I

HYDRAULIC MOTOR

SOLTECH

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	Mounting Standard (sae j477C, ISO/3019-1)	Weight		Option for inlet & outlet port SAE 4 bolt SAE threaded J781c, ISO/DIS 6162-1	Moment of Innertia		Page
		lbs	kgs		$lbsin^2$	kgm^2x10^{-4}	
M4C~M4C1, M4SC~M4SC1	SAE-B	34	15	1"	2.7	7.9	364
M4D~M4D1, M4SD~M4SD1	SAE-C	60	27	1-1/4"	1.4	4.11	366
M4E~M4E1, M4SE~M4SE1	SAE-C	99	45	2"	20.0	58.7	368

Series	Size	Displacement	Theor. Displ. Vi	Torque T	Power at 100 Rev/min	Torque T	Power P
						n = 2000 RPM at Δ p 175 bar	
			ml/rev.	Nm/bar	kW/bar	N.m	kW
M4	C C1 SC SC1	024	24.4	0.39	0.0040	60.5	12.7
		027	28.2	0.45	0.0047	70.0	14.7
		031	34.5	0.55	0.0058	86.8	18.0
		043	46.5	0.74	0.0078	120.0	25.1
		055	58.8	0.93	0.0098	149.0	31.2
		067	71.1	1.13	0.0120	170.0	35.6
		075	80.1	1.27	0.0130	198.0	41.5
	D D1 SD SD1	062	65.1	1.04	0.0110	165.0	34.6
		074	76.8	1.22	0.0130	200.0	41.9
		088	91.1	1.45	0.0150	236.0	49.4
		102	105.5	1.68	0.0180	264.0	55.3
		113	116.7	1.86	0.0200	340.0	71.2
		128	132.4	2.11	0.0220	340.0	71.2
		138	144.4	2.30	0.0240	372.0	77.9
	E E1 SE/SE1	153	158.5	2.52	0.0260	398.0	83.4
		185	191.6	3.05	0.0320	484.0	101.4
		214	222.0	3.53	0.0370	567.0	118.8

Series	Size	Displ.	Max. pressure					Operating pressure range drain	Max. speed for low loaded condition	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)
			bar	bar	bar	bar	bar	bar	RPM	RPM	RPM	RPM	RPM	RPM	RPM
M4	C C1	024	175	175	175	---	---	3.5	4000	2500	3600	2500	3600	2000	2500
		027													
		031													
		043													
		055													
		067													
		075													
	SC SC1	024	230	210	175	175	140								
		027													
		031													
		043													
		055	210	210											
		067													
		075	175	175											
	D D1	062	175	175	140	---	---			2500	3000	2500	2800	2000	2500
		074													
		088													
		102													
		113													
		128													
		138													
	SD SD1	062	230	190	140	140	140								
		074													
		088													
		102	210	190											
		113													
		128	190	190											
		138	175	175											
	E E1	153	175	175	140	---	---		3600	2500	3000	2000	2800	1800	2200
		185													
		214													
	SE SE1	153	175	175	140	140	140								
		185	180												
		214	175												

1) Low loaded condition 35 bar for M4, 80 bar max. for M4S.

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 M4C1, M4SC1, M4D1, M4SD1, M4E1, M4SE1, M4DC1, M4SDC1.

※MOTOR SELECTION

Performances required

Torque	T [N.m.]	140
Pump flow (available) at 24 cSt	qVe [l/min]	1500
Speed	n [RPM]	115
Pressure	p [bar]	175

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

$$0.85 \times \frac{Q\ Ve \times p}{600} \geq \frac{T \times \pi\ n}{30 \times 1000}$$

$$0.85 \times \frac{115 \times 175}{600} \geq \frac{140 \times \pi \times 1500}{30 \times 1000}$$

28,5 > 22

Two ways of calculation :

2a. Calculate Vi from T required torque

$$Vi = \frac{20\ \pi\ x\ T}{p} = \frac{20\ \pi\ x\ 140}{175} = 50.26\ \text{ml/rev.}$$

3a. Motor choose from Vi immediately greater
M4C 055 Vi = 58.8

4a. Check real motor pressure for T = 140 Nm. around 1500 RPM
M4C 055 T = 140 N.m n = 1500 RPM
p = 163 bar (see page 15)

5a. Flow loss M4C 055 at 163 bar at 24 cSt
qVs = 16 l/min (see page 22)

Real flow used by the motor :
qV = qVe - qVs = 115 - 16 = 99 l/min

6a. Real speed of the motor :

$$n = \frac{qV \times 1000}{Vi} = \frac{99 \times 1000i}{58.8} = 1680\ \text{RPM}$$

Real performances

Vi = 58,8 ml/rev.
n = 1680 RPM
T = 140 Nm.
p = 163 bar
} M4C 055

2b. Calculate Vi from T required torque

$$Vi = \frac{1000 \times 115}{p} = 76.6\ \text{ml/rev.}$$

3b. Motor choose from Vi immediately smaller
M4C 067 Vi = 71.1

4b. Check motor press. with T = 140 Nm. at 1500 RPM
M4C 067 T = 140 N.m n = 1500 RPM
p = 140 bar (see page)

5b. Flow loss M4C 067 at 140 bar at 24 cSt
qVs = 14 l/min (see page)

Real flow used by the motor :
qV = qVe - qVs = 115 - 14 = 101 l/min

6b. Real speed of the motor :

$$n = \frac{qV \times 1000}{Vi} = \frac{101 \times 1000i}{71.1} = 1420\ \text{RPM}$$

Real performances

Vi = 71.1 ml/rev.
n = 1420 RPM
T = 140 Nm.
p = 140 bar
} 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.

※CHARACTERISTICS

■ 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.

■ 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.

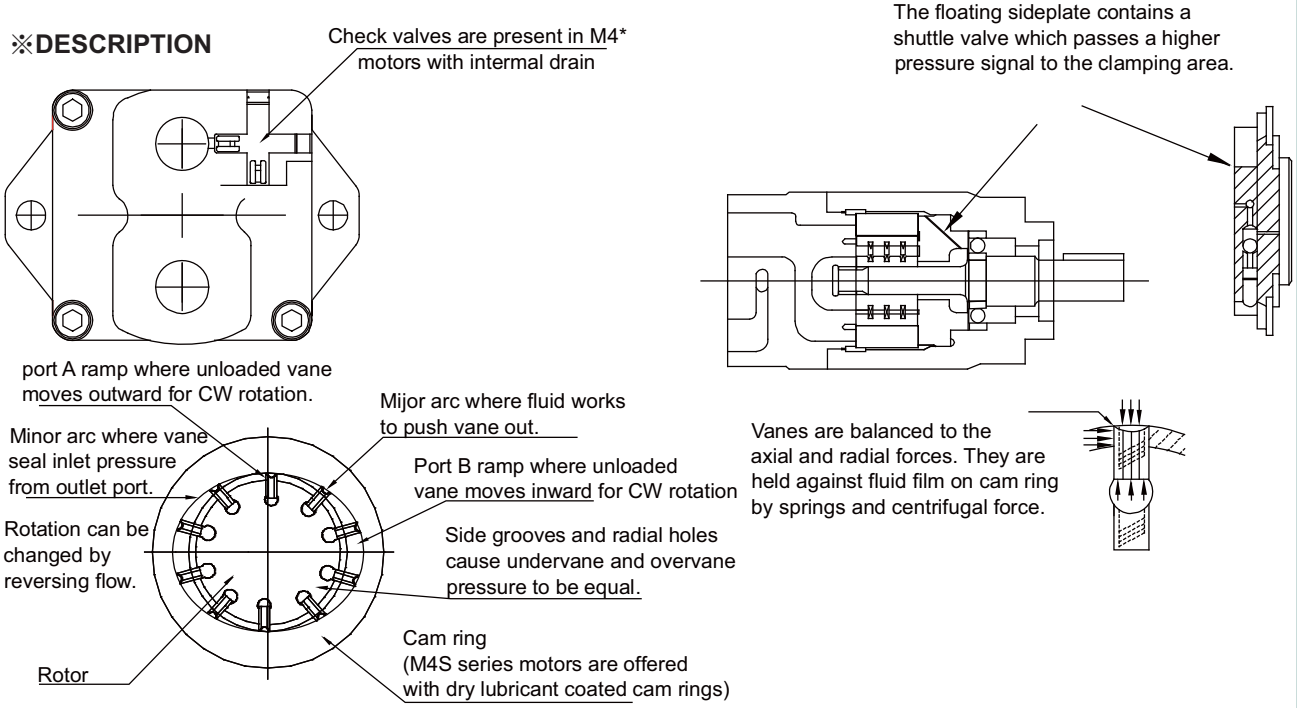
■ WIDE SPEED RANGE
Starting to maximum RPM, with full torque capability during acceleration

■ 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.

■ M4* SERIES MOTORS
The M4* have been designed especially for severe duty applications which require high pressure up to 230 bar, high speed up to 4000 RPM and low fluid lubricity (HF-1, HF-2A, HF-3, HF-4, HF-5).

※DESCRIPTION



■ 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 hem 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 230 bar max. Whichever port is at low pressure should not be subjected to more than 35 bar. If it is necessary to exceed these limitations, please contact SOLTECH Hydraulics for application assistance.

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

May be alternately pressurized at Ports A & B to 230 bar max. Whichever port is at low pressure must not be subjected to more than 1,5 bar for M3B, 3,5 bar for M4* (pressure peak 7 bar). To insure maximum motor performance in conjunction with your specific application, consult your SOLTECH Hydraulics Representative if your pplication 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 140 bar and speed is over 2000 RPM. They are also ecommended when fluid viscosity can be under 25 cSt and speed over 2000 RPM. For such evere 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 SOLTECH 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)_____ 860 mm2/s (cSt)
Max. (full speed & pressure) _____ 108 mm2/s (cSt)
Optimum (max. life)_____ 30 mm2/s (cSt)
Min. (full speed & pressure for HF-1 fluid) _____ 18 mm2/s (cSt)
Min. (full speed & pressure for HF-0 & HF-2 fluids) _____ 10 mm2/s (cSt)

■ VISCOSITY INDEX:
90° min. Higher values extend range of operating temperatures and life time.
Maximum fluid temperature (θ) °C
HF-0, HF-1, HF-2_____ + 100°
Minimum fluid temperature (θ) °C
HF-0, HF-1, HF-2_____ - 18°

■ 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.

■ SPLINED SHAFTS COUPLINGS SPLINES
- The mating female spline should be free to float and find its own center. If both members are rigidly supported, they must be aligned within 0,15 TIR or less to reduce fretting. The angular alignment of two spline axes must be less than ± 0,002 mm/mm.
- The coupling spline must be lubricated with a lithium molydisulfide grease or a similar lubricant.
- The coupling must be hardened to a hardness between 27 and 45 HRc.
- The female spline must be made to confom to the Class 1 fit as described in SAE-J498b (1971). This is described as a Flat Root Side Fit.

■ KEYED SHAFT
SOLTECH Hydraulics supplies the M3B and M4* series keyed shaft motors with high strength heat-treated keys. Therefore, when nstalling or replacing these motors, the heat-treated keys must be used in order to ensure maximum life in the application. If the key is replaced, it must be a heat-treated key between 27 and 34 R.C. hardness. The corners of the keys must be chamfered 0,76 to 1,02 at 45° to clear radii in the key way.

■ NOTE
Alignment of keyed shafts must be within tolerances given for splined shafts.

■ SHAFT LOADS
Axial or radial load are permissible. Consult specific sections for more details.

Series	Speed [RPM] - Oil viscosity = 32 cSt									
	500		1000		2000		3000		3600	
	psi	bar	psi	bar	psi	bar	psi	bar	psi	bar
M4C/M4SC	10	0.7	20	1.4	45	3.1	80	5.5	135	9.3
M4D/M4SD	10	0.7	20	1.4	45	3.1	80	5.5	135	9.3
M4E/M4SE	20	1.4	40	2.8	75	5.2	160	11	---	---

The inlet port of the fluid motor must be supplied with replenishment pressure as listed above to prevent cavitation during dynamic braking. These pressures should be multiplied by a coefficient of 1,5 for M4S motors used with fire resistant fluids (HF-3, HF-4, HF-5).
Replenishment pressure for tandem 2 & 3-speed motors must be provided during periods when the motor is dynamic braking, shutting down or coasting. When the motor is operating in the high speed mode and the nonworking cartridge is at low pressure, it is necessary to create a back pressure, as listed above, at the motor discharge port. The above mentioned minimum replenishment pressure chart is for maximum displacement cartridges. Smaller cartridges require lower minimum pressures.
Contact SOLTECH Hydraulics for further information.

※MODEL NUMBER DESIGNATION

M4*C/M4*C1	024-	1-	N-	00-	A-	1-	02-
Ⅰ	Ⅱ	Ⅲ	Ⅳ	Ⅴ	Ⅵ	Ⅶ	Ⅷ

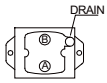
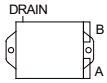
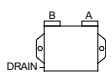
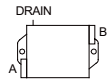
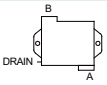
Ⅰ : Series No.
M4*C: Series external drain
M4*C1: Series internal drain
* = S = Severe duty motor
M4C1 - M4SC1 : Drain port is plugged.

Ⅱ : Torque (Nm/Bar)
024 = 0.39
027 = 0.45
031 = 0.55
043 = 0.74
055 = 0.93
067 = 1.13
075 = 1.27

Ⅲ : Type of shaft
1 = keyed (SAE B)
2 = keyed (non SAE)
3 = splined (SAE B)

Ⅵ : Direct. of rotation (view on shaft end)
N = bi-directional

Ⅴ : Porting combination

REAR PORT	SIDE PORTS		OPPOSITE PORTS	
00(Standard)	01	02	03	04
				

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

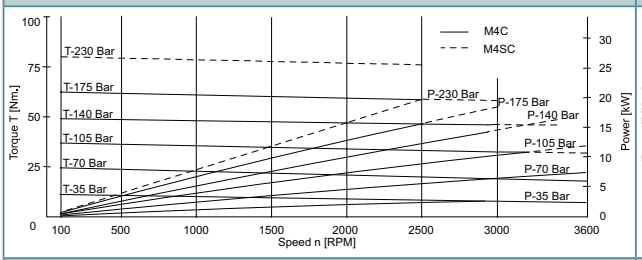
Ⅵ : Design letter

Ⅶ : Seal class
1 = S1 (M4C), 5 = S5 (M4SC)

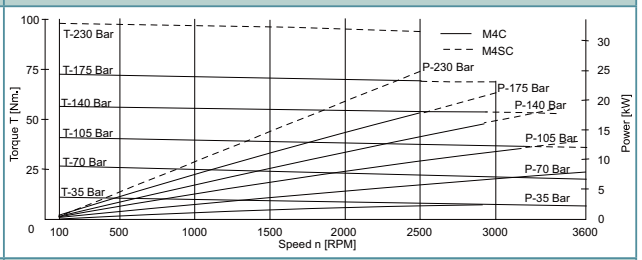
Ⅷ : Port connections
01 = SAE threaded port, SAE drain
02 = SAE 4 bolt flange, UNC threaded - SAE drain
04 = SAE 4 bolt flange, UNC threaded - BSPP drain
M4 = SAE 4 bolt flange, metric threaded - BSPP drain

※PERFORMANCE CURVES - OIL VISCOSITY : 24 cSt (45°) - M4* SERIES

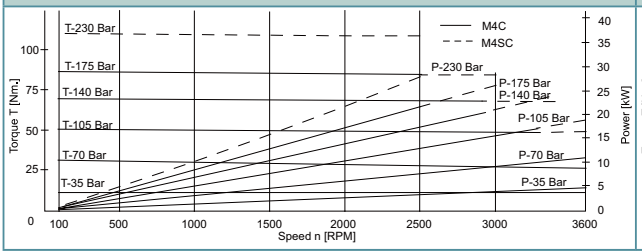
M4C 024



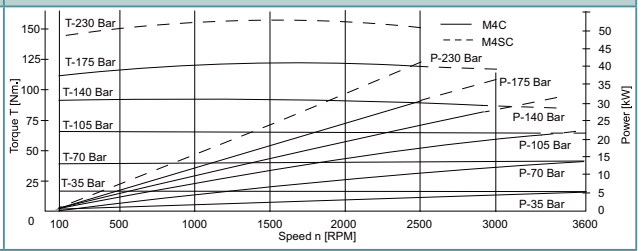
M4C 027



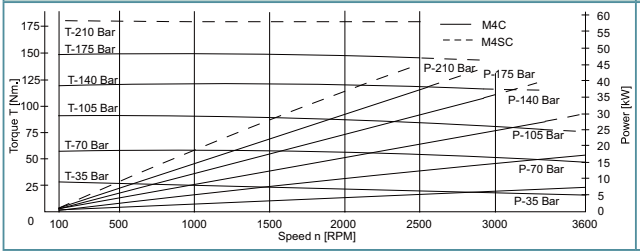
M4C 031



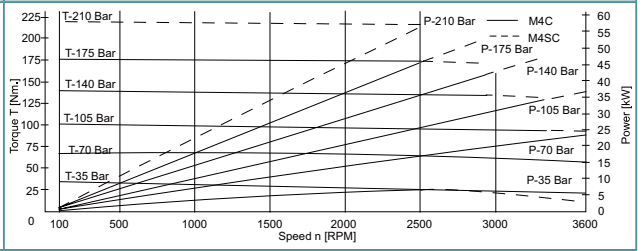
M4C 043



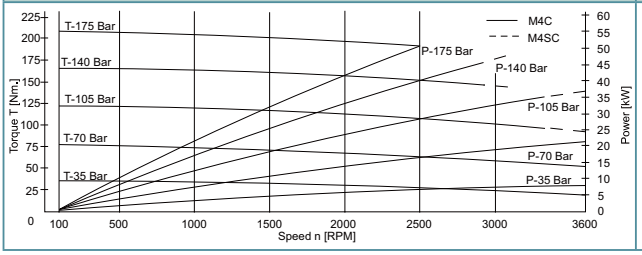
M4C 055



M4C 067



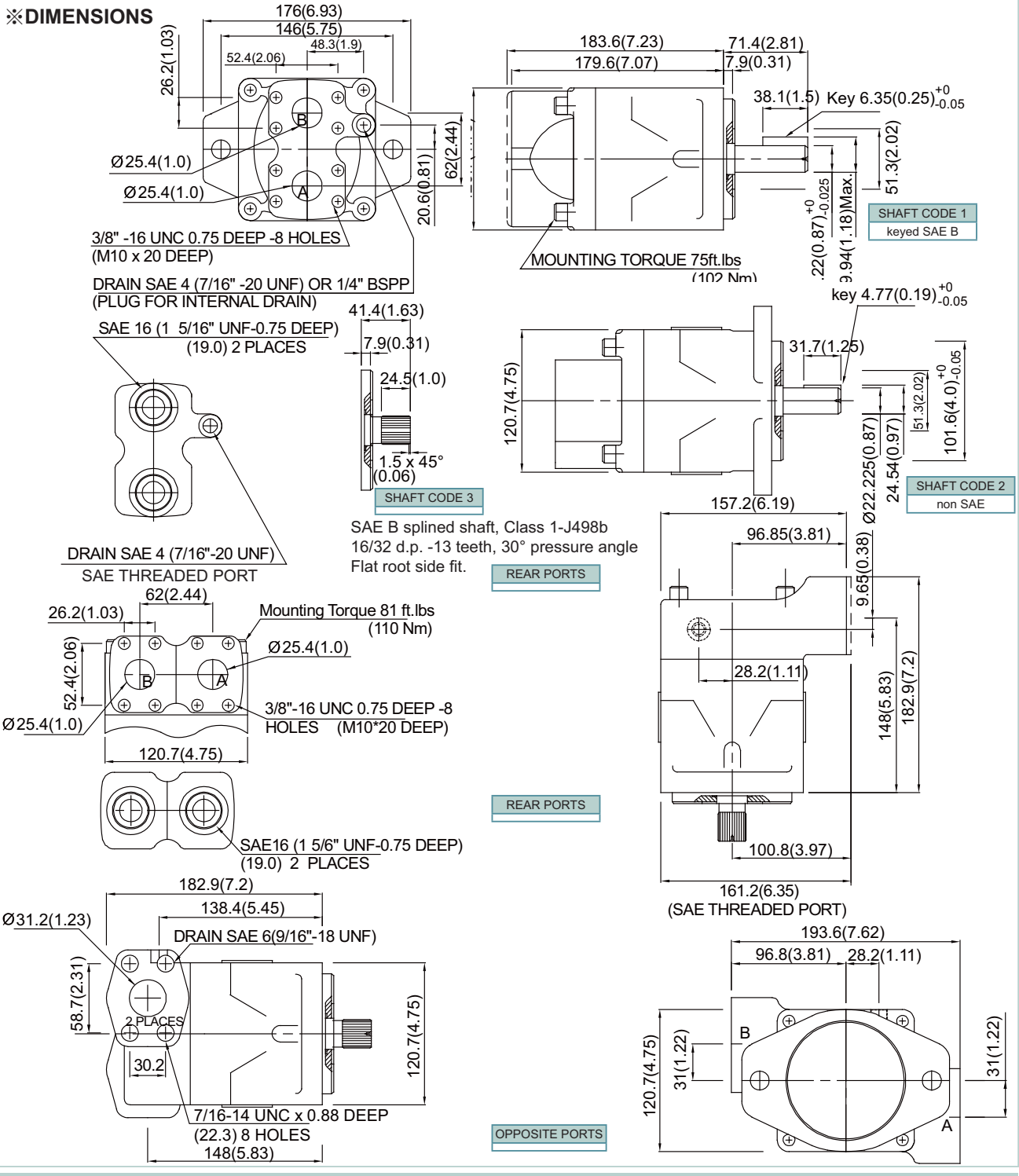
M4C 075



Model	Series	Volumetric Displacemnet Vi	Input Flow at n=2000 rpm		Torque T at n=2000 rpm	Power Output at n = 2000rpm	P. Max.
			Theorical	at 175 bar Δ p	at 175 bar Δ p	at 175 bar Δ p	
		ml/rev.	l/min(USGPM)	l/min(USGPM)	Nm	kW	Bar(PSI)
M4C/ M4SC	024	24.4	49.0(12.94)	67.0(17.70)	60.5	12.7	175 (2540)
	027	28.2	56.0(14.79)	74.0(19.55)	70.0	14.7	
	031	34.5	69.0(18.22)	87.0(22.98)	86.8	18.0	
	043	46.5	93.0(24.57)	111.0(29.32)	120.0	25.1	
	055	58.8	118.0(31.17)	136.0(35.93)	149.0	31.2	
	067	71.1	142.0(37.51)	160.0(42.27)	170.0	35.6	
	075	80.1	160.0(42.27)	178.0(47.02)	198.0	41.5	

► Max. rpm = 4000

※DIMENSIONS



※MODEL NUMBER DESIGNATION

M4*D/M4*D1	088-	1-	N-	00-	B-	1-	02-
Ⅰ	Ⅱ	Ⅲ	Ⅳ	Ⅴ	Ⅵ	Ⅶ	Ⅷ

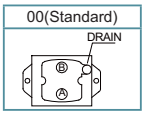
Ⅰ : Series No.
M4*D: Series external drain
M4*D1: Series internal drain
* = S = Severe duty motor
M4D1 - M4SD1 : Drain port is plugged.

Ⅱ : Torque (Nm/Bar)
062 = 1.04 113 = 1.86
074 = 1.22 128 = 2.11
088 = 1.45 138 = 2.30
102 = 1.68

Ⅲ : Type of shaft
1 = keyed (SAE C) S = splined (SAE J718c)
3 = splined (SAE C)

Ⅳ : Direct. of rotation (view on shaft end)
N = bi-directional

Ⅴ : Porting combination



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

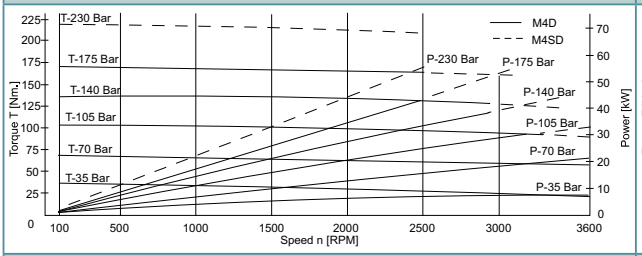
Ⅵ : Design letter

Ⅶ : Seal class
1 = S1 (M4D), 5 = S5 (M4SD)

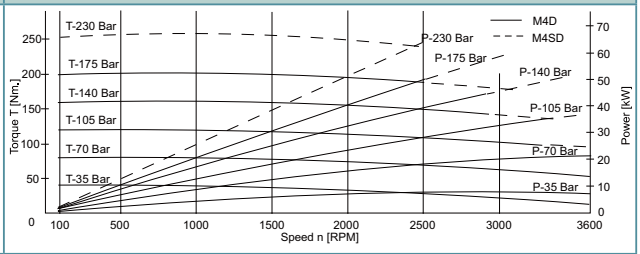
Ⅷ : Port connections
01 = SAE threaded port, SAE drain
02 = SAE 4 bolt flange, UNC threaded - SAE drain
04 = SAE 4 bolt flange, UNC threaded - BSPP drain
M4 = SAE 4 bolt flange, metric threaded - BSPP drain

※PERFORMANCE CURVES - OIL VISCOSITY : 24 cSt (45°) - M4* SERIES

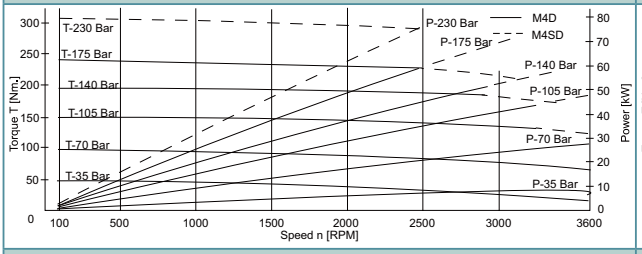
M4D 062



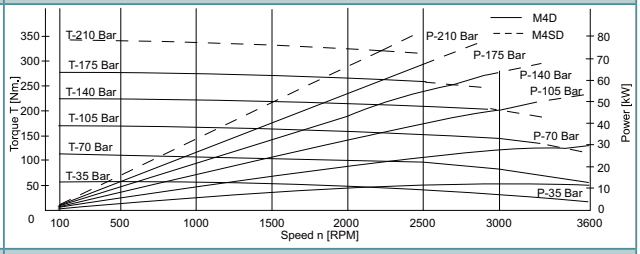
M4D 074



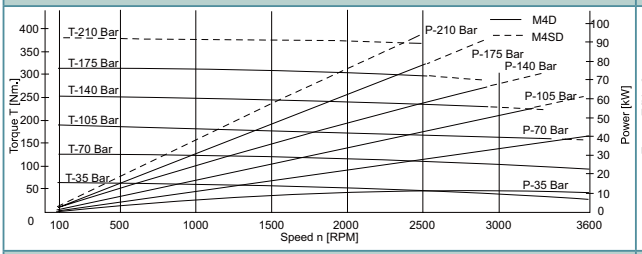
M4D 088



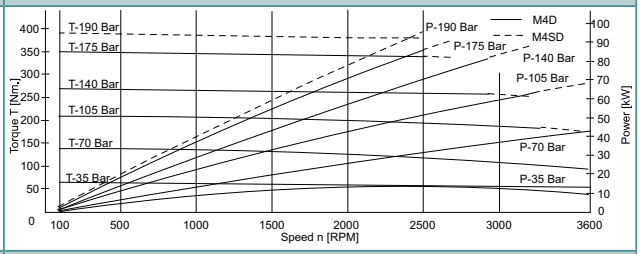
M4D 102



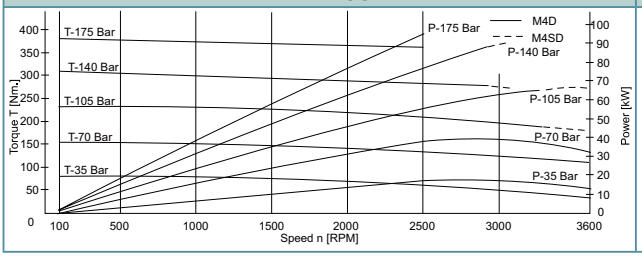
M4D 113



M4D 128



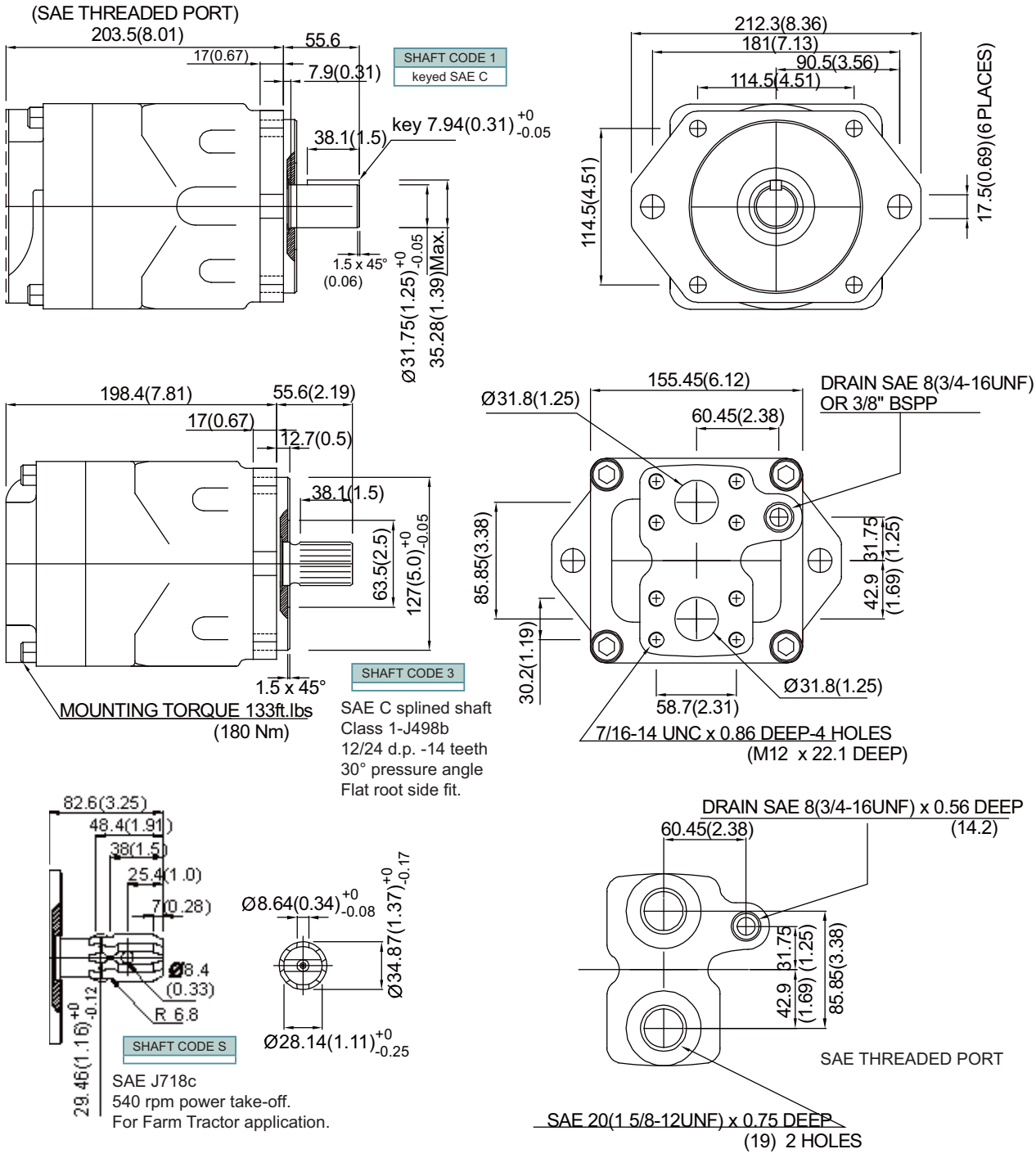
M4D 138



Model	Series	Volumetric Displacemnet Vi	Input Flow at n=2000 rpm		Torque T at n=2000 rpm	Power Output at n = 2000rpm	P. Max.
			Theorical	at 175 bar Δ p	at 175 bar Δ p	at 175 bar Δ p	
		ml/rev.	l/min(USGPM)	l/min(USGPM)	Nm	kW	Bar(PSI)
M4D/ M4SD	062	65.1	130.0(34.34)	154.0(40.68)	165.0	34.6	175 (2540)
	074	76.8	154.0(40.68)	178.0(47.02)	200.0	41.9	
	088	91.1	182.0(48.08)	206.0(54.42)	236.0	49.4	
	102	105.5	211.0(55.74)	241.0(63.67)	264.0	55.3	
	113	116.7	233.0(61.55)	257.0(67.89)	300.0	62.8	
	128	132.4	265.0(70.01)	289.0(76.35)	340.0	71.2	
	138	144.4	289.0(76.35)	313.0(82.69)	372.0	77.9	

► Max. rpm = 4000

※DIMENSIONS



※MODEL NUMBER DESIGNATION

M4*E/M4*E1	214-	1-	N-	00-	B-	5-	02-
Ⅰ	Ⅱ	Ⅲ	Ⅳ	Ⅴ	Ⅵ	Ⅶ	Ⅷ

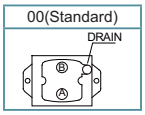
Ⅰ : Series No.
M4*E: Series external drain
M4*E1: Series internal drain
* = S = Severe duty motor
M4E1 - M4SE1 : Drain port is plugged.

Ⅱ : Torque (Nm/Bar)
153 = 2.52
185 = 3.05
214 = 3.53

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

Ⅳ : Direct. of rotation (view on shaft end)
N = bi-directional

Ⅴ : Porting combination



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

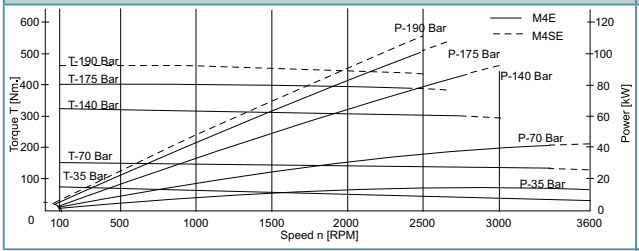
Ⅵ : Design letter

Ⅶ : Seal class
5 = S5

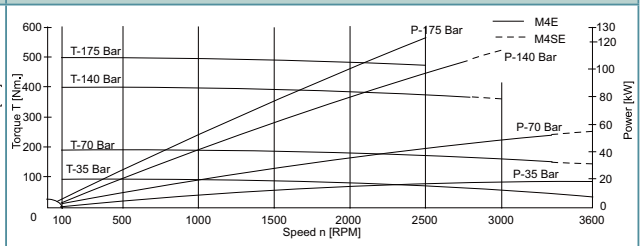
Ⅷ : Port connections
01 = SAE threaded port, SAE drain
02 = SAE 4 bolt flange, UNC threaded - SAE drain
04 = SAE 4 bolt flange, UNC threaded - BSPP drain

※PERFORMANCE CURVES - OIL VISCOSITY : 24 cSt (45°) - M4* SERIES

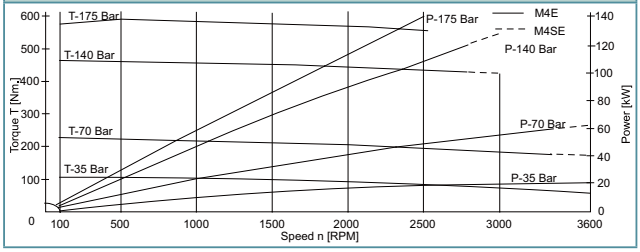
M4E 153



M4E 185



M4E 214



※DIMENSIONS

SAE C splined shaft, Class 1-J498b
12/24 d.p. -14 teeth, 30° pressure
angle, Flat root side fit.

► Max. rpm = 3600

Model	Series	Volumetric Displacemnet Vi	Input Flow at n=2000 rpm		Torque T at n=2000 rpm	Power Output at n = 2000rpm	P. Max.
			Theorical	at 175 bar Δ p	at 175 bar Δ p	at 175 bar Δ p	
		ml/rev.	l/min(USGPM)	l/min(USGPM)	Nm	kW	Bar(PSI)
M4E/ M4SE	153	158.5	317.0(83.74)	343.0(90.61)	398.0	83.4	175 (2540)
	185	191.6	383.0(101.18)	409.0(108.05)	484.0	101.4	
	214	222.0	444.0(117.3)	470.0(124.16)	567.0	118.8	