microtact hydraulic

ISO 9001

Company Profile

Microtact a leading name in Hydraulic Valves and Systems worldwide, has deliveries across the globe. Microtact has good knowledge of the needs of the customers, with a tradition of quality and service that spans many decades.

We are a ISO 9001 Company, ensuring the quality standards as per International Standards and Specifications.

We at Microtact, guarantee our customers the international experience, reliability and back-up in providing solutions which are both most effective and cost-effective.

Microtact products means more than Three Decades of experience, innovative product development, high quality standards, application know-how and prompt service back-up to all customers.

Ruppel Hydraulik, this name synonymous with movement and actuation – and has been for more than 45 years. Our knowledge and expertise is focused on Hydraulic Systems. From the system solution that exactly fits, to custom manufacture and the associated services – everything is available from one source.

Ruppel Hydraulik - that's 45 years of experience and competence in hydraulics. Ruppel produces and distributes high quality industry components such as Control Blocks, Aggregates, Valves and Cylinders, and provides installation, training, on-site support and repair services.

Ruppel Hydraulik stands for reliability, flexibility and great professional competence. Our outstanding market insight, close collaboration with leading producers and our uncompromising quality make us the partner of choice for national and international machine manufacturers.

Our technical collaboration and supply agreements with Microtact Hydraulic India Pvt. Ltd. enables Microtact to produce quality Hydraulic Systems with German technology in India.

Infrastructure

microtact hydraulic

ISO/ANSI BASIC SYMBOLS

For Fluid Power Equipments And Systems

Lines	
Line, Working (Main)	
Line, Pilot (For Control)	
Line, Liquid Drain	
Hydraulic Flow, Direction of Pneumatic	
Lines Crossing	OR
Lines Joining	
Lines With Fixed Restriction	
Line, Flexible	
Station, Testing, Measurement or Power Take-Off	
Variable Component (run arrow through symbol at 45^0	
Pressure Compen-sated Units (arrow parallel to short side of symbol)	
Temperature cause or Effect	
Vented Reservoir Pressurized	
Line, To Reservoir Above Fluid Level Below Fluid Level	
Vented Manifold	

Pumps	
Hydraulic Pump Fixed Displacement	
Variable Displacement	

Motors and Cylinders	
Hydraulic Motor Fixed Displacement	
Variable Displacement	
Cylinder, Single Acting	
Cylinder, Double Acting	
Single End Rod	
Double End Rod	
Adjustable Cushion advance Only	
Differential Piston	

Miscellaneous Units	
Electric Motor	M
Accumulator, Spring Loaded	
Accumulator, Gas Charged	
Heater	
Cooler	
Temperature Controller	
Filter, Strainer	
Pressure Switch	
Pressure Indicator	
Temperature Indicator	
Component Enclosure	
Direction of Shaft Rotation (assume arrow on near side of shaft)	

Introduction

Whether standard or custom engineered, Microtact Hydraulic Power Unit are designed and built by hydraulic experts to the industry's highest quality standards.

The selection of compatible components is possible because Microtact designs and builds the most complete line of hydraulic components and systems available anywhere. These units are designed for easy trouble-free operation. Standard components and maximum accessibility make service fast and keep down parts inventories.

Standard Units :
Microtact integral Hydraulic Power Unit include motor, pump, valving, reservoir, and oil filter. They can be used, economically and reliably, in virtually any machine application. These hydraulic power units are built to comply with industry standards. The unique, efficient design of Microtact motorized power units, permits easy installation and offers exceptionally high operating dependability. A simple bolt-down of the entire unit is all that is required.

General Data :
Microtact Hydraulic Power Unit Stacking Modules are available in one, two, or three module versions, with reservoir capacities from 12 to 70 litres. The overhead tank design provides recommended positive pump inlet pressure to all modules.

Application Guidance :
It is recommended that the tank capacity in litres be approximately double the pump delivery in LPM. Deviation from this is permitted when adequate precautions are taken to insure that aerated fluid is not being pulled into the pump inlet connection. At low fluid level aeration problems are worst.

General Information :
Microtact compact Hydraulic Power Unit have been designed as per the modular design system and can be thus aligned in different variations to the respective project. The design in a project specific valve interconnection facilitates complex hydraulic systems.

Oil container :
The light aluminum cast fabricated is manufactured as per the standard requirements, with dipping floor design for oil drain screw. The high heat transfer coefficient of Aluminum facilitates good heat output through the container. A resilient jointing averts breathing between the oil container and the tank plate.

General Safety Information :

Read General Safety Information carefully before attempting to assemble, install, operate, or maintain these products. Failure to comply with these instructions may result in personal injury and/or property damage. Retain these instructions for future reference.

1. Make all electrical connections in accordance with the National Electrical Code (NEC) and Occupational Safety and Health Act (OSHA) regarding branch circuit protection and means of motor disconnection to avoid electric shock and fire hazards.

2. Avoid the potential for oil spills and slippery floor conditions by:
   - Maintaining oil reservoir on a level surface
   - Maintaining leak-free hydraulic hose or pipe connections to the unit
   - Not overfilling the unit with hydraulic fluid.

3. Exceeding the recommended operating temperatures may cause system components to become too hot to handle. Overheated components create a potential for burns, leaks, and premature component failure.
4. Ensure that the relief valve setting does not exceed the pressure rating of the unit or of the lowest rated component connected to the power unit. The system pressure setting should be within the horsepower specifications of the unit's electric motor.
   Use the formula

$$Kw = \frac{\text{Flow rate (l/min) x Pressure (psi)}}{600}$$

   for general guidelines

5. Ensure all pressure is released from the system before attempting to remove or repair any valve, pump, or component of the system. Failure to follow this procedure may result in the release of pressurized hydraulic fluid that has the potential to cause severe personal injury.

6. Ensure that all electrical power is disconnected at the junction box before attempting removal or repair of any electric motor starter, valves, or pumps, or other components in the system.

Hydraulic Power Unit Installation and Start-Up Information

Unpacking & Setup

1. Unpacking: All Hydraulic Power Unit are tested and inspected before shipment. Any damage or shortages evident when the equipment is received should be reported immediately to the commercial carrier that transported the equipment.
   Assistance is available from your Microtact representative, if required. Always refer to the purchase order number and Microtact model and serial numbers when contacting Microtact.

2. Select a clean and well-ventilated area to install the power unit. Level the power unit before bolting the reservoir to the floor.

3. Fill the reservoir through the filler-breather with a high quality hydraulic oil:
   For ambient temperature –18° C to 70° C (0° to160° F), use SAE 10 grade oil,
   For ambient temperature 0° C to 90° C (32° to 200° F), use SAE 20 grade oil.
   New hydraulic oil is often highly contaminated.
   Assure the oil is filtered through a high efficiency filter when filling.

4. Fill oil to the top of the full mark on fluid level gauge on the reservoir. Do not overfill.

5. Fill the case of external horizontally mounted piston pumps. Open pump inlet valves, if installed.

6. Connect the powerunit's hydraulic pressure supply and return connections using proper line sizing and cleanliness practices. Connect all other model auxiliary functions per manufacturer's data sheets included with power unit information packet, i.e. temperature switches, pressure switches, water coolers etc.

7. Check the motor nameplate and motor starter identification tag, if your unit is so equipped, for proper voltage requirements. Connect the power unit to a proper electrical source. Jog the motor to check rotation. Rotation must match the direction of the arrow decal(s) affixed to the unit, or the pump may be damaged. Polyphase motors are bidirectional, and proper rotation can be established by reversing any two power leads.

8. System pressures should be set as low as possible to prevent unnecessary fluid heating. On some applications, this setting may be from 3.5 to 14 bar (50 to 200 psi) above necessary static pressures to overcome dynamic pressure drop or to achieve proper acceleration.

9. Pump noise and “crackle” are most often caused by air entering the pump suction inlet. Tiightening the suction fittings will usually eliminate such problems. If the pump fails to prime, vent the pump discharge to atmosphere to establish fluid flow. Continue to jog the electric motor to initially prime the pump and lines. Completion of the jog mode will be achieved when the pressure gauge indicates a positive pressure. The power unit is now ready for operation.

10. The fluid level should be rechecked and maintained so it always registers in the sight gauge.

11. The first few hours of operation are critical to the life of the system. The system should be run at minimum pressure and maximum flow for a minimum of two hours to remove contamination introduced during installation. After the first few hours of operation, any foreign material from the system will be flushed to the return filter. It is good practice to replace filter elements to maintain fluid cleanliness. Fluid temperature should be monitored to achieve stability below 54°C (130° F) range during the initial start-up and commissioning period.

12. For most industrial applications, an operating temperature of 66° C (150° F) is considered maximum. At higher temperatures, reliable and consistent hydraulic control is reduced, component service life is compromised, hydraulic fluid deteriorates and a potential danger to operation personnel is created. Note: At least once a year or every 4,000 operating hours, the air vent filter should be replaced and the entire system checked for possible future difficulties. A fluid sample should be taken and analyzed for particle contamination and chemical composition. Some applications or environmental conditions may dictate such maintenance be performed at more frequent intervals.

Hydraulic Power Unit Installation and Start-Up Information

OPERATION WARNING:
Read General Safety Information section on Page 1 prior to starting any maintenance procedures.

CAUTION

Never run unit without oil.

1. At initial startup, start and stop the motor several times to allow the pump to prime before full flow begins.

2. Bleed all air from the hydraulic system to prevent erratic operation of the pump.

3. Re-check reservoir oil level after a few complete cycles of the hydraulic system and refill, if necessary.

Adjusting Relief Valve/Compensator Setting

The relief valve and/or compensator on this unit is factory set at 0 - 25 bar (0-350 psi), unless otherwise specified at time of order.

Use the formula

$$Kw = \frac{\text{Flow rate (l/min)} \times \text{Pressure (psi)}}{600}$$

for a general guideline before adjusting the relief valve or compensator to ensure you are within the operating limits of the electric motor being used.
Set the relief valve at least 9 bar (120 psi) higher than the compensator if this unit has a pressure compensated pump (see note below). It is recommended that the compensator (or relief valve in the case of a non compensated pump) be approximately 7 bar (100 psi) higher than the operating pressure required. To adjust the setting, refer to the following steps:

1. Turn unit on.

2. Block supply port or extend cylinder to full stroke so oil is going over the relief valve for fixed volume pumps or compensation is reached for variable piston pumps.

3. Check system pressure gauge.

4. Loosen lock nut on relief valve or compensator adjustment valve.

5. Turn the adjustment screw:
   - Clockwise (CW) to increase pressure setting.
   - Counterclockwise (CCW) to decrease pressure setting.

6. When the desired pressure is reached on the pressure gauge, tighten lock nut.

- Note: To set the relief valve on a unit that has a pressure compensator: Close the compensator CW all the way before adjusting the relief. Set the relief to no more than 16 bar (220 psi) above the maximum recommended operating pressure. Open the compensator CCW to the lower of 9 bar (120 psi) below the relief setting, or 7 bar (100psi) above the desired operating pressure.

General Operating Specifications

- Maintain fluid cleanliness at an ISO code of 18/16/14 or better. Use original equipment replacement filter elements.
- Filtration return line 18/16/14 or better
- Operating temperature 66° C (150° F) maximum
- Fluid viscosity 70-250 SUS (13-54 cSt)
- Inlet pressure 5 In. Hg. vacuum – atmospheric
- When looking at the fan end of the motor or shaft end of the pump, the typical motor rotation is clockwise.

Hydraulic Power Unit
Ordering Information

HSS - T* - M* - P* - */* - V
1 2 3 4 5 6

1	HSS - HYDRAULIC UNIT SYSTEM

2	T - RESERVOIR SIZE
	12 = 12 litres
	20 = 20 litres
	30 = 30 litres
	44 = 44 litres
	70 = 70 litres

3	M - MOTOR SELECTION	
	05 = 0.55 kW	**30** = 3.0 kW
	07 = 0.75 kW	**40** = 4.0 kW
	11 = 1.1 kW	**55** = 5.5 kW
	15 = 1.5 kW	**75** = 7.5 kW
	22 = 2.2 kW	

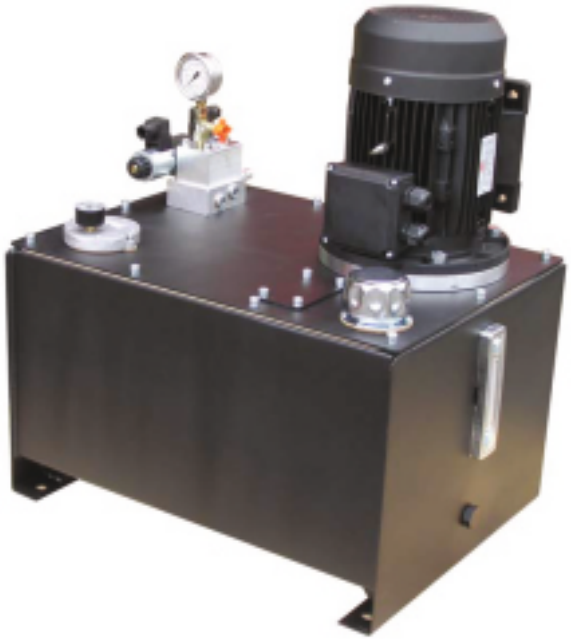
4	P-PUMP FLOW RATE	
	1.6 = 1.6 lpm	**10.4** = 10.4 lpm
	2.4 = 2.4 lpm	**14.2** = 14.2 lpm
	3.2 = 3.2 lpm	**16.9** = 16.9 lpm
	4.8 = 4.8 lpm	**21** = 21 lpm
	5.5 = 5.5 lpm	**26.7** = 26.7 lpm
	6.7 = 6.7 lpm	**31.2** = 31.2 lpm
	9.5 = 9.5 lpm	

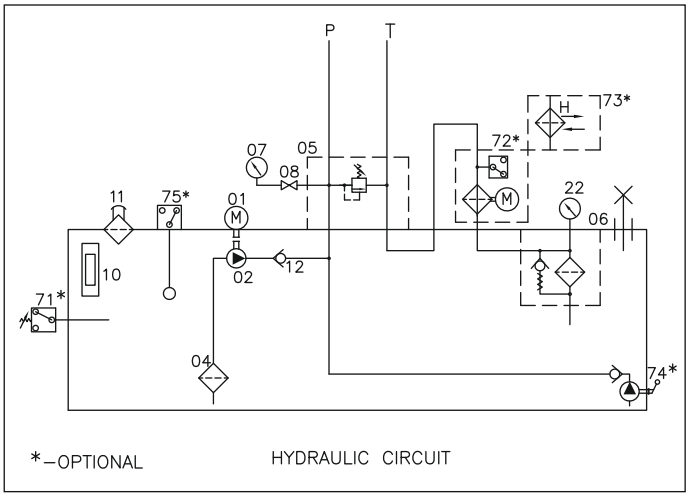
5	ACCESSORIES	
	a = Damping Ring	**f =** Breather Filler
	b = Temperature Display	**g =** Suction Strainer
	c = Temperature Switch	**h =** Return Line Filter
	d = Oil Level Indicator	**I =** Gauge Isolator
	e = Tank Feet	**j =** Pressure Gauge
		W = Without acessories

6	V = VALVE SELECTION

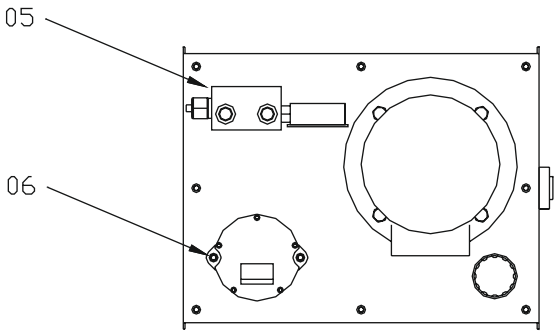
Motor Selection In kW	Max. Pressure in psi with Pump Flow Rate in lpm at 1500 U/min.									Reservoir Size Litres
0.55	2700 psi 1.6 lpm	1800 psi 2.4 lpm	1350 psi 3.2 lpm	1100 psi 3.9 lpm	900 psi 4.8 lpm	800 psi 5.5 lpm	650 psi 6.7 lpm	- - -	- - -	12-44
0.75	3000 psi 1.6 lpm	2500 psi 2.4 lpm	1850 psi 3.2 lpm	1500 psi 3.9 lpm	1250 psi 4.8 lpm	1000 psi 5.5 lpm	900 psi 6.7 lpm	600 psi 9.5 lpm	- - -	12-44
1.1	3000 psi 2.4 lpm	2700 psi 3.2 lpm	2200 psi 3.9 lpm	1800 psi 4.8 lpm	1500 psi 5.5 lpm	1300 psi 6.7 lpm	900 psi 9.5 lpm	840 psi 10.4 lpm	600 psi 14.2 lpm	12-44
1.5	3000 psi 3.2 lpm	3000 psi 3.9 lpm	2500 psi 4.8 lpm	2100 psi 5.5 lpm	1700 psi 6.7 lpm	1250 psi 9.5 lpm	1150 psi 10.4 lpm	840 psi 14.2 lpm	700 psi 16.9 lpm	12-44
2.2	3000 psi 4.8 lpm	3000psi 5.5 lpm	2600 psi 6.7 lpm	1850 psi 9.5 lpm	1650 psi 10.4 lpm	1200 psi 14.2 lpm	1000 psi 16.9 lpm	840 psi 21.0 lpm	700 psi 26.7 lpm	20 -70
3.0	3000 psi 6.7 lpm	2500 psi 9.5 lpm	2300 psi 10.4 lpm	1670 psi 14.2 lpm	1400 psi 16.9 lpm	1100 psi 21.0 lpm	900 psi 26.7 lpm	750 psi 31.2 lpm	- - -	20 -70
4.0	3000 psi 9.5 lpm	3000 psi 10.4 lpm	2200 psi 14.2 lpm	1880 psi 16.9 lpm	1500 psi 21.0 lpm	1200 psi 26.7 lpm	1000 psi 31.2 lpm	- - -	- - -	20 -70
5.5	3000 psi 14.2 lpm	2600 psi 16.9 lpm	2000 psi 21.0 lpm	1600 psi 26.7 lpm	1400 psi 31.2 lpm	- - -	- - -	- - -	- - -	44 -70
7.5	3000 psi 16.9 lpm	2800 psi 21.0 lpm	2200 psi 26.7 lpm	1900 psi 31.2 lpm	- - -	- - -	- - -	- - -	- - -	44 -70

Standard Hydraulic Power Unit

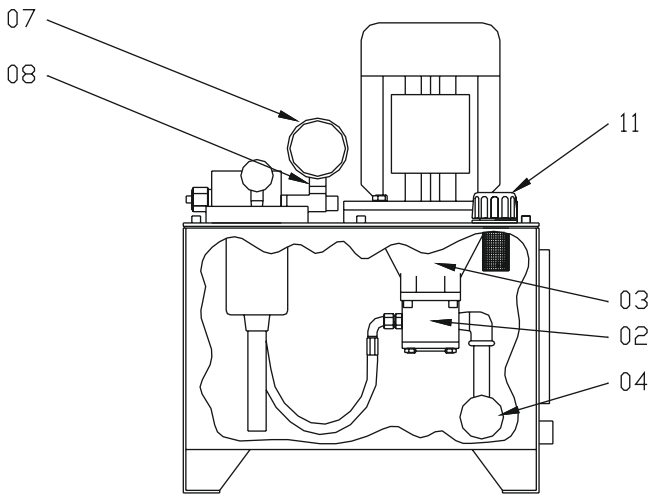


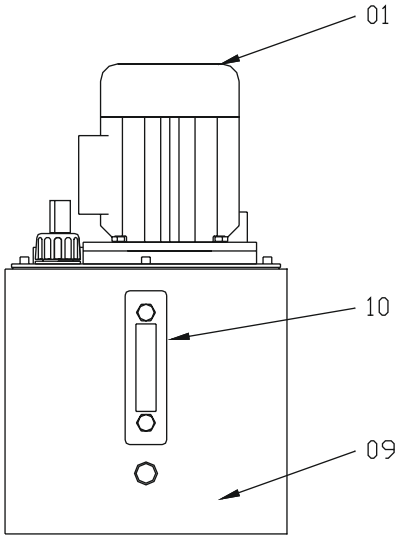


Hydraulic Power Unit Over View



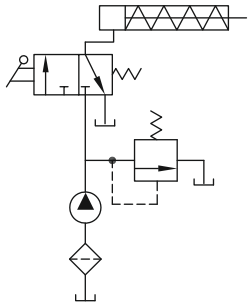
01 Motor
02 Pump
03 Bellhousing and coupling
04 Suction filter
05 Manifold base plate
06 Return Filter & Indicator
07 Pressure Gauge
08 Gauge Isolator
09 Tank
10 Level Gauge
11 Filler Breather





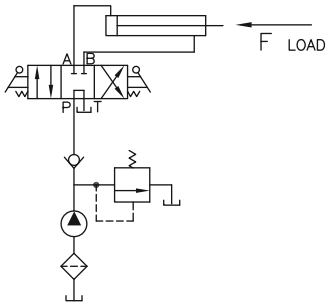
Circuit Diagrams

Control of a Single Acting Hydraulic Cylinder



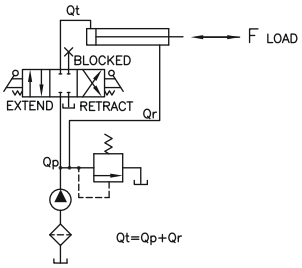
Two Position, Three Way
Manually Actuated
Spring Offset, DCV

Control of a Double Acting Hydraulic Cylinder



Three Position, Four Way
Manually Actuated
Spring Centered, DCV

Regenerative Circuit

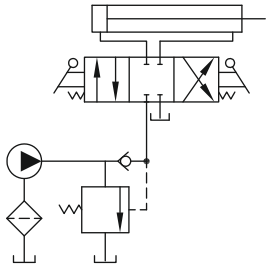


Pressurized fluid,
discharge returned to system

Speed up, extending speed

Retraction bypass, DCV

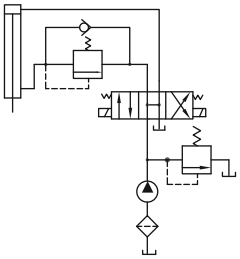
Pump Unloading circuit



Unloading valve, unloads the pump at the ends of retracting strokes

As well as in spring centered position of DCV

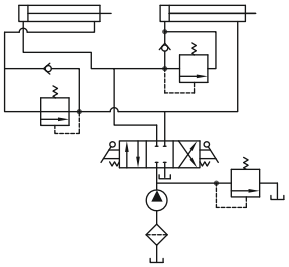
Counterbalance Valve



To keep vertically mounted cylinder in upward position while pump is idling.

Counterbalance valve is set to open at slightly above the pressure required to hold the piston up.

Hydraulic Cylinder Sequence Circuit



Left Cylinder extends completely and then Right Cylinder extends.

Right Cylinder retracts fully and then Left Cylinder retracts.

Trouble Shooting Guide

Excessive Noise

PROBLEM	CAUSE	REMEDY
Noisy Pump	Cavitation	• Replace dirty filters. • Wash strainers in solvent compatible with system fluid. • Clean clogged inlet line. • Clean reservoir breather vent. • Change system fluid. • Change to proper pump-drive motor speed. • Overhaul or replace supercharge pump. • Fluid may be too cold.
		▪ Eliminate air in the fluid by any or all of the following: - Tighten leaky inlet connection. - Fill reservoir to proper level (with rare exception all return lines should be below fluid level in reservoir). - Bleed air from system. - Replace pump shaft seal (and shaft if worn at seal journal)
	Pump worn or damaged	• Overhaul or replace.
Noisy Motor	Coupling misaligned	• Align unit, if assembled with pump/motor adapter and couplings, and check condition of seals, bearings, and couplings.
Noisy Relief Valve	Setting too low or too close to another valve	• Install pressure gauge and adjust to correct pressure.
	Worn poppet and seat	• Overhaul or replace.

Trouble Shooting Guide

Excessive Heat

PROBLEM	CAUSE	REMEDY
Pump Heated	Fluid heated	• Install pressure gauge and adjust to correct pressure (keep at least 9 bar (130 psi) difference between valve settings). Also, refer to Fluid Heated below.
	Cavitation	• Replace dirty filter. • Clean clogged inlet line. • Clean reservoir breather vent. • Change system fluid. • Change to proper pump drive motor speed. • Air in fluid Any or all of the following: - Tighten leaky connections. - Fill reservoir to proper level (with rare exception all return lines should be below fluid level in reservoir). - Bleed air from system. - Replace pump shaft seal (and shaft, if worn at seal journal
	Relief or unloading valve set too high	• Install pressure gauge and adjust to correct pressure. (Keep at least 9 bar (130 psi) difference between valve setting).
	Excessive load	• Align unit, if assembled with pump/motor adapter and couplings and check condition of seals and bearings. Locate and correct mechanical binding.
		• Check for workload in excess of circuit design.
	Pump worn or damaged	• Overhaul or replace.
Motor Heated	Fluid heated	• Install pressure gauge and adjust to correct pressure. (Keep at least 9 bar (130 psi) difference between valve setting).
	Relief valve or unloading valve set too high	• Install pressure gauge and adjust to correct pressure. (Keep at least 9 bar (130-psi) difference between valve setting).
	Excessive load	• Align unit, if assembled with pump/motor adapter and couplings, and check condition of seals and bearings. Locate and correct mechanical binding.
		• Check for workload in excess of circuit design.
	Motor worn or damaged	• Overhaul or replace
	Relief Valve setting incorrect	• Install pressure gauge and adjust to correct pressure (keep at least 9 bar (130 psi) difference between valve settings).
	Worn or damaged relief valve	• Overhaul or replace.
Excessive Heat	Unloading valve set too high	• Install pressure gauge and adjust to correct pressure (keep at least 9 bar (130-psi) difference between valve settings).
		• Also refer to Fluid Heated below
	Fluid dirty or low supply	Change filters and system fluid if incorrect viscosity. Fill reservoir to proper level.
	Incorrect fluid viscosity	• Change filters and system fluid if incorrect viscosity. • Fill reservoir to proper level.
	Faulty fluid cooling system	• Clean cooler. Repair or replace cooler.
	Worn pump, valve, motor, cylinder, or other component	• Overhaul or replace.
Fluid Heated	System pressure too high	• Install pressure gauge and adjust to correct pressure (keep at least 9 bar (130-psi) difference between valve settings).

Trouble Shooting Guide

Incorrect Flow

PROBLEM	CAUSE	REMEDY
No Flow	Pump not receiving fluid	• Replace dirty filters. • Clean clogged inlet line. • Clean reservoir breather vent. • Fill reservoir to proper level. • Overhaul or replace supercharge pump.
	Pump drive motor not operating	• Overhaul or replace.
	Pump to drive coupling sheared	• Check for damaged pump or pump drive. Replace and align coupling.
	Pump drive motor turning in wrong direction	• Reverse rotation.
	Directional control set in wrong position	• Check position of manually operated controls. • Check electrical circuit on solenoid operated controls. • Repair or replace pilot pressure pump.
	Entire flow passing over relief valve	• Adjust.
	Damaged pump	• Check for damaged pump or pump drive. • Replace and align coupling
	Improperly assembled pump	• Overhaul or replace.
Low Flow	Flow-control set too low	• Adjust.
	Relief or unloading valve set too low	• Adjust.
	Flow bypassing thru partially open valve	• Overhaul or replace-or check position of manually operated controls. • Check electrical circuit on solenoid operated controls. • Repair or replace pilot pressure pump.
	External leak in system	• Tighten leaky connections. Bleed air from system.
	Yoke actuating device inoperative (variable displacement pumps)	• Overhaul or replace.
	RPM of pump drive motor incorrect	• Replace with correct unit.
	Worn pump, valve, motor, cylinder, or other components.	• Overhaul or replace.
Excessive Flow	Flow-control set too high	• Adjust.
	Yoke actuating device inoperative (variable displacement pumps)	• Overhaul or replace.
	RPM of pump drive motor incorrect	• Replace with correct unit.
	Improper sized pumps for replacement	• Replace with correct unit.

Trouble Shooting Guide

Incorrect Pressure

PROBLEM	CAUSE	REMEDY
No Pressure (No Flow)	Pump not receiving fluid	• Replace dirty filters. • Clean clogged inlet line. • Clean reservoir breather vent. • Fill reservoir to proper level. • Overhaul or replace super-charge pump.
	Pump drive motor not operating	• Overhaul or replace.
	Pump-to-drive coupling sheared	• Check for damaged pump or pump drive. Replace and align coupling.
	Pump drive motor turning in wrong direction.	• Reverse rotation.
	Directional control set in wrong position	• Check position of manually operated controls. • Check electrical circuit on solenoid operated controls. • Repair or replace pilot-pressure pump.
	Entire flow passing over relief valve	• Adjust
	Damaged pump	• Check for damaged pump or pump drive. Replace and align coupling.
	Improperly assembled pump	• Overhaul or replace.
Low Pressure	Pressure relief path exists	• Refer to remedies above for No Pressure and the following remedies.
	Flow-control set too low	• Adjust.
	Relief/unloading valve set too low	• Adjust.
	Flow bypass thru partially open valve	• Overhaul or replace-or check position of manually operated control. • Check electrical circuit on solenoid operated controls. • Repair or replace pilot-pressure pump.
	External leak in system	• Tighten leaky connections. • Bleed air from system.
	Yoke actuating device inoperative (variable displacement pump)	• Overhaul or replace.
	RPM of pump-drive motor incorrect	• Replace with correct unit.
	Worn pump, valve, motor, cylinder, etc.	• Overhaul or replace.
	Pressure reducing set too low	• Check position of manually operated control. • Check electrical circuit on solenoid-operated controls. • Repair or replace pilot-pressure pump
	Damaged pump, motor, or cylinder	• Overhaul or replace
Erratic Pressure	Air in fluid	• Tighten leaky connections. • Fill reservoir to proper level and bleed air from system.
	Worn relief valve	• Overhaul or replace.
	Contamination in fluid	• Replace dirty filters and system fluid.
	Accumulator defective or has lost charge	• Charge to correct pressure. • Check gas valve for leakage. • Overhaul if defective.
	Worn pump, motor, or cylinder	• Overhaul or replace.
Excessive Pressure	Incorrect setting of pressure reducing, relief, or unloading valve	• Adjust
	Yoke actuating device inoperative (variable displacement pumps)	• Overhaul or replace.
	Pressure reducing, relief, or unloading valve worn or damaged	• Overhaul or replace.

Trouble Shooting Guide

Faulty Operation

PROBLEM	CAUSE	REMEDY
No Movement	No flow or pressure	• Refer to Incorrect Flow Chart.
	Limit or sequence device (mechanical, electrical, or hydraulic) inoperative or misadjusted	• Overhaul or replace.
	Mechanical bind	• Locate bind and repair.
Slow Movement	Fluid viscosity too high	• Low flow Refer to Incorrect Flow chart • Fluid may be too cold or should be changed to clean fluid of correct viscosity.
	Insufficient control pressure for valves	• Refer to Incorrect Pressure chart.
	No lubrication of machine ways or linkage	• Lubricate.
	Worn or damaged cylinder or motor	• Overhaul or replace.
Erratic Movement	Erratic pressure	• Refer to Incorrect Pressure chart.
	Air in fluid	• Any or all of the following: - Tighten leaky inlet connection - Fill reservoir to proper level (with rare exception all return lines should be below fluid level in reservoir.) - Bleed air from system. - Replace pump shaft seal (and shaft, if worn at seal journal).
	No lubrication of machine ways or linkage	• Lubricate
	Erratic command signal	• Repair command console or interconnecting wires.
	Worn or damaged cylinder or motor	• Overhaul or replace.
Excessive Speed or Movement	Excessive flow	• Refer to Incorrect Flow chart.

Conversion Equations

Application Formulas

- 1 GPM at 1500 PSI = 1 HP (General Rule)
- 1 Gallon = 231 Cubic Inches (3.7854 Liters)
- 1 Gallon Oil = 7.08 Lbs.
- 1 bar = 14.5 PSI
- 25.4mm = 1 Inch
- 1 HP = 42.4 BTU/Min.
- 1 Gallon = 3.7854 Liters

$$HP = \frac{GPM \times PSI}{1714 \times \text{Pump Efficiency}}$$

$$PSI = \frac{1714 \times \text{Pump Efficiency} \times HP}{GPM}$$

$$GPM = \frac{1714 \times \text{Pump Efficiency} \times HP}{PSI}$$

$$HP = \frac{\text{Torque (in.-lbs.)} \times RPM}{63025}$$

$$\text{Torque} = \frac{HP \times 63025}{RPM}$$

$$RPM = \frac{HP \times 63025}{\text{Torque}}$$

Motor Information
At 440V — 3-Phase Motor Draws 1.25 AMP/HP
At 220V — 3-Phase Motor Draws 2.5 AMP/HP
At 110V — Single Phase Motor Draws 10 AMP/HP

Hydraulic Formulas

Horsepower :

$$\text{Horsepower} = \frac{\text{GPM} \times \text{psi}}{1714}$$

Torque:

$$\text{Torque (lb. in.)} = \frac{\text{CU IN./REV.} \times \text{psi}}{2}$$

$$\text{Torque (lb. in.)} = \frac{\text{HP} \times 63025}{\text{RPM}}$$

Flow :

$$\text{Flow (gpm)} = \frac{\text{CU IN./REV.} \times \text{RPM}}{231}$$

Overall Efficiency :

$$\text{Overall efficiency} = \frac{\text{OUTPUT HP}}{\text{INPUT HP}} \times 100$$

Volumetric Efficiency:

$$\text{Volumetric efficiency (pump)} = \frac{\text{OUTPUT GPM}}{\text{THEORETICAL GPM}} \times 100$$

$$\text{Volumetric efficiency (motor)} = \frac{\text{THEORETICAL GPM}}{\text{INPUT GPM}} \times 100$$

CONVERSION FACTORS:

1 hp = 33,000 ft. lbs. per minute
1 hp = 42.4 btu per minute
1 hp = 0.746 kwhr (kilowatt hours)
1 U. S. gallon = 231 cubic inches.

Pipe volume varies as the square of the diameter; volume in gallons = $0.0034\ D^2L$

where: D = inside diameter of pipe in inches
L = length in inches.

$$\text{Velocity in feet per second} = \frac{0.408 \times \text{flow (gpm)}}{D2}$$

where: D = inside diameter of pipe in inches.

Atmospheric pressure at sea level = 14.7 psi
Atmospheric pressure decreases approximately 0.41 psi for each one thousand feet of elevation up to 23,000 feet.

Pressure (psi) = feet head x 0.433 x specific gravity.
Specific gravity of oil is approximately 0.85.
Thermal expansion of oil is approximately 1 cu. in. per 1 gal. per 10°F rise in temperature.

Practical hydraulic formulae

Geometric flow rate (l/min) (pumps and motors)

$$= \frac{\text{Geometric displacement (cm}^3\text{/r)} \times \text{shaft speed (r/min)}}{1000}$$

Theoretical shaft torque (Nm) (pumps and motors)

$$= \frac{\text{Geometric displacement (cm}^3\text{/r)} \times \text{pressure (bar)}}{20\ \pi}$$

Shaft power (kW)

$$= \frac{\text{Torque at shaft (Nm)} \times \text{shaft speed (r/min)}}{9550}$$

Hydraulic power (kW)

$$= \frac{\text{Flow rate (l/min)} \times \text{pressure (bar)}}{600}$$

Heat equivalent of hydraulic power (kJ/min)

$$= \frac{\text{Flow rate (l/min)} \times \text{pressure (bar)}}{10}$$

Geometric flow rate (l/min) (cylinders)

$$= \frac{\text{Effective area (cm}^2\text{)} \times \text{piston speed (m/min)}}{10}$$

Theoretical force (N) (cylinders)

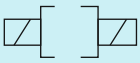
$$= \text{Effective area (cm}^2\text{)} \times \text{pressure (bar)} \times 10$$

Velocity of fluid in pipe (m/s)

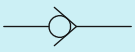
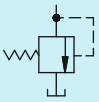
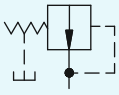
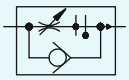
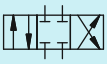
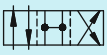
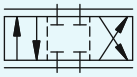
$$= \frac{\text{Flow rate (l/min)} \times 21{,}22}{D^2}$$

where D = inside diameter of pipe in millimeters.

Methods of Operation

SPRING	
MANUAL	
PUSH BUTTON	
PUSH-PULL LEVER	
PEDAL OR TREADLE	
MECHANICAL	
DETENT	
PRESSURE COMPENSATED	
SOLENOID, SINGLE WINDING	
SERVO MOTOR	
PILOT PRESSURE REMOTE SUPPLY INTERNAL SUPPLY	

Valves

CHECK	
ON-OFF (MANUAL SHUT-OFF)	
PRESSURE RELIEF	
PRESSURE REDUCING	
FLOW CONTROL, ADJUSTABLE NON-COMPENSATED	
FLOW CONTROL, ADJUSTABLE (TEMPERATURE AND PRESSURE COMPENSATED)	
TWO POSITION TWO CONNECTION	
TWO POSITION THREE CONNECTION	
TWO POSITION FOUR CONNECTION	
THREE POSITION FOUR CONNECTION	
TWO POSITION IN TRANSITION	
VALVES CAPABLE OF INFINITE POSITIONING (HORIZONTAL BARS INDICATE INFINITE POSITIONING ABILITY)	

COLOR CODE FOR FLUID POWER SCHEMATIC DRAWINGS

COLOR CODE

Function	Color
Intensified Pressure	Black
Supply	Red
Charging Pressure	Intermittent Red
Reduced Pressure	Intermittent Red
Pilot Pressure	Intermittent Red
Metered Flow	Yellow
Exhaust	Blue
Intake	Green
Drain	Green
Inactive	Blank

DEFINITION OF FUNCTIONS

Function	Definition
Intensified Pressure	Pressure in excess of supply pressure which is induced by a booster or intensifier.
Supply Pressure	Power-actuating fluid.
Charging Pressure	Pump-inlet pressure that is higher than atmospheric pressure.
Reduced Pressure	Auxiliary pressure which is lower than supply pressure.
Pilot Pressure	Control-actuating pressure.
Metered Flow	Fluid at controlled flow rate, other than pump delivery.
Exhaust	Return of power and control fluid to reservoir.
Intake	Sub-atmospheric pressure, usually on intake side of pump.
Drain	Return of leakage fluid to reservoir.
Inactive	Fluid which is within the circuit, but which does not serve a functional purpose during the phase being represented.