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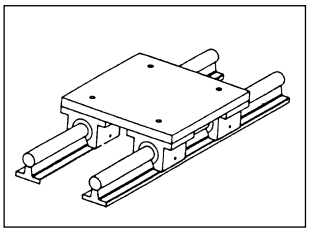
STEP 4



SYSTEM 6

COMPONENT SELECTION SYSTEMS 6 / INCH & METRIC

Bill of Material — Systems 6 / Inch

Shaft Dia. (in)	Bearing			Bearing Housing		Shafting			Shaft Support		Table Top	
	Type	Part No.	QTY	Part No.	QTY	Type	Part No.	QTY	Part No.	QTY *	Part No.	QTY
1/2	Self-Aligning	PFLO-8	4	S5-13S	4	1060 Steel	A10-8D-**	2	PSR-8PD	2	LMT50-55	1
	Engr. Plastic	PLO-8	4	S5-13		303 Stainless	A11-8D-**					
5/8	Self-Aligning	PFLO-10	4	S5-14S	4	1060 Steel	A10-10D-**	2	PSR-10PD	2	LMT62-55	1
	Engr. Plastic	PLO-10	4	S5-14		303 Stainless	A11-10D-**					
3/4	Self-Aligning	PFLO-12	4	S5-15S	4	1060 Steel	A10-12D-**	2	PSR-12PD	2	LMT75-75	1
	Engr. Plastic	PLO-12	4	S5-15		303 Stainless	A11-12D-**					
1	Self-Aligning	PFLO-16	4	S5-16S	4	1060 Steel	A10-16D-**	2	PSR-16PD	2	LMT100-75	1
	Engr. Plastic	PLO-16	4	S5-16		303 Stainless	A11-16D-**					
1 1/4	Self-Aligning	PFLO-20	4	S5-17S	4	1060 Steel	A10-20D-**	2	PSR-20PD	2	LMT125-100	1
	Engr. Plastic	PLO-20	4	S5-17		303 Stainless	A11-20D-**					
1 1/2	Self-Aligning	PFLO-24	4	S5-18S	4	1060 Steel	A10-24D-**	2	PSR-24PD	2	LMT150-130	1
	Engr. Plastic	PLO-24	4	S5-18		303 Stainless	A11-24D-**					

Bill of Material — Systems 6 / Metric

Shaft Dia. (mm)	Bearing			Bearing Housing		Shafting			Shaft Support		Table Top	
	Type	Part No.	QTY	Part No.	QTY	Type	Part No.	QTY	Part No.	QTY *	Part No.	QTY
12	Self-Aligning	MPFLO-12	4	MSO-12	4	1060 Steel	MA10-12D-**	2	MPSR-12-PD	2	MLMT12-125	1
	Engr. Plastic	MPLO-12	4			303 Stainless	MA11-12D-**					
16	Self-Aligning	MPFLO-16	4	MSO-12	4	1060 Steel	MA10-16D-**	2	MPSR-16-PD	2	MLMT16-125	1
	Engr. Plastic	MPLO-16	4			303 Stainless	MA11-16D-**					
20	Self-Aligning	MPFLO-20	4	MSO-20	4	1060 Steel	MA10-20D-**	2	MPSR-20-PD	2	MLMT20-200	1
	Engr. Plastic	MPLO-20	4			303 Stainless	MA11-20D-**					
25	Self-Aligning	MPFLO-25	4	MSO-25	4	1060 Steel	MA10-25D-**	2	MPSR-25-PD	2	MLMT25-200	1
	Engr. Plastic	MPLO-25	4			303 Stainless	MA11-25D-**					
30	Self-Aligning	MPFLO-20	4	MSO-30	4	1060 Steel	MA10-30D-**	2	MPSR-30-PD	2	MLMT30-250	1
	Engr. Plastic	MPLO-20	4			303 Stainless	MA11-30D-**					
40	Self-Aligning	MPFLO-40	4	MSO-40	4	1060 Steel	MA10-40D-**	2	MPSR-40-PD	2	MLMT40-320	1
	Engr. Plastic	MPLO-40	4			303 Stainless	MA11-40D-**					

Example

System 6 Bill of Material Example:

48 inches long with self aligning recirculating bearings as follows:

- 4 PFLO-8 Bearings
- 4 S5-13S Bearing Housings
- 2 A10-8D-48 Shafts
- 4 PSR-8-PD 48" Shaft Supports (Each PSR-8-PD is 24" long).
- 1 LMT50-55 Table Top

For PIC assembled systems, see System Ordering Code on page 1-12

Example — System 6:

48" long, 1/2" shaft with self-aligining recirculating bearings.

Part Number = LS68-48

NOTE: * Quantity of support rail depends on shaft length: each support rail is 24 inches (610 mm) long.

** Length of shaft in inches for inch systems. Length of shaft in millimeters for metric systems.

† Can be ordered pre-assembled by PIC DESIGN

STEP 5

SYSTEM 7 & 8 LEAD SCREW ASSEMBLY SELECTION

PIC has engineered all the components required to add a lead screw, radial bearings, coupling, motor mount, and base plate to systems 5 and 6. System 5 with the added components becomes system 7; system 6 with the added components becomes system 8.

The total length of the system is based on the desired length of travel plus Lmin, as shown on the bill of materials. The length of the base plate plus motor frame thickness is the total length of the system. Mounting holes for the base plate are based on the length.

When adding components for system 7 or 8, additional components from the series listed below must be added to the components for system 5 or 6, respectively.

Component	Quantity	PIC Series No.
Motor adapter	1	**LMA**
Lead screw	1	**ARS***
Lead screw nut	1	**ANR2**
Flange adapter	1	**LMB**
Flange spacer	1	**SMB (system 8 only)**
Ball bearings	3	**E2**
Bearing Housing	2	**S12**
Coupling	1	**T22A**
Base plate	1	**LBP***

* Dependent on length of travel, diameter and lead screw pitch

NOTE:

System 7 — *To determine length of shafting, lead screw and base plate*

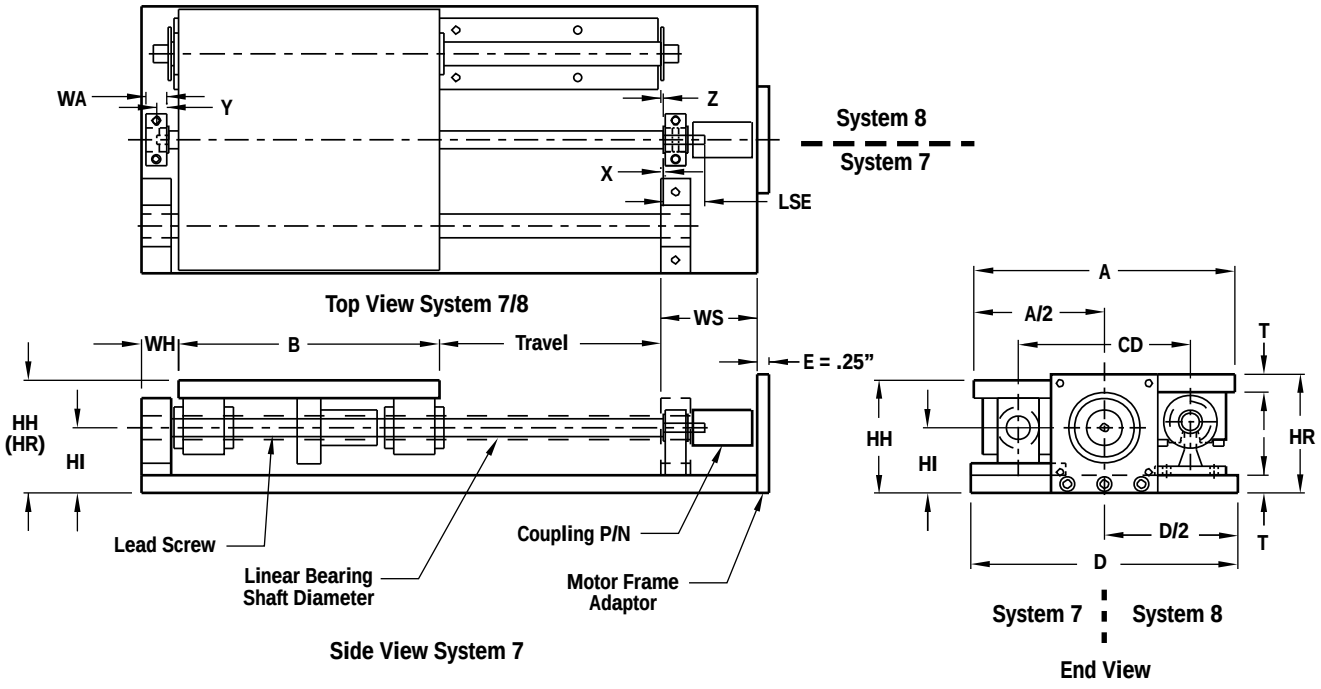
Length of shafting = Travel + B + 2X + 2WH + .062
Length of lead screw = Travel + B + 2X + 2Z + LSE + Y + .062
Length of base plate = L_{min} + Travel + 2X + .062

System 8 — *To determine length of shafting, support rail, lead screw and base plate*

Length of shafting = Travel + B + 2X + .062
Length of lead screw = Travel + B + 2X + 2Z + LSE + Y + .062
Length of base plate = L_{min} + Travel + 2X + .062
(Rail length is .060" shorter per side than shafting)

Note that part number series are listed above. The exact part number for a particular system depends on various dimensions of the system, shown in the dimension diagrams. Refer to the selection chart for the applicable system for the exact part numbers once the required dimensions have been determined.

System 7 and 8 Dimension Diagram



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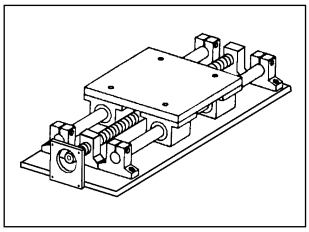
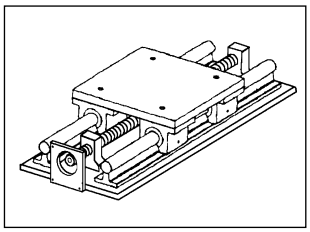
STEP 5

User Assembled †



SYSTEM 7



SYSTEM 8

COMPONENT SELECTION SYSTEMS 7 AND 8 / INCH & METRIC

NOTE —
For system 7, specify all components listed for system 5 plus the required components from the list below; for system 8, specify all components listed for system 6 plus the required components from the list below.

Dimensions — Systems 7 & 8

Nominal Shaft Diameter (Inches)	A	B	CD	D	HI	HH	HR	WH	WS	X	Y	Z	$L_{Min.}$	T	WA	LSE
1/2	5.50	5.50	3.625	5.625	1.375	2.375	2.500	.625	2.031	.094	.250	.051	8.156	.375	.438	.875
5/8	5.50	5.50	3.625	6.125	1.375	2.512	2.637	.688	2.063	.150	.250	.083	8.250	.375	.438	.875
3/4	7.50	7.50	5.500	8.000	2.000	3.125	3.375	.750	2.281	.188	.250	.114	10.531	.500	.438	.875
1	7.50	7.50	5.000	7.625	2.000	3.500	3.750	1.000	2.406	.250	.250	.114	10.906	.500	.438	.875
1 1/4	10.00	10.00	7.250	10.250	2.750	4.562	4.937	1.125	3.125	.253	.375	.188	14.250	.750	.625	1.250
1 1/2	13.00	13.00	9.25	13.000	2.750	5.125	5.625	1.250	3.188	.375	.375	.251	17.438	.750	.625	1.250

Bill of Material — Systems 7 & 8

Nominal Shaft Diamter (Inches)	Motor Frame Adaptor	Lead Screw Diameter	Lead Screw Journal Diameter	Flange Adaptor	Flange Spacer*	Ball Bearings	Bearing Housing	Coupling	Maximum Travel (Inches)
1/2	**LM23-6**	3/8	.1872	**LMB-6**	**SMB-6**	**E2-6**	**S12-6**	**T22A-2518D**	48**
5/8	**LM23-6**	3/8	.1872	**LMB-6**	**SMB-6**	**E2-6**	**S12-6**	**T22A-2518D**	48**
3/4	**LM23-8**	1/2	.2497	**LMB-8**	**SMB-8**	**E2-9**	**S12-8**	**T22A-25**	48
1	**LM23-8**	1/2	.2497	**LMB-8**	**SMB-8**	**E2-9**	**S12-8**	**T22A-25**	48
1 1/4	**LM34-10**	5/8	.3747	**LMB-10**	**SMB-10**	**E2-15**	**S12-10**	**T22A-37**	48
1 1/2	**LM34-10**	5/8	.3747	**LMB-10**	**SMB-10**	**E2-15**	**S12-10**	**T22A-37**	48

* Flange space — used on System 8
** System 7 max travel 20"

† Systems 7 & 8 can be ordered pre-assembled by PIC®. See next page for ordering information.

STEP 5

Systems 7 & 8 can be ordered pre-assembled by PIC®.
Use the information below to develop a proper system ordering code.

CONTINUED FROM PREVIOUS PAGE

System Ordering Code

System 1 through 6 ordering code is as follows:

M	LS	X	XX	—	XXXX	—	EP

- **M** = metric; Blank = inch
- **LS** = Linear system
- **X** = System number (1 - 6)
- **XX** = Shaft diameter code

Diameter (Inches/mm)	Shaft Dia. Code
1/4"	4
3/8"	6
1/2"	8
5/8"	10
3/4"	12
1"	16
1 1/4"	20
1 1/2"	24
12 mm	12
16 mm	16
20 mm	20
25 mm	25
30 mm	30
40 mm	40

For Inch: Code = the number of 1/16" diameter
For Metric: Code = the diameter in millimeters

- **XXXX** = Shaft length:
  - — inches up to 120 in whole inches
  - — metric up to 3000 mm in millimeters
- **EP** = Blank = self-aligining linear bearings/ 1060 shafting.
  EP = engineered plastic bearings/ 303 s.s. shafting

System Ordering Code

System 7 and 8 ordering code is as follows:

	LS	X	XX	—	XXXX	—	XX

- **M** = metric (Consult Factory); Blank = inch
- **LS** = Linear system
- **X** = System number (7 or 8)
- **XX** = Shaft diameter code

Diameter (Inches/mm)	Shaft Dia. Code
1/2"	8
5/8"	10
3/4"	12
1"	16
1 1/4"	20
1 1/2"	24

Code = the number of 1/16" diameter

- **XXXX** = Travel of table top:
  - — See page 11 for maximum travel
  - — inches series in whole inches
- **XX** = Lead Screw Code

Lead Screw Diameter	Lead	Code	Ref. Shaft Dia.
3/8"	.050	21	1/2" and 5/8"
	.0625	22	
	.100	23	
	.125	24	
	.200	25	
	.250	26	
	.500	27	
	1.00	28	
	1.25	29	
1/2"	.100	41	3/4" & 1"
	.200	42	
5/8"	.100	51	1 1/4" & 1 1/2"
	.125	52	
	.200	53	
8 mm	2 mm	61	1/2" & 5/8"
10 mm	2 mm	71	3/4" & 1"
	6 mm	72	
14 mm	4 mm	81	1 1/4" & 1 1/2"

System 7 and 8 Bills of Material Examples

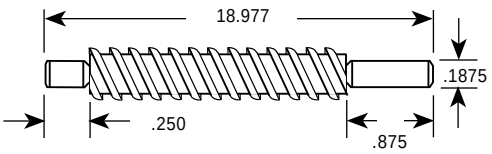
System 7 (Inch)

Linear system assembly P/N LS78-12-27
Travel: 12"
Bearing Shaft Diameter: 1/2"
Diameter / lead acme lead screw:
3/8" diameter with 0.500 lead

Complete Bill of Material — From system 5:

Description	Quantity	Part Number
Bearing - self aligning	4	**PFL-8**
Linear bearing housing	4	**S5-3**
Shaft 1060 steel	2	**A10L-8-19.1**
Shaft hanger	4	**SHA-8**
Carriage Top	1	**LMT50-55**
Additional Parts		
Motor adaptor	1	**LMA23-6**
Lead screw (see note)	1	**ARS4X3708-18.977**
Lead screw nut	1	**ANR24-3708**
Flange adaptor	1	**LMB-6**
Ball bearings	3	**E2-6**
Bearing housing	2	**SI2-6**
Coupling	1	**T22A-2518D**
Base plate	1	**LBP8-20.406**

LEAD SCREW



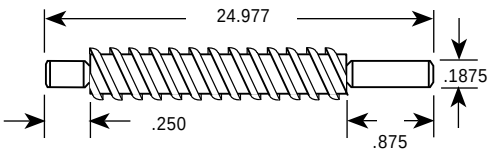
System 8 (Inch)

Linear system assembly P/N LS8 8-18-23
Travel: 18"
Bearing shaft diameter: 1/2"
Diameter / lead acme lead screw:
3/8" diameter with .100 lead

Complete Bill of Material — From System 6:

Description	Quantity	Part Number
Bearing self-aligning	4	**PFL0-8**
Linear bearing housing	4	**S5-13S**
Shaft 1060 steel	2	**A10L-8D-23.75**
Shaft support rail	2	**PSR8-PD**
Carriage Top	1	**LMT50-55**
Additional Parts		
Motor adaptor	1	**LMA23-6**
Lead screw (see note)	1	**ARS1X3710-24.977**
Lead screw nut	1	**ANL21-3710**
Flange adaptor	1	**LMB-6**
Flange spacer	1	**SMB-6**
Ball bearings	3	**E2-6**
Bearing housing	2	**S12-6**
Coupling	1	**T22A-2518D**
Base plate	1	**LBP8-26.406**

LEAD SCREW



NOTE: Lead screws shown in examples are for PIC assembled systems. Part numbers are less journals. Must advise at time of inquiry if journals are required.

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