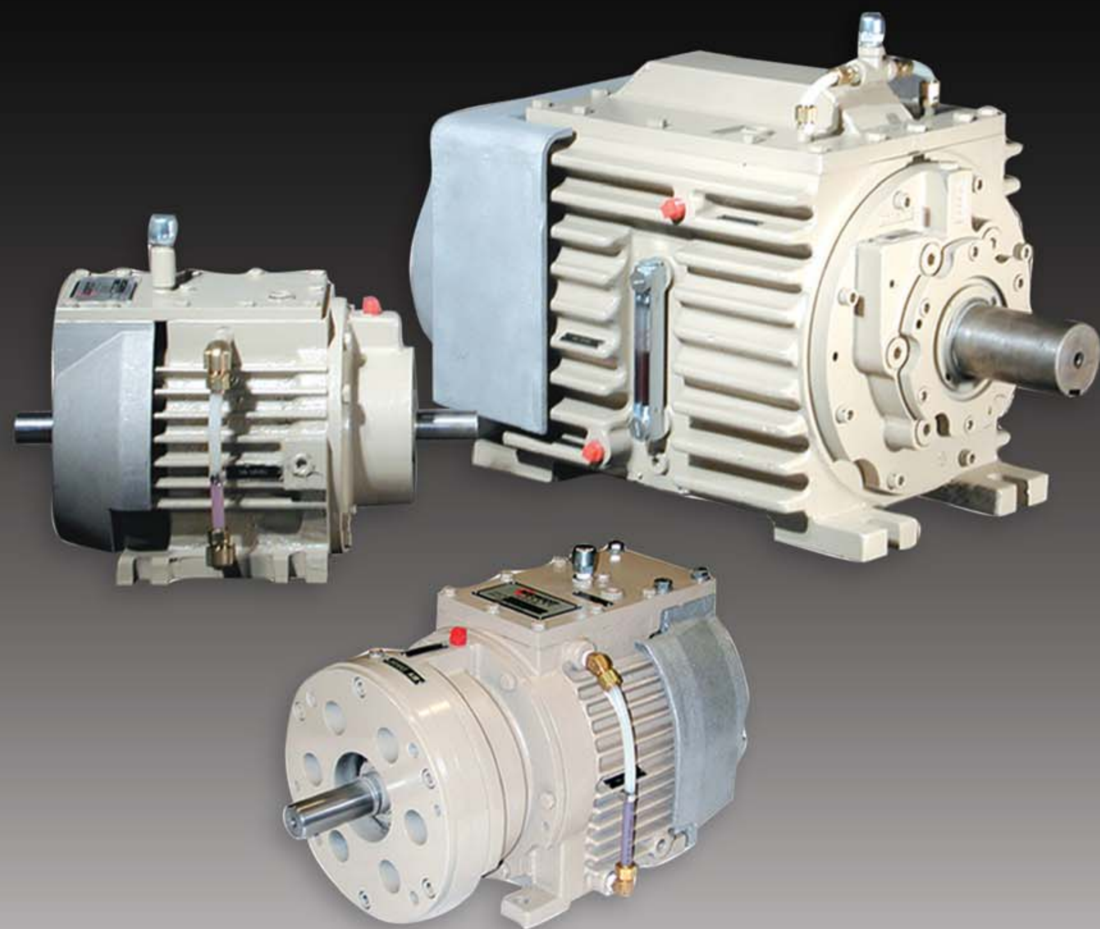
SOM PAC®
CLUTCHES & BRAKES

SOM PAC® 1 SERIES
CLUTCH/BRAKE DRIVE SYSTEMS



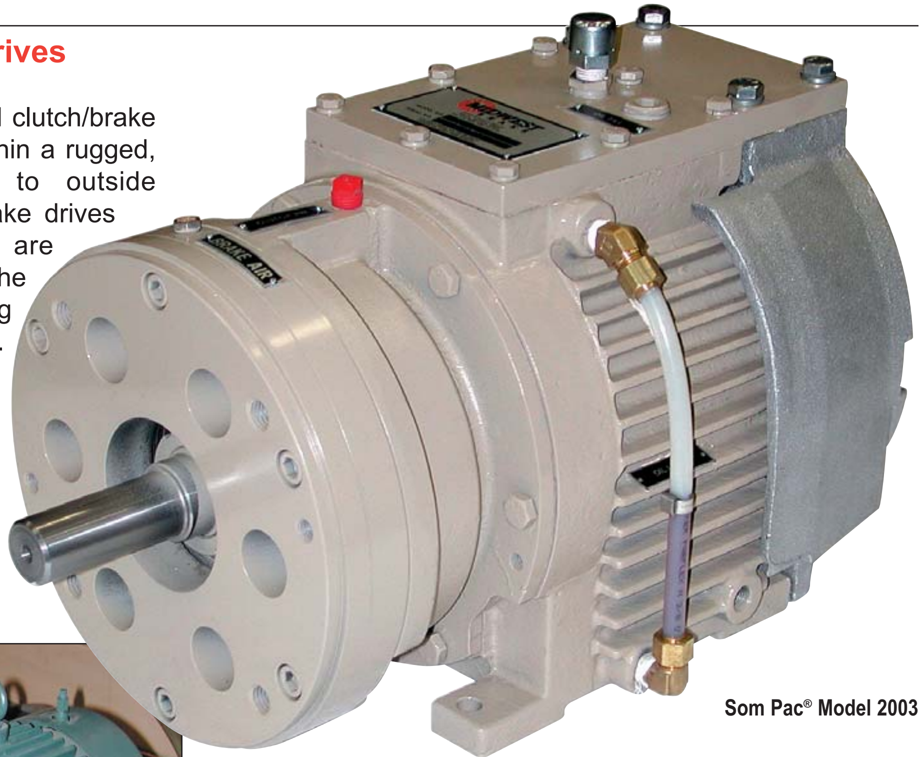
World Class Oil Shear Clutch / Brake Technology

MIDWEST® BRAKE

Som Pac® 1 Series Clutch/Brake Drive Systems

Som Pac® Series Clutch / Brake Drives

Som Pac® drives are completely assembled clutch/brake drive systems operating in a bath of oil within a rugged, sealed housing which is impervious to outside contaminants. These oil shear clutch / brake drives contain multiple plate disc packs that are immersed in oil. Torque is transmitted by the shearing of the oil across the disc providing cooling and lubrication to the disc surfaces. The result is no wear on the disc surfaces, superior heat transfer and long trouble free performance.



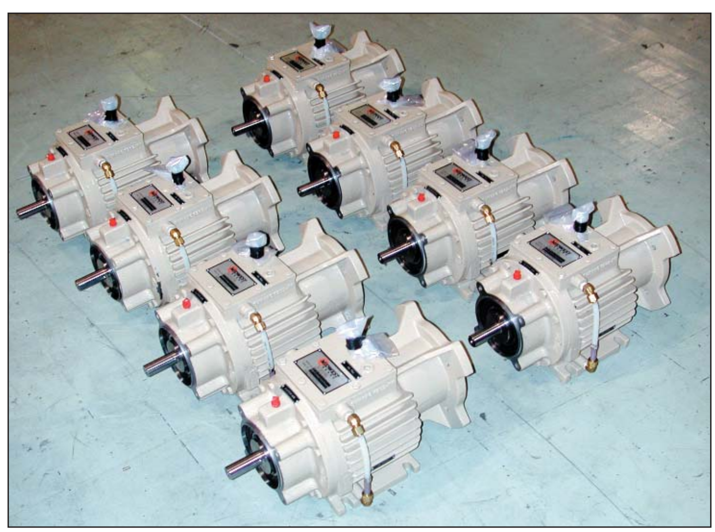
Som Pac® Model 2003

Som Pac® Model 1202FF Running on Test Stand

Som Pac® Features Include:

- Fully Enclosed Clutch/Brake Drive System
- Continuous Oil Flow
- Clutch/Brake Mechanically Interlocked
- Air Engaged Clutch
- Spring Set Brake (In Standard Units)
- Brake Torque Can Be Adjusted Externally
- Easy Installation
- Reduced Maintenance Costs

Som Pac® Model 1202

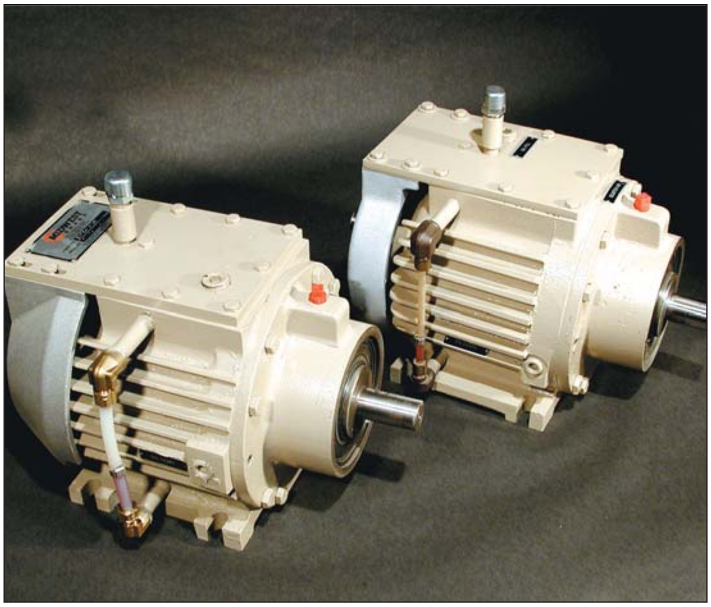


Som Pac® Model 1202 FF

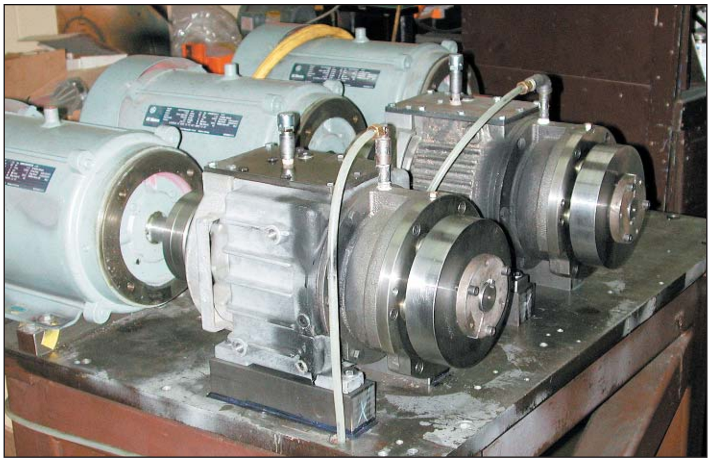
Som Pac® 1 Series Clutch/Brake Drive Systems

Som Pac® Applications Include:

- Conveyors
- Transfers
- Shuttles
- Machine Tools
- Index Tables
- Assembly Machines
- Turnovers
- Palletizing Machines
- Welding Machinery
- Electric Motor Manufacturing
- Coil Feeding Equipment
- Spinning Machinery
- Packaging Machinery
- Presses
- Grinding Machines
- Winding Equipment
- Cement Block Machines
- Testing Equipment
- Container & Drum Manufacturing

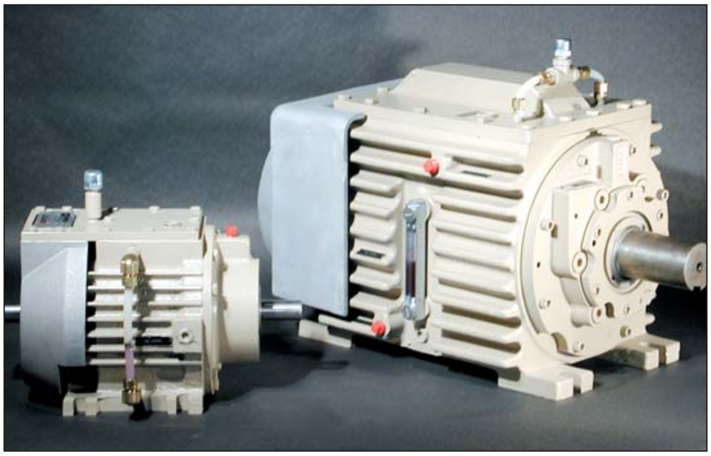


Som Pac® Model 2402 3/4 & 1202

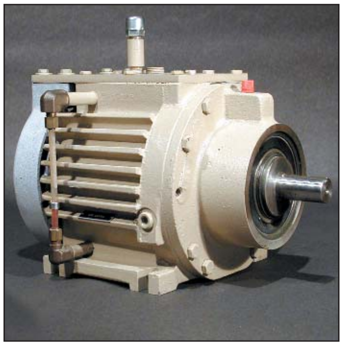


Som Pac® Model 1203 & 2003 on Test Stand

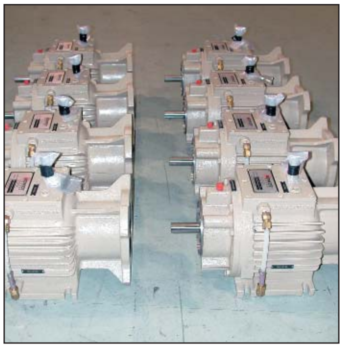
Som Pac® Model 2410



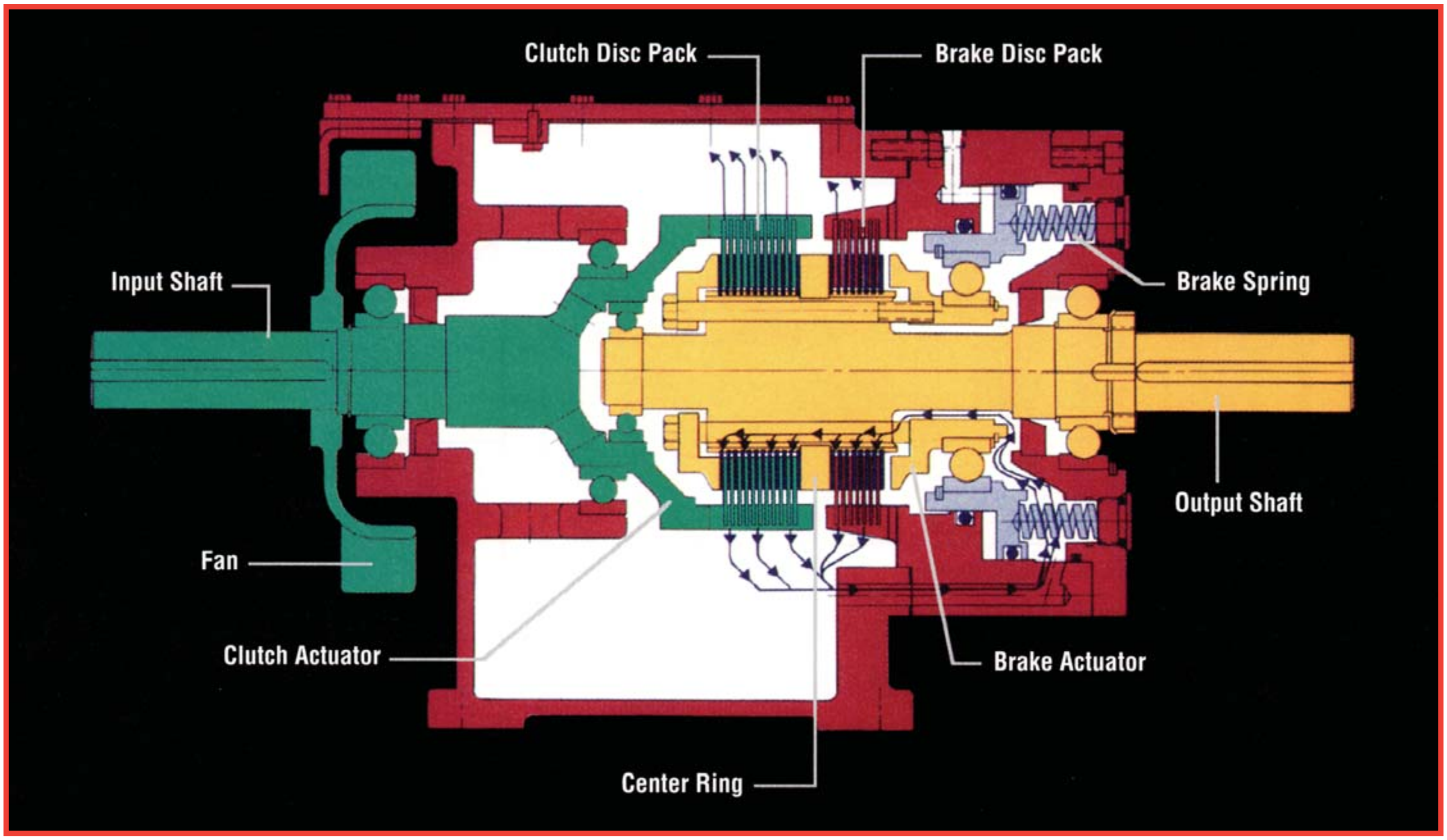
Som Pac® Model 1202 & 2410



Som Pac® Model 1202



Som Pac® Model 1202 FF Units Ready for Shipment



Operation

Som Pac® 1 drives are completely assembled clutch/brake systems, operating in a bath of oil within a rugged, sealed housing.

Torque is transmitted by the viscous shear of an oil film maintained between the friction surfaces of adjacent discs. In start-stop applications, this oil film is maintained until the last 10% from synchronous speed. The result is that wear of friction surfaces is virtually eliminated.

The kinetic energy absorbed by the drive when starting and stopping machinery is transferred to the oil contained in the housing. Two methods are used to cool this oil. A shrouded fan is used to force air across the housing. If more thermal capacity is required, the unit is water cooled either by a manifold plate mounted under the cover plate of the housing or copper tubing mounted inside the housing.

A positive flow of oil is pumped thru the discs by vanes on the hub whenever the output shaft is rotating. Even though pumping of the oil by the output shaft limits the slippage that can be tolerated, these drives have been proven extremely durable in most application since 1968.

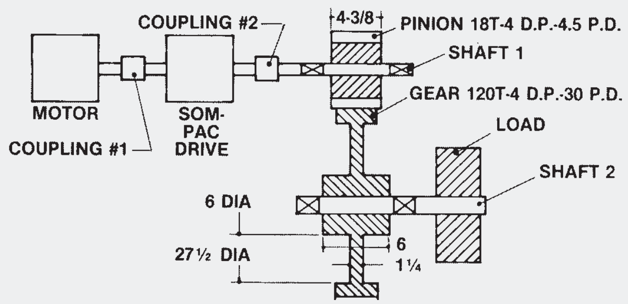
The drive is shown with the clutch engaged. Actuation pressure in the cavity to the left of the piston forces the piston to the right, clamping the clutch disc stack between the clutch actuator and a center ring. The piston transmits the clamping force to the clutch actuator through the ball bearing, the brake actuator assembly, and the screws and rods of the hub of the output shaft. The piston is mounted within drive housing and does not rotate.

When air is exhausted from the left side of the piston, the brake springs force the piston to the left and clamp the brake disc stack through the ball bearing and the brake actuator. Since the clutch actuator is solidly connected to the brake actuator assembly by the screws and spacer rods, motion to the left automatically releases the clutch and engages the brake at the same time. The torque capacity of the brake can be changed externally by using either 3, 4 or 6 springs. The springs are accessible for removal or installation by removing plugs at the output end of the housing.

Alternatively, air can be used to actuate the brake instead of springs.

When a model with an "L" suffix is specified, 3 light springs are used for mechanical reasons. When it is necessary to position the spindle for loading of the work piece on machine tool applications, "N" (neutral position) is specified as a suffix.

Example



Example

Motor – 20HP – 1750 RPM
WR^2 of Load = 600 lbs.-ft.^{2}
WR^2 of Couplings = 300 lbs.-in.^{2}
Shaft #1 = 1-3/4 dia x 15" lg.
Shaft #2 = 3-1/2 dia x 26" lg.
Cycle Rate = 6 per minute
Air Pressure Available - 60 PSI
Acceleration/Deceleration Time = .75 seconds

Calculations

Step #1

$$T = \frac{HP \times 63{,}000 \times 2.75}{1750} \qquad \text{(Formula 1)}$$

Step #1

The inertia of coupling #1 can be ignored since it is on input side of drive.

WR^2 of coupling #2 = 130/144 = .903 lbs.-ft.^{2}

Shaft #1

WR^2/in of dia from chart = .0018
WR2 = .0018 x 15 = .027 lbs.-ft.^{2}

Pinion

(Use pitch dia of gears for cylinder outside diameter.)

$$WR^2 = \frac{.281 \times 4.375 \times (4.5^2 - 1.75^2) \times (4.5^2 + 1.75^2)}{1466.8}$$

$$= .336 \text{ lbs.-ft.}^2$$

Total Inertia at Drive Speed

Coupling	=	.903
Pinion	=	.336
Drive (preliminary est. is 1207)	=	.735
		1.974 lbs.-ft.^{2}

Shaft #2

$$WR^2 = \frac{.281 \times 26 \times 3.5^2 \times 3.5^2}{1466.8}$$

$$= .747 \text{ lbs.-ft.}^2$$

Gear

$$\text{RIM: } WR2 = \frac{.281 \times 4.25 \times (30^2 - 27.5^2) \times (30^2 + 27.5^2)}{1466.8}$$

$$= 193.85 \text{ lbs.-ft.}^2$$

$$\text{WEB: } WR2 = \frac{.281 \times 1.25 \times (27.5^2 - 6^2) \times (27.5^2 + 6^2)}{1466.8}$$

$$= 136.64 \text{ lbs.-ft.}$$

$$\text{HUB: } WR2 = \frac{.281 \times 6 \times (6^2 - 3.5^2) \times (6^2 + 3.5^2)}{1466.8}$$

$$= 1.317 \text{ lbs.-ft.}^2$$

Total Inertia at Shaft #2

Shaft	=	.747
Gear	=	193.850
		136.640
		1.317
Load	=	600.000
		932.550 lbs.-ft.^{2}

Equivalent Inertia Drive Speed

Speed of Shaft #2 RPM = $1750 \times \frac{18}{120} = 262.5$

$$WR2 = 932.55 \times \left(\frac{262.5}{1750}\right)^2 \qquad \text{(Formula 3)}$$

$$= 20.98 \text{ lbs.-ft.}^2$$

Total Inertia of Machine, Drive, Coupling & Load Referred to Drive

$$WR2 = 1.974 + 20.98 = 22.96 \text{ lbs.-ft.}^2$$

Step #3

$$T = \frac{22.96 \times 1750}{17.9 \times .75} = 2993 \text{ in.-lbs.} \qquad \text{(Formula 5)}$$

Step #4

$$\text{Heat Load} = \frac{3.4 \times 22.96 \times \left(\frac{1750}{100}\right)^2 \times 6}{33{,}000} = 4.35 \text{ THP} \qquad \text{(Formula 6)}$$

Calculate Static Clutch Torque at 60 PSI

This torque is more than calculated in Step #1 so the 1207-6 would be the proper selection for driving load but is less than step #5. Also, the torque in step #5 is larger than step #1. The designer must either use a larger drive and motor or increase the acceleration time. (Deceleration time is O.K.) The designer now checks what the acceleration time would be using the torque calculated in step 1.

$$T = \frac{22.96 \times 1750}{17.9 \times 1980} = 1.134 \text{ seconds}$$

After reviewing total machine performance lets assume this acceleration time will be O.K. The final selection is thus, 2407-6

Som Pac® 1 Series Clutch/Brake Drive Systems

Drive Selection

The selection of the correct Som Pac® is determined by the analysis of the following factors.

1. Static Torque required to drive machine.
2. Acceleration/Deceleration Torque required to start and stop machine. This requires the following machine
   a. Acceleration Time
   b. Deceleration Time
   c. Inertia of Machine and Drive
   d. Speed of Drive
3. Heat Load imposed on the drive by starting and stopping machine. This is determined by the following.
   a. Factors 2c and 2d above.
   b. Number of Cycles Per Minute.

It is recognized that in many instances when an existing machine is to be retrofitted with a Som Pac® not all the information is available for a rigorous analysis of all the factors involved. It is for this reason the following SELECTION GUIDE is presented. This guide has been developed by the engineering staff of Midwest Brake® based on many years of applying these drives to a wide variety of types of machinery in many industries. The selection is based on "average" requirements and conditions. Original Equipment Manufacturers should use the above detailed analysis and users are urged to do likewise if the information required can be obtained.

Som Pac® Selection Guide

MOTOR HP	DRIVE RPM	Model Number	
		Class 1	Class 2
2	1160	1202-BF	2403-F
	1750	1202-BF	2403-F
5	1750	2402 3/4	2402 3/4
3	1160	1203-F	2403-F
	1750	1203-F	2403-F
5	1160	1203-F	2403-F
	1750	1203-F	2403-F
7-1/2	1160	1203-F	2403-F
	1750	1203-F	2403-F
10	1160	1205-F	2405-F
	1750	1205-F	2405-F
15	1160	1207-F	2407-F
	1750	1205-F	2405-F
20	1160	1207-F	2407-F
	1750	1207-F	2407-F
25	1160	1210-W	2407-F
	1750	1207-W	2407-F
50	1160	2412-F	2412-F
	1750	2412-F	2412-F
75	1160	1220-W	2420-W
	1750	2412-F	2412-F
100	1160	2420-W	2420-W
	1750	2412-W	2412-W
125	1160	2420-W	2420-W
	1750	2420-W	2420-W
150	1750	2420-W	2420-W
175	1750	2420-W	2420-W
200	1750	2420-W	2420-W

Class I – Standard start/stop duty
Class II – Where acceleration or deceleration times exceed 1 sec. or where programmed accel/decel are required. Specify valve 2401 for programmed accel/decel.

Static Torque

Som Pac® drives are generally driven by a squirrel cage motor. It is assumed that the machine designer has correctly determined the correct horsepower motor to drive the machine. Static torque calculation of clutch is then based on the motor horsepower.

$$T = \frac{HP \times 63{,}000 \times 2.75}{N} \qquad \text{(Formula 1)}$$

Where:

T = Static Clutch

HP = Motor Horsepower

N = RPM of Drive (not the same as motor RPM if reduction is used between motor and drive)

Note: If a flywheel is used on the input side of the drive, the above formula is NOT valid. Torque must be determined by actual torque required by machine.

(Example: Stamping Presses)

The brake is usually sized based on dynamic torque requirements. In those cases that require the brake to hold a platen or other component in the vertical plane, the drive selected should have a brake torque rating of 120% of the actual calculated torque.

Machine Inertia

It is necessary to calculate the inertia of the machine before acceleration and deceleration torques can be calculated. Heat load calculations also require this information.

The rotating elements of the machine, no matter how complex, can usually be defined by a series of solid or hollow cylinders. Inertia of a machine component is usually expressed as lbs.-ft.^{2} (WR^2).

The formula for calculating the inertia of solid or hollow cylinders is:

$$WR^2 = \frac{WL\,(D^2 - d^2)\,(D^2 + d^2)}{1466.8} \qquad \text{(Formula 2)}$$

Where:

WR2 = Inertia – (lbs.-ft.2)

W = Weight per cubic inch of material in pounds.

Steel = .281 lbs. Aluminum = .093 lbs.
Cast Iron = .260 lbs. Brass = .305 lbs.

D = Outside diameter of cylinder in Inches

d = Inside diameter of cylinder in Inches
d = 0 in the case of solid cylinder.

L = Length or thickness of cylinder in inches.

WR^2 Per Inch (Lbs.-Ft.^{2})

Shaft Dia.	WR^2	Shaft Dia.	WR^2	Shaft Dia.	WR^2
1.000	.00019	9.250	1.4140	25.000	75.15
1.250	.00047	9.500	1.5732	25.500	81.67
1.500	.00098	9.750	1.7454	26.000	88.26
1.750	.0018	10.000	1.9315	26.500	95.25
2.000	.0031	10.500	1.9315	26.500	95.25
2.250	.0050	11.000	2.8278	27.500	102.65
2.500	.0075	11.500	3.3781	28.000	118.72
2.750	.0110	12.000	4.0051	28.500	127.43
3.000	.0156	12.500	4.7155	29.000	136.61
3.250	.0215	13.000	5.5164	29.500	146.28
3.500	.0290	13.500	6.4153	30.000	156.45
3.750	.0382	14.000	7.4199	30.500	167.14
4.000	.0494	14.500	8.5380	31.000	178.37
4.250	.0630	15.000	9.7780	31.500	190.16
4.500	.0792	15.500	11.1481	32.000	202.53
4.750	.0983	16.000	12.6580	32.500	215.49
5.000	.1207	16.500	14.3159	33.000	229.05
5.250	.1467	17.000	16.1317	33.500	243.26
5.500	.1767	17.500	18.1149	34.000	258.11
5.750	.2111	18.000	20.2756	34.500	273.63
6.000	.2503	18.500	22.6241	35.000	289.81
6.250	.2947	19.000	25.1709	35.500	306.76
6.500	.3448	19.500	27.9269	36.000	324.41
6.750	.4010	20.000	30.9032	36.500	342.81
7.000	.4637	20.500	34.11	37.000	361.99
7.250	.5336	21.000	37.56	37.500	381.95
7.500	.6111	21.500	41.27	38.000	402.73
7.750	.6968	22.000	45.25	38.500	424.35
8.000	.7911	22.500	49.50	39.000	446.83
8.250	.8947	23.000	54.05	39.500	470.19
8.500	1.0082	23.500	58.91	40.000	494.15
8.750	1.1322	24.000	64.08		
9.000	1.2672	24.500	69.59		

Chart shows WR^2 for steel. For other materials multiply above values by the following:

Cast Iron: .92
Aluminum: .33
Brass: 1.09

For hollow cylinders subtract the inside diameter WR^2 from the outside diameter WR^2.

The typical machine has several different shafts, each with its gears, sprockets, etc., and rotating at different speeds. The WR^2 of all the components on each shaft are added to kept separate from the components on the other shafts. The WR^2 of the components on the shafts that DO NOT rotate at the same speed as the drive must be translated to an equivalent WR^2 at drive speed.

$$\text{EQ. } WR^2 = WR^2 \left[\frac{N_1}{N_2}\right]^2 \qquad \text{(Formula 3)}$$

Where:

EQ. WR^2 = WR^2 mounted on shaft of drive that would have the same effect as the WR^2 on the different speed shaft.

WR^2 = Total WR^2 on shaft that rotates at speed different from drive.

N_1 = RPM of subject WR^2

N_2 = RPM of drive.

Some machines have assemblies that travel linearly such as transfer tables or shuttles and platens. The equivalent WR^2 is calculated as follows.

$$\text{EQ } WR^2 = \frac{WV^2}{39.5\,N^2} \qquad \text{(Formula 4)}$$

Where:

W = Weight of assembly-include any load (lbs.)

V = Maximum linear velocity of assembly (ft./min.)

N = RPM of drive.

Add the equivalent WR^2 of the components at the different speeds. This total is the WR^2 used in subsequent calculations. DO NOT FORGET the flexible coupling that connects the drive to the machine nor the “Start/Stop WR^2” of the drive that is shown on the specification charts. The WR^2 of commercial couplings is usually given in lbs.-In.^{2}. To convert this to lbs.-ft.2 divide by 144.

Acceleration/Deceleration Torque

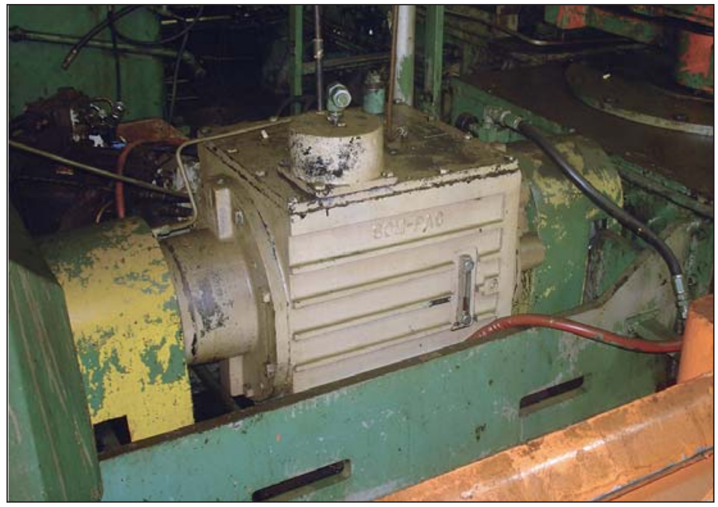
$$T = \frac{WR^2 N}{17.9t} \qquad \text{(Formula 5)}$$

Where:
T = Required equivalent Static Torque (in.-lbs.) of clutch or brake in drive. (Torque values listed in specification charts are “Static Torque”).

N = RPM of drive

t = Acceleration/Deceleration Time (seconds)

Note: Calculate clutch and brake torques separately if starting and stopping times are different.



Som Pac® Model 2480 Transfer Line Application

Heat Load

The heat load or thermal capability of the drives is given in the specification charts as Thermal Horsepower (THP). The required THP for the drive is calculated as follows.

$$THP = \frac{3.4\,(WR^2)\left(\frac{N}{100}\right)^2 C}{33{,}000} \qquad \text{(Formula 6)}$$

Where:
WR2 = Total inertia of machine, coupling and drive (lbs.-ft.^{2})

N = RPM of drive

C = Cycles/Min.

3.4 = Constant composed of content 1.7 which is derived from basic formula for rotary motion

K.E. (ft.-lbs.) at 100 RPM = 1.7 (WR^2) and constant 2 which takes into consideration that each cycle includes one clutch and one brake operation

33,000 = Energy (ft.-lbs./Min.) generated by 1 horsepower

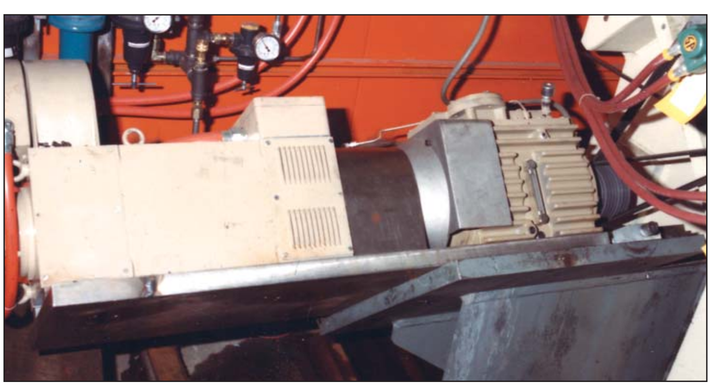
Static Torque Rating at Any Air Pressure

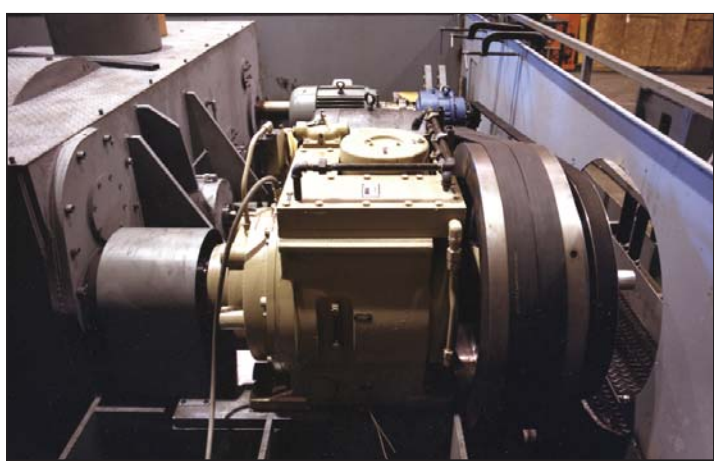
The static clutch torque of Som Pac® are rated at 80 psi. Using the following formula to determine clutch torque rating at a different air pressure.

$$T_1 = (P_1 - P_2)\left[\frac{T_2}{80 - P_2}\right] \qquad \text{(Formula 7)}$$

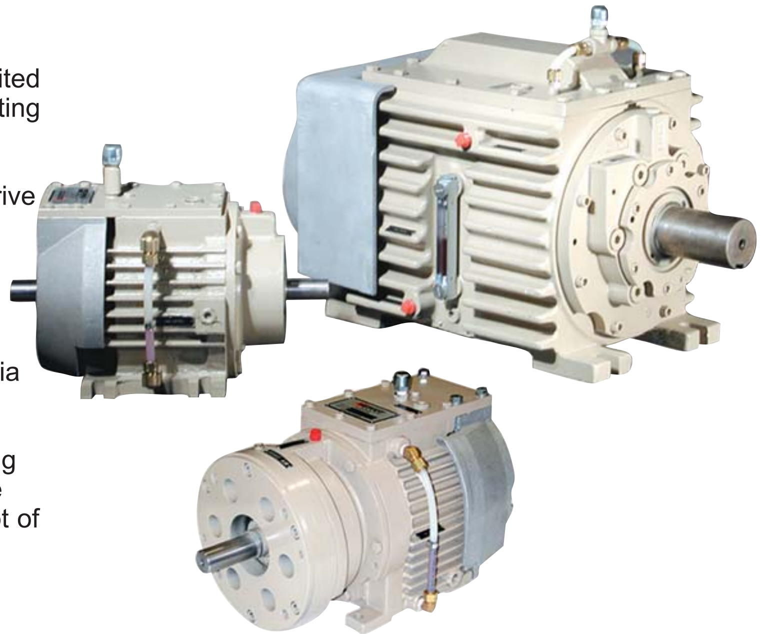
Where:
T_1 = Clutch static torque at operating air pressure of P_1.
T_2 = Rated clutch torque at 80 PSI
P_1 = Operating air pressure (PSI)
P^2 = Clutch engaged PSI: (see specification charts)

The static brake torque of all drives with spring set brakes is modified by changing the number of brake springs (with the exception of the 2402 3/4). Som Pac® I and III are designed so the number of brake springs can be changed externally. Som Pac® II can be ordered with either an A or B spring.





Final Selection of Drive



The Som Pac® drive give the engineer an almost unlimited flexibility in specifying a drive that best suits his operating conditions.

The specific steps required in order to make the final drive selection are as follows.

1. Calculate static torque required. (Formula 1)
2. Calculate machine inertia (Formula 2, 3 & 4). Don't forget coupling between machine and drive nor inertia of drive.
3. Calculate equivalent static torque required for starting and stopping machine (Formula 5). This step can be skipped if actual acceleration/deceleration time is not of specific importance.
4. Calculate heat load. (Formula 6)
5. Make preliminary selection of drive size in either Som Pac® I, II or III on steps 1, 2, 3 & 4. Rating of drive selected must be equal or greater than calculated values. Specify Som Pac® III if accel/decell time of more than 1 second was used in Formula 5 (step 3). If acceleration/deceleration rate is to be programmed, select a Som Pac® III and specify use of Valve 2401.
6. Determine what maximum air pressure is available at plant location where drive will be installed. If air pressure is less than 80 PSI, calculate Formula 7 for preliminary drive selection made in step 6.
7. Repeat step 5 using new torque valves calculated in step 6.
8. If step 3 was skipped, check for actual acceleration 6
9. Repeat step 6 using new torque values calculated in step 6.
10. If step 3 was skipped, check for actual acceleration and deceleration time for drive selected in step 5 or step 7 by calculating following formula which is Formula 5 rewritten.

$$t = \frac{WR^2\,N}{17.9T} \qquad \text{(Formula 8)}$$

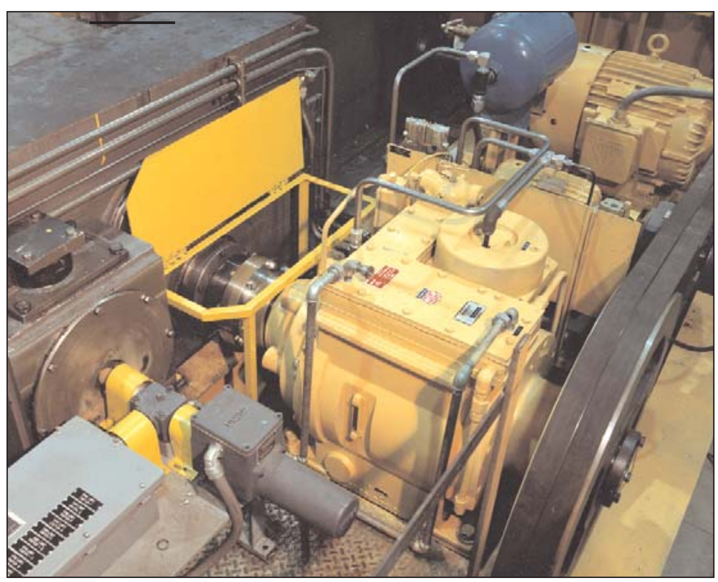
Note: The torque value of T here is either rated torque or torque calculated in step 6.

If T is more than 1 second for either clutch or brake, Som Pac® III or a larger Som Pac® I must be used. Consult factory for possible modifications if time is more than 1 second.

Machine Started Under Load

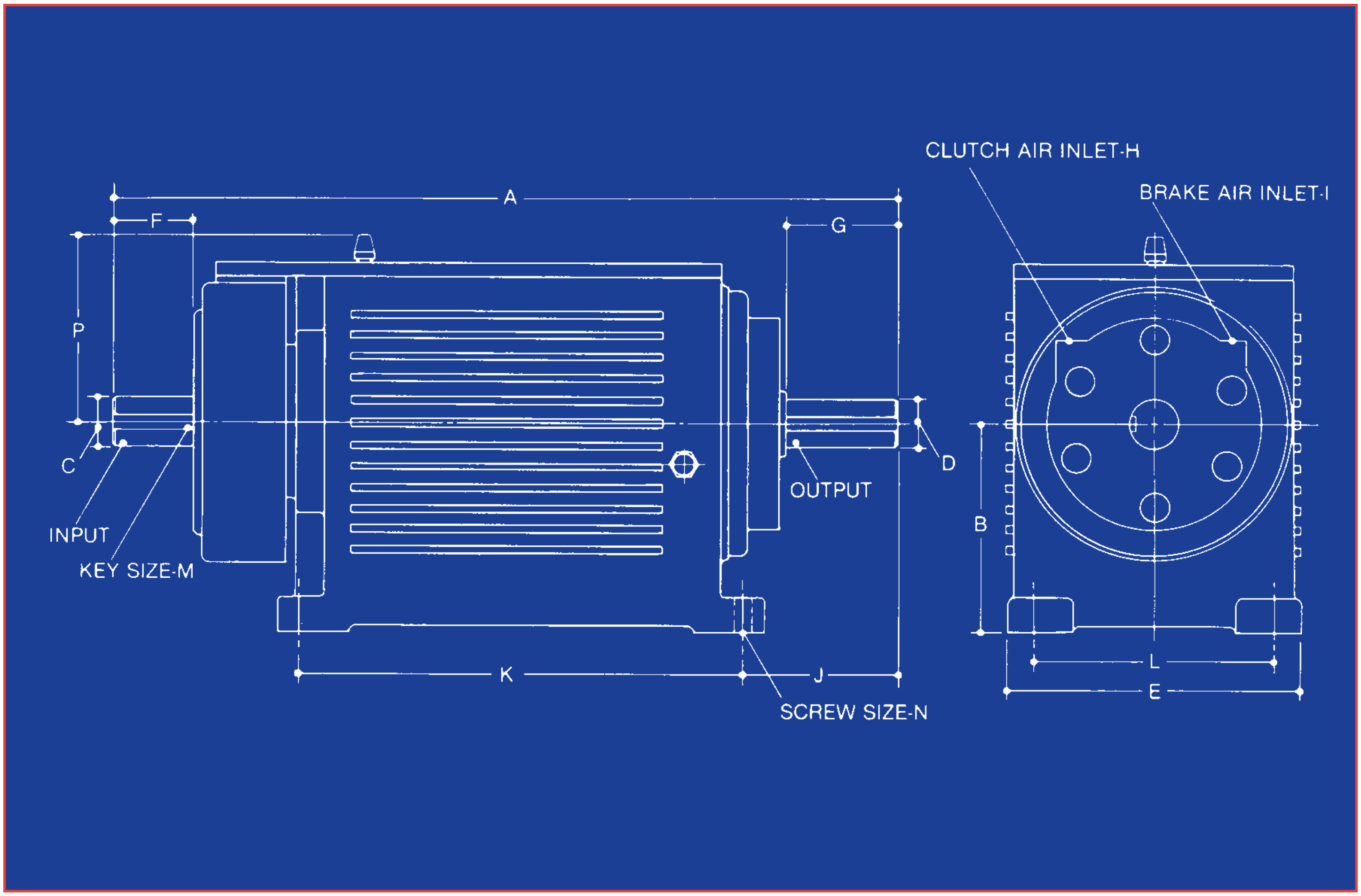
The steps given above are only valid if the machine is stated under a “no load” condition. The typical machine to which these drives are applied are started in this condition, e.g., machine tools, automation equipment and presses.

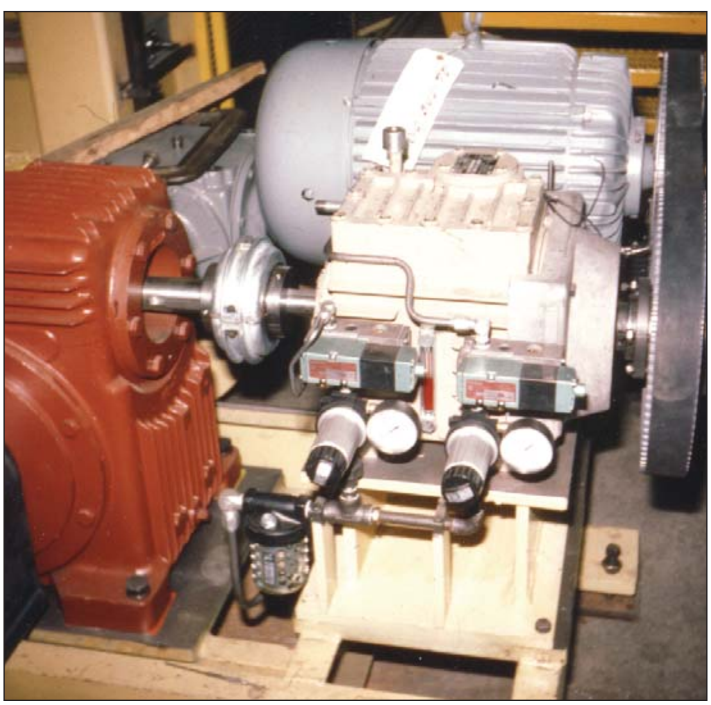
However, if the machine must perform work during the acceleration of the machine to full speed, this must be considered when calculating starting torque (step 3) and heat load (step4). Examples of this type of machine are certain pump applications, bulk conveyors, fans and grinding mills. Unless the reader knows how to make these calculations, he is urged to refer his application to the factory since each type of machine requires its own type of analysis.

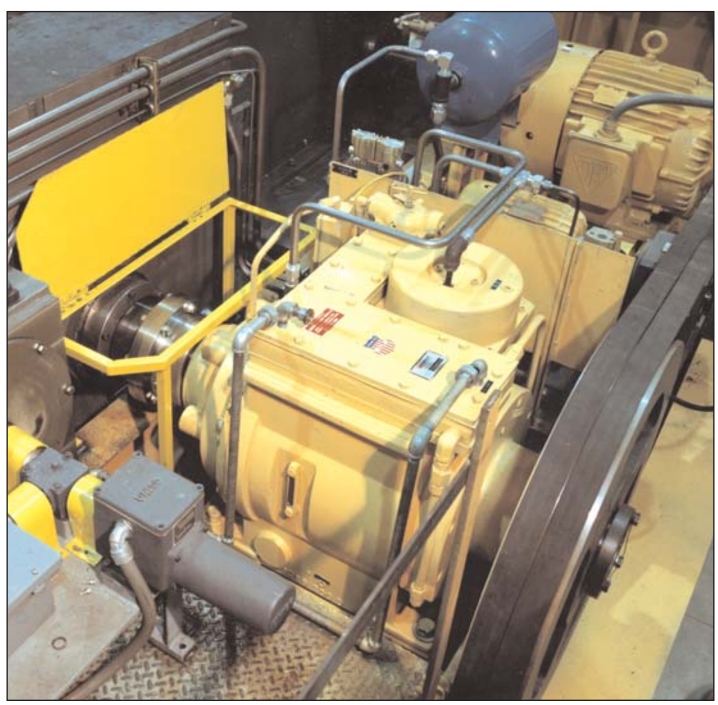


Som Pac® 1 Series Clutch/Brake Drive Systems

Som Pac® 1 Installation Drawing



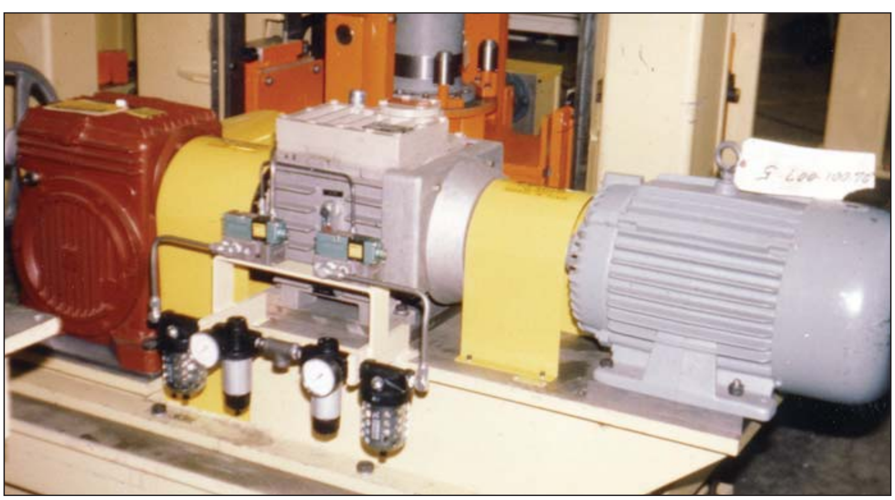




Som Pac® 1 Series Clutch/Brake Drive Systems

Specifications

MODEL	NO. BRAKE SPRINGS	STATIC CLUTCH TORQUE (IN.-LBS.)	STATIC BRAKE TORQUE (IN.-LBS.)	CLUTCH ENGAGE PSI	RATED PSI	HP/THERMAL CAPACITY START/STOP WR² (LBS.-FT.²)	HP/THERMAL CAPACITY AIR COOLED	HP/THERMAL CAPACITY FORCED AIR 1800 RPM	HP/THERMAL CAPACITY WATER COOLED
1203	L	2,370	2,120	3	65	0.200	N.A.	2.2	6.0
	3	2,220	718	22	80				
	4	1,880	960	30	80				
	6	1,170	1,436	44	80				
1205	L	3,740	2,440	3	65	0.245	N.A.	2.8	6.5
	3	3,500	835	22	80				
	4	2,950	1,120	30	80				
	6	1,835	1,670	44	80				
1207	L	7,460	4,844	3	65	0.735	N.A.	3.1	9.5
	3	7,100	1,570	21	80				
	4	6,325	2,080	29	80				
	6	4,750	3,130	42	80				
1210	L	7,460	6,886	3	65	0.790	N.A.	3.1	12.0
	3	7,100	2,140	21	80				
	4	6,325	2,975	29	80				
	6	4,750	4,450	42	80				
1215	L	14,300		3	65	5.320	2.6	N.A.	13.0
	3	13,600	4,500	22	80				
	4	12,100	6,000	30	80				
	6	9,300	9,000	44	80				
1220	L	27,740	18,900	3	65	5.320	2.6	N.A.	15.0
	3	26,400	6,400	22	80				
	4	23,500	8,600	30	80				
	6	18,000	12,800	44	80				



Dimensions

	1203	1205	1207	1210	1215 1220
A	17-1/4	22-3/4	27-1/2	28	35-1/2
B +.000 -.010	4-1/2	6-1/2	6-1/2	7-1/2	8
C +.000 –.0005	1-3/8	1-7/16	1-5/8	1-5/8	2-1/2
D +.000 –.0005	1-3/8	1-7/16	1-3/4	1-3/4	2-3/4
E	9	9-1/2	10	10-1/2	14-1/2
F	2-1/4	4	2-7/8	2-7/8	4-1/2
G	2-1/2	4	4	4	5
H N.P.T.	1/4	1/4	1/4	1/4	1/2
I N.P.T.	1/8	1/8	1/4	1/4	1/2
J	5-11/16	8-1/2	5-1/2	5-1/2	7-3/8
K	7-1/4	7-1/2	15-3/8	15-7/8	19-5/8
L	6-5/8	7	7	8-1/2	10
M	3/8	3/8	1/2	1/2	5/8
N	3/8	1/2	5/8	5/8	3/4
P	5-3/4	5-3/4	6-3/4	6-3/4	9-1/2

Notes:

1. *Dynamic pickup torque is 70% of Static Torque.*
2. *Models with “L” number of springs are used for air set brakes. Specify “N” (neutral position) when output shaft is to be “free-to-turn” after brake air is exhausted.*
3. *Use Som Pac® 3 when acceleration-deceleration control is required or if these times exceed one second.*

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