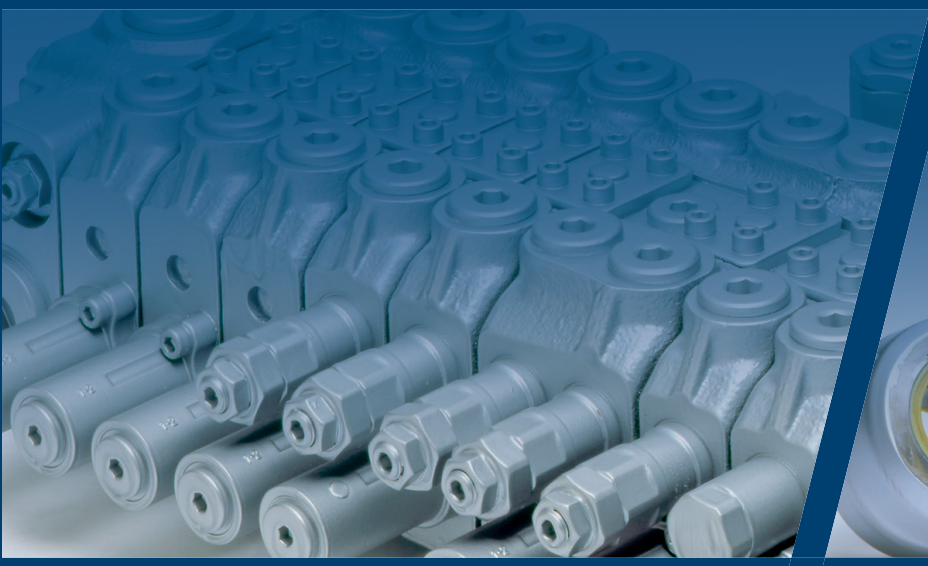
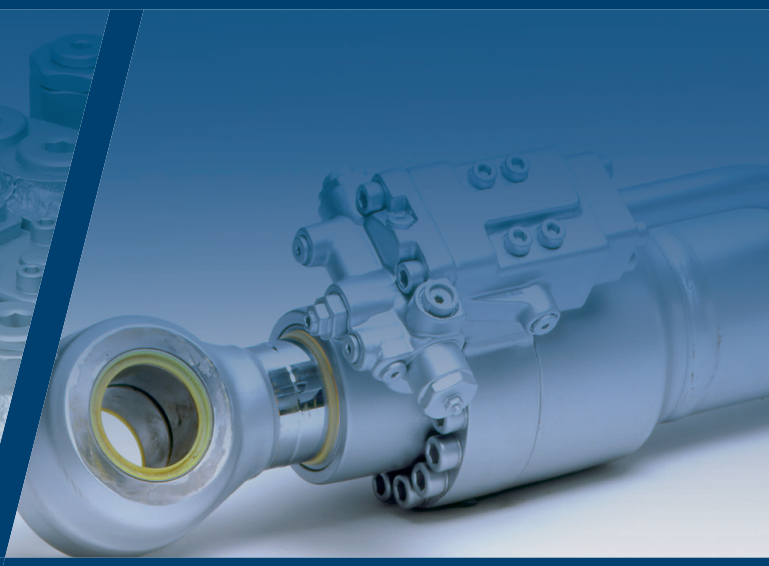
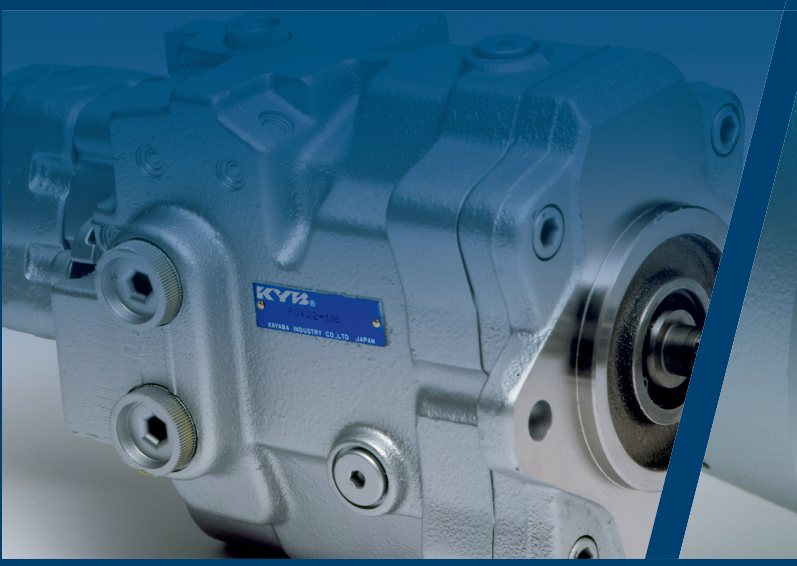
Our Precision, Your Advantage

KYB HYDRAULICS

PRODUCTS GUIDE







Hydraulic Component Catalog (Detailed version)

(For construction equipment, industrial vehicles, agricultural equipment, and other industrial equipment)

- This catalog provides detailed information on hydraulic pumps, motors, integrated HSTs, cylinders, and valves for vehicles such as excavators, mini-excavators, loaders, forklift trucks, and agricultural machines. As for information on some products not included in this catalog, please contact KYB Hydraulic Sales Department.
- Some products require prototype tests based on the specifications of customer machines so as to secure their on-site fine tuning. In some cases, new functions need to be added to our products to meet customer requirements.
- The catalog makes general suggestions for product selection, handling precautions, and basic dimensions. Confirmation on detailed specifications may be necessary for actual use. Please contact KYB Sales Department for clarification of details. (Refer to Page 66 and to the back cover of the catalog for the contact details of Sales Department.)

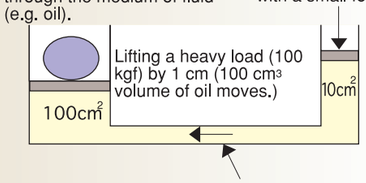
Basics of Oil Hydraulics

【What is oil hydraulics?】

Oil hydraulics refer to a group of devices or a system that drives a hydraulic pump with power sources, such as engines and electric motors, to transform mechanical energy to fluid energy in order to produce mechanical movement using an actuator like a cylinder while controlling energy output.

＜Pascal's Law＞

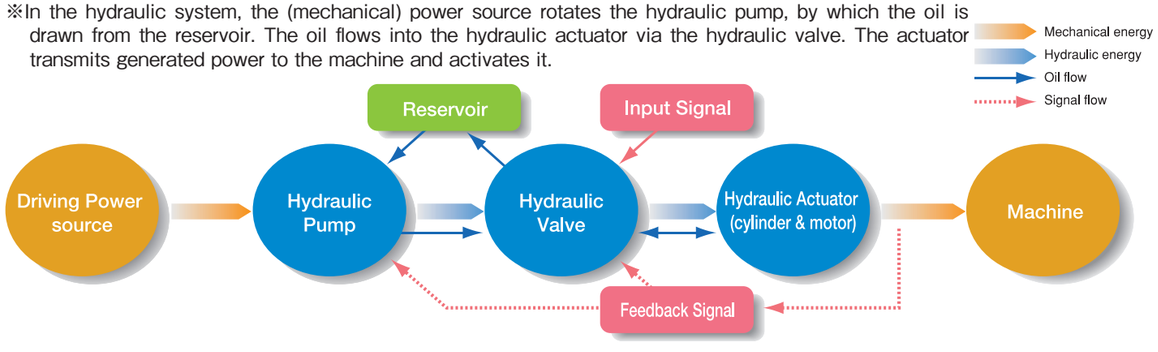
The law states the relationship between pressure and area through the medium of fluid (e.g. oil).



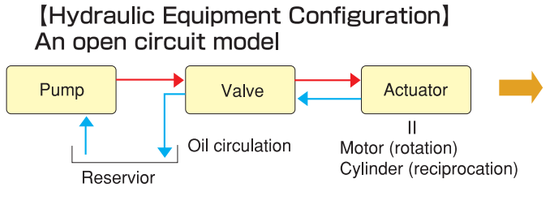
【Unit conversion table】

	Gravitational Unit	----- × -----▶ ◀----- ÷ -----	SI Unit (Symbol)	SI Unit (Name)
Force	kgf	9.807	N	Newton
	lbf	4.448	N	Newton
Torque (Moment of force)	kgf・cm	0.0981	N・m	Newton meter
	lbf・ft	1.356	N・m	Newton meter
	lbt・in	0.113	N・m	Newton meter
Pressure	kgf/cm²	0.0981	MPa	Mega Pascal
	atm	0.1013	MPa	Mega Pascal
	psi(lbf/in²)	0.0069	MPa	Mega Pascal
	bar	0.1	MPa	Mega Pascal
	mmHg	133.3	Pa	Pascal
Power	kgf・m/s	0.00981	kW	Kilowatt
	lbf・ft/s	0.00136	kW	Kilowatt
	PS	0.7355	kW	Kilowatt
	HP	0.746	kW	Kilowatt
Energy	kgf・m	9.807	J	Joule
	kcal	4186	J	Joule
Viscosity	kgf・s/cm²	98067	Pa・s	Pascal second
	cP	0.001	Pa・s	Pascal second
	P (poise)	0.1	Pa・s	Pascal second
Kinetic viscosity	cSt	1×10^{-6}	m²/s	Square meter per second
		1	mm²/s	Square millimeter per second
	St	1×10^{-4}	m²/s	Square meter per second

※In the hydraulic system, the (mechanical) power source rotates the hydraulic pump, by which the oil is drawn from the reservoir. The oil flows into the hydraulic actuator via the hydraulic valve. The actuator transmits generated power to the machine and activates it.

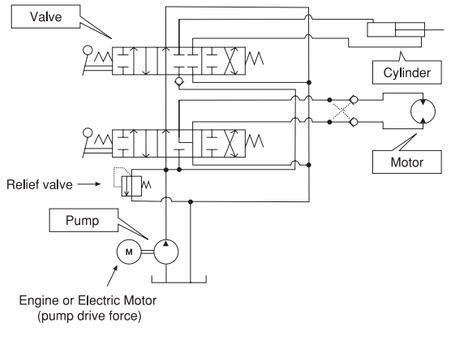


【Basic Configuration of Hydraulic Circuit】



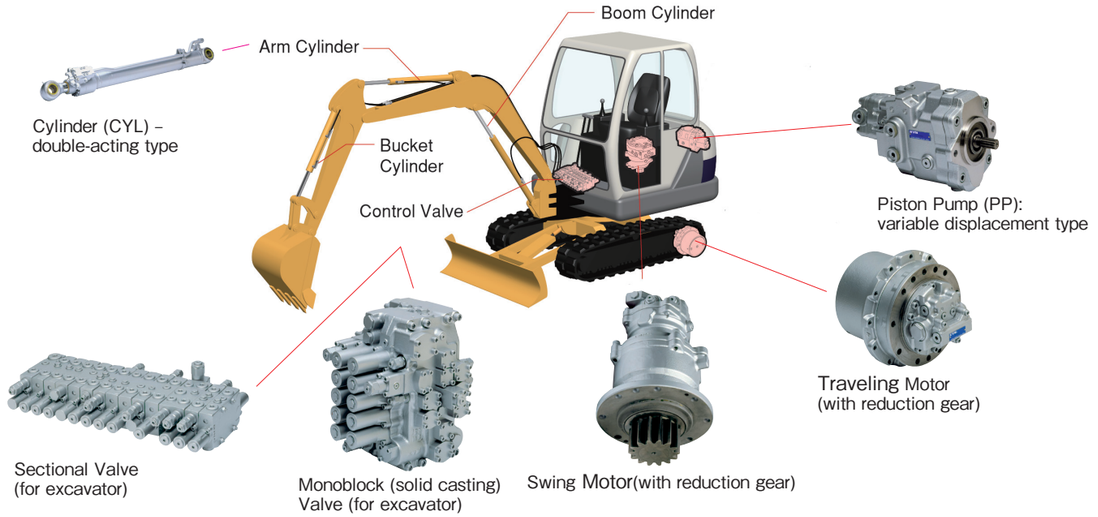
※When the tip of the actuator is loaded, the oil pressure between the pump and actuator rises.

【Hydraulic Circuit Example】

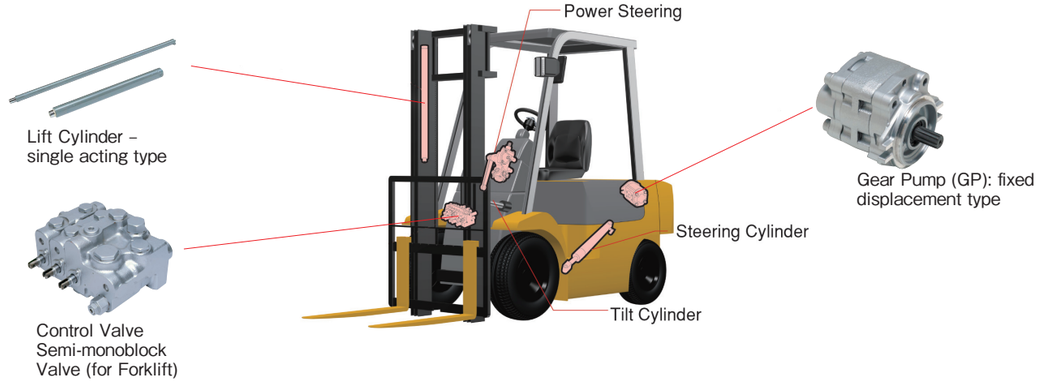


Products for Each Machine (examples)

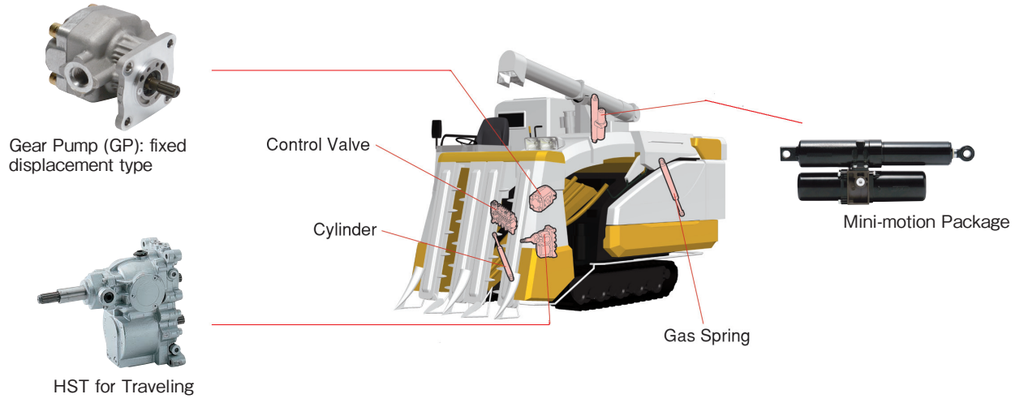
Hydraulic Equipment for Excavators and Mini-excavators



Hydraulic Equipment for Forklift Truck



Hydraulic Equipment for Combines



Caution regarding this Product Brochure

Definition of Alert Marks

In this brochure, the "Danger", "Warning", and "Caution" signs are defined as follows.

※These warning signs are very important for the operator's safety. Understand them before using the products.

Danger Improper handling will result in an imminently dangerous situation such as death or serious injury.
Warning Improper handling may potentially risk death or serious injury.
Caution Improper handling may result in slight to moderate injury or damage.

Instruction Manual

The cautions and notices described in this manual are intended to help select products. Please read the manuals of the selected products and fully understand the properties of the selected products before using them.

Regulations and Standards

Please observe the warnings and cautions described in this manual and the following regulations and standards for the safe use of products.
[Safety related regulations and standards]
① High Pressure Gas Safety Law, ② Industrial Safety and Health Law, ③ Fire Service Law, ④ Explosion Protection Classes,
⑤ Construction of Pressure Vessels (JIS B 8243), and ⑥ General Rules for Hydraulic Systems (JIS B 8361)

Safety Precautions

(1) On Product Handling

① Caution Wear necessary protective equipment when handling the product so as to prevent any injury.
② Caution Always be alert to avoid getting your hand pinched or suffering a backache from an unnatural operating posture or overload when handling the product.
③ Caution Do not step on, strike, drop, or apply stress to the product. Such an act may cause malfunction, damage, or oil leakage.
④ Caution Oil on a product or the floor makes it slippery and dangerous. When you find the hydraulic fluid on the product or the floor, wipe it off immediately.

(2) On Mounting and Dismounting products

① Caution Mounting, dismounting, piping, and wiring should be performed only by a qualified engineer (preferably one who has been trained by KYB) with the required knowledge.
② Warning Before starting such work, make sure that the machine is turned off, the motor or engine is not in motion, and pressure inside the hydraulic piping is zero.
③ Warning Turn off the power supply before doing wiring work. A failure to do so may cause an electric shock.
④ Caution Keep the mounting holes and surfaces of the product clean. A loose bolt or broken seal may cause damages or oil leakage.
⑤ Caution When mounting the product, use specified bolts only and tighten them with the specified torque. A failure to do so may cause malfunction, damage, or oil leakage.

(3) On Operation

① Danger Use only explosion- or combustion-proofed products in a explosive or combustible state.
② Warning Apply a protection cover on the rotation shaft of the pump and motor to avoid your hand or clothing being caught in the machine.
③ Caution If you find something wrong, such as strange sound, oil leakage and smoke, stop the operation immediately and take necessary action. A failure to do so may cause damage, fire, or injuries.
④ Caution Make sure that the hydraulic circuits and wiring are properly connected with no loose connections before the initial operation.
⑤ Caution Use the product only according to the specifications described in the catalog and drawings, and the specifications provided by KYB.
⑥ Caution The product becomes very hot during operation because of a rise in the temperature at the circuit oil and the solenoid valve. Make sure that the operator's hand or another part of his body does not touch such heated parts. A failure to do so may cause burns.
⑦ Caution Use the specified or proper hydraulic fluid and keep the contamination level within the recommended range. A failure to do so may cause malfunction or damage.

(4) On Maintenance and Storage

① Caution Any alteration or modification of the product by a customer is strictly prohibited.
② Caution Do not disassemble and reassemble the product without permission of KYB or its authorized agency. A violation may cause poor performance, damage, or an accident.
③ Caution Transport or store the product in a proper environment at a proper temperature and humidity with proper dust- and rust-preventative measures in place.
④ Caution Replacing seals may be necessary after storing the product for a long period.

Precautions on the Use of Hydraulic Equipment

All Hydraulic Circuits

※When selecting hydraulic components, contact each manufacturer for the characteristics of hydraulic equipment such as piping, joints, filters, and oil reserviors manufactured by other manufacturers.
① Pressure drop: Pressure drop is proportional to the square of the flow rate. Because the loss may increase depending on the specific equipment and the size and/or length of joints, the normal flow rate and the maximum flow rate being used also should be taken into account.
② Circuit temperature control: The temperature of the hydraulic fluid in the entire circuit may rise because of the operation frequency and/or pressure drop. Consult the component manufacturer to make sure the reservoir and cooler capacity is sufficient.

Hydraulic Fluids

● Applicable hydraulic fluids

Cold regions	Warm regions
ISO VG32	ISO VG46
Outside air temperature −10 ~ 25℃	Outside air temperature 0 ~ 35℃

● Applicable hydraulic fluids

	Kinetic viscosity mm²/s	Oil temperature	
		ISO VG32	ISO VG46
Proper range	25 ~ 100	17 ~ 45℃	23 ~ 55℃
Practical range	15 ~ 500	−7 ~ 60℃	0 ~ 70℃

● Strainers and Filters
Apply a 150 mesh strainer to the suction line from a reservoir and a 10μm filter to the return line to the reservoir. Determine the capacity based on the pump flow rate on the maximum input rotation and maintain the pressure drop below 0.03 MPa.
<Hydraulic fluid contamination level control>
It is recommended to maintain hydraulic fluid contamination within the NAS 9 class range.

● Circuit Oil Temperature
Permissible oil temperature range: -20℃ (starting temperature) up to 100℃ (total 100 hours), and between 20℃ and 80℃ for a continuous operation.
Please contact us when you plan to use the equipment outside the permissible oil temperature range.

Precautions on Handling Pump/Motor

■ Mounting

① In general, the pump/motor can be mounted in any direction. But the drain piping should be connected to the reservoir at a point lower than the oil level after it is taken out from the upper surface of the pump/motor housing. This is to lubricate the reduction gears. Please note that the travel motor and the swing motor are to be mounted in the specified direction.
② Make sure that the rotating direction is correct for both pump and motor.
③ Make sure there is some allowance between the pump shaft and driving shaft (with a motor or engine), and between the motor shaft and driven shaft (on the load side), in either case in the radial direction. Avoid applying thrust load to the pump or motor shaft.
④ Maintain the center dislocation between the pump and driving shafts, and between the motor and driving shafts within 0.1 mm on FIR (full indicator reading).

■ Selecting Shaft End Configuration

Select a shaft end configuration appropriate for the driving system based on the following pump and motor requirements.
① Direct driving: When it is difficult to give some allowance in the radial direction, use a spline shaft. Make sure to apply lubricant and dust-protection to the spline. Selecting a counterpart spline with the surface hardness over HRC 50 and the surface roughness below 32a is recommended.
② Coupling driving: When using a flexible coupling, select one with a straight shaft and assemble it in such a way that no thrust load is applied to the pump motor shaft. (See Fig. 2 below.)
③ Applicable shaft configurations vary depending on the product. Please contact us for details.

【Pump/Motor Shaft Driving System】

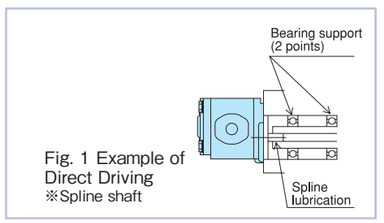


Fig. 1 Example of Direct Driving
※Spline shaft

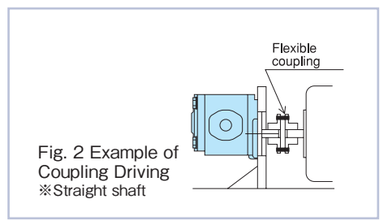


Fig. 2 Example of Coupling Driving
※Straight shaft

■ Pump Suction Pressure and Piping

During a normal pump operation, maintain pressure on the pump suction port (less than 30 mm from the port surface) above -0.02 MPa. Pressure may come down as low as -0.05 MPa for a short while on a cold start, but air suction from the piping should be strictly avoided. For the suction side piping, use pipes with a diameter equal to or larger than the diameter of the pump suction port and try to keep the length as straight and short as possible.

Piston Pump Motor Drain Piping and Case Internal Pressure

◇ Drain piping is to be connected to the reservoir at the point lower than the reservoir oil level after being taken out from the point higher than the pump/motor housing. This is necessary for lubrication in reduction gears.
Always keep the motor housing filled with oil. Otherwise, it will result in poor lubrication in the housing and cause the seizure of parts.
◇ Maintain the case internal pressure below 0.1 MPa.
Higher drain pressure will shorten the life of internal parts. Smaller or longer piping will raise the internal pressure.
◇ Contact us about the proper drain flow, which varies depending on the condition.
◇ Operating the product without drain piping will raise the pressure in housing and may cause internal damage or oil leakage. If you have done so, inspect and repair damage or replace the housing. (This will not apply to some pumps that do not need drain piping.)
◇ Fill the housing with oil before starting an operation. Otherwise, it may cause an initial seizure.

Closed Circuit Pump and Motor Boost Pressure

A closed circuit pump requires boost pressure of 0.3 to 0.5 MPa at the suction port.
Lower boost pressure may cause cavitation, noise, poor braking, or damage to the pump.

Piston Motor Back Pressure

If the output port of a motor in a series- or meter-out circuit is pressurized highly and constantly, the product life shortens and excessive back pressure may damage the motor at an early stage of its life. Contact us for permissible maximum back pressure for each product.

Piston Motor Cavitation Prevention

With a motor used in an open circuit, cavitation may occur at a low-pressure area when the motor stops running. Install a cavitation preventive function in the circuit to avoid such damage.

Precautionary Cylinder Handling

● **Initial Unpacking**
Do not remove the plug placed on the cylinder port until you start assembling the unit. Mount the cylinder on the prepared equipment right after unplugging it, and fill the cylinder with oil.

● **Rust Protection**
When leaving the rod extended after the cylinder is mounted on the equipment, apply grease to the exposed rod surface once a month.

Precautions on Valve Handling

● **On Assembly**
◇ Do not remove the plug placed on each port until it is connected to the piping.
◇ When mounting a valve, use bolts of the right size and work on the provided flat mounting plate so as to protect the valve from the tightening torque.
◇ Use an operation link that does not apply a horizontal load to the spool. (Manual lever, etc.)

● **On Operation**
◇ Set the valve lever at the neutral position when starting an operation. Otherwise, it may cause the actuator to start running unexpectedly.
◇ Allowable maximum backpressure: The figure in the specifications includes a peak value at the tank port of the valve. A careful attention is also required when viscosity is high at a low temperature.

※Please read the precautions described in each chapter after page 7.

Definition of terms frequently used with hydraulic circuit trouble

Entire circuit		Hydraulic equipment	
Oil hammer	Pressure increase generated by a rapid decrease in the flow rate of oil in the system.	Chattering	A self-induced high-frequency vibration of the check valve or relief valve generated by the oscillation of the valve seat.
Aeration	Process in which air is entrained in hydraulic fluid	Hunting	A phenomenon in which the movement of the motor and cylinder fluctuates due to the oscillation of the flow control valve (the piston, etc.) and pressure variance resulting from the air bubbles in a circuit.
Cavitation	A phenomenon in which tiny gas bubbles in oil inflate with pressure from the oil flow partially reduced.	Hydraulic lock	Undesirable locking of a piston or a spool attributed to a trapped liquid prevents movement.
Erosion	Loss of material from mechanical elements caused by the impingement of fluid or fluid-suspended particulate matter, micro-jets or a combination thereof	Flow force	Force on a movable element in components caused by the flow or fluid passing by.
Contamination	A state in which hydraulic fluid in the circuit is mixed with various contaminants, such as casting sand, chips, rust, welding beads, seal scrapings, dust, and dirt.	External leak	Oil leakage outside the hydraulic equipment that contaminates the equipment and surrounding objects.
Flushing	A cleaning method in which the cleaning operation is conducted to remove foreign objects that have been on the piping from the beginning. (This has nothing to do with a flushing valve system in a closed circuit.)	Internal leak	Oil leakage from the high-pressure side to the low-pressure side in the hydraulic equipment. Serious leakage lowers performance and may cause an excessive lowering of a cylinder.
Heat shock	A phenomenon in which very hot oil flows into the low temperature parts of the equipment and entire circuit that has not quite warmed up yet, resulting in a sudden inflation of parts causing malfunction.	Crack (Burst)	Cracking of the equipment body or its parts caused by excessive high pressure, fatigue, drop, or external force.

Table of Contents

<Main contents of this product guidance>

Products are explained in the following order.
● Category (Pumps, Motors, HSTs, Cylinders, and Valves): General categorization of KYB products
● Equipment (Gear Pumps, Piston Pumps, etc.): Each product line
Features (characteristics), basic structure, mechanisms, circuits, functions, specifications, applications, model names, etc.
● Series: Each model
Dimensions, performance curves, specific functions and characteristics, precautions, etc.

Hydraulic Pump (General)

	Piston pump (for high and medium pressure applications)	Gear pump (for medium and low pressure applications)	Vane pump, screw pump, etc. (for low pressure applications)
Products included in this catalog.	Axial piston pump in swashplate design For closed circuit For open circuit (for excavator, mini-excavator, etc.)	External gear pump (for forklift truck, agricultural machine, and general purpose products)	
KYB products not included in this catalog. (Contact KYB)	Load sensing pump for mixer truck Axial piston pump in bent axis design		Vane pump (for automobile power steering and industrial equipment)
Not included in KYB product lineup		Internal gear pump	Screw pump

Pump: Gear pump

【General Description】

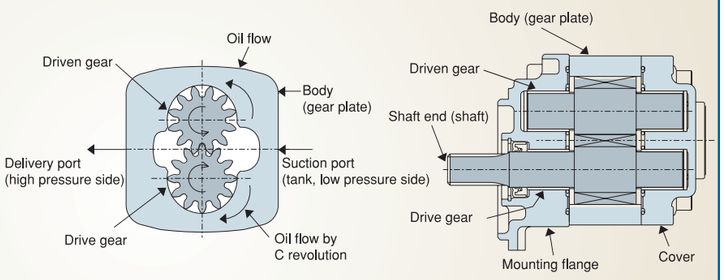
High reliability is the primary policy for developing KYB pumps and is based on long experience in various applications, advanced technology and excellent production technology. The KFP series pumps having cast-iron bodies are those of high performance, light in weight, compact in design, and durable.

Basic Construction

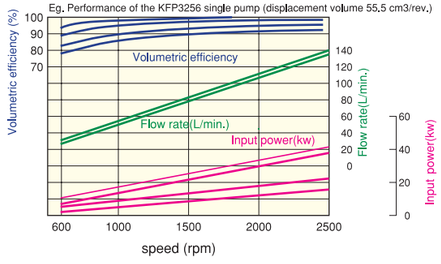
[Construction and Mechanism]

1. The shaft connected to the gear is driven by an engine or an electric motor.
2. While the gears are rotating, the oil filling the gear tooth grooves is moved from the suction port to the delivery port.

※The shaft is designed to be rotated in one direction to realize high performance. When placing an order, please specify the direction of shaft rotation: C rotation (clockwise viewing from the shaft end) or A rotation (anti-clockwise viewing from the shaft end) .
Note: Rotating the pump in the direction opposite to the design will damage the inside of the pump and render it unusable.



Basic characteristics



- Volumetric efficiency (actual flow / theoretical flow)
  Operation at a low speed and high pressure increases internal leakage causing low performance.
- Input power (theoretical shaft power / mechanical efficiency)
  Operation at a high speed and high pressure increases shaft power.
- The actual flow and actual input power are related to the speed and pressure. Please contact KYB if the properties of each model need to be clarified.

Displacement of each Model

	Displacement (cm³/rev) 0 20 40 60 80 100 120
KP05	
KFP23	
KFS23	
KFS24	
KFP32	
KFS32	
KFP51	

※ Please consult KYB when selecting an appropriate gear pump model under the same displacement.

KP, KFP, and KFS Series (Single)

【Model code】 ＜Single series＞

Example KFP23 | 23 | A | P | * | 5～7

1	Gear pump series	KP, KFP, and KFS (low pulsation type)
2	Pump displacement	Nominal displacement (cm³/rev)
3	Direction of rotation	A (anticlockwise viewing from the shaft side) or C (clockwise)
4	Shaft end	S (spline) or P (straight). Other signs indicate special configurations.
5～7	Additional information	Port position (side or rear), port configuration, mounting flange shape, shaft end seal, etc.

KP05

KFP23.KFS23

Symbol

	Displacement (cm³/rev)	Max. operating pressure (MPa)	Speed min-max. (rpm)	Weight (kg)	Old model (approx. displacement value)	
					Old model name	Compatibility
★ KP05	3.0–13.2 (10 types)	20.6	600–3000	1.6–1.7	GPI	○
KFP23	11.9–33.3 (10 types)	20.6	600–3000	2.4–4.3	KRP4 KFP22	△ ○
* KFS23	12.5–32.8 (10 types)	20.6	600–3000	2.4–4.3	DGP4 KFS4	△ △
★ KFS24	12.5–32.8 (10 types)	20.6	600–3000	3.6–5.1	DGP4 KFS4 KFS23	△ △ ○
KFP32	20.0–60.0 (11 types)	20.6	600–3000	3.9–11.4	2P3000	△
*★ KFS32	20.7–51.6 (9 types)	20.6	600–3000	3.9–9.5	—	—
★ KFP51	63.0–125.0 (7 types)	20.6	600–2500	20.5–24.7	KP50	○

* KFS is a low pulsation type
★ Depending on the displacement, pressure and rotation speed are limited. Please refer to page 10 - 11.

○: Compatible
△: Compatible except for the port

※ Low pulsation gear pump (KFS series)

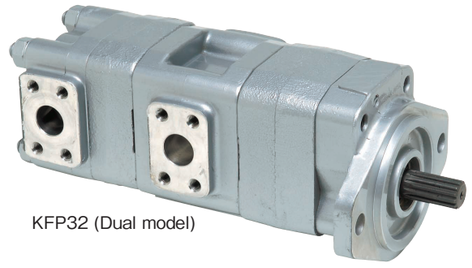
KFS23 series and KFS32 series are low pressure pulsation version of KFP23 series and KFP32 series. Noise in hydraulic systems is generally caused by the pressure pulsation created by the pump and dual flank engagement gear technology is utilized for these gear pump series to reduce the pressure pulsation.

KFP Series (Tandem)

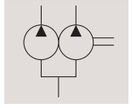
【Model codes】 ＜Tandem series＞ (Dual and triple models)

Example KFP23 | 19 – 19 – 12 | A (Triple model)

1	Gear pump series	KFP
2	Front pump displacement	Nominal displacement (cm³/rev)
3	Center pump displacement	Nominal displacement (cm³/rev). No sign for the tandem dual model
4	Rear pump displacement	Nominal value (cm³/rev)
5	Direction of rotation	A(anticlockwise)or C(clockwise)



KFP32 (Dual model)



Symbol

Each series is available with a variety of tandem models

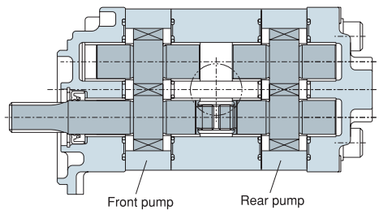
	KFP23	KFP32	KFP51
Dual	○	○	○
Triple	○		
Tandem combination with different models		○	○

※The front pump represents the model name of the tandem combination with different models.
※The displacement of the front pump needs to be greater than that of the rear pump or the same.

【Caution to specify a tandem pump(Dual or Triple)】

- Two or three pumps are driven with a single shaft.
- Specifications of each pump are the same as the single pump.
- Supply hydraulic fluid from the single reservoir, even if the front, center (in the triple model), and rear pumps have separate suction ports.
- Set the displacement volume as follows: Front pump ≧ Center pump ≧ Rear pump
- When only the front pump is operated, the maximum operating pressure may be applied. When multiple pumps are loaded simultaneously, however, the torque value (T value) in the following Q x P formula should not be exceeded.

【Basic construction of tandem pump (dual model)】



※With a triple-pump model, the pump nearest the shaft is the front pump, followed by the center pump, and finally the rear pump.

<Q x P expression (T value)> ※T values (TT, TR, and TC): Simple expression to obtain allowable shaft torsional torque

For dual model: $(QF \times PF) + (QR \times PR) \leqq TT$
$(QR \times PR) \leqq TR$

For triple model: $(QF \times PF) + (QC \times PC) + (OR \times PR) \leqq TT$
$(QC \times PC) + (QR \times PR) \leqq TC$
$(QR \times PR) \leqq TR$

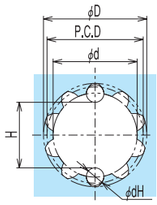
QF: Front pump displacement (cm^3/rev)
PF: Front pump pressure (MPa)
QC: Center pump displacement (cm^3/rev)
PC: Center pump pressure (MPa)
QR: Rear pump displacement (cm^3/rev)
PR: Rear pump pressure (MPa)

TT, TC, and TR values

Model	Shaft Specification	T T	T C	T R
KFP23	DP16/32: 10T spline	543.3	Front pump is less than 19 cc/rev.: 288.5 Front pump is over 23 cc/rev.: 633.5	288.5
	DP16/32: 11T spline	633.5		
KFP32	DP16/32: 13T spline	1479	1030	–
	DP16/32: 14T spline	1886		
KFP51	DP16/32: 14T spline	3957	2368	–

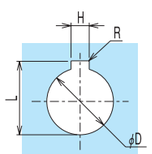
Coupling hole unit: mm

● Spline: L



Model	D. P	T o o l pressure angle	No. of Teeth	P.C.D	d	d H	Direct drive without flexible coupling H	Direct drive without flexible coupling D	Drive with flexible coupling H	Drive with flexible coupling D
KP05	Module 1.0	20°	12	12	12.000 ~ 12.020	2.000	10.067 ~ 10.137	13.970 ~ 14.500	–	–
KFP23 KFS23	16/32	30°	10	15.875	14.465 ~ 14.592	2.743	11.834 ~ 11.912	17.463 ~ 17.742	11.463 ~ 11.561	17.048 ~ 17.078
			11	17.463	16.020 ~ 16.147		13.287 ~ 13.358	19.050 ~ 19.329	12.958 ~ 13.041	18.636 ~ 18.666
KFP32 KFS32			13	20.638	19.134 ~ 19.261		16.521 ~ 16.588	22.225 ~ 22.504	16.229 ~ 16.300	21.811 ~ 21.842
			14	22.225	20.700 ~ 20.827		18.267 ~ 18.329	23.812 ~ 24.092	17.961 ~ 18.037	23.400 ~ 23.430
KFP51	12/24		14	29.634	27.589 ~ 27.716	3.657	24.342 ~ 24.407	31.750 ~ 32.080	24.188 ~ 24.255	31.505 ~ 31.539

● Straight: M



Model	D	L	H	R
KP05	$12.5^{+0.018}_{0}$	$14^{+0.2}_{+0.1}$	$4^{+0.015}_{0}$	0.3
KFP23 KFS23	$21.02^{+0.030}_{+0.005}$	$23.27^{+0.1}_{0}$	$5^{+0.03}_{0}$	0.25 ~ 0.4
KFP32 KFS32	$22^{+0.028}_{+0.007}$	$24.8^{+0.15}_{0}$	$6^{+0.030}_{0}$	
KFP51	$30^{+0.028}_{+0.007}$	$30.3^{+0.2}_{0}$	$8^{+0.036}_{0}$	

Dimensions (unit: mm)

■ KP05

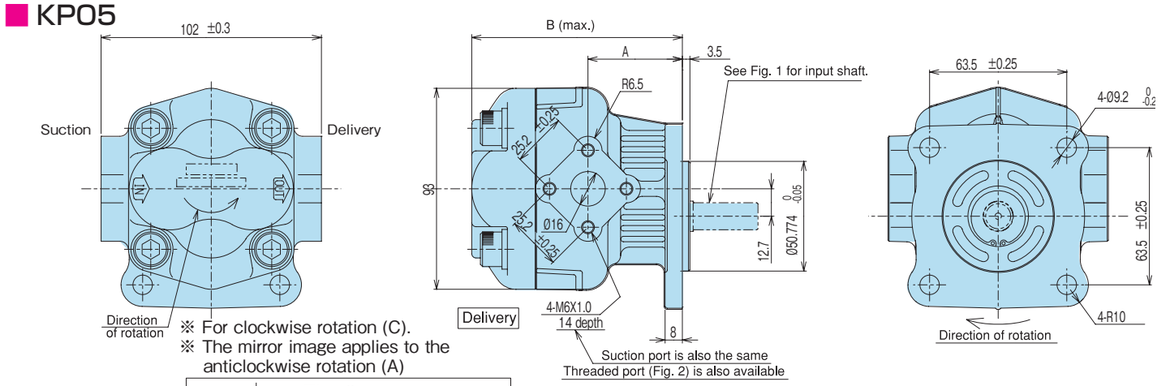


Fig. 2
Threaded port

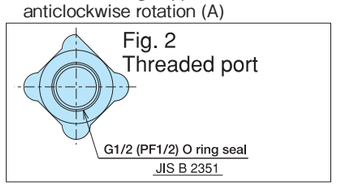
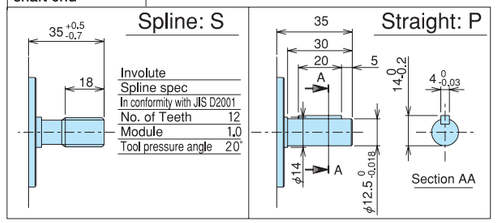


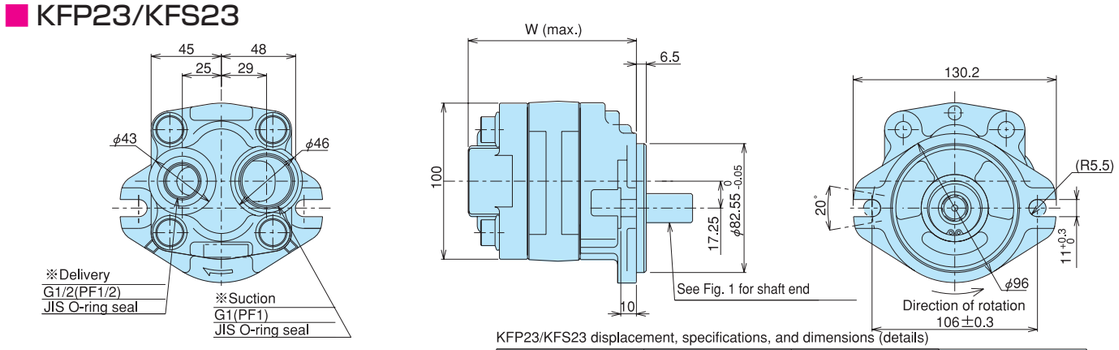
Fig. 1
shaft end



KPO5 displacement, specifications, and dimensions (details)

Model	Displacement (cm3/rev)	Max. operating pressure (MPa)	Speed (rpm)	A (size)	B (size)	Weight (kg)
KP0530	3.0	20.6	600 ~3000	39.9	93.5	1.6
KP0535	3.5					
KP0540	4.0					
KP0553	5.3					
KP0560	6.0					
KP0570	7.0					
KP0588	8.8					
KP05106	10.6	17.2		43.7	97.3	1.7
KP05123	12.3	15.2				
KP05132	13.2	14.2				

■ KFP23/KFS23



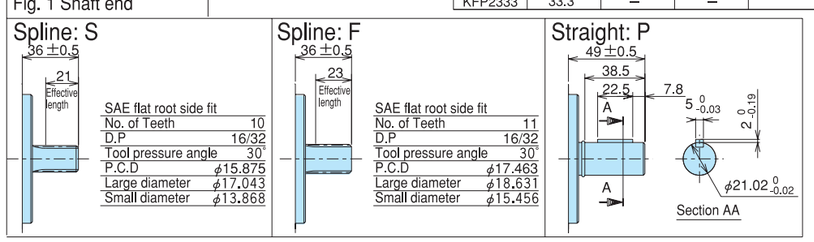
※For anticlockwise rotation (A)
※The mirror image applies to the clockwise rotation (C).

The side port type is also available.

KFP23/KFS23 displacement, specifications, and dimensions (details)

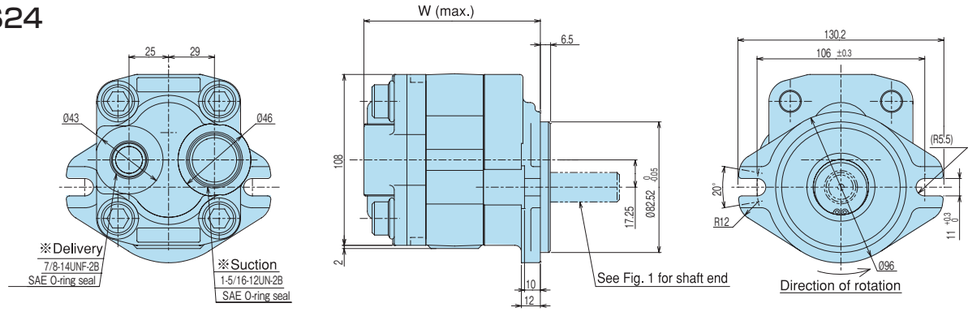
Standard pump (KFP) Model	Displacement (cm3/rev)	Low pulsation pump (KFS) Model	Displacement (cm3/rev)	Specifications Max. operating pressure (MPa)	Specifications Speed (rpm)	Dimensions and Weight W mm	Weight (kg)
KFP2312	11.9	KFS2312	12.5	20.6	600 ~3000	96.5	2.4
KFP2314	14.3	KFS2315	15.0			99.6	2.6
KFP2317	16.8	KFS2317	17.6			102.9	2.8
KFP2319	19.2	KFS2320	20.2			106.1	3.0
KFP2323	22.9	KFS2324	24.0			110.9	3.5
KFP2325	24.5	KFS2325	25.7			113.1	3.7
KFP2327	26.5	KFS2327	27.8			115.7	3.8
KFP2328	28.2	KFS2329	29.4			117.7	3.9
KFP2330	30.0	KFS2331	31.2			120.0	4.1
–	–	KFS2333	32.8			122.0	4.3
KFP2333	33.3	–	–			124.3	4.3

Fig. 1 Shaft end



Dimensions (unit: mm)

KFS24



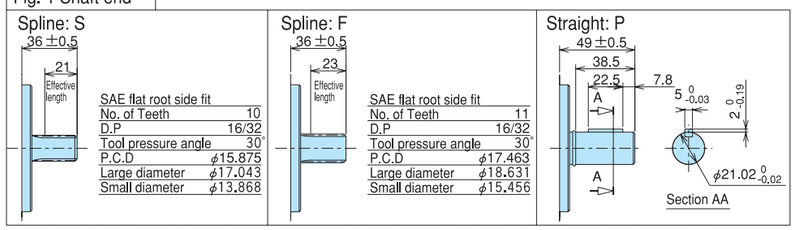
※For anticlockwise rotation (A)
※The mirror image applies to the clockwise rotation (C).

The side port type is also available.

24 specification table

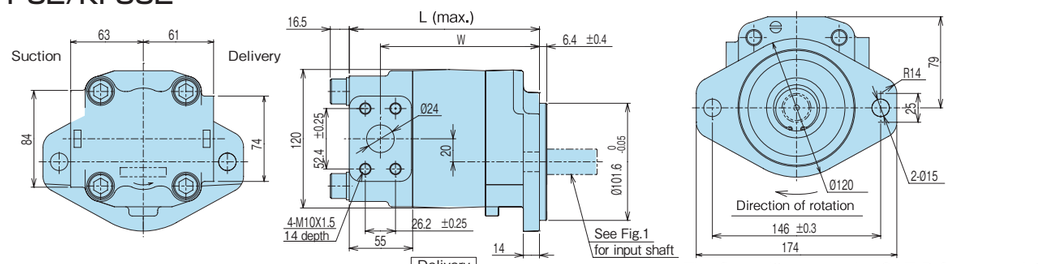
Model	Diplacement (cm3/rev)	Max operating pressure (MPa)	Speed [rpm]	W [mm]	Weight [kg]
KFS2412	12.5	20.6	600~3000	96.5	3.3
KFS2415	15.0			99.7	3.5
KFS2417	17.6			103	3.7
KFS2420	20.2			106.1	3.9
KFS2422	22.0			108.5	4
KFS2424	24.0			111	4.2
KFS2425	25.7			113.1	4.3
KFS2427	27.8			115.7	4.4
KFS2429	29.4			117.7	4.6
KFS2431	31.2			120	4.7
KFS2433	32.8			122	4.8

Fig. 1 Shaft end



◇ Tandem (dual) model and tandem combination with the KFP23 series is possible.

KFP32/KFS32



The figure illustrates the SAE B flange model.
SAE A flange model is also available.

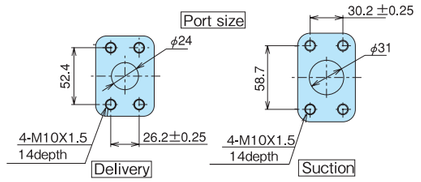
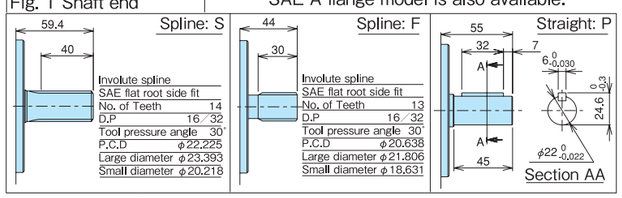


Fig. 1 Shaft end



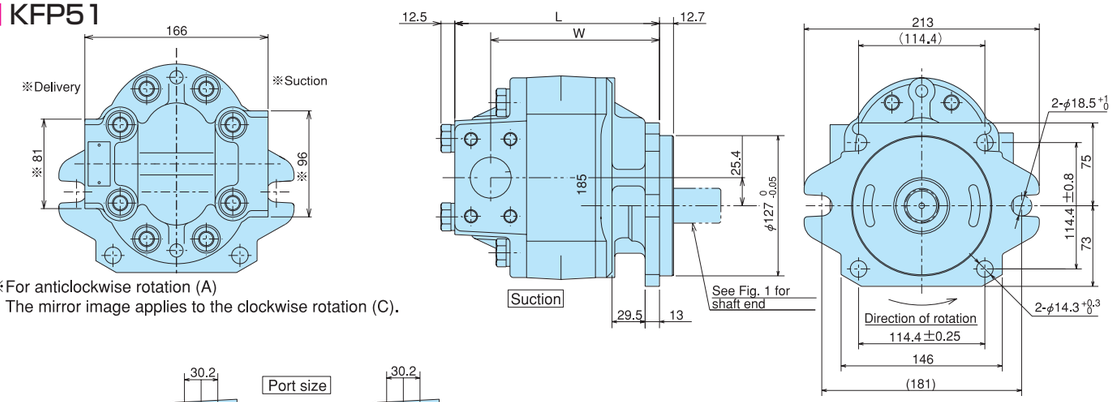
KFP32/KFS32 displacement, specifications, and dimensions (details)

Standard pump (KFP)		Low pulsation pump (KFS)		Specifications			Dimensions and Weight		
Model	Displacement (cm3/rev)	Model	Displacement (cm3/rev)	Max. operating pressure (MPa)	Instantaneous max. pressure	Speed (rpm)	W mm	L mm	Weight (kg)
KFP3220	20.0	KFS3220	20.7	20.6	24.5	600~3000	108.4	135.9	3.9
KFP3223	22.5	KFS3223	23.2				110.9	138.3	4.4
KFP3225	25.0	KFS3225	25.8				113.3	140.8	4.9
KFP3228	28.0	KFS3229	28.9				116.3	143.8	5.5
KFP3232	31.5	KFS3232	32.5				119.8	147.2	6.2
KFP3236	35.5	KFS3236	36.7				123.7	151.2	6.9
KFP3240	40.0	KFS3241	41.3				128.2	155.6	7.8
KFP3245	45.0	KFS3247	46.5			600~2600	133.1	160.6	8.6
KFP3250	50.0	KFS3252	51.6			600~2500	138.0	165.5	9.5
KFP3256	55.5	—	—	17.2	20.6	600~2400	143.4	170.9	10.5
KFP3260	60.0	—	—				※ 83.4	176.3	11.4

※KFP3260 has a different port location and different dimensions.

◇ Tandem (dual) model and tandem combination with the KFP23 series is possible.

KFP51



※For anticlockwise rotation (A)
The mirror image applies to the clockwise rotation (C).

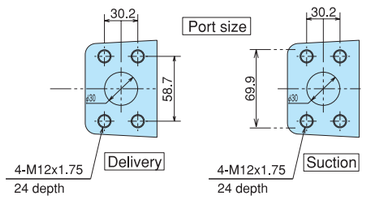
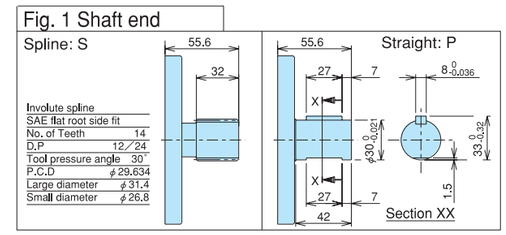


Fig. 1 Shaft end

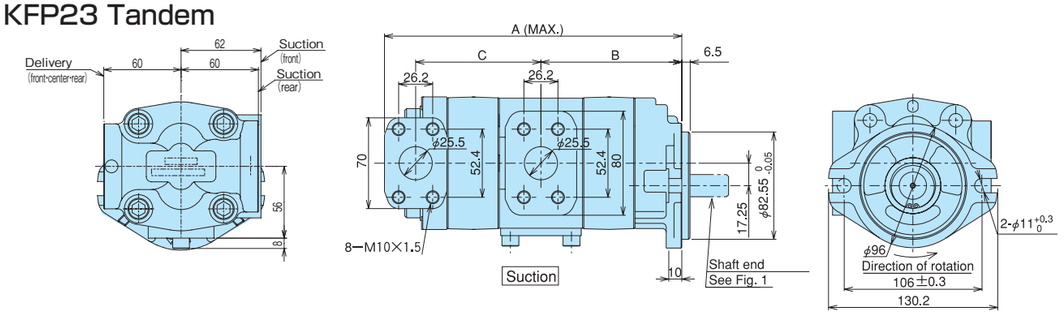


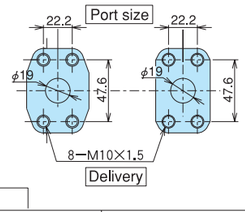
KFP51 displacement, specifications, and dimensions (details)

Model	Displacement (cm3/rev)	Max. operating pressure (MPa)	Speed (rpm)	W	L	Weight (kg)
KFP5163	63	20.6	600~2500	139.7	172.7	20.5
KFP5171	71			143.6	176.6	21.0
KFP5180	80			148.0	181.0	21.6
KFP5185	85			150.5	183.5	22.0
KFP5190	90			152.9	185.9	22.3
KFP51100	100			157.8	190.8	23.0
KFP51125	125	17.2	600~2000	169.2	202.2	24.7

◇ Tandem models and tandem combination with KFP23 and KP05 series are possible.

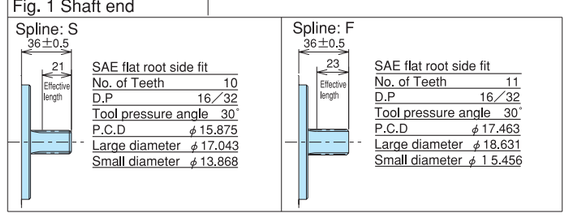
KFP23 Tandem





※ Formula to calculate A, B and C (See Table 1.)
YF = Front pump Y length, YR = Rear pump Y length.
(1) If KFP2319 or a smaller pump is used as a front pump
A = 141.1 + YF + YR
B = 63.8 + YF
C = 52.0 + YR
(2) If KFP2323 or a larger pump is used as a front pump
A = 149.1 + YF + YR
B = 67.8 + YF
C = 56.0 + YR

Fig. 1 Shaft end



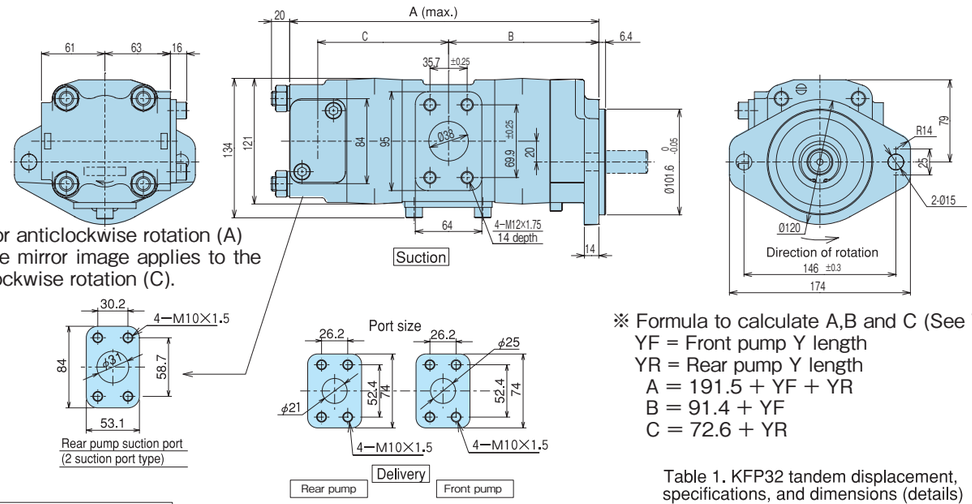
◇ KFP23 tandem (dual and triple) are available.
◇ When the max flow rate is less than 100 l/min, the common suction port on the front unit can be used.

Table 1. KFP23 tandem displacement, specifications, and dimensions (details)

Model	Displacement (cm3/rev)	Max. operating pressure (MPa)	Intermittent max. pressure	Speed (rpm)	Y
KFP2312	11.9	20.6	24.5	600~3000	21.8
KFP2314	14.3				25.0
KFP2317	16.8				28.3
KFP2319	19.2				31.4
KFP2323	22.9				36.3
KFP2325	24.5				38.4
KFP2327	26.5				41.1
KFP2328	28.2				43.1
KFP2330	30.0				45.4
KFP2333	33.3				49.7

Dimensions (unit: mm)

KFP32 Tandem



※ For anticlockwise rotation (A)
The mirror image applies to the clockwise rotation (C).

※ Formula to calculate A,B and C (See Table 1.)
YF = Front pump Y length
YR = Rear pump Y length
A = 191.5 + YF + YR
B = 91.4 + YF
C = 72.6 + YR

Fig. 1 Shaft end

Table 1. KFP32 tandem displacement, specifications, and dimensions (details)

Model	Displacement (cm3/rev)	Max. operating pressure (MPa)	Speed (rpm)	Y length
KFP3220	20.0	20.6	600～3000	33.4
KFP3223	22.5			35.9
KFP3225	25.0			38.3
KFP3228	28.0			41.3
KFP3232	31.5			44.8
KFP3236	35.5			48.7
KFP3240	40.0			53.2
KFP3245	45.0		600～2600	58.1
KFP3250	50.0		600～2500	63.0

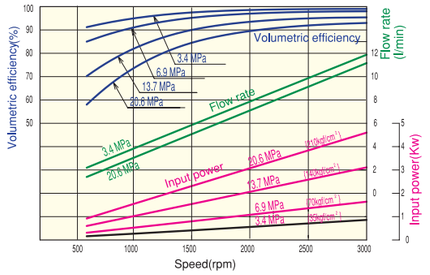
◇ KFP32 tandem (dual) pump is available.
◇ When the max. flow rate is less than 190 l/min.,the common suction port on the front unit can be used.

Pump

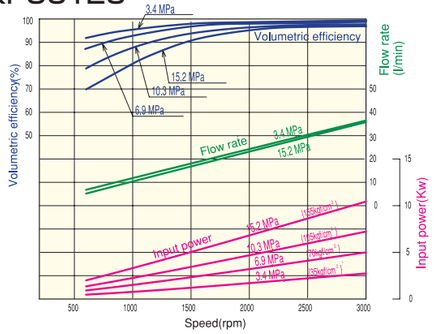
Performance Curve (Hydraulic fluid: ISO VG32, oil temperature: 50℃)

※ The typical displacements of models of each series are illustrated. Please consult us for models of other displacements.

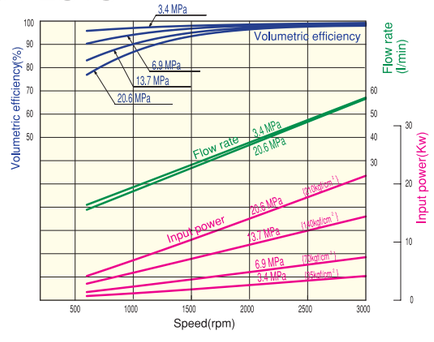
KP0540



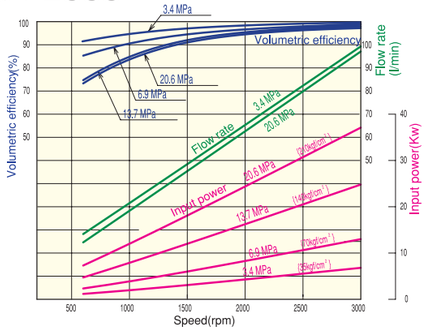
KP05123



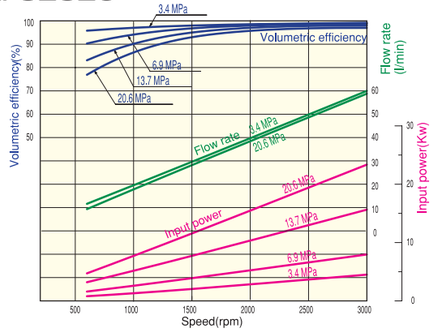
KFP2319



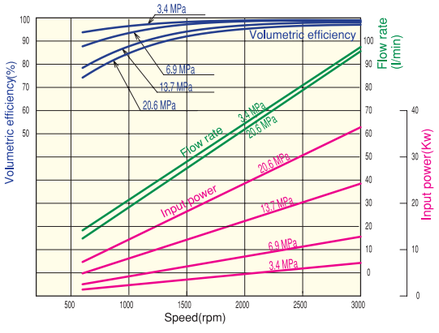
KFP2333



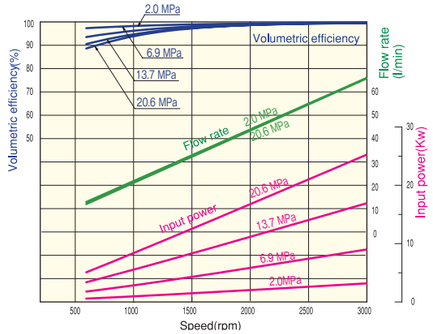
KFS2320



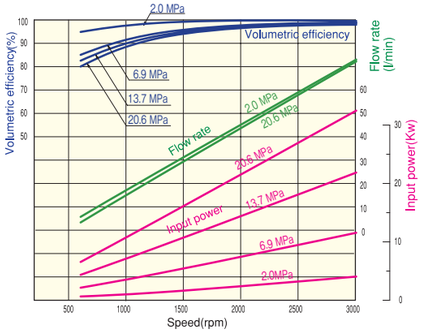
KFS2333



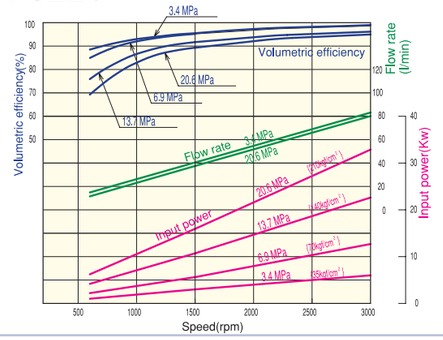
KFS2422



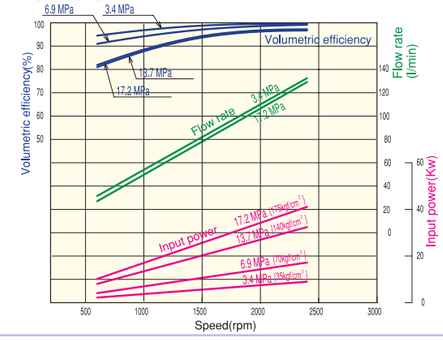
KFS2427



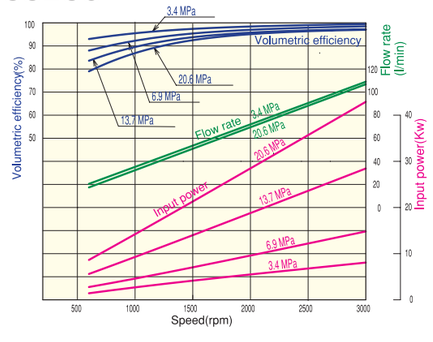
KFP3228



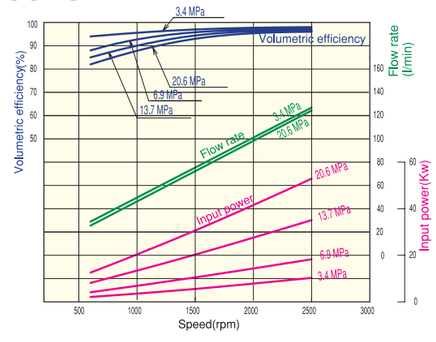
KFP3256



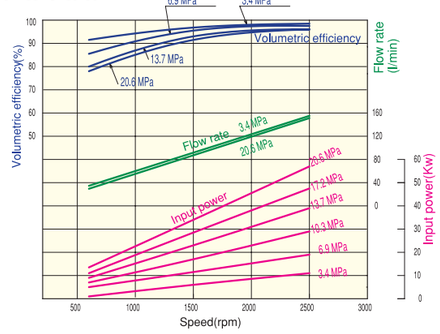
KFS3236



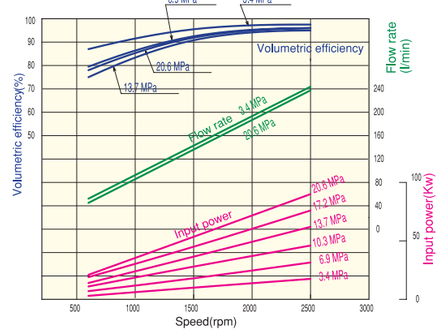
KFS3252



KFP5163



KFP51100



Pump: Swashplate type piston pump

【General Description】

KYB's piston pumps are used for construction equipment, agricultural machines, and other industrial equipment in a wide variety of market sectors. All series are high-performance, high-reliability piston pumps developed on an abundance of experience in numerous applications. They are manufactured by advanced production systems. This catalog provides only piston pumps for general-purpose closed circuit applications and construction equipment open circuit applications.
All rotary parts are manufactured by one of KYB's affiliated companies, Takako Industries, Inc., which is the world's leading company in this technology.

Basic Construction

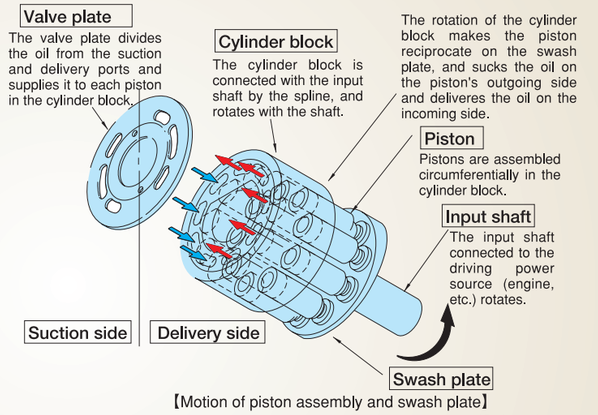
※This piston pump has the same basic structure with the piston motor, and is equipped with additional pump functions. The direction of rotation of the input shaft is fixed.

【Construction and Mechanism】

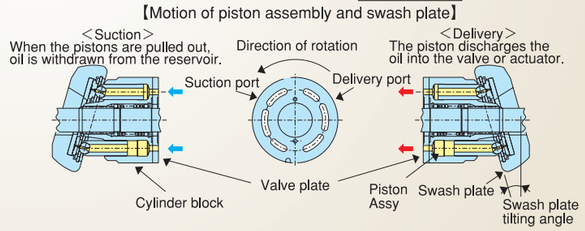
1. The input shaft connected to the driving power source rotates. So does the connection between the cylinder block and the input shaft is made by the spline.
2. Then, the pistons reciprocate along the cylinder bores in a movement determined by the swash plate's tilting angle.
3. When the pistons are pulled out from the cylinder block, oil is drawn from the reservoir. When the pistons are pushed in, oil is delivered to the valve and actuator side.
4. The suction port and delivery port are divided by the valve plate.

<Variable displacement pump>

1. The greater the tilting angle of the swash plate, the greater the reciprocation stroke (displacement) of the piston. When the angle is 0, the reciprocation of the piston stops, reducing the discharge volume to zero.
2. In the closed circuit, the delivery side and suction side are reversed as the swashplate tilting angle shifts from $+\alpha$ to $-\alpha$ even though the rotating direction of the input shaft remains unchanged.



【Motion of piston assembly and swash plate】

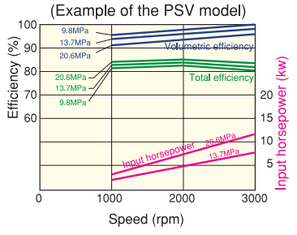


Basic characteristics

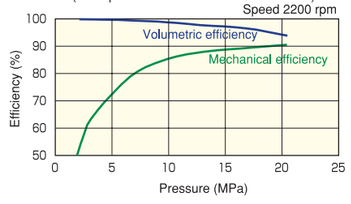
When selecting the pump, examine the following characteristics.

Volumetric efficiency, input horsepower, and mechanical efficiency

(Example of the PSV model)



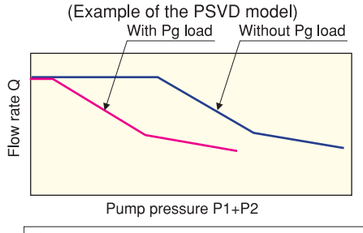
(Examples of the PSVD and PSVL models)
Speed 2200 rpm



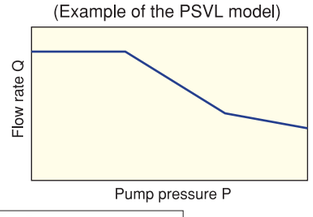
- Volumetric efficiency (actual flow rate / theoretical flow rate)
  An operation at a low speed and high pressure increases internal leakage decreasing volumetric efficiency.
- Actual horsepower (theoretical horsepower / mechanical efficiency)
  An operation at a higher speed and higher pressure increases mechanical efficiency.
- The actual delivery flow rate (volumetric efficiency) and actual shaft power are related to the speed and pressure. Please contact us regarding the specific characteristics of individual displacement volumes of each model.

Pressure and flow characteristics (horsepower control characteristics)

(Example of the PSVD model)

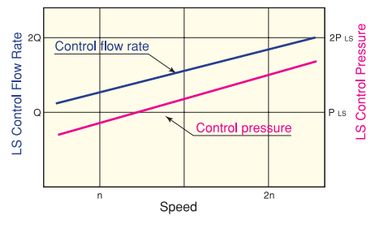


(Example of the PSVL model)



P1: First pump pressure P2: Second pump pressure Pg: Gear pump pressure

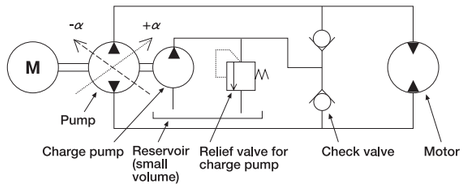
LS Control characteristics



※It is possible to control the flow rate almost proportional to the pump rotating speed.

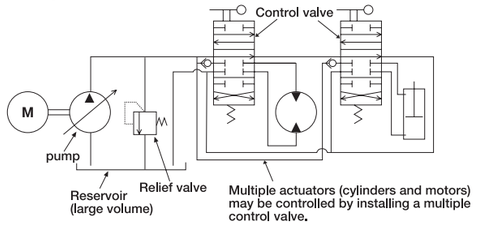
Closed Circuit and Open Circuit

● Closed circuit



1. The closed hydraulic circuit is constructed with an actuator (motor) and a pump.
2. The speed and direction of the actuator can be decided by changing the pump tilt angle to $+\alpha$, or to $-\alpha$ as the delivery port and the pump flow change accordingly.
3. The closed circuit features a smooth starting and stopping of the actuator.
4. The pump and the motor can be put into one case and made into a compact size as integrated HST.

● Open circuit



1. In the open circuit, oil is drawn by the pump from the reservoir, and the returning oil from the actuator is flown to the reservoir.
2. With a fixed-displacement pump, the speed and direction of an actuator are controlled with the switching and spool opening of the control valve. With the variable displacement pump, the pump controls the flow rate and the swash-plate tilting angle can be changed only in the $+\alpha$ direction.
3. In the open circuit, a single pump can connect to and control multiple actuators.

Main Functions

【Variable Displacement】

The pump displacement can be changed by external control of the swash-plate tilting angle. (A two-way delivery flow in the closed circuit.)

● Manual type: The swash plate angle is controlled with a lever link.

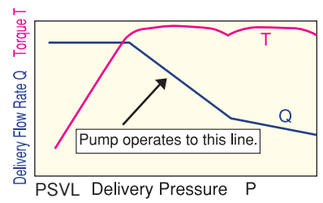
<Regulator>

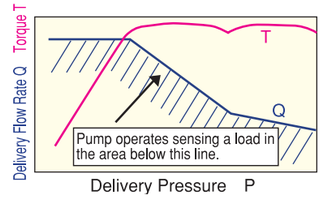
The regulator for the control of the swash plate angle of an open circuit pump has the following control devices:

● Horsepower control: The swash plate angle (and the pump displacement) changes depending on the pump delivery pressure in order not to exceed the engine horsepower, thereby making constant the maximum input torque to the pump, and ultimately making constant the pump's horsepower consumption. This control is effective in preventing the engine from stalling due to the pump power consumption exceeding the engine power, and in utilizing the engine horsepower efficiently. (PSVD)

● Load sensing control: This control aims to deliver the required flow that matches the ongoing operation. The pump delivers the required flow to the actuator at required pressure. The pump swash plate angle (and pump displacement) fluctuates so that differential pressure between the upstream and downstream sides of the LS valve can remain constant. Then, no sufficient flow and less heat generation can be made, which generates energy-saving system.

PSVD

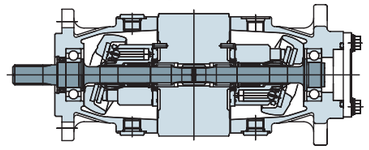




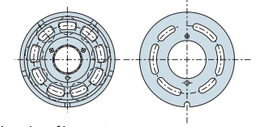
【Tandem pumps (Dual,Triple)】

● Two or three pumps are driven with a single input shaft. Flow rates in the first and second pumps can be set independently. The piston pump is used to drive travel motors. The third pump may be used as a charge pump in the closed circuit as well.
(PSV2)

In the tandem configuration, the second pump is connected with coupling in the axial direction.



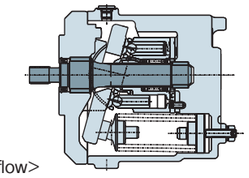
<Tandem dual configuration (single flow)>



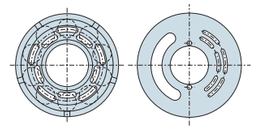
Single flow type cylinder block　Valve plate

【Single flow and split flow】

● As described in the basic construction of the piston pump, a typical piston pump is a single flow type with one suction port and one delivery port. On the other hand, a split flow type pump has two independent delivery systems with alternately positioned ports on a single cylinder block. (PSVD)



<Split flow>
※A single cylinder block with a two flow system



Split flow type cylinder block with each port split into internal and external ports for separate delivery　Valve plate

Pump: Piston Pump

Typical piston pumps are variable and high-pressure types mainly used for construction equipment, etc, engaged in heavy-duty work. They are widely used in areas that require horsepower control, load-sensing, and other control functions.

[Model codes] PSV | D2 | – | 17 | E

Example 1 2 3 4

1	Variable-displacement swash plate type piston pump		
2	Pump type Void: Single pump, 2: Tandem pump (dual type), D2: Split-flow pump (Single cylinder block with two flow systems), L: Load-sensing pump S: Load sensing pump for truck mixer H2:Tandem pump for Loader/HST		
3	Pump displacement	Nominal (cm³/rev)	
4	Additional information	E: Series symbol	SP:Hydraulic pilot

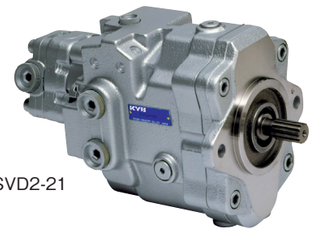
PSV Series (Closed circuit)

PSV2-16

Model	Displacement (cm³/rev)	Max. working pressure(MPa)	Max. speed (rpm)	Typical input horsepower(kw)
PSV–10	10.0	27.5	3,600	8.0
PSV–16	16.4	27.5	3,600	13.2
PSV2–10	10.0×2	27.5	3,200	7.0×2
PSV2–16	16.4×2	27.5	3,200	11.7×2
PSVH2–28	28.1×2	34.3	3,000	23.3×2

※ The direction of rotation of the input shaft is to be set in one direction. Please specify either "CW" or "CCW" as the direction of rotation.

PSVD Series (Open circuit)

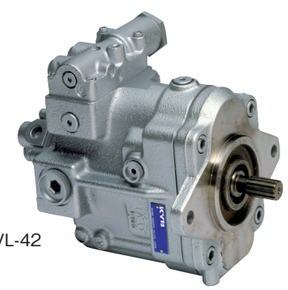


PSVD2-21

Model	Displacement (cm³/rev)	Max. working pressure(MPa)	Max. speed(rpm)	Control device control (N·m)
PSVD2–17E	16.8×2	24.5	2,550	Horsepower control
PSVD2–21E	20.8×2	24.5	2,400	
PSVD2–27E	26.9×2	24.5	2,400	
PSVD2-42	42.3×2	32	2,200	

※ Only CW is available (clockwise when viewing from the input shaft side).

PSVL Series
(Open circuit and load sensing)



PSVL-42

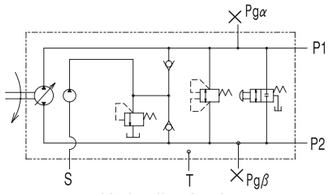
Model	Displacement (cm³/rev)	Max.working pressure(MPa)	Max. speed(rpm)	Control device control (N·m)
PSVL–42	42	24.5	2,500	Horsepower control Load-sensing control
PSVL–54	54	24.5	2,400	
PSVL–84	84.6	32	2,200	

※ Load sensing type variable displacement pump
※Use together with a load-sensing (LS) valve. (See Page 49.)
※Only CW type is available (clockwise when viewing from the input shaft side).

Dimensions (unit: mm)

<Closed circuit>

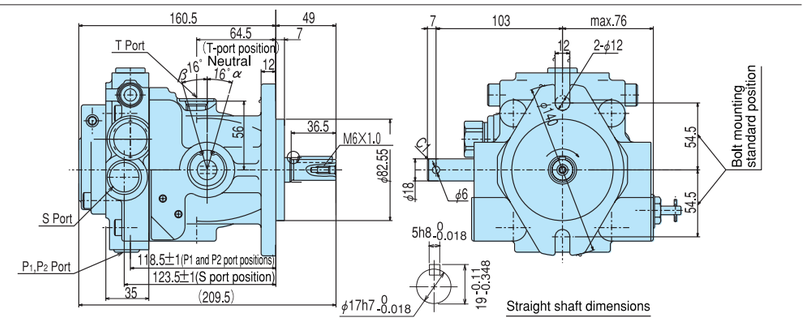
PSV-10 (single)



Hydraulic circuit

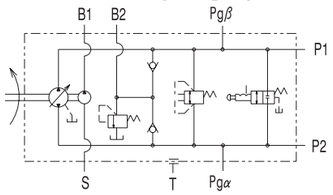
Ports

P1,P2	Pressure port	G1/2(PF1/2)
S	Suction port	G1/2(PF1/2)
T	Case drain port	G3/8(PF3/8)



Straight shaft dimensions

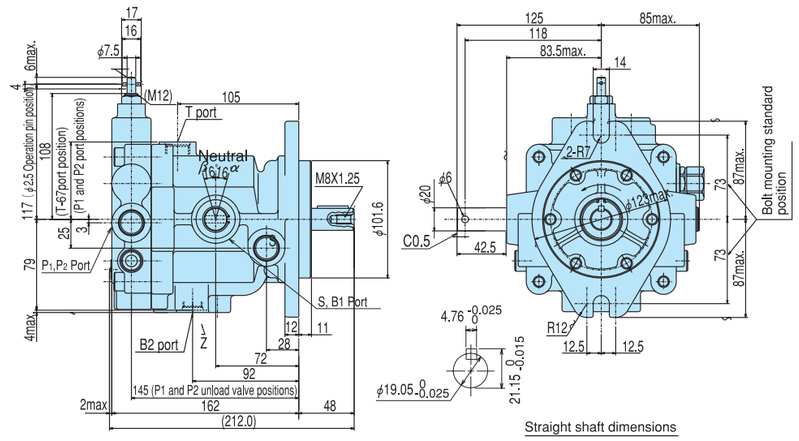
PSV-16 (single)



Hydraulic circuit

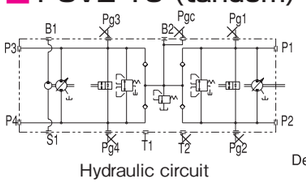
Ports

P1,P2	Pressure port	G1/2(PF1/2)
B1	Pilot port	G3/8(PF3/8)
B2	Charge port	G3/8(PF3/8)
S	Suction port	G1/2(PF1/2)
T	Case drain port	G1/2(PF1/2)



Straight shaft dimensions

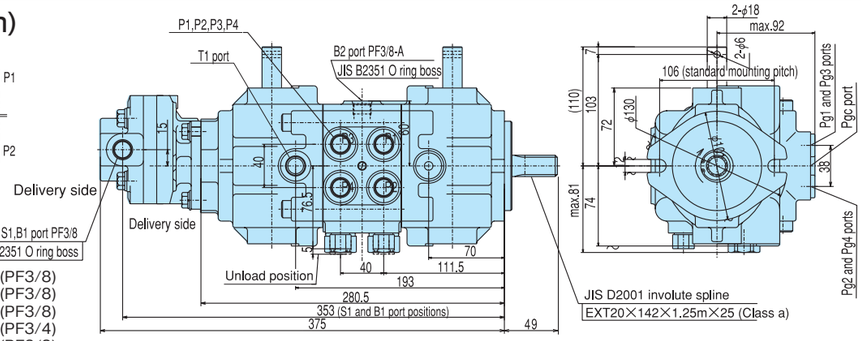
PSV2-10 (tandem)



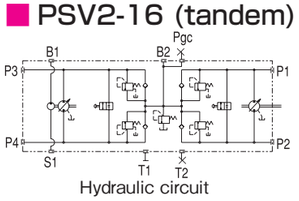
Hydraulic circuit

Ports

P1,P2,P3,P4	Pressure port	G3/8(PF3/8)
B1	Pilot port	G3/8(PF3/8)
B2	Charge port	G3/8(PF3/8)
S	Suction port	G3/4(PF3/4)
T1,T2	Case drain port	G3/8(PF3/8)



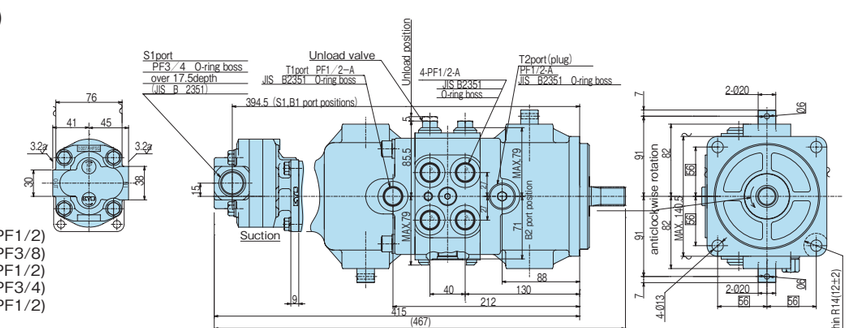
PSV2-16 (tandem)



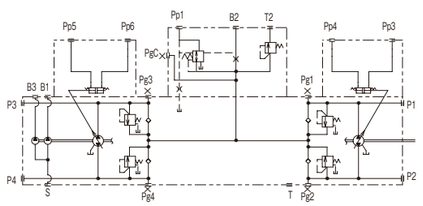
Hydraulic circuit

Ports

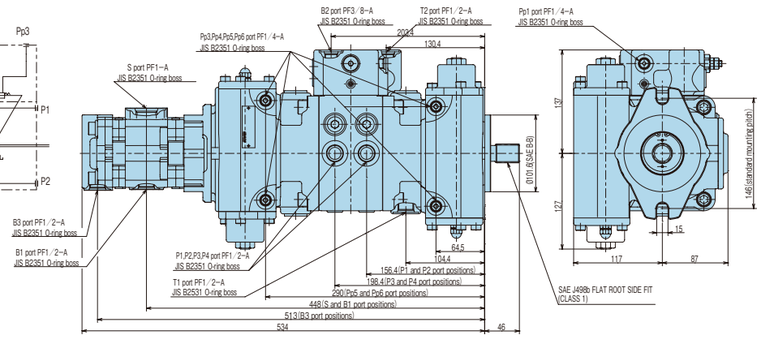
P1,P2,P3,P4	Pressure port	G1/2(PF1/2)
B1	Pilot port	G3/8(PF3/8)
B2	Charge port	G1/2(PF1/2)
S	Suction port	G3/4(PF3/4)
T1	Case drain port	G1/2(PF1/2)



■ PSVH2-28

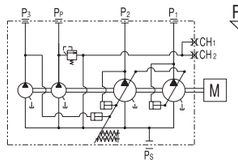


Hydraulic circuit

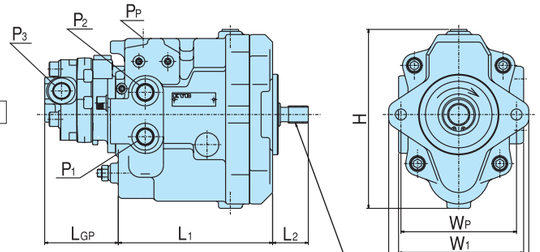


〈開回路〉

■ PSVD2-17、21、27 and 42 [Split flow (Single cylinder block with two flow systems)]



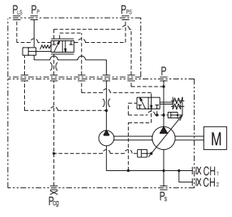
Hydraulic circuit



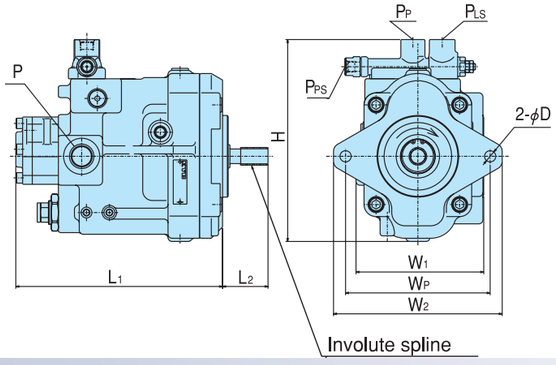
	Dimensions					
	L_1	L_2	L_{GP}	W_1	W_2	H
PSVD2-17E	181	46	90	160	181	221
PSVD2-21E	199	57	〃	160	181	226
PSVD2-27E	217	52	106	181	234	252
PSVD2-42	238	72	62~112	182.5	271	232

	Mounted dimensions		Port sizes			
	W_P	D	P_1	P_2	P_3	P_P
PSVD2-17E	146	14	PF1/2	PF1/2	PF1/2	PF1/4
PSVD2-21E	146	14	PF1/2	PF1/2	PF1/2	PF1/4
PSVD2-27E	200	17.5	PF1/2	PF1/2	PF1/2	PF1/4
PSVD2-42	228.6	17	PF3/4	PF3/4	PF1/2	PF3/8

■ PSVL-42、54 and 84 [Load sensing] ※To be used with an LS valve. (See Page 55.)



Hydraulic circuit



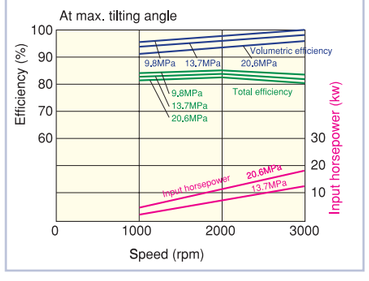
	Dimensions				Mounted dimensions		
	L_1	L_2	W_1	W_2	H	W_P	D
PSVL-42	260	57	159	214	252	180	14
PSVL-54	284	48	180	234	258	200	17.5
PSVL-84	292	72	182.5	271	230	228.6	17

	Port sizes			
	P	P_P	P_{PS}	P_{LS}
PSVL-42	PF3/4	PF3/8	PF1/4	PF1/4
PSVL-54	PF3/4	PF3/8	PF1/4	PF1/4
PSVL-84	PF1	PF3/8	PF1/4	PF1/4

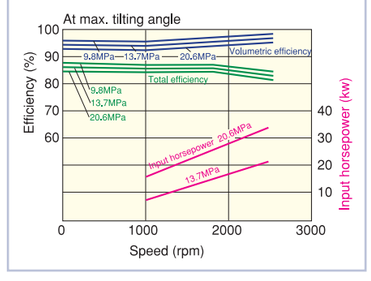
Performance Curve Operating oil: ISOVG46 Oil temperature: 50℃

<Closed circuit>

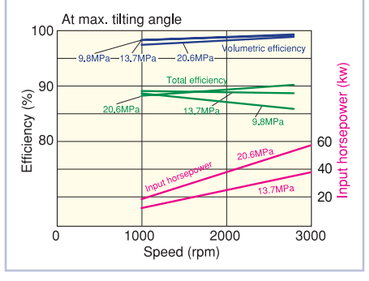
■ PSV-10



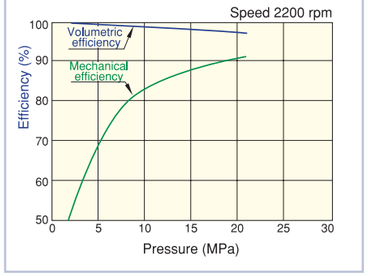
■ PSV-16



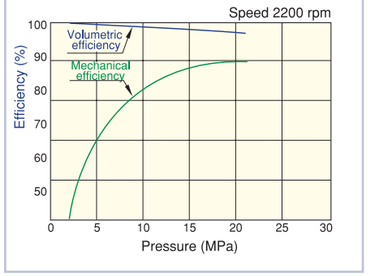
■ PSVH2-28



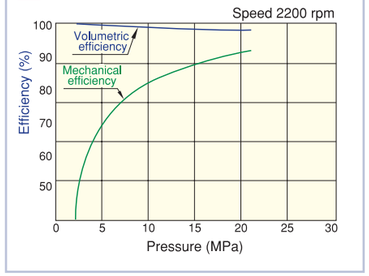
■ PSVD2-17



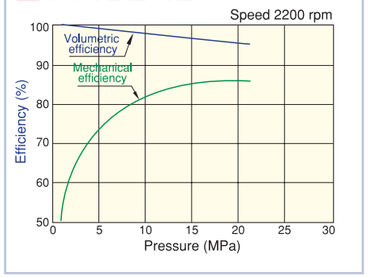
■ PSVD2-21



■ PSVD2-27

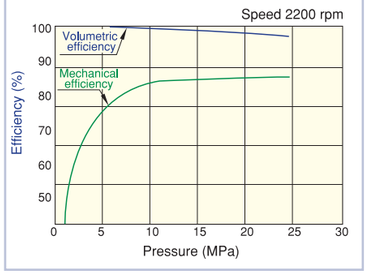


■ PSVD2-42

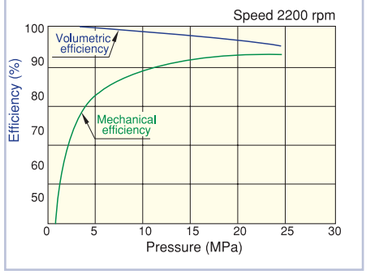


<Open Circuit:road sensing>

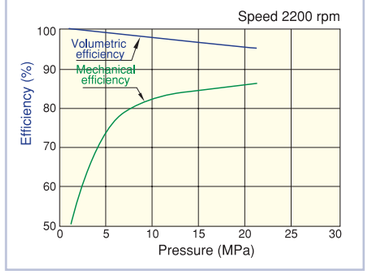
■ PSVL-42



■ PSVL-54

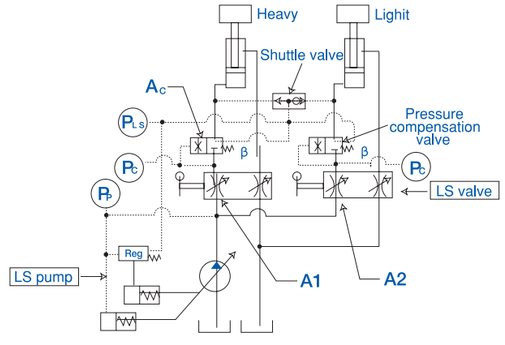


■ PSVL-84



<Load sensing system working mechanism> (multiple operations)

- The maximum load pressure Pls is selected by the shuttle valve, which controls the pump regulator and the pressure compensator valve.
- The pressure compensator valve adjusts the flow at Ac so that PC upper stream pressure equals (Pls + β)
- Differential pressure (Pp-Pc) between the uppersteam and downstream sides of A1 and A2, which control the flow to each actuator, remains constant, enabling multiple operations under different loading conditions.



Hydraulic Motor (General)

	Piston Motor		Gear motor, vane motor, etc
	Motor unit	Motor with reduction gear	
Products included in this catalog	Piston motor in swash plate design for general purpose and fan application.	For excavator and mini-excavator (For travel and swing systems)	
KYB products not included in this catalog. (Contact KYB)	Piston motor in bent axis design Radial piston motor (Low speed high torque)	For mixer truck	Internal gear motor (Manufactured by Sauer-Danfoss)
Not included in KYB product lineup			External gear motor (Production discontinued) Vane motor

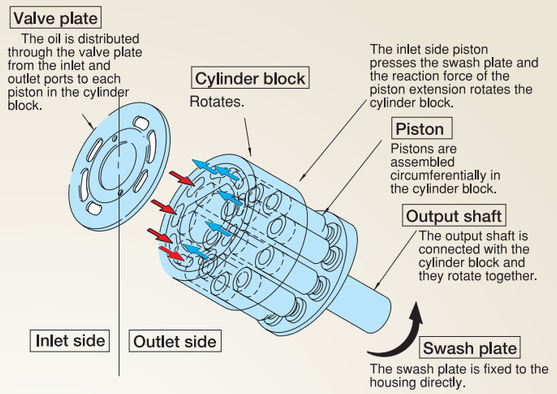
Motor: Piston Motor (Swash plate type)

Basic Construction

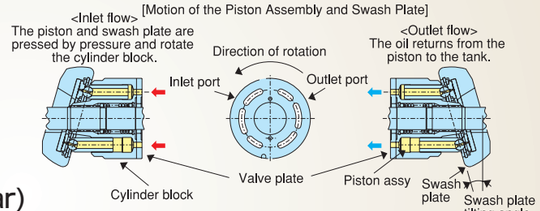
Motor unit

[Construction and Mechanism]

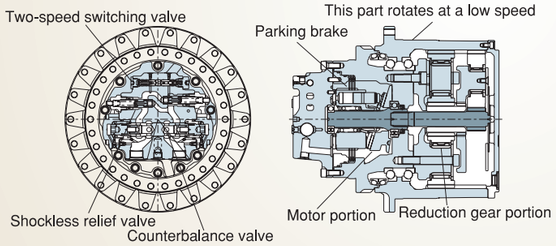
1. When high-pressure oil supplied from the pump flows into the cylinder block through the valve plate, the swash plate is pushed by the force of the piston assembly.
2. The piston assembly receives reaction force against it and produces reaction force in the rotating direction.
   The total force of high-pressure side piston assembly produces a rotating force in the cylinder block, and the torque is transmitted to the shaft through the spline, resulting in the rotation of the shaft.
3. The oil delivered from the outlet port returns to the reservoir through the valve plate.
4. The inlet and outlet sides can be switched by an external valve operation to rotate the motor in the reverse direction.

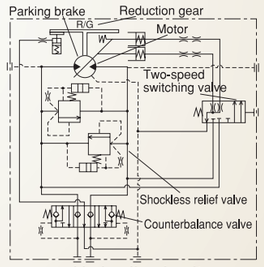


[Motion of the Piston Assembly and Swash Plate]



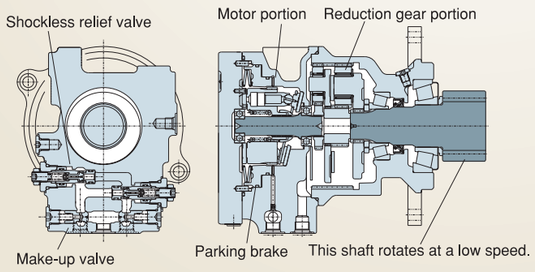
Traveling motor (with reduction gear)

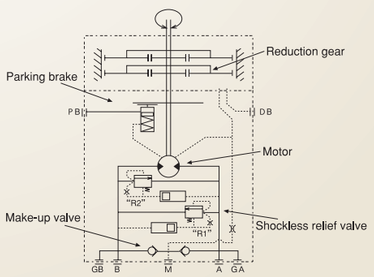




Hydraulic circuit

Swing motor (with reduction gear)





Hydraulic circuit

【Main Components of the Travel Motor (MAG)】

◇ Reduction gear
- ● A case rotation type simple planetary reduction gear is adopted.

◇ Motor (standard component)
- ● Counterbalance valve (standard component for all models): Prevents the motor from overrunning on a down slope. The valve is effective to prevent cavitation.
- ● Two speed mechanism (standard component for all models): Two step speed change can be done under the same flow, which allows a wider range of speed control. (See Page 24)
- ● Shockless relief valve (standard component for MAG-50 through 230): Reduces shocks at the stop and prevents cavitation.
- ● Anti-cavitation valve (with no relief mechanism) (standard component for MAG-18 through 33): This valve has stopping performance similar to the shockless version and can prevent cavitation.
- ● Parking brake (standard component for MAG-50 through 230 and optional for MAG-12 through 33): A multiple-plate wet disk brake system is adopted.

(Optional Component)
- ● Automatic two-speed system (except for MAG-12): Speed is automatically switched from Low to High or vice versa according to travel load pressure.

【Main Components of the Swing Motor (MSG)】

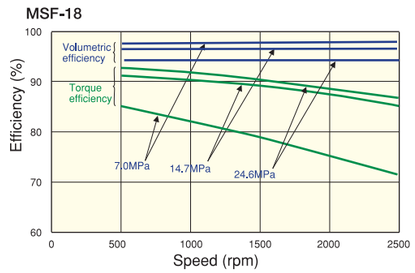
◇ Reduction gear
- ● Shaft rotation type planetary reduction gear is adopted.
- ● Motor lubricant circulation system: Hydraulic fluid is also used as a reduction gear lubricant. No maintenance is required.

◇ Motor (standard component for all models)
- ● Shockless relief valve: Reduces shocks at the stop and prevents cavitation.
- ● Parking brake: Multiple-plate disk brake is adopted. (Output torque ratio over 100%)
- ● Make-up valve: Prevents cavitation.

(Optional Components for All Models)
- ● Parking brake delaying valve: Delays the response time of the parking brake
- ● Anti-reaction valve: Reduces the reaction at the time the motor stops.

Basic Characteristics

The motor's general characteristics (performance) are as follows.



Output torque calculation formula:

$$T = \frac{P \times D}{2 \times \pi} \times \eta_m$$

D: Motor displacement [cm³/rev]
T: Output torque [N-m]
P: Effective pressure [MPa]
η_V: Mechanical (torque) efficiency

○ Output torque can be obtained from motor displacement, pressure, and mechanical efficiency.
○ The torque efficiency is affected by mechanical friction and other factors, and drops at a higher speed and lower pressure.

Output speed calculation formula:

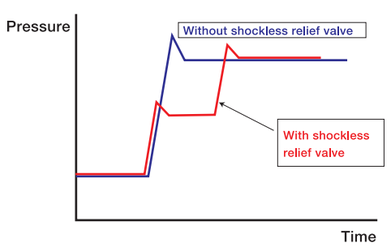
$$N = \frac{Q \times 10^3}{D} \times \eta_v$$

N: Speed [rpm]
Q: Flow rate [L/min.]
η_V: Volumetric efficiency

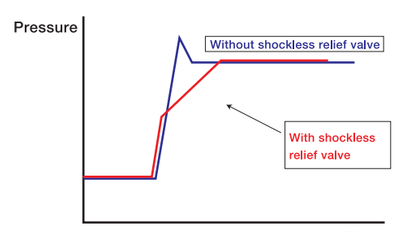
○ The speed can be decided by motor capacity, flow rate, and volumetric efficiency.
○ Volumetric efficiency is affected by leakage inside the motor (from the high pressure side to the low pressure side), and decreases at a slower speed and higher pressure.

【Characteristics of the Shockless Relief Valve】

<Travel motor>



<Swing motor>



Motor: Piston Motor Unit

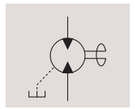
【Swash Plate Piston Motor】

The MSF series is a compact, light, swashplate type piston motor, which has been used for construction and agricultural machines.
All rotary parts are manufactured by one of KYB-affiliated companies, Takako Industries, Inc., which is the world's leading company in this technology.

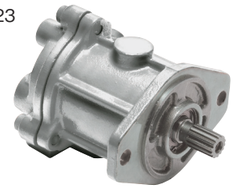
【Model code】 MSF – 23
Example 1 2

1	Fixed displacement swashplate type piston motor	
2	Max. displacement	Nominal value (cm³/rev)

■ MSF Series (motor unit)


Symbol

MSF-23



<General purpose>

Model	Displacement (cm³/rev)	Max. working pressure(MPa)	Max. speed(rpm)	Max. flow rate (L/min.)
MSF-12	8～12.5	20.6	3500	40
MSF-18	16.4～18.4	24.5	3000	50
MSF-23	23.4	24.5	3000	70
MSF-30	26.1～30.2	25.0	2000	60
MSF-50	42.2～50.9	28.0	2000	90

Models for fan and mixer drum driving applications are also available.
Please contact us for details.

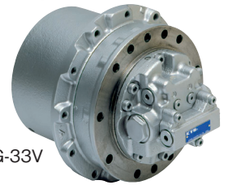
Motor: Piston motor (with reduction gear)

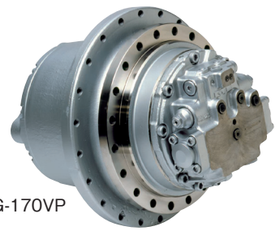
The MAG series offers high-torque motors for medium- or high-speed traveling crawler vehicles. It consists of a case rotation planetary reduction gear and a swash plate piston motor, and is equipped with a two-speed change unit and a parking brake unit. .
The two-speed change mechanism supports the automatic speed change according to the load. The MSG series motors incorporating a shaft-rotation type simple planetary reduction gear and the swash plate motor are ideal solutions for the swing system of excavators and mini-excavators. The motor is equipped with a parking brake in our standard version.

【Model code】 MAG – 170 V P – 3800 F
Example 1 2 3 4 5 6

1	MAG: Case-rotation type motor with reduction gear (for travel systems)	
	MSG: Shaft-rotation type motor with reduction gear (for swing systems)	
2	Max. displacement	Nominal (cm³/rev)
3	Two-speed change mechanism	V: Equipped Void: Not equipped
4	Parking brake system	P: Equipped Void: Not equipped
5	MAG: Output torque (kgf-m)	MSG: Reduction gear ratio
6	Development serial number	

■ MAG Series (with reduction gear)


MAG-33V

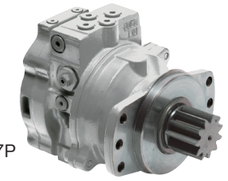

MAG-170VP

(For excavator and mini-excavator travel)

Model	Max. output torque(kN-m)	Max. working pressure(MPa)	Max. speed(rpm)	Max. flow rate(L/min.)	Typical applications
MAG-12VP-120E	1.18	20.6	80	20	Mini excavator
MAG-18VP-230E	2.16	24.5	70	30	
MAG-18VP-350E	3.14	27.5	60	40	
MAG-26VP-400E	3.92	27.5	60	50	
MAG–33VP–650G	6.37	27.5	60	64	
MAG–50VP–1100F	10.7	34.3	60	92	Midi excavator
MAG–85VP–1800E	17.7	34.3	55	150	Excavator
MAG–85VP–2400E	23.5	34.3	50	150	
MAG–170VP–4000H	37.3	34.3	50	270	
MAG–180VP–6000G	56.0	34.3	50	300	

Models for winches and skid-steer loaders are also available.
Please contact us for details.

■ MSG Series (with reduction gear)


MSG-27P

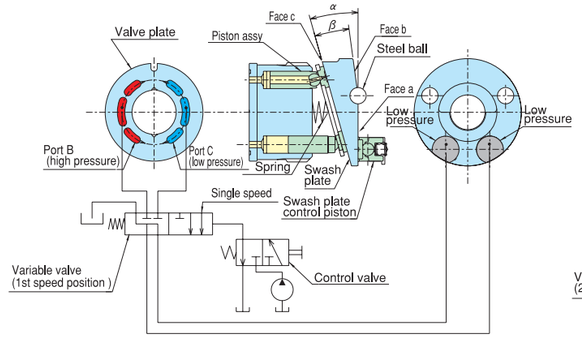
(For excavator and mini-excavator swing)

Model	Max. output torque(kN-m)	Max. working pressure(MPa)	Max. speed(rpm)	Max. flow rate(L/min.)	Typical applications
MSG–27P–10E	0.83	20.6	90	25	Mini excavator
MSG–27P–16E	1.27	20.6	85	35	
MSG–27P–23E	2.04	20.6	70	44	
MSG–50P–21	3.48	24	85	77	

【Two-speed Change Mechanism】(MAG series for travel systems)

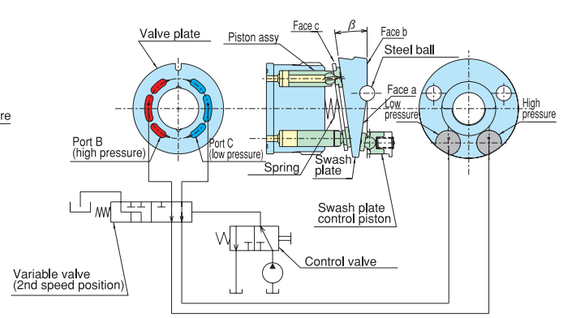
The swashplate has three surface sections, a, b, and c, and can be tilted by external pilot pressure with two steel balls at the rear of the swashplate working as fulcrums.

1st Speed : Low speed (high torque)



Low speed = Large displacement
When the control valve position is switched to 1st speed, the variable valve connects the swash plate control piston chamber behind the swash plate with the reservoir and the section "a" of the swash plate is pressed against the fixed face by the driving force of the motor on the piston and the spring on the cylinder block side. As a result, the swash plate tilts at a maximum angle α to output a larger displacement (1st speed).

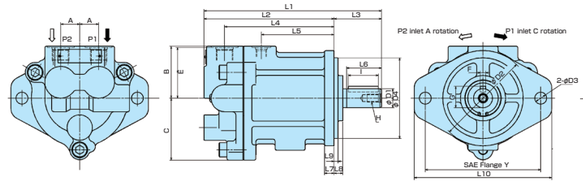
2nd Speed : High speed (low torque)



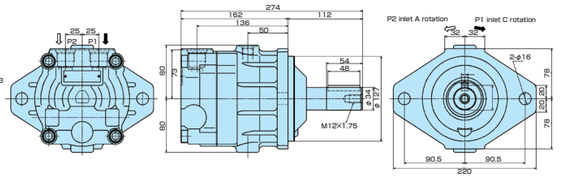
High speed = Small displacement
Switching the variable valve position to 2nd speed with the control valve leads the motor driving pressure to the swash plate control piston. As the force of the piston overcomes the driving force of the motor and the force of the spring, the face "b" of swash plate is pressed to the fixed face, making the swash plate tilt at a minimum angle β to generate a smaller displacement. (2nd speed).

Dimensions Unit: mm

■ MSF-12、18、23、30 (motor unit)



■ MSF-50 (motor unit)



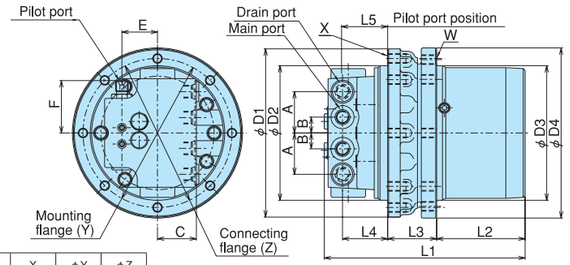
Type	φD3	φD4	L1	L2	L3	L4	L5	L7	L8	L9	L10	L11
MSF-12	11	82.5	170	122	48	100.5	62	14	5.5	-	131	96.5
MSF-18	15	101.6	188	137	51	113	67.5	12	11	5	180	125
MSF-23	15	101.6	230	170	60	138.5	92	12	11	5	180	125
MSF-30	15	101.6	230	170	60	138.5	92	12	11	5	180	125
MSF-50	18	127	276	164	112	136	60	16	28	10	220	156

Type	A	B	C	E	Y	Main port	Drain port
MSF-12	16	54	60	48	106.4	PF3/8	PF1/4
MSF-18	20	57	74	54	146	PF1/2	PF3/6
MSF-23	24	67	80	64	146	PF1/2	PF1/4
MSF-30	24	67	80	64	146	PF1/2	PF1/4
MSF-50	25	81	81	73	181	PF3/4	PF3/8

	Key type						Spline type		
Type	F	G	H	I	φD1	L6		H	L6
MSF-12	5	20	M8×1.25 depth 20	29	18	38.5	JISB1603 Involute spline EXT 20×14z×1.25m×20(a class)	M8×1.25 depth 20	16
MSF-18	7	26.9	M10×1.5 depth 20	28	24	38.5	SAE Involute spline Flat root side fit DP16/32 tooth13class6	M10×1.25 depth 18	27
MSF-23	7	26.9	M10×1.5 depth 20	38	24	44	SAE Involute spline Flat root side fit DP16/32 tooth14class6	M10×1.25 depth 18	30
MSF-30	7	26.9	M10×1.5 depth 20	38	24	44	SAE Involute spline Flat root side fit DP16/32 tooth14class6	M10×1.25 depth 18	40
MSF-50	10	37	M12×1.75 depth 20	48	34	54	JISB1603 Involute spline EXT 30×16z×1.667m×20(a class)	M10×1.5 depth 19	34

Dimensions (unit: mm)

MAG-12V (for travel)

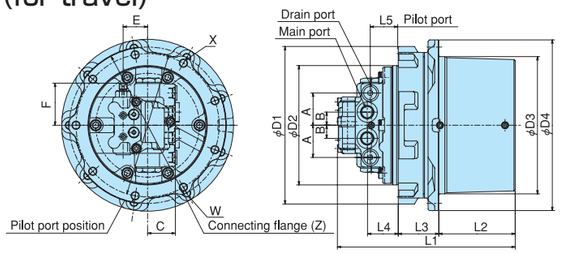


Model	φD1	φD2	φD3	φD4	L1	L2	L3	L4	L5
MAG-12V-120E	179	140	140	177	209	95	45	50	51

Model	A	B	C	E	F	Main port	Drain port	Pilot port	W	X	φY	φZ
MAG-12V-120E	43	16.5	39	37	54.5	G1/4(PF1/4)	G1/4(PF1/4)	G1/4(PF1/4)	8-M10	8-M10	155	155

Mounting flange (Y): Vehicle mounting P.C.D. (Mounting screw X) Connecting flange (Z): Sprocket mounting P.C.D. (Mounting screw W)

MAG-18VP, 26VP, 33VP, and 50VP (for travel)

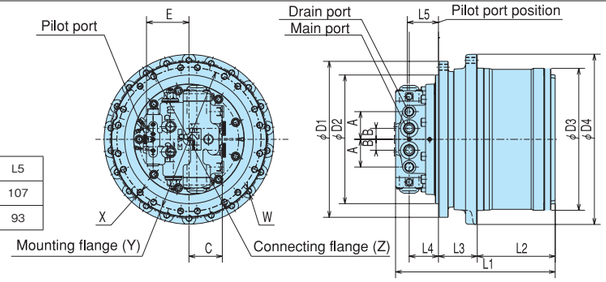


Model	φD1	φD2	φD3	φD4	L1	L2	L3	L4	L5
MAG-18VP-230F (W/A.C.V)	190	150	160	200	250	104	40	59	61
MAG-18VP-350F (W/A.C.V)	215	165	190	238	263	115	50	48	41.5
MAG-26VP-400F (W/A.C.V)	215	165	204	255	288	120	70	48	41.5
MAG-33VP-650G (W/A.C.V)	264	200	230	286	296	128	68	50	43.5
MAG-50VP-1100F (W/R.V)	284	210	265	332	354	145	80	70	61

Model	A	B	C	E	F	Main port	Drain port	Pilot port	W	X	φY	φZ
MAG-18VP-230F (W/A.C.V)	46.5	19.5	40	37	58	PF-3/8	PF-1/4	PF-1/4	13-M10	12-M10	170	180
MAG-18VP-350F (W/A.C.V)	54	22	45	41	71	PF-1/2	PF-1/4	PF-1/4	11-M12	11-M12	192	215
MAG-26VP-400F (W/A.C.V)	54	22	45	41	71	PF-1/2	PF-3/8	PF-1/4	9-M12	11-M12	192	232
MAG-33VP-650G (W/A.C.V)	54	22	45	41	71	PF-1/2	PF-3/8	PF-1/4	9-M14	9-M14	240	262
MAG-50VP-1100 (W/R.V)	58	23	50	48	71	PF-1/2	PF-3/8	PF-1/4	12-M16	12-M14	250	300

Mounting flange (Y): Vehicle mounting P.C.D. (Mounting screw X) Connecting flange (Z): Sprocket mounting P.C.D. (Mounting screw W)

MAG-85VP (for travel)

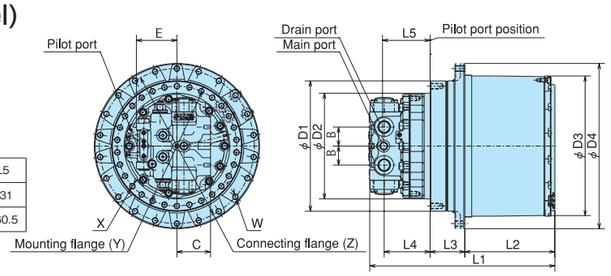


Model	φD1	φD2	φD3	φD4	L1	L2	L3	L4	L5
MAG-85VP-1800E	350	290	324	394	387	180	83	89	107
MAG-85VP-2400E	400	330	365	437	713	200	100	75	93

Model	A	B	C	E	Main port	Drain port	Pilot port	W	X	φY	φZ
MAG-85VP-1800E	71	28	84	108	G3/4(PF3/4)	G1/2(PF1/2)	G1/4(PF1/4)	16-M16	15-M15	320	364
MAG-85VP-2400E	71	28	84	108	G3/4(PF3/4)	G1/2(PF1/2)	G1/4(PF1/4)	16-M16	22-M16	370	405

Mounting flange (Y): Vehicle mounting P.C.D. (Mounting screw X) Connecting flange (Z): Sprocket mounting P.C.D. (Mounting screw W)

MAG-170VP and 180VP (for travel)



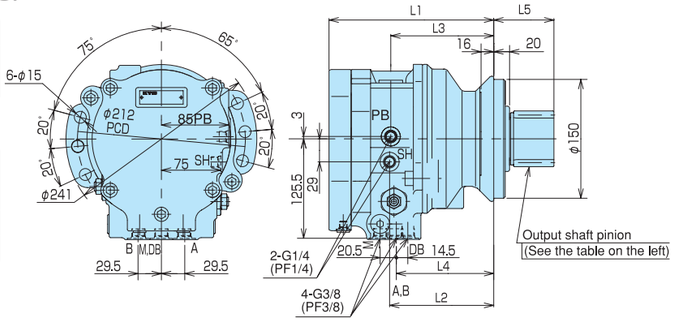
Model	φD1	φD2	φD3	φD4	L1	L2	L3	L4	L5
MAG-170VP-4000H	370	300	402	469	512	239.5	99	128	131
MAG-180VP-6000G	484	380	450	530	619	312.5	102.5	157.5	160.5

Model	A	B	C	E	Main port	Drain port	Pilot port	W	X	φY	φZ
MAG-170VP-4000H	–	54	95	110	PF-1	PF-1/2	PF-1/4	30-M16	22-M16	340	440
MAG-180VP-6000G	–	54	94.5	110	PF-1	PF-1/2	PF-1/4	18-M24	26-M20	440	492

Mounting flange (Y): Vehicle mounting P.C.D. (Mounting screw X) Connecting flange (Z): Sprocket mounting P.C.D. (Mounting screw W)

MSG-27P-10E and 16E (for swing)

Model	L1	L2	L3	L4	L5
MSG-27P-10E	208	131.5	130	123	76
MSG-27P-16E	240	163.5	162	155	83

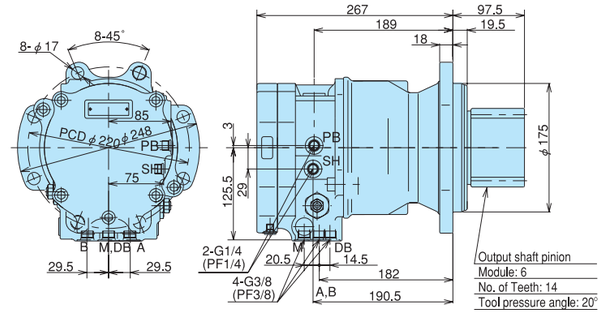


Output shaft pinion

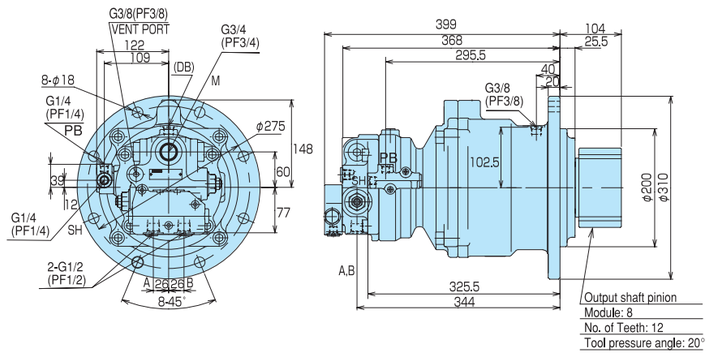
Model	Module	No. of Teeth	Tool pressure angle
MSG-27P-10E	5	11	20°
MSG-27P-16E	6	11	20°

※ SH port: Signal pressure port for a model with an optional parking brake delaying valve mechanism.

MSG-27P-23E (for swing)



MSG-44P-21 (for swing)



Precautions for handling MAG/MSG series

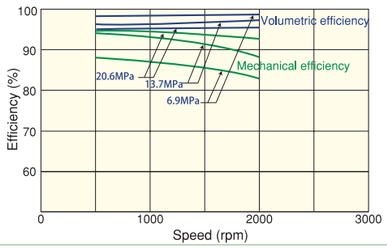
◇These series are designed for excavators and mini-excavators with open circuit. MAG models are also available for closed circuit travel motors and winch applications. Please contact us for details.
◇ We may recommend motor capacities and speed ratios suitable for the customer's requirements. Please let us know what your application requirements are.
◇ MAG motor is to be installed with its output shaft horizontally positioned and the main port facing sideways or upward. When the main port is set facing sideways, use the upper one out of two drain ports. Do not install MSG motor with the output shaft facing downward. Also use the specific drain port. It should not be substituted with the vent port.
◇ Do not use the parking brake of MSG motor for dynamic braking. Configure the circuit so that the parking brake applies after the motor stops.
◇ Please read the "Precautionary on the Use of Hydraulic Equipment" on Page 4. Please contact us with any questions.

Motors

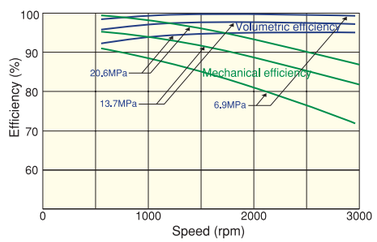
Performance Curve Operating oil:ISOVG46 Oil temperature: 50℃

<Motor unit>

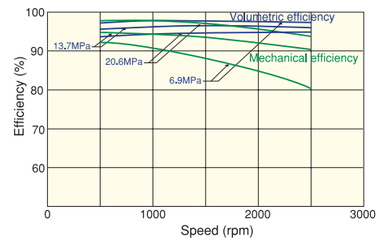
MSF-12



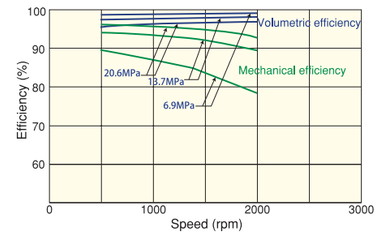
MSF-18



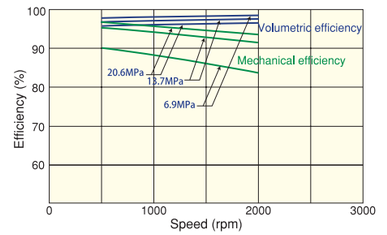
MSF-23



MSF-30

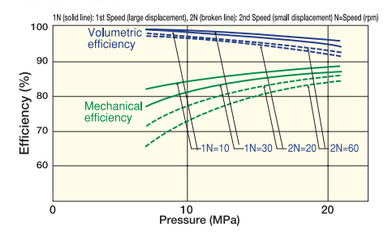


MSF-50

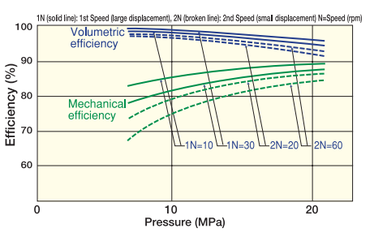


<Motor with reduction gear for travel>

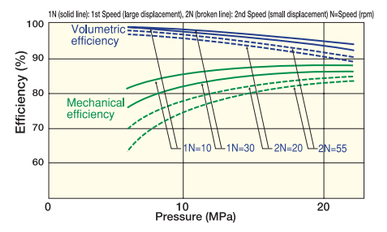
MAG-12VP



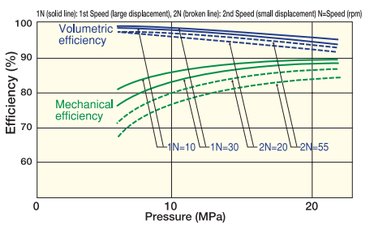
MAG-18VP



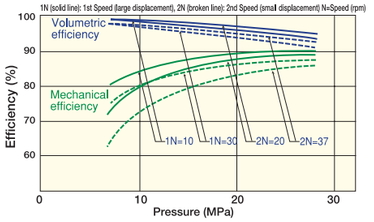
MAG-26VP



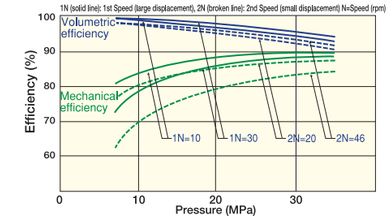
MAG-33VP



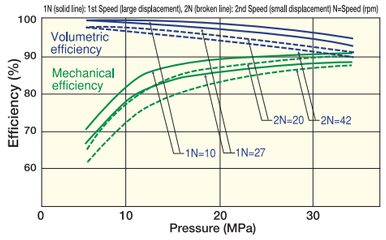
MAG-50VP



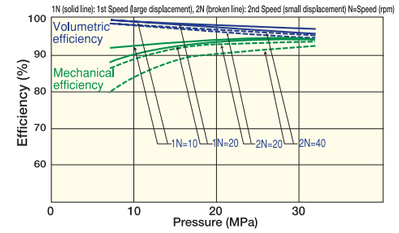
MAG-85VP



MAG-170VP

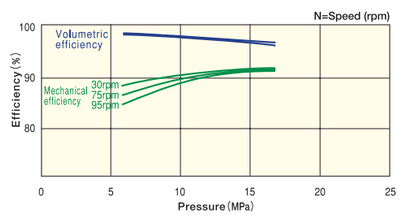


MAG-180VP

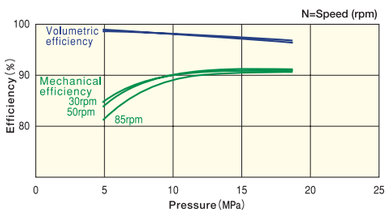


<Motor with reduction gear for swing system>

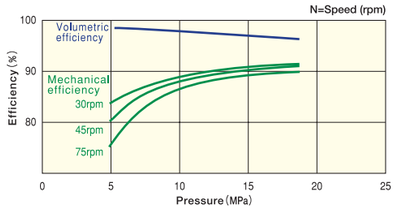
MSG-27P-10E



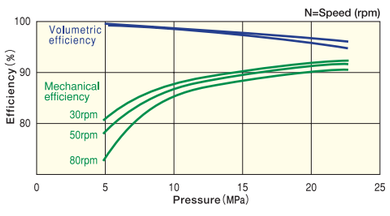
MSG-27P-16E



MSG-27P-23E



MSG-44P-21



HST (General)

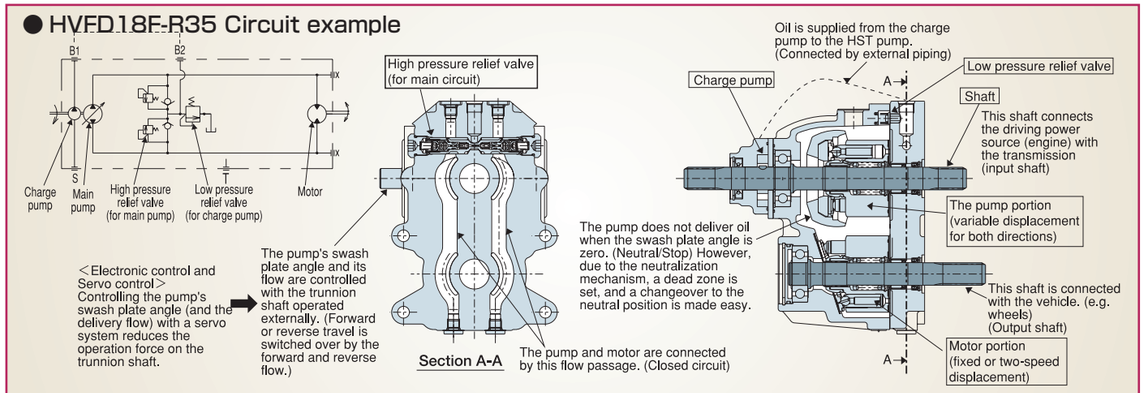
HST stands for Hydrostatic Transmission and is used in a travel system to connect the hydraulic pump with the motor in a closed circuit enabling continuous speed change from Forward to Stop/Neutral and Reverse or vice versa. HST is smoother in operation and smaller in size than mechanical transmissions installed on automobiles.

	Integrated type	Separate type
Products included in this catalog.	A pump and a motor are integrated in a single unit (closed circuit piston pump with a piston motor)	
Not included in KYB product lineup.		Closed circuit piston pump is connected with a hydraulic motor with piping.

Integrated HST (Pump & Motor)

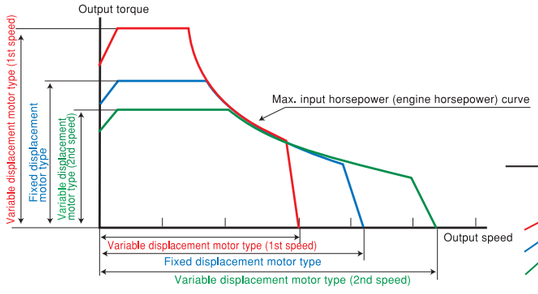
Basic Construction

● HVFD18F-R35 Circuit example

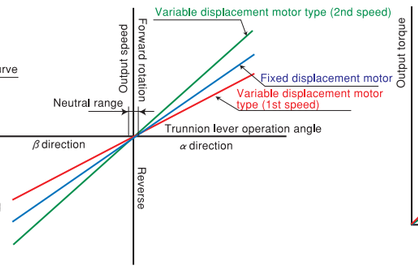


Basic Characteristics

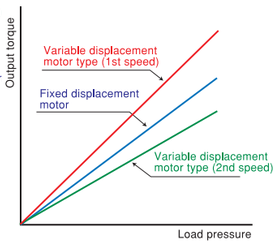
■ Output Horsepower characteristic



■ Output Speed characteristics



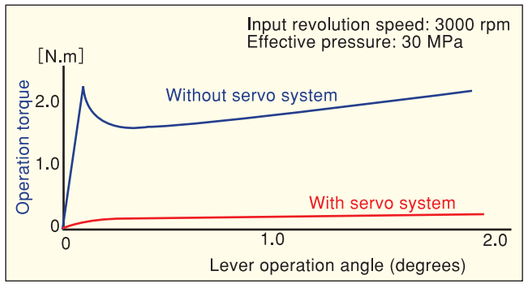
■ Output torque characteristic



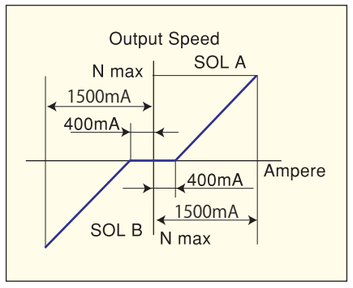
① Theoretical output speed: (Pump displacement)/(motor displacement)×(Input speed)
② Actual speed: (Theoretical output speed)×(Volumetric efficiency)
③ Theoretical output torque: (Motor displacement)×(HST load pressure)

■ Servo Regulator (Manual Operation) [SL] Lever operation torque characteristic

HVFD37F-R35-SL example



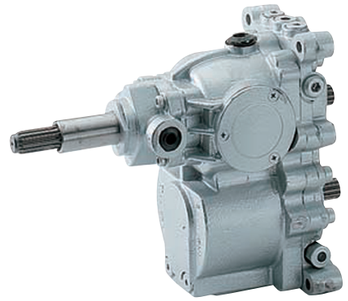
■ Servo Regulator (Electric Control) [EL] Ampere - Output speed characteristics



Integrated HST (Pump and Motor)

Integrated HST enables an easy combination of a speed reducer and a transmission. This unit is designed to meet the vehicle travel requirements for tractors, combine harvesters, snowplows, etc.
It can be combined with electronic control or servo functions.

■ HVFD Series



HVFD28V37

【Model code】

Accessories (optional)

Example HVFD – 28 V 37 – R 38 – P – LT – SL
(1) (2) (3) (4) (5) (6) (7) (8) (9)

1	Integrated HST	
2	Pump displacement	Nominal (cm³/rev)
3	Motor type	F: Fixed displacement, V: Variable displacement (2-speed)
4	Motor displacement	Nominal (cm³/rev)Void: The same as the pump displacement
5	High pressure relief	R: With relief valve, N: Without relief valve
6	Max. pressure	MPa
7	Neutralization mechanism	P: Movable thrust plate type (mechanical) O: Fixed orifice type, Void: Not equipped
8	Charge pump	Void: Separate charge pump type LT: With charge pump
9	Servo control	Void: Without servo control, SL: Manual, EL: Electric control

Integrated HST (Standard type)

Application	Model	Pump: Motor displacement (cm³/rev)	Max. pressure (MPa)	Max. input speed (rpm)	Max. output speed (rpm)	Weight (kg)	Neutralization mechanism	Option
Light duty	HVFD10F–N15	10:10	15	3000	0～3000	6.5	Orifice	Unload valve
	HVFD10F–N18	10:10	18	3000	0～3000	7	Orifice	Unload valve
	HVFD21F–R18	21.5 : 21.5	18	3600	0～3600	13.5	Orifice	Unload valve
	HVFD21F–R23	21.5 : 21.5	23	3600	0～3600	13.5	Orifice	Unload valve
Heavy duty	HVFD18F–R35	18 : 18	35	3600	0～3600	18	Orifice/movable thrust plate	—
	HVFD23F–R35	23.4 : 23.4	35	3200	0～3200	22	Orifice/movable thrust plate	Servo mechanism
	HVFD30F–R38	29.5 : 30.2	38	3000	0～2930	24	Orifice/movable thrust plate	Servo mechanism
	HVFD37F–R35	37 : 37	35	3200	0～3200	26	Orifice/movable thrust plate	Servo mechanism
	HVFD42F–R38	41.5 : 41.5	38	2600	0～2600	26	Orifice/movable thrust plate	Servo mechanism

Integrated HST (Two-speed motor type)

Model	Pump: Motor displacement (cm³/rev)	Max. pressure (MPa)	Max. input speed (rpm)	Max. output speed (rpm)	Weight (kg)	Neutralization mechanism	Option
HVFD28V37–R38	28.1 : 22.0/37.2	38	3600	0～3300	35	Orifice/movable thrust plate	Servo mechanism

※The direction of rotation of the pump input shaft can be set in either the CW or CCW direction for HVFD10 Series only. Please specify the type: either CW (clockwise) or CCW (counterclockwise) for another series, when ordering.

【Light and Heavy duty Models】

● Light duty models: Suitable for the travel system of vehicles that serve light load work such as lawn mowers and combine harvesters, up to 18kw or smaller.
● Heavy duty models: Suitable for the travel system of vehicles that serve moderate load work such as tractors and combine harvesters with engine horsepower of 18 to 59kw.

Main Mechanism

【Neutral mechanism】

● Orifice
Standard neutral mechanism allowing a relatively large neutral width.
● Movable thrust plate
This method is less affected by the given conditions such as the input speed and oil temperature, allowing a stable neutral width. This is superior to the orifice method in neutral zone stability and adjustability of the neutral point.

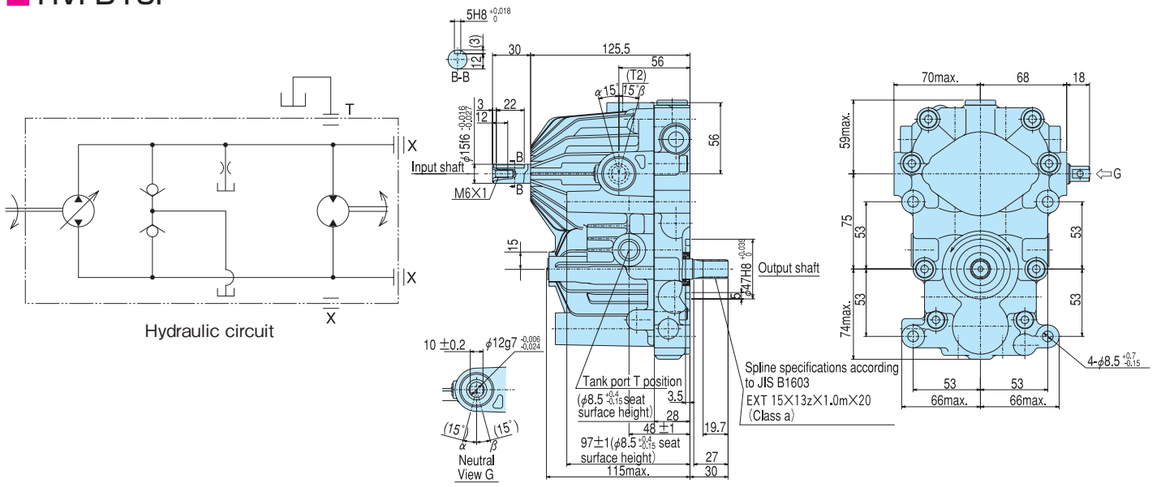
【Option】

● Charge pump
When the charge pump is used together with an oil hydraulic unit installed on the vehicle, select the charge pump displacement approximately 25% of the HST pump.
● Servo regulator
This component features the following advantages:
◇ Low operation torque allowing an easy operation and lower noise caused by link vibrations.
◇ Good responsiveness and a stable neutral characteristic.
◇ The fail-safe mechanism is included as a standard accessory for automatic return to the neutral position in case of a hydraulic power source failure or link connection failure.
◇ Can be mounted on to a manual type HST.

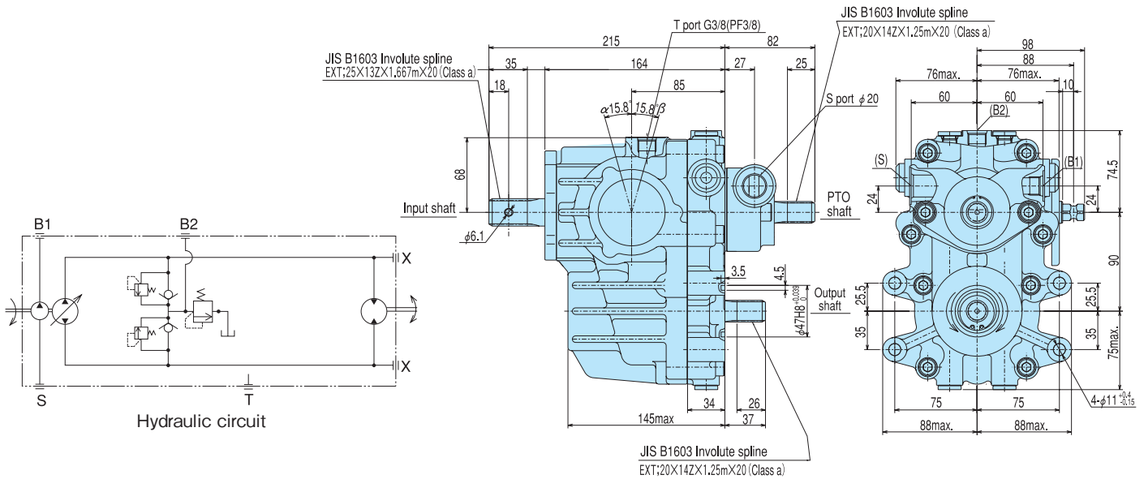
HST

Dimensions (unit: mm)

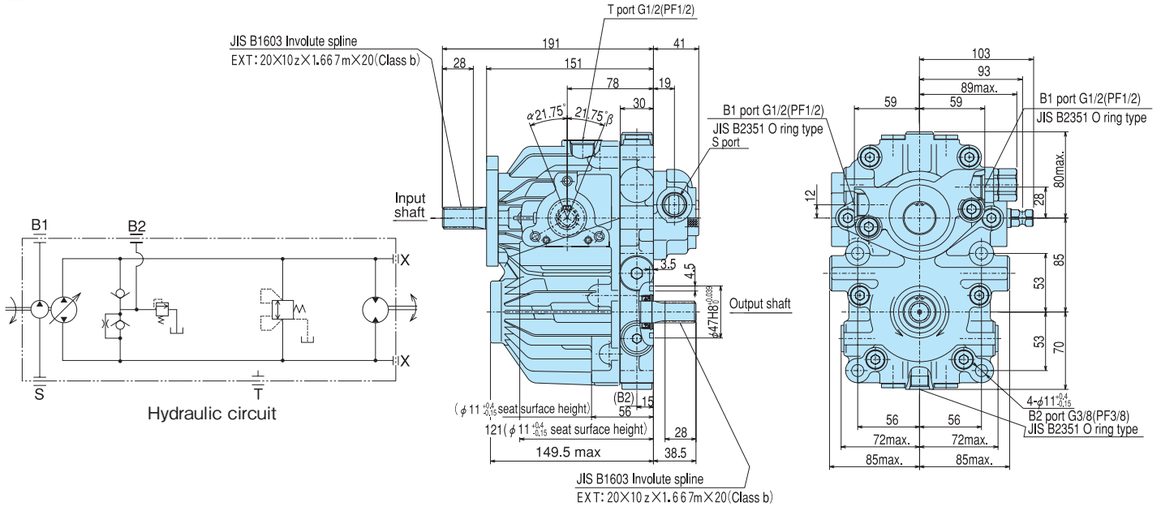
HVFD10F



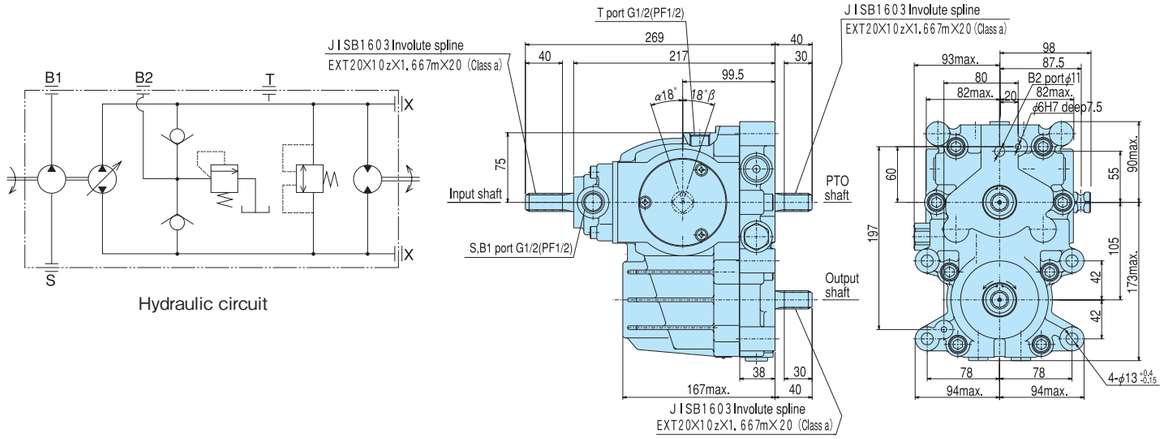
HVFD18F



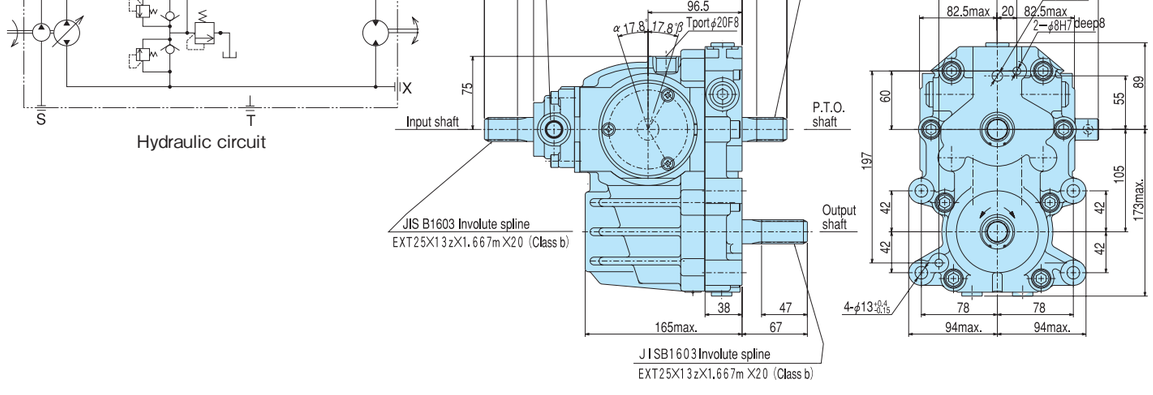
HVFD21F



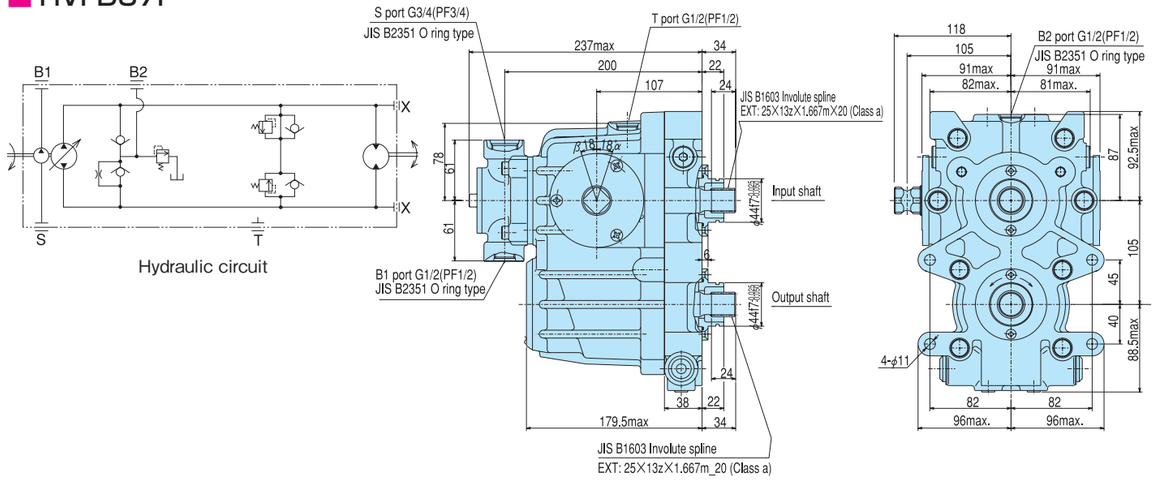
HVFD23F



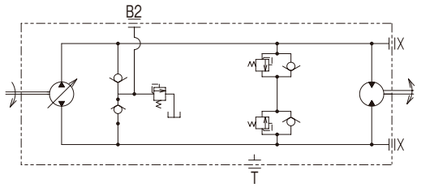
HVFD28F



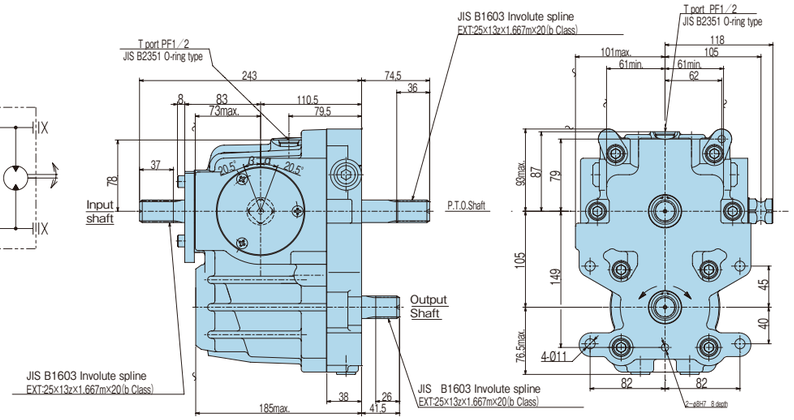
HVFD37F



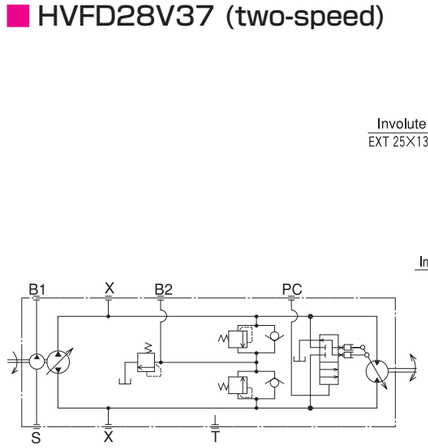
HVFD42F



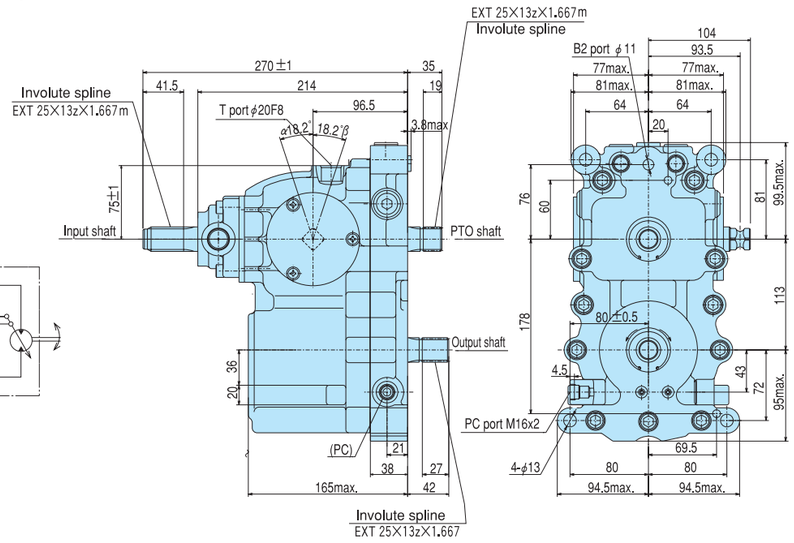
Hydraulic circuit



HVFD28V37 (two-speed)



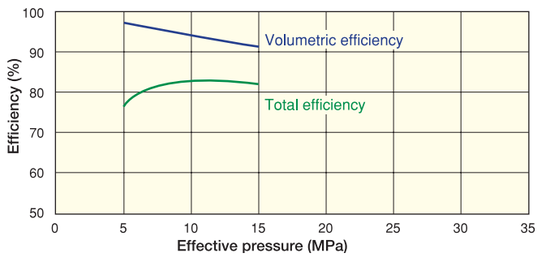
Hydraulic circuit



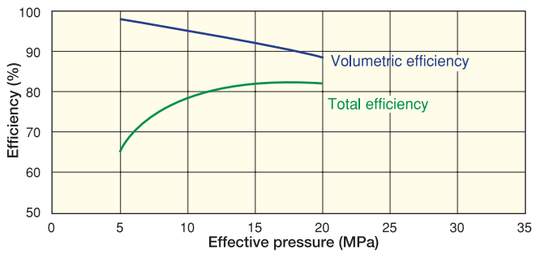
Performance Curve Operating oil: ISOVG46 Oil temperature: 50℃

<HST: Light load model>

HVFD10F-N15,N18



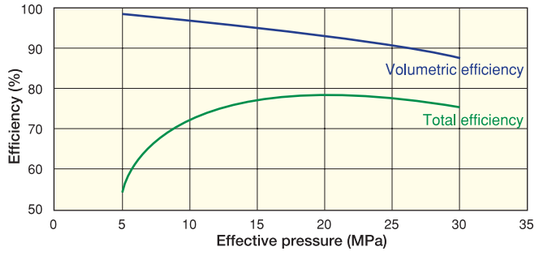
HVFD21F-R18,R23



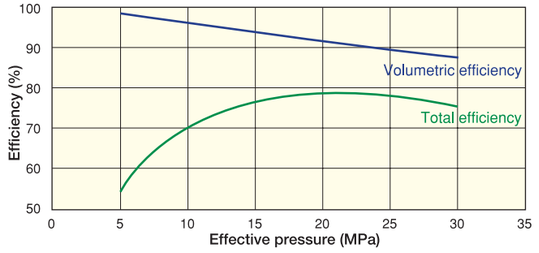
Performance Curve Operating oil:ISOVG46 oil temperature:50℃

⟨HST:Heavy load model⟩

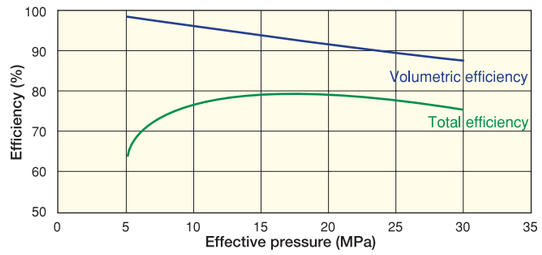
HVFD18F-R35



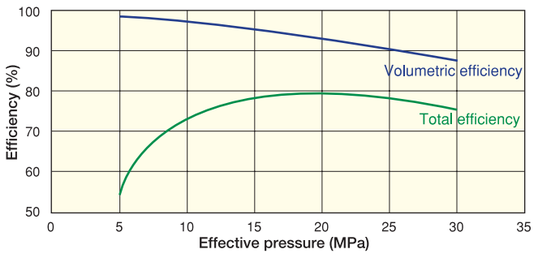
HVFD23F-R35



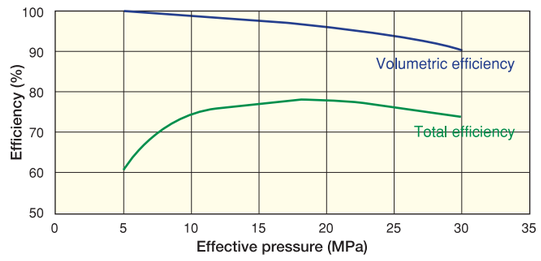
HVFD28F-R35



HVFD37F-R35

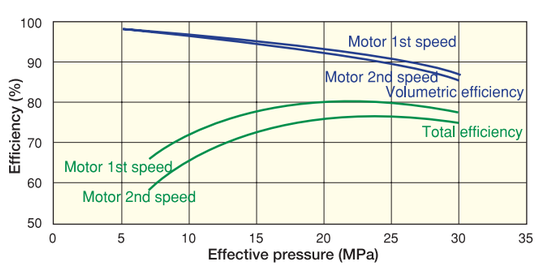


HVFD42F-R38



<HST: Two-speed motor type>

HVFD28V37-R35



Hydraulic Cylinder (General)

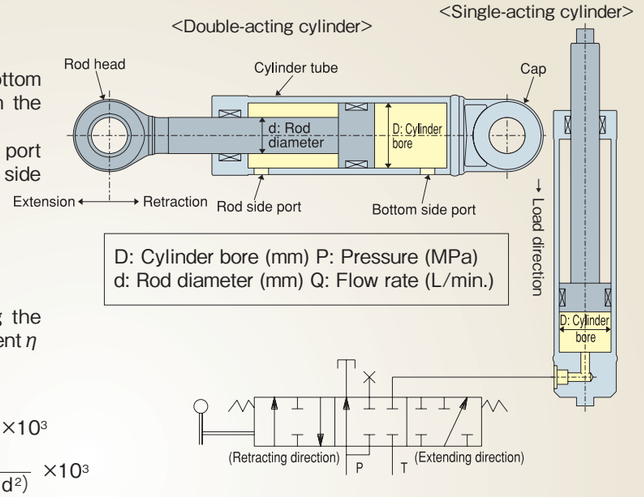
	For Vehicle Application		For Industrial Application, etc.
	Double-acting cylinder	Single -acting cylinder	
Products included in this catalog	For excavator For mini-excavator	For forklift truck (lifting)	Electro-hydraulic cylinder (MMP)
KYB products not included in this catalog.	For forklift truck (tilt cylinder) For steering (double rod cylinder)		Special design (very large models) may be available.
Not included in KYB product lineup			For industrial equipment (JIS type, etc.)

[Basic Construction and Calculation Formula of Hydraulic Cylinder]

[Construction and Mechanism]

1. The pressurized hydraulic fluid through the bottom port extends the cylinder rod, and the fluid on the rod side returns to the reservoir.
2. The pressurized hydraulic fluid from the rod port retracts the cylinder, and the fluid on the bottom side returns to the reservoir.

<Double-acting cylinder> <Single-acting cylinder>



D: Cylinder bore (mm) P: Pressure (MPa)
d: Rod diameter (mm) Q: Flow rate (L/min.)

<Calculating Thrust >

● Theoretical thrust
Extension thrust F_1 $N=\pi/4\cdot D^2\times P$
Retraction thrust F_2 $N=\pi/4\cdot(D^2-d^2)\times P$

● Actual thrust: To be obtained by multiplying the above theoretical thrust value with the coefficient η (0.95 for vehicle)

<Calculating velocity>

● Extending velocity V_1 [m/min] $= \dfrac{Q}{\pi/4\cdot D^2}\times 10^3$

● Retracting velocity V_2 [m/min] $= \dfrac{Q}{\pi/4\cdot(D^2-d^2)}\times 10^3$

※Flow rate Q is calculated using the pump's delivery flow (meter-in), but the value may be significantly affected by the flow control with the valve return-side restriction (meter-out) depending on the load direction and pressure. In such case, calculate the tank return-side flow rate using the following formula:

Flow rate Q[L/min] = $60CA\sqrt{\dfrac{2\Delta P}{\rho}}$ Then go back to the above formula and calculate the velocity based on the return-side cylinder area. (Single -acting cylinder, etc.)

C: Flow coefficient (0.6-0.7) A: Valve restriction (opening) area (mm^2) ΔP: Pressure difference before and after restriction (MPa) ρ: Hydraulic fluid density (kg/m^3)

<Buckling strength and stroke>

● The stroke of the cylinder to which retraction load is applied is restricted by the buckling strength. An approximate value of the buckling load is obtained from the following formula: Wa (allowable retraction load (at full extension: N)) = Pk (buckling strength N) / S (safety ratio: typically 1.5-2.5 or more)
Since the value will vary depending on the support mechanism (whether the load is supported by the rod only or the tube as well.) please contact us.

● Consider installing a cylinder support and linkage mechanism to avoid thrust load on the cylinder.

[Precautions for operation]

● Speed

① A speed exceeding 60 m/min affects the durability of the cylinder with standard specifications.
② Install a cushion device for equipment protection and safety if a stroke end speed consistently exceeds 18 m/min.
③ For protection and safety of the cylinder, care must be taken not to cause a great impact on it when stopping it.
④ When designing a hydraulic circuit, pay attention to return flow rate increase at cylinder retraction.
⑤ Operation slower than 0.5 m/min will affect performance (particularly vibration performance). Please contact us when a low speed operation is expected.

● Starting operation

① Remove air inside the cylinder completely when starting an operation. If air remains, operate at a low speed until the air is removed completely.
② A rapid pressure rise while air remains in the cylinder may damage/burn the seal due to a so-called diesel effect (abnormal air temperature rise caused by isentropic compression).
③ Avoid negative pressure inside the cylinder during the operation because cavitation may cause malfunction.

Cylinder: For construction equipment and industrial vehicles

■ KCH, KCM, and KCFL Series

For excavator, mini-excavator, and forklift truck applications

KCH

KCM

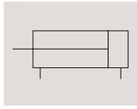
KCFL

【Model code】 KCH – 230 – 160 – 2800
Example 1 2 3 4

1	Model	KCH for excavator, KCM for mini-excavator, and KCFL for forklift truck
2	Cylinder bore	mm
3	Rod diameter	mm
4	Stroke	mm

Series	Tube i.d. (mm)	Max. stroke (mm)	ax. working pressure (MPa)	Main applications
KCH	95～170 170～480	2000 3700	35.0 32.0	Excavator
KCM	50～65 70～125	800 1200	24.5 29.4	Mini-excavator, Wheel loader, etc.
KCFL	45～70 65～120	1000～2500 650～1300	18.1	Forklift truck

※Please contact us for other applications.
(Very large models with a cylinder bore over 1200 mm are available.)
※See Page 61 for accessory valves
(flow control valve, down safety valve, and hose rupture valve)



Symbol

■ Main Features of the KCH and KCM Series

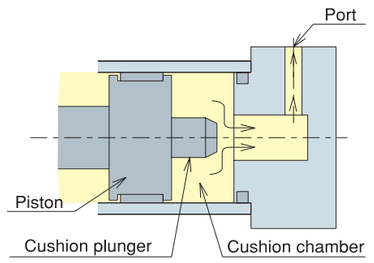
● Compact, lightweight, and strong
KYB has developed its compact, lightweight, and durable cylinders based on their long marketing experience, in-house test systems, capability to design products according to its strength and fatigue analysis, and manufacturing and inspection technologies enabling high quality product production.

● Seal
KYB enhanced its seal's durability by developing and evaluating seals and sealing systems in-house, protecting them from dirt and dust, and optimizing the oil film.

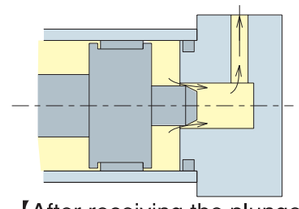
● Piston rod
Piston rod sliding surfaces are treated with induction hardening and protected with hard chromium plating for engineering purposes or nickel-chrome plating to improve wear- and corrosion-resistance and surface strength against scratches.

● Safety precautions, other
Please install a cushioning device to reduce the stroke end shocks, and various valves such as hose rupture and slow return valves if required. (See Page 61 for additional valves.)
Also, Stroke Sensing Cylinders and Pipe-Less Cyliders with Hollow Rod passage are available. (for Specific types only)

■ Cushion Mechanism for Cylinders



【Before receiving the plunger】

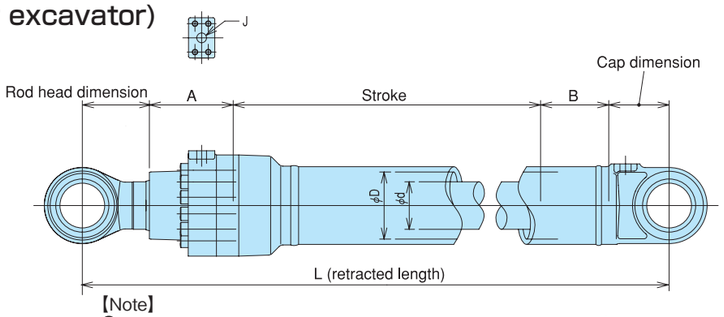


【After receiving the plunger】

● As the piston approaches the stroke end, compressed oil reduce shocks at the stroke end.
● The cushioning device can be installed on either the rod or bottom side of the cylinder or on both ends.

Dimensions (unit: mm)

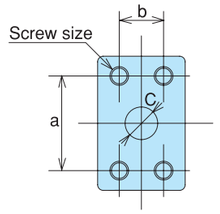
■ KCH Series (for excavator)



【Note】
- The cylinder head portion length A, piston portion length B, and the port position depend on customers'request. Please contact us for details.
- See the opposite page (p.38) for standard sizes of a rod head and a cap.
- Cylinder bore D greater than the figures in the table below are also available. However, the construction of those models may be slightly changed.

Cylinder bore ϕD	Rod diameter ϕd	Max stroke	Retracted length L (min.)	Port size J
95	65,70	1100	1250	1/2
100	70	1100	1250	1/2 or 3/4
105	70,75	1200	1250	1/2 or 3/4
110	70,75,80	1200	1250	1/2 or 3/4
115	80,85	1400	1250	1/2 or 3/4
120	80,85	1400	1250	1/2 or 3/4
125	85,90	1500	1300	3/4 or 1
130	85,90,95	1600	1350	3/4 or 1
135	90,95,100	1700	1350	3/4 or 1
140	90,90,95	1700	1350	3/4 or 1
145	90,95,100,105	1900	1530	3/4 or 1
150	95,100,105,110	1900	1530	1 or 1-1/4

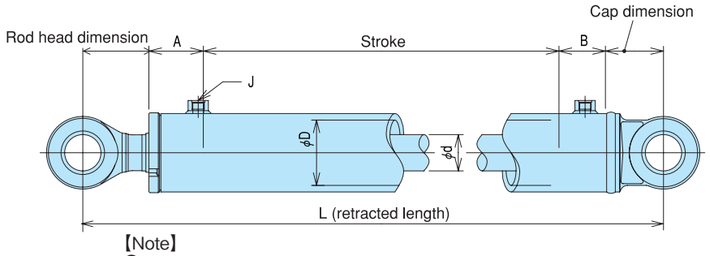
<Port sizes>



Port size	a	b	c	Screw size
1/2	40.5	18.2	ϕ13.5	M8×1.25
3/4	50.8	23.8	ϕ17.5	M10×1.5
1	57.2	27.8	ϕ22	M12×1.75
1-1/4	66.7	31.8	ϕ26.5	M14×2

The port shape is equivalent to an SAE high pressure flange.

■ KCM Series (for mini-excavator)



【Note】
- The cylinder head portion length A, piston portion length B, and the port position depend on customers request. Please contact us for details.
- See the opposite page (p. 38) for standard sizes of a rod head and a cap.

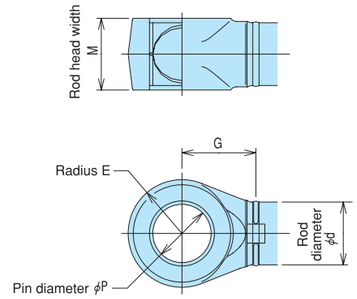
Cylinder bore ϕD	Rod diameter ϕd	Max stroke	Retracted length L (min.)	Port size J
70	40	500	400	G3/8(PF3/8)
75	40,45	600	400	G3/8(PF3/8)
80	45,50	700	400	G3/8(PF3/8)
85	45,50,55	800	530	G1/2(PF1/2)
90	50,55	800	530	G1/2(PF1/2)
95	55,60,65	900	530	G1/2(PF1/2)
100	55,60,65	900	530	G1/2(PF1/2)
105	55,60,65,70	900	700	G1/2(PF1/2)
110	60,65,70	900	750	G1/2(PF1/2)
115	65,70,75	1000	750	G1/2(PF1/2)
120	65,70,75	1000	800	G1/2(PF1/2)
125	70,75	1000	800	G1/2(PF1/2)

Dimensions of the Rod Head and Cap

- Standard clevis dimensions for KCH/ KCM series are shown as follows.
- When different sizes on clevis widths of the rod heads and caps and pin diameters are required, please contact us.

■ Rod head dimensions

※ KCH and KCM



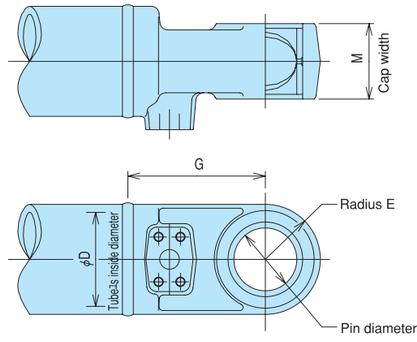
ϕd	ϕP	E	M	G
40	35	39	50	60
45	40	42	60	60
50	45	50	70	75
55	50	50	70	75
60	50	55	70	80
65	60	60	85	85
70	65	62	98	88
75	60	68	90	95
80	75	70	105	95
85	85	75	95	95
90	85	75	95	90
95	85	83	105	105
100	85	105	120	110
105	90	85	120	125
110	110	100	140	135

■ Cap dimensions

● With port on cap

※ KCH and KCM

The drawing shows the KCH series dimensions. KCM has the standard PF (O ring boss) port. Please contact us when an SAE flange port is required.

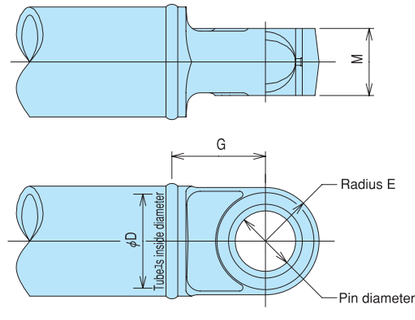


ϕD	ϕP	E	M	G
95	50	55	70	110
100	60	55	85	136
105	70	62	85	155
110	65	65	95	170
115	70	70	95	170
120	60	70	95	175
125	65	70	95	165
130	75	70	110	170
135	65	70	105	150
140	75	75	120	185
145	90	85	120	150
150	85	85	130	190

● With port on cap

※ KCM only

Please contact us regarding the position and size when installing ports on the cylinder tube.



ϕD	ϕP	E	M	G
70	40	36	55	60
75	50	45	60	65
80	50	50	60	80
85	60	55	70	75
90	50	50	70	80
95	60	55	70	75
100	60	55	75	80
105	60	55	75	80
110	65	58	75	85
115	60	58	70	125
120	75	65	90	165

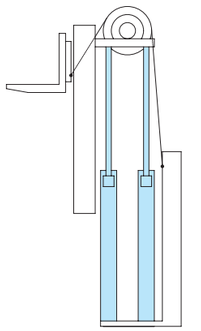
KCFL Series (for forklift truck)

KCFL series cylinders are designed to fit forklift truck masts and be adequate for lifting work. Three types (L1, L2, and L3) are available for three mast types.

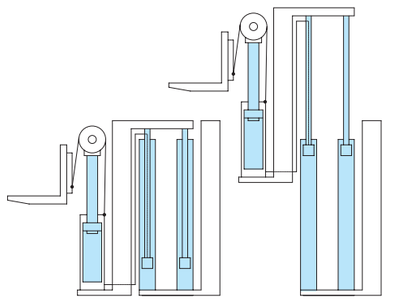
● KCFL series lifting cylinder types
L1 for the second cylinder of standard and 3-stage mast, L2 for the second cylinder of 2-stage mast, and L3 for the first cylinder of 2/3 stage full free mast

Forklift truck mast mechanism and lifting cylinder

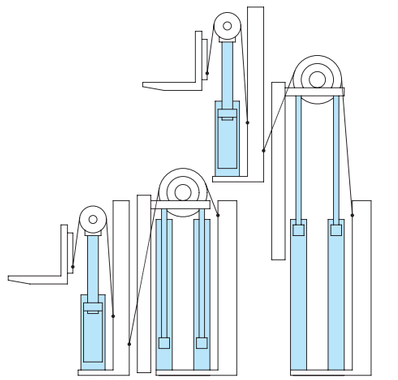
(1) 2-stage standard mast

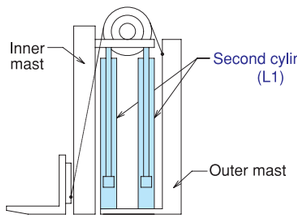


(2) 2-stage full free mast

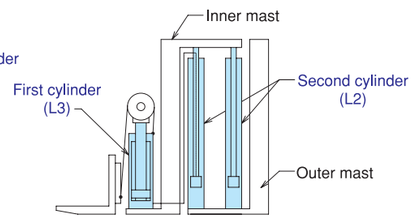


(3) 3-stage full free mast

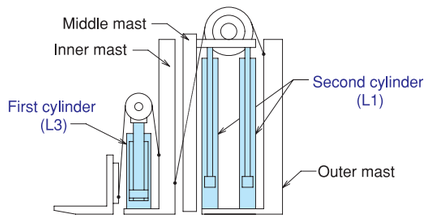




Max. retraction



Max. retraction

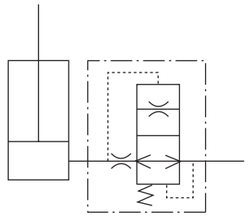


Max. retraction

Main Features of KCFL Series

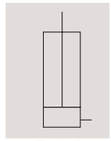
- Small diameter, light weight, and high strength…Cylinders for forklift mast applications are designed to fit the mast mechanism with small diameters and high strength. The single-acting cylinder with a small diameter and light weight has been achieved by a thinner tube and special welding technologies. The second cylinder for 2-stage masts employs a hollow ram for lighter weight and easy lubrication.
- Seal…Seals made by KYB are utilized for smooth motion and prevention of internal leakage.
- Tube…The inside wall is finished with roller burnishing for smooth motion and high durability.
- Rod…The surface is hard-chromium plated for engineering purposes (nickel-chromium plated for special specifications) for rust proof and wear resistance.
- Safety/shock absorption … A down safety valve may be added to ensure safety in the event of piping rupture or other accidents, which may bring the cylinder to a complete stop. A cushion mechanism may be built in each cylinder to reduce shocks at the time of retraction.
- KYB's standard models are of the internal drain type. Visibility can be improved due to no drain hose.
- Special valves for forklift truck use…Low energy consumption type valves (KVMF series) to enable a precise and safe forklift operation, flow control valves to control a lowering speed, and down safety valves are available. (See pages 49, 58, 61, and 62 for additional valves.)

<Down safety valve installation circuit example>

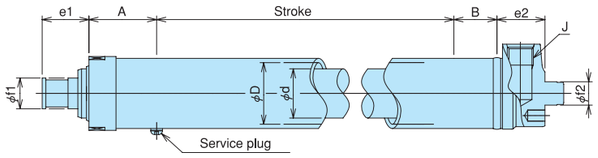


Dimensions (unit: mm)

KCFL1 (for the second cylinder of standard and 3-stage mast)



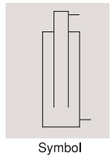
Symbol



ϕD	ϕd	J	Standard stroke
45	35	G3/8(PF3/8)	1000 ~ 2500
50	40	G3/8(PF3/8)	
55	45	G1/2(PF1/2)	
60			
65	50	G1/2(PF1/2)	

● The cylinder head length A and piston length B depend on customer's request. Please contact us for details.
● Contact us for mounting part dimensions: ϕf1, e1, ϕf2, and e2

KCFL2 (for the second cylinder of the 2-stage mast)



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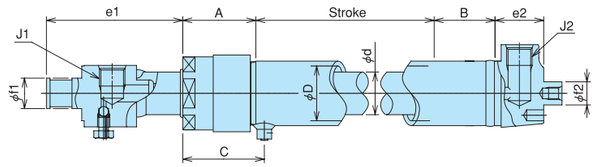
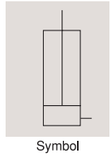


ϕD	ϕd	C	J1	J2	Standard stroke
45	30	65	G1/2(PF1/2)	G3/8(PF3/8) G1/2(PF1/2)	1000 ~ 2500
	32				
	35	67		G1/2(PF1/2)	
50	38	68			
	40		G1/2(PF1/2)		
55	42	68.5	G3/4(PF3/4)		

● The cylinder head length A and piston length B depend on customer's request. Please contact us for details.
● Contact us for mounting part dimensions: ϕf1, e1, ϕf2, and e2
● J1 port is connected to J port on KCFL3. (KCFL2 extends after KCFL3 extends.)

KCFL3 (for the first cylinder of 2- and 3-stage mast)



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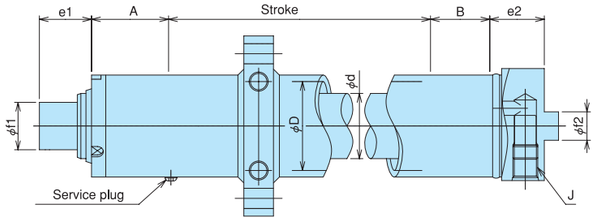


ϕD	ϕd	J	Standard stroke
65	50	G1/2(PF1/2)	500 ~ 1300
70	55		
75			
80	60		
85	65		
90			

● The cylinder head length A and piston length B depend on customer's request. Please contact us for details.
● Contact us for mounting part dimensions: ϕf1, e1, ϕf2, and e2

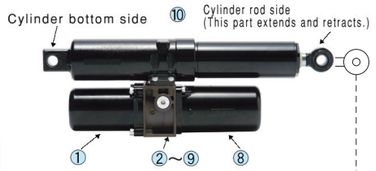
Electro-Hydraulic Cylinder: Mini-Motion Package (MMP)

【General description】

Mini-Motion Package (MMP) is a hydraulic linear actuator integrated with a DC motor, a hydraulic pump, valves, and a cylinder. By making the best use of unique features of hydraulic system that are not gained by mechanical types such as electric screws, this is the best choice of labour-saving and automated work environment including machines, facilities of office and residential environment.
A new design concept different from the conventional hydraulic systems enables the broadening of new applications.

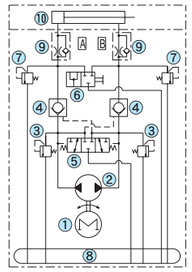
■①～⑩ All the following components are integrated in this hydraulic linear actuator.

<Application>



① DC motor
② Gear pump
③ Relief valve
④ Pilot-operated check valve
⑤ Control valve
⑥ Manual release valve (for emergency)
⑦ Overload relief valve
⑧ Oil reservoir
⑨ Slow return valve
⑩ Cylinder

Hydraulic Circuit



Retraction Stop Extension

※Refer also to the following mechanism descriptions for the components, ①～⑩

Explanation of the operating mechanism

■ Cylinder "retraction"

When the DC motor ① rotates in the reverse direction, the gear pump ② begins to rotate and the control valve moves to the ◱ position. High pressure oil pumped out from the gear pumps passes through the pilot-operated check valve ④ and flows into the cylinder from the B port side. The hydraulic fluid returning from the A port side of the cylinder ⑩ flows back into the gear pumps and the surplus oil drains back to the oil reservoir. The relief valve ③ activates if the system overloads or the cylinder stretches out to the limit of its stroke.
※Connecting the black lead to the terminal (＋) and the white lead to the terminal (－) retracts the cylinder.

■ "Stop" and load retention

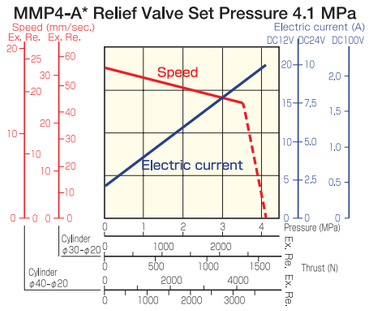
When power to the DC motor ① is interrupted, the cylinder ⑩ stops and the load is retained by the pilot-operated check valve. (Assuming internal oil leakage of 0.3 cm^3/min or less.)
Max pressure corresponding to the retained load is 13.7 MPa. When pressure increases to 13.7MPa due to an increase in the temperature, for example, the overload relief valve ⑦ activates for protection.(The cylinder starts working when the overload relief valve activates.)

■ Cylinder "extension"

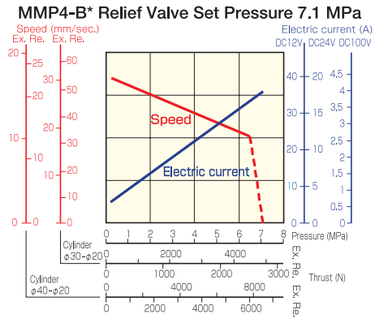
When the DC motor ① rotates in the normal direction, the gear pump ② begins to rotate, the control valve ⑤ moves to the ◲ position, and hydraulic oil is drawn from the oil reservoir ⑧. High pressure oil from the gear pump passes through the pilot-operated check valve ④ and flows into the cylinder from the A port side. Hydraulic oil returning from the B port side of the cylinder ⑩ flows back into the gear pumps. The relief valve ③ activates if the system overloads or the cylinder stretches out to the limit of its stroke.
※ Connecting the black lead to the terminal (－) and the white lead to the terminal (＋) extends the cylinder.

Characteristics: Typical values at the ambient temperature 25℃ and rated voltage

MMP4-A* Relief Valve Set Pressure 4.1 MPa



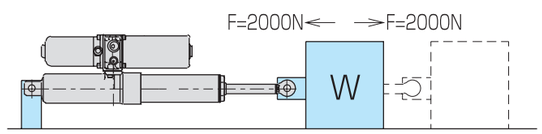
MMP4-B* Relief Valve Set Pressure 7.1 MPa



Conversion: 1 MPa = 10.2 kgf/cm^2, 1000N = 102 kgf

The above charts show the characteristics of MMP without the slow return valve orifice ⑨. Cylinder's extension and retraction speeds differ due to the receiving area difference.

● Example
Model: MMP4-A2B250AA
With a cylinder of ϕ40-ϕ20-250 and a motor of DC 24 V
When the extension thrust is 2000N
Extension speed: Approx. 16 mm/s (15.6 sec/250 mm)
Electric current: Approx. 6 A
Retraction speed: Approx. 20 mm/s (12.5 sec/250 mm)
Electric current: Approx. 7 A



Features

- No new hydraulic facilities are required.
- The cylinder can be easily mounted with additional pins on both ends and completed electrical wiring.
- Low energy consumption and cost saving as the hydraulic pump is operated on request.
- The DC motor and hydraulic circuit are completely sealed and thus there is no oil leakage, allowing the preservation of the environment.
- Smooth and strong operation are unique to the hydraulic system. Max. thrust: 8000N (816 kgf)
- The pilot-operated check valve secures load retention. No backlash is generated, which is different from mechanical types.
- The relief valve prevents overload. The motor is protected from overload operation by the circuit breaker.

Main applications

- For the automation and energy saving of general purpose / industrial equipment
- For compact transport equipment, hoists, food processing equipment, and clamps
- For small vehicles, agricultural vehicles, and attachments
- For office, medical, beauty, nursing, and fitness equipment
- For Sports, recreation, and amusement equipment
- For the automation and energy saving systems such as residences, buildings, and green houses, including automatic sunroofs
- Others

Model

【Model code】 MMP4 – A 1 B 250 B A –

Example: 1 2 3 4 5 6 7 8

1	Model		MMP4 (Type 4) Mini-Motion Package
2	DC motor output and relief valve set pressure		A:250W、4.1MPa B:250W、7.1MPa
3	Power supply		1: 12VDC, 2: 24VDC, and 3: 100VDC (100VAC full-wave rectified)
4	Cylinder size		A: ϕ34–ϕ20 B: ϕ40–ϕ20(Cylinder bore-rod diameter)
5	Cylinder stroke		150:150mm 200:200mm 250:250mm （ϕ40only） 300:300mm （ϕ40only） 350:350mm （ϕ40only）
6	A port orifice	A:Void B:ϕ0.8 C:ϕ0.6	An orifice is required in case the cylinder causes a hunting phenomenon during its free-fall. KYB may recommend an adequate version according to the customer's load condition.
7	B port orifice	A:Void B:ϕ0.8 C:ϕ0.6	
8	Optional spec.	Void: Standard spec.	Contact us for optional and special specifications.

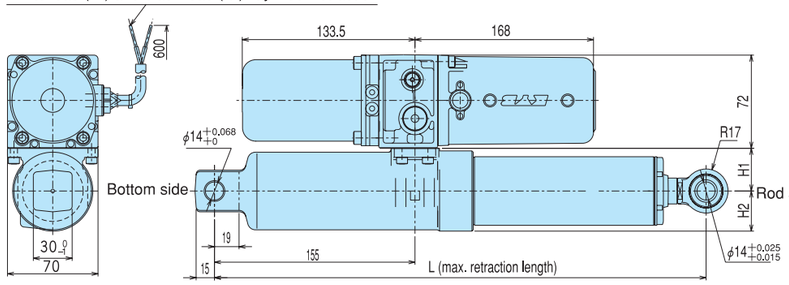
Specifications

Series	Hydraulic system spec.						Power supply spec.			Entire unit	
	Relief valve set pressure (MPa)	Cylinder max. retention pressure (Overload relief valve setting) (MPa)	Cylinder size (mm)	Rated extension thrust (N)	Stroke (mm)	Operating temperature range℃	Rated voltage (V)	Relief valve operation current (A)	Rated time (sec.)	Dimensions	Weight (kg))
MMP4-A	4.1	13.7	ϕ34-ϕ20	3100	150	－20～50	DC12 DC24 DC100	23 (DC12V) 11 (DC24V) 2.4 (DC100V)	30	ϕ34-ϕ20×150	4.2
					200					ϕ34-ϕ20×200	4.5
			ϕ40-ϕ20	4300	150					ϕ40-ϕ20×150	4.3
					200					ϕ40-ϕ20×200	4.7
					250					ϕ40-ϕ20×250	5.1
					300					ϕ40-ϕ20×300	5.4
					350					ϕ40-ϕ20×350	5.8
MMP4-B	7.1	13.7	ϕ34-ϕ20	5800	150	－20～50	DC12 DC24 DC100	40.8 (DC12V) 18.5 (DC24V) 4.4 (DC100V)	30	ϕ34-ϕ20×150	4.2
					200					ϕ34-ϕ20×200	4.5
			ϕ40-ϕ20	8000	150					ϕ40-ϕ20×150	4.3
					200					ϕ40-ϕ20×200	4.7
					250					ϕ40-ϕ20×250	5.1
					300					ϕ40-ϕ20×300	5.4
					350					ϕ40-ϕ20×350	5.8

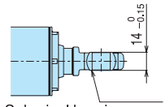
■ Waterproof : JISD0203 D2 compliant
■ Vibration durability: JISD1601 Class 3 B compliant

Dimensions (unit: mm)

White lead (＋) and black lead(－): Cylinder extension
White lead (－) and black lead (＋): Cylinder retraction



Cylinder size Cylinder bore i.d.-rod diameter×stroke	Max. retraction length L	H1	H2
ϕ34-ϕ20×150	280	31	28.5
ϕ34-ϕ20×200	330		
ϕ40-ϕ20×150	280	33	31
ϕ40-ϕ20×200	330		
ϕ40-ϕ20×250	380		
ϕ40-ϕ20×300	430		
ϕ40-ϕ20×350	480		



Spherical bearing
Piston rod end details

Recommended pin diameter
ϕ 14 -0.025 -0.068

Caution on Selecting/Using Models

Select proper models according to the following selection procedure and check sheet:

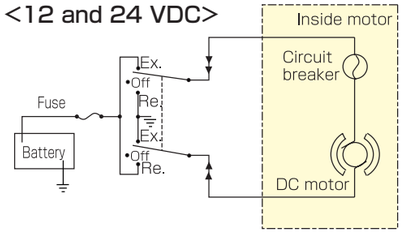
- MMP specifications and characteristic values are typical ones and may vary depending on operational conditions like the temperature. Try to select the model with thrust and speed large enough to meet requested specifications.
- Maximum internal leakage may amount to 0.3 cm³/min. Apply a mechanical lock for secure load retention.

Selection Procedure

(1) Determine maximum thrust, maximum speed, power supply, and stroke required of an MMP cylinder from the application and specifications of the equipment.
(2) Select the relief valve set pressure, power supply, cylinder size, and cylinder stroke from the specifications and characteristics of the selected MMP model.
(3) Select orifices for port A and B from the load to be applied to the cylinder at page 44.
A: Port A orifice (retraction load), B: Port B orifice (extension load), D: Port A and B orifices (retraction and extension load)
(4) Electric wiring and Switching
※The customer should prepare the power supply and switching system. Please contact us for any details.

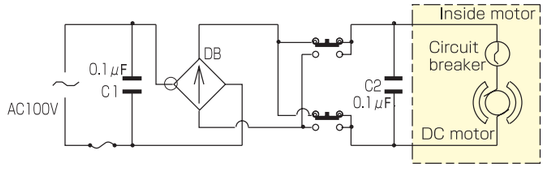
【Wiring example】

<12 and 24 VDC>



- Use a bipolar, double throw, instantaneous-contact type switch with the switching off position at the neutral point at the center for 12/24 VDC switching.

<100 VDC>



- Use a 100-VDC MMP with the 100-VAC power supply via an full-wave rectifier.

(5) Selecting wire

- Select a wire diameter suitable for a DC motor operation voltage applied in the range ±10% of the rated voltage.

Caution on cylinders in operation

<Relief valve>

Do not activate the relief valve over 2 seconds. Otherwise, a rise in the oil temperature or a malfunction may result. The relief valve set pressure is fixed (at 4.1 or 7.1 MPa) and cannot be changed.

<Duty cycle / Circuit breaker>

- All models are designed for an intermittent operation and will automatically shut down when operated continuously. Use the MMP under the rated pressure (thrust) in intervals of 30 seconds within ED25% (pause over 90 seconds).
- When the allowable duty cycle is exceeded, the circuit breaker built in the DC motor will automatically turn off the MMP.
- When the DC motor cools down, the circuit breaker will automatically reset enabling the restart of the MMP. Continuing to use the MMP in conditions, in which the circuit breaker is often triggered, is not recommended.

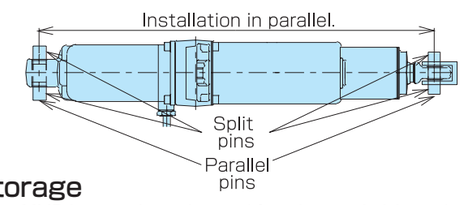
<Manual operation in case of an emergency>

- In case of power failure, electric wire break, and other emergencies, the cylinder may be extended or retracted using the manual release valve ⑥.

After loosening the manual release valve by turning it two or three times with a hex wrench, the cylinder can be extended or retracted by the hand or by its own weight. (Be careful of a free fall.)

Mounting

- Mount the MMP with two parallel pins (recommended diameter: $\phi 14\ ^{-0.025}_{-0.068}$) and secure in place with split pins.
- The MMP can be easily mounted by securing the rod side to the load side and the bottom side to the frame of the equipment.



Storage

When the MMP is not going to be used for a long period, keep the cylinder in the fully retracted position.
If the cylinder is kept in the extended position for a long time, dust deposits or rust may damage the oil seal, causing eventual malfunction.

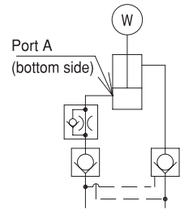
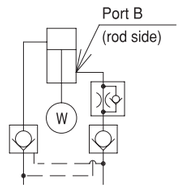
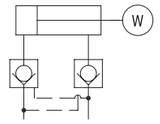
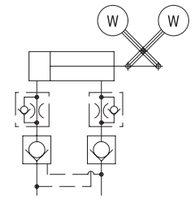
Disposal

When disposing the MMP, unplug the oil tank, remove operating oil from the oil reservoir and cylinder.
When removing the plug, do it slowly after extending the cylinder. Otherwise, the oil may gush out because the tank is pressurized.

Selecting an orifice (slow return valve)

- If a hunting phenomenon occurs with the weight of the cylinder, an orifice will be required on the return side. (Hunting phenomenon: Uncontrollable intermittent motion of a cylinder)

※Select orifices for Port A and B according to the load applied to the cylinder.
※When the cylinder is diagonally positioned, select kind of load by its own weight from A ~ D.
※An orifice is installed to prevent a hunting phenomenon. It is not useful for speed control.
※Please contact us if you do not know the criteria for selection.

A. Compression load	B. Tension load	C. Horizontal load	D. Compression and tension load
			
An orifice is required at Port A.	An orifice is required at Port B.	An orifice is not required.	An orifice is required at Port A and B.

Orifice diameter (calculated value)

Load condition	Cylinder size	Load (kN) 0 1 2 3 4 5 6 7 8 9
A. Compression load	φ34	φ0.8 φ0.6
	φ40	φ0.8 φ0.6
B. Tension load	φ34	φ0.8 φ0.6 ※
	φ40	φ0.8 φ0.6 ※

【Note】
1. In the case of D (compression and tension load), select both A (compression load) and B (tension load).
2. Please contact us for the parts marked with an asterisk (※).
3. Make sure to test the selected MMP on the intended equipment.

【Selection example】
For a compression load of 6 kN on the cylinder of φ40, select an orifice of φ0.6.

Check sheet

Basic specifications

Relief valve pressure		☐ 4.1MPa ☐ 7.1MPa	
Cylinder	Cylinder bore - rod dia.	☐ φ34- φ20 ☐ φ40- φ20	
	Stroke	☐150 ☐200 ☐250 ☐300 ☐350mm	
	Required speed	☐Standard ☐Non-standard （ mm/sec）	
DC motor	Voltage (V)		
	Voltage fluctuation		
Required thrust	Max. Ordinary	Required speed Max.	at thrust

Motor

Wiring	☐Standard (600 mm)
	End treatment ☐Standard (lead wire only)
Stop method	
☐Position detection ☐Visual observation ☐Stroke end	
Selecting orifice	●Port A orifice：☐None ☐φ0.8 ☐φ0.6
	●Port B orifice：☐None ☐φ0.8 ☐φ0.6

Installation environment

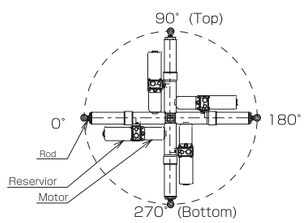
Place	☐Indoor ☐Outdoor
Ambient temperature	～ ℃
Others	☐On vehicle ☐Stationary
Vibration	☐No ☐Yes （ G）

Duty cycle

Stop duration	(min./time)
Intermittent operation	(times/day)
Annual operation frequency	(times/year)

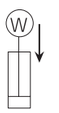
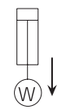
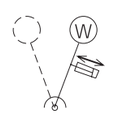
Additional requirements

Mounting position



(Mounting angle)
With cylinder max. retraction (degrees)
With cylinder max. extension (degrees)

Load on cylinder

A. Compression	B. Tension	C. Horizontal	D. Tension and Compression
			
☐ A	☐ B	☐ C	☐ D
Loads		～	(N)

Selected model

MMP4—

Note

Hydraulic Valve (General)

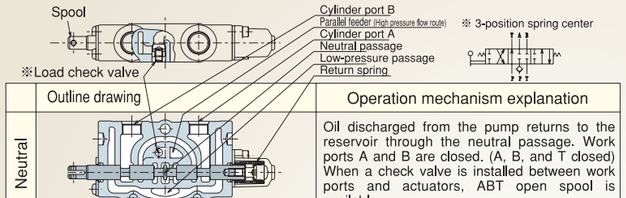
	Multiple control valve (for vehicle and general purpose)		Single function valve, etc.
	Serving all three factors of valve control: direction, pressure, and flow rate		Providing one of three functions (directional, pressure, or flow control)l)
Products included in this catalog	Mono-block type (integrated model) (for excavators and loaders)	Sectional (separated model) and semi-mono-block types (for mini-excavators, forklift trucks, loaders, and general purpose)	Flow control valve (for cylinders)
KYB products not included in this catalog. (Contact KYB)			Solenoid valve for industrial equipment Cartridge valve (Sterling products) A variety of single function valves

The multiple control valve mainly provides the directional control function for supplying oil to each actuator, but also has pressure and flow control functions.
● Pressure control valves: relief, pressure reducing, and unloading valves, etc. ● Flow control valves: throttle, flow dividing, and pressure compensation valves, etc. ● Directional control valves: directional change and check valves, etc.
<Classification by body construction>
◇ Mono-block type: The circuit and functions are designed for a specific model with simple construction (single-function valves)
◇ Sectional type: The basic circuit, variations, and the number of spools can be flexibly designed (general purpose and single-function valves)
◇ Semi-mono-block type: With mono-block as basic circuit design, additional valves are arranged to be sectional. (Special-purpose valve)

Valve: Multiple Control Valve

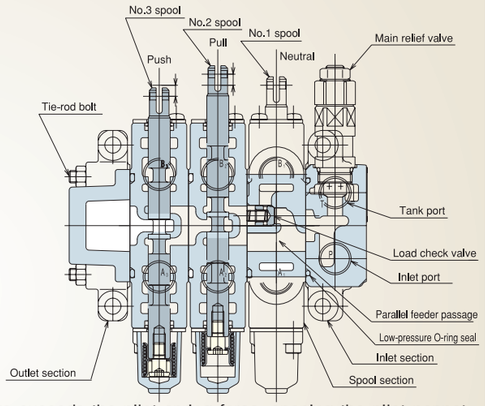
Basic construction, operation, and accessory valves

Directional Control Operation [KVS65 model-sectional type]

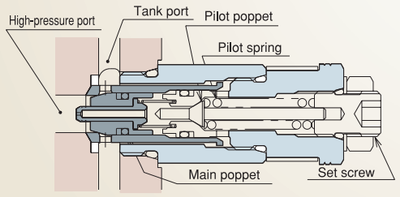


	Outline drawing	Operation mechanism explanation
Neutral		Oil discharged from the pump returns to the reservoir through the neutral passage. Work ports A and B are closed. (A, B, and T closed) When a check valve is installed between work ports and actuators, ABT open spool is available.
Spool push-in		The neutral passage is closed. Oil flows from the parallel feeder, pushing open the load check valve, to work port B. Oil returning to work port A flows into the low-pressure passage to return to the reservoir. The spool is pushed back to the neutral position by the return spring.
Spool pull-out		The neutral passage is closed. Oil flows from the parallel feeder, pushing open the load check valve, to work port A. Oil returning to work port B flows into the low-pressure passage to return to the reservoir. The spool is returned to the neutral position by the return spring.

※Load check valve: This valve prevents a drop in the load on the actuator caused by reverse flow of oil from the actuator during a spool change.
※Position: A three-position type (spool neutral, push, and pull) is commonplace, but the two- and four-position types (for the loader's boom section, etc.) are also available.



Combination Relief Valve Operation



(1) Relief valve
The work port pressure exceeds the pilot spring force, opening the pilot poppet to flow oil to the tank port. The pressure difference between the front- and backsides of the main poppet caused by the flow opens the main poppet to flow oil from the work port to the tank port.
The mechanism enables a compact design and better performance (smaller override) than a direct-type relief valve.
(2) Anti-cavitation (port relief)
When pressure on the port side is decreased lower than one on the tank side by cavitation, etc., the difference of the pressure receptive areas between the tank and work port sides of the main poppet opens the main poppet to let oil flow from the tank side to the port side.
※The port relief valve of a combination type provides relief and anti-cavitation functions.

Spool Operation and Return to Neutral Position

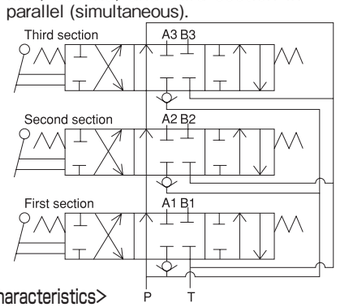
● Manual operation: Most small valves are manually operated with levers.
● Pilot operation: Most large-scale valves and multiple-valve-units for excavator and mini-excavator applications use a pilot valve allowing light force or parallel operation.
● Solenoid-operation: On-off or proportional changeover of the spool can be performed using the solenoid-operated valve.
【Return to neutral position】
● Often a return spring is adopted for the return to the neutral position, but a mechanical or electric detent system is also used.

Various accessory valves: An additional accessory valve may be installed on the inlet port of the pump or on each port.

● The main relief valve is used to control the maximum pressure of the pump. ● The overload relief valve (port relief valve) is used to prevent overload of the actuator.
● The anti-cavitation valve is used to prevent cavitation in the actuator. ● The shut-off valve is used for plugging when no relief valve or anti-cavitation valve is used.

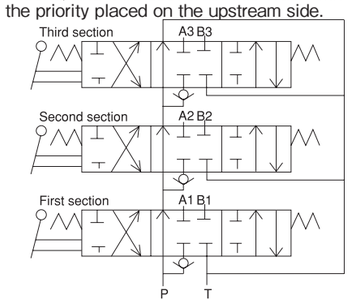
Basic Circuit (parallel, tandem, and series circuits)

● Parallel circuit
Oil from the pump is supplied to the first, second, and third section in parallel (simultaneous).



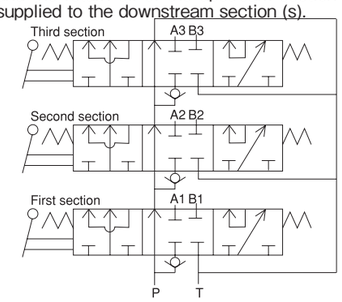
<Characteristics>
◇ Each machine can be operated independently
◇ On a simultaneous operation, the lowest-pressure circuit is activated first, followed by the mid-pressure circuit and then by the highest-pressure circuit.
◇ Simultaneous operation is possible with an adjustment of spools.

● Tandem circuit
Oil from the pump is supplied to the first, second, and third section in this order with the priority placed on the upstream side.



◇ When the upstream section operates, the downstream section stops.
◇ Adjustment of the upstream spool enables the downstream section operation.

● Series circuit
Priority is placed on the upstream section and the return oil of the upstream section is supplied to the downstream section (s).

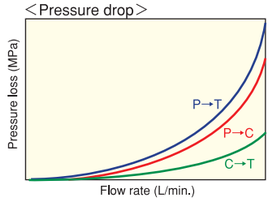


◇ A simultaneous operation is possible irrespective of the load.
◇ Pump pressure is the sum of all sections.

※The above examples are representative of each model, and multiple circuit models may be combined or a special circuit (e.g. two-pump conflux) may be integrated. Please contact us for circuit configurations.
※Carry over: Oil from the pump inlet may flow to the next circuit through the outlet of the last section.

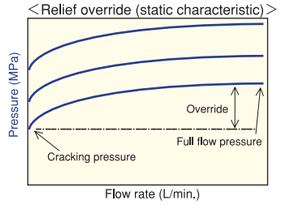
Basic Characteristics

<Pressure drop>



For the selection of a multiple control valve, the following characteristics should be examined.
【Pressure drop characteristics】
The relationship between pressure drop and flow rate is expressed by the formula:
$P = \beta \cdot Q^2/A^2$
Q: Flow rate, β: Coefficient, A: Valve opening area, and P: Pressure
As pressure increases by the square of the flow rate, make sure not to let the flow rate exceed a rated value even momentarily. As the number of spools increases, the equivalent area becomes smaller and the pressure drop increases.
※Our products are designed in a compact form to reduce pressure loss.

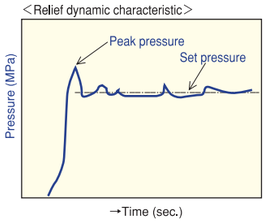
<Relief override (static characteristic)>



◇ Cracking pressure: Pressure level to open the relief valve
◇ Full flow pressure: Pressure and flow rate set for operation
◇ Override: Pressure difference between the cracking and full flow

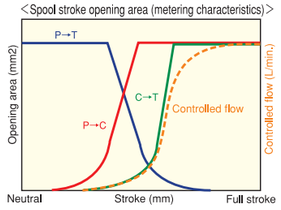
【Relief override performance】
Note 1: Please specify the set pressure as「full flow pressure:[ ]MPa at[ ]L/min.」
Please contact us when cracking pressure is required to be set.
Note 2: When setting the pressure of main relief valve and port relief valve, remember that pressure difference between the two, exceeding the override pressure is required (over 2 MPa) to prevent pressure interference during a simultaneous operation. ※A combination relief valve is supplied as a standard accessory in order to realize a compact design and high performance (static and dynamic characteristics).

<Relief dynamic characteristic>



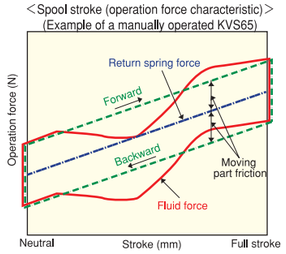
Peak pressure on relief operation should be taken into account.

<Spool stroke opening area (metering characteristics)>



【Metering characteristic】
<Spool stroke opening area (flow rate) characteristic >
P to T opening: For opening or closing the flow from the pump to the reservoir in the neutral passage and regulating the partial flow to actuators.
P to C opening: For opening or closing the flow from the valve to the actuator and regulating the flow rates to actuators.
C to T opening: For opening or closing the flow from the actuator to the reservoir and regulating the return flow from the actuator.
※The flow characteristic (- - - - -) varies depending on load conditions on the P and C sides. Therefore, some systems require prototype tests.
※Spool opening adjustment (metering) during changeover enables fine-tuning of the equipment or the absorption of lever operation impact.
※Spool setting adequate for the system is possible by combination of opening area.
<Spool stroke (spool effort)>
○ Against the spring force returning to the neutral position (—·—·—), the friction of the moving part works in the positive direction while moving from neutral to full stroke and in the negative direction while returning from full stroke to neutral.
(- - - - -)

<Spool stroke (operation force characteristic)>
(Example of a manually operated KVS65)



○ The operation force is shown with (- - - - -) when the oil does not flow. The hydraulic operation generates"flow force"according to the flow rate and pressure. When flow force is too large, it may prevent the spool from returning or affect fine tuning capacity during pilot operation. This way a decrease in flow force from the spool can ensure smooth performance.
※KYB products feature light lever operation and high durability by ① strict moving part clearance management, ② use of low-friction sealing and wiper sealing, and ③ adoption of fluid-force-reduction spools.

Additional functions of the special-purpose valve

Additional functions of the single valve

※Based on our long experience, we have made available necessary additional functions for each machine.
These functions are provided as standard specifications for some models and as options for others. Please contact us regarding your application.

■ For Excavator and Mini-excavator

[Refer to both the explanations for ① to ⑦ and the circuit diagram on the right]

※In most cases, more than two pump ports are installed to regulate flows separately for the travel motors (left and right), swing motor, and bucket cylinder. Each boom and arm cylinder requires two sections, such as Boom 1 and 2, and Arm 1 and 2, so as to improve work efficiency. On top of that, a auxiliary section is installed for attachment purposes. In total there are nine sections.

※Various functions are incorporated to operate all actuators in simultaneous operation.

① Straight travel circuit

When attachment sections are operated with two travel motors in action, the straight travel valve works to supply oil from P2 pump to other sections and oil from P1 pump to left and right travel motors.

※Straight travel is possible while operating travel motors and another attachment sections at the same time.

② Conflux circuit

During a boom or arm operation with other actuators not in use, the oil flow to Boom 2 and Arm 2 is added to the oil flow to Boom 1 and Arm 1, causing an increase in the total oil flow.

※Increasing cylinder speed improves work efficiency.

③ Priority in a multiple operation

In a simultaneous operation of actuators with different working pressure, it prevents much oil from flowing into lower pressure line.

※A simultaneous operation of the swing and arm sections or the boom and arm sections becomes easy.

④ Neutral flow cut-off valve

The valve closes the neutral flow of the control valve to raise pump pressure.

※The valve enables the division of oil from the control valve to additional valves for attachment.

⑤ Regeneration circuit

The circuit combines return oil from the actuator with oil from the pump. The circuit is used for arm and boom.

※Increasing the cylinder speed is useful in preventing cavitation and recycling oil discharged from the pump. (Energy saving effect)

⑥ Anti-drift valve

The poppet valve and the pilot unit for the opening and closing of the poppet valve are incorporated between the flow from the spool and the cylinder port. Better sealing performance with the poppet valve reduces oil leakage. It is also very useful in preventing the boom or arm from falling down.

⑦ Two-stage main relief valve

Adding signal pressure to the standard main relief valve can raise set pressure.

※ It is usable when more driving force is required.
Please contact us for other additional functions such as a spool switch detection function and a pump control signaling function (load sensing, positive/negative control, etc.).

【Load sensing valve】(KVSX)

※To be used in combination with the LS valve and LS pump. (Load pressure sensing variable displacement pump at page 17.)

※See page 20 for the working mechanism of the load sensing system.

(1) By using the valve in conjunction with the pump to provide the discharge for only the required pressure and required flow according to lever operation, a low energy consumption system can be realized easily.

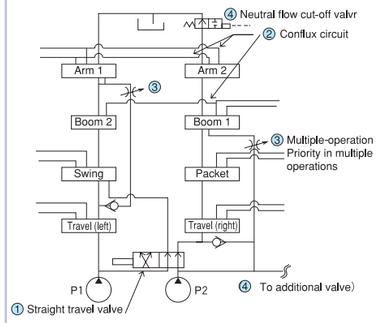
(2) Since the valve is not influenced by load, it is easy to improve simultaneous operation performance by electronic control.

(3) A compact design can be made with less piping and no conflux circuit.

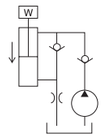
(4) Easy flow setting for each valve section.

(5) The tuning period can be reduced as the flow characteristic can be easily estimated.

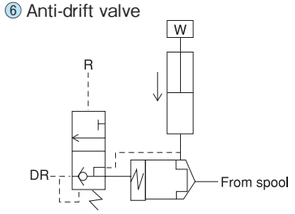
<Circuit Diagram example (for a brief explanation)>



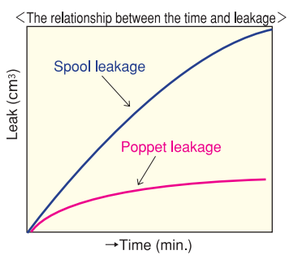
⑤ Regeneration circuit (e.g. boom regeneration)



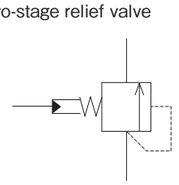
⑥ Anti-drift valve



<The relationship between the time and leakage>



⑦ Two-stage relief valve



■ For forklift truck applications

[Refer to both explanations for ① to ⑤ and the circuit diagram on the right]

※Two valves for lifting and tilting compose the basic mono-block on which sections for attachments can be added. (KVMF)

① Flow priority valve (VPF)
The pump flow is delivered to the hydraulic power steering system with priority through the PF port.
A type corresponding to the load sensing steering unit is also available.

※The performance is not affected by the engine speed.

[Various safety mechanisms] ※For securing safe operation

② Lift lock valve
This is a safety valve, prohibiting the lift from falling down. The return line to the cylinder is stopped by solenoid valves.

※A lever operation in error while the engine is off will not lower the lift.

③ Unloading valve
This is to insure safety by prohibiting the lift raising operation by connecting the pump line to the reservoir line with electric signals to the solenoid valve

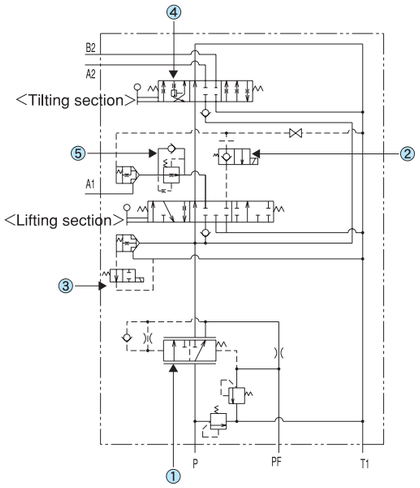
※A lever operation in error will not raise the lift.

④ Tilt lock valve
The supply side pressure opens the return line.

※Load drop from the fork due to mast tilting is prevented even when the lever is operated accidentally while the engine is off.

⑤ Flow regulator valve (FRV)
A safety valve (flow control valve) to limit the maximum lift lowering speed.

※The lift lowering speed can be adjusted.



<KVMF70 Model>

■ For wheel loader application (boom and arm)

[Refer to both explanations for ① to ④ and the circuit diagram on the right]

※Two valves for the boom and bucket compose a basic mono-block on which sections for attachments can be added. (KVML)

① Boom lowering floating position
In addition to the three positions for Neutral, Lifting, and Lowering of the boom, the fourth position for drifting (lowering by its own weight) is given by connecting the line between the cylinder rod and bottom and the reservior.

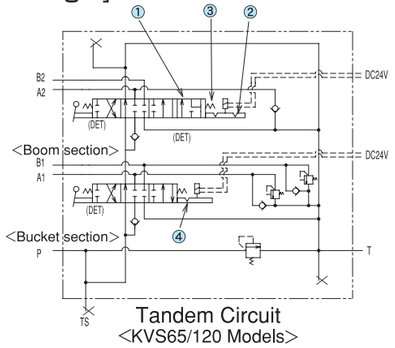
※This position is required for leveling the ground.

※Traveling is possible while keeping the valve at the detent position.

② Boom lowering detent
The boom is kept at the drifting position with magnetic detent.

③ Boom lifting detent
The boom is kept at the lifting position with magnetic detent.

④ Bucket crowding detent
A mechanism to maintain a bucket crowding position



Tandem Circuit
<KVS65/120 Models>

■ For wheel loader application (steering) [KVMT]

※ A special valve for articulated wheel loader steering

※A pressure compensation valve is incorporated in the mono-block construction.

※Light steering force generates great power.

<Operation mechanism>

(1) Manual: Mechanical linkage compatible

(2) Floor amplifier

Main spool switching by means of a stroking adjustment corresponding to supply flow

※Suitable for orbit pump systems.

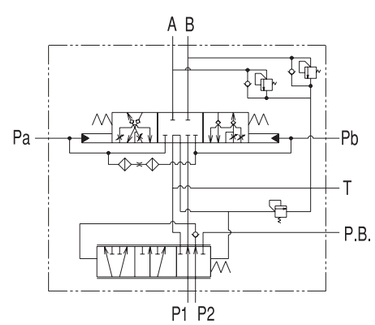
<Pump method>

Both single- and tandem-pump systems are available.

※Please select the one appropriate for your system.

<Pressure compensator model>

As the supply flow is controlled by the main spool opening, a flow rate adequate for steering can be maintained at both high and low speed.



<KVMT—200,400>

Valve: Multiple Control Valve

A control valve works a single actuator or multiple actuators simultaneously, and may incorporate multiple functions.
KYB provides a wide variety of valves which includes hydraulic control valves, and electro-hydro valves with electric and hydraulic control systems combined.
Multiple mono-block cast products are manufactured by KYB-YS Casting Center, one of KYB's affiliated companies.

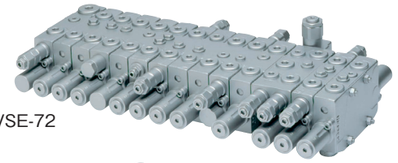
【Model code】 KV 1 – M 2 – G 3 – 270 4

Example

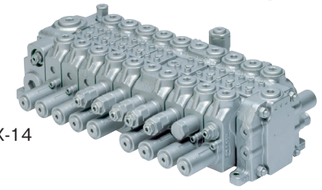
1	Multiple Control Valve	
2	Construction	M: Mono-block or semi-mono-block, and S: Sectional
3	Application	E, G, and M: for excavators, mini-excavators, and X: for load sensing applications L: Main valve for wheel loaders, and F: for forklift trucks T: For wheel loader steering
4	Rated flow rate (L/min.), and spool diameter (mm) for KVSX	

KVS and KVM Series

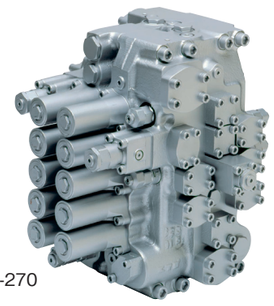
● For excavators and mini- excavators



KVSE-72



KVSX-14



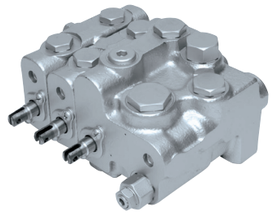
KVMG-270

Model	Rated flow rate(L/min.)	Max. working pressure(MPa)	Type and Feature	Typical applications
KVSE–36	40	24.5	Sectional	Mini-excavator
KVSE–72	70	27.0	Sectional	
KVSX–12	40	24.5	Sectional, for load sensing	
KVSX–14	80	27.5	Sectional, for load sensing	
KVMX–18	160	32.0	Sectional, for load sensing	
KVMM–80	80	30.6	Mono-block	Excavator
KVMM–160	160	34.3	Mono-block	
KVMG–270	270	34.3	Mono-block	
KVMG–400	400	31.4	Mono-block	

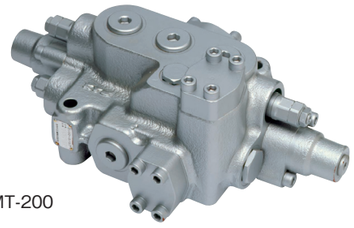
※Various functions required for excavator and mini-excavator are incorporated.

KVS, KVMF, and KVMT Series

● Multiple control valve for forklift trucks, wheel loaders, and other applications



KVMF-70



KVMT-200

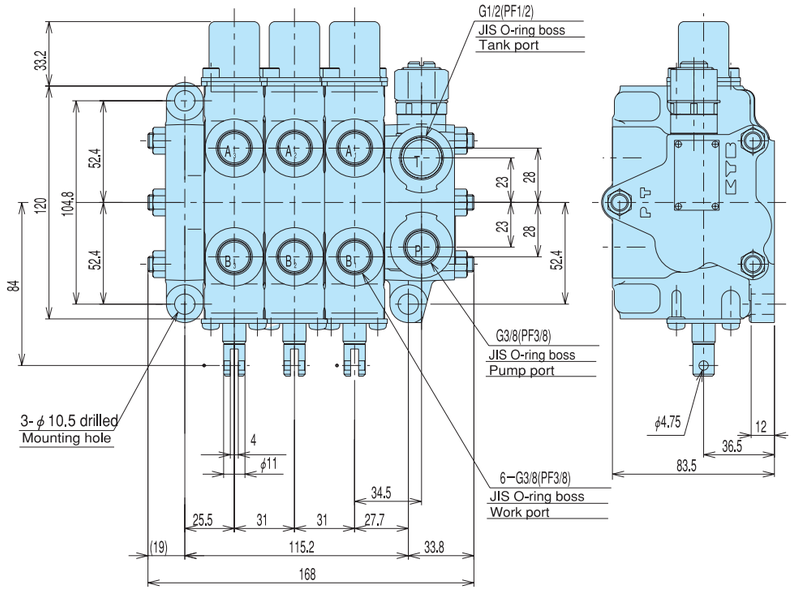
Model	Rated flow rate(L/min.)	Max. working pressure(MPa)	Type and Feature	Typical applications
KVS–31	30	20.6	Sectional	General purpose
KVS–65	65	20.6	Sectional	General purpose
KVMF–70	70	20.6	Semi-mono-block, with flow control incorporated	Forklift trucks
KVS–120	120	20.6	Sectional	General purpose
KVS–200	200	34.3	Sectional	General purpose
KVS–600	600	29.4	Sectional	Excavators and general purpose
KVS–1000	1000	29.4	Sectional	Excavators and general purpose
KVML–200	200	20.6	Semi-mono-block	Wheel loaders and forklift trucks
KVML–270	270	20.6	Semi-mono-block	Wheel loaders
KVMT–200	200	20.6	Steering valve (single unit, flow control incorporated)	Wheel loaders (steering)
KVMT–400	400	29.4	Steering valve (single unit, flow control incorporated)	Wheel loaders (steering)

※High pressure type KVS-120H (27.5 Mpa) is also available.

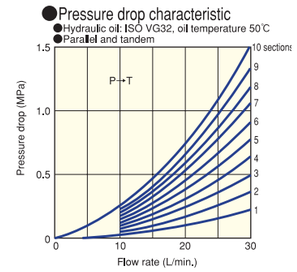
Dimensions (typical example) (unit: mm)

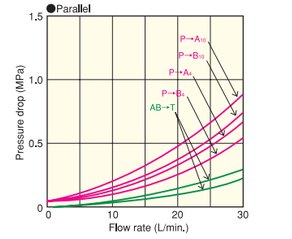
KVS Series: General purpose

【General purpose KVS-31】 Mainly used for mini-excavators, forklift trucks and industrial equipment

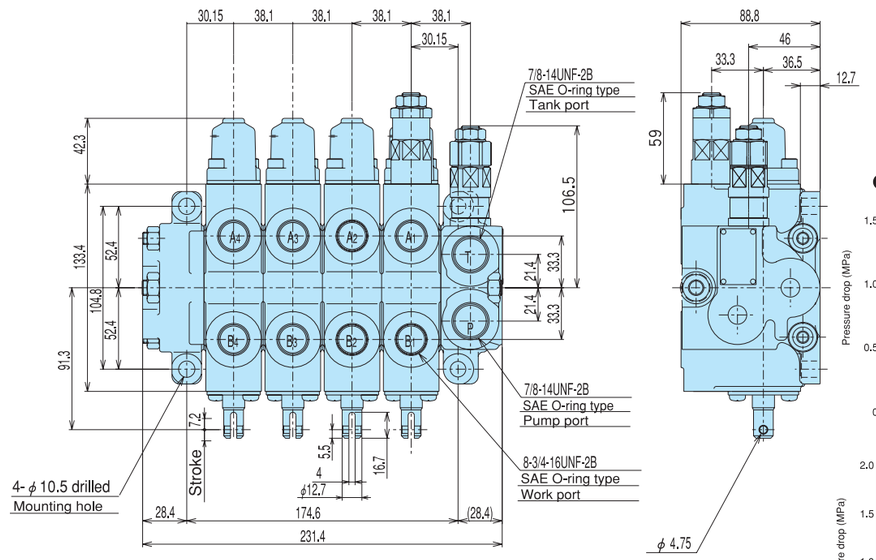


【Optional functions】	
Main relief valve	✓
Overload relief valve	✓
Anti-cavitation valve	✓
Detent	✓
Four positions	✓
Carryover	✓



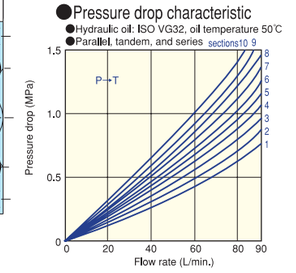


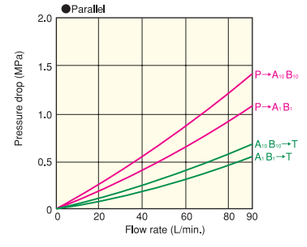
【General purpose KVS-65】 Mainly used for mini-excavators, forklift trucks, and industrial equipment



【Optional functions】	
Main relief valve	✓
Overload relief valve	✓
Anti-cavitation valve	✓
Detent	✓
Four positions	✓
Carryover	✓

【Optional functions for forklift trucks】	
Flow priority valve	✓
Tilt lock valve	✓

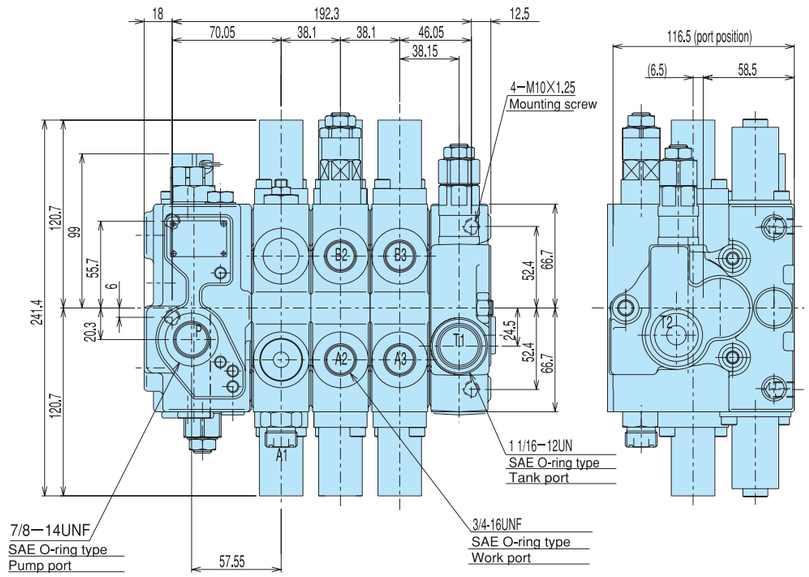




Dimensions (typical example) (unit: mm)

【General purpose KVS-65PSL】

Mainly used for compact construction equipment, forklift trucks, and industrial equipment



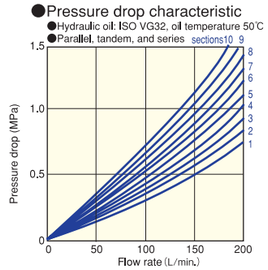
【KVS-65PSL optional functions】	
Main relief valve	✓
Overload relief valve	✓
Anti-cavitation valve	✓
Detent	−
Four positions	−
Carryover	−

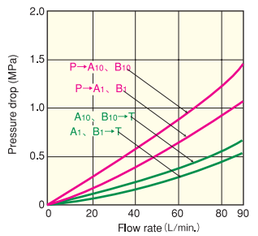
【Optional functions for forklift trucks】	
Flow priority valve	✓
Tilt lock valve	✓

●Pressure drop characteristic

●Hydraulic oil: ISO VG32, oil temperature 50℃

●Parallel, tandem, and series

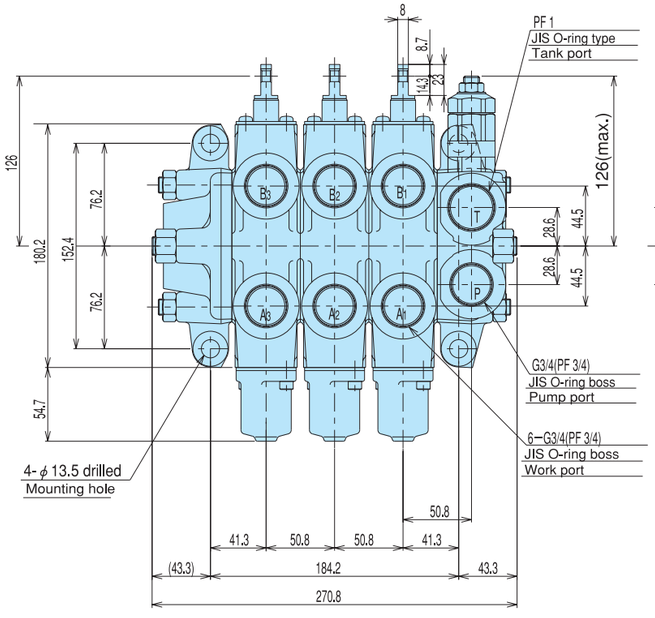


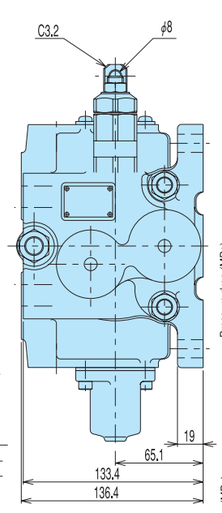


<KVS-65PSL main features>

- Based on KVS-65, operating the spool with the internal pilot type proportional solenoid pressure reducing valve.
- The pressure compensation mechanism (optional) enables stable flow unaffected by load pressure fluctuation.

【General purpose KVS-120】 Mainly used for a variety of compact construction equipment, forklift trucks, and industrial equipment





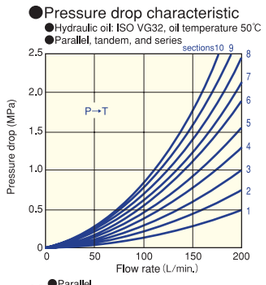
【Optional functions】	
Main relief valve	✓
Overload relief valve	✓
Anti-cavitation valve	✓
Detent	✓
Four positions	✓
Carryover	✓

【Optional functions for forklift trucks】	
Flow priority valve	✓
Tilt lock valve	✓

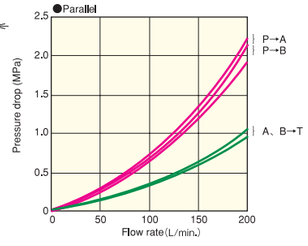
●Pressure drop characteristic

●Hydraulic oil: ISO VG32, oil temperature 50℃

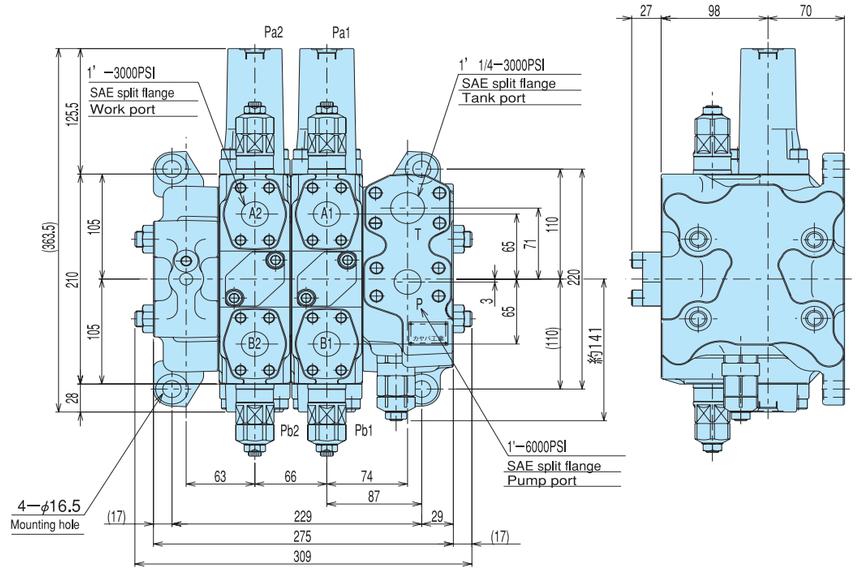
●Parallel, tandem, and series



●Parallel

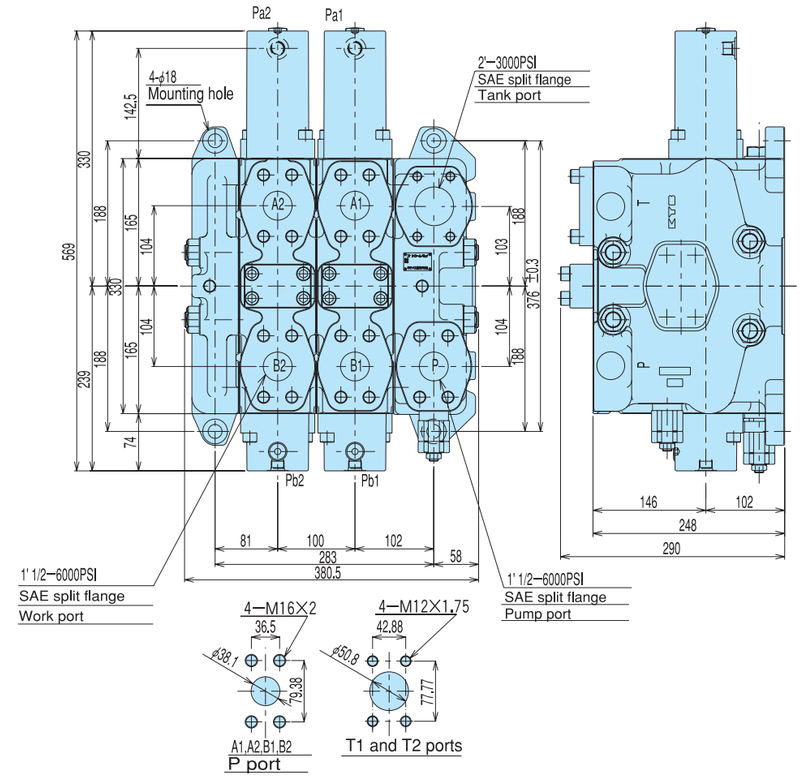


【General purpose KVS-200】 Mainly used for medium- and large-sized construction equipment



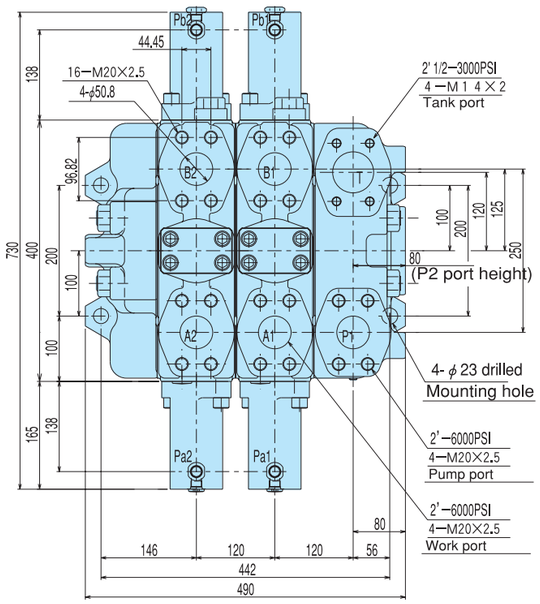
【Optional functions】	
Main relief valve	✓
Overload relief valve	✓
Anti-cavitation valve	✓
Detent	−
Four positions	−
Carryover	✓

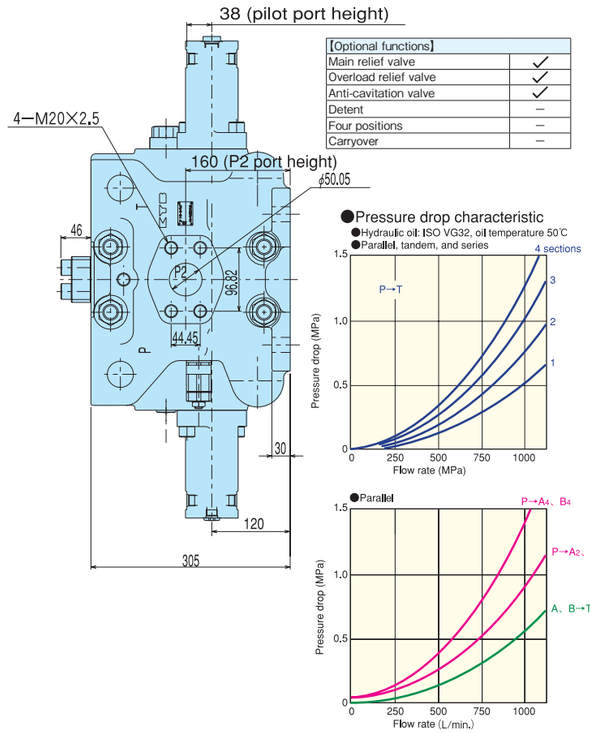
【General purpose KVS-600】 Mainly used for various large-sized construction equipment



【Optional functions】	
Main relief valve	✓
Overload relief valve	✓
Anti-cavitation valve	✓
Detent	−
Four positions	−
Carryover	−

【General purpose KVS-1000】 Mainly used for various large-sized construction equipment



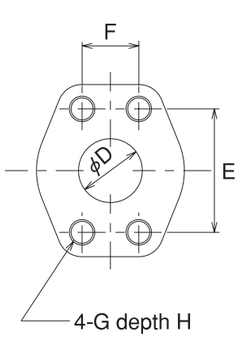


【Optional functions】	
Main relief valve	✓
Overload relief valve	✓
Anti-cavitation valve	✓
Detent	–
Four positions	–
Carryover	–

● Split Flange Dimensions

Nominal sizes	D	E	F	H (Ref. sizes)	G
3/4	19.1	47.6	22.2	17.5	M10×1.5
		50.8	23.8	19.1	
1	25.4	52.4	26.2	17.5	M10×1.5
		57.2	27.8	22.3	M12×1.75
1 1/4	31.8	58.7	30.2	23.8	M12×1.75
		66.7	31.8	20.7	M14×2
1 1/2	38.1	69.8	35.7	22.3	M14×2
		79.4	36.5	30.2	M16×2
2	50.8	77.8	42.9	22.3	M14×2
		96.8	44.4	33.4	M20×2.5
2 1/2	63.5	88.9	50.8	25.4	M14×2
		–	–	–	–

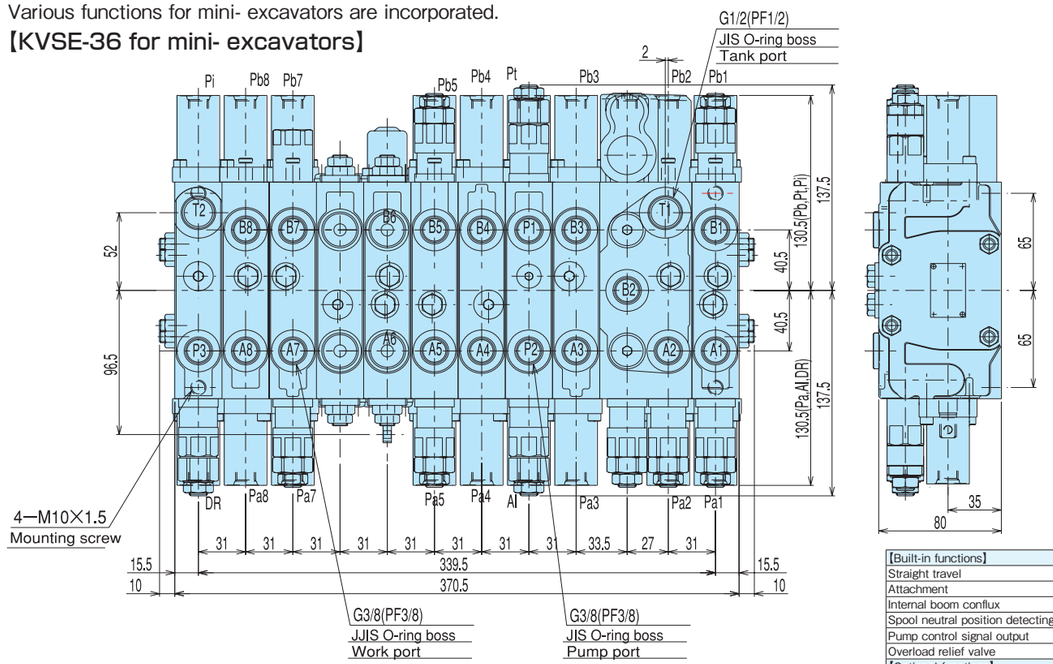
Upper rows: Standard pressure (3000 psi)
Lower rows: High pressure (6000 psi)



■ KVSE/KVSX Series: Special models for mini- excavators

Various functions for mini- excavators are incorporated.

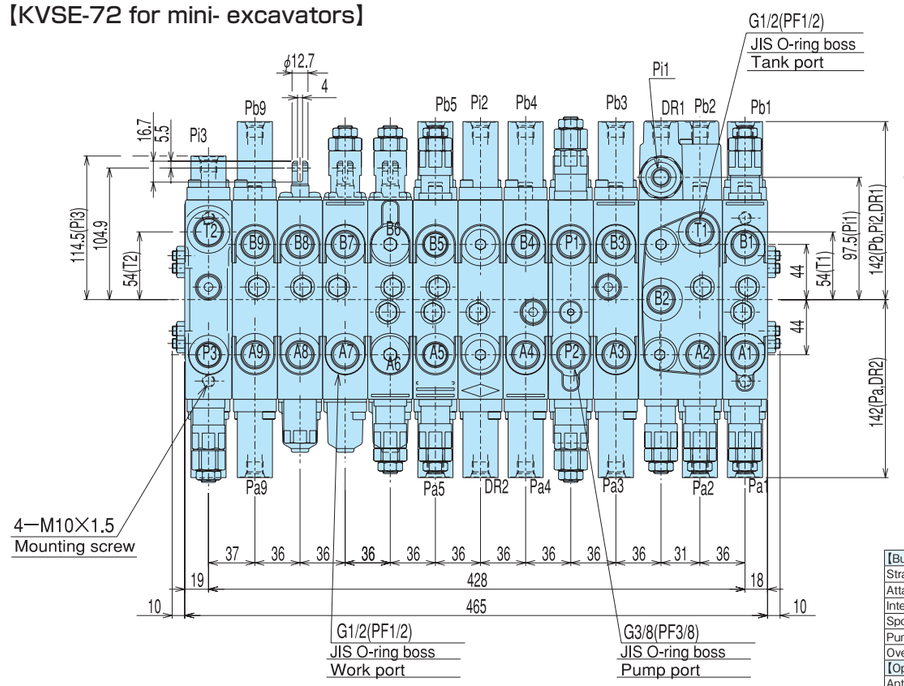
【KVSE-36 for mini- excavators】



【Built-in functions】	
Straight travel	✓
Attachment	※
Internal boom conflux	–
Spool neutral position detecting signal	✓
Pump control signal output	–
Overload relief valve	✓
【Optional functions】	
Anti-drift valve	✓
Add-on for spool section	✓
Add-on of third pump spec.	✓
Regeneration circuit	✓
Arm closing variable regeneration	–
Two-staged main relief	✓
Flow priority at multiple operation	✓
Neutral cut-off valve	–

※ Available on request

【KVSE-72 for mini- excavators】



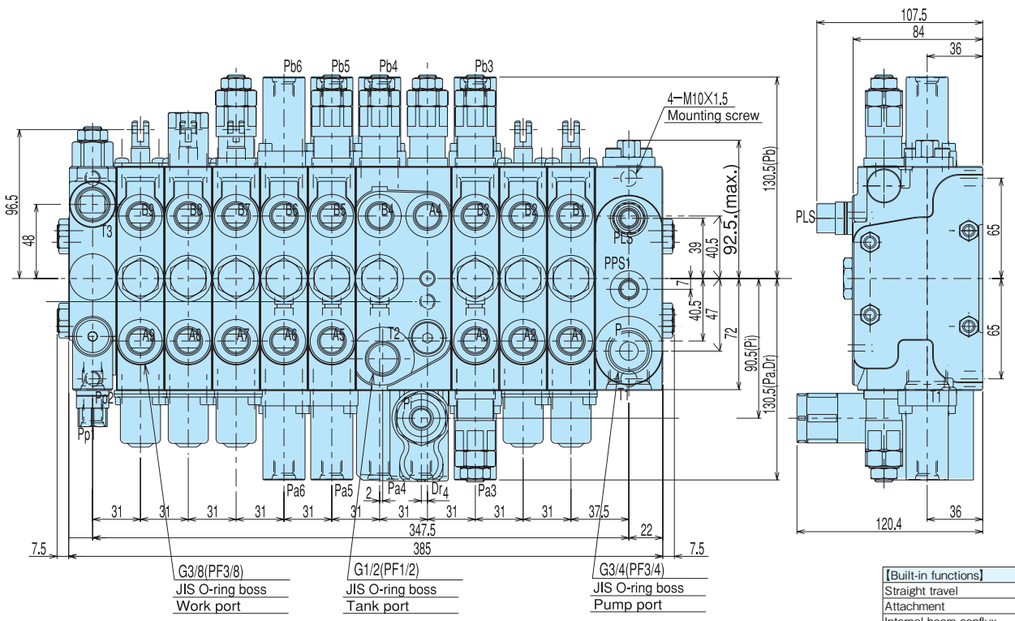
【Built-in functions】	
Straight travel	✓
Attachment	※
Internal boom conflux	–
Spool neutral position detecting signal	✓
Pump control signal output	–
Overload relief valve	✓
【Optional functions】	
Anti-drift valve	✓
Add-on for spool section	✓
Add-on of third pump spec.	✓
Regeneration circuit	✓
Arm closing variable regeneration	–
Two-staged main relief	✓
Flow priority at multiple operation	✓
Neutral cut-off valve	–

※ Available on request

Dimensions (typical example) (unit: mm)

【KVSX-12 for mini-excavator load sensing】

※ To be used in combination with the LS pump. (See“Load sensing pump”at page 19.)

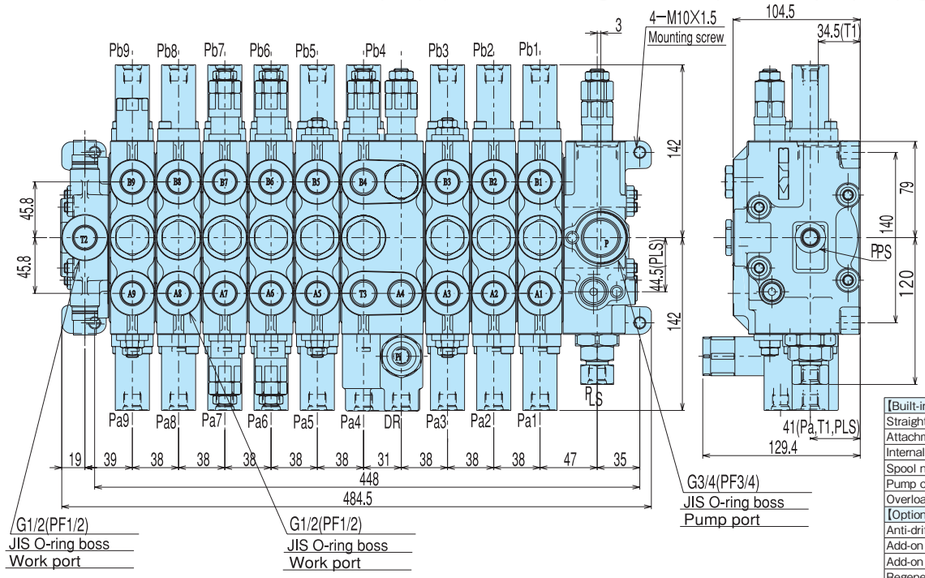


【Built-in functions】	
Straight travel	–
Attachment	※
Internal boom conflux	–
Spool neutral position detecting signal	✓
Pump control signal output	✓
Overload relief valve	✓
【Optional functions】	
Anti-drift valve	✓
Add-on for spool section	–
Add-on of third pump spec.	–
Regeneration circuit	–
Arm closing variable regeneration	–
Two-staged main relief	✓
Flow priority at multiple operation	–
Neutral cut-off valve	–

※ Available on request

【KVSX-14 for mini-excavator load sensing】

※ To be used in combination with the LS pump. (See“Load sensing variable displacement pump”at page 19.)

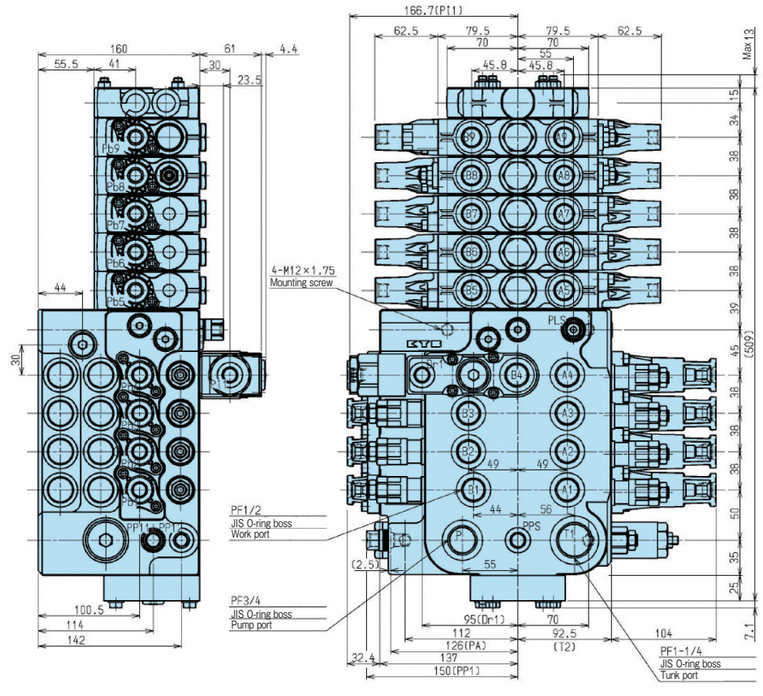


【Built-in functions】	
Straight travel	–
Attachment	※
Internal boom conflux	–
Spool neutral position detecting signal	✓
Pump control signal output	✓
Overload relief valve	✓
【Optional functions】	
Anti-drift valve	✓
Add-on for spool section	–
Add-on of third pump spec.	–
Regeneration circuit	–
Arm closing variable regeneration	–
Two-staged main relief	✓
Flow priority at multiple operation	–
Neutral cut-off valve	–

※ Available on request

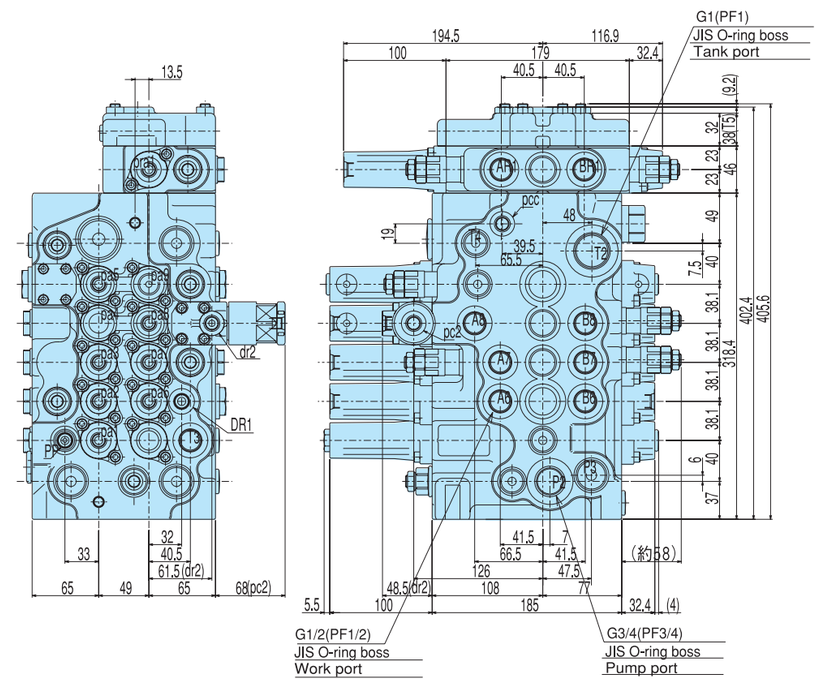
KVMM/KVMG Series: Special models for excavators

【KVMX-18】 For excavators in the 6-9 ton class range



【Built-in functions】	
Straight travel	–
Attachment	※
Internal two sections conflux	–
Spool neutral position detecting signal	○
Pump control signal output	○
Overload relief valve	○
【Optional functions】	
Anti-drift valve	○
Add-on for spool section	○
Add-on of third pump spec.	–
Regeneration circuit	○
Arm closing variable regeneration	○
Two-staged main relief	○
Flow priority at multiple operation	–
Neutral cut-off valve	–

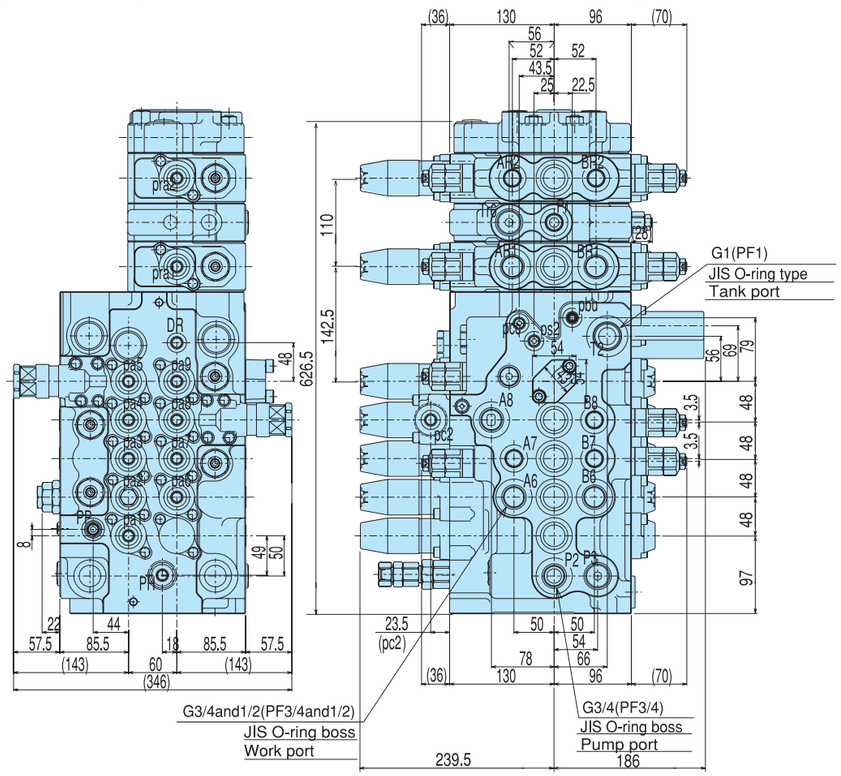
【KVMM-80】 For excavators in the 6-9 ton class range



【Built-in functions】	
Straight travel	✓
Attachment	✓
Internal two sections conflux	✓
Spool neutral position detecting signal	✓
Pump control signal output	–
Overload relief valve	✓
【Optional functions】	
Anti-drift valve	✓
Add-on for spool section	✓
Add-on of third pump spec.	✓
Regeneration circuit	✓
Arm closing variable regeneration	–
Two-staged main relief	✓
Flow priority at multiple operation	✓
Neutral cut-off valve	✓

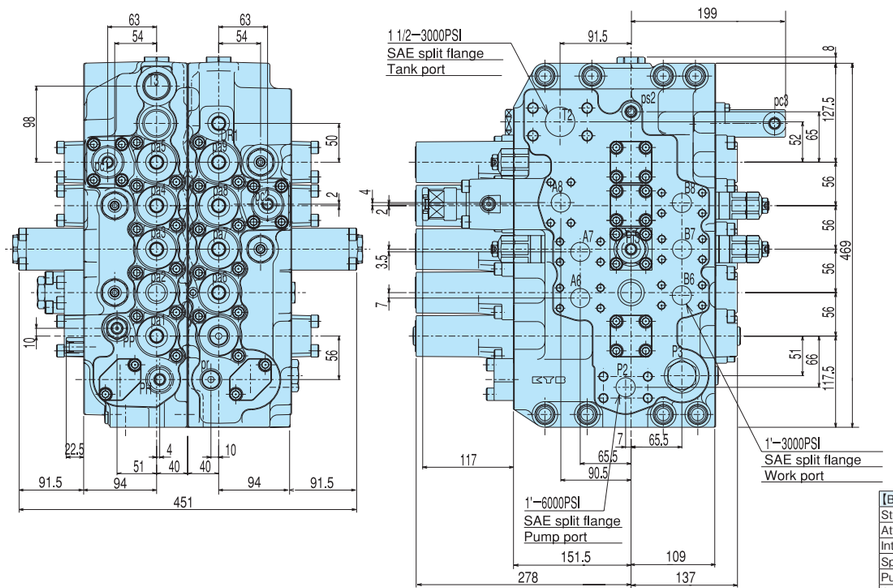
Dimensions (typical example) (unit: mm)

【KVMM-160】 For excavators in the 10-16 ton class range



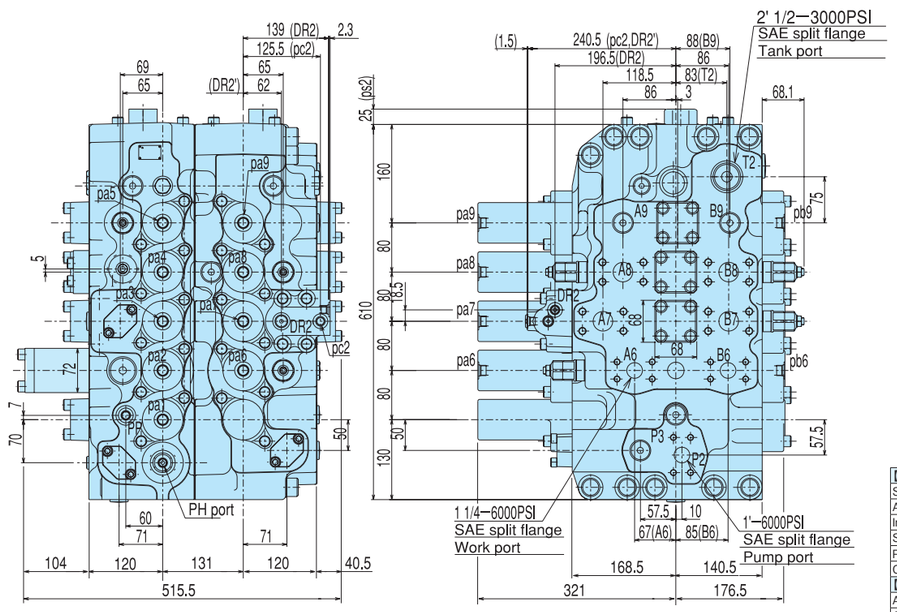
【Built-in functions】	
Straight travel	✓
Attachment	✓
Internal boom conflux	✓
Spool neutral position detecting signal	✓
Pump control signal output	✓
Overload relief valve	✓
【Optional functions】	
Anti-drift valve	✓
Add-on for spool section	✓
Add-on of third pump spec.	✓
Regeneration circuit	✓
Arm closing variable regeneration	✓
Two-staged main relief	✓
Flow priority at multiple operation	✓
Neutral cut-off valve	✓

【KVMG-270】 For excavators in the 20-30 ton class range



【Built-in functions】	
Straight travel	✓
Attachment	✓
Internal two units conflux	✓
Spool neutral position detecting signal	✓
Pump control signal output	✓
Overload relief valve	✓
【Optional functions】	
Anti-drift valve	✓
Add-on for spool section	–
Add-on of third pump spec.	–
Regeneration circuit	✓
Arm closing variable regeneration	✓
Two-staged main relief	✓
Priority at multiple operation	✓
Neutral cut-off valve	–

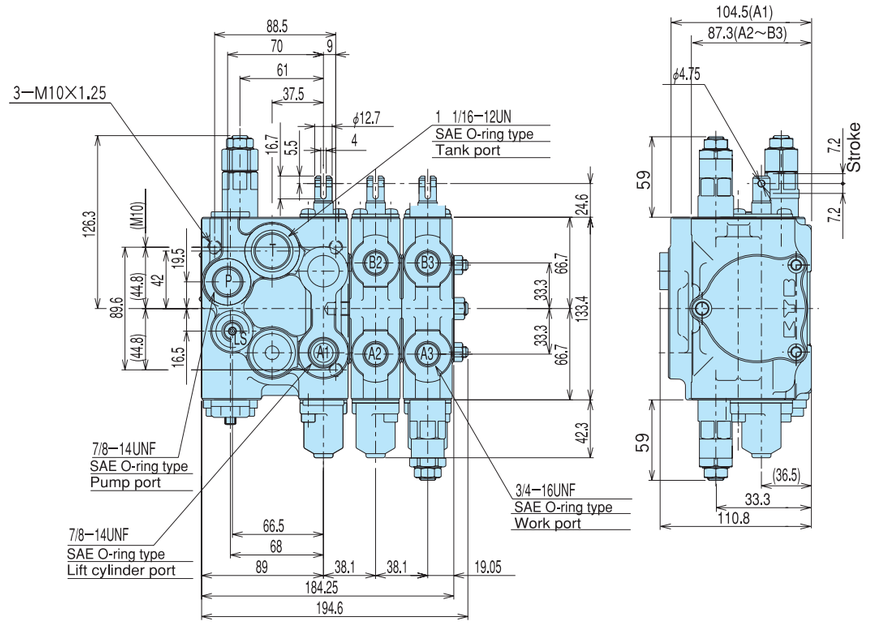
【KVMG-400】 For excavators in the 40-50 ton class range



【Built-in functions】	
Straight travel	✓
Attachment	✓
Internal two units conflux	✓
Spool neutral position detecting signal	✓
Pump control signal output	✓
Overload relief valve	✓
【Optional functions】	
Anti-drift valve	✓
Add-on for spool section	–
Add-on of third pump spec.	–
Regeneration circuit	✓
Arm closing variable regeneration	✓
Two-staged main relief	✓
Priority at multiple operation	✓
Neutral cut-off valve	✓

■ KVMF Series: Special models for forklift trucks

【KVMF-70】 For forklift trucks in the 1-3 ton range

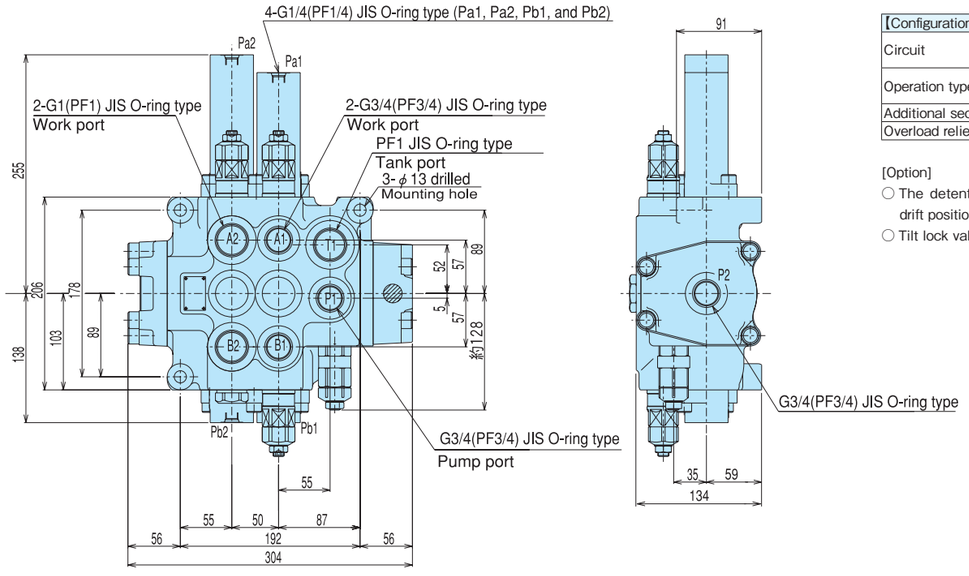


【Configuration】		
Circuit	Parallel	✓
	Tandem	–
Operation type	Manual	✓
	Pilot	✓
Additional sections	Add-on	✓
Overload relief valve		✓

[Features]
○ Flow priority valve (VPF): Standard accessory
(Removable on request)
○ Flow regulator valve (FRV): Standard accessory
(Removable on request)
[Option]
○ Lift lock valve
○ Tilt lock valve
○ Unload valve

KVML Series: For loaders (main) and forklift trucks

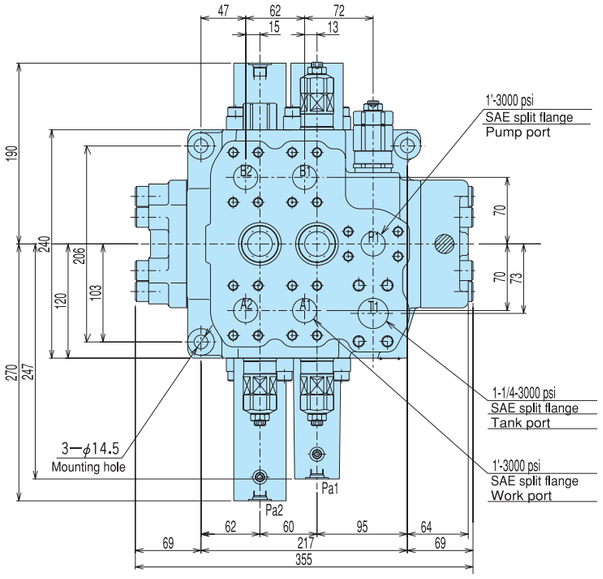
【KVML-200 for loader and forklift trucks】 For wheel loaders (2-3.5 m³) and forklift trucks (over 7 tons)

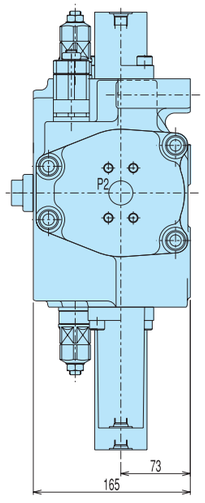


【Configuration】		
Circuit	Parallel	✓
	Tandem	✓
Operation type	Manual	✓
	Pilot	✓
Additional sections	Add-on	✓
Overload relief valve		✓

[Option]
- ○ The detent function is added to the drift position of the boom section
- ○ Tilt lock valve

【KVML-270 for loader (main)】 For wheel loaders in the 2.5-4 m³ range





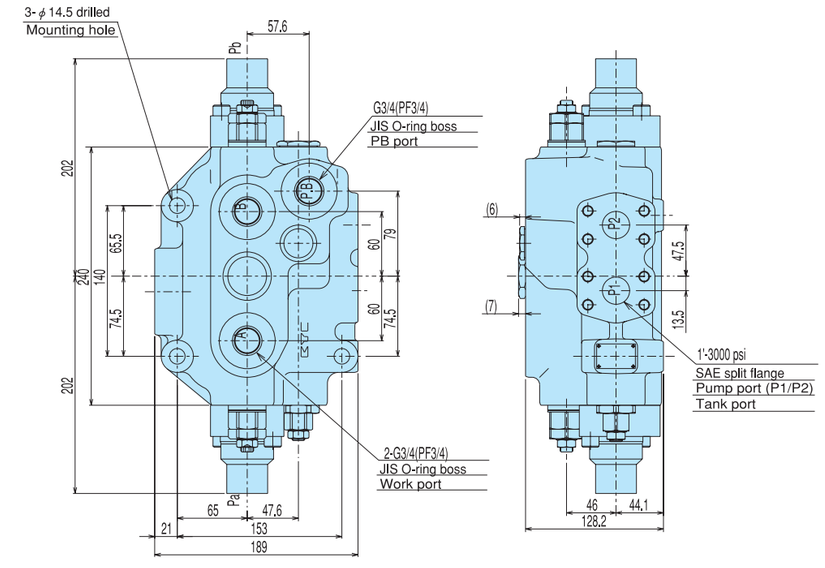
【Configuration】		
Circuit	Parallel	✓
	Tandem	✓
Operation type	Manual	✓
	Pilot	✓
Additional sections	Add-on	✓
Overload relief valve		✓

[Features]
- ○ The boom section is of the four-position switching type with the drift position added to the lowering position

KVMT Series: For loader (steering) applications

※ A special valve for articulated wheel loader steering

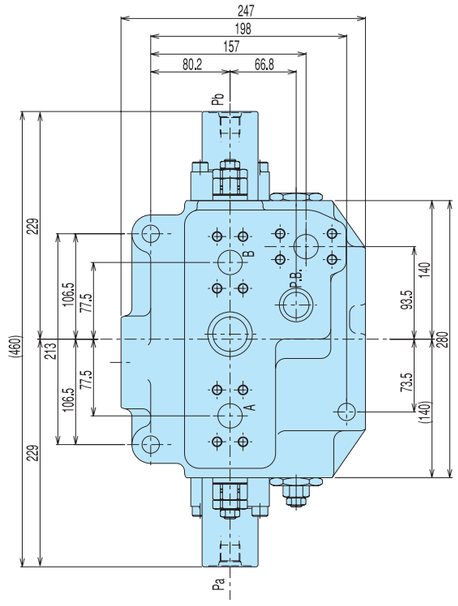
【KVMT-200 for loader (steering)】 For wheel loaders in the 2.5-5.5 m³ range

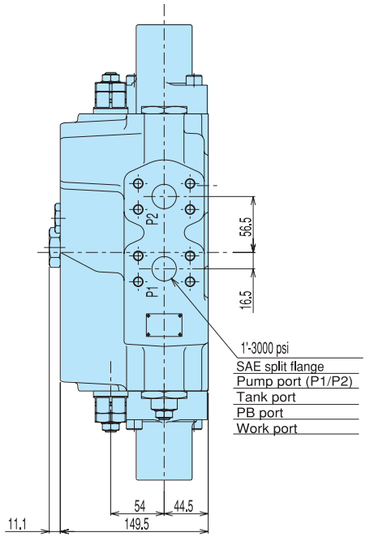


【Configuration】		
Circuit	Parallel	—
	Tandem	—
Operation type	Manual	✓
	Pilot	✓
Additional sections	Add-on	—
Overload relief valve		✓

[Features]
- ○ Built-in pressure compensation valve
- ○ Both single- and double-pump types are available
- ○ Carryover circuit provided

【KVMT-400 for loader (steering)】 For wheel loaders in the 6-13 m³ and over range





【Configuration】		
Circuit	Parallel	—
	Tandem	—
Operation type	Manual	✓
	Pilot	✓
Additional sections	Add-on	—
Overload relief valve		✓

[Features]
- ○ Built-in pressure compensation valve
- ○ Both single- and double-pump types are available
- ○ Carryover circuit provided

Valve: Single-function Valve

Please consult us for other models not included in this catalog.

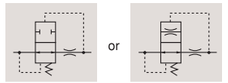
Flow Control Valve


Symbol

Model	Controlled flow rate (L/min.)	Max. working pressure (MPa)	Max. free flow rate (L/min.)	Weight (kg)
F C-03	18～36	20.6	27～54	0.5
F C-04	42～66		63～99	0.9
F C-06	75～115		112～172	1.8

・Flow control valve Pressure-compensated flow control valve (with the free-flow function).

Down Safety Valve

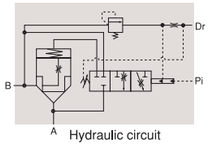


Symbol

Model	Nominal flow rate (L/min.)	Controlled flow rate (L/min.)	Max. working pressure (MPa))	Blocked flow rate (L/min.)	Weight (kg)
D S-03	18～36	0 or 6-12	20.6	Nominal flow rate x 1.5	0.14
D S-04	42～66	0 or 14-22			0.4
D S-06	75～115	0 or 25-38			0.6

・The valve detects an abnormal (excessive) flow rate caused by hydraulic piping damage or other trouble and blocks or reduces the flow.

Hose Rupture Valve



Hydraulic circuit

Model	Rated flow rate (L/min.)	Max. working pressure (MPa)	Weight (kg)
H R V	110	34.3	8.3
H R V	200		8.9
H R V	280		8.9

・The valve was developed for hydraulic excavators and is mounted on a hydraulic cylinder.

※The hose rupture valves are designed for each application considering the equipment and cylinder specifications, and thus the details have been omitted here. (Please contact KYB sales department.)

Flow Control Valve

Features

This is the in-line directional flow control valve with pressure compensation function. The flow is maintained at a fixed rate without being affected by the load fluctuation, and the reverse direction is made to free flow.
This valve is suitable for controlling maximum speed and regulating the lowering of speed.

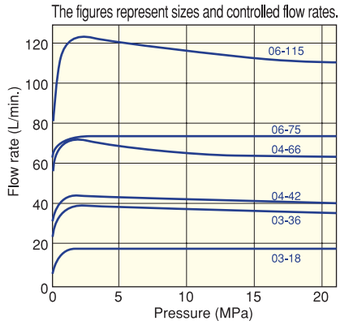
Performance curve

Hydraulic oil: ISO VG32 / Oil temperature: 40。C

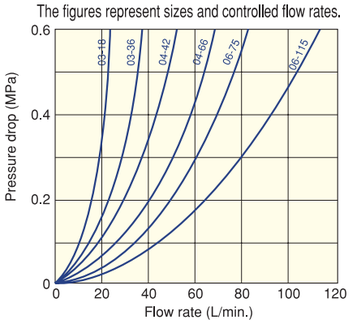
【Model code】 [ ] – FC – 03 – 24
Example 1 2 3 4

1	Nipple side joint shape No symbol: Parallel pipe male threads-female seat joint FO: Parallel pipe male threads-male seat joint
2	Flow control valve
3	Nominal size
4	Control flow rate

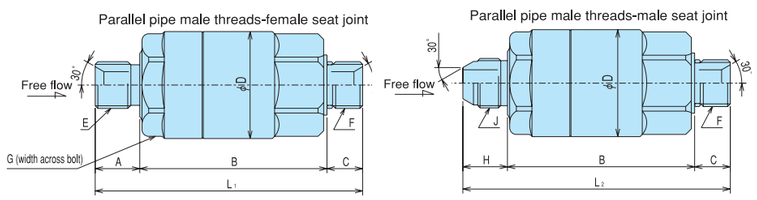
●Pressure and flow characteristic
The figures represent sizes and controlled flow rates.



●Free flow pressure decrease characteristic
The figures represent sizes and controlled flow rates.



Dimensions (unit: mm)



Model	L1	L2	A	B	C	φD	E.F.J	G	H
FC-03	87	100	15	70	12	37	G3/8(PF3/8)	32	18
FC-04	120	120	20	84	16	48	G1/2(PF1/2)	41	20
FC-06	153	153	20	113	18	60	G3/4(PF3/4)	55	22

Note:
E: JIS B8363 parallel pipe male threads-female seat joint
F: JIS B8363 parallel pipe male threads-female sheet joint as well as JIS B2351 O-ring seal type
J: JIS B8363 parallel pipe male threads-male seat joint

Down Safety Valve

Features

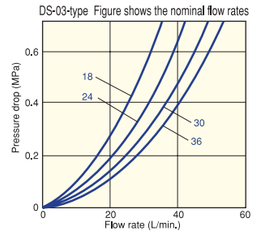
The valve detects hydraulic piping damage or an abnormal (excessive) flow rate and blocks or reduces the flow. The down safety valve is available with"flow blocking"and"flow reduction"types. Mounting one at the actuator port improves work and equipment safety. (The valve functions comply with the Japan Industrial Vehicle Association Standard's safety criteria.)

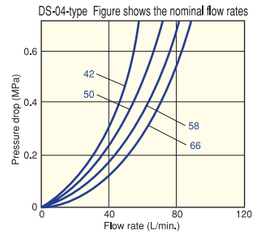
[Model code] [ ] – DS – [ ] – 03 – [ ] – 24 – 0
Example 1 2 3 4 5 6 7

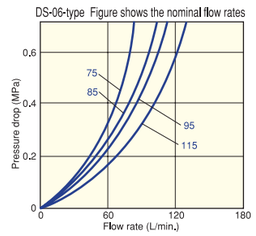
1	Nipple side joint shape No symbol: Parallel pipe male screw-female seat FO: Parallel pipe male screw-male seat
2	Down Safety Valve
3	With or without Bushing No symbol: without, and B: with
4	Nominal size
5	Bushing type joint shape No symbol: no bushing, and T: PT screw
6	Nominal flow rate
7	Blocked flow rate

Performance curve

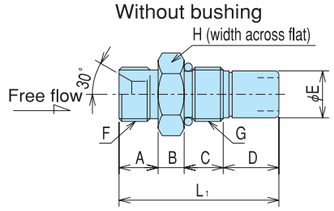
Hydraulic oil: ISO VG32 / Oil temperature: 40℃
● Pressure drop characteristic

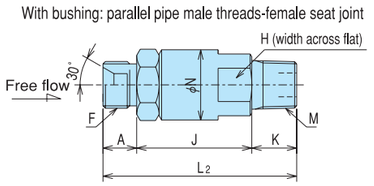


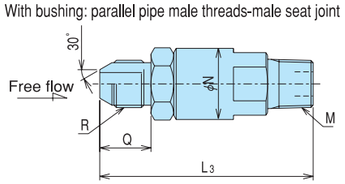




Dimensions (unit: mm)







Model	L1	A	B	C	D	E	F/G/R	H	L2	J	K	M	L3	Q	φN
DS-03	49	12	8	12	17	14.5	G3/8(PF3/8)	22	69	41	16	PT3/8	75	18	25
DS-04	67	16	10	16	25	18.2	G1/2(PF1/2)	27	89	55	18	PT1/2	93	20	31
DS-06	–	20	–	–	–	–	G3/4(PF3/4)	36	98	58	20	PT3/4	100	22	40

Note:
F: JIS B8363 parallel pipe male threads-female seat joint
G: JIS B2351 parallel threads O-ring seal joint
R: JIS B8363 parallel pipe male threads-male seat joint
M: JIS B0203 pipe tapered threads

Caution upon handling

● Select a model with sufficient blocked flow against an excessive flow expected during switchover.
● Do not use in applications in which open-close cycles are constantly repeated.
● The following pressures should be retained after blocking:
DS-03: More than 1.8 MPa
DS-04: More than 2.2 MPa
DS-06: More than 1.5 MPa

Additional Data

1.Main Formulas (Source: Extracted from the Practical Hydraulic System Pocket Book) published by the Japan Fluid Power Association)

<Formulas for Pump and Motor Characteristics (The International System of Units)>

Definition	Symbol	Unit	Pump	Motor
Displacement	Vg	cm^3		
Pressure difference	ΔP	MPa	Pout − Pin	Pin − Pout
Revolution speed	n	min^{-1} (rpm)	n	$\frac{q_v \cdot 10^3 \cdot \eta_v}{V_g}$
Flow rate	qv	L/min	$\frac{V_g \cdot n \cdot \eta_v}{10^3}$	$\frac{V_g \cdot n}{10^3 \cdot \eta_v}$
Torque	T	N・m	$\frac{V_g \cdot \Delta P}{2 \cdot \pi \cdot \eta_{hm}}$	$\frac{V_g \cdot \Delta P \cdot \eta_{hm}}{2 \cdot \pi}$
Volumetric efficiency	η_v	−	$\frac{q_v \cdot 10^3}{V_g \cdot n}$	$\frac{V_g \cdot n \cdot 10^{-3}}{q_v}$
Mechanical efficiency	η_{hm}	−	$\frac{V_g \cdot \Delta P}{2 \pi \cdot T}$	$\frac{2 \pi \cdot T}{V_g \cdot \Delta P}$
Total efficiency	η_t	−	$\frac{q_v \cdot \Delta P \cdot 10^3}{2 \pi \cdot T \cdot n}$	$\frac{2 \pi \cdot T \cdot n \cdot 10^{-3}}{q_v \cdot \Delta P}$
Driving power source (pump input) (motor output)	Ph	k W	$\frac{2 \pi \cdot T \cdot n}{60{,}000}$ or $\frac{q_v \cdot \Delta P}{60 \cdot \eta_t}$	$\frac{2 \pi \cdot T \cdot n}{60{,}000}$ or $\frac{q_v \cdot \Delta P \cdot \eta_t}{60}$

Reference: 1kW = 10^3 N・m/s = 102kgf・m/s
1PS = 735.5 N・m/s = 75kgf・m/s

<Motor related formulas>

■ Revolution load and hydraulic motor selection
Rotation is considered to generate the following loads.
Static friction torque
Breakaway torque $T_1 = \mu_S \cdot m \cdot g \cdot R$〔N・m〕
Dynamic friction torque $T_2 = \mu_D \cdot m \cdot g \cdot R$〔N・m〕
Inertia torque $T_3 = I \cdot \frac{d\omega}{dt} = \frac{GD^2}{4} \cdot \frac{2\pi \cdot N}{60t} = \frac{N \cdot GD^2}{38t}$〔N・m〕
Where,
R: Bearing radius of rotating object (m)
I: Inertia moment of rotating object〔kg・m^2〕
GD^2: Flywheel effect
ω: Revolution angular velocity $\omega = \frac{2\pi \cdot N}{60}$〔rad/$s^2$〕
$\frac{\omega}{t}$: Revolution angular acceleration $\frac{\omega}{t} = \frac{2\pi \cdot N}{60t}$〔rad/$s^2$〕
N: Revolution velocity (min-1)
t: Acceleration time (s)
Sum of GD2 in multi-axis rotation:

$$GD^2 = GD^2_1 + GD^2_2 \cdot \left(\frac{N_2}{N_1}\right)^2 + GD^2_3 \cdot \left(\frac{N_3}{N_1}\right)^2$$

Where,
GD^2: Whole GD2 on one axis
GD^2_1 and N_1: GD^2 on the first axis and revolution velocity
GD^2_2 and N_2: GD^2 on the second axis and revolution velocity
GD^2_3 and N_3: GD^2 on the third axis and revolution velocity
Select a hydraulic motor considering the magnitude of the load torque. The output torque of a hydraulic motor varies at operation start and during operation, and the former is more important.
$T = \frac{P \cdot D \cdot \eta_T}{2\pi}$〔N*m〕 Consequently $D = \frac{2\pi \cdot T}{P \cdot \eta_T}$〔$cm^3$〕
$P = \frac{2\pi \cdot T}{D \cdot \eta_T}$〔MPa〕
$Q = \frac{D \cdot N}{1000 \eta_V}$〔L/min〕
Where,
D: displacement volume of a hydraulic motor〔cm^3〕
T: Output torque of a hydraulic motor〔N・m〕
P: Effective pressure of a hydraulic motor〔MPa〕
N: Revolution velocity of a hydraulic motor〔min^{-1}〕
η_TT: Torque efficiency of a hydraulic motor
η_Tv: Volumetric efficiency of a hydraulic motor

<Cylinder related formulas>

■ Reciprocation load and cylinder selection
A double acting movement is considered to generate the following loads.
Static friction resistance $F_1 = \mu_S \cdot m \cdot g$〔N〕
Dynamic friction resistance $F_2 = \mu_D \cdot m \cdot g$〔N〕
Inertia load $F_3 = m \cdot a = m \cdot \frac{dV}{dt}$〔N〕
Elasticity load $F_4 = k \cdot x$〔N〕
Where,
μs: Moving angle static friction coefficient
μD: Moving surface dynamic friction coefficient
M: Load mass〔kg〕
g: Gravitational acceleration〔m/s^2〕
a: Acceleration〔m/s^2〕
V: Cylinder velocity〔m/s〕
t: Acceleration time〔s〕
k: Spring constant〔N/mm〕
x: Spring displacement〔mm〕
Select a cylinder considering the load magnitude. When the compression force is great, consider the rod buckling strength.
Determine standard dimensions of the hydraulic cylinder to satisfy the calculated dimensions.
Piston rod diameter $d = \sqrt{\frac{4 \times F \cdot S}{\pi \cdot \sigma}}$〔mm〕
Cylinder bore $D = \sqrt{\frac{4(A_1 + A_2)}{\pi}}$〔mm〕
Where,
F: Cylinder load〔N〕
S: Safety factor
σ: Tensile strength〔N/mm^2〕
A_1: Piston rod area $A_1 = \frac{\pi}{4} \cdot d^2$〔$mm^2$〕
A_2: Cylinder effective area $A_2 = \frac{F}{P_R}$〔mm^2〕
P_R: Pressure on cylinder〔MPa〕
Determine the cylinder size and obtain the required pressure and flow.
$P_1 = \frac{F}{A_1}$〔MPa〕
$Q = A_1 \cdot V \times 10^{-3}$〔L/min〕
Where P_1: Pressure required of a cylinder〔MPa〕
Q: Flow rate required of a cylinder〔L/min〕
F: Cylinder thrust〔N〕
A_1: Inlet side pressure receiving area〔mm^2〕
V: Cylinder velocity〔m/min〕

<Valve related formulas>

(1) Pressure and flow rate Q before and after throttle
$Q = 60\, cA\sqrt{\frac{2\Delta P}{\rho}}$
Q: Flow rate〔L/min〕
c: Flow coefficient〔0.6 ~ 0.7〕
A: Throttle area (opening)〔mm^2〕
ΔP: Pressure difference before and after throttle〔MPa〕
ρ: Hydraulic oil density〔kg/m^3〕

(2) Spool leak amount q
$q = \frac{\pi \, db^3}{12 \mu l}(l + 1.5\varepsilon^2)\ \Delta P$
q: Leak amount〔cm^3/s〕
d: Spool diameter〔mm〕
l: Lap length (clearance length)〔mm〕
b: Clearance (hole dia. - shaft dia.) / 〔μm(10^{-3}mm)〕
ε: Eccentricity (spool eccentric distance) / b
μ: Viscosity (Pa*S)
△ P: Front and rear pressure difference〔MPa〕

2. Tightening Torque for Piping (Reference data)

Note: The tightening torque may vary depending on various conditions such as material, specifications, tightening methods, etc. The following figures represent hypothetical conditions:

(1) Metric screw

Coarse pitch strength grade II — Unit : N・m (kgf・m)

Strength grade	M5 × 0.8	M6 × 1	M8 × 1.25	M10 × 1.5	M12 × 1.75	M14 × 2	M16 × 2	M18 × 2.5	M20 × 2.5	M22 × 2.5
6 T	3.3 ± 0.2 (0.34 ± 0.02)	5.6 ± 0.3 (0.57 ± 0.03)	13.7 ± 0.7 (1.40 ± 0.07)	27.17 ± 1.37 (2.77 ± 0.14)	47.5 ± 2.4 (4.84 ± 0.24)	75.9 ± 3.8 (7.74 ± 0.39)	118.7 ± 5.9 (12.1 ± 0.6)	162.8 ± 7.85 (16.6 ± 0.8)	231.5 ± 11.8 (23.6 ± 1.2)	315.8 ± 15.7 (32.2 ± 1.6)
8 T	5.4 ± 0.3 (0.55 ± 0.03)	9.1 ± 0.5 (0.93 ± 0.05)	22.3 ± 1.1 (2.27 ± 0.11)	44.13 ± 2.26 (4.50 ± 0.23)	77.1 ± 3.8 (7.86 ± 0.39)	123.6 ± 5.9 (12.6 ± 0.6)	192.2 ± 9.8 (19.6 ± 1.0)	264.8 ± 13.7 (27.0 ± 1.4)	375.6 ± 18.6 (38.3 ± 1.9)	513.9 ± 25.5 (52.4 ± 2.6)
10 T	7.5 ± 0.4 (0.76 ± 0.04)	12.7 ± 0.6 (1.29 ± 0.06)	30.8 ± 1.6 (3.14 ± 0.16)	61.10 ± 3.04 (6.23 ± 0.31)	106.9 ± 5.9 (10.9 ± 0.6)	170.6 ± 8.8 (17.4 ± 0.9)	266.8 ± 13.7 (27.2 ± 1.4)	366.8 ± 18.6 (37.4 ± 1.9)	519.8 ± 26.5 (53.0 ± 2.7)	711.0 ± 35.3 (72.5 ± 3.6)

Fine pitch strength grade II — Unit : N・m (kgf・m)

Strength grade	M5 × 0.5	M6 × 0.75	M8 × 1	M10 × 1.25	M12 × 1.25	M14 × 1.5	M16 × 1.5	M18 × 1.5	M20 × 1.5	M22 × 1.5
6 T	3.8 ± 0.2 (0.39 ± 0.02)	6.3 ± 0.3 (0.64 ± 0.03)	14.8 ± 0.8 (1.51 ± 0.08)	28.93 ± 1.47 (2.95 ± 0.15)	52.5 ± 2.7 (5.35 ± 0.27)	82.7 ± 4.1 (8.43 ± 0.42)	127.5 ± 6.9 (13.0 ± 0.7)	185.4 ± 9.8 (18.9 ± 1.0)	258.9 ± 12.8 (26.4 ± 1.3)	350.1 ± 17.7 (35.7 ± 1.8)
8 T	6.2 ± 0.3 (0.63 ± 0.03)	10.1 ± 0.5 (1.03 ± 0.05)	24.0 ± 1.2 (2.45 ± 0.12)	46.98 ± 2.35 (4.79 ± 0.24)	85.2 ± 4.2 (8.69 ± 0.43)	134.4 ± 6.9 (13.7 ± 0.7)	206.9 ± 10.8 (21.1 ± 1.1)	301.1 ± 14.7 (30.7 ± 1.5)	420.7 ± 20.6 (42.9 ± 2.1)	568.8 ± 28.4 (58.0 ± 2.9)
10 T	8.6 ± 0.4 (0.88 ± 0.04)	14.0 ± 0.7 (1.43 ± 0.07)	33.3 ± 1.7 (3.39 ± 0.17)	65.02 ± 3.24 (6.63 ± 0.33)	117.7 ± 5.9 (12.0 ± 0.6)	186.3 ± 9.8 (19.0 ± 1.0)	286.4 ± 14.7 (29.2 ± 1.5)	416.8 ± 20.6 (42.5 ± 2.1)	582.5 ± 29.4 (59.4 ± 3.0)	787.5 ± 39.2 (80.3 ± 4.0)

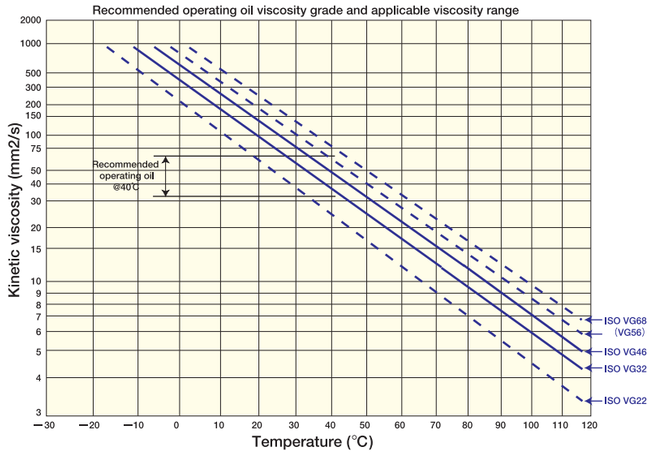
(2) G O-ring boss joint Unit: N・m (kgf・m)

Size	Working pressure	
	20.6MPa	27.5MPa
G1/8	9.0 ± 0.4 (0.92 ± 0.04)	11.8 ± 0.6 (1.2 ± 0.06)
G1/4	22.6 ± 1.0 (2.3 ± 0.1)	29.4 ± 1.0 (3.0 ± 0.1)
G3/8	39.2 ± 2.0 (4.0 ± 0.2)	57.0 ± 2.0 (5.2 ± 0.2)
G1/2	70.6 ± 2.9 (7.2 ± 0.3)	92.2 ± 3.9 (9.4 ± 0.4)
G3/4	157 ± 8 (16.0 ± 0.8)	216 ± 11 (22.0 ± 1.1)

(3) Unified O-ring boss joint Unit: N・m (kgf・m)

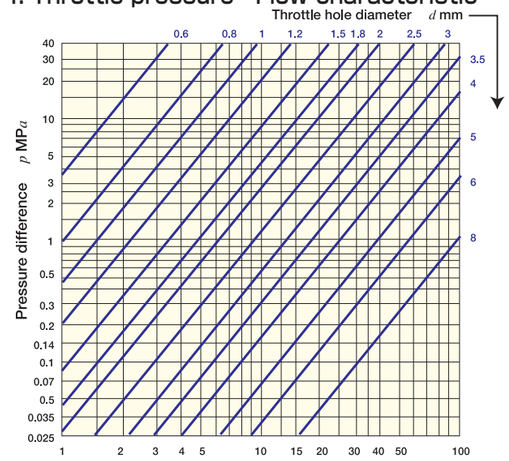
Size	Working pressure	
	20.6MPa	27.5MPa
7/16-20UNF	11.8 ± 0.6 (1.2 ± 0.06)	15.7 ± 0.8 (1.6 ± 0.08)
9/16-18UNF	23.5 ± 1.0 (2.4 ± 0.1)	31.4 ± 1.0 (3.2 ± 0.1)
3/4-16UNF	53.0 ± 2.0 (5.4 ± 0.2)	70.6 ± 2.9 (7.2 ± 0.3)
7/8-14UNF	80.4 ± 3.9 (8.2 ± 0.4)	107.9 ± 4.9 (11.0 ± 0.5)

3. Working oil viscosity - Temperature graphs



Use hydraulic oil ISO VG32 in cold areas and ISO VG46 in warm areas.

4. Throttle pressure - Flow characteristic



Typical Applications and Products

Pumps, valves, motors, and cylinders for excavators and mini-excavators

Pumps, valves, and motors for wheel loaders and skid-steer loaders

Pumps, valves, HSTs, and MMPs for agricultural equipment

Pumps, valves, and cylinders for forklift trucks

Major business locations

Domestic manufacturing plant

■ Sagami Plant

1-12-1,Asamizodai,Minami-ku,Sagamihara-shi,Kanagawa,Japan

- About fifteen minutes by taxi from Sagami-Ono station on the Odakyu Line
- About ten minutes by taxi from Kobuchi station on the JR Yokohama Line

■ Gifu South Plant

505 Dota, Kani-shi, Gifu, Japan

- Two-minute walk from Kanigawa station on the Inuyama Line bound for Mitake-cho and Shinkani (via Inuyama towards) that starts at Meitetsu Nagoya station. (Approx: fifty minutes from Meitetsu Nagoya station in total)

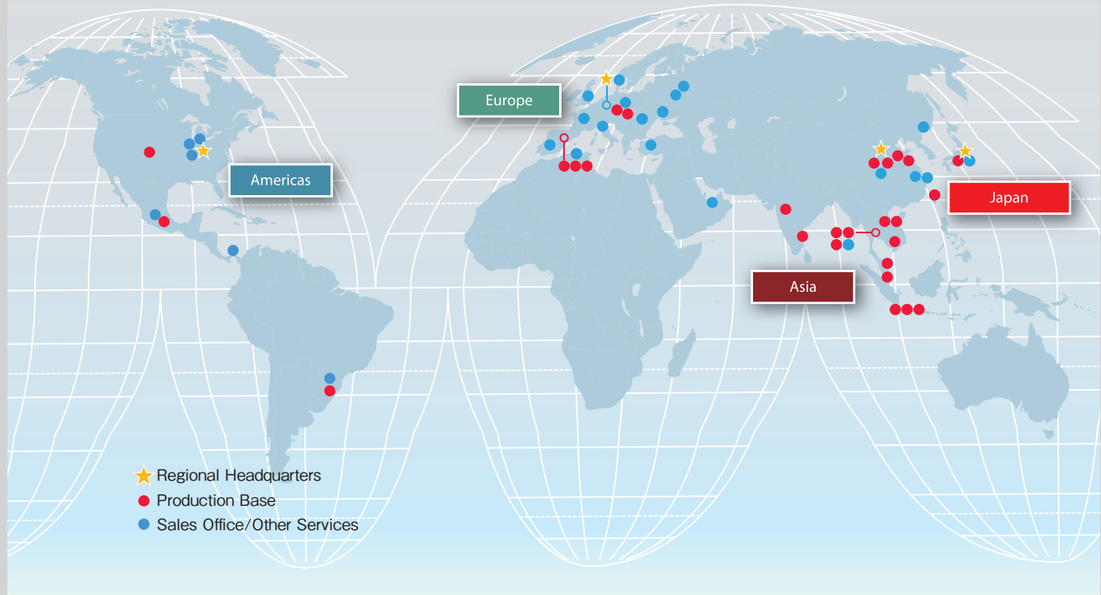
■ Gifu East Plant

60 Dota, Kani-shi, Gifu, Japan

- From Meitetsu "Meitetsu Nagoya" station the Inuyama Line Mitake, Shinkani area (via Inuyama)
  It is approximately five minutes by taxi from "Kanigawa" station

Global Network

KYB's global production system meets the needs of customers everywhere by timely providing high performance, high quality products that satisfy customer requirements.



【Hydraulic equipment business locations】

Other business (automobile, motorcycle, special vehicle, etc.) locations are not indicated.

＜Sales＞

＊ KYB Corporation (Hydraulic Component Business Headquarters)

＜Main line of business＞

- Hydraulics Sales Headquarters: Sales of overall hydraulic equipment
- Hydraulics Sales Dept.: Sales in Japan on an OEM basis, overseas export sales
- Osaka Branch: Sales in Japan on an OEM basis, overseas export sales
- Railway Sales Department: Sales of railway equipment
- KYB America LLC (U.S.): Sales of overall hydraulic equipment in the U.S.
- KYB Corporation (Germany): Sales of overall hydraulic equipment in Europe
- KYB Trading (Shanghai) Co., Ltd.: Sales of overall hydraulic equipment in China

＊KYB Engineering and Service Co., Ltd. Head office（Tokyo）, Office（Saitama）, Sales branch（Sendai, Nagoya, Osaka, Hiroshima）Domestic After sales (distributor sale), Service and OEM

＜Production＞

＜Main plants＞

Sagami Plant: Pumps, motors, HSTs, valves, railway equipment, shock absorbers for industrial equipment, etc.

Gifu South Plant ／ Gifu East Plant: Cylinders, valves for industrial equipment, etc.

＜Main affiliated manufacturing companies＞

KYB-YS Co.,Ltd.: Valves (for compact excavators and forklift trucks), cylinders (for compact excavators), Casting facilities for valves (for excavators) and dampers [Nagano]

Takako Industries, Inc.: Piston pump and motor parts [Kyoto, U.S.A., and Vietnam]

(KIMZ) KYB Industrial Machinery (Zhenjiang):Cylinders (for excavators) [Zhenjiang, China]

＜Technical partners＞

＊HUSCO International, Inc.(U.S.: Valve)

＊Bonfiglioli Transmital (Italy: Motor)

＊Deere & Company (U.S.: Cylinder)

＊CNH Industrial (Itaria:Cylinder)

KYB Corporation

http://www.kyb.co.jp

[Sales] Hydraulic Components Operations
Head Office:
World Trade Center Bldg.,
2-4-1,Hamamatsu-cho,Minato-ku,Tokyo 105-6111,Japan
Hydraulic Sales Dept.
TEL:+81-3-3435-3581 FAX:+81-3-3436-2907

Osaka Branch:
TEK 2nd Bldg.,1-23-20,Esaka-cho,Suita-shi,Osaka 564-0063
TEL:+81-6-6387-3221 FAX:+81-6-6387-3280

[Production]

Sagami Plant:
1-12-1,Asamizodai,Minami-ku,Sagamihara-shi,Kanagawa 252-0328,Japan
TEL:+81-42-746-5511 FAX:+81-42-745-6388

Gifu South Plant:
505 Dota, Kani-shi, Gifu 509-0297, Japan
TEL:+81-574-26-1111 FAX:+81-574-26-1114

Gifu East Plant
60 Dota, Kani-shi, Gifu 509-0206, Japan
TEL:+81-574-26-2135 FAX:+81-574-26-2137

[Overseas Plant]
KYB Industrial Machinery (Zhenjiang)
Wei 3 Road 38, dingmao, Zhenjiang New Zone, Zhenjiang, Jiangsu,212009,China
TEL:+86-511-8889-1008 FAX:+86-511-8888-6848

PT.KYB HYDRAULICS MANUFACTURING INDONESIA
JL. Irian X Blok Pr2 Kawasan Industri MM2100
Desa Cikedokan, Kec, Cikarang Barat, Kabupaten
Bekasi, Indonesia,17845
TEL:+62-02129922211 FAX:+62-2129922211

[Overseas sales]

U.S.A.:
KYB America LLC
140 North Mitchell Court, Addison,IL60101,U.S.A
TEL:+1-630-620-5555 FAX:+1-630-620-8133

Europe:
KYB Corporation
Europe Branch
Kimpler Strasse 336,D-47807 Krefeld,Germany
TEL:+49-2151-93143-50 FAX:+49-2151-93143-30

China:
KYB Trading (Shanghai) Co., Ltd.
Unit B & C, 9F, Block 3, No.269 Tongxie Road,
Changning District, Shanghai, PRC

KYB Engineering & Service Co.,Ltd.

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[Sales]
KYBES (Head Office):
Sumitomo Realty & Development landmark plaza
1-6-7, Shibakouen, Minato-ku, Tokyo 105-0011,Japan
TEL:+81-3-6895-1260 FAX:+81-3-6895-1270

KYBES (Toda establishment):
1159, Bijogi, Toda-shi, Saitama 335-0031,Japan
TEL:+81-48-421-1436 FAX:+81-48-421-1438

KYBES (Sendai Office):
Satobil 4-11-55, Kamiyagari, Izumi-ku, Sendai-shi, Miyagi
981-3121,Japan
TEL:+81-22-771-4820 FAX:+81-22-773-2530

KYBES (Nagoya Branch):
Sakaemachi Building 3-23-31, Nishiki, Naka-ku, Nagoya-shi, Aichi
461-0003,Japan
TEL:+81-52-961-3506 FAX:+81-52-953-9458

KYBES (Osaka Branch):
TEK 2nd Bldg.,1-23-20,Esaka-cho,Suita-shi,Osaka 564-0063
TEL:+81-6-6387-3471 FAX:+81-6-6821-2940

KYBES (West Japan Branch):
Hiroshima Chamber of Commerce Building
5-45, Motomachi, Naka-ku, Hiroshima-shi, Hiroshima 730-0011 ,Japan
TEL:+81-82-228-1488 FAX:+81-82-223-1496

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