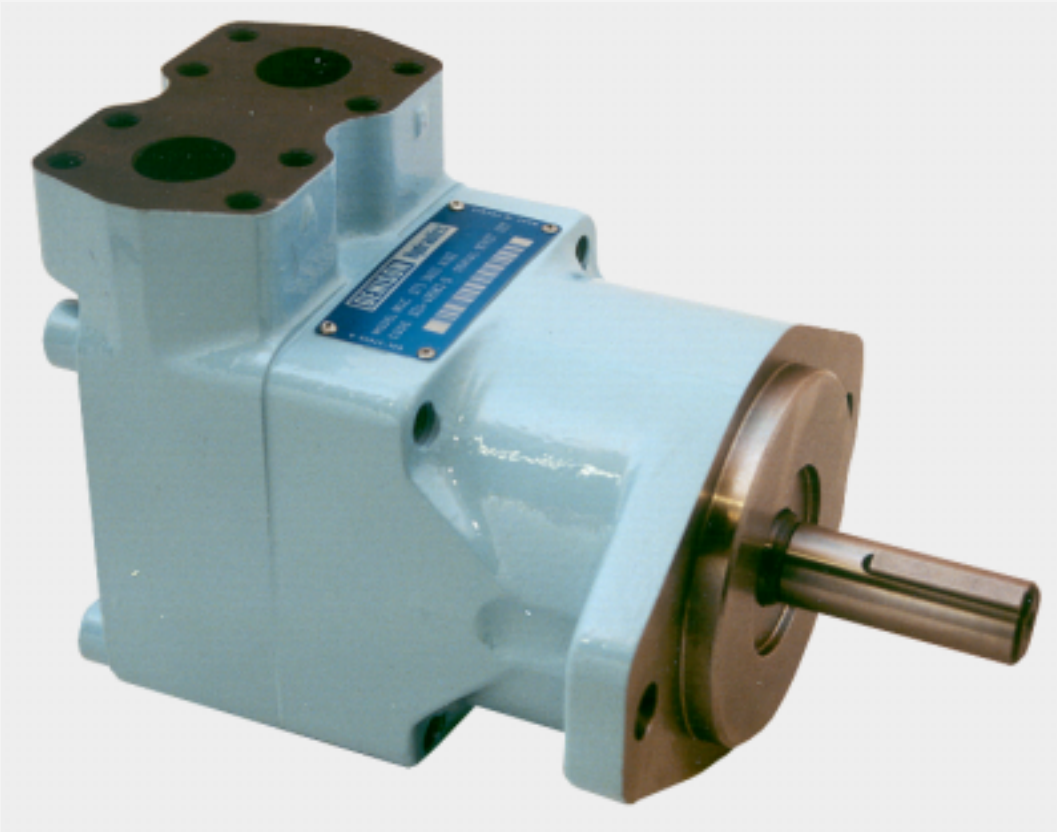
Vane motors
Single & double
M3B - M4 / M4S series



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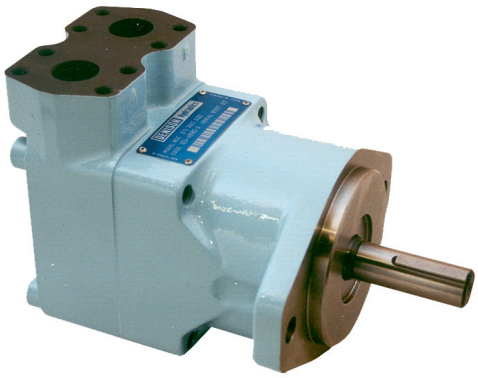
DENISON Hydraulics

CHARACTERISTICS - M3* AND M4* SERIES



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).

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Series	Size	Displ.	Theor. Displ. V_i	Torque T	Power at 100 Rev/min	Torque T	Power P
						n = 2000 RPM at Δ p 2500 PSI	
			$in^3/rev.$	in.lbf/PSI	HP/100 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 equiped 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**

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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	
										Cont.	Int.[2]	Cont.	Int.[2]	Cont.	Int.[2]
			PSI	PSI	PSI	PSI	PSI	PSI	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								
		027													
		031													
		043													
		055	3000	3000											
		067													
		075	2500	2500											
	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								
		074													
		088													
		102	3000	2700											
		113													
		128	2700	2700											
		138	2500	2500											
	E E1	153	2500	2500	2000				3600	2500	3000	2500	2800	1800	2200
		185													
		214													
	SE SE1	153	2700	2500	2000	2000	2000								
		185	2600												
		214	2500												
	DC DC1	All models	2500	2500	2000				4000	2500	3000	2500	2800	2000	2500
	SDC SDC1	D-062 at 088	3400	2700	2000	2000	2000								
		C-024 at 043													
		D-102	3000	2700											
		D-113													
		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 equiped with internal drain. Then the model numbers will be M3B1, M4C1, M4SC1, M4D1, M4SD1, M4E1, M4SE1, M4DC1, M4SDC1.

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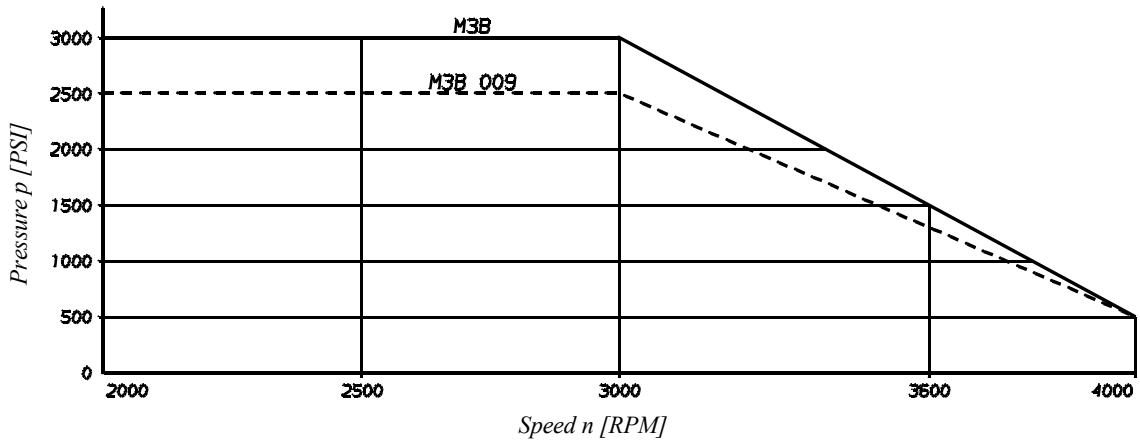
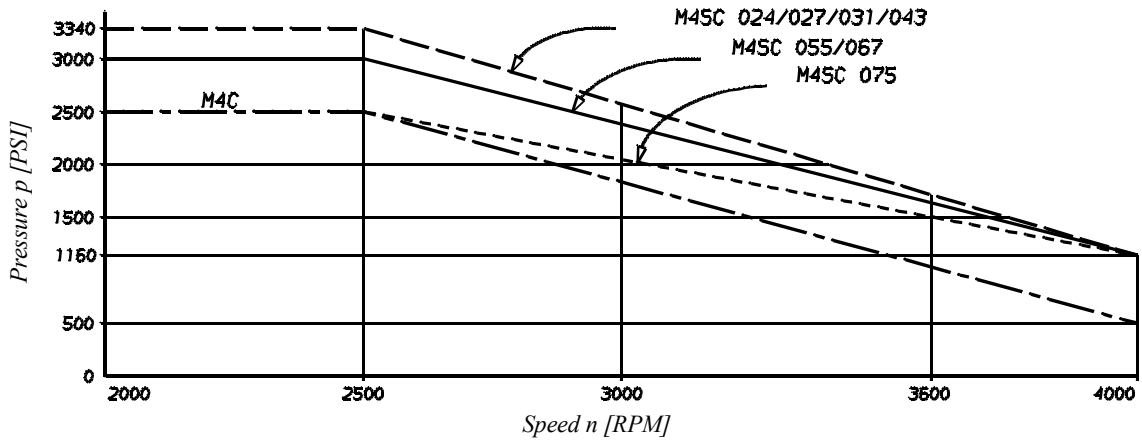
MAX. SPEED AND MAX. CONTINUOUS PRESSURE - M3B AND M4* SERIES

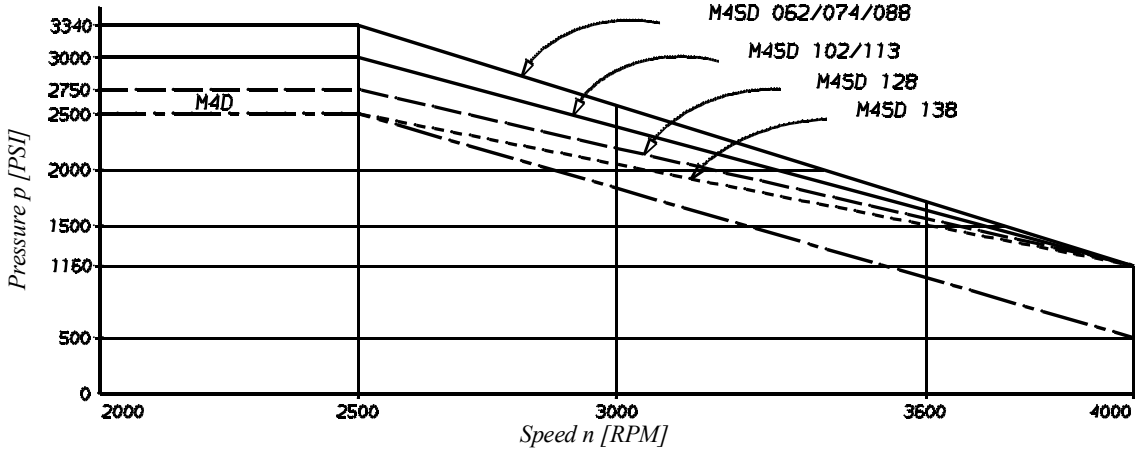
M3B



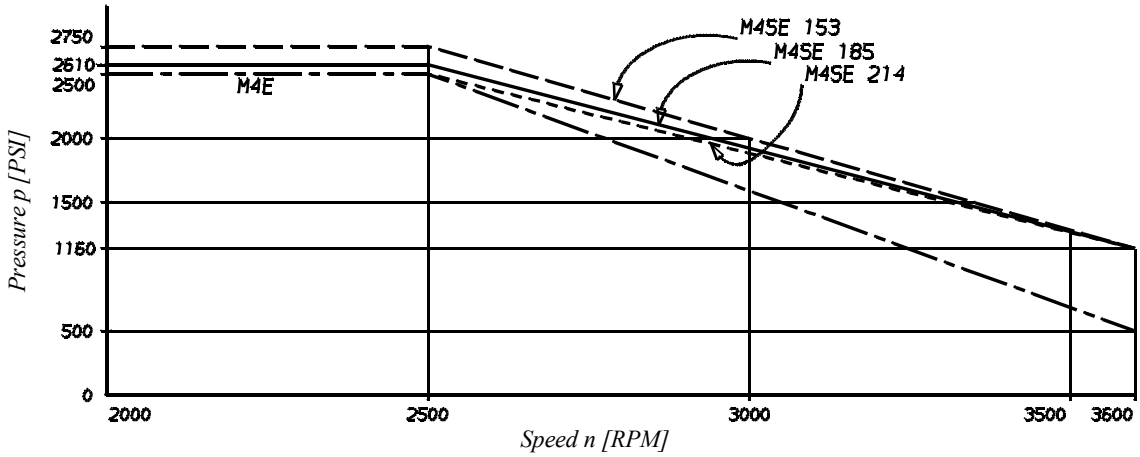
M4C/M4SC



M4D/M4SD



M4E/M4SE



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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).

$$0.85 \ x \ \frac{Q_{Ve} x\, p}{1714} \geq \frac{T x\, RPM}{63025}$$

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

$37.7 > 29.5$

Two ways of calculation :

2a. Calculate V_i from T required torque

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

3a. Motor choose from V_i immediately greater
M4C 055 V_i = 3.59 in^3/rev.

4a. Check real motor pressure for T = 1240 in.lbf around 1500 RPM
M4C 055 T = 1240 in.lbf n = 1500 RPM
p = 2370 PSI (see page 15)

5a. Flow loss M4C 055 at 2370 PSI at 115 SUS
q_{Vs} = 4.2 GPM (see page 22)
Real flow used by the motor :
$q_V = q_{Ve} - q_{Vs}$ = 30.4 - 4.2 = 26.2 GPM

6a. Real speed of the motor :

$$n = \frac{q_V \ x \ 231}{V_i} = \frac{26.2 \ x \ 231}{3.59} = 1686 \ RPM$$

Real performances

V_i	=	3.59 in^3/rev.	} *M4C 055*
n	=	1680 RPM	
T	=	1240 in.lbf	
p	=	2370 PSI	

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

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

3b. Motor choose from V_i immediately smaller
M4C 067 V_i = 4.34 in^3/rev. (see page 22)

4b. Check motor press. with T = 1240 in.lbf at 1500 RPM
M4C 067 T = 1240 in.lbf n = 1500 RPM
p = 2030 PSI (see page 15)

5b. Flow loss of M4C 067 at 2030 PSI at 115 SUS
q_{Vs} = 3.7 GPM (see page 22)
Real flow used by the motor :
$q_V = q_{Ve} - q_{Vs}$ = 30.4 - 3.7 = 26.7 GPM

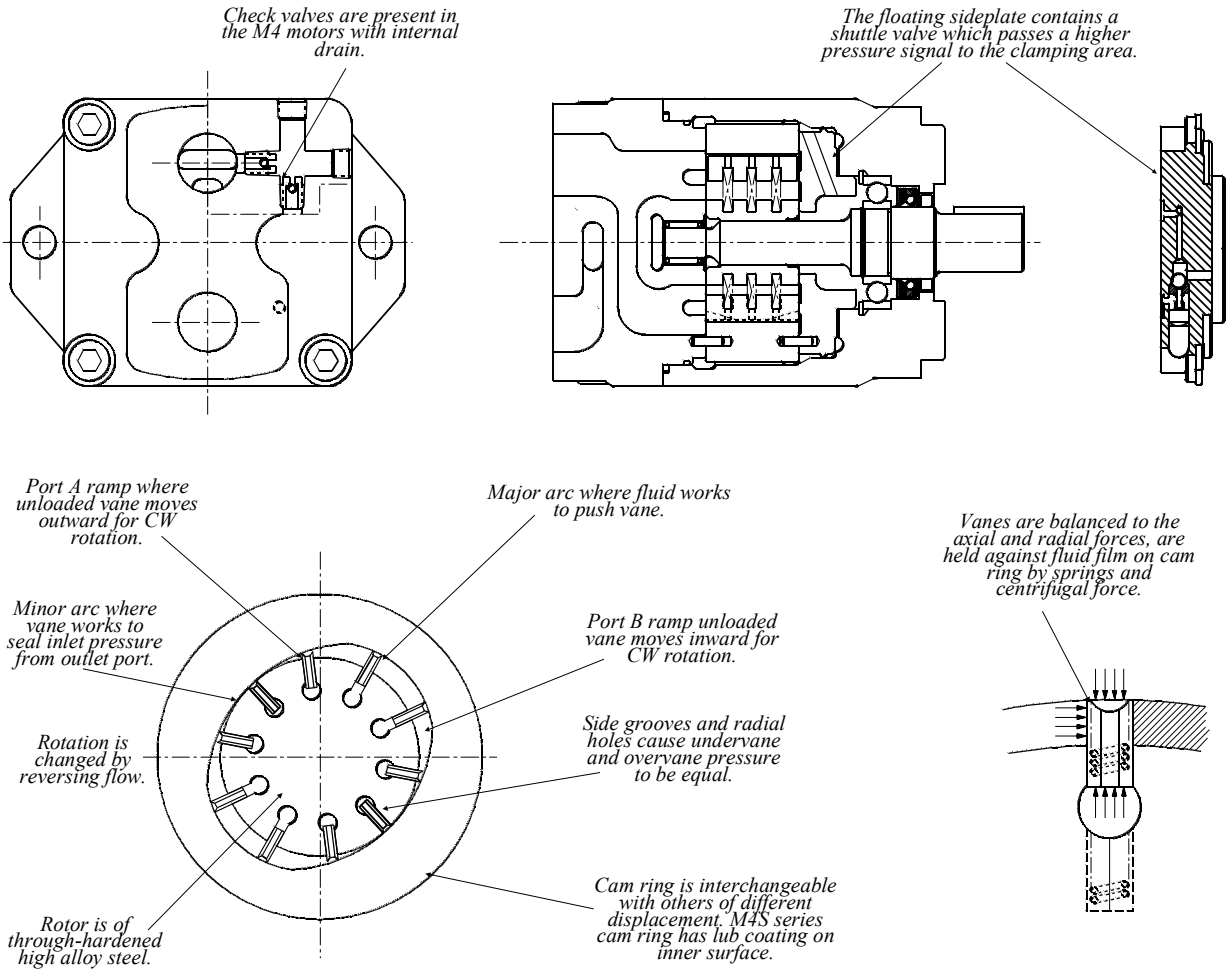
6b. Real speed of the motor :

$$n = \frac{q_V \ x \ 231}{V_i} = \frac{26.7 \ x \ 231}{4.34} = 1420 \ RPM$$

Real performances

V_i	=	4.34 in^3/rev.	} *M4C 067*
n	=	1420 RPM	
T	=	1240 in.lbf	
p	=	2030 PSI	

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



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 AND HYDRAULIC FLUIDS - M3B AND M4* SERIES

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, howewer 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 exhibity 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, ß10 ≥ 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

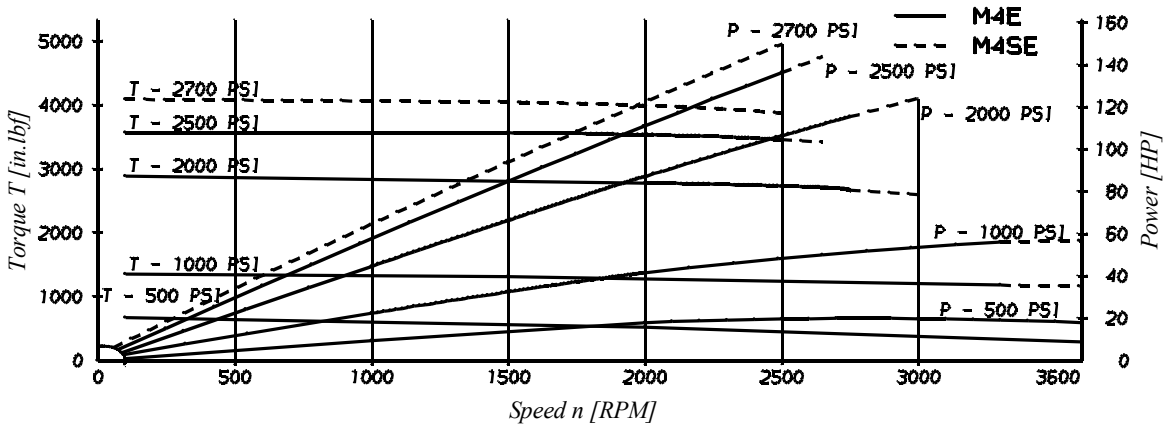
Maximum acceptable content of water.

- 0,10 % for mineral base fluids.
- 0,05 % for synthetic fluids, crankcase oils, biodegradable fluids.

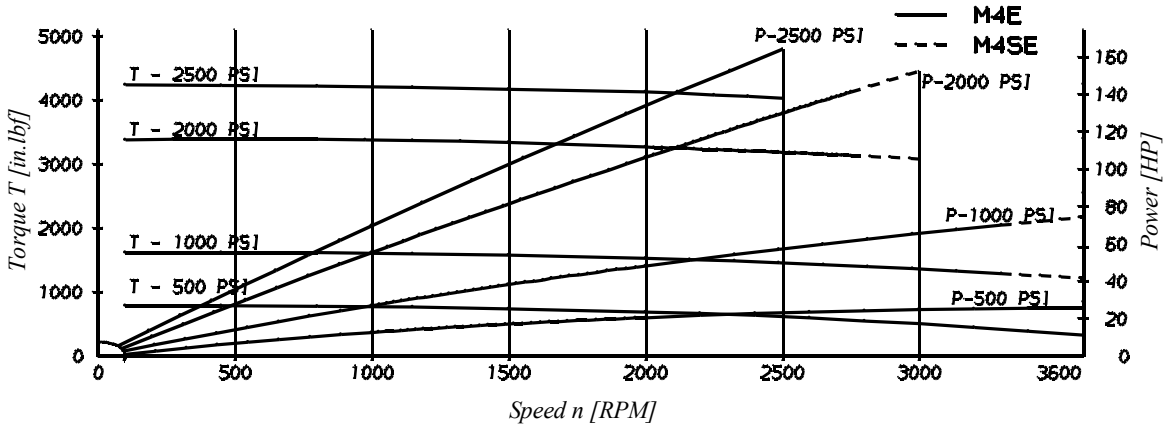
If amount of water is higher then it should be drained off the circuit.

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

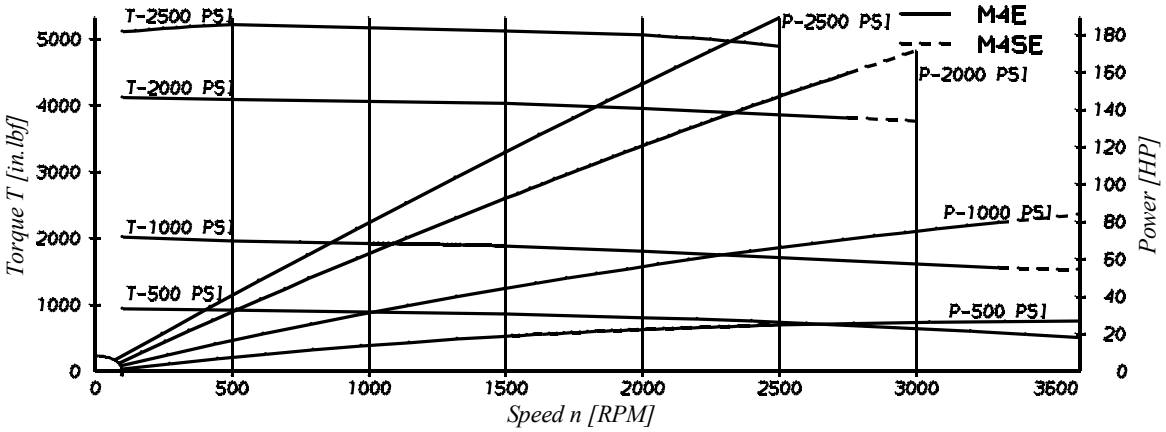
M4E 153



M4E 185



M4E 214



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ORDERING CODE - M4E - M4SE SERIES

Model No. **M4*E1**
M4*E - 214 - 1 N 00 - B 5 02 ..

Series external drain

Series internal drain

Torque
153 = 1.54 in.lb/PSI
185 = 1.86 in.lb/PSI
214 = 2.16 in.lb/PSI

Type of shaft
1 = keyed (SAE C)
3 = splined (SAE C)

Rotation
N = bi-directional

* = S = *Severe duty motor.*

M4E1 - M4SE1 : Drain port is plugged.

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

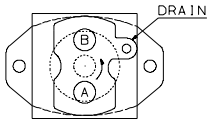
Seal class
5 = S5

Design letter

Porting combination
00 = standard

View from shaft end :

CW rotation		CCW rotation	
	A = inlet		A = outlet
	B = outlet		B = inlet



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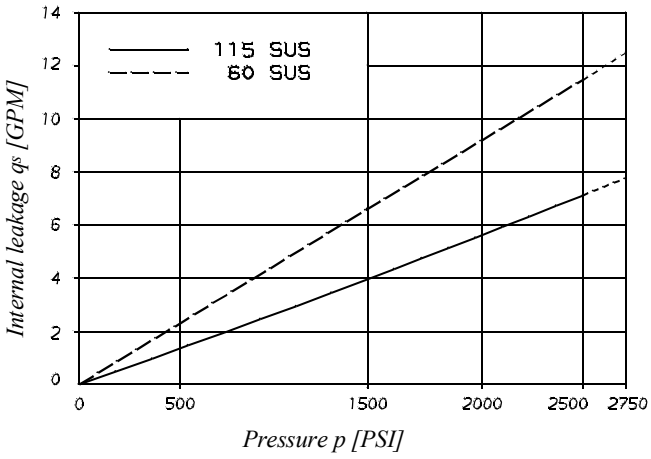
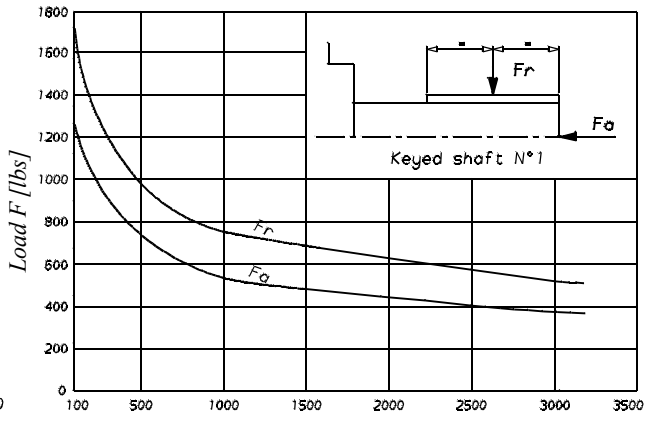
INTERNAL LEAKAGE



Pressure p [PSI]

PERMISSIBLE RADIAL AND AXIAL LOADS



Speed n [RPM]

Do not apply Fr and Fa 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
		Theorical	at 2500 PSI Δ p	at 2500 PSI Δ p	at 2500 PSI Δ p
	in^3/rev.	GPM	GPM	in.lbf	HP
M4E - M4SE 062	9.67	83.7	90.6	3522.0	111.8
M4E - M4SE 074	11.69	101.2	108.0	4283.2	136.0
M4E - M4SE 088	13.55	117.3	124.2	5017.7	159.3

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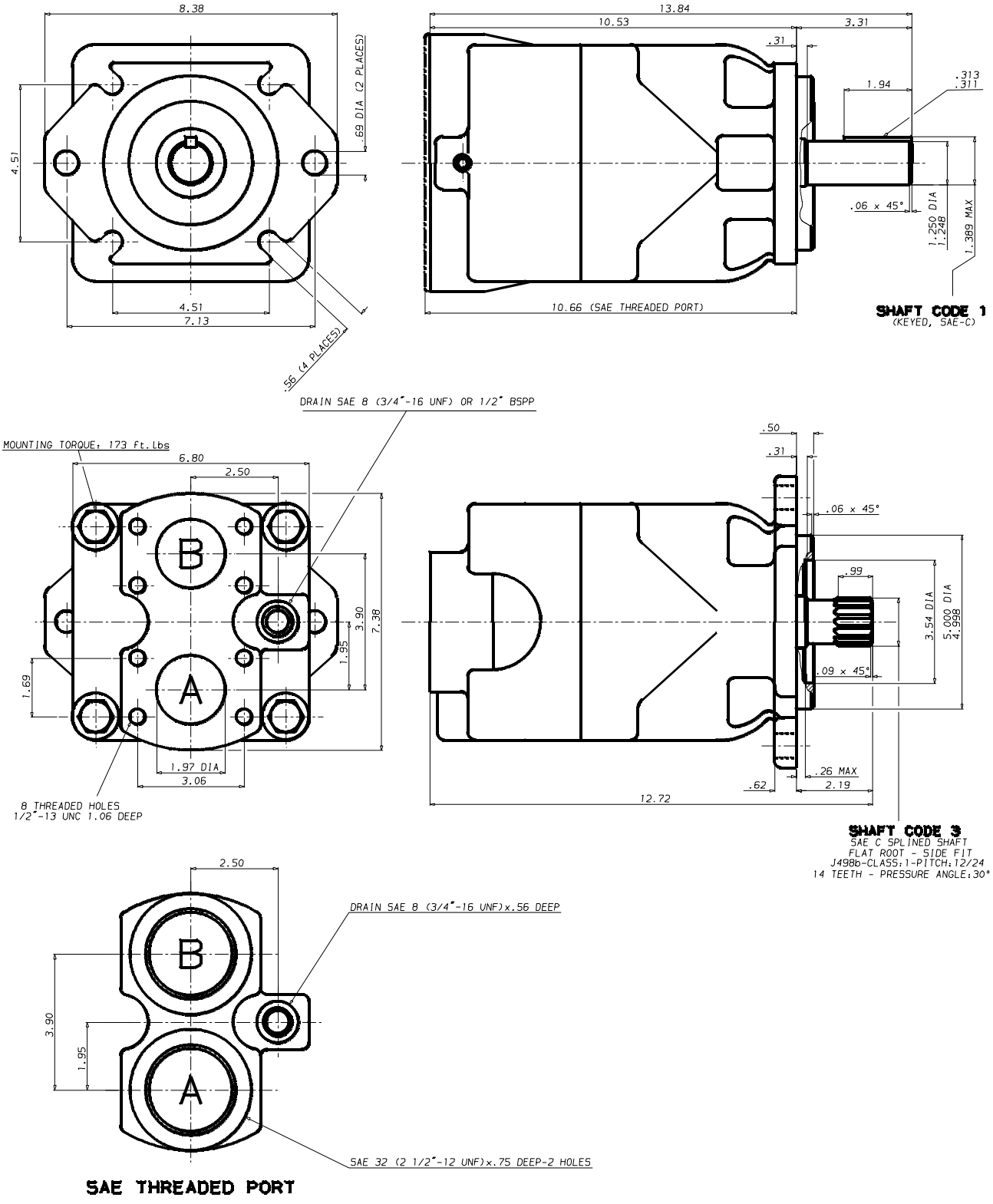
DIMENSIONS & OPERATING CHARACTERISTICS - Weight : 99.0 lbs - M4E - M4SE SERIES



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