INSTRUCTION MANUAL

Simrad RPU80/160/300
Reversible Pump

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Warning!

The equipment to which this manual applies must only be used for the purpose for which it was designed. Improper use or maintenance may cause damage to the equipment or injury to personnel. The user must be familiar with the contents of the appropriate manuals before attempting to operate or work on the equipment.

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Instruction Manual

This manual is intended as a reference guide for correctly installing and maintaining the RPU80, RPU160 and RPU300 reversible pumps.

Please take time to read this manual to get a thorough understanding of the reversible pump and its relationship to a complete autopilot system.

Other documentation material that is provided with your system includes a warranty card. This must be filled out by the authorized dealer that performed the installation and mailed in to activate the warranty.

Document revisions

	Documentation department		Hardware/Software design		Project/Product Management	
Rev	Date	Sign	Date	Sign	Date	Sign
D	24/10-96	N.G.	24/10-96	I.K.	24/10-96	Th.H.
E	20/2-97	N.G.	20/2-97	I.K.	20/2-97	Th.H.
F	5/1-98	N.G.	5/1-98	I.K.	5/1-98	Th.H.
G	20/1-99	N.G.	20/1-99	I.K.	20/1-99	Th.H.
H	21/1-00	N.G.	21/1-00	I.K.	21/1-00	Th.H.
I	17/10-00	N.G.	17/10-00	I.K.	17/10-00	Th.H.
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Document history

Rev. D Page 1-3: Bosvik steering gear included. Page 3-1 and 3-2: Changes in notes. Page 4-2: New warning added. Page 7-2: New subparagraph added to paragraph 7.3.

Rev. E Page 3-1 and 3-2: Changes in notes due to modification of RPU80. Page 4-2: Warning removed. Page 7-1, Paragraph 7.3: Changed text in brackets. Page 8-1: Modified drawing. Page 9-1 and 9-2: Spare part lists modified due to modification of RPU80.

Rev. F Minor corrections for rudder speed and rudder time in section 1 and 2.

Rev. G New layout. Steering gear table (Paragraph 1.2) revised. New fittings included, pages 17 and 31.

Rev. H Corrected part no. for valve block, page 32. New distributor list.

Rev. I Corrected formula on page 12. Added note on page 17. New distributor list.

Rev. J Added colour for the o-ring at pos. 18, page 33 to avoid mix up.

Rev. K Fig. 9.1. Pos 8. Spring. New part. no. 21100193. Added text and illustrations under ‘Siting’ page 17.

Rev. L Fracmo motors substituted by Lemac motors. All drawings in chapter 8 revised.

Rev. M New part no. on RPU80 Lemac motor, page 34. New distributor list.

Rev. N New paragraph under ‘Fault tracing’ regarding poor brushes. Updated with new autopilot computers.

Contents

1 INTRODUCTION

Note ! *This manual does not cover a previous model RPU80 with serial numbers 101-248. The model is covered by the RPU100 Reversible Pump Manual. Minor modifications where made to the RPU100 model and they are described in a separate "Technical Information" no. 01/94.*

1.1 General

Hydraulic steering systems are now being used in every category of small vessel. In many respects hydraulic steering is preferable to mechanical steering.

Hydraulic systems normally comprise of two main components, a steering wheel pump and steering cylinder(s). The steering wheel pump may be either a gear pump or a plunger pump. Which ever type is installed, steering is achieved by turning the steering wheel in either direction causing oil from the wheel pump to be supplied to the appropriate side of the cylinder. Oil is returned via the opposite side of the cylinder back to the pump.

The linear motion of the cylinder rod is transformed to a rotary motion by the tiller, which turns the rudder shaft and rudder.

Check valves (non-return valves) are usually incorporated to prevent the rudder driving the steering wheel pump.

If an autopilot is to be included in such a hydraulic steering system, then the oil flow providing the rudder movement must be controlled by electrical signals from the autopilot.

The maximum flow rate of RPU80, RPU160 and RPU300 is 0,8 l/min., 1,6 l/min. and 3,0 l/min. respectively, measured at a pressure of 10 bar with nominal voltage (12 VDC) on the motor terminals.

Note ! *RPU300 measurements are based on charging voltage (14,4VDC)*

The flow rate is controlled by the output voltage from the autopilot's junction unit/computer. When connected to autopilots using the J300, J3000, all "X"-models of junction units and ACXX Autopilot Computers, the output voltage that controls the motor speed is proportional to the heading error from the autopilot.

This will give slow and smooth rudder movements when steering on a straight course in calm weather, but will also ensure fast rudder response for bigger course changes or course deviations caused by rough sea conditions.

An automatic "Rudder test" function in these autopilots will also limit the output equivalent to a rudder speed of 8 degrees per second which is optimum for autopilots with proportional rudder control. (Equals to approx. 9 seconds for 35-0-35 degrees rudder travel). Consequently when operating a steering lever or the Port/Stbd push buttons on the autopilot in manual mode, the rudder speed will be 8 degrees per second, whilst the rudder speed when in "Auto" mode normally is less and proportional to the heading error.

If the pump unit is used with older autopilot models like AP2500, AP200 or AP45, using J1000B, J101A or J45A junction units, the output level/flow rate is set by a potentiometer within the junction unit.

External rudder speed control can be provided by a separate potentiometer connected to J1000B/J101A/J45A and mounted near the steering position.

The flow rate must be chosen such that optimum automatic steering is obtained.

Experience has shown that a rudder time between 10 and 15 seconds hard over to hard over normally gives the best steering performance. In order to achieve a rudder time within these limits, the flow rate must correspond with the cylinder volume.

Some boats will perform good automatic steering even with a hardover time of 20 seconds. The flow-rate, however, is reduced by increasing load, i.e. increased pressure. It is therefore not recommended to select a pump with a flow rate that is not able to move the rudder hardover to hardover in 20 seconds as shown on the nomogram on page 13. Study the tables on the following pages for appropriate pump selection, and use the nomogram on page 13 as a guideline.

On page 7 to 11 are listed some well known hydraulic steering gears together with the corresponding values for the rudder time hardover to hardover.

The values are calculated from the maximum flow rate at 10 bar pressure.

If a specific system is not listed, the cylinder volume must be calculated as explained in section 2.1.

Any well known hydraulic oil with viscosity between 15-70 cSt at 40°C can be used with RPU80, RPU160 and RPU300.

Use higher viscosity in warmer areas.

1.2 Hydraulic steering gear suitable for the RPU80/RPU160/RPU300

All cylinders are single and balanced type unless otherwise specified. If the cylinder type in your boat is not listed, please refer to section 2.

Steering gear	Cylinder volume cm^3 (cu.in.)	Estimated rudder time in seconds hard over to hard over		
		RPU80	RPU160	RPU300
BCS (Italian)				
MT 25	98 (6,0)	7		
MT 35	130 (7,9)	10	5	
MT 60	261 (15,9)	20	10	5
MT 120	506 (30,9)		19	10
MT 250	918 (56,0)			18
Bosvik (Norwegian)				
EB40	92 (5,6)	7		
EB55	124 (56,0)	9		
Capilano, Flexatrol (Canadian). See SEASTAR.				
Harmek (Norwegian)				
Marius 175	95 (5,8)	7		
Marius 200	153 (9,3)	11	6	
Marius 250	153 (9,3)	11	6	
Marius 275	295 (18,0)	22	11	6
Marius 300	700 (42,7)			14
HC (HYDRO-CONTROL) (German)				
Regina 50	112 (6,8)	8		
Regina 100	172 (10,5)	13	6	
HYNAUTIC (USA)				
K-1	198 (12,1)	15	7	
K-2	288 (17,6)	21	11	6
K-3	378 (23,1)		14	7
K-4	500 (30,5)		19	10
K-7	205 (12,5)	15	8	
K-8	642 (39,2)			13
K-10	123 (7,5)	9		

Steering gear	Cylinder volume cm^3 (cu.in.)	Estimated rudder time in seconds hard over to hard over		
		RPU80	RPU160	RPU300
HYNAUTIC (continued)				
K-18	115 (7,0)	9		
K-19	147 (9,0)	11	6	
K-22, K27	218 (13,3)	16	8	
K-28, K29	262 (16,0)	20	10	
K-31	418 (25,5)		16	8
K-51	167 (10,2)	13	6	
Old models				
K-25	218 (13,3)	16	8	
K-26	262 (16,0)	20	10	5
K-32	327 (20,0)		12	7
K-33	374 (22,8)		14	7
Twin (unbalanced) cylinder				
K-5, (x2)	425 (26)		16	9
K-11, K-13 (x2)	360 (22,0)		14	7
K-12, K-14 (x2)	282 (17,2)	21	11	
Servo cylinders				
PSK-10	108 (6,6)	8	17	
PSK-11	225 (13,75)	17	8,5	
LECOMBLE & SCHMITT (France)				
VHM 228	106 (6,5)	8		
VHM 232	138 (8,4)	10	5	
VHM 40 DTP	191 (11,7)	14	7	
VHM 40-254	239 (14,6)	18	9	
VHM 50 DTP	352 (21,5)		13	7
VHM 50-300	464 (28,3)		17	9
VHM 45 228	268 (16,4)	20	10	5
VHM 60 DT	505 (30,8)		19	10
VHM 60-300	664 (40,5)			13

Steering gear	Cylinder volume cm^3 (cu.in.)	Estimated rudder time in seconds hard over to hard over		
		RPU80	RPU160	RPU300
LECOMBLE & SCHMITT – Old models:				
VHM 32-DT	90 (5,5)	7		
VHM 35-DTP	152 (9,3)	11	6	
VHM 35-DT	129 (7,9)	10	5	
VHM 45-DT	240 (14,6)	18	9	
SEASTAR				
BA 125-7	118 (7,2)	9		
BA 150-7	167 (10,2)	13	6	
BA175-7	225 (13,7)	17	8	
BA 200-7	310 (18,9)		12	6
Twin (unbalanced) cylinder				
150-7 TM (x2)	377 (23,0)		14	8
175-7 TM (x2)	508 (31,0)		19	10
200-7 TM (x2)	672 (41,0)			13
175-11 TM (x2)	738 (45,0)			15
200-11 TM (x2)	1000 (61,0)			20
SEIPEM (Italian)				
AF230	77 (4,7)	6		
CF/CS 230	113 (6,9)	8		
CV 51	82 (5,0)	6		
CV 76	118 (7,2)	9		
CV111	160 (9,8)	12		
CM 151	320 (19,5)		12	6
CM 251	440 (26,9)		17	9
CM 351	530 (32,3)		20	11
CM 501	541 (33,0)		20	11
CM 651	706 (43,1)			14
CW 801	1000 (61,0)			20

Steering gear	Cylinder volume cm^3 (cu.in.)	Estimated rudder time in seconds hard over to hard over		
		RPU80	RPU160	RPU300
SERVI (Norwegian)				
MA 60	141 (8,6)	11	5	
MA 120	294 (17,9)	22	11	6
MA 200	500 (30,5)		19	10
MA 300	750 (45,8)			15
SLEIPNER, HYDRIVE (Norwegian)				
LS 35	90 (5,5)	7		
LC 55	129 (7,9)	10	5	
LS 60	152 (9,3)	11	6	
LC 105	268 (16,4)	20	10	5
LC 155	505 (30,8)			10
LC 250	646 (39,4)			13
LC 330	750 (45,8)			15
TELEFLEX (See SEASTAR)				
TENFJORD (Norwegian)				
JR 1.10	100 (6,1)	8		
JR 1.12	114 (7,0)	9		
JR 1.20	210 (12,8)	16	8	
JR 1.25	230 (14,0)	17	9	
JR 1.30	340 (20,7)		13	7
JR 1.35	375 (22,9)		14	8
JR 1.50	565 (34,5)		21	11
JR 1.60	540 (33,0)		20	11
VETUS (Dutch)				
MT 30	67 (4,1)	5		
MT 52	104 (6,3)	8		
MT 72	146 (8,9)	11	5	
MT 105	261 (15,9)	20	10	5
MT 125	253 (15,4)	19	9	5
MT 175	356 (21,7)		13	7
MT 215	532 (32,5)		20	11

Steering gear	Cylinder volume cm^3 (cu.in.)	Estimated rudder time in seconds hard over to hard over		
		RPU80	RPU160	RPU300
VETUS (continued)				
MT 225	500 (30,5)		19	10
MT 340	750 (45,8)			15
MT 450	1000 (61,0)			20
Outboard engine cylinders:				
OB 35	106 (6,5)	8		
OB 85	170 (10,4)	13	6	
Old models:				
MT 30	81 (4,9)	6		
MT 50	142 (8,7)	11	6	
MT 75	195 (11,9)	15	7	
MT 100	261 (15,9)	20	10	5
MT 150	530 (32,3)		20	11
B 320	918 (56,0)			18
WAGNER (Canadian)				
N40-120	127 (7,8)	10	5	
N40-190	200 (12,2)	15	8	
N50-190	314 (19,2)		12	6
N50-300	495 (30,0)		19	10
N80-190	802 (48,9)			16
Type 700-1¼ x7	105 (6,4)	8		
Type 700-1¼ x9	136 (8,3)	10	5	
Type 700-1½ x7	168 (10,3)	13	6	
Other types:				

2 MEASUREMENTS AND CALCULATIONS FOR APPLYING THE RPU

2.1 Calculation of cylinder volume

The RPU80 is recommended for cylinders between 80-250 cm^3 (4,9-15,2 cu. in.), RPU160 for cylinders between 160-550 cm^3 (9,8-33,5 cu.in.) and RPU300 for cylinders between 290 -960 cm^3 (17,7-58,5 cu.in.). These figures will give for a rudder angle of 70 degrees (35°-0-35°) a hardover to hardover time of 6-20 seconds equivalent to a rudder speed of 11,6-3,5 deg./second. Based on experience 6-8 deg./second seems to be the optimum speed for autopilots with proportional rudder control. However, a rudder speed between 11,6 deg./second and 3,5 deg./second should normally cause no problem, particularly not the high speed which will be reduced by the autopilot electronics.

Depending on type of autopilot the rudder speed is automatically or manually adjusted during installation and commissioning. Refer to page 1-1 and the autopilot manual for detailed information.

The cylinder volume is calculated from the formula:

$$\text{Volume} = \frac{L(D^2 - d^2)\pi}{4}$$

Where

L = stroke length
D = internal cylinder diameter (= outside diameter – 0,6)
d = push rod diameter
$\pi = 3,14$

(All dimensions in centimeters)

2.2 Minimum rudder time adjustment

(Applies only for Junction units J1000B, J101A and J45A)

The minimum rudder time can be found as follows (see figure 2-1):

Draw a horizontal line from the applicable value on the cylinder volume axis. Rudder time may now be read on the horizontal axis.

By means of potentiometer RV1 in the Junction unit the rudder time can be increased.

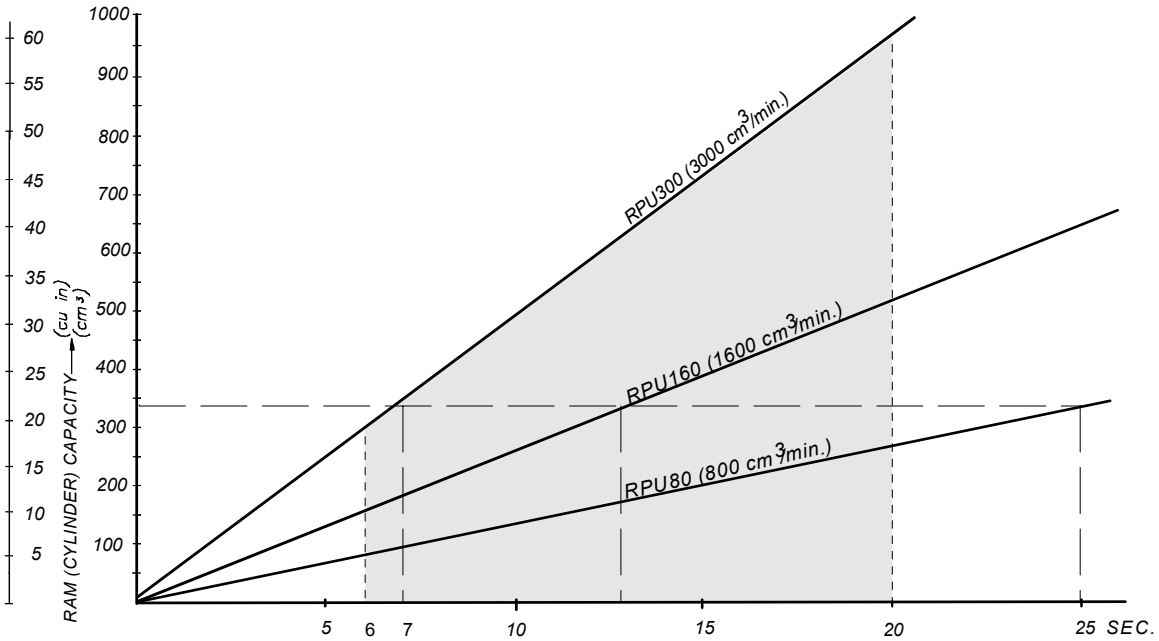
Recommended rudder time: 10-15 seconds is normal for a 70° (35°-0-35°) rudder angle. (The time will be shorter for smaller angles and longer for larger angles.) A longer rudder time (20 sec.) should be chosen if the boat has a quick response.

Example:

The stroke length is measured to be 20 cm, D = 5.0 cm and d = 1.8 cm

The cylinder volume is: $\frac{20(5^2 - 1{,}8^2)\pi}{4} = 340 \text{ cm}^3$

From the nomogram we find that the estimated rudder time in seconds, hard over to hard over, will be 7 seconds for RPU300, 13 seconds for RPU160 and 25 seconds for RPU80.



REVERSIBLE PUMP UNITS RPU80/RPU160/RPU300, CAPACITY NOMOGRAM AT 10 BAR PRESSURE.
RUDDER TIME (SEC.) H.O. TO H.O. FOR A GIVEN CYLINDER VOLUME.

Figure 2-1
Capacity nomogram for Reversible Pump
RPU80/RPU160/RPU300

Based on the above calculation and the nomogram, the recommended pump type should be RPU160.

3 DESCRIPTION OF RPU80/RPU160/RPU300

3.1 Construction

The pump comprises an electric permanent magnet motor, valve block with reversible gear pump, non-return (check) valves on outlet A and B and suction valves from both sides of the gear pump to outlet C. Outlet C is connected to either the expansion tank in the steering wheel pump or a separate expansion tank.

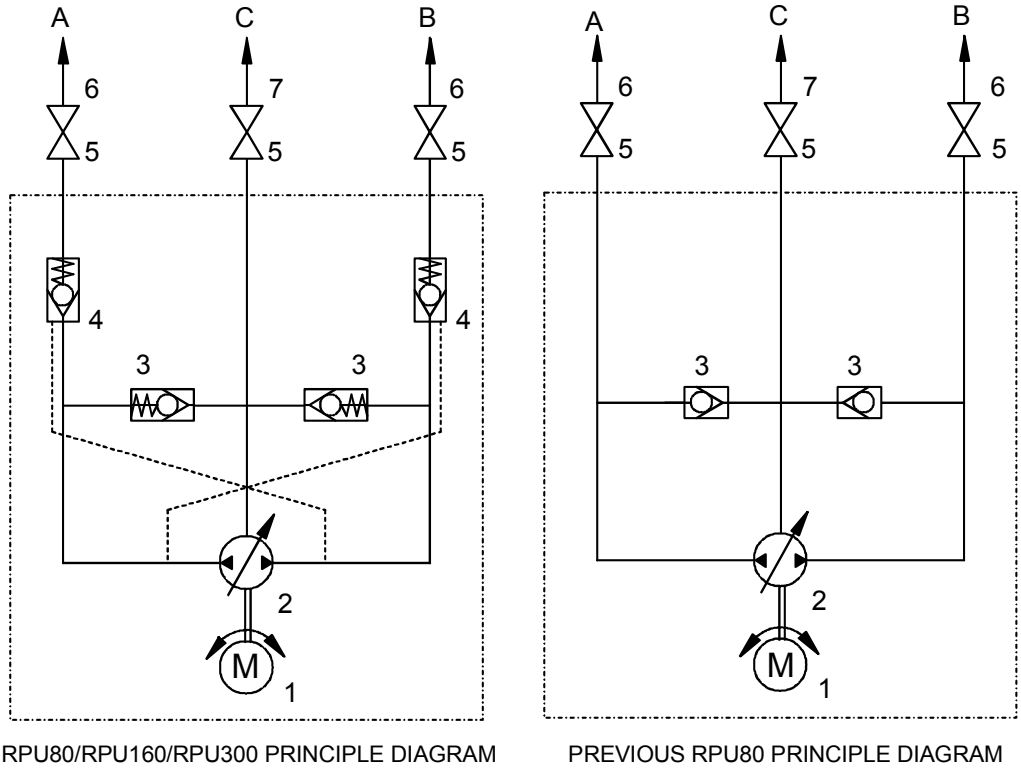


Figure 3-1
Principle diagram RPU80/RPU160/RPU300

1. Electric permanent magnet motor
2. Reversible gear pump
3. Suction valves
4. Pressure operated non-return valves
5. Stop cocks (Not supplied with pump)
6. A+B to main pipes
7. C to expansion tank

The previous model of the RPU80 Reversible Pump was simplified according to the principle diagram above. It had no check valves and there was no spring in the suction valves.

The simplified units have ser. no. below 1317 H02 (P/N 21116165) and 1805 H03 (P/N 21116181-US version).

3.2 Principle of operation (ref. figure 3-1 and figure 9-1)

RPU80/160/300 is reversible: that is the motor changes direction of rotation and the gear pump delivers oil to that side of the rudder cylinder dictated by the signal from the autopilot. The pump runs until the signal from the autopilot ceases. The pump unit has non-return valves on the outlets A and B. When running, the pressurized (or delivery) side will hold both non-return valves open, using direct oil pressure upon the valve on the delivery side. This oil pressure is also used to push a slide to open the valve on the suction side.

When the motor stops, the spring (8) in the non-return valve on the suction side returns the slide to the neutral position. Both non-return valves are now closed and the rudder cylinder locked. Both sides of the gear pump have suction valves to outlet C.

If the rudder cylinder is loaded in the same direction as the rudder command, the slide (10) precisely positions the non-return valve (suction side) such that the creation of a vacuum in the rudder cylinder is prevented. (A vacuum in the rudder cylinder would result in air being drawn past the seals round the cylinder piston rod, since these stops the oil pressure only). At that side of the valve block where the motor is connected, there is mounted sealing ring (15) and support ring (16) in the valve block. The support ring causes that the tank connection C can hold a maximum pressure of 7 bar (Ref. Hynautic steering systems).

Note !

1. *A previous model of RPU80 Reversible Pump was simplified according to the principle diagram. (Ref. figure 3-1 and figure 9-2). The principle of operation was similar to that of RPU160. The (suction) valves, however, operated as combined suction and non-return (check) valves controlled by internal pressure and direction of oil flow. The resulting effect was a smoother non-return (check valve) function as compared to the one with separate non-return valves.*
2. *It should be observed however, that the previous model of RPU80 does not have the extra protection against internal leakage (bypass) as the other models with separate check valves.*

3.3 Valve block

This is an aluminum block with borings for non-return valves, suction valves, slide, gear pump, motor coupling and all necessary oil ways. The three outlets A, B and C are positioned on top of the valve block.

3.4 Gear pump

This comprises of the driving gear wheel, which is coupled to the motor shaft via a flexible shaft coupling, and meshed with the driven gear wheel supported by the valve block (1) at one end and by the pump cover (5) at the other.

The gear wheels run in the pump housing. The gear wheels are 1/100-2/100 mm smaller than the pump housing.

O-rings are fitted to both the valve block and the pump cover to provide oil tight seals on both sides of the pump housing.

The pump cover is held by 4 screws (25).

When the gear wheels rotate, oil is carried in the inter-tooth spaces around the periphery of the pump housing from the suction side to the pressure side.

3.5 Pressure operated non-return (check) valves on outlet A and B

These are screwed into the valve block from both sides. The valve comprise of valve housing (6), plug (7), ball (12), spring (8), copper washer (17), O-ring (13) and copper washer (14). The housing and plug are made of stainless steel.

3.6 Suction valves on outlet C

These are connected to both sides of the gear pump via oil ways in the valve block. The valve comprises of a grub screw (21), spring (9) and ball (20).

If the grub screw (21) is removed, it should be refitted with Loctite 542 after degreasing the threads.

3.7 Slide (10)

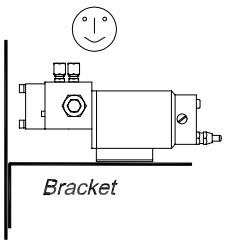
This is located within the valve block in a cylindrical run between the non-return valves for outlets A and B. The slide is grooved to allow location of an O-ring (13).

3.8 Pipe connections

The 3 outlets have fittings for 3/8" (US model) or 10 mm (EU model) outer diameter pipe. The two outer outlets A and B connect to the main pipes. The middle outlet C connects to the bottom of the expansion tank in the steering wheel pump or a separate expansion tank.

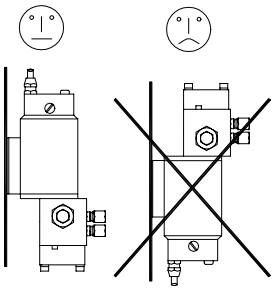
4 INSTALLATION

4.1 Mechanical Installation



Siting

The pump unit should be sited where it is most practical between rudder cylinder and helm pump, however, it should not be mounted in a wet area. If the pump unit is sited higher than the rudder cylinder, air bubbles in the oil coming from the rudder cylinder could pass through the pump unit on the way to the expansion tank in the steering wheel pump. This will disturb the oil flow as the air bubbles pass through.



The pump unit should be mounted horizontally, with the pipe connections/fittings pointing upwards. Use a 90° bracket if mounted on a bulkhead. It could however be mounted directly on a bulkhead, but never with the motor pointing downwards, as oil leak/sweating from a poor shaft seal can easily penetrate the motor and destroy it.

Fittings

For pump units manufactured before January 1999, the fittings are factory mounted on the pump housing.

From January 1999 a different type of fitting is used. The new fitting has an O-ring seal between the fitting and the pump housing.

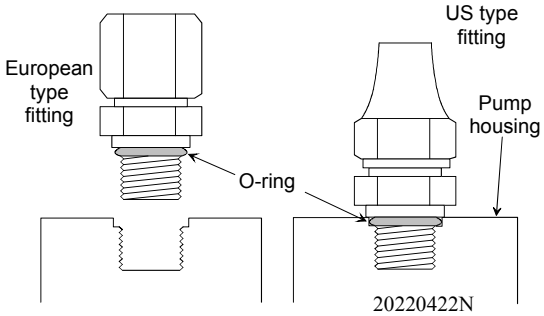
The threads are changed from ¼" NPT to 7/16"-20 UNF both on the European and the U.S. version. The pipe connection remains the same as before.

Note ! *Because the threads are different the new fittings cannot be used with an old pump and vice versa.*

The fittings are easily inserted and less critical with regard to tightening torque. Consequently the fittings need not be mounted at the factory. They are now supplied with the pumps in a plastic bag for mounting during pump installation. Protection caps cover the threads in the pump housing during transportation.

Note ! *As these fittings have o-ring sealing there is no need for additional sealing compound.*

Use following procedure when mounting the fittings on the pump;



- Use the fingers and turn clockwise until a noticeable increase in torque is required.
- Tighten further by 30 degrees (= 1/12 of a turn) using necessary force (25-30 Nm/230-260 In.Ibs).

Pumps with new fittings have got new serial no. code and is valid from the following s.no's; RPU80: s.n. 2460 H06, RPU160: s.n. 1560 H14, RPU300: s.n. 380 H28, RPU300, 24V: s.n. 180 H29

Installation of pipes

Drain the oil from the steering gear by loosening the rudder cylinder couplings. At a convenient point cut the pipes and mount a T-coupling to each pipe. Cutting ring couplings of an appropriate diameter should be used. Ensure that the pipe is cut at a right angle as otherwise the ultimate tightness of the coupling may be adversely affected. It is preferable to use pipe cutting tool for this operation.

Note ! *It is very important to remove ALL traces of metal filings and other impurities from the pipes after cutting.*

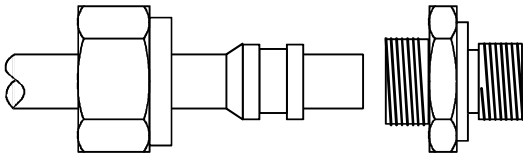


Figure 4-1

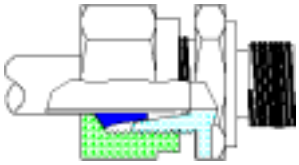


Figure 4-2

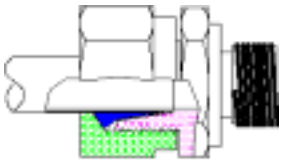


Figure 4-3

Figure 4-1, 4-2 and 4-3 show the parts that form a cutting ring coupling. It is important to note which way the cutting ring is fitted, the following procedure should be followed:

a) Nut and cutting ring are slid over the pipe, figure 4-1.

b) A few drops of oil are first applied to the threads of the coupling. The pipe is then inserted fully into the coupling and held whilst the nut is tightened by hand until the cutting ring rests against the cone (figure 4-2).

c) The nut is now tightened 1½ - 2 turns until the cutting ring cuts into the pipe surface (figure 4-3). Ensure that the pipe is held firmly in place whilst the nut is tightened. Release the coupling and check that the cutting ring has successfully cut into the pipe.

A clearly formed lip should be visible on the pipe in front of the cutting ring. If this is not present, the nut should be tightened by an additional ½ - 1 turn. Check once again as above. From the T-couplings run a pipe 10x1 mm (US model: 3/8"), to the pump unit. Avoid high points in the run that could allow air pockets to form.

Sharp bends in the pipes (i.e. elbow bends) should be avoided as these restrict the oil flow. For the same reason couplings should not be fitted on bends, see Figure 4-4.

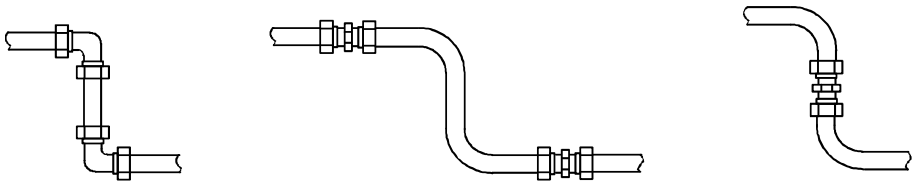


Figure 4-4

Pipes should be bent cold. Attempts to use blowtorch and sand will lead to impurities entering the system, and should therefore be avoided.

Stop cocks should be fitted to all pipes near the pump unit. Sluice cocks or similar should be used, and not cocks of the water supply type. Pipes should be fitted from the stopcocks to the outlet A and B of the pump unit.

Connection to expansion tank

Most hydraulic steering gears have an expansion tank incorporated in the steering wheel pump. At the bottom of this tank is a drain plug, which should be removed and replaced by a coupling which fits the expansion pipe (10x1 mm, US model: 3/8").Fit a 10x1 mm (US model: 3/8") pipe from the wheel pump at a uniform, gradual, downward slope to the pump unit. A stop cock should also be inserted in this pipe near the pump unit.

Connection to separate expansion tank

If the steering wheel pump does not incorporate expansion tank, a separate expansion tank must be installed. This tank should have a volume of 1/4 liter (0.25 qt), and be placed at approximately the same level as the steering wheel pump.

Lock valve for steering wheel pump

If the steering wheel pump is not provided with a lock valve (they most often are), an adequate lock valve should be fitted.

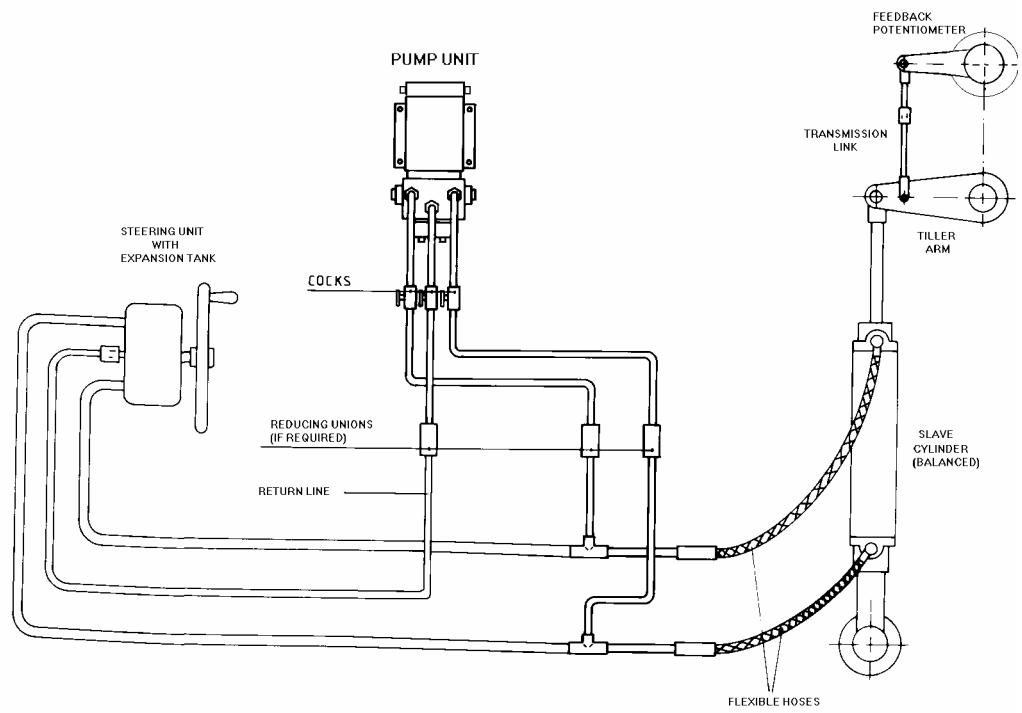


Figure 4-5
Connection to hand hydraulic steering gear
Drw.no. 3-110101

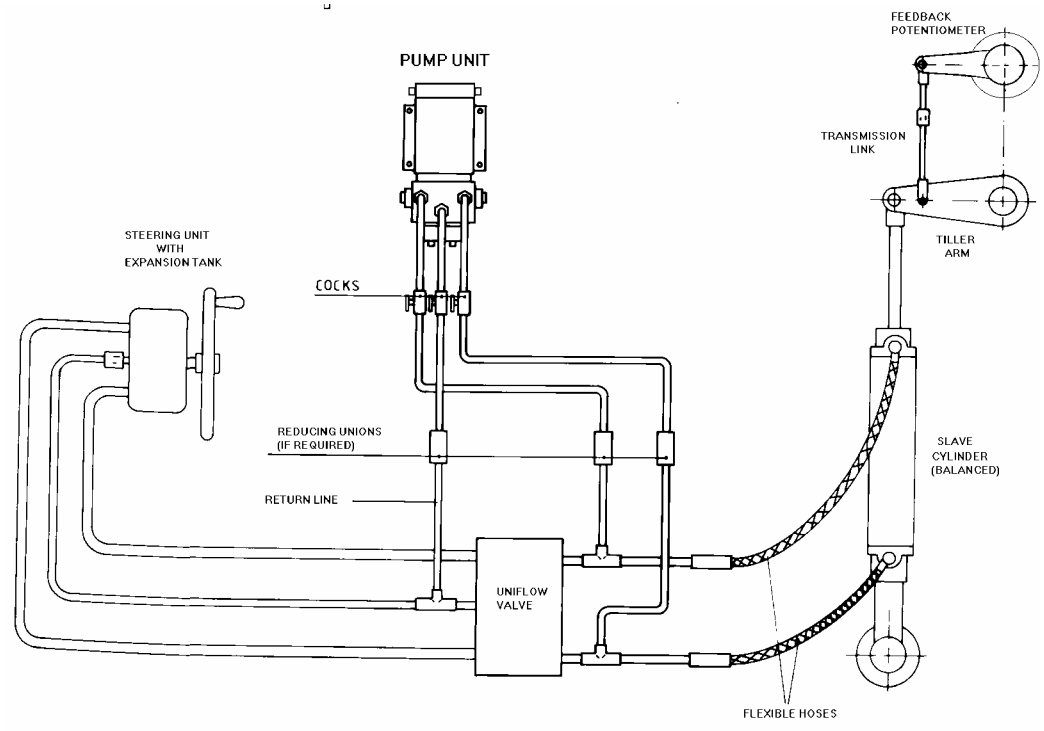


Figure 4-6
Connection to Capilano steering gear
Drw.no. 3-110115

4.2 Electrical installation

J3000X, J300X, J300X-40, J50, J50-40, AC10, AC20, AC40

The two leads from the motor are connected to the terminal block marked "MOTOR" in the Junction unit/Autopilot computer. There is no dedicated Port and Stbd output. The autopilot will automatically set the correct direction during "Rudder Test".

Refer to Autopilot manual for further details.

J1000B, J101A and J45A

The two leads from the motor are connected to the terminal block in the Junction unit marked Motor A and B. Interchanging of the two leads will change the rotary direction of the motor (see paragraph 5.2).

The Reversible Pump units are operated from 12V DC via the Junction unit. This 12V output can be reduced by internal trim potentiometer (RV1) to reduce rudder speed (see paragraph 2.2).

5 PREPARATION AND TESTING

5.1 Oil filling and bleeding

When installing a pump unit, it is recommended that the whole system be emptied and refilled. Use a well known oil of a viscosity meeting the specification of the steering gear manufacturer.

Start by opening all stop cocks in the pipes leading to the pump unit. Simultaneously fill the steering wheel pump with oil whilst turning the wheel itself, back and forth. Proceed by opening the couplings at the rudder cylinder whilst still turning the wheel, this will assist in creating pressure within the system, continue until clean oil is seen at the couplings. Now tighten the couplings. Then open the 3 couplings on outlet A, B and C on top of the pump unit, and repeat the same procedure.

5.2 Testing

Set the autopilot to manual mode and use a remote control or the Port/Stbd buttons on the control unit to run the rudder hard over to hard over to check the operation of the system. Check that the rudder goes to the same side as the signal you are giving by the remote control. If not, interchange motor cable connections A and B in the junction unit (J1000B, J101A, J45A). If necessary top-up the expansion tank. Repeat the bleeding procedure (paragraph 5.1) after the equipment has been used for about 5-10 hours.

In the X-series Autopilots (AP300X, AP35, AP20, AP21, AP22) and the AP16, AP25, AP26, AP27 and AP50 autopilots, checking motor rotation or interchange of cables in the junction unit/autopilot computer is not necessary, because the autopilot will determine the correct rotation automatically during the "rudder test".

6 MAINTENANCE

6.1 Dismantling

After approximately 1000 operating hours, the pump unit should be removed for examination.

Close the stop cocks to the pump unit, remove the nuts on the 3 couplings and all retaining nuts.

Screw out the 2 fixing screws (24) located on each side of the pump cover which hold the valve block and motor together. (See figure 9-1).

6.2 Electric motor

Examine the brushes for wear and replace if required.

6.3 Valve block

Examine the oil seal (15) for wear and replace if required.

7 FAULT TRACING

If fault develops, the source and location must be traced. Close all stop cocks to the pump unit and check whether the steering gear functions normally using only the steering wheel pump. If so, then the fault is most probably in the pump unit or junction unit/autopilot computer.

The following faults may be tested for:

7.1 Pump (motor) is not running/not responding to rudder command

Probable reason:

Brushes sticking or worn out. Remove the brushes and check. Sticking brushes should be wiped clean and any carbon dust should be removed from the brush holders. Check that the brushes move without restraint before they are secured.

7.2 The piston rod does not move with rudder commands

Probable reason:

1. Check that the stop cocks are open.
2. The pump is sucking air. Check outlets A, B and C for leakage. If the fault is not found here, check the non-return valves for leakage, especially the copper gaskets between the end plug and the valve housing.
   Leakage may also occur in the threads of the suction valves grub screws (21). Check both. If leakage is present, the pump unit has to be dismantled. See paragraph 7.10 for dismantle and cleaning of the suction valves.
3. See also paragraph 7.10.

7.3 Excessive noise from the pump unit

Probable reason:

1. Air in outlet C to expansion tank. Ensure that the stop cocks are open, if so, loosen the nut on the coupling and check that the oil is flowing normally.

7.4 The rudder does not stay in off-midship position, but drifts towards midship due to water pressure on the rudder

Probable reason (Does not apply for the previous model of RPU80):

1. The non-return valves are leaking. Shut the stop cocks to the pump unit, and operate the steering gear by means of the steering wheel pump. If the steering is normal by hand operation, the fault must be in the non-return valves or the slide.
   If the slide is locked because of oil contamination, the non-return valve may be held open.
   If the fault is not found on the slide, both of the non-return valves have to be disassembled. Check the ball seat in the valve housing for wear etc. Replace the O-ring and copper gaskets. After having assembled the ball, spring, gasket and plug, check that the spring pressure on the ball is sufficient to keep the ball seated. The spring needs a certain pre-loading to bring the slide back to neutral position.
2. If the problem appears on an RPU80 installation, the reason may be oil contamination or worn ball seals in the suction valves. Remove the steel balls for inspection and check the seals for possible wear. Refer to paragraph 7.10.
3. If the steering gear does not function normally by hand with the pump unit isolated from the system, there must be a fault in the steering gear. In order to trace a fault of this nature, use the instructions given by the manufacturer of the steering gear.

7.5 Steering wheel is turning while pump unit is operated

Probable reason:

1. Leaking lock valve in the wheel pump. Check as described under paragraph 7.4.2.
2. Lock valves are not fitted. Attach lock valve.

7.6 The piston rod of the rudder cylinder does not move smoothly.

Probable reason:

1. Air in the steering system. Repeat bleeding procedure described under paragraph 5.1. Look for leakage.

7.7 Rudder movement stops as water pressure on the rudder increases.

(J1000B, J101A, J45A only)

Probable reasons:

1. Overload. Check whether the r.p.m. of the motor is too low. Eventually turn potentiometer RV1 in junction unit clockwise (CW) until rudder movement is recovered.

7.8 When on automatic steering, the boat swings from side to side without stabilizing after course changes

(J1000B, J101A, J45A only)

Probable reasons:

1. The rudder movement is too slow. Correct as in paragraph 7.7
2. Wrong setting of the autopilot. Refer to the set-up procedure for the autopilot.

7.9 Small and sudden heading changes while on automatic steering

(J1000B, J101A, J45A only)

Probable reasons:

1. The rudder movement is too fast. Turn potentiometer RV1 in junction unit counter-clockwise (CCW) until optimum rudder speed is achieved.
2. Refer to paragraph 7.8.2.

7.10 Rudder moves only in one direction (with pump running)

Probable reason:

Suction valve not working (pos. 20, 9, 21) on one side. This is most probably caused by metal fragments that have entered into the suction valve(s) through the tube fitting for the return line (C) during installation. Ref. figure 3-1.

The suction valve (3) on the side that is not giving pressure must be opened and thoroughly cleaned, and for safety reasons the other valve should also be inspected and cleaned before reinstalling the pump unit.

For disassembling and cleaning of the suction valves please use following procedure (Ref. figure 9-1):

1. Unscrew the grub screw - pos. 21.
2. Remove the spring - pos. 9, and the steel ball - pos. 20.
3. Thoroughly clean the valve seat and the threads in the valve block (1). Also clean the removed steel ball (20), spring (9) and grub screw (21). Use Loctite "Super Clean" or similar.

Reassemble as follows:

1. Put the steel ball (20) into the valve block.
2. Put the spring (9) onto the grub screw (21) before it is screwed into the valve block.

Note !

Use Loctite 542 or similar on the threads to prevent oil leakage. If Loctite 747 "Activator" is sprayed on the threads before applying Loctite 542, this will speed up the hardening process.(With Loctite 542 only, you have to wait 4 hours before the pump unit can be put in operation again. Using Loctite "Activator" reduces the hardening time to 1 hour).

3. Make sure the grub screw (21) is screwed in until it is flush with the valve block (1). This will ensure correct spring tension in the suction valve.

8 TECHNICAL SPECIFICATIONS

8.1 Specifications

Note ! *RPU300 measurements at charging voltage*

MODEL	MOTOR VOLTS *	JUNCTION UNIT/ AUTOPILOT COMPUTER **	RAM CAPACITY		FLOW RATE AT 10 bar cm^3/min (cu.in/min)	MAX PRES-SURE bar	PWR. CONSUM-PTION ***	BOAT LENGTH
			MIN cm^3 (cu. in.)	MAX cm^3 (cu. in.)				
RPU80	12 V	J3000X/AC10	80 (4,9)	250 (15,2)	800 (49)	60	2,4-6 A	<35 ft
RPU160	12 V	J300X/AC20	160 (9,8)	550 (33,5)	1600 (98)	60	3-10 A	35-50 ft.
RPU300	12 V	J300X-40/ AC40	290 (17,7)	960 (58,5)	3000 (183)	60	5-18 A	50-70 ft
RPU300	24 V	J300X/AC20	290 (17,7)	960 (58,5)	3000 (183)	60	3,5-10A	50-70 ft

* The motor voltage is transformed by the junction unit/autopilot computer when operating from 24V or 32V mains.

** The specified junction unit/autopilot computer is necessary to achieve max. drive unit capacity.

*** Typical average 40% of max. value.

8.2 Dimensions

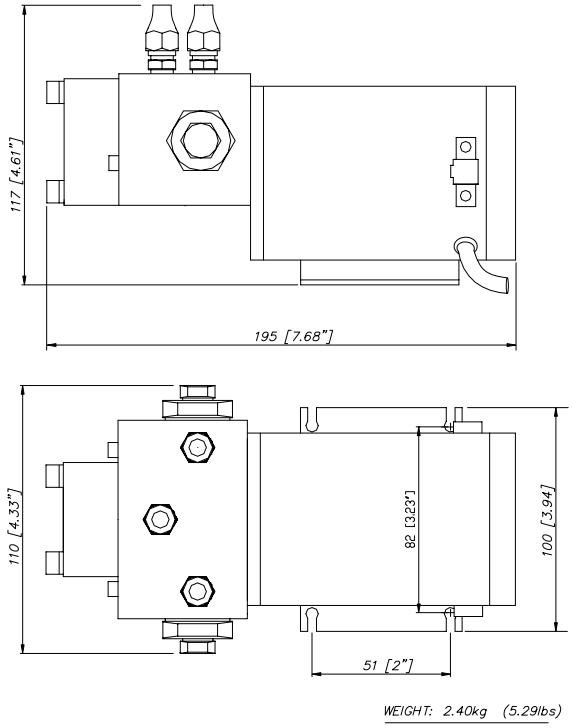


Figure 8-1
RPU80 Dimensions
Drw.no. N3-111836

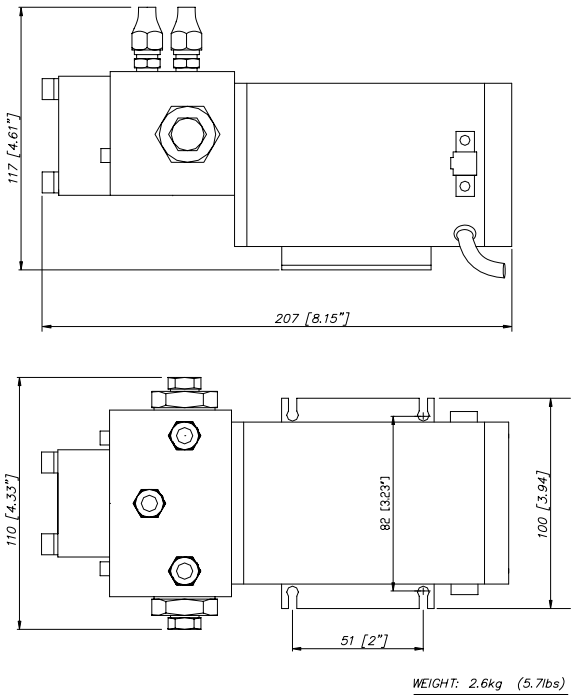


Figure 8-2
RPU160 Dimensions
Drw.no. N3-111835

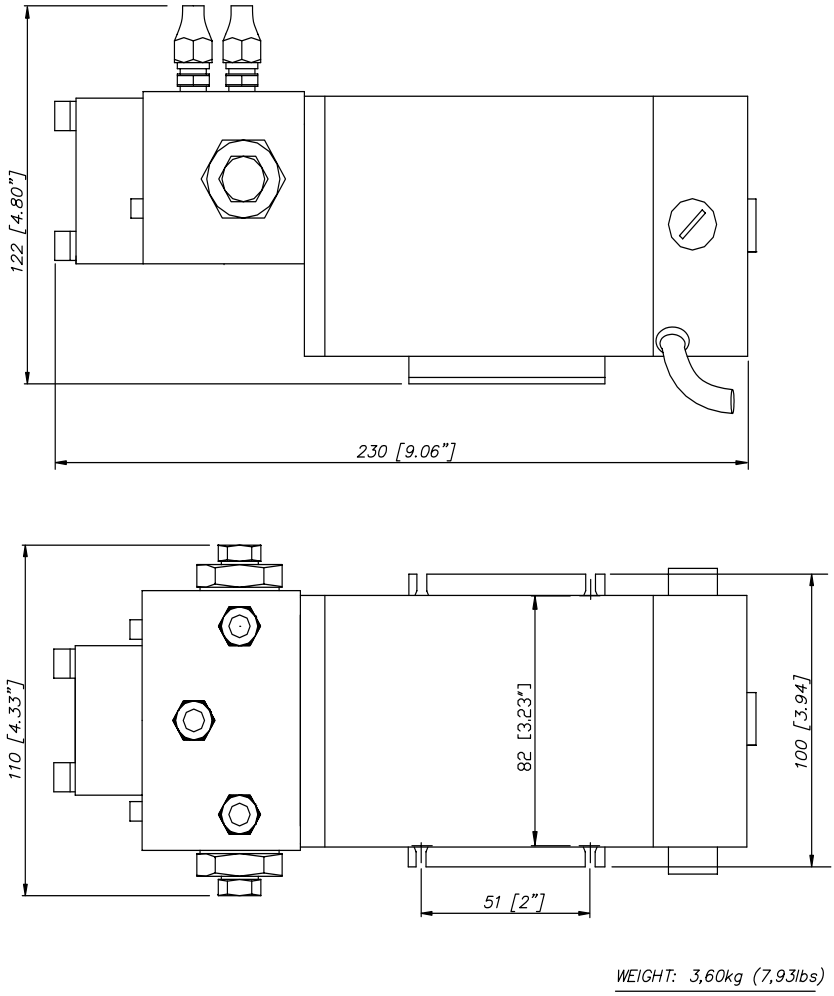
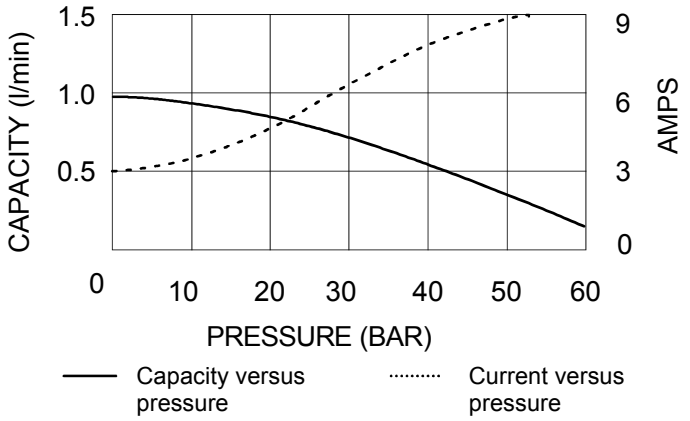
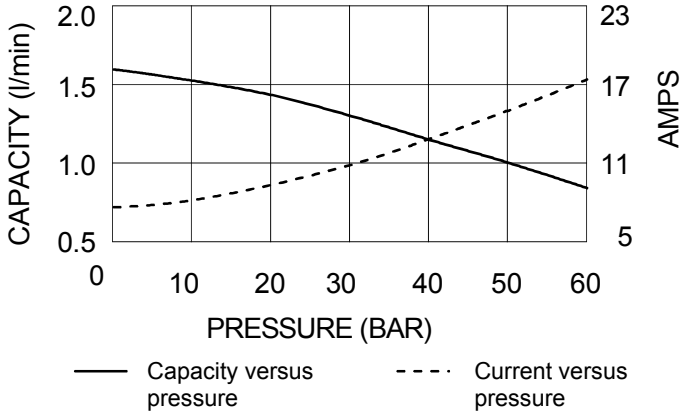


Figure 8-3
RPU300 Dimensions
Drw.no. N3-111834

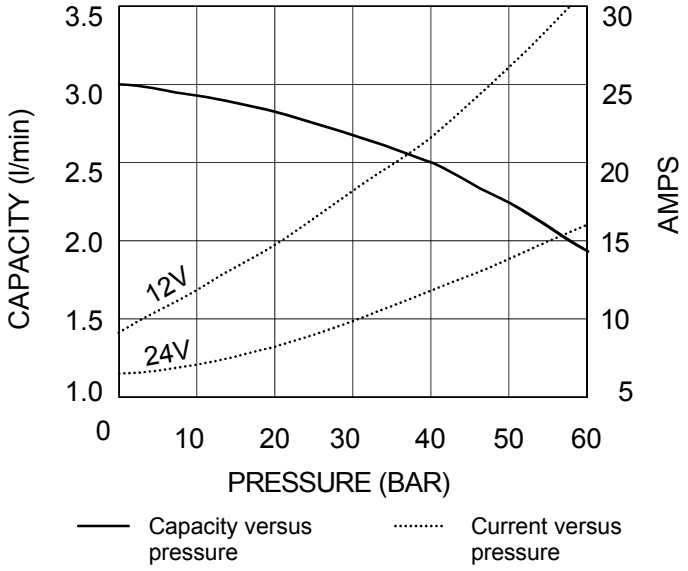
8.3 RPU80 performance



8.4 RPU160 performance



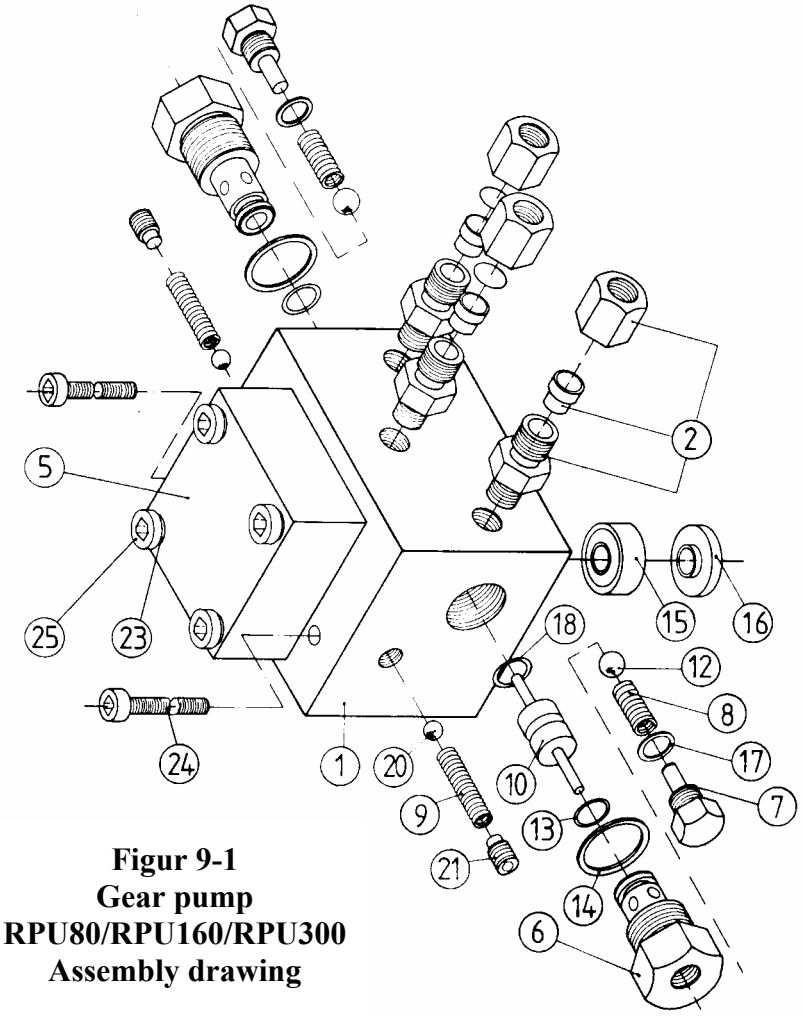
8.5 RPU300 performance*



* Measured at charging voltage.

9 SPARE PARTS

9.1 RPU80/RPU160/RPU300



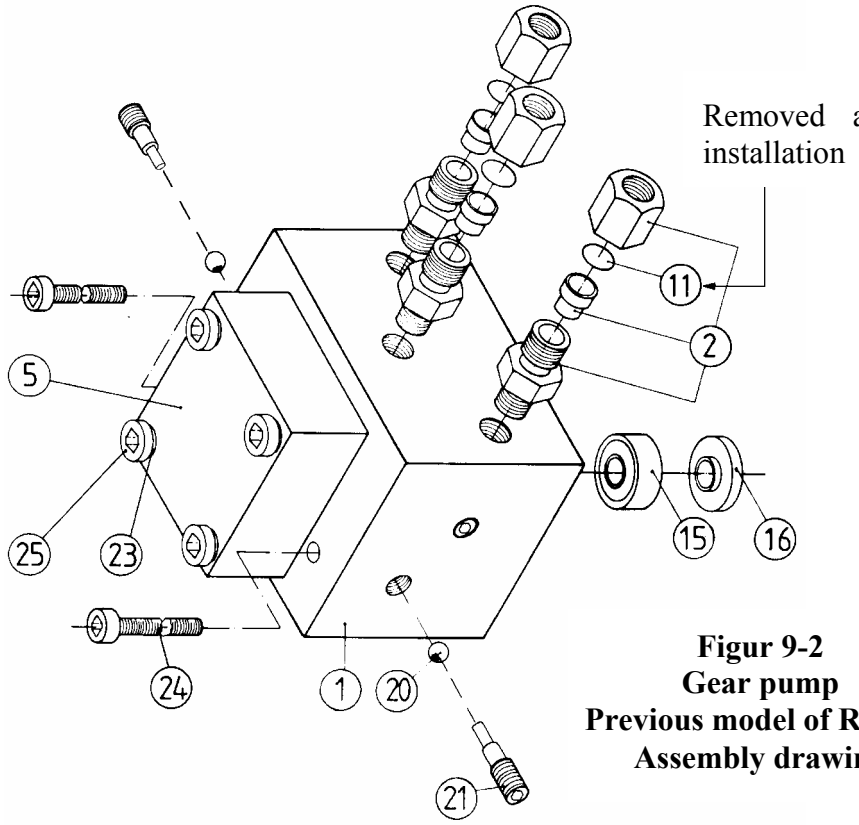
Figur 9-1
Gear pump
RPU80/RPU160/RPU300
Assembly drawing

Pos.	Qty.	Gear pump parts	Part no.
1	1	Valve block	21100250
2	3	Fitting complete 7/16-20UNF	44166767
2	3	Fitting US model complete: Nut 3/8” with 5/8”x18 SAE Fitting SAE 5/8”-18-7/16-20UNF	21101399 44155927 44166775
5	1	Pump cover RPU80/160 Pump cover RPU300	21101191 21111018
6	2	Valve housing	21100276
7	2	Plug	21100292
8	2	Spring	21100193
9	2	Spring	21100391
10	1	Slide	21100268
12	2	Steel ball Ø8	44149656

13	2	O-ring 9,25x1,78 Nitrile	44149649
14	2	Copper washer Ø10,2x14x1,5	44149706
15	1	Oil seal 8x22x7	44149722
16	1	Support ring	21100185
17	2	Copper washer Ø10,2x14x1	44148146
18	1	O-ring 9,25x1,78 Silicon, red	44154656
20	2	Steel ball Ø6,35	44118552
21	2	Grub. Screw sock. head M8x10	44149904
23	4	Split washer M6 A2	44150050
24	2	Screw sock. head M5x60 A2	44149912
25	4	Screw sock. head M6x35 A2	44152775
	1	Gear wheel (1) RPU80/160	21100169
	1	Gear wheel (2) RPU80/160	21100227
	1	Gear wheel (1) RPU300	21111926
	1	Gear wheel (2) RPU300	21111034
		Motor parts (LEMAC)	
	1	RPU80 Lemac motor (Substitutes RPU80 Fracmo motor)	44170199
	1	RPU160 Lemac motor (Substitutes RPU160 Fracmo motor)	44177525
	2	Brush for RPU80/160 Lemac motor, C8386 9x6x18,2mm	44169845
	2	Brush cap for RPU80/160 Lemac motor	44170132
	1	RPU300 Lemac motor, 12V (Substitutes RPU300 Fracmo motor, 12V)	44170009
	1	RPU300 Lemac motor, 24V (Substitutes RPU300 Fracmo motor, 24V)	44169993
	2	Brush for RPU300 Lemac motor, short type, 12,7x7,94x12mm	44170116
		Brush for RPU300 Lemac motor, long type, 12,7x7,94x19mm	44170108
	2	Brush cap for RPU300 Lemac motor	44170124
		Parts for Fracmo motors:	
	2	Brush for RPU160 Fracmo motor	44161941
	2	Brush cap RPU80/160 Fracmo – Type I	44163228
	2	Brush cap RPU80/160 Fracmo – Type II	44163236
	2	Brush for RPU300 Fracmo motor	44161925
	2	Brush cap RPU300 Fracmo – Type I	44163244
	2	Brush cap RPU300 Fracmo – Type II	44163251

9.2 RPU80 – Previous model gear pump

RPU80 Reversible Pump with ser. no. 1317 H02 onwards (P/N 21116165) and 1805 H03 onwards (P/N 21116181 – US version) have identical gear pump with the RPU160 (see figure 9-1).



Figur 9-2
Gear pump
Previous model of RPU80
Assembly drawing

Pos.	Qty.	Gear pump parts (Previous RPU80 model)	Part no.
1	1	Valve block, Previous model	21116256
2	3	Fitting complete	44158483
2		US model:	
	3	Nut 3/8” with 5/8”x18 SAE	44155927
	3	Fitting SAE 5/8”-18-45	44158491
5	1	Pump cover RPU80/160	21101191
11	3	Cover (Removed at installation)	21217047
15	1	Oil seal 8x22x7	44149722
16	1	Support ring	21100185
20	2	Steel ball Ø6,35	44118552
21	2	Grub. Screw sock. head M8x10	21112933
23	4	Split washer M6 A2	44150050
24	2	Screw sock. head M5x60 A2	44149912
25	4	Screw sock. head M6x35 A2	44152775
	1	Gear wheel (1) RPU80/160	21100169
	1	Gear wheel (2) RPU80/160	21100227

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Fax: +27 21 559 2752

MIDDLE EAST

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Fax: +972 3 5271 772

UNITED ARAB EMIRATES
Emphor FXCO
P. O. Box 6488
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Tel.: +971 4 324 7500
Fax: +971 4 324 7503

LEBANON
Selcom Marine Sarl
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Beirut
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Fax: +961 149 5325

IRAN
Darya Negar Co.
Office 2, 1st Floor,
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Teheran
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Fax: +98 21 896 6658

PACIFIC

AUSTRALIA
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89 St Vincent Street
Port Adelaide, SA 5015
Tel.: +61 88 447 1277
Fax: +61 88 341 0567

NEW ZEALAND
Advance Trident Ltd.
P.O. Box 4174
Kingsland
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Tel.: +64 9 845 5347
Fax: +64 9 845 5348
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ASIA

SINGAPORE
Jason Electronics Pte Ltd.
Blk 194 Pandan Loop #06-05
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CHINA & HONG KONG
CITE Limited
Rm C-E, 16/F, Yan's Tower,
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Norinco Pvt Ltd.
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Fax: +91 484 2323 694

INDONESIA
PT Sarana Teknologi Samudera
Wisma Dharmala Sakti
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Fax: +62 21 570 72 21

SOUTH KOREA
Lucky Susan Co. Ltd.
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Taesung B/D. #508
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Tel.: +82 2 736 4328
Fax: +82 2 739 5689

Turn-On Electronics Co.
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Fax: +81 3 3913 3479

Shipmate Japan Co. Ltd. 2-5-4
Fukuura
Kanazawa-ku
Yokohama 236-0004
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TAIWAN
Dragon & Elephant Enterprise Co. Ltd.
12F-4, No. 251
Min Chuan 1st Road
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AMERICAS

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Fax: +1 425 771 7211
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Calle Los Topacios 266-268
Urb. San Antonio
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Fax: +51 1 453 7325

URUGUAY
Electromaritima Uruguaya Ltda.
Guatemala 1260
11800 Montevideo
Tel.: +59 8 2 924 7139
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The above companies represent only main importers. Each country is in addition served by a network of local service outlets.

Some importers represent only specific market segments according to the following codes:

Professional:
Coastal and Fishery market
Recreational:
Leisure market

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