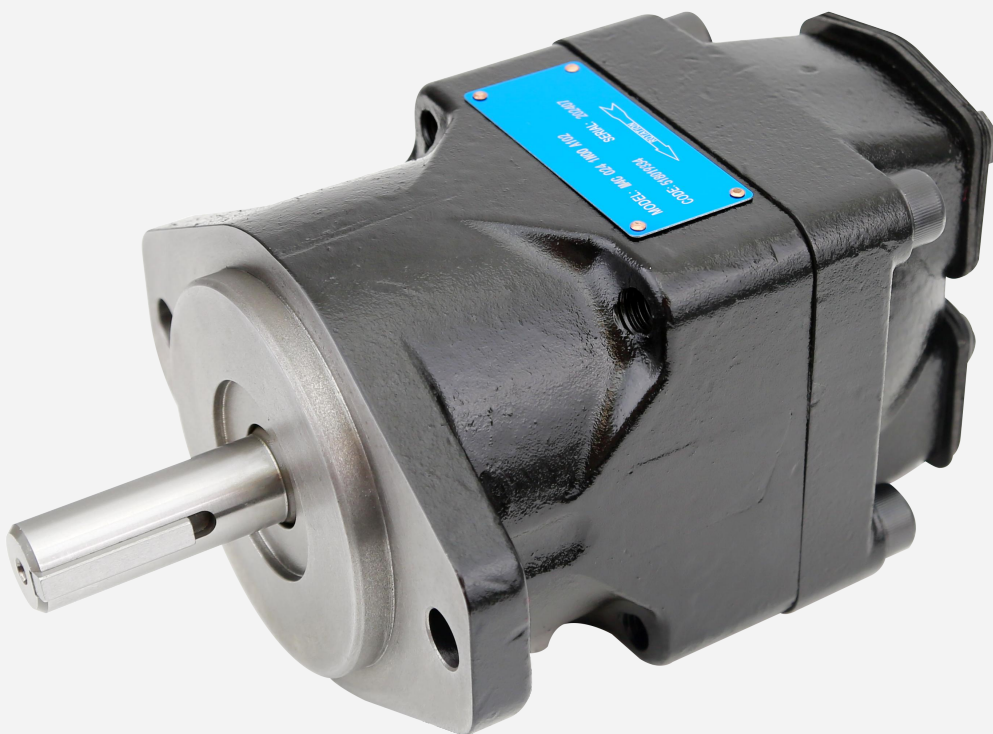


Vane motors

Single & double

M3B - M4 / M4S series



Publ. 2 - AM 157 - B

07 / 97 / FB

Replaces : 2 - AM 157 - A





HIGH STARTING TORQUE EFFICIENCY

The high starting torque efficiency of vane type motors makes them especially applicable in load hoist winch drives, swing drives and propulsion drives. This high starting torque efficiency allows the motor to start under high load without pressure overshoots, jerks and high instantaneous horsepower loads.

HIGH VOLUMETRIC EFFICIENCY

Vane motors begin life with high volumetric efficiency and maintain that efficiency throughout their operating life.

LOW TORQUE RIPPLE AT LOW SPEED

When operating at very low speeds on applications such as swing and load hoist drives, the vane motor exhibits very low torque ripple.

2 AND 3-SPEED VERSIONS AVAILABLE

The M4DC, because of its unequal size cartridges, allows the use of 3 speed operation. This makes them more applicable in traction drive circuits to replace manually shifted gear-boxes. 2-speed motors are available in a wider range of ratios than standard gear motors.

BALANCED DESIGN

Vane, rotor and cam ring are pressure balanced to increase life and efficiency over full speed range.

INTERCHANGEABLE ROTATING GROUPS

Rotating groups may be easily replaced to renew the motor or change displacement to suit altered requirements for speed or torque.

REVERSIBLE ROTATION

The motors may be stopped or reversed repeatedly and rapidly driving or braking the connected shaft load at controlled torque levels.

WIDE SPEED RANGE

Starting to maximum RPM, with full torque capability during acceleration.

PORTS AND MOUNTING

Conform fully to SAE J744c (ISO-3019-1) standards to simplify refitting and installation.

FIRE RESISTANT FLUIDS

Are easily used in the standard M3B and M4* versions of these motors. These include phosphate or organic ester fluids and blends, water-glycol solutions and water-oil invert emulsions.

M3B AND M4* SERIES MOTORS

The M3B and M4* have been designed especially for severe duty applications which require high pressure up to 3400 PSI, high speed up to 4000 RPM and low fluid lubricity (HF-1, HF-2A, HF-3, HF-4, HF-5).

TECHNICAL DATA - M3B AND M4* SERIES

Series	Size	Displ.	Theor. Displ. V _i	Torque T	Power at 100 Rev/min	Torque T	Power P
			in ³ /rev.	in.lbf/PSI	HP/100 PSI	n = 2000 RPM at Δ p 2500 PSI in.lbf	HP
M3	B B1	009	.56	0.08	0.014	174.3	5.8
		012	.75	0.11	0.018	236.3	7.8
		018	1.13	0.19	0.030	412.4	13.4
		027	1.70	0.30	0.046	680.5	21.8
		036	2.26	0.38	0.060	902.6	28.3
M4	C C1 SC SC1	024	1.49	0.24	0.037	535.4	17.0
		027	1.72	0.28	0.043	619.5	19.7
		031	2.11	0.33	0.054	768.0	24.1
		043	2.84	0.45	0.072	1062.0	33.6
		055	3.59	0.57	0.091	1318.6	41.8
		067	4.34	0.69	0.111	1504.5	47.7
		075	4.89	0.78	0.120	1752.2	55.6
	D D1 SD SD1	062	3.97	0.63	0.102	1460.0	46.4
		074	4.69	0.75	0.120	1770.0	56.2
		088	5.56	0.88	0.139	2088.5	66.2
		102	6.44	0.96	0.166	2336.3	74.1
		113	7.12	1.13	0.185	2655.0	84.2
		128	8.08	1.28	0.203	3009.0	95.5
		138	8.81	1.40	0.222	3292.0	104.5
	E E1 SE/SE1	153	9.67	1.54	0.240	3522.0	111.8
		185	11.69	1.86	0.296	4283.2	136.0
		214	13.55	2.16	0.342	5017.7	159.3
	DC DC1 SDC SDC1	See M4C/C1/SC/SC1 and M4D/D1/SD/SD1					

Internal drain : All these motors may be equipped with internal drain. Then the model numbers will be M3B1, M4C1, M4SC1, M4D1, M4SD1, M4E1, M4SE1, M4DC1, M4SDC1.

For further information or if the performance characteristics outlined above do not meet your own particular requirements, please consult your local DENISON Hydraulics office.

GENERAL CHARACTERISTICS

	Mounting standard	Weight without connector and bracket - lbs	Moment of inertia lb.in ²	Option for inlet and outlet port	
M3B	SAE J744c ISO/3019-1 SAE A	17.6	1.03	SAE threaded SAE 4 bolt J718c ISO/DIS 6162-1 - 3/4" BSPP threaded	
M4C/SC	SAE J744c ISO/3019-1 SAE B	34.0	2.7	SAE threaded SAE 4 bolt J718c ISO/DIS 6162-1 - 1"	
M4D/SD	SAE J744c ISO/3019-1 SAE C	59.5	1.4	SAE threaded SAE 4 bolt J718c ISO/DIS 6162-1 - 1 1/4"	
M4E/SE	SAE J744c ISO/3019-1 SAE C	99.0	20.0	SAE threaded SAE 4 bolt J718c ISO/DIS 6162-1 - 2"	
M4DC/SDC	SAE J744c ISO/3019-1 SAE C	88.0	10.0	SAE 4 bolt J718c ISO/DIS 6162-1 - 1 1/4"	P2 = See M4C/M4SC

MAXIMUM SPEED, PRESSURE RATINGS - M3B AND M4* SERIES

Series	Size	Displ.	Max. pressure					Operating pressure range drain	Max. speed for low loaded condition ¹⁾	Max. speed for max. pressure ratings																			
			HF-0 HF-2	HF-2A	HF-1	HF-3 HF-5	HF-4			HF-0, HF-2		HF-2A		HF-1															
			PSI	PSI	PSI	PSI	PSI			Cont.	Int. ²⁾	Cont.	Int. ²⁾	Cont.	Int. ²⁾														
			RPM	RPM	RPM	RPM	RPM	RPM	RPM	RPM	RPM	RPM	RPM	RPM	RPM														
M3	B B1	009	2500						22	4000	3000	3600																	
		012	3000																										
		018																											
		027																											
		036																											
M4	C C1	024	2500	2500	2500			50	4000	2500	3600	2500	3000	2000	2500														
		027																											
		031																											
		043																											
		055																											
		067																											
		075																											
	SC SC1	024	3400	3000	2500	2500	2000									4000	2500	3000	2500	2800	2000	2500							
		027																											
		031																											
		043																											
		055																											
		067																											
		075																											
	D D1	062	2500	2500	2000				4000	2500	3000	2500	2800	2000	2500														
		074																											
		088																											
		102																											
		113																											
		128																											
		138																											
	SD SD1	062	3400	2700	2000	2000	2000									3600	2500	3000	2500	2800	1800	2200							
		074																											
		088																											
		102																											
		113																											
		128																											
		138																											
	E E1	153	2500	2500	2000				4000	2500	3000	2500	2800	2000	2500														
		185																											
		214																											
	SE SE1	153	2700	2500	2000	2000	2000																4000	2500	3000	2500	2800	2000	2500
		185	2600																										
		214	2500																										
DC DC1	All models	2500	2500	2000			4000	2500																					
SDC SDC1	D-062 at 088	3400	2700	2000	2000	2000																							
	C-024 at 043																												
	D-102																												
	D-113	3000	2700																										
	C-055																												
	C-067																												
	D-128	2500	2500																										
	D-138																												
	C-075																												

1) Low loaded condition 500 PSI for M3 and M4, 1160 PSI max. for M4S (see page 6).

2) Intermittent speed - Do not exceed 6 seconds per minute of operation.

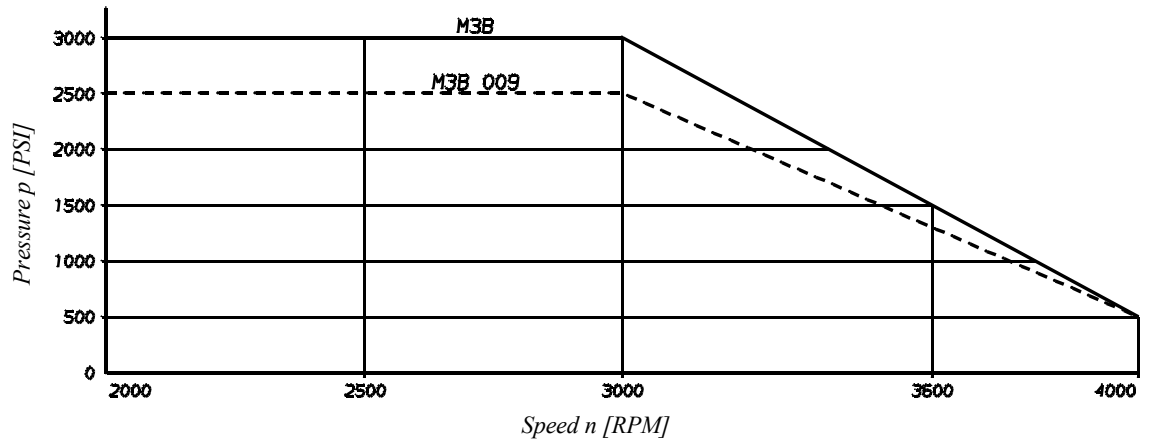
HF-0, HF-2 = Antiwear petroleum base. HF-2A = Crankcase. HF-1 = Non antiwear petroleum base. HF-5 = Synthetic fluids.

HF-3 = Water in oil emulsions. HF-4 = Water glycols.

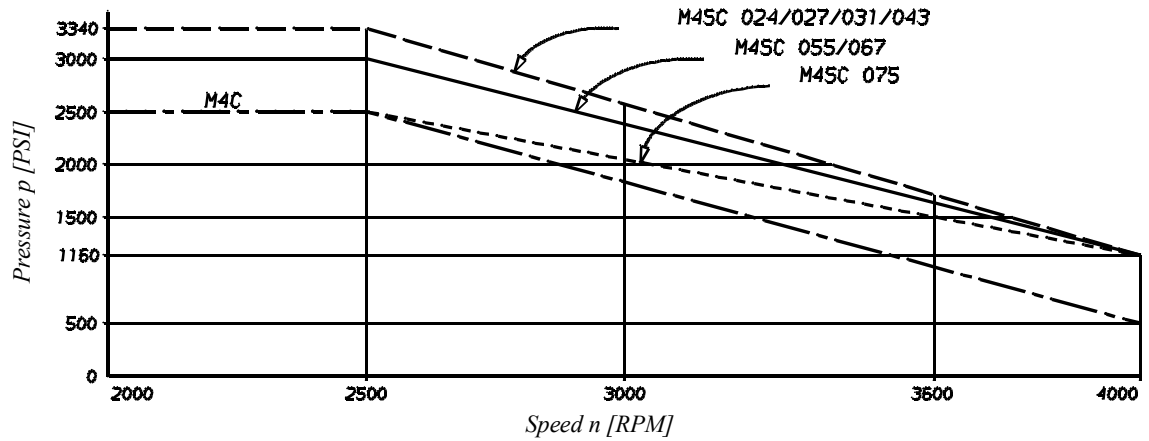
Internal drain : All these motors may be equipped with internal drain. Then the model numbers will be M3B1, M4C1, M4SC1, M4D1, M4SD1, M4E1, M4SE1, M4DC1, M4SDC1.

MAX. SPEED AND MAX. CONTINUOUS PRESSURE - M3B AND M4* SERIES

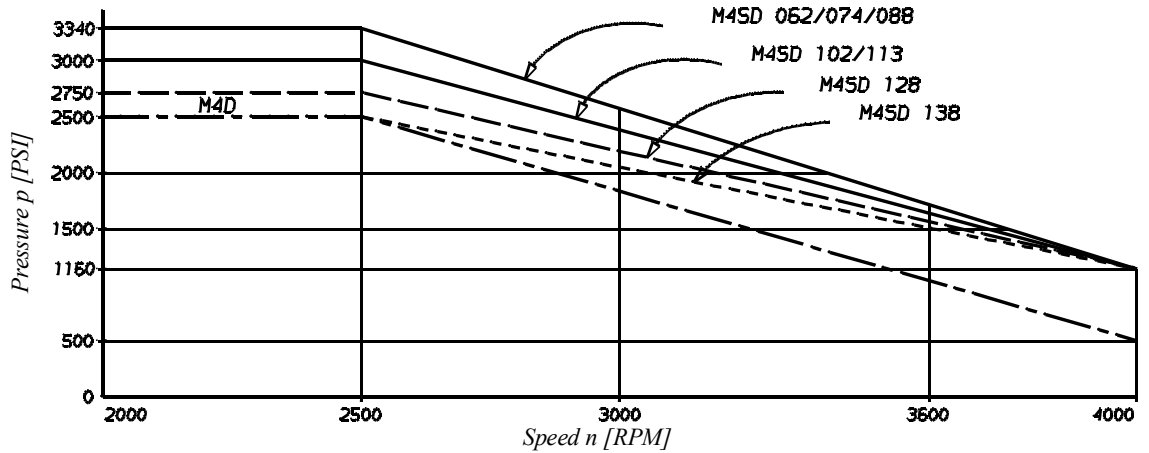
M3B



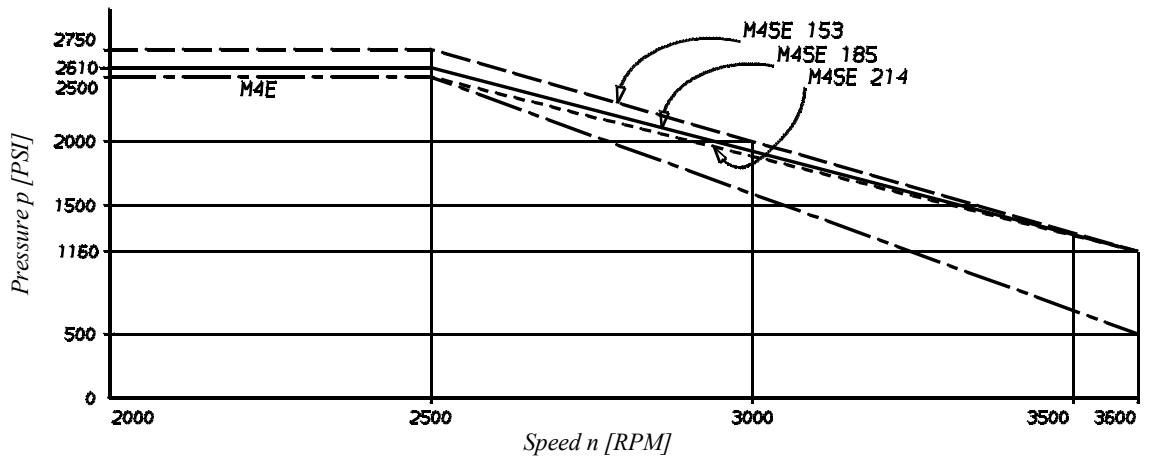
M4C/M4SC



M4D/M4SD



M4E/M4SE



Performances required

Torque	T [in.lbf]	1240
Pump flow (available) at 115 SUS	q_{ve} [GPM]	30.4
Speed	n [RPM]	1500
Pressure	p [PSI]	2500

1. Check if available power is compatible with required power (0.85 estimated overall efficiency).

$$0.85 \times \frac{Q_{ve} \times p}{1714} \geq \frac{T \times RPM}{63025}$$

$$0.85 \times \frac{30.4 \times 2500}{1714} \geq \frac{1240 \times 1500}{63025}$$

$$37.7 > 29.5$$

Two ways of calculation :

2a. Calculate V_i from T required torque

$$V_i = \frac{2 \pi \times T}{p} = \frac{2 \pi \times 1240}{2500} = 3.12 \text{ in}^3/\text{rev.}$$

3a. Motor choose from V_i immediately greater

$$M4C 055 V_i = 3.59 \text{ in}^3/\text{rev.}$$

4a. Check real motor pressure for

$T = 1240 \text{ in.lbf}$ around 1500 RPM

M4C 055 $T = 1240 \text{ in.lbf}$ $n = 1500 \text{ RPM}$

$p = 2370 \text{ PSI}$ (see page 15)

5a. Flow loss M4C 055 at 2370 PSI at 115 SUS

$q_{vs} = 4.2 \text{ GPM}$ (see page 22)

Real flow used by the motor :

$$q_v = q_{ve} - q_{vs} = 30.4 - 4.2 = 26.2 \text{ GPM}$$

6a. Real speed of the motor :

$$n = \frac{q_v \times 231}{V_i} = \frac{26.2 \times 231}{3.59} = 1686 \text{ RPM}$$

Real performances

$$\left. \begin{array}{l} V_i = 3.59 \text{ in}^3/\text{rev.} \\ n = 1680 \text{ RPM} \\ T = 1240 \text{ in.lbf} \\ p = 2370 \text{ PSI} \end{array} \right\} M4C 055$$

2b. Calculate V_i from q_{ve} available flow

$$V_i = \frac{30.4 \times 231}{1500} = 4.68 \text{ in}^3/\text{rev.}$$

3b. Motor choose from V_i immediately smaller

$$M4C 067 V_i = 4.34 \text{ in}^3/\text{rev.} \text{ (see page 22)}$$

4b. Check motor press. with $T = 1240$

in.lbf at 1500 RPM

M4C 067 $T = 1240 \text{ in.lbf}$ $n = 1500 \text{ RPM}$

$p = 2030 \text{ PSI}$ (see page 15)

5b. Flow loss of M4C 067 at 2030 PSI at 115 SUS

$q_{vs} = 3.7 \text{ GPM}$ (see page 22)

Real flow used by the motor :

$$q_v = q_{ve} - q_{vs} = 30.4 - 3.7 = 26.7 \text{ GPM}$$

6b. Real speed of the motor :

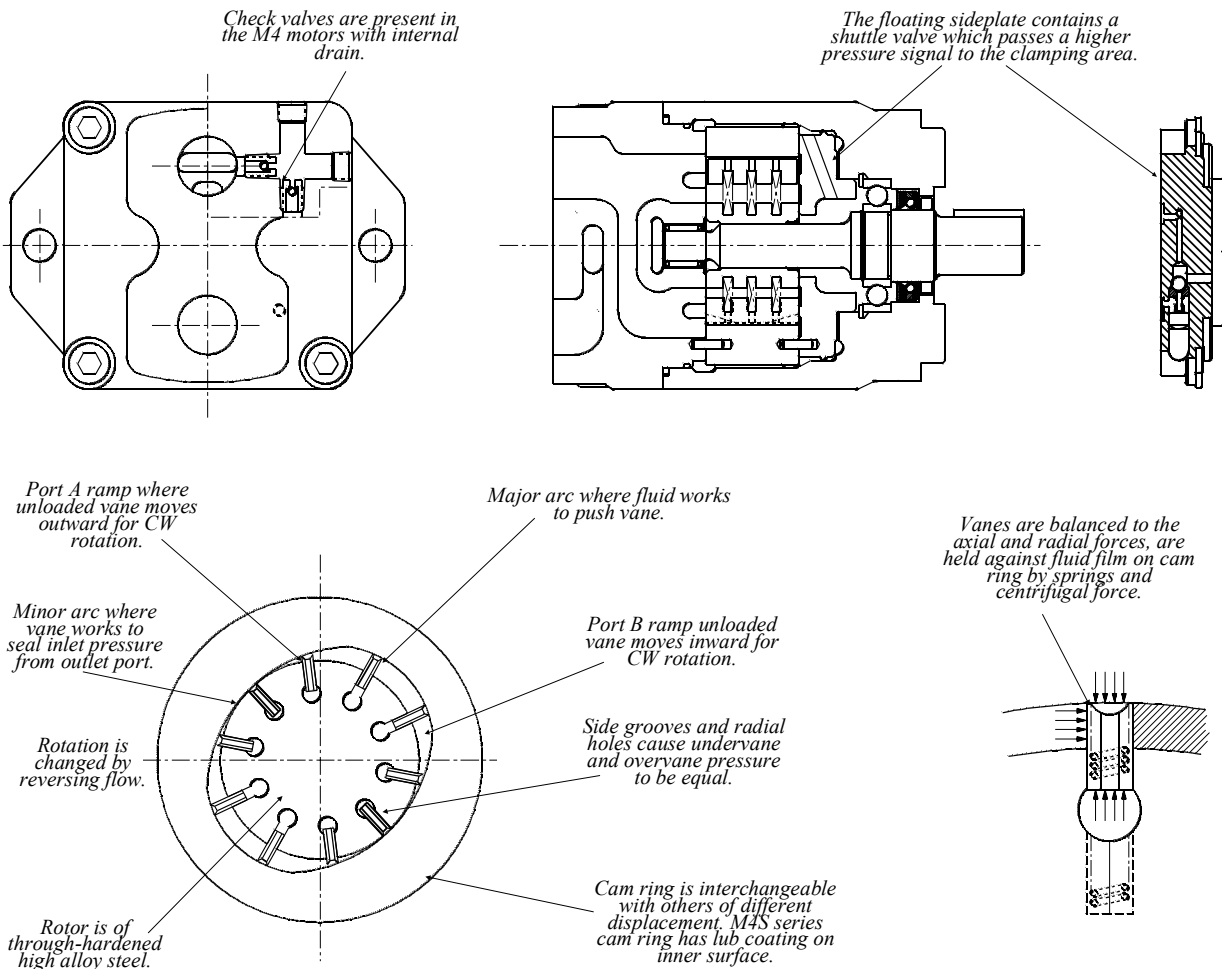
$$n = \frac{q_v \times 231}{V_i} = \frac{26.7 \times 231}{4.34} = 1420 \text{ RPM}$$

Real performances

$$\left. \begin{array}{l} V_i = 4.34 \text{ in}^3/\text{rev.} \\ n = 1420 \text{ RPM} \\ T = 1240 \text{ in.lbf} \\ p = 2030 \text{ PSI} \end{array} \right\} M4C 067$$

In each case always choose the smallest motor which will operate at the highest speed and pressure, and offers the most efficient solution.

DESCRIPTION - M3* AND M4* SERIES



OPERATION - SINGLE CARTRIDGE

- The motor shaft is driven by the rotor. Vanes, closely fitted into the rotor slots move radially to seal against the cam ring. The ring has two major and two minor radial sections joined by transitional sections called ramps. These contours and the pressures exposed to them are balanced diametrically.
- Light springs urge the vanes radially against the cam contour assuring a seal at zero speed so the motor can develop starting torque. The springs are assisted by centrifugal force at higher speeds. Radial grooves and holes through the vanes equalize radial hydraulic forces on the vanes at all times. Fluid enters and leaves the motor cartridge through opening in the side plates at the ramps. Each motor port connects to two diametrically opposed ramps. Pressurized fluid entering at Port A torques the rotor clockwise. The rotor transports it to the ramp openings which connect to Port B from which it returns to the low pressure side of the system. Pressure at Port B torques the rotor counter-clockwise.
- The rotor is separated axially from the sideplate surfaces by the fluid film. The front sideplate is clamped against the cam ring by the pressure, maintains optimum clearance as dimensions change with temperature and pressure. A 3-way shuttle valve in the sideplate causes clamping pressure in Port A or B, whichever is the highest.
- Materials are chosen for long life efficiency. Vanes, rotor and cam ring are made out of hardened high alloy steels. Cast semi-steel sideplates are chemically etched to have a fine crystalline surface for good lubrication at start-up.

**PORTS
EXTERNALLY DRAINED
SINGLE CARTRIDGE MOTORS**

These motors may be alternately pressurized at Ports A & B to 3400 PSI max. Whichever port is at low pressure should not be subjected to more than 500 PSI. If it is necessary to exceed these limitations, please contact DENISON Hydraulics for application assistance.

**INTERNALLY DRAINED
TANDEM CARTRIDGE MOTORS**

These motors must have a drain line connected to the center housing drain connection of sufficient size to prevent back pressure in excess of 50 PSI, and returned to the reservoir below the surface of the oil as far away from the supply pump suction as possible. Model M4DC1 does not require an external drain line, however the outlet pressure must not exceed 50 PSI.

**INTERNALLY DRAINED MOTORS
(M4C1, M4D1, M4E1, M4DC1)**

May be alternately pressurized at Ports A & B to 3400 PSI max. Whichever port is at low pressure must not be subjected to more than 22 PSI for M3B, 50 PSI for M4* (pressure peak 100 PSI).

To insure maximum motor performance in conjunction with your specific application, consult your DENISON Hydraulics Representative if your application requires :

- minimum speed of less than 100 RPM,
- indirect drive,
- overrunning loads,
- braking or retarding.

M4S SEVERE DUTY MOTORS

M4S motors are recommended to be used when back pressure is over 2000 PSI and speed is over 2000 RPM. They are also recommended when fluid viscosity can be under 115 SUS and speed over 2000 RPM. For such severe duty applications M4S motors will exhibit longer life time at high efficiency.

RECOMMENDED FLUIDS

Petroleum based antiwear R & O fluids.

These fluids are the recommended fluids for M3B and M4* series motors. Maximum catalog ratings and performance data are based on operation with these fluids. These fluids are covered by DENISON Hydraulics HF-0 and HF-2 specifications.

Acceptable alternate fluids :

**ACCEPTABLE ALTERNATE
FLUIDS**

The use of fluids other than petroleum based antiwear R & O fluids requires that the maximum ratings of the motors will be reduced. In some cases, the minimum replenishment pressures must be increased. Refer to the following chart and the operating characteristics chart for each M3B and M4* motor model for specific details of the reduced ratings.

VISCOSITY

Max. (cold start, low speed & pressure)	3900 SUS
Max. (full speed & pressure)	500 SUS
Optimum (max. life)	140 SUS
Min. (full speed & pressure for HF-1 fluid)	89 SUS
Min. (full speed & pressure for HF-0 & HF-2 fluids)	59 SUS

VISCOSITY INDEX

90° min. Higher values extend range of operating temperatures and life time.

Maximum fluid temperature (θ) °F

HF-0, HF-1, HF-2 _____ + 176°

Minimum fluid temperature (θ) °F

HF-0, HF-1, HF-2 _____ - 0.4°

FLUID CLEANLINESS

The fluid must be cleaned before and during operation to maintain contamination level of NAS 1638 class 8 (or ISO 18/14) or better. Filters with 25 micron (or better, β10 ≥ 100) nominal ratings may be adequate but do not guarantee the required cleanliness levels.

**OPERATING TEMPERATURES
AND VISCOSITIES**

Operating temperatures are a function of fluid viscosities, fluid type, and the pump. Fluid viscosity should be selected to provide optimum viscosity at normal operating temperatures. For cold starts the pumps should be operated at low speed and pressure until fluid warms up to an acceptable viscosity for full power operation.

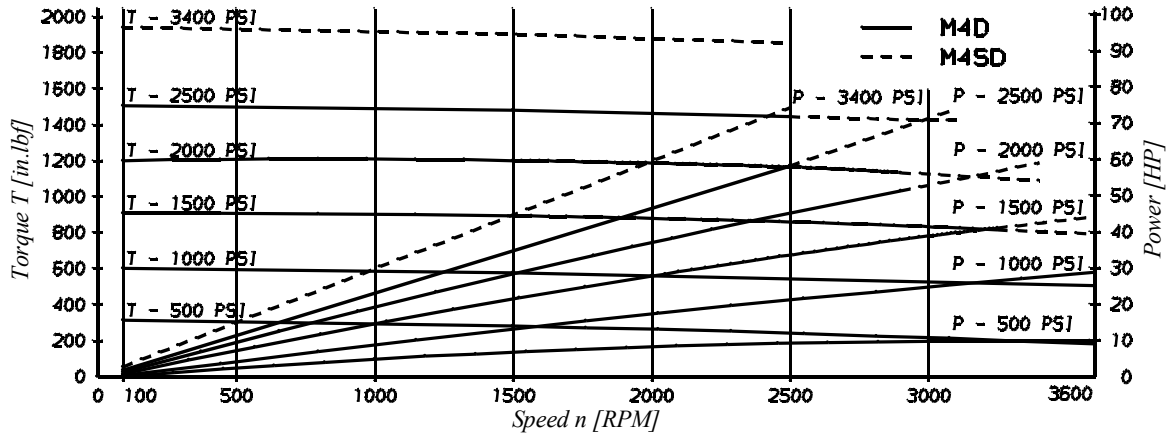
**WATER CONTAMINATION IN
THE FLUID**

Maximum acceptable content of water.

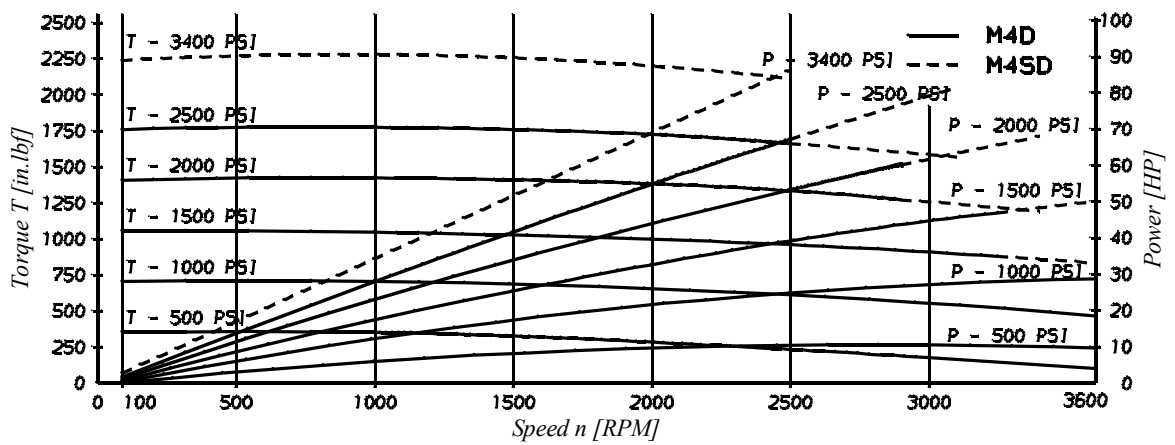
- 0,10 % for mineral base fluids.
 - 0,05 % for synthetic fluids, crankcase oils, biodegradable fluids.
- If amount of water is higher then it should be drained off the circuit.

PERFORMANCE CURVES - OIL VISCOSITY : 115 SUS (45°) - M4* SERIES

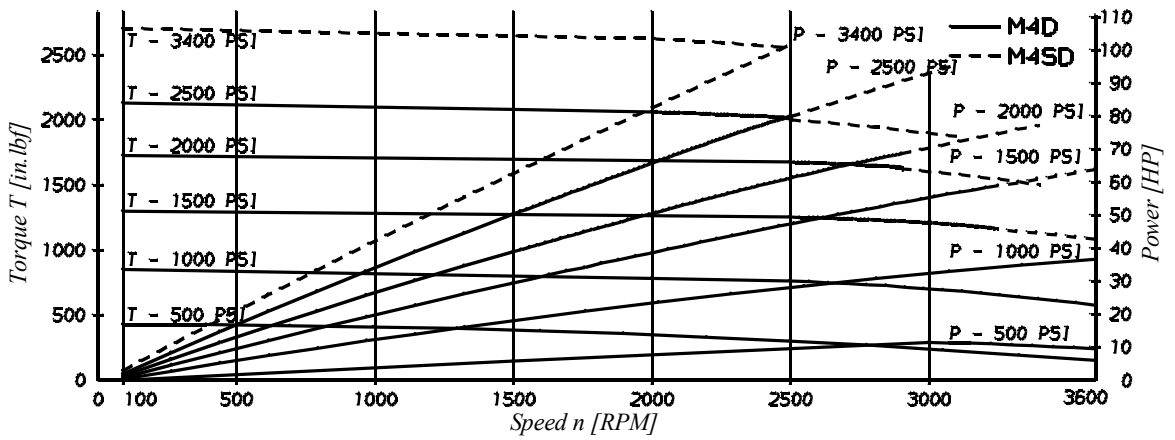
M4D 062



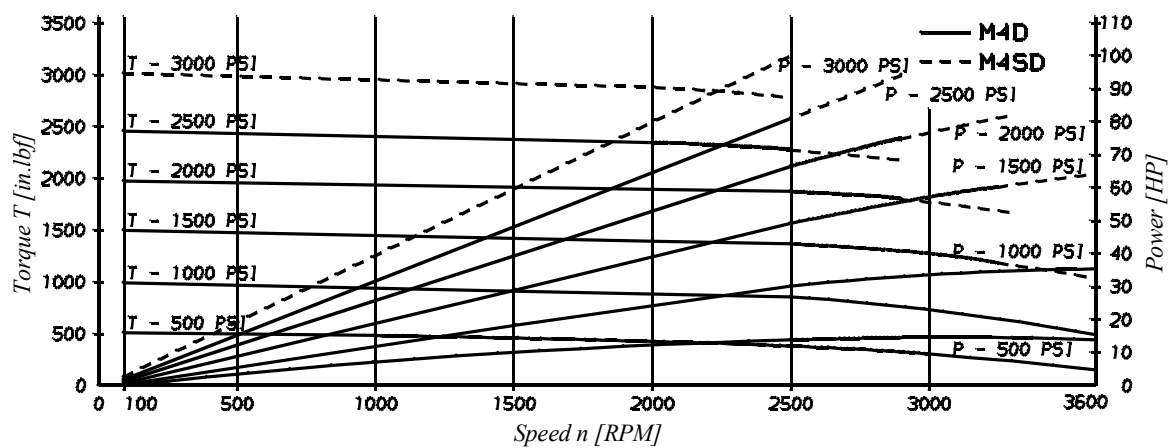
M4D 074



M4D 088

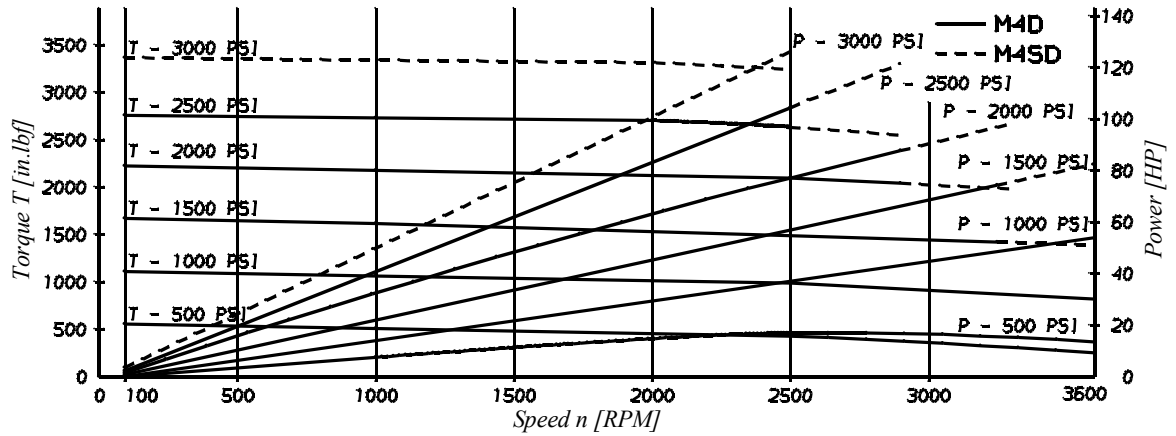


M4D 102

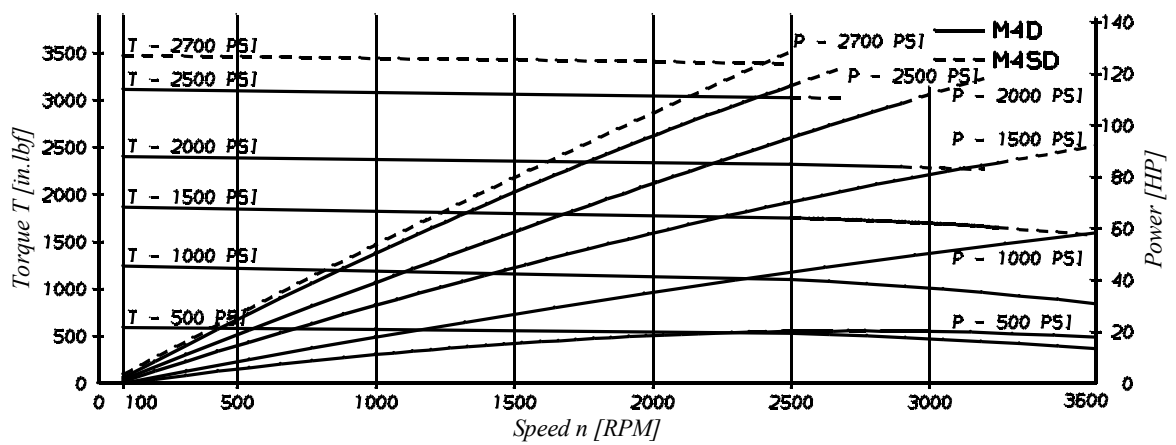


PERFORMANCE CURVES - OIL VISCOSITY : 115 SUS (45°) - M4* SERIES

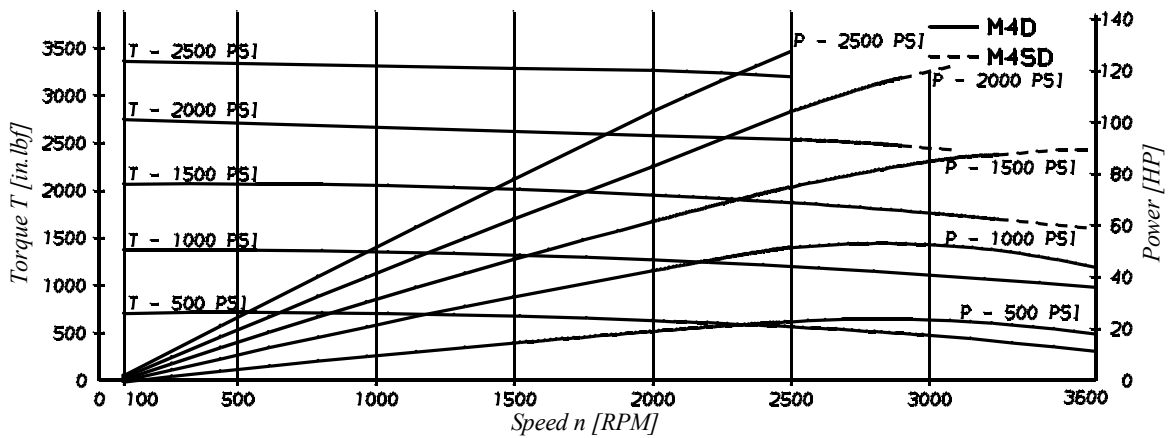
M4D 113



M4D 128



M4D 138



ORDERING CODE - M4D - M4SD SERIES

Model No. **M4*D1**
M4*D - 138 - 1 N 00 - B 1 02 ..

Series external drain _____

Series internal drain _____

Torque _____

062 = .63 in.lb/PSI
 074 = .75 in.lb/PSI
 088 = .88 in.lb/PSI
 102 = .96 in.lb/PSI
 113 = 1.13 in.lb/PSI
 128 = 1.28 in.lb/PSI
 138 = 1.40 in.lb/PSI

Type of shaft _____

1 = keyed (SAE C)
 3 = splined (SAE C)

Rotation _____

N = bi-directional

Modification _____

Port connections
 01 = SAE threaded port
 SAE drain
 02 = SAE 4 bolt flange
 UNC threaded - SAE drain
 04 = SAE 4 bolt flange
 UNC threaded - BSPP drain
 M4 = SAE 4 bolt flange
 metric threaded - BSPP drain

Seal class
 1 = S1 (M4D)
 5 = S5 (M4SD)

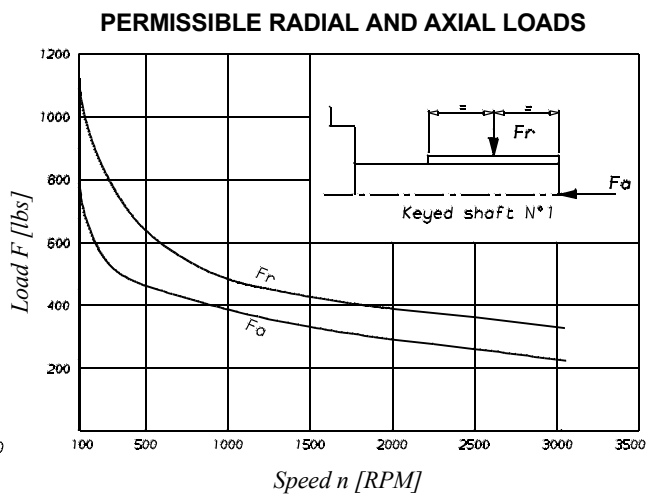
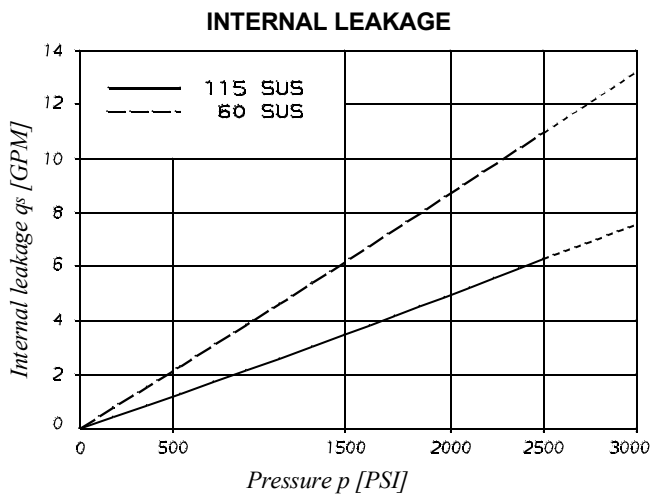
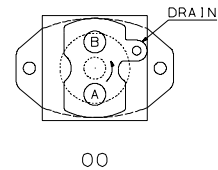
Design letter _____

Porting combination
 00 = standard

* = S = Severe duty motor.

M4D1 - M4SD1 : Drain port is plugged.

View from shaft end :
 CW rotation A = inlet CCW rotation A = outlet
 B = outlet B = inlet

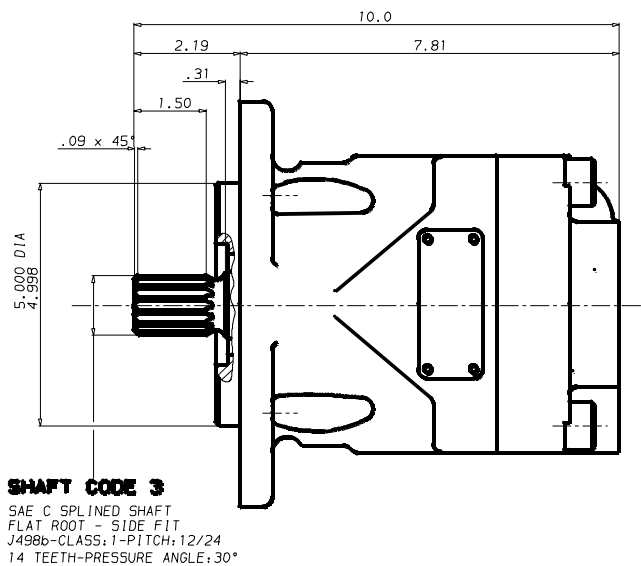
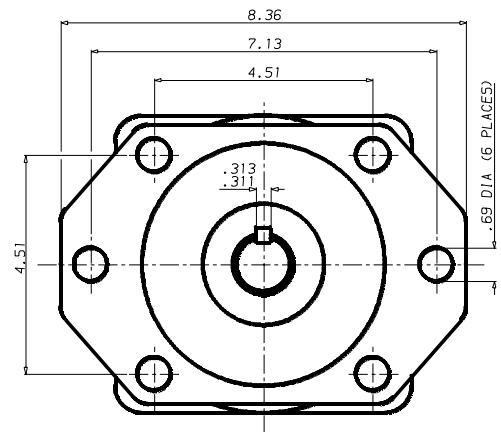
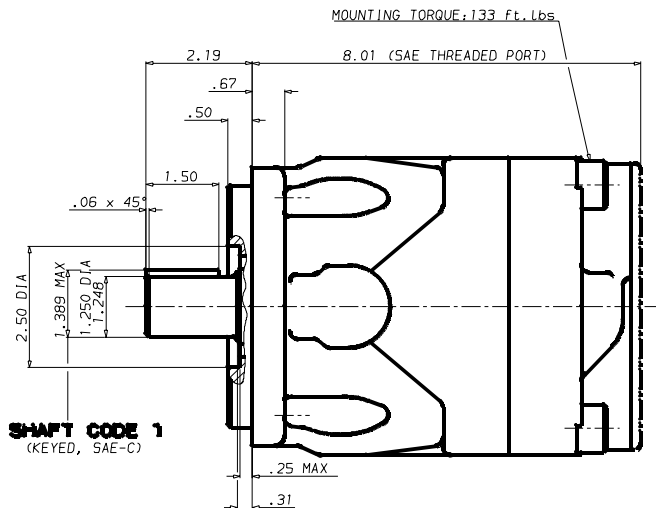


Do not apply F_r and F_a loads simultaneously

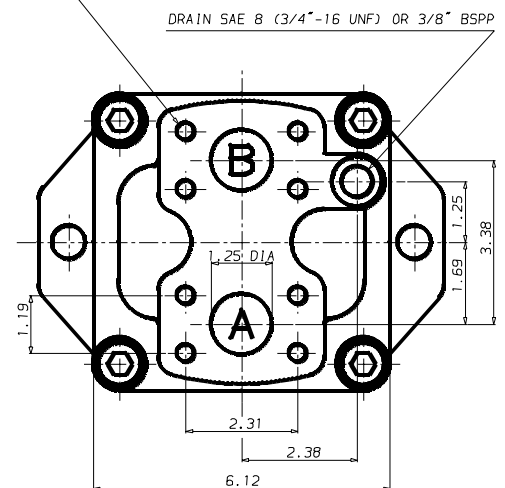
OPERATING CHARACTERISTICS - TYPICAL [115 SUS]

Model	Volumetric displacement V_i	Input flow at $n = 2000$ RPM		Torque T at $n = 2000$ RPM	Power output at $n = 2000$ RPM
		Theoretical	at 2500 PSI Δp	at 2500 PSI Δp	at 2500 PSI Δp
	in ³ /rev.	GPM	GPM	in.lbf	HP
M4D - M4SD 062	3.97	33.8	40.0	1460.0	46.4
M4D - M4SD 074	4.69	41.5	47.8	1770.0	56.2
M4D - M4SD 088	5.56	48.0	54.4	2088.5	66.2
M4D - M4SD 102	6.44	55.5	61.8	2336.3	74.1
M4D - M4SD 113	7.12	61.5	67.9	2655.0	84.2
M4D - M4SD 128	8.08	70.0	76.3	3009.0	95.5
M4D - M4SD 138	8.81	76.3	82.7	3292.0	104.5

DIMENSIONS & OPERATING CHARACTERISTICS - Weight : 59.5 lbs - M4D - M4SD SERIES



7/16"14 UNC .87 DEEP-8 HOLES
(M12 x .87 DEEP-METRIC VERSION)



SAE 20 (1 5/8"-16 UNF) x .75 DEEP-2 HOLES

